AVIATION WEEK

A McGRAW-HILL PUBLICATION

AUGUST 17, 1953

THIS ISSUE $2.00

AIR RESEARCH AND DEVELOPMENT COMMAND EDITION

Including a Special Report ... **AVIONICS IN THE AIR FORCE**

LOCKHEED WV-2

ZENITH plastic parts

in planes that

make history

CONVAIR B36

In planes that are today marking historic milestones in aviation history, Zenith reinforced plastic parts are keeping pace with the giant strides in the progress of the aircraft industry. Vastly enlarged facilities and outstanding experience in reinforced plastic fabrication keep Zenith Plastics always abreast of the onward sweep of aviation development.

LOCKHEED F80

ZENITH PLASTICS CO. Z **gardena, calif.**

50TH ANNIVERSARY OF POWERED FLIGHT

A Salute

TO THE LOW-FLYING MEN !

All hail to the ace in the "wild blue yonder" . . . but let's give with some man-sized cheers for the lads who slug it out at hill-top level. From the time they take off . . . till the mission is completed, these strategic fighter bombers and tactical close support pilots face a brutal blasting all along the way.

➢ ➢ ➢ Sniped at by small arms and machine guns . . . bracketed by flak with the constant hazard of limping home harassed by enemy aircraft . . . these are the stout warriors for whom we've planned Republic's rugged **THUNDER-craft** *. . . to get them there . . . do the job, and bring them back.*

REPUBLIC AVIATION

FARMINGDALE, LONG ISLAND, N. Y.

Makers of the Mighty Thunderbolt · Thunderjet · Thunderstreak · XF-91

TECO ...
the airline seat with
THINK
THINK
THINK

Exploring all lines of thought in every direction has resulted in TECO leadership for the development of improved design, stronger lightweight construction, trouble-free operation plus greater safety and economies in modern airline seats. These are outstanding reasons why leading airlines agree the finest airline seats are TECO-built! Catalog sent on request.

manufactured by
TRANSPORT EQUIPMENT CO.
Burbank • California

REPRESENTED IN CANADA BY:
RAILWAY & POWER ENGINEERING CORPORATION
LIMITED • 3745 St. James Street • Montreal 30, P. Q.

AVIATION WEEK

August 17, 1953
Volume 59 Number 7

CONTENTS FOR THIS EDITION ON PAGE 71

Editorial Offices: 330 W. 42nd St., New York 36.
Tel. Longacre 4-3000
National Press Bldg., Washington 4, D. C.
Tel. National 8-3414
49,350 copies of this issue printed

Robert W. Martin, Jr. ..... *Publisher*
Robert H. Wood ..... *Editor*

Robert B. Hotz *Executive Editor* — Merlin H. Mickel *Managing Editor*

Albert W. Bentz ..... News Editor
Alexander McSurely ..... Aviation Safety
David A. Anderton ..... Engineering
Irving Stone ..... Technical
G. L. Christian .. Equipment, Maintenance
Katherine Johnsen ..... Congress
Lee Moore ..... Transport
Philip Klass ..... Avionics
Scott Reiniger ..... New Products
Erwin J. Bulban ..... Special Assignments
Richard Balentine ..... Federal Agencies
William J. Coughlin ..... West Coast
Henry Lefer ..... News Desk
Gordon C. Conley ..... News Desk
Victoria Giaculli ..... Editorial Makeup
Leo T. Tarpey ... Printing & Production

DOMESTIC NEWS BUREAUS

Atlanta 3 ..... 1321 Rhodes-Haverty Bldg.
Chicago 11 ..... 520 N. Michigan Ave.
Cleveland 15 ..... 1510 Hanna Bldg.
Detroit 26 ..... 856 Penobscot Bldg.
Houston 25 ..... 1303 Prudential Bldg.
Los Angeles 17 ..... 1111 Wilshire Blvd.
San Francisco 4 ..... 68 Post St.
Washington 4 .. 1189 National Press Bldg.

FOREIGN NEWS SERVICE

Editor ..... Joseph K. Van Denburg, Jr.
London ..... Nathaniel McKitterick
Paris ..... Ross Hazeltine
Frankfurt ..... Gerald W. Schroder
Manila ..... Herbert Leopold
Mexico City ..... John Wilhelm
Sao Paulo ..... Lionel J. Holmes
Tokyo ..... Alpheus W. Jessup

Aviation Week is served by Press Association, Inc., a subsidiary of Associated Press.

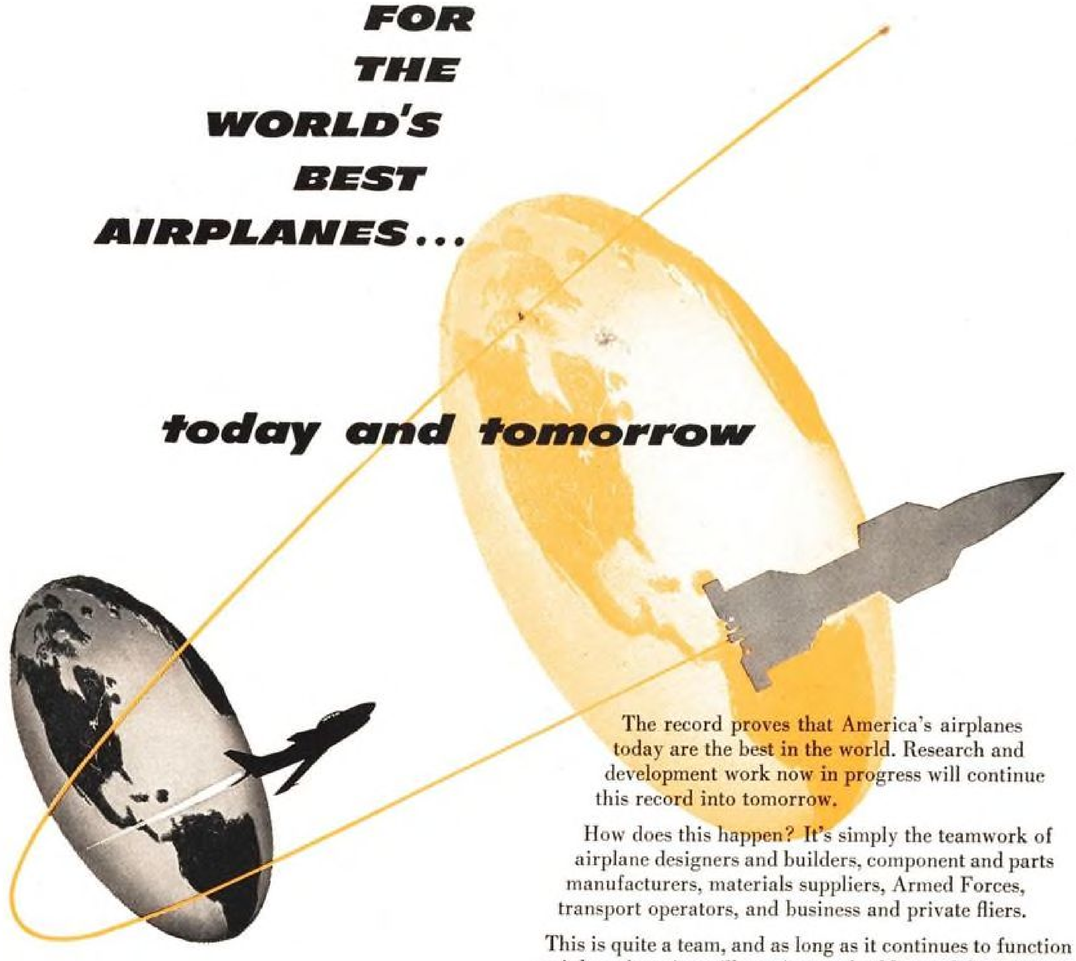
J. G. Johnson ..... *Business Manager*

Sales Representatives: J. C. Anthony, **New York**; H. P. Johnson, **Cleveland**; L. J. Biel and D. T. Brennan, **Chicago**; W. E. Donnell, **St. Louis**; E. P. Blanchard, Jr., **Boston**; James Cash, **Dallas**; Robert H. Sidur, **Atlanta**; R. E. Dorland, **San Francisco**; C. F. McReynolds, **Los Angeles**; W. S. Hessey, **Philadelphia**. Other sales offices in **Pittsburgh, Detroit, London**. *Research and Marketing:* Catherine Miner.

AVIATION WEEK ● August 17, 1953 ● Vol. 59—No. 7
Member ABP and ABC

Published weekly by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. **Publication Office: 99-129 North Broadway, Albany 1, N. Y.**
Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 W. 42nd St., New York 36, N. Y.
Curtis W. McGraw, President; Willard Chevalier, Executive Vice-President; Joseph A. Gerardi, Vice-President and Treasurer; John J. Cooke, Secretary; Paul Montgomery, Senior Vice-President, Publications Division; Ralph B. Smith, Vice-President and Editorial Director; Nelson Bond, Vice-President and Director of Advertising; J. E. Blackburn, Jr., Vice-President and Director of Circulation.
Subscriptions: Address correspondence to AVIATION WEEK—Subscription Service, 99-129 North Broadway, Albany 1, N. Y., or 330 W. 42nd St., New York 36, N. Y. Allow ten days for change of address.
Subscriptions are solicited only from persons having a commercial or professional interest in aviation. Position and company connection must be indicated on subscription orders.
This issue: $2.00. Subscription rates—United States and possessions, $6 a year; $9 for two years; $12 for three years. Canada $8 a year; $12 for two years; $16 for three years, payable in Canadian currency at par; other Western Hemisphere, $10 a year; $16 for two years; $20 for three years. All other countries $20 a year; $30 for two years; $40 for three years. Entered as second-class matter, July 16, 1947, at the Post Office at Albany, N. Y., under Act of Mar. 3, 1879. Printed in U. S. A. Copyright 1953 by McGraw-Hill Publishing Co., Inc.—All Rights Reserved. Cable Address: "McGraw-Hill New York." Publications combined with AVIATION WEEK are AVIATION, AVIATION NEWS, AIR TRANSPORT, AERONAUTICAL ENGINEERING and AIRCRAFT JOUINAL. All rights to these names are reserved by McGraw-Hill Publishing Co.

FOR THE WORLD'S BEST AIRPLANES...
today and tomorrow



The record proves that America's airplanes today are the best in the world. Research and development work now in progress will continue this record into tomorrow.

How does this happen? It's simply the teamwork of airplane designers and builders, component and parts manufacturers, materials suppliers, Armed Forces, transport operators, and business and private fliers.

This is quite a team, and as long as it continues to function as it has, America will continue to build — and fly — the world's best airplanes.

Air Associates is proud to be a member of this team serving aviation in these phases —

AIRCRAFT PRODUCTS — Unusually flexible engineering and manufacturing facilities for producing a wide variety of electrical, mechanical, hydraulic, and pneumatic aircraft equipment.

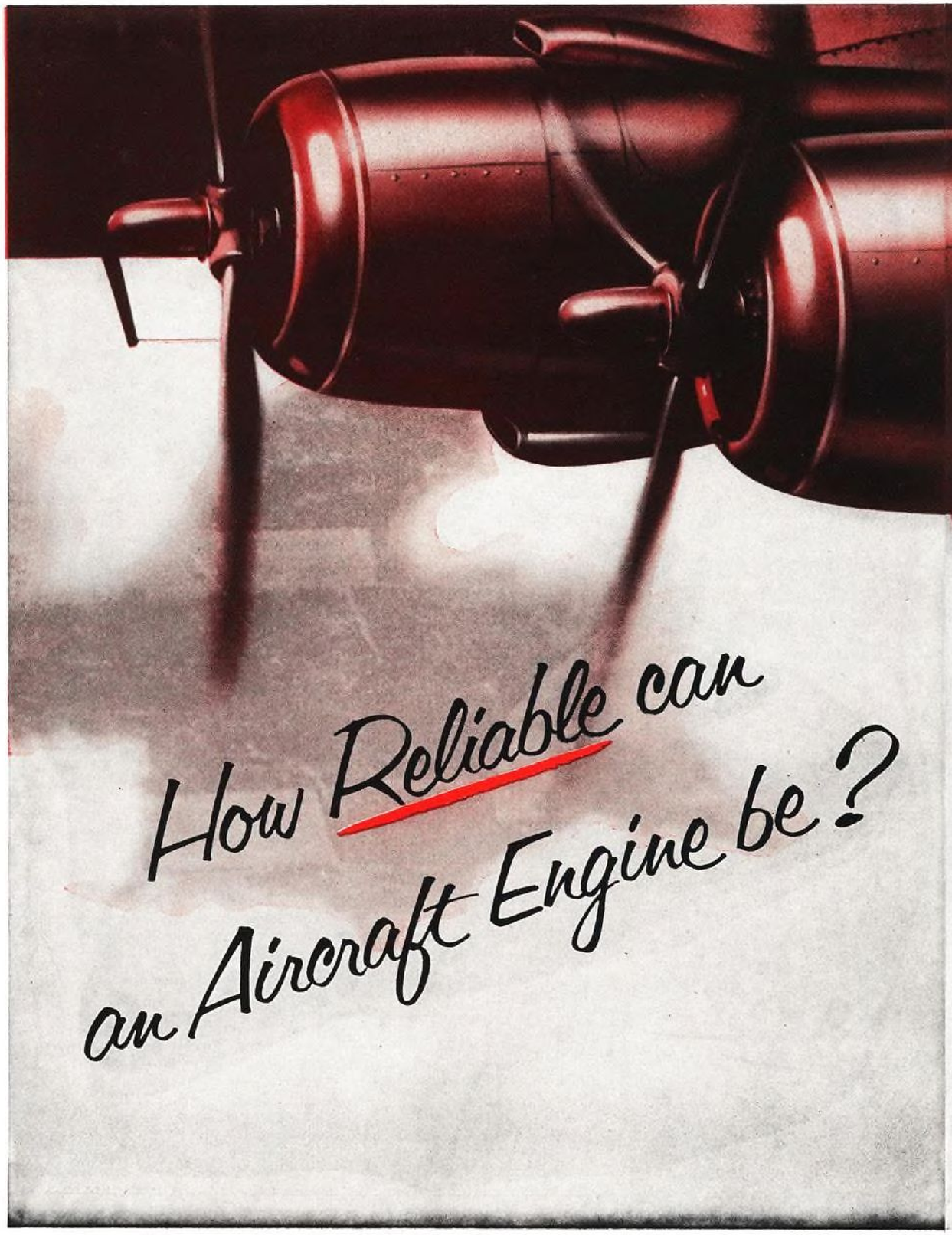
ELECTRONIC EQUIPMENT — Design and fabrication of complete electronic controls, communication receivers and transmitters, including ultra-high-frequency units, varying from subminiature handsets to assemblies weighing more than 1,000 pounds.

AVIATION SUPPLIES — Merchandising and distribution of more than 2,000 different kinds of aviation materials and supplies made by leading manufacturers.

We've been a major part of the aviation industry for over 25 years, and we expect to continue and improve this record.
Air Associates, Incorporated, Teterboro, New Jersey.

Manufacturers and Distributors of Aviation Materials and Equipment

AIR ASSOCIATES, INC.



From the moment an airliner's propellers bite the air —
to the time hours later when their thundering engines are cut,
oil fights a constant battle against damaging heat and friction. *An engine's performance is only as reliable as the oil that lubricates it.*
To maintain their reputation for dependability, the top airlines in the nation specify the very best in Aircraft Oils. *Today, more than 45% of the oil* used by major scheduled airlines in the U.S. is supplied by Sinclair.
There is no better proof of dependability.

SINCLAIR AIRCRAFT OILS

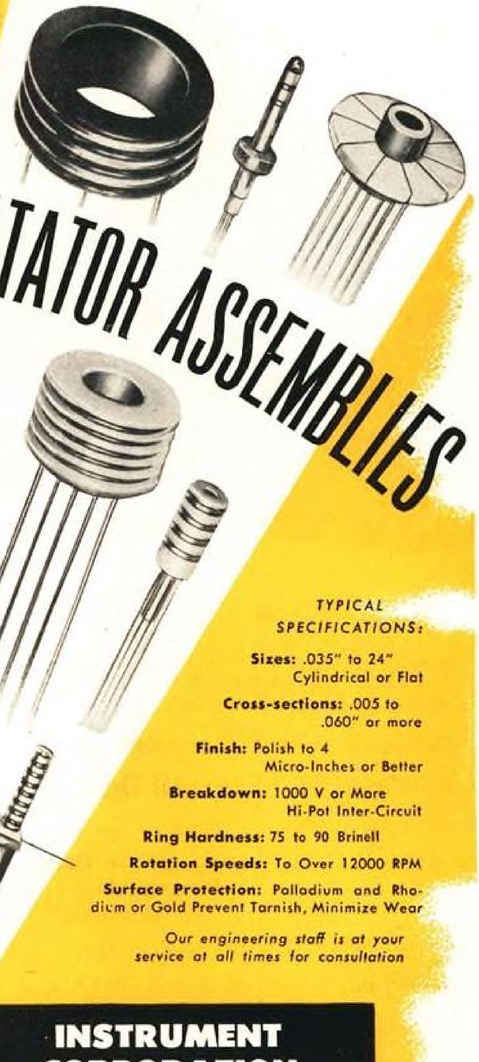
Sinclair Refining Company, Aviation Sales
600 Fifth Avenue, New York 20, N.Y.

SLANT your requirements to

INSTRUMENT CORP. OF AMERICA

for miniature

SLIP RING AND COMMUTATOR ASSEMBLIES



This Instrument Corporation of America plant contains the most modern and complete facilities available anywhere in the world for the exclusive production of Miniature Slip-Ring and Commutator Assemblies to precision standards. It is now in full scale production to meet your requirements in the fastest possible time at the lowest possible cost.

COMPLETE ENGINEERING AND PRODUCTION FACILITIES AVAILABLE

Our assemblies can be supplied at low cost. Quality is the highest in the industry. Dimensional accuracy and other characteristics are excellent and these units are highly recommended for instruments such as synchros, etc.

ONE PIECE ELECTRO-PLATED TYPES FOR EXTREME ACCURACY

Wherever extreme dimensional precision, accurate concentricity and high dielectric qualities are required, the electro-deposition method is recommended . . . the production of which is licensed under an exclusive arrangement with the Electro Tec Corporation.

TYPICAL SPECIFICATIONS:

Sizes: .035" to 24" Cylindrical or Flat

Cross-sections: .005 to .060" or more

Finish: Polish to 4 Micro-Inches or Better

Breakdown: 1000 V or More Hi-Pot Inter-Circuit

Ring Hardness: 75 to 90 Brinell

Rotation Speeds: To Over 12000 RPM

Surface Protection: Palladium and Rhodium or Gold Prevent Tarnish, Minimize Wear

Our engineering staff is at your service at all times for consultation

INSTRUMENT CORPORATION OF AMERICA

BLACKSBURG • VIRGINIA

UNDER EXCLUSIVE LICENSE OF ELECRO TEC CORPORATION

NEW DC-7's GO SKYDROL!

Monsanto Fire-Resistant Hydraulic Fluid Specified For *All* DC-7's On Initial Orders

Planes for AMERICAN, DELTA-C&S, NATIONAL and UNITED will carry Skydrol in either the hydraulic system or cabin supercharger transmission, or both.

Skydrol is now being used by 18 major airlines. Here are the reasons for this wide and growing acceptance:

- ★ **SKYDROL** is fire-resistant . . . the *only* such fluid which can be used in both cabin supercharger transmission and hydraulic system, as well as oleo struts.
- ★ **SKYDROL** has double the lubricity of conventional hydraulic fluids.
- ★ **SKYDROL** extends the service life of hydraulic components, cuts maintenance costs.
- ★ **SKYDROL** is nontoxic . . . noncorrosive . . . stable at required operating temperatures and pressures.

Skydrol: Reg. U. S. Pat. Off.

ASK for new charts on pump replacement rates, Skydrol vs. mineral oil. They will be sent to you with this book. Write Monsanto Chemical Company, Organic Chemicals Division, 800 North Twelfth Blvd., St. Louis 1, Missouri.

MONSANTO
CHEMICALS — PLASTICS
SERVING INDUSTRY...WHICH SERVES MANKIND

One of the P & W Kellers in operation. These machines permit a wide range of contour and profile milling operations.

Four-Spindle Cincinnati Vertical Hydro-Tel, provides increased production of various Axelson produced aircraft components.

Among many precision components, Axelson produces these main landing gear shock struts for military planes.

Partial view of new plant facilities. "Kellering" machines are processing various bulkhead segments.

Typical view of bulkhead segment in process for current military plane.

G & L Horizontal Boring Mill speeds production on aircraft structural parts.

An Axelson produced 32" x 100" maximum swing gap type engine lathe.

Axelson Aircraft Division's new, modern 57,000 square foot factory addition.

a partner you can count on

AXELSON AIRCRAFT COMPONENTS, including landing gear shock struts, gears, geared mechanisms, segments, spars, braces, any plane structural part are in flight throughout the world in both military and commercial planes. Now, a new, modern addition to its facilities houses the Axelson Aircraft Division. This Division is soundly staffed with competent engineers, master craftsmen, and fully equipped with the latest machine tools to handle a variety of precision aircraft production. If you have a production problem involving the foregoing, we invite your inquiry and personal inspection of our facilities. Get bids *now* on up-coming work.

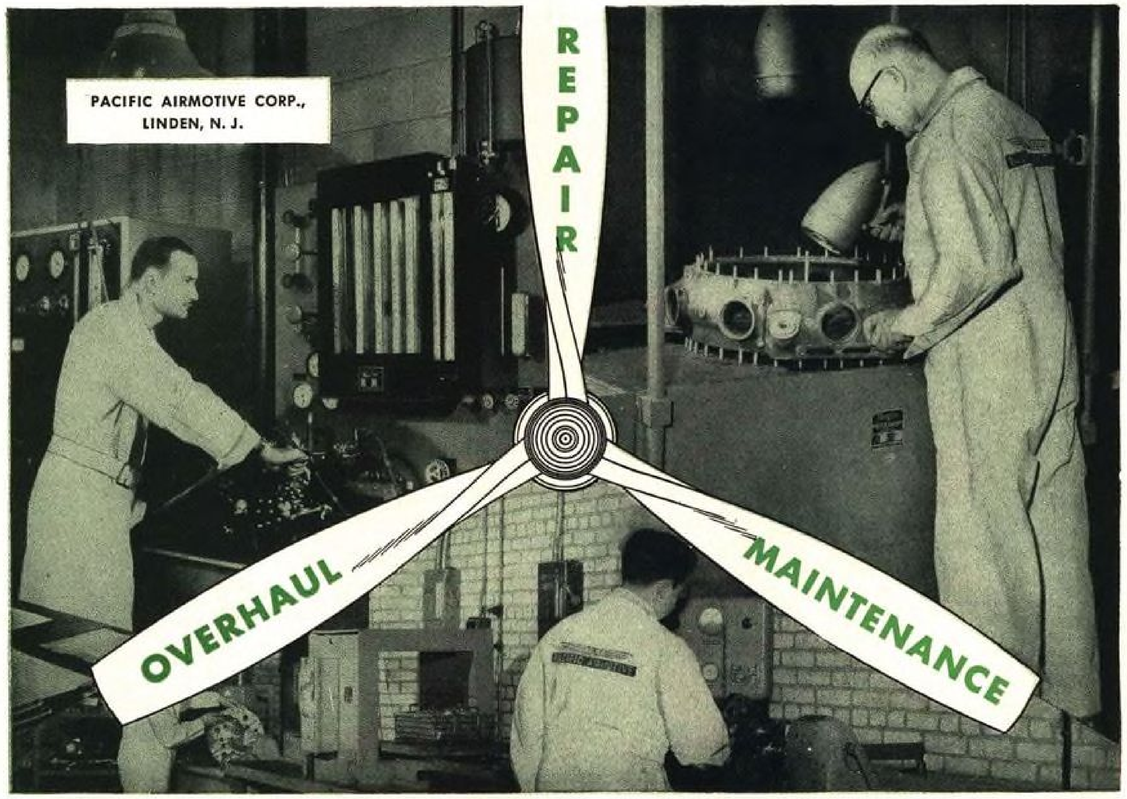
AXELSON Manufacturing Company

PSC

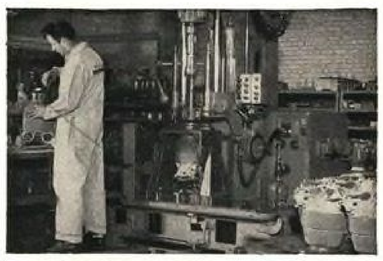
THERE IS NO ECONOMICAL SUBSTITUTE FOR QUALITY

6160 South Boyle Avenue • Los Angeles 58, California

DIVISION OF PRESSED STEEL CAR COMPANY, INC.



A World Leader In Engine And Aircraft Rebuilding



*P.A.C. is an authorized Pratt & Whitney distributor and overhaul agency and is main supplier of spare parts and assemblies for the de Havilland Dove Aircraft and Gipsy Queen 70 Engines.

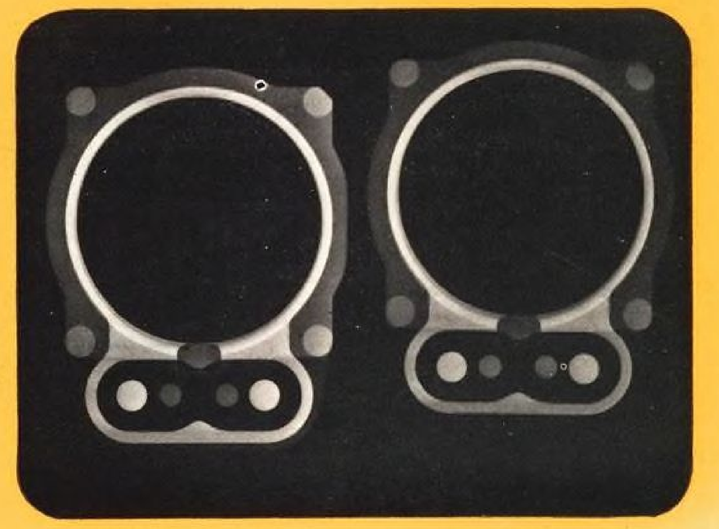
Pacific Airmotive Corp. Specializes In Aircraft Engine & Accessory Overhaul, Maintenance And Repair*

Whatever your private aircraft needs . . . overhaul, repair or maintenance . . . you can be certain of the best at Pacific Airmotive (Eastern Division, Linden, N. J., pictured). Pacific Airmotive's rigid rules for accuracy and specifications meet and even exceed the requirements of government and military agencies.

P.A.C. maintains a complete shop for the overhaul of engine accessories. The fuel flow test bench shown above, and the forge and welding shop shown at left, are typical of Pacific Airmotive's complete facilities. You can be sure your airplane will be expertly overhauled, repaired or serviced at Pacific Airmotive . . . the finest for technicians and facilities, and serving the very finest aviation petroleum products—Cities Service Aviation Products.

CITIES SERVICE
AVIATION PRODUCTS
New York • Chicago • In the South: Arkansas Fuel Co., Inc.

This casting must accept responsibility



Radiograph of flight instrument part

—RADIOGRAPHY SAYS IT CAN

WHERE this casting goes, strains are measured in G's, speeds in machs, and altitudes in tens of thousands of feet. And the instrument of which it's a part must be sturdy and dependable to help guard the safety of a costly craft and human life.

So to be certain this part—together with other parts—is sound, it is radiographed. No flaws can lie hidden to cause failure—or to consume costly machining time before being discovered.

Radiographing castings is becoming routine in more and more progressive foundries. It lets them know that only high-quality castings are released. It frequently shows how casting methods can be changed to increase yield in production runs.

You can find out how radiography can improve operations in your plant by talking it over with an x-ray dealer. And we'll be glad to send you a free copy of "Radiography As A Foundry Tool."

Eastman Kodak Company • X-ray Division
Rochester 4, N. Y.

Radiography . . .
another important function of photography

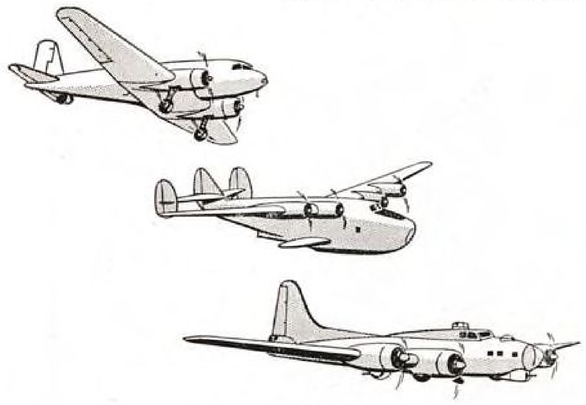
Kodak
TRADE-MARK

BARBER COLMAN

AUTOMATIC

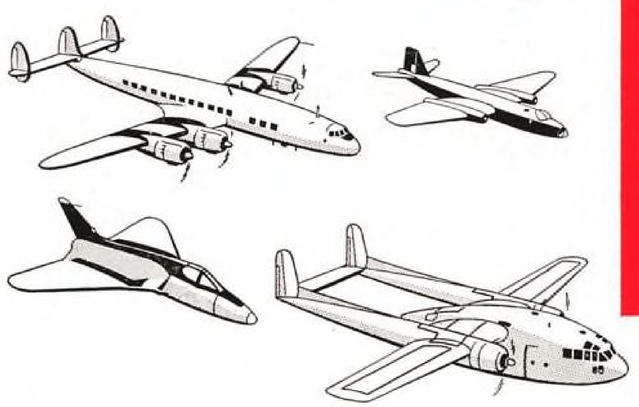
Aircraft Controls

contribute constantly to comfort of occupants and the precision operation of leading military, commercial and executive aircraft



Since the earlier days of the DC-1, the Yankee Clipper and the B-17, Barber-Colman controls have been on most of America's history-making planes.

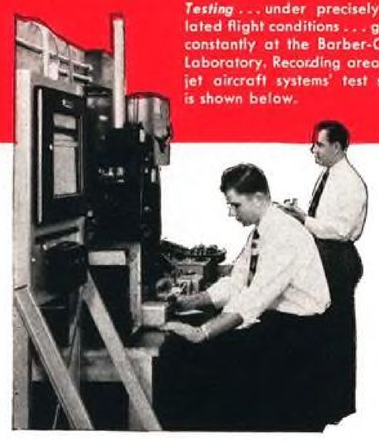
Today, on more and more aircraft, such as the Super Constellation, B-57, F4D, C-119 and many others, Barber-Colman controls contribute to better performance.



These key aircraft manufacturers are among the many who have helped greatly in the constant development and refinement of Barber-Colman controls: Boeing; Beech; Canadair; Consolidated Vultee; Chance-Vought; Douglas; Fairchild; Goodyear; Grumman; Lockheed; Martin; McDonnell; NorthAmerican; Northrop; Republic; A.V.Roe.

TEMPERATURE CONTROLS

Barber-Colman's newest electronic control assembly, shown above, is recognized as outstanding in its class. Only Barber-Colman Company offers complete coverage of the automatic control field, cycling, full proportional, Micropulse, and electronic, for military, commercial, and executive aircraft.



Testing . . . under precisely simulated flight conditions . . . goes on constantly at the Barber-Colman Laboratory. Recording area in the jet aircraft systems' test section is shown below.

Back in the early thirties . . . when Barber-Colman Company made its first control equipment for aircraft . . . the nation's most important aviation era was just in the making.

That was the beginning of the great developments we know today . . . high-speed, long-range craft . . . instrument operation . . . high-altitude, all-weather flight . . . automatically controlled heating and cooling of cockpits and cabins . . . precise automatic control for countless components . . . and a long list of other major advancements that have brought us up to this age of jets and super transports.

Through all this critical development period, it has been the privilege and the responsibility of Barber-Colman engineers and production facilities to keep pace with and make real contributions to America's aviation.

In doing this Barber-Colman Company has constantly developed its line of electro-mechanical devices to give them the diversity and scope necessary to solve the newest of control problems as they arise. For complete data, send coupon below.

VALVES

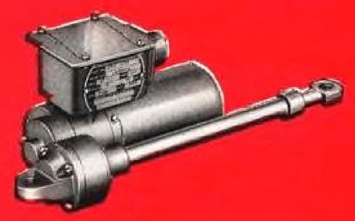
Barber-Colman Company offers a wide variety of electrically actuated air valves for use in conjunction with temperature and pressure control applications. Exceptional performance at lowest weight!

MOTORS

Small permanent-magnet and split-series d-c motors with true electrical balance, 25% higher efficiency, superior commutation, exceptionally low radio noise, and outstanding constructional features.

ULTRA-SENSITIVE RELAYS

Available in sensitivities from 50 microwatts to 1 milliwatt. Wide range of coils, enclosures, mounting details. Extensively used in balance detecting bridge circuits and as plate current relay in electronic applications.



ACTUATORS

Rotary and linear types. These Barber-Colman actuators combine gear reductions, switching, mounting details, and other design features to meet most aircraft applications in their load-speed class.

POSITIONING CONTROLS

Completely integrated high-speed positioning control system inclusive of transmitting rheostat, d-c non-electronic control box, and remote actuator. Unique circuitry provides anti-hunt feature.

THERMO-SENSITIVE ELEMENTS

Low-cost simplified temperature control for less critical applications. Also, a complete line of thermo-sensitive wire and thermistor sensing elements for use in resistance bridge type circuits.

BARBER COLMAN

AUTOMATIC

Aircraft Controls

Aircraft Controls • Automatic Controls • Industrial Instruments • Small Motors • Air Distribution Products • OVERdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

BARBER-COLMAN COMPANY, ROCKFORD, ILL., U.S.A.
Dept. G, 1422 Rock Street. Field offices in aircraft centers.
Gentlemen: Please send bulletin on this product.

Name_____

Firm Name_____

Address_____

City_____ State_____

A SPECIALIST DOES IT BEST!

Packless Construction — Illustrating packless valve construction. Same principle used to seal stem movement or adjustment in many types of apparatus.

● If your products or product plans require bellows assemblies, you can get real help from specialists at Fulton Sylphon or Bridgeport Thermostat. They've specialized in this field for over half-a-century.

This valuable experience can help you in many ways. Skilled personnel and ample production facilities are ready to take care of your bellows assemblies needs quickly and accurately.

And our specialists are equally helpful in working with you to design and produce bellows assemblies specifically adapted to your requirements. On all counts you save time, production worries and expense.

Sylphon and Bridgeport bellows assemblies are used in many ways—as flexible connectors, for thermostatic devices, pressure controls, hydraulic mechanisms, expansion joints and other units. Wide range of metals and sizes. Write for information. Ask for helpful, idea-filled Catalog PA-1400.

FULTON SYLPHON DIVISION Knoxville 1, Tenn.

Robertshaw-Fulton CONTROLS COMPANY "EVERYTHING'S UNDER CONTROL"

TEMPERATURE CONTROLS • BELLOWS ASSEMBLIES • BELLOWS DEVICES

BRIDGEPORT THERMOSTAT DIVISION Bridgeport 1, Conn.

Guardian of America

THE LOCKHEED STARFIRE F-94C

Designed to guard the United States against enemy air invasion Lockheed's new Starfire F-94C is the most powerful single engine plane in production. It climbs in record time to 7 miles or higher — flies more than 600 M.P.H.— locates enemy bombers automatically — and destroys the invader without ever seeing it. Guided by its electronic brain this all-weather jet fighter attacks and fires automatically.

An outstanding example of Lockheed's leadership — the F-94C is the third in the Starfire series and augments squadrons of F-94As and F-94Bs which have provided valiant protection for such key cities as New York and Washington, D.C.

Rezolin salutes Lockheed on this great achievement which has contributed much to aviation's development and America's protection.

We are proud of the fact that 80% of the formed skins on the Lockheed Starfire F-94C are formed with tools made of REZOLIN TOOLPLASTIK.

REZOLIN, INC., Los Angeles, Detroit, New York City, Dallas.

The toughest jobs are formed with **REZOLIN TOOLPLASTIK** *The only Non-Shrink casting resin*

Serving Industry Since 1938

APPLICATIONS FOR REZOLIN TOOLPLASTIK— Stretch dies • Acrylic form dies • Double-action draw dies Keller patterns • Foundry patterns • Check fixtures • Polyester laminating molds • Trim and routing fixtures • Master models • Jig bases Hydro-press dies • Spinning chucks.

EYES OF *FLIGHT*

Eyes of flight—the canopies, domes, noses and windows of PLEXIGLAS on fighters, bombers, transports, helicopters. Through these transparent shields against wind and weather, the men who fly our country's planes obtain their all-important unobstructed view.

Whether enclosures are formed from PLEXIGLAS II UVA, noted for its all-round serviceability, or from recently introduced PLEXIGLAS 55, with increased resistance to crazing, they have the clarity, strength, light weight, formability, dimensional stability, and weather-resistance that have established PLEXIGLAS as *aviation's standard transparent plastic.*

To make the most efficient use of PLEXIGLAS in aircraft applications, call on the Rohm & Haas Company service staff and technical representatives. Their services are backed by years of close cooperation with the aircraft industry; the Department of the Air Force, Air Material Command and Air Research and Development Command; and the Department of the Navy, Bureau of Aeronautics.

PLEXIGLAS is a trade-mark, Reg. U.S. Pat. Off. and other principal countries in the Western Hemisphere.

Canadian Distributor: *Crystal Glass & Plastics, Ltd., 130 Queen's Quay at Jarvis Street, Toronto, Ontario, Canada.*

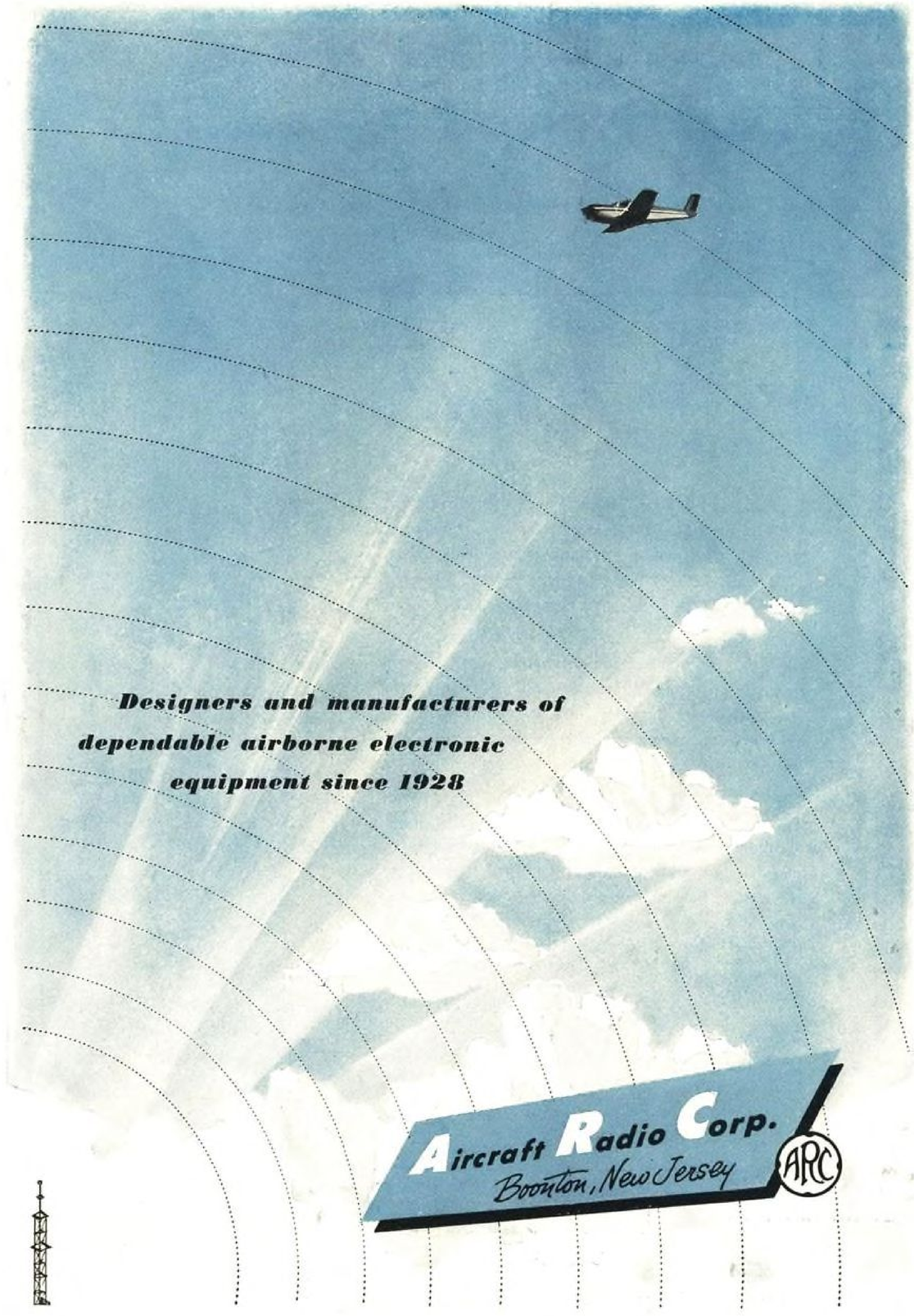
CHEMICALS FOR INDUSTRY

PLEXIGLAS

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Representatives in principal foreign countries

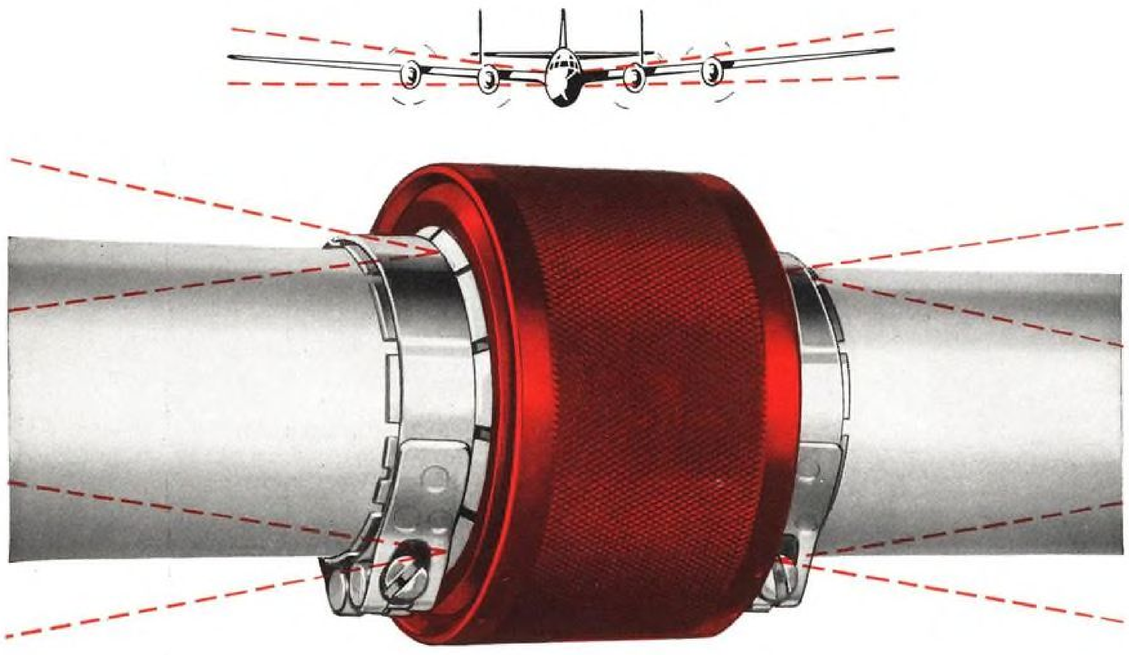


Designers and manufacturers of dependable airborne electronic equipment since 1928

Aircraft Radio Corp.
Boonton, New Jersey
ARC

The Aeroquip Flex Joint

FIRST TO PERMIT SUCCESSFUL FLEXING OF RIGID FUEL LINES



Another "first" for Aeroquip! The amazing Flex Joint permits flexing of rigid fuel lines in aircraft while maintaining a positive, fluid-tight seal. Of simple, bellows-type design, the Flex Joint allows tubing to "give" 10°, plus or minus, and accommodates wing deflections, vibration, thermo-expansion, and construction tolerances. It is compact, light in weight and can be installed in confined areas without special tools . . . without precise cutting of tubing or flaring of tube ends. Extensive tests on the Flex Joint have been conducted ranging from —65° F. to +160° F., from flexing, vibrating and actuating, to testing under pressure and vacuum, and determining ultimate strength by bursting. The work has been conducted along lines laid down by the N.A.S.C. Descriptive literature is available; please write.

REG. TRADE MARK **Aeroquip**

AEROQUIP CORPORATION, JACKSON, MICHIGAN

SALES OFFICES: BURBANK, CALIF. • DAYTON, OHIO • HAGERSTOWN, MD. • HIGH POINT, N. C. • MIAMI SPRINGS, FLA. MINNEAPOLIS, MINN. • PORTLAND, ORE. • WICHITA, KAN. • TORONTO, CANADA

AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

For every Electrical need

CHECK General for ELECTRICAL

AUTOMOTIVE - AIRCRAFT

COMMUNICATIONS

CONSTRUCTION

GENERAL INDUSTRY

MFRS. ELECTRICAL APPARATUS

MINING-EARTH MOVING

MUNICIPAL

POWER

RAILROADS

SHIPBUILDING - SHIPYARDS

GENERAL CABLE
CORPORATION

"More Power to You"®

Executive Offices: 420 Lexington Avenue, New York 17, N. Y.
Sales Offices in Principal Cities of the United States

Cable FIRST for WIRE and CABLE

Copper, bronze and aluminum conductors in thousands of different sizes and types of product. Constructions and insulations of every modern variety.

This is General Cable, a *prime source of supply* for everyone who generates electricity, distributes electricity or utilizes electricity.

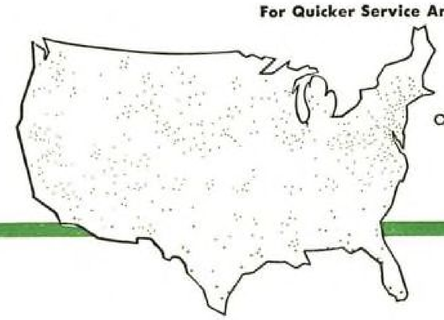
Whatever your electrical wire and cable need, whenever you need it—say "General Cable" to your purchasing agent, your distributor—or call on the nearest General Cable office.

ONE Source of Complete Supply

ONE Completeness of Service

ONE Standard of Quality

For Quicker Service Anywhere in the United States... General Cable maintains



22 Sales Offices
14 Resident Sales Representative Locations
Over **600** Distributor Sales Locations
6 Regional Stock Distribution Points
6 Manufacturing Plants and Stocks

PRECISION-BUILT BEARINGS

SPEED MODERN JET PLANES!

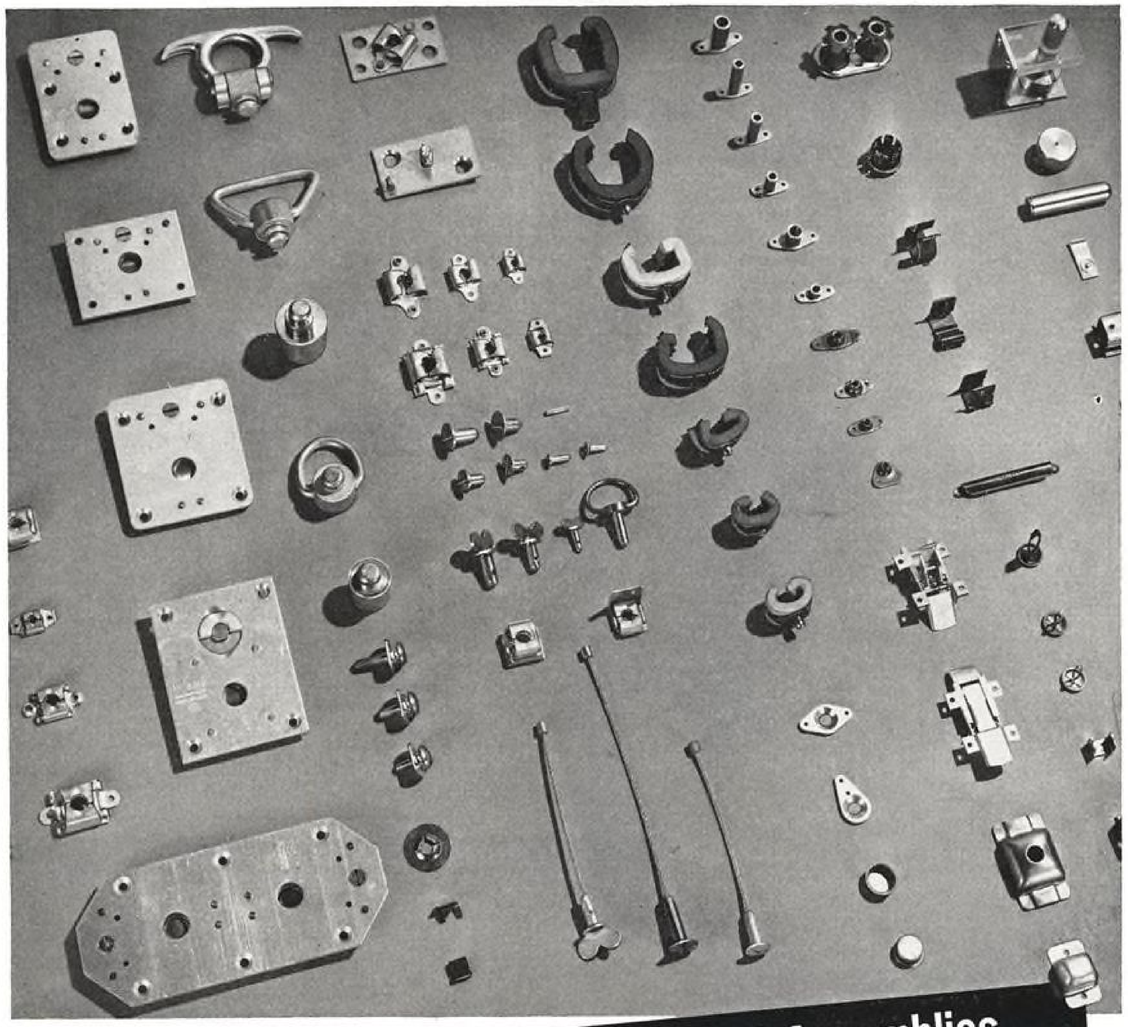
Jet planes flying faster than the speed of sound . . . turbines spinning at a rate of 12,000 RPM . . . temperatures as high as 500° F.—with a minimum of lubrication! Those are the punishing demands today's modern aircraft put on bearings! Small wonder then that major manufacturers of jet engines standardize on Bower aircraft bearings. Precision-built to tolerances measured in millionths of an inch, these quality bearings operate with complete efficiency at peak speed and temperature loads. What do you make? If your product demands top-quality bearings you'll be wise to specify dependable Bower bearings.

THE BOWER ROLLER BEARING COMPANY
Detroit 14, Michigan

BOWER

SPHER-O-HONED

ROLLER BEARINGS

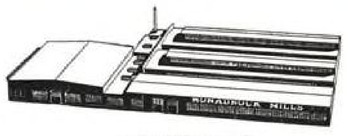


From Metal Stampings To Finished Assemblies . . .

AIRLOC
SOL-A-NUT
WIRE HARNESS BAND
ADAMS-RITE WEDJIT
FABRI-LOC
SNAP-IT-TRIM

. . . our service is complete. We manufacture a variety of specialized aircraft fasteners and our design and engineering staff is ready to modify these or design completely new fasteners to your specifications.

Monadnock, with a wealth of fastening experience, welcomes inquiries from manufacturers who seek reliable development and production facilities.



subsidiary of
UNITED-CARR FASTENER CORP.

MONADNOCK MILLS San Leandro California

When you *TEST*, use the *BEST*...

THE SYMBOL OF QUALITY, ACCURACY, DEPENDABILITY

The equipments illustrated are typical examples of the complete line of PRD quality test components. Rigorously engineered and meticulously manufactured to the highest attainable standards, these units are now standard equipment in many of the leading research and development laboratories throughout the world. In addition to the widely diversified standard equipments offered, PRD maintains a highly qualified staff for special products development. This staff is at your service at all times for consultation.

Type 587 UHF FREQUENCY METER
470-900 mc/s

Type 801-A UNIVERSAL KLYSTRON POWER SUPPLY
300-1500 V at 65 ma;
1.5–3.6 KV at 25 ma

FREQUENCY MEASURING DEVICES

Frequency Meters	Frequency Range (kmc/sec)	Type No.	Transmission Line Size (Naminal O.D.—inches)	R—Reaction T—Transmission
General Purpose	0.47—0.95	587	⅜	T
	2.40—3.40	583	⅜	R
	4.00—10.0	562-A	⅜	Detector included
	3.95—5.85	574	2 x 1	R
	5.85—8.20	575	1½ x ¾	R
	7.05—10.0	576	1¼ x ⅝	R
	8.2—10.0	585-A	1 x ½	R
	8.2—10.0	585-B	1 x ½	T
	8.2—10.0	586-A	1¼ x ⅝	R

In addition to the General Purpose Frequency Meters listed above, PRD manufactures a complete line of Precision Frequency Meters covering the entire frequency range from 0.55 to 39.0 kmc/s. Transmission line sizes include ⅜" coaxial line and all standard wave guide sizes from 0.280" x 0.140" I.D. to 2" x 1" O.D. All types are available in Reaction and Transmission styles.

The Type 500 Frequency Standard Multiplier is available to generate standard frequency signals in the UHF and microwave regions when used with the Type 612-A Tunable Crystal Mount.

Type 854 UNIVERSAL SPECTRUM ANALYZER
8.5–9.6 kmc/s

SIGNAL SOURCES AND RECEIVERS

ITEM	DESCRIPTION
TUBE MOUNTS Type 701 Type 702 Type 703	 For type 2K28 klystrons, 2.400—3.445 kmc/sec For type 2K25 klystrons, 8.50—9.60 kmc/sec, 1¼x⅝ waveguide For type 2K25 klystrons, 8.50—9.60 kmc/sec, 1x½ waveguide
OSCILLATORS Type 705 Type 706	 Covering the frequency range from 7.0 to 11.0 kmc/sec Covering the frequency range from 3.6 to 7.3 kmc/sec
POWER SUPPLIES Type 801-A	 Providing all required electrode voltages to operate a wide variety of klystrons, plus internal modulators
SPECTRUM ANALYZERS Type 853 Type 854 Type 855	 Covering the frequency range from 2.40 to 3.40 kmc/sec Covering the frequency range from 8.50 to 9.60 kmc/sec Combining both of the above ranges in one instrument
GENERATORS Type 902 Type 903 Type 907	 Covering the frequency range from 3.65 to 7.30 kmc/sec Covering the frequency range from 7.00 to 10.5 kmc/sec Covering the frequency range from 40 to 900 mc/sec
NOISE GENERATORS Type 904	 For the direct measurement of noise factors in the range of 10 to 1000 mc/sec

Type 907 BROADBAND SWEEP FREQUENCY GENERATOR
40-900 mc/s

Type 904 VHF-UHF NOISE GENERATOR
.01—1.0 kmc/s

Type 275 VOLTAGE STANDING WAVE RATIO AMPLIFIER
300—3000 cps.

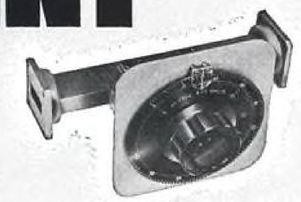
WRITE FOR NEW CATALOG
Send today for your free copy of the PRD catalog. Completely illustrated, it is a valuable addition for your reference files. Address DEPT. A-8.

Polytechnic
RESEARCH & DEVELOPMENT CO., Inc.

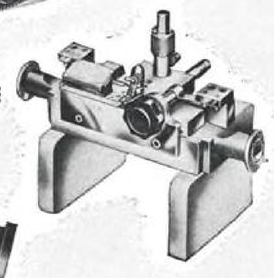
–from *VHF* through *EHF*,

PRECISION *RF* TEST EQUIPMENT

Type 312 E/H TUNER
26.5—40.0 kmc/s

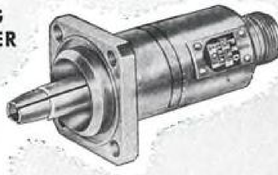


Type 196-B VARIABLE ATTENUATOR
8.20-12.4 kmc/s
0-40 db



Type 211 PRECISION WAVEGUIDE SLOTTED SECTION
18.0—26.5 kmc/s

Type 585 DIRECT READING FREQUENCY METER
8.20-10.0 kmc/s



Type 389 COAXIAL TRANSMISSION LINE ADAPTER
0—4.0 kmc/s

Type 612-A CRYSTAL BOLOMETER MOUNT
1.00—12.4 kmc/s

ITEM	COAXIAL (Nom. O.D.-in.)		TRANSMISSION LINE SIZE WAVEGUIDE (Nominal O.D.-inches)							
	⅞	⅜	3x1½	2x1	1⅞x¾	1¼x⅝	1x½	0.622x 0.311 I.D.	0.420x 0.170 I.D.	0.280x 0.140 I.D.
ATTENUATORS AND TERMINATIONS										
Variable Attenuators Uncalibrated			171	162	1156 161	160	154-A 159	189	190	191
Dial			174-A	169-B	177-B	184-A	196-C 196-D	187		
Precision			175-B	170-A	178-B	185-B	195-B	188-A	153-A	192
Cut-off		181,198					180			
Fixed Attenuators Low Power	136 series	130 series 1100-C	s	s	s	s	140 series	s		
Terminations	145	139	129	115	121	114	116	131	132	133
TRANSMISSION LINE COMPONENTS										
Waveguide to Coaxial Adapters			365	357	356	355	354-A			
Coaxial Transitions	389,390 391,392	389,390 391,392								
Directional Couplers				400	404	401	402	405		
Waveguide Stands			375-A	376-A	377-A	378-A	379-A	386-A	387-A	388-A
Flange Bolt & Nut Assemblies			369-A	369-B	369-B	369-C	369-D	369-E	f	f
Bends and Tees				s	s	s	462 465 481	s	s	s
IMPEDANCE MEASUREMENT & TRANSFORMATION										
Slotted Sections	200-C	205-A 215-A	209-A	201-A	204-A	202-A	203-A	210	211	212
Tuners		306	309	300	305	302	303-A	311 314	313	312

The Type 250-A Broadband Probe is designed for use with the Types 200-C through 209-A and 215-A Slotted Sections; Types 210-212 are supplied with built-in tunable probes. The Type 361 R-F Adapter is available for use with the Type 250-A Probe.

DETECTION AND POWER MEASUREMENT										
Detector Mounts Crystal		612-A 613					601	616	621	615
Bolometer	(s)	612-A,613 627-A,628-A						616	620 621	618
Thermistor							635			

The Type 650-A Universal Power Bridge is designed to be used with any of the bolometers or thermistors listed for the measurement of absolute power level.

Type 650-A UNIVERSAL POWER BRIDGE
0.1, 1.0, 10, 100 mw full scale

BOLOMETERS

TYPE No.	FOR USE WITH	TYPE No.	FOR USE WITH	TYPE No.	FOR USE WITH
610-A	250-A, 612-A, 613	629-A(s)	623(s)	630-B(s)	626(s)
614	210, 211, 616, 621	629-B(s)	624(s)	631-C	627-A
617	212, 618, 620	630-A(s)	625(s)	631-D	628-A

f—Equipment is supplied with captive flange screws

s—Available on special order only

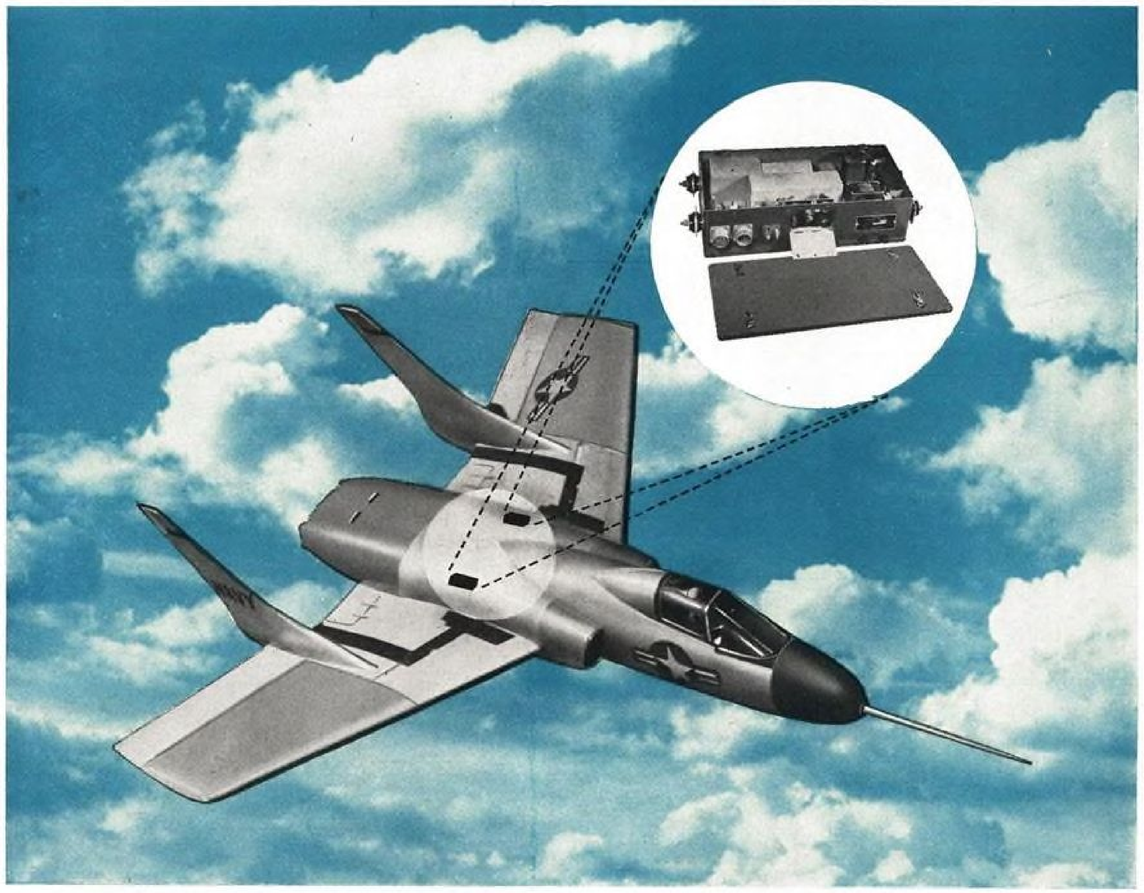
Type 627-A BROADBAND COAXIAL BOLOMETER MOUNTS
.5-10.0 kmc/s

AND NOW IN PRODUCTION!

PRD Magnetic Amplifiers

Our Magnetic Amplifier Division is now in production to meet your needs with custom designs or "packaged" units. The T806 is a low level amplifier which will amplify a signal from a thermocouple, strain gauge, thermistor bridge, photo tube, etc., to operate an insensitive meter or relay.

55 JOHNSON STREET, BROOKLYN 1, NEW YORK
WESTERN SALES OFFICE: 741 NO. SEWARD STREET, HOLLYWOOD 38, CALIFORNIA



TURBOJET ENGINE

TEMPERATURE CONTROL AMPLIFIERS

You want and must have completely reliable temperature control amplifiers — amplifiers designed and constructed to meet specific basic requirements of your turbojet engines, such as:

1. Efficient operation in ambient temperatures from minus 65°F to plus 200°F.
2. Vibration endurance covering a range from 5 to 150 cycles per second.
3. Operation in altitudes up to 60,000 feet through the use of hermetically-sealed components.
4. Center-of-gravity shock mounting to permit installation right on the turbojet engine.

Manning, Maxwell & Moore turbojet engine temperature control amplifiers satisfy all four requirements. They incorporate a highly successful design principle thoroughly proved during years of concentrated research, development and tests devoted exclusively to automatic control systems for jet engines.

We believe our ability to apply our unique design technique to specific and unusual turbojet engine temperature control problems can be of real value to you. Our engineering counsel and extensive manufacturing and test facilities are at your service. We welcome your inquiry.

MANNING, MAXWELL & MOORE, INC.

AIRCRAFT PRODUCTS DIVISION • STRATFORD, CONN.

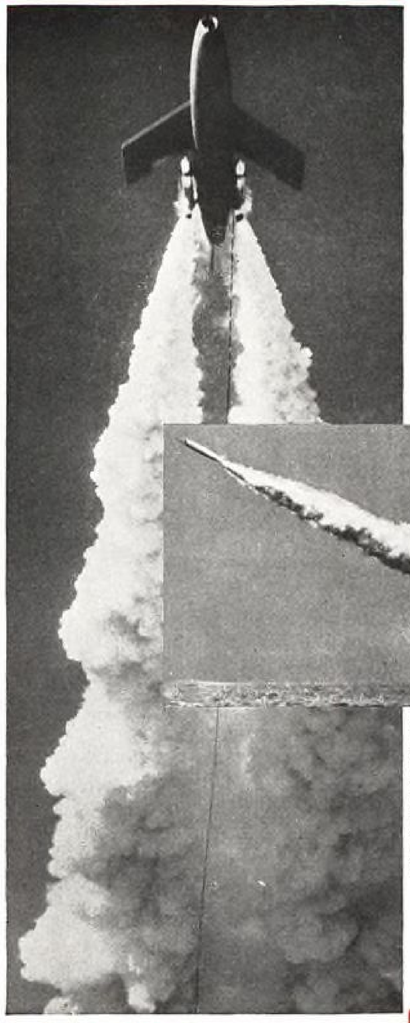
OUR AIRCRAFT PRODUCTS INCLUDE: TURBOJET ENGINE TEMPERATURE CONTROL AMPLIFIERS • ELECTRONIC AMPLIFIERS PRESSURE SWITCHES FOR ROCKETS, JET ENGINE AND AIRFRAME APPLICATIONS • PRESSURE GAUGES THERMOCOUPLES • HYDRAULIC VALVES • JET ENGINE AFTERBURNER CONTROL SYSTEMS.

IDEAS *in the making*

Bonding, Casting and Coating Resins developed by Ciba Research are simplifying manufacturing methods, improving product efficiency, and opening new fields of product development. You will want to know more about them.

REDUX *Bonding Process, used in rivetless assembly of primary structures in aircraft, now adapted for* **GUIDED MISSILES**

The Redux® Bonding Process, developed by Ciba's subsidiary, Aero Research in England, has made possible the rivetless assembly of primary structures in such aircraft as the famed de Havilland "Comet". In this country, the Redux Bonding Process has been specified as standard procedure in military types as well, such as the U. S. Navy's "Cutlass" jet fighter built by Chance-Vought, and most recently in the "Regulus" guided missile designed for launching from submarines, surface ships and shore bases.



Shown in this official photograph is the launching of a "REGULUS" Guided Missile from the flight deck of an aircraft carrier at sea.

Performance of the "REGULUS", components of which were assembled by the Redux Bonding Process, reportedly exceeds design specifications.

The Redux Process as developed by Dr. N. A. de Bruyne, Ciba's distinguished associate at Aero Research, has won widespread engineering and public attention both here and abroad. In response to long-standing invitations from American universities, engineering societies and aircraft companies, Dr. de Bruyne recently completed a coast-to-coast lecture itinerary.

SEND FOR REDUX DATA FILE FOLDER

. . . which includes reprints of published papers by Dr. N. A. de Bruyne, and technical bulletins to serve as a preliminary guide to aircraft engineers in evaluating use of the REDUX Bonding Process.

CIBA *Plastics*

BONDING ★ CASTING
COATING RESINS

CIBA COMPANY, INC. PLASTICS DIVISION
627 Greenwich St., New York 14, N. Y.
(In Canada: Ciba Co. Ltd., Ciba Bldg., Montreal) Please send me Ciba Plastics Technical Bulletins for
BONDING ☐ CASTING ☐ COATING ☐

*Name*_____ *Title*_____

*Company*_____

*Address*_____

AW8

more **FIGHT** for

F 84 G
F 84 F
RF 84 F
F 86 H

read how the KIDDE Compressor makes pneumatics work at amazingly high altitudes

More fight for planes in flight is provided by the new Kidde 4-Stage Compressor . . . auxiliary power that is more reliable, more foolproof than ever before.

Think of it! The very space you fly through becomes your reservoir of pneumatic power. The supply is literally unlimited.

The new Kidde 4-Stage Compressor is currently being installed aboard such fighter planes as the F84 and F86.

Its unusually light weight and reliable performance make the Kidde 4-Stage Compressor the perfect "workhorse" for your aircraft, too.

Why not write and let a Kidde engineer give you full information on Kidde pneumatic devices.

Kidde **Walter Kidde & Company, Inc.**

818 Main Street, Belleville 9, N. J.

Walter Kidde & Company of Canada, Ltd., Montreal, P. Q.

Here is a bolt of titanium produced by Harper to meet the demands of today's aircraft for lighter, stronger fastenings—fastenings capable of standing up under excessive temperature.

The Harper Aero Division is producing fastenings of all the new high temperature alloys, such as Discaloy, Refractaloy, A-286 and special grades of stainless steel.

Harper metallurgists and engineers are backed by nearly a third of a century of experience in producing fastenings of corrosion-resistant metals. Today, The H. M. Harper Company is the largest exclusive producer of such fastenings.

If you require fastenings of high temperature alloys or any of the more common corrosion-resistant metals—brass, naval bronze, silicon bronze, Monel, copper, nickel, aluminum and all stainless steels—call Harper. Harper metallurgists and engineers are available to work with you on the production of fastenings to meet any design, temperature, abrasion or corrosion conditions.

THE H. M. HARPER COMPANY
AERO DIVISION
8280 Lehigh Avenue, Morton Grove, Illinois

THE H. M. HARPER COMPANY
AERO DIVISION
8280 Lehigh Avenue, Morton Grove, Ill.

Please send me information on:
☐ High Temperature Fastenings
☐ Corrosion-Resistant Fastenings

Name.....
Position.....
Company.....
Address.....
City.....*Zone*.....*State*.....

The Eaton Process of Producing Jet Blades is Saving Critical Materials—Reducing Costs by Millions of Dollars

The savings inherent in Eaton processes for the production of jet engine blades are an accomplished fact – savings in critical materials, savings in cost totaling millions of dollars. These cost-saving processes have been developed and perfected *in production* – representing millions of blades for jet engines now flying in actual combat.

Eaton research – in the laboratory and in the shop – will continue to strive for the achievement of the high quality necessary for these critical parts – at the lowest possible cost!

EATON MANUFACTURING COMPANY

General Offices: CLEVELAND, OHIO

VALVE DIVISION: 9771 FRENCH ROAD • DETROIT 13, MICHIGAN

PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

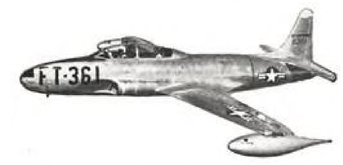
Revere INSTRUMENTS HAVE A RECORD OF TOP PERFORMANCE IN TOP AIRCRAFT

Revere control instruments have shared the responsibility and achievements of the aircraft industry since 1939 with years of dependable performance under all types of weather conditions. Today Revere is recognized as one of the foremost producers of precision instruments. You'll find them installed in many world-famous airplanes.

Extensive research and development facilities coupled with precision production methods contribute immeasurably to Revere's reputation for highest quality control instruments. Contact Revere's field engineering department today. Let qualified engineers assist you with your liquid or electro-mechanical control problems . . .

FUEL FLOW SWITCH
Specially designed by Revere for use in the auxiliary fuel line of the McDonnell F2H-3 twin-jet, carrier-based fighter. This instrument transmits a warning signal whenever fuel flow falls below a pre-determined value. *Send for Bulletin No. 1400*

FUEL FLOW TRANSMITTER
The Revere Fuel Flow Totalizer is an integral part of the fuel system. It records the rate of fuel flow in the T-33's jet engines. The flow totalizer can be used on piston engines, diesels or test stand operations. *Send for Bulletin No. 1300*



LIQUID LEVEL SWITCH
Republic's F-84G Thunderjet, first USAF fighter-bomber to refuel in mid air, has Revere's Liquid Level Switches installed in their fuel tanks. This hermetically-sealed, magnetically actuated switch presents a new standard of safety. *Send for Bulletin No. 1100*

FLOAT SWITCH
Boeing's B-47 Stratojets have Revere Float switches installed in all fuel tanks to maintain high-level fuel control. These switches can be furnished with single or dual float systems with levels set at the factory. *Send for Bulletin No. 1200*

SEND FOR FREE BULLETINS!

REVERE CORPORATION OF AMERICA
WALLINGFORD 2, CONNECTICUT, U.S.A.
precision instruments for aircraft and industry

LIKE "opening a barn door in a hurricane"..... with a FEATHER

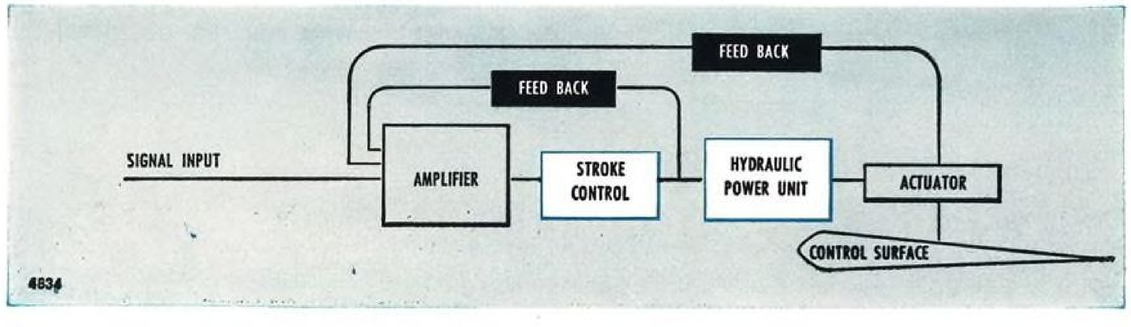
30 Milliamp Signal Controls 50 Horsepower

Modern aircraft control surfaces are not the size of a barn door but the wind across them is several times hurricane velocity. Results are similar . . . it takes plenty of power to control them.

Vickers Electro-Hydraulic Servo Power Units provide rapid and accurate control of up to 50 horsepower with a 30 milliamp signal. This is another Vickers accomplishment in the control of heavy power by means of very minute signal inputs. Write for special bulletin No. SE-18.

VICKERS Incorporated
DIVISION OF THE SPERRY CORPORATION
1462 OAKMAN BLVD. • DETROIT 32, MICH.

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921



TIME WAS when Calbraith Rodgers took 84 days to complete the "First Transcontinental Aeroplane Flight" on Goodyear tires—a daring trip during which Rodgers had to be accompanied by a train carrying spare parts, as well as a tow truck for hauling his Wright biplane out of ditches!

For that was back in 1911 when plane and engine usually required drastic overhaul after a few hours' flight. In those days the number of civilian aviators could be counted almost on one's fingers. "Landing fields" were any available pasture, and airports and service facilities were practically non-existent.

GOODYEAR AVIATION PRODUCTS

NOW modern private planes can make the coast-to-coast trip in a matter of hours—with complete assurance that, should parts be needed, Goodyear Aviation Products are *quickly available* at any of the vast network of landing fields where distributors display the Goodyear "Sign of Service."

Convenient warehousing and complete distribution of tires, tubes, wheels, brakes—or any of the other many Goodyear Aviation Products—mean quick *and* reliable *service for today's private plane owner and operator.*

Goodyear Aviation Products Division—Akron 16, Ohio or Los Angeles 54, Calif.—contributing to aviation progress since 1909.

We think you'll like THE GOODYEAR TELEVISION PLAYHOUSE every other Sunday—NBC TV Network

DOW

MAGNESIUM CUTS DEAD WEIGHT, INCREASES HELICOPTER EFFICIENCY

Extensive use of DOW MAGNESIUM sheet, extrusions, and sand castings saves many important pounds on this versatile aircraft

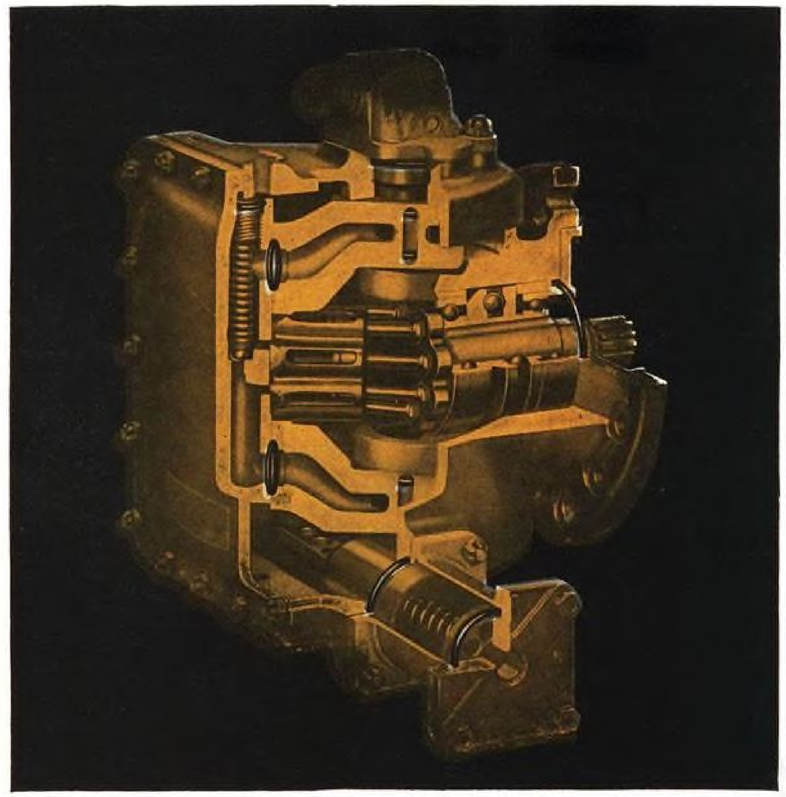
When you have to go straight up from a standing start, weight saving is of prime importance. That's why designers of helicopters are making extensive use of magnesium, the world's lightest structural metal.

The range and capacity of one current production model helicopter have been greatly increased by the use of magnesium. In this ship the requirements of magnesium are equal to approximately 25% of the craft's total empty weight. This consists of 400 pounds of castings, comprising 90 different parts, and 700 pounds of sheet and extrusions, including nearly all of the fuselage skin.

The weight saved by the use of magnesium has helped increase the efficiency of helicopters. Where only yesterday these craft were novelties, today they are the real work horses of our armed forces.

Whenever you have a weight problem, investigate magnesium. One-third lighter than aluminum, magnesium offers you an exceptionally high strength/weight ratio. It is a practical metal, available in all common forms, workable by all standard shop methods. For complete information, call your nearest Dow office or write to: Magnesium Department, THE DOW CHEMICAL COMPANY, Midland, Michigan.

you can depend on DOW MAGNESIUM DOW



Cutaway view showing O-rings. Illustration courtesy Vickers, Inc.

PARKER O-RINGS help pumps set endurance record

THIS IS IT

Cross section drawing of O-ring in groove, sealing under pressure.

Vickers reversible flow 3,000 PSI hydraulic pumps, equipped with PARKER O-rings, recently operated 304,578 pump hours without malfunction for a 12-month period at one airline.

This noteworthy performance—in all sorts of weather—demonstrates the leakproof, long service qualities of PARKER O-rings . . . precision-molded from superior synthetic rubber compounds. Important, too, they provide simplified as well as efficient sealing. Design involves only a small groove to retain the ring. They are economical to use, easy to replace.

PARKER is the one source for *all* standard O-rings for fuel, hydraulic and engine oil services, and for special service O-rings. Ask your PARKER Distributor for Catalog 5100, or write The PARKER Appliance Company, 17325 Euclid Avenue, Cleveland 12, Ohio.

Parker

TUBE FITTINGS • VALVES • O-RINGS

Plants in Cleveland • Los Angeles • Eaton, Ohio • Berea, Ky.

Parker O-RINGS ARE STOCKED BY THESE AUTHORIZED DISTRIBUTORS

AKRON, O.
B. W. Rogers Co.
850 So. High St. (9)

BOSTON, Mass.
Irving B. Moore Corp.
65 High Street

BUFFALO, N. Y.
Hercules Gasket & Rubber Co.
327 Washington St. (3)

CHICAGO, Ill.
Air Associates, Inc.
5315 W. 63rd St. (38)
Shields Rubber Co.
564 W. Randolph St. (6)

CLEVELAND, O.
Cleveland Ball Bearing Co.
3865 Carnegie Ave. (3)
Neff-Perkins Co.
2130 St. Clair Ave. (14)

DALLAS, Tex.
Air Associates, Inc.
3214 Love Field Dr. (9)
Metal Goods Corp.
6211 Cedar Springs Rd. (9)

DENVER, Colo.
Metal Goods Corp.
2425 Walnut St.

DETROIT, Mich.
J. N. Fauver Co.
49 West Hancock St. (1)

FORT WORTH, Tex.
Adco Industries
3414 Camp Bowie Blvd.

HOUSTON, Tex.
Metal Goods Corp.
711 Milby St. (1)

INDIANAPOLIS, Ind.
F. H. Langsenkamp Co.
229 E. South St.

KANSAS CITY, Mo.
Metal Goods Corp.
1300 Burlington Ave. (16)

LOS ANGELES, Cal.
Aero Bolt & Screw Co., Inc.
1071 Arbor Vitae Ave.
Inglewood, Calif.
Synthetic Rubber Products Co.
1538 South Eastern Ave. (22)

MIAMI, Fla.
Air Associates, Inc.
International Airport

MILWAUKEE, Wis.
Allrubber Products & Supply Co.
612 So. Second St. (4)

MINNEAPOLIS, Minn.
Van Dusen Aircraft Supplies, Inc.
2004 Lyndale Ave., South (5)

NEW ORLEANS, La.
Metal Goods Corp.
432 Julia St. (12)

NEW YORK, N. Y.
Durham Aircraft Service Co.
5615 Northern Blvd., Woodside, N. Y.
Nielsen Hydraulic Equipment, Inc.
298 Lafayette St. (12)

PHILADELPHIA, Pa.
Goodyear Supply Co.
1506 Latimer St.

PITTSBURGH, Pa.
Shields Rubber Co.
137 Water St. (22)

PORTLAND, Ore.
Hydraulic Power Equipment Co.
2316 N. W. Savier St. (10)

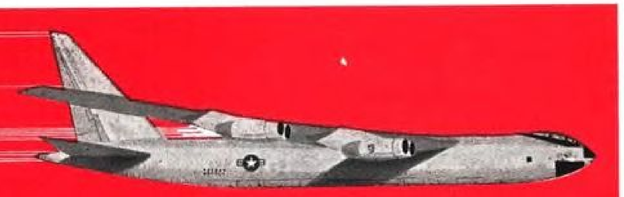
ST. LOUIS, Mo.
Metal Goods Corp.
5239 Brown Ave. (15)

TULSA, Okla.
Metal Goods Corp.
302 North Boston (3)

WICHITA, Kans.
Standard Products, Inc.
650 E. Gilbert (11)

CANADA
Railway & Power Engineering Corp., Ltd.
3745 St. James St.

HOW MUCH ARE YOU PENALIZING YOUR FLIGHT TEST PROGRAM?



The flexibility and effectiveness of Bendix-Pacific Telemetering Systems are materially speeding up flight test programs for several air frame companies, and cutting costs at the same time.

Standardized Systems are available which provide for compact, lightweight airborne equipment and stable ground recording stations. The systems will measure any kind of information that can be recorded by older methods—and with an accuracy that can be depended upon.

The effectiveness of Bendix-Pacific telemetering equipment is being demonstrated in the wide range and multiplicity of information transmitted simultaneously. Numerous flutter tests, for example, can be observed and flight conditions varied by radio communication while a single flight is in progress. The crew is free to concentrate on flying the airplane. The system also offers an important safety factor by warning of any dangerous conditions.

Above—Typical universal airborne package is provided with plug-in components for quick change over of testing factors.

Below—The ground station can include visual recording equipment for in-flight study by engineers. Such recordings are invaluable should the aircraft be lost.

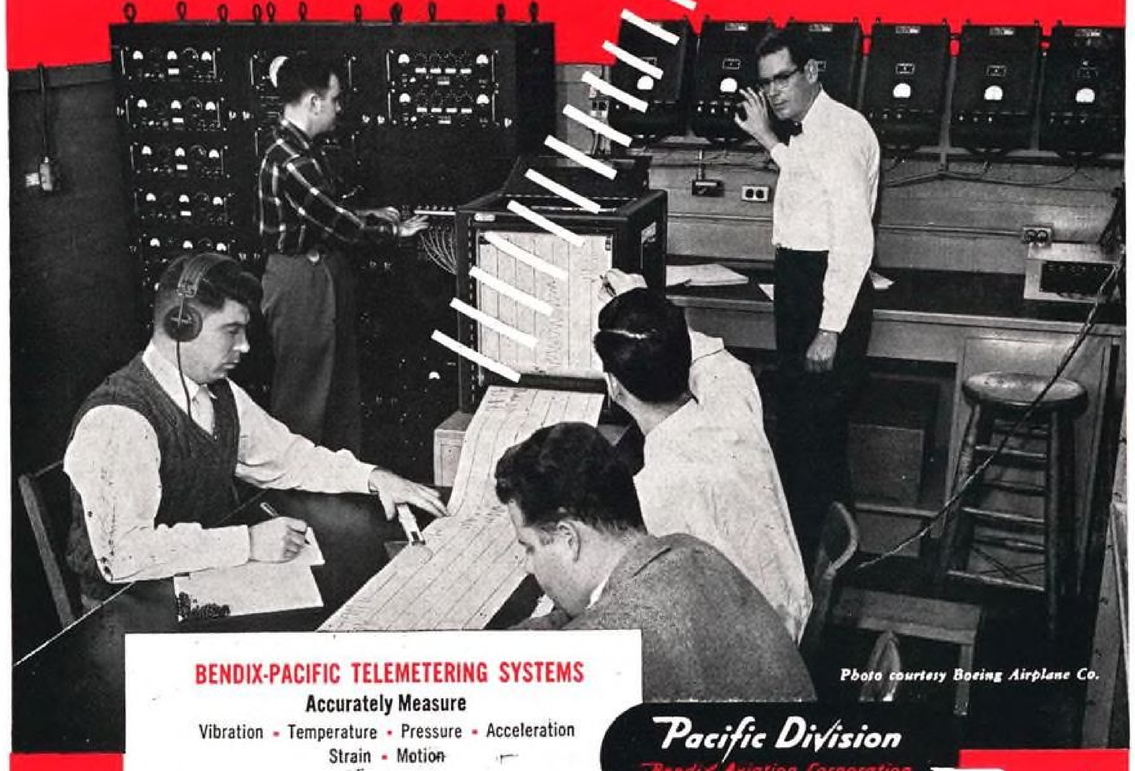


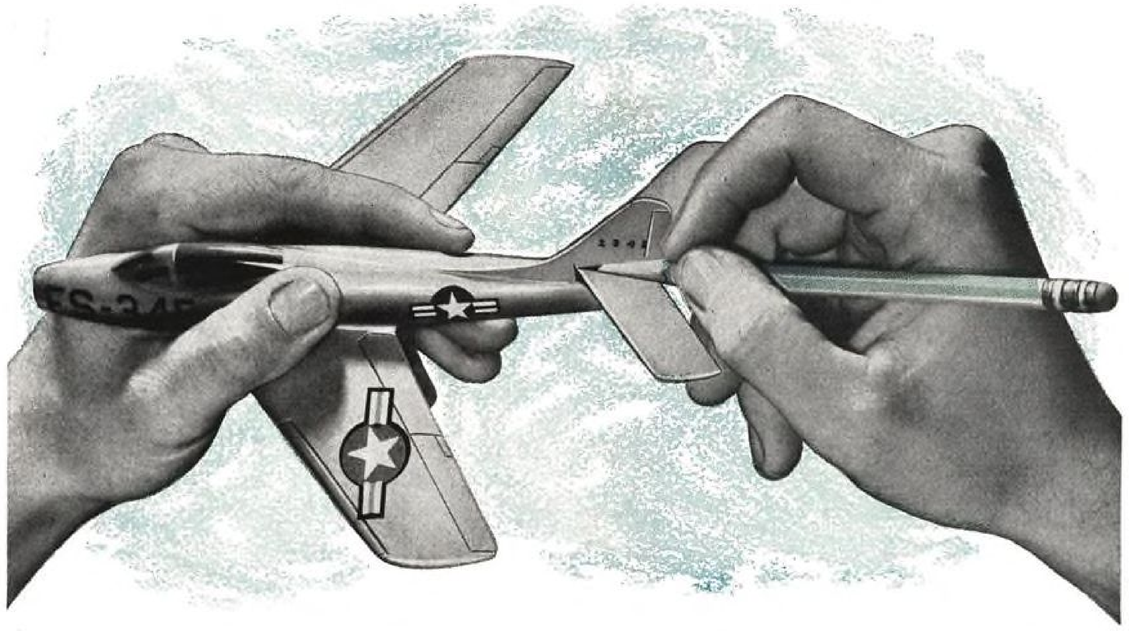
Photo courtesy Boeing Airplane Co.

BENDIX-PACIFIC TELEMETERING SYSTEMS
Accurately Measure
Vibration • Temperature • Pressure • Acceleration
Strain • Motion

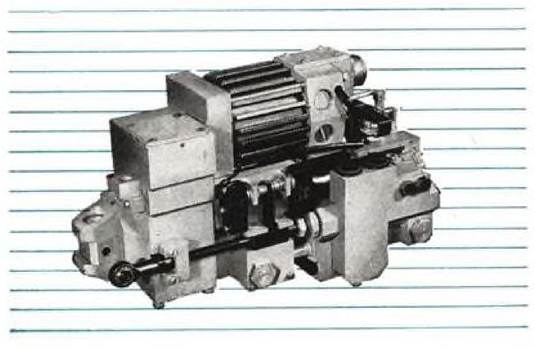
Pacific Division
Bendix Aviation Corporation
NORTH HOLLYWOOD, CALIF.

Bendix

AIRCRAFT HYDRAULIC CONTROLS • AIRBORNE RADAR • SONAR • INDUSTRIAL HYDRAULIC CONTROLS • TELEMETERING • ELECTRO-MECHANICAL EQUIPMENT
East Coast Office: 475 Fifth Ave., N. Y. 17 • Export Division: Bendix International, 72 Fifth Ave., N. Y. 11 • Canadian Distrib.: Aviation Electric, Ltd., Montreal



AEROPRODUCTS ACTUATORS RELIEVE DESIGN PROBLEMS



Aeroproducts self-locking actuators . . . by providing instantaneous adjustment of variable surfaces to any position within their designed range . . . have eliminated many previous restrictions in aircraft design. Without pre-selection or positioning, these new actuators permit variable surfaces to be locked in position and held until changed by the pilot.

Any combination of systems—hydraulic, pneumatic, electric or manual—can serve as the primary power source. These actuators can be synchronized readily in tandem or in series to provide coordinated control of related movements.

Announced uses of Aeroproducts self-locking actuators include control of the "flyable tail" of the new Republic F84F "Thunderstreak" jet fighter, the horizontal stabilizer on another high-speed jet fighter, and the afterburner of a jet engine. Additional applications include control of wing flaps, dive brakes, bomb bay or cargo doors, gun turrets, variable wing sweep and incidence, wing fold and canopy slides.

Building for today
Designing for tomorrow

AEROPRODUCTS GM

GM GENERAL MOTORS

Aeroproducts

ALLISON DIVISION • GENERAL MOTORS CORPORATION
DAYTON, OHIO

REMARKABLE DESIGN

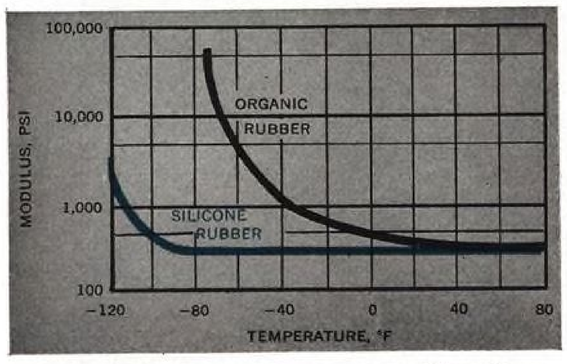
NEW SILICONE

DEMONSTRATED BY TEST...

High temperature resistance: Elevated temperatures have no appreciable effect on the 1000-1200 volts per mil dielectric strength of glass cloth coated with SE-100.

SE-100—IDEAL FOR ELECTRICAL AND MECHANICAL APPLICATIONS!

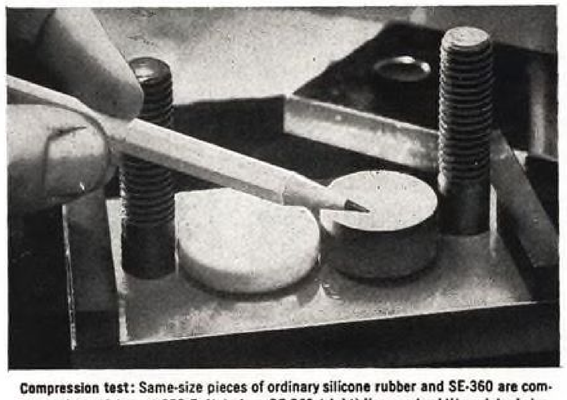
General Electric's new silicone rubber coating compound, SE-100, combines outstanding heat resistance, electrical and physical properties for a wide variety of electrical and mechanical applications. SE-100 may be coated on glass or organic fabrics for service at high or low temperatures or where resistance to weather, ozone, corona or chemicals is required.



Flexible at −120 F: A glance at the blue curve shows the difference (Young's Modulus in flexure) of SE-550 versus organic rubber after 24 hours.

SE-550—STILL FLEXIBLE AFTER 24 HOURS AT —120 F!

G. E.'s new extreme low-temperature silicone rubber, SE-550, combines high strength and elongation with maximum low-temperature usefulness. SE-550 shows practically no increase in modulus at −100 F and retains useful flexibility at −120 F. This flexibility is achieved without sacrifice of high-temperature resistance or any of the other desirable properties inherent in silicone rubber.



Compression test: Same-size pieces of ordinary silicone rubber and SE-360 are compressed for 22 hrs. at 350 F. Note how SE-360 (right) "comes back" to original size.

SE-360—MORE "COME BACK" THAN ANY KNOWN RUBBER!

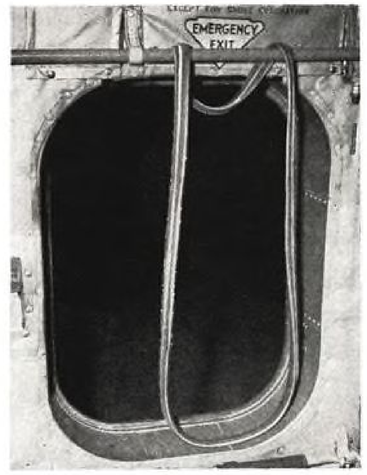
G. E.'s new low compression set silicone rubber, SE-360, is designed to provide more positive sealing action in parts subject to compression at elevated temperatures. In addition to its outstanding low compression set, SE-360 has unusually low shrinkage when cured. This means parts with more uniform properties, closer tolerances and opportunities for your fabricator to cut scrap loss.

POSSIBILITIES OF THREE GREAT

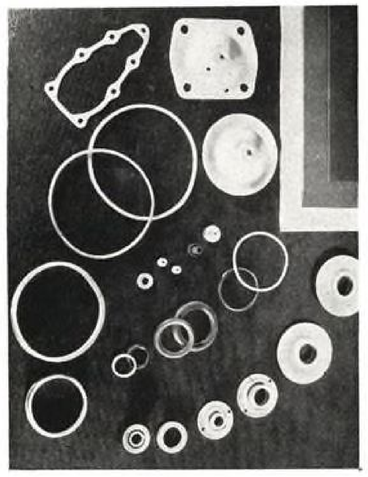
RUBBER COMPOUNDS

CONFIRMED BY APPLICATION

G.E.'s SE-100 silicone rubber is finding steadily increasing application in the electrical industry for coating cloth, tapes and sleeving; for coating glass-served wire; for encapsulating coils. Among the many mechanical uses for SE-100 are ducts and tubing; gaskets and seals; diaphragms.



Gaskets for emergency hatches (shown here at 50 below zero F) astra domes and access windows on the Douglas Globemaster are now made of G.E.'s SE-550 silicone rubber because it remains flexible and maintains a seal at extremely low temperatures; does not stick to metal after long inactivity.



O-rings, gaskets and seals are being designed with G.E.'s new SE-360 silicone rubber for applications where sustained resilience at high temperatures is required. Aircraft, automotive and railway design engineers find SE-360 ideal for jet engine parts, transmission seals and Diesel gaskets.

FOR MORE INFORMATION

about these new G-E silicone rubber compounds, just mail the coupon! You will also receive a free copy of "Imagineering with Silicone Rubber" which describes other G-E silicone rubber products and tells how you can put them to work.

You can put your confidence in—

GENERAL ELECTRIC

CLIP AND MAIL TODAY!

General Electric Company
Section 351-6A
Waterford, New York

Please send me product data on ( ) SE-100 ( ) SE-550 ( ) SE-360, including a free copy of "Imagineering with Silicone Rubber." I want this information for ( ) Reference purposes only ( ) An immediate application on

_____

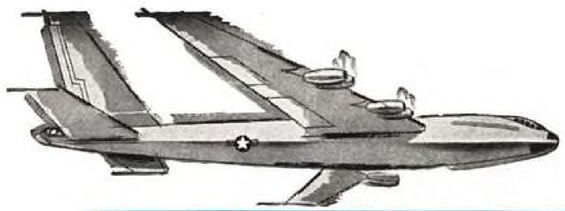
Name_____

Firm_____

Street_____

City_____ Zone_____ State_____

(In Canada, mail to Canadian General Electric Company, Ltd., Toronto)



EVERY TYPE OF PLANE . . . IN

EVERY TYPE OF SERVICE

USES THOMPSON

PUMPS

Practically every American-made aircraft . . . commercial, private, and military . . . relies on pumps built and designed by Thompson to maintain flight operations with fewest non-scheduled removals.

Thompson has over 50 years of experience in the aircraft and automotive industries. From this experience has come leadership and know-how in developing seals, perfecting alloys and mechanisms to pump aviation fuels at widely varying pressures, temperatures, and altitudes.

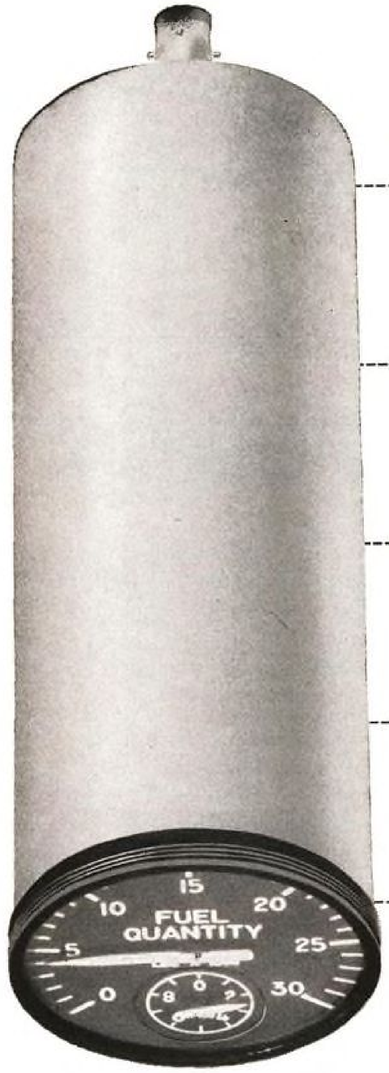
Fuel booster, water-alcohol, and engine-driven pump applications . . . you'll find a Thompson pump to do the job with simplicity, dependability, and economy.

Just tell us your requirements.

Accessories Division

Thompson Products, Inc.

DEPARTMENT AC-8 • CLEVELAND 17, OHIO



1 IT COSTS LESS. This "repackaging" of Avien's fuel gaging system brings the purchase price to a new low. The system is reduced to a sensing unit and an indicating unit, eliminating the bulky and expensive intermediary unit.

2 IT'S 50% LIGHTER. Lightness always brings cost savings. Avien's Two-Unit Fuel Gage incorporates the bridge and amplifier functions into the indicator case. Less wiring and connectors are needed.

3 IT NEEDS NO FIELD ADJUSTING. With the elimination of the intermediate unit, which had to be supplied as a common part, *all* Avien units are pre-calibrated for the aircraft they are designed for.

4 IT TAKES LESS TIME TO INSTALL. The Two-Unit Gage is remarkably easy to install. No specially-trained personnel are needed. No specialized test equipment is needed. No calibration instruction or data is needed.

5 IT'S EASIER TO MAINTAIN. With fewer components in the system, less maintenance is required. Trouble-shooting becomes easier. And fewer parts must be stocked for replacement and repair.

6 IT CAN BE INTEGRATED WITH FUEL MANAGEMENT. Simulators, level switches, balancing controls, etc., can be hooked up to the Two-Unit basic system with less expense and less trouble than ever before.

6 definite ways you can cut costs with Avien's "TWO-UNIT" FUEL GAGE

Avien's Two-Unit Fuel Gage is creating a lot of talk with manufacturers, engineers, and purchasing men.

This new "package" means that Avien units are now all "shelf items." As long as the units are designed for the same aircraft, they're completely interchangeable.

The Avien Two-Unit Fuel Gage is now scheduled for production, to meet your manufacturing programs. The indicator is available in either large or small sizes, with all varieties of dial configurations.

Every month, Avien produces over ten thousand major instrument components for the aviation industry.

We believe the Two-Unit Gage is so important that your inquiry should not be delayed another day. Write or call us.

Avien

AVIATION ENGINEERING DIVISION

AVIEN-KNICKERBOCKER, INC.

58-15 NORTHERN BOULEVARD, WOODSIDE, L. I., N. Y.

What JACK & HEINTZ *is doing about...*

COMPLEXITY

Converting a baffling jigsaw puzzle of scattered electrical controls, protective devices and miles of wiring into one easily serviced, plug-in panel no larger than a table radio . . . Jack & Heintz is helping to solve the serious problem of aircraft complexity.

Complexity is just one of the problems we face in *our business* of developing and producing complicated, lightweight, high-output electrical, electromechanical and hydraulic devices . . . designed to meet extreme conditions of stress, temperature and environment.

The name *Jack & Heintz* on aviation or commercial products stands for advanced engineering . . . precise manufacturing . . . pretested performance. Write Jack & Heintz, Inc., Dept. 805, Cleveland 1, Ohio.

JACK & HEINTZ
Rotomotive
EQUIPMENT

©1953, Jack & Heintz, Inc.

means electrical, hydraulic or mechanical devices designed to solve unusual problems of developing power, controlling it or using it.

Aircraft Generating Equipment—a-c and d-c—including Control Systems and Components • Electric Starters • Actuators and Special Aircraft Motors • Custom-built Commercial Motors • J&H Eisemann Magnetos

These Kodagraph Autopositive Intermediates

Protect vital drawings

You're looking behind the scenes at the American Locomotive Company, Ordnance Division, Schenectady, New York.

The prints you see streaming from the processing machine are positive photographic reproductions of M47 tank drawings. They're produced without a negative step . . . and under ordinary room light.

This fast, low-cost operation enables the Ordnance Division to protect thousands of M47 drawings against expensive wear and tear. For the drawings are filed away after the Autopositives are made. Then, because the engineering department of the Ordnance Division holds the design contract for the M47, these highly legible and durable intermediates are used to produce all the quantity prints required by the 29 manufacturers and government agencies involved in the distribution of engineering changes on the M47 tank.

Produce better prints

These Kodagraph Autopositive intermediates, used in place of the valuable original drawings, produce sharp, legible blueprints or direct-process prints time after time. Their dense photographic black lines—on an evenly translucent paper base—will not smear or lose density . . . which simplifies print production and eliminates reading errors and bottlenecks all along the line. *And another important point*—Autopositives are photo-lasting in the files . . . will not turn yellow or become brittle.

Advantages which you will appreciate, too, in your own operations. *And, remember, this is only part of the Autopositive story!*

Kodagraph Autopositive Paper

"THE BIG NEW PLUS" in engineering drawing reproduction

Learn how you, or your local blueprinter, can process this unique photographic intermediate paper at low cost . . . *with existing equipment;* how it is used to reclaim drawings . . . speed design changes in thousands of drafting rooms.

MAIL COUPON TODAY — 107

EASTMAN KODAK COMPANY
Industrial Photographic Division, Rochester 4, New York

Gentlemen: Please send me a copy of "New Short Cuts and Savings" . . . describing the many savings Kodagraph Autopositive Paper is bringing to industry.

Name_____ Position_____

Company_____

Street_____

City_____ Zone____ State_____

Kodak
TRADE-MARK

Only

ELECTRO TEC

PRECISION-MINIATURE

slip ring assemblies

AND COMMUTATORS

offer all these advantages:

EXCLUSIVE* ELECTRO TEC TECHNIQUES

insure closer tolerances, absolute uniformity, and the ultimate in miniaturization

Electro Tec units are the product of an exclusive manufacturing technique that results in accuracy unattainable by conventional fabricating methods. In this process a plastic is moulded around the wire leads. Accurate machining reduces this blank to the proper shape, complete with grooves. Hard silver is deposited into the grooves by electroplating to produce the required rings. Final machining insures concentricity and dimensional accuracy. The result is one-piece, unitized construction with conducting rings of 60 to 70 Brinell hardness.

Diameters of these assemblies range from .045" to 24" cylindrical or flat. Cross-sections may range from .005" to .060" or more. Rings are polished to a jewel-like finish and can be held to 4 micro-inches or better. Even the smallest sizes withstand a 1000 V.A.C. breakdown test. Most types easily withstand rotational speeds up to 12000 rpm.

ELECTRO TEC Assemblies are Specified by the Nation's Leading Precision Instrument and Equipment Manufacturers for Proven Greater Dependability, Longer Life, Smoother Functioning.

The uniformly superior performance of Electro Tec slip ring and commutator assemblies in thousands of industrial and governmental applications has resulted in wide adoption of these component units by most leading manufacturers of precision instruments and equipment. Although these products provide improved performance and extra dependability, prices are strictly competitive. Write today for fully illustrated literature.

- ONE PIECE, UNITIZED CONSTRUCTION
- ABSOLUTE MINIMUM TORQUE FRICTION
- DIAMETERS FROM .045" TO 24.0"
- MINIMUM 1000 V.A.C. HI-POT INTER-CIRCUIT
- UNIFORMLY HARD SILVER RINGS PLATED INTO GROOVES ON PRECISION MACHINED ONE PIECE PLASTIC FORM
- SPECIAL SURFACE DEPOSITS PREVENT TARNISH, MINIMIZE FRICTION, BRUSH NOISE AND PRACTICALLY ELIMINATE WEAR

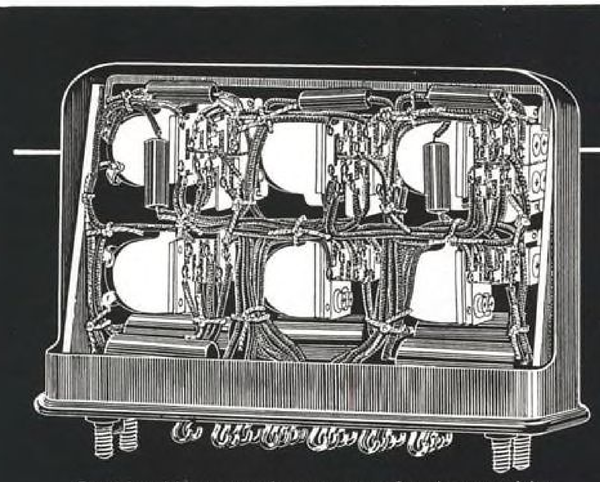
*PATENTS PENDING

ELECTRO TEC CORPORATION

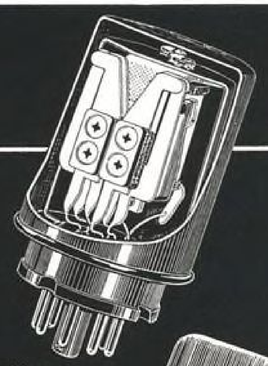
SO. HACKENSACK NEW JERSEY

PRODUCTS OF PRECISION CRAFTSMANSHIP BY A NEW AND REVOLUTIONARY PROCESS

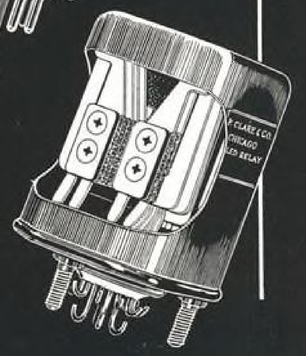
CLARE offers the widest variety of HERMETICALLY SEALED RELAYS for most exacting design requirements!



Considerable cost and space can often be saved by sealing more than one relay in an enclosure. Illustration shows six CLARE Type "K" relays, associated resistors and capacitors, wired and mounted in a common enclosure.



Here is one of over 300 plug-in relays in the CLARE SK-5000 series.



CLARE Type "N" relay in a Series SN-41000 container.

What CLARE Hermetic Sealing Means:

After assembly in the container, the enclosure is attached to a high vacuum pump and pumped down to a few microns pressure to remove all traces of moisture and gases, then flushed with dry nitrogen, and again pumped down.

While under this extreme vacuum, the enclosure and seals are tested for leaks by means of a Mass Spectrometer—a device so sensitive that it can detect a leak so tiny that more than thirty-one years would be required for one cubic centimeter of air to pass through it. This highly refined method of leak testing causes rejection of many enclosures which could pass the usual immersion tests without detection.

For most applications, the enclosure is then filled with dry nitrogen, which has a relatively high arcing potential.

IN THE fourteen years since CLARE first began the development of hermetically sealed relays for airborne, military and industrial use, CLARE has developed over 50 different series of hermetically sealed relays.

Each series varies in the size of the container, the number and kind of terminals, mounting facilities and the type or types of relays which can be sealed in it. Within each series, innumerable variations of relay coil and contact specifications are possible.

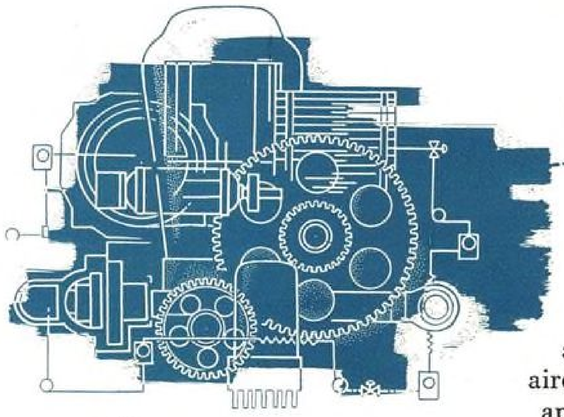
Two things, however, never vary: the high quality of the CLARE relay which goes into each enclosure and the completely airtight sealing which permits no gas or spirit to escape from the enclosure or enter it.

If your product requires the use of hermetically sealed relays, CLARE can supply you just the relay you need from this wide variety, or will develop and seal for you a special, "custom-built" relay to meet your most exacting requirements.

Send for CLARE BULLETIN NO. 114 on Hermetically Sealed Relays or contact the nearest CLARE sales engineer for complete information. Address: C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Co., Ltd., Toronto 13. Cable address: CLARELAY.

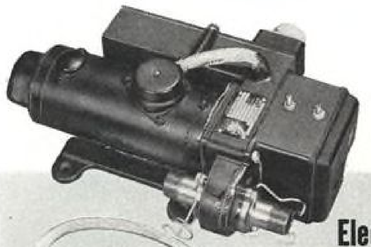
CLARE RELAYS

...First in the Industrial Field

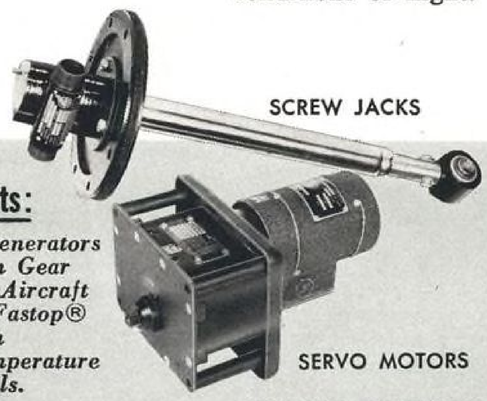


BRAINS, NERVES,

Typical of modern aeronautical miracles are systems that activate, guide and control subsonic and supersonic flight. Lear electro-mechanical equipment and gyro instrument products for commercial aircraft and modern military planes measure and apply the forces necessary to maintain required conditions of flight.



POWER UNITS



SCREW JACKS

LINEAR AND ROTARY ACTUATORS

Electro-Mechanical Products:

Sub-Miniature • Motor-Generators Motor Driven Precision Gear Mechanisms • Precision Aircraft AC and DC Motors • Fastop® Electro-Magnetic Clutch Automatic Electronic Temperature and Positioning Controls.

SERVO MOTORS

GRAND RAPIDS DIVISION

Fluid System Components:

Fuel, Oil and Air Pumps • Rotary Hand Pumps Fluid Regulator Valves • Water Injection Pumps Airborne Air Compressors • Centrifugal and Turbine Pumps • Pressurization Assemblies for Radar • Camera Vacuum Pumps • Pneumatic Motors • Absolute Pressure Switches • Dehydrators.

OIL AND HYDRAULIC PUMPS

LEAR-ROMEC DIVISION

Autopilots, Radio Communication and Navigation Equipment:

VHF communications and Automatic Omnirange Navigation equipment • VHF Airport Communications • Low Frequency Receivers • Automatic Flight Control Systems.

AUTOPILOT SYSTEMS

OMNIMATIC® SYSTEMS

LEARCAL DIVISION

LEAR, INCORPORATED

EXECUTIVE OFFICES,
3171 South Bundy Drive,
Los Angeles 34, California

MUSCLES... for Safer, Faster, Flight!

Lear-Romec pumps, compressors and related components handle air, water, lubricants, hydraulic fluid, anti-detonant solutions and gasoline.
Lear aircraft radio communication and navigation and flight control equipment has been selected by leading executive airplane manufacturers as standard factory installed accessory equipment.

For detailed information please address the Division concerned, as listed below.

Instrument Products:

Automatic Flight Controls
Automatic Approach Couplers • Gyros for Control Mechanisms
Remote Reading Gyro Instruments • Rate Gyros • Yaw Damper Systems
Missile Controls (Stabilization and Maneuvering).

DIVISION

AUTOPILOT SYSTEMS

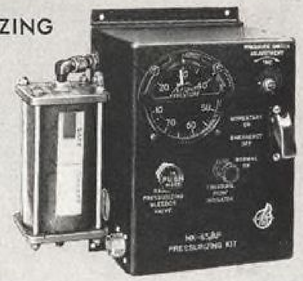
GYRO CONTROL SYSTEMS

PRESSURIZING EQUIPMENT

DIVISION

FUEL PUMPS

PRESSURIZING KITS



DIVISION

AUTOMATIC DIRECTION FINDERS

MULTI-CHANNEL VHF

MARKER BEACON RECEIVER (CAATC)

Advancing the Frontiers of Flight

LEAR-ROMEC DIVISION, Abbe Road, Elyria, Ohio
LEARCAL DIVISION, 11916 West Pico Boulevard, Los Angeles, California
GRAND RAPIDS DIVISION, 110 Ionia Ave., N.W., Grand Rapids 2, Michigan.

The Most Trusted Name in Ignition

in research, design and manufacturing

For over a quarter of a century, Bendix has set the pace in meeting the ever changing ignition problems of the industry. It is perfectly obvious that solutions to this perpetual challenge of product improvement and application can only be found by an unceasing search for advanced design, better materials and more efficient manufacturing methods.

How well Bendix has met this challenge is evidenced by the overwhelming endorsement the aviation industry has given to Bendix ignition equipment.

Whether the requirement is for a better electrical connector or a complete new ignition system, the industry has come to look upon Bendix as the one source best qualified to meet every ignition problem.

Remember, the unmatched facilities of Bendix are yours to command from planning to finished product.

AVIATION PRODUCTS

Low and high tension ignition systems for piston, jet, turbo-jet engines and rocket motors . . . ignition analyzers . . . radio shielding harness and noise filters . . . switches . . . booster coils . . . electrical connectors.

Bendix

SCINTILLA MAGNETO DIVISION
SIDNEY, NEW YORK

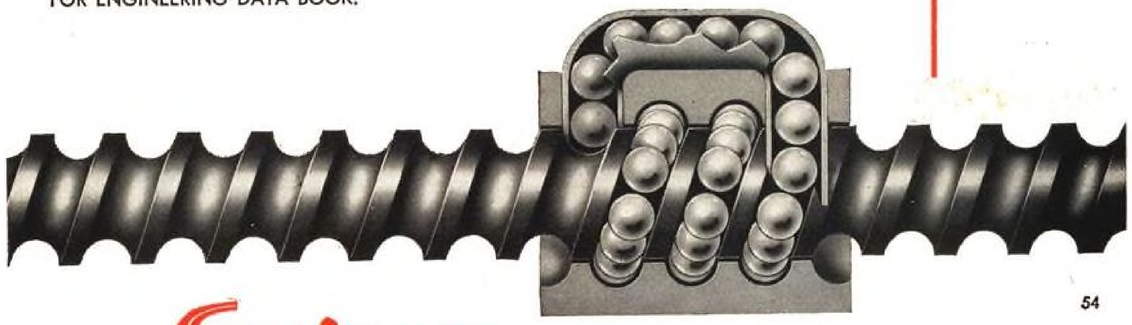
Export Sales: Bendix International Division 72 Fifth Avenue, New York 11, N. Y.

FACTORY BRANCH OFFICES: **117 E. Providencia Avenue, Burbank, California • Stephenson Building, 6560 Cass Avenue, Detroit 2, Michigan • Brouwer Building, 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California**

SAGINAW BALL BEARING SCREWS PROVE THEIR EFFICIENCY IN THE BANSHEE

Nine of the electro-mechanical actuators on the McDonnell Banshee F2H-2 use Saginaw Recirculating ball-bearing screw and nut mechanisms. Installations include wing fold, main landing gear, landing gear doors, speed brakes and nose landing gear. Saginaw screws with rotary-to-linear force transmitted through rolling steel balls operate at more than 90% efficiency. This means that the torque —the rotary power equipment—is only a small fraction of that required for a thread-to-thread screw, thus resulting in important weight savings. Saginaw screws are efficient, accurate, reliable, compact, and low in weight-strength ratio. They can be effectively combined with electrical, hydraulic or pneumatic units and can be furnished for actuator applications in any size in a complete range of load and life requirements.

FOR MORE COMPLETE INFORMATION, WRITE FOR ENGINEERING DATA BOOK.



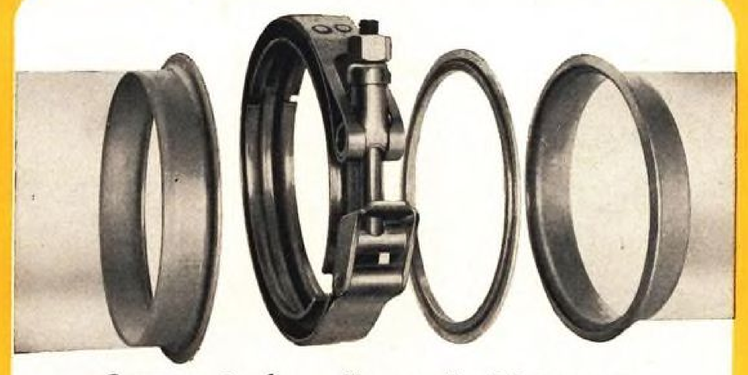
54

Saginaw STEERING GEAR
DIVISION, GENERAL MOTORS CORPORATION, SAGINAW, MICHIGAN
MANUFACTURER OF SAGINAW POWER STEERING FOR PASSENGER CARS, TRUCKS AND TRACTORS

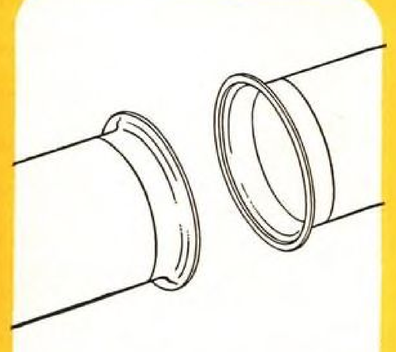
Lightweight LIVE JOINT SYSTEM

FOR HIGHER TEMPERATURES AND HIGHER PRESSURES

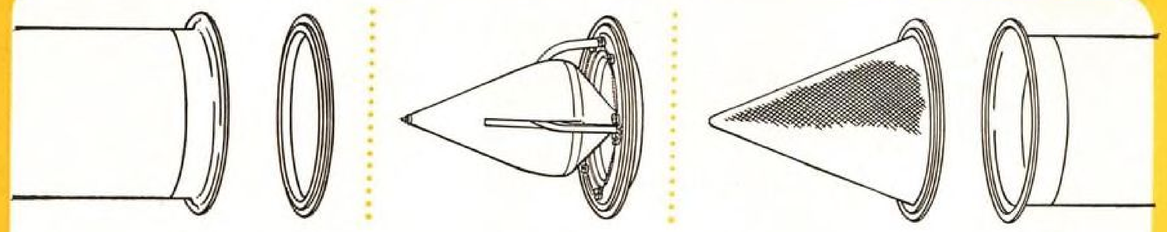
Completely new Marman live joint system speeds assembly—cuts costs—saves weight. It consists of a V-Band Coupling with integral stainless steel flanges. The unique design of the joint allows the introduction of a screen or check valve in the joint assembly without further modification.



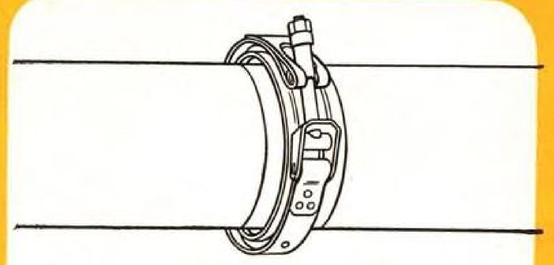
Components of new Marman live joint system.



1. Weld flanges to ducting



2. Insert metal self-aligning seal, . . . valves . . . . . or filters.



3. Assemble with Marman V-Band coupling for positive seal and dependable operation.

Easy to specify for quick delivery in a wide range of sizes—for information write Dept. W-5

MARMAN
PRODUCTS CO., Inc.
11214 EXPOSITION BLVD.
LOS ANGELES 64, CALIF.

Potent Applied For

3-432

New helicopter to hit 180 mph with help of 17 TIMKEN® bearings

TO make its new Model 104 helicopter faster than previous models, Jacobs Aircraft Engine Company designed a new one-unit engine and transmission. Weight was reduced 20% compared to installations of equal horsepower. Speeds were increased to 180 mph top, 150 mph cruising.

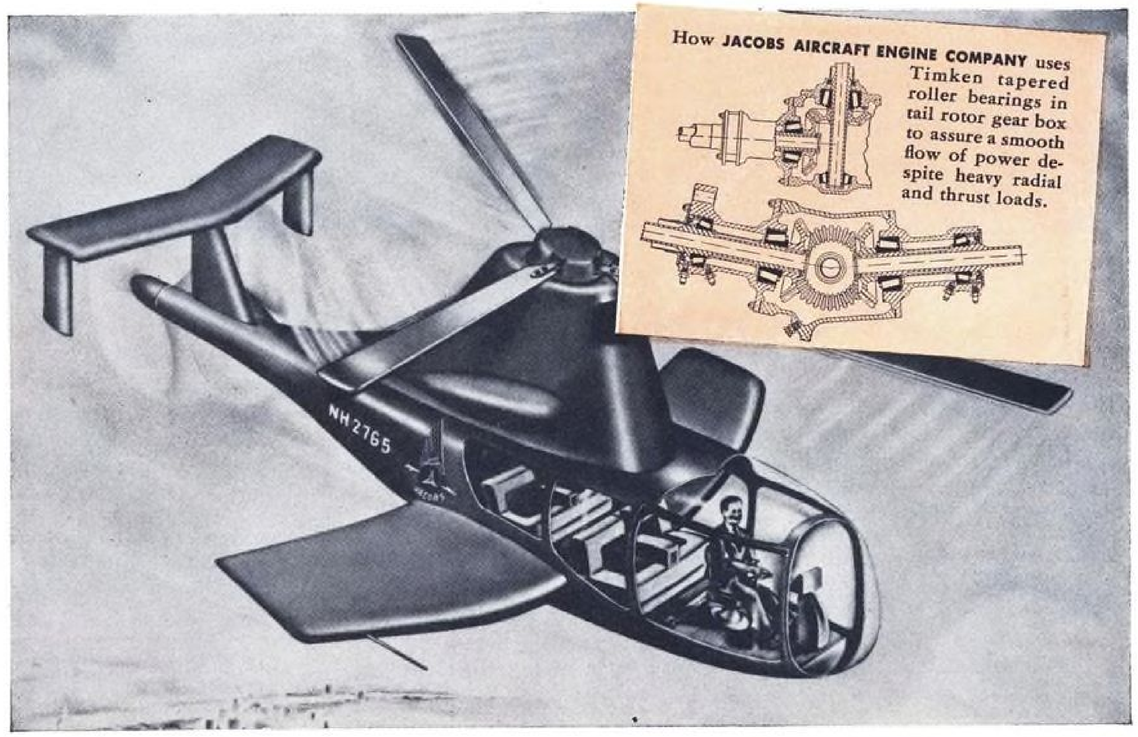
To keep the transmission light yet rugged, the gears were specially designed for this application and Timken® tapered roller bearings were specified for the transmission shafts.

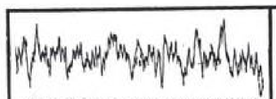
In both the transmission and tail rotor gear box, Timken bearings hold shafts in rigid alignment. Gears mesh accurately, transmit a smooth flow of power with minimum vibration. Fewer transmission and gear box overhauls are required.

The main rotor shaft takes not only the tremendous radial loads of the whirling blades, but also a thrust load equal to the weight of the helicopter itself. For this reason, the shaft was mounted on Timken bearings. Their tapered construction lets them take radial and thrust loads in any combination.

Whether you build or buy aircraft, make sure the bearings have the trade-mark "Timken". No other bearing can give you so many advantages. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN BEARING EQUIPPED — *This symbol on a product means its bearings are the best.*



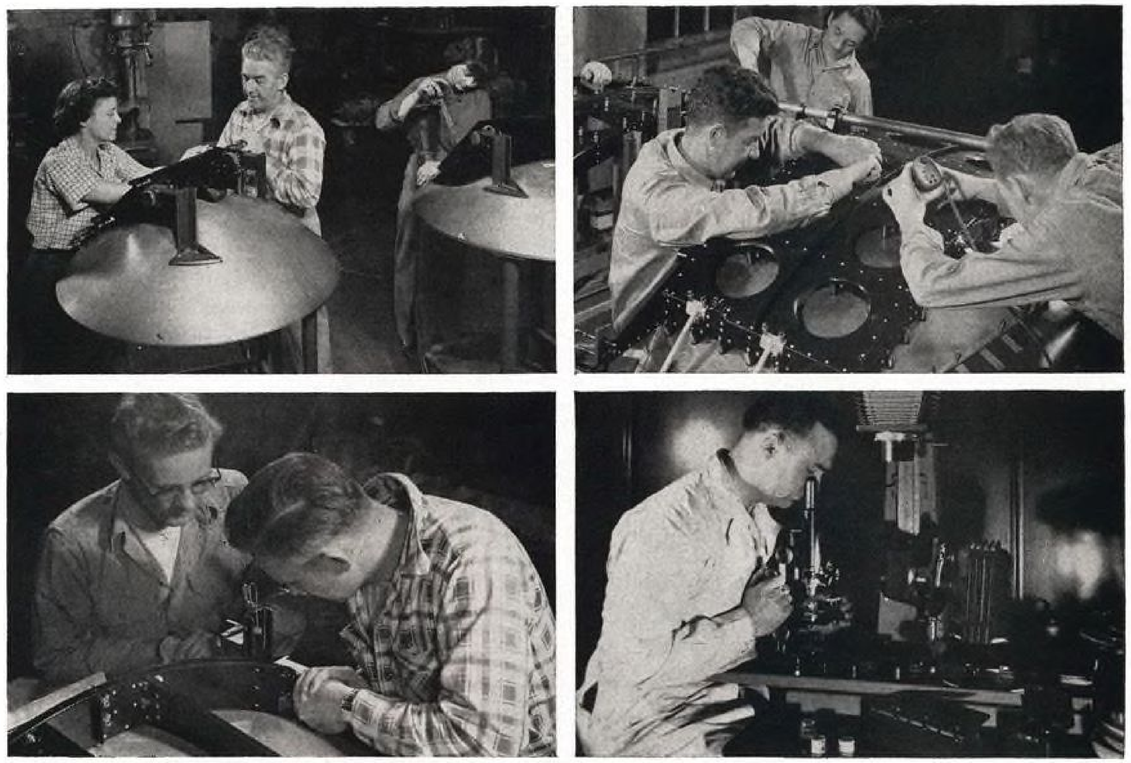


SMOOTH TO MILLIONTHS OF AN INCH

Surface finish of high quality Timken bearing rollers and races is so smooth that it takes a profilograph to measure its smoothness. This instrument measures surface variations to a millionth of an inch, as shown at the left.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◫ AND THRUST →◫← LOADS OR ANY COMBINATION



REFLECTORMEN, FIRST CLASS

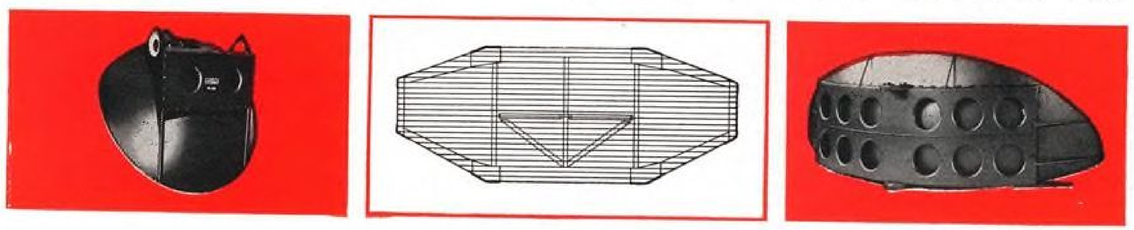
The nation's leading electronics manufacturers look to Lavelle for radar reflector fabrication that fulfills every precise specification of their design engineers. They have learned from experience that they can *count on Lavelle.*

Many years' experience in fabricating stainless steel, aluminum and allied metals qualifies Lavelle as true specialists in this field. Staff and facilities are complete — Customers' Engineering Staff, great diversity of jigs and fixtures, equipment for all types of welding, mechanical and microscopic inspection facilities and a complete anodizing plant.

Together, these men, methods and machines have brought Lavelle widespread recognition as a first-class, reliable subcontractor to the electronics industry.

Lavelle

AIRCRAFT CORPORATION • NEWTOWN, BUCKS COUNTY, PA.



gearing for the *Age of Flight* at WESTERN GEAR WORKS

Designing, manufacturing, testing and producing in quantity — one or thousands — of specialized gear drives for the Aviation Industry has been a major activity at Western Gear since the first days of mechanized aircraft. Western Gear aircraft engineers are available to work with you to efficiently and effectively solve your mechanical power transmission problems. Call on us now — no obligation.

Turbine powered auxiliary power unit is shown. Western Gear has designed and built many gear drives for use with gas turbines.

Actuators . . . illustrated is a special dual powered rotary actuator using both hydraulic and electric motors. Thousands of different types of specialized actuators have come from Western Gear drawing boards.

Avionics . . . Electronics in Aviation . . . electronic equipment manufacturers use Western Gears for many kinds of airborne equipment. Fine pitch differential shown was used on electronic equipment aboard guided missile.

Power-On Scale Models . . . illustrated is a Western Gear designed and built scale model of counter rotation unit for power-on wind tunnel testing.

Illustrated is a Western Gear main power drive for a wind tunnel. Many standard and special gear drives are available for laboratory, research and other aviation industry experimental projects.

5329

WESTERN GEAR WORKS

Manufacturers of **PACIFIC-WESTERN** Gear Products

Pacific Gear & Tool Works

Our 65th year

Plants: **Seattle**
San Francisco
Belmont (S. F. Peninsula)
Lynwood (Los Angeles County)
Pasadena
Houston

Write, wire or phone your nearest Pacific-Western office

Plants—417 Ninth Ave. S., Seattle 4, Washington
2600 E. Imperial Highway, Lynwood (Los Angeles County), California
1035 Folsom St., San Francisco 3, California
Belmont (San Francisco Peninsula), California
132-134 W. Colorado St., Pasadena 1, California
117 N. Palmer St., Houston 3, Texas

Representatives—N. 2665 Division St., Spokane, Washington
930 S. E. Oak St., Portland 14, Oregon
Room 212, Ross Bldg., Denver 2, Colorado
500 South Ervay Street, Dallas, Texas
Engineering & Machinery Ltd., 1366 W. Broadway, Vancouver, B. C.

DID YOU GET YOUR COPY OF GEARING FOR THE AGE OF FLIGHT? Use the convenient coupon below to obtain this important brochure.

WESTERN GEAR WORKS
Executive Offices, Post Office Box 182, Lynwood, California

Please send booklet No. 5201
"GEARING FOR THE AGE OF FLIGHT"

NAME_____

COMPANY_____

TITLE_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

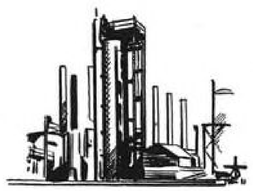
Esso Q.C.*

makes the difference!

***Quality Control** of aviation petroleum products means *safety,* peak performance and economy to international aircraft operators everywhere – and quality control depends on constant and thorough *testing.*

Aviation gasoline refined in one country may be distributed for use in many other areas. The interval between a refinery run of an average overseas shipment of ESSO aviation fuel, and delivery into aircraft by ESSO Aviation Service, often is measured in thousands of miles and many days. It is transported by tanker, by rail, by barge, by pipeline or by other means.

Yet the quality control of ESSO fuel is vigilantly supervised every step of the way. En route, the product is subjected to numerous quality inspections to insure uniformity and compliance with specifications.



To begin with, a complete analysis is made at the refinery when the newly manufactured fuel goes into storage tanks to verify that the product meets or exceeds government, airline, and ESSO's own standards.

A second series of tests is made on composite samples taken from the tanker immediately after loading.

On completing the voyage, cargo samples of the fuel are checked for quality just before off-loading into ocean terminal storage tanks.

Product samples from the ocean terminal are subjected to a quality analysis; from the ocean terminal the product may go through an inland storage depot or directly to airfield storage.

Airfield storage samples are tested at regular intervals.

When airport refuelers are loaded, and after each change of shift, the fuel is carefully checked for possible water content and contamination.

As a final precaution, all fuel is passed through 5-micron filters during refueling by ESSO airport service personnel.

Yes, ESSO's follow-through tests and analyses make the difference. They mean greater safety and better performance because they guarantee *Quality Controlled* aviation fuel at all times wherever and whenever ESSO aviation gasolines are delivered into aircraft by ESSO Aviation Service.

More good reasons why

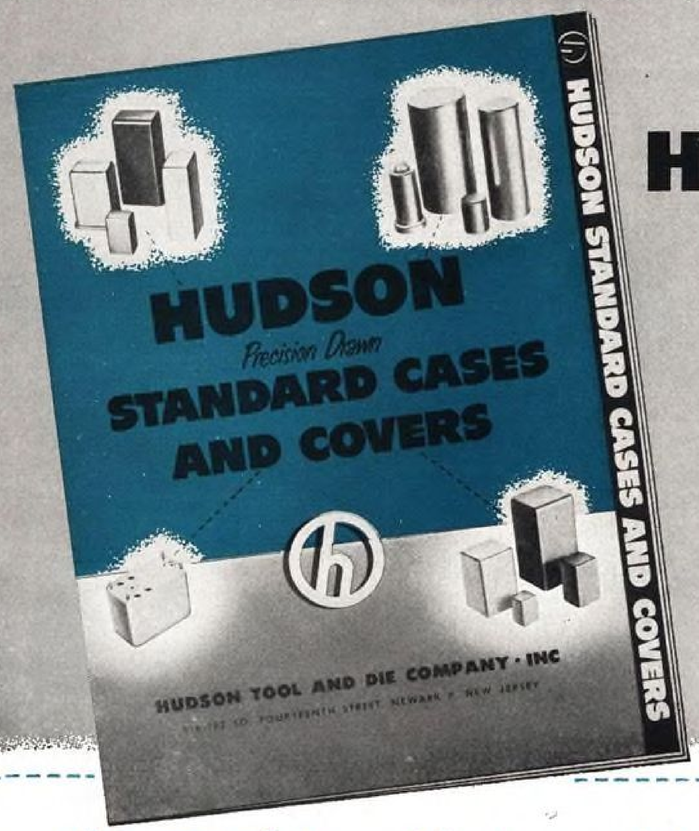
8 out of every 10 international airlines use

Esso

AVIATION PRODUCTS

AIR-PARTS INC. 723 Sonora Ave., Glendale 1, Calif. • New York • Washington, D.C. • Oakland

When SPECIFICATIONS call for STANDARD CASES & COVERS



–consult the new

HUDSON DATA FILE!

–including

- STANDARD DRAWN CASES & COVERS
- SPECIAL METAL STAMPINGS
- SPECIAL COVER & CAN ASSEMBLIES

–the complete guide to precision metal parts

The new Hudson Handbook contains full engineering data and specifications on hundreds of standard cases and covers. All are craftsmen-made to provide a quick, economical solution to component problems. Keep a copy of the Handbook on file in your engineering and purchasing departments. Request yours now!

–plan your production around Hudson

All drawn cases and covers in the new Hudson Data File are standard and orders are filled promptly from regular factory stocks. Quality metal stampings are precision made to your exact specifications. For complete information on standard components, consult the Hudson Data File—for specification metal stampings, call or write Hudson for prompt service! Address inquiries to Desk 810.

HUDSON TOOL AND DIE COMPANY · INC
118-122 SO. FOURTEENTH STREET, NEWARK 7, NEW JERSEY

use braided insulation made with

REFRASIL YARN

In braided insulation, it's the yarn that counts!

Continental Wire Corporation, York, Pennsylvania, braids Refrasil Yarn directly on wire using equipment made by Wardwell Braiding Machine Company of Central Falls, R. I.

Refrasil Yarn braided directly on wire is one of the many applications of this *high performance* yarn for the aircraft industry.

Whatever textile form your product requires, make certain that the yarn can withstand temperatures up to 2000° F. *Refrasil Yarn performs under such extremely high temperatures!* Be sure that your yarn is of high silica content, chemically stable, unaffected by ordinary acids, and resistant to fire. *Refrasil Yarn has all of these features!* If your aircraft electrical insulation must operate under extremely high temperatures or in a corrosive atmosphere, you can depend on *Refrasil Yarn* to deliver the performance you require. Remember, in braided insulation for aircraft, it's the *yarn* that counts!

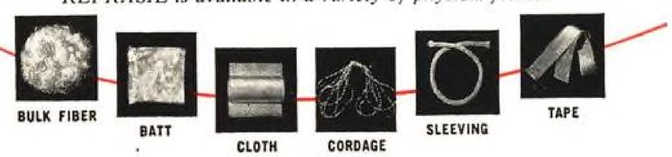
For HITCO engineering counsel without obligation, and free sample of Refrasil Yarn, address inquiries to Mr. A.W. Williams, The H. I. Thompson Co., 1733 Cordova Street, Los Angeles 7, California.

Illustrated above is the Lockheed F-94C STARFIRE, equipped with Refrasil Lightweight Removable Insulating Blankets.

HITCO

THE H. I. THOMPSON CO.
1733 Cordova St., Los Angeles 7, Calif.
Telephone REpublic 3-9161

REFRASIL is available in a variety of physical forms:

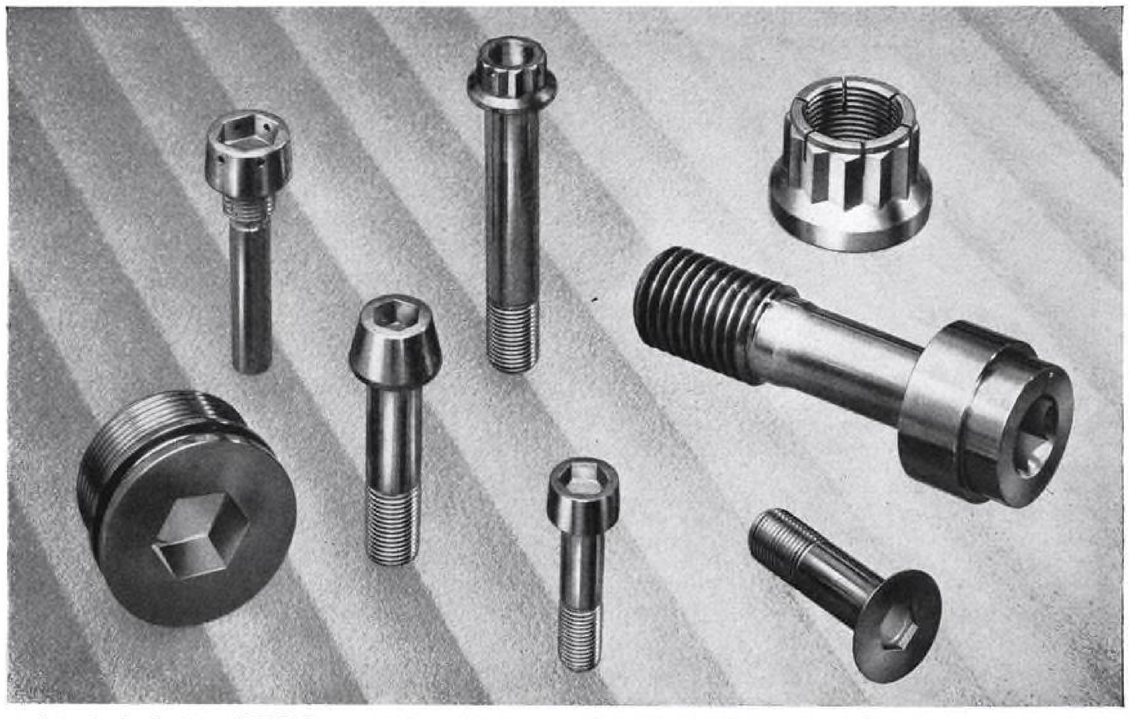


Write or call your nearest REFRASIL representative:

EASTERN	MIDWEST	SOUTHWEST
Fred W. Muhlenfeld	Burnie L. Weddle	Marshall Morris
6659 Loch Hill Road	3219 West 29th St.	3513 South Drive
Baltimore 12, Md.	Indianapolis 22, Ind.	Fort Worth, Texas
Valley 3135	Hickory 8685	Webster 2965

Represented in Canada by RAILWAY & POWER ENGINEERING CORP.

McDonnell Banshee uses SPS Fasteners



A typical selection of SPS Fasteners. For information, write STANDARD PRESSED STEEL CO., Jenkintown 3, Pa.

AIRCRAFT PRODUCTS DIVISION SPS JENKINTOWN PENNSYLVANIA

Our Fiftieth Year : A START FOR THE FUTURE

Add Greater Strength to Lighter Weight...

and take your **PROFIT IN PAYLOAD!**

The New LORD MR-36M DYNAFOCAL ENGINE MOUNTING

FOR R-2800 C ENGINES

SAE NATIONAL AERONAUTIC MEETING
HOTEL STATLER—BOOTH NO. 21
LOS ANGELES, CALIFORNIA
SEPT. 29-OCT. 3, 1953

EXPLODED VIEW

Ask about maintenance cost savings you can enjoy by using Lord Core Renewal Service on Dynafocal Suspensions.

See Our Exhibit Booth 232
NATIONAL AIRCRAFT SHOW
Dayton Municipal Airport, Vandalia, Ohio
Sept. 5-6-7

THIS new Lord Dynafocal Mounting is interchangeable as to vibration characteristics and physical dimensions with any mounting now in use on Convair 240 and 340, Douglas DC 6 Series, Martin 404 and Military Aircraft using R-2800c engines. The Lord MR36M is stronger than any mounting of previous design. Its light weight saves up to 16 pounds per engine, depending on the type of mounting system now used. This new Lord Dynafocal can replace your present heavy mountings without any rework whatever.

The Lord MR36M Mounting is approved by CAA, USAF and Navy Bureau of Aeronautics. The reduced weight on 2 and 4 engine aircraft enables you to realize an immediate profit in additional payload. For complete details you are invited to write direct or refer to the field offices listed below.

BURBANK, CALIFORNIA	DALLAS, TEXAS	PHILADELPHIA 7, PENNSYLVANIA	DAYTON 2, OHIO
233 South Third Street	413 Fidelity Union Life Building	725 Widener Building	410 West First Street
DETROIT 2, MICHIGAN	**NEW YORK 16, NEW YORK**	**CHICAGO 11, ILLINOIS**	**CLEVELAND 15, OHIO**
911 Curtis Building	280 Madison Avenue	520 N. Michigan Ave.	Room 811 Hanna Building

LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER — *Headquarters for* **VIBRATION CONTROL**

TO MEET YOUR AIRCRAFT PRODUCTION DEMANDS

IT WILL PAY YOU TO INVESTIGATE A

DESPATCH

Quick Quench

ALUMINUM *HEAT TREATING* FURNACE

Specially Engineered to handle production problems

Is your production schedule suffering because of inadequate aluminum heat treating equipment? You can eliminate this bottleneck with a specially engineered DESPATCH bottom-entry, quick-quench Furnace for the solution heat treating of aluminum and aluminum alloy shapes. Many leading aircraft plants report more production, better quality and lower costs since installing modern DESPATCH equipment.

These DESPATCH Furnaces are completely automatic, are electrically heated, recirculating type designed to operate at temperatures from 350 to 1250° F. They are capable of temperature uniformity within limits of plus or minus 5° F. From work chamber to completion of quench is accomplished in considerably less than 10 seconds.

Call, Write or Wire Now to Dept. W

Why not let DESPATCH engineers analyze your heat treating problem now. They are ready to talk things over with you, offer advice or design, build and install the proper equipment for your plant. There is a resident engineer near you, who will **assist with your heat treating requirements.**

TOP PHOTO: This DESPATCH furnace is being used for the solution heat treating of aluminum and aluminum alloy shapes. It is heated by 270 kw electric heater. Load passes through fog quench chamber to quench tank. Complete quench less than 10 seconds.

BOTTOM PHOTO: DESPATCH quick quench furnace of similar design being operated on defense production. Speed, uniformity and economy are also being achieved with this modern, fully automatic unit.

DESPATCH OVEN COMPANY

MINNEAPOLIS OFFICE: 619 S. E. 8th Street

CHICAGO OFFICE: 4554 N. Broadway

Sales Offices in all Principal Cities

PIONEERS IN ENGINEERING HEAT APPLICATIONS FOR INDUSTRY

ELECTRONIC BRAINS FOR AIR FORCE BRAWN

U. S. fighting aircraft, like this six-jet B-47, fly with Collins navigation or communications equipment. Airforce veterans remember Collins as the name on the first automatically tuned radio equipment used in World War II. Today, Collins plants in Cedar Rapids, Dallas and Burbank are hard at work filling orders that put Collins units on the latest military aircraft.

DESIGNERS AND MANUFACTURERS OF ADVANCED ELECTRONIC EQUIPMENT

- *The Integrated Flight System*
- *Airborne Transmitters and Receivers*
- *Ground Station Communications Equipment*
- *Electronic Navigational Equipment*
- *Automatic Flight Control Equipment*

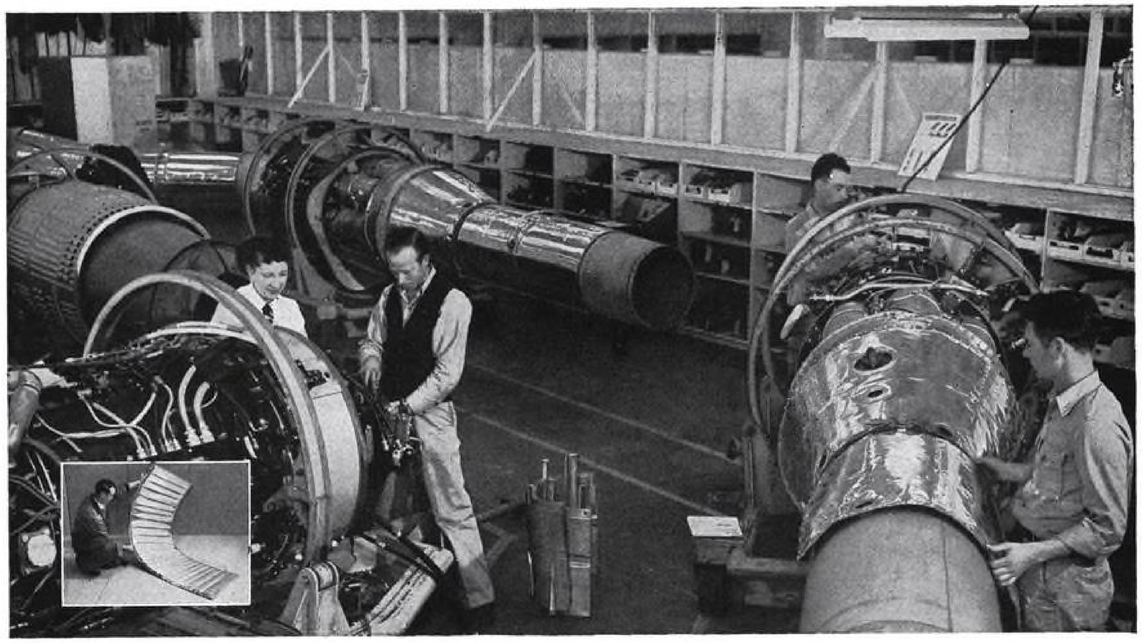
COLLINS RADIO COMPANY Cedar Rapids, Iowa

COLLINS

11 W. 42nd St., NEW YORK 36 1930 Hi-Line Drive, DALLAS 2 2700 W. Olive Ave., BURBANK

Proved... for Aviation's Higher Speeds

J-M Thermal Insulations



J-M Thermoflex* Blankets—used as standard protection on many Air Force and Navy jet aircraft, to insulate tail pipes, engine cones, afterburners, aftframes and shaft housings. Also available in special preformed shapes for many other applications. These flexible blankets are made by Johns-Manville from a highly stable refractory fiber felt sealed between sheets of corrosion-resistant metal foils.

*Registered Johns-Manville Trade Mark.

New and improved products are constantly being developed in the Johns-Manville Research Center—world's largest insulation and packing laboratory. Here J-M Engineers and Scientists cooperate with leaders in the Aviation Industry to help solve their toughest problems and create products which will keep pace with aviation requirements.

As the aviation industry observes the golden anniversary of powered flight, Johns-Manville marks its 95th year of service to industry.

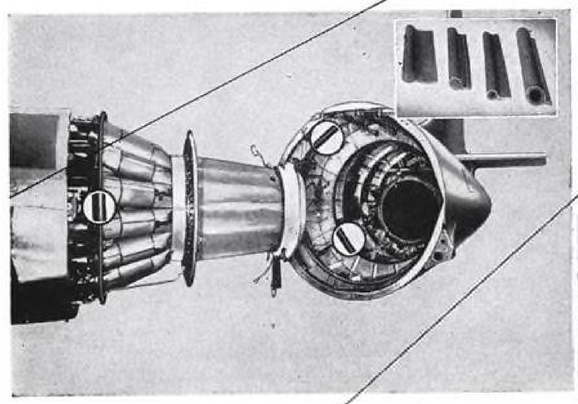
Johns-Manville is proud of the part its products have played in aircraft development . . . thermal insulation for protection against extremes of temperature . . . packings and gaskets to seal in lubricants and hot gases . . . asbestos textiles for fireproofing . . . friction materials to control motion.

For further information about Johns-Manville Aviation Products, write for copy of booklet AV-1A. Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ont.

Johns-Manville

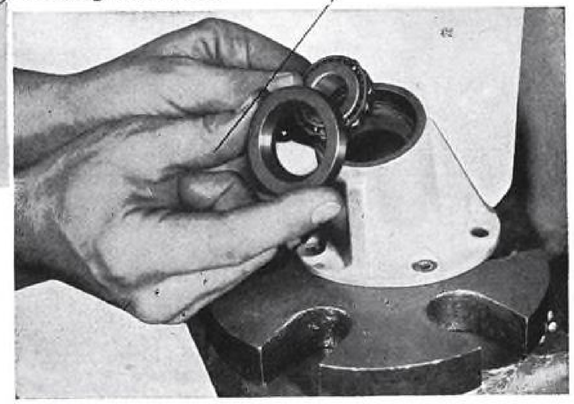
and Temperatures

...J-M Packings & Gaskets

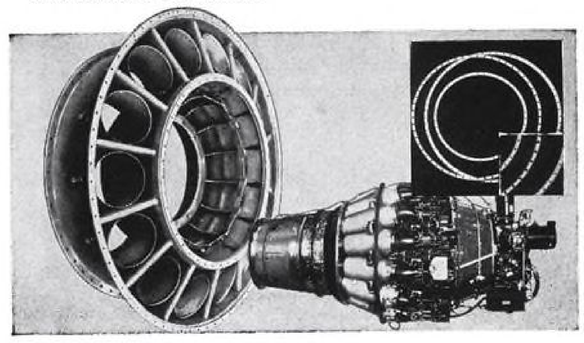


J-M Clipper Seals—used on helicopters, in rotor and gear systems, to keep abrasives out, seal oil in. Available in split form for easy application in small spaces. In addition to Clipper Seals, Johns-Manville offers special-shaped propeller seals in accordance with design specifications. Available in a wide variety of compounds and shapes such as "U," "O," "T" and "Hat-shaped."

J-M Firewall Seals—to reduce fire hazards. Besides the tadpole tapes illustrated here, Johns-Manville makes many types of asbestos cloth, tape and tubing. They are used for insulating, fireproofing, cushioning and sealing fuel, lubrication, hydraulic and electrical lines; also exhaust system shroud and cowling assemblies.

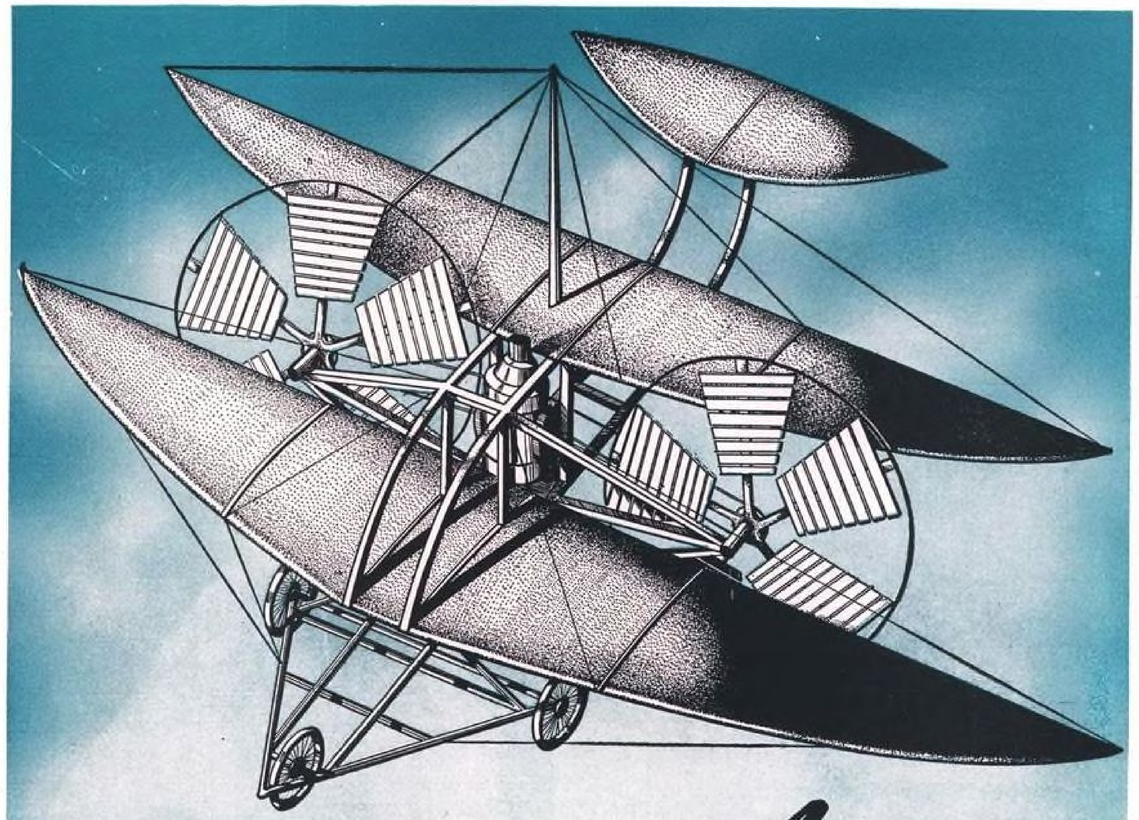


J-M Goetze Gaskets—These custom crafted metallic gaskets may be fabricated in almost any shape or size, for sealing igniters, compressor bleed-offs, cross ignition tubes and many other applications. Many types of J-M asbestos gaskets are also available for sealing, cushioning and mounting in aircraft power plants, airframes and accessories.



Products for the Aviation Industry

JOHNS-MANVILLE JM PRODUCTS



...out of this came Aviation

...a precision industry

To serve this great industry a manufacturer must maintain the best and most modern equipment available, operate it with skilled craftsmen, and use every existing method of tightening specifications and cutting production costs. Indiana Gear is such a manufacturer—a company of craftsmen producing fine quality transmissions and actuators for industry.

This is the control panel room in I. G. W.'s ultra modern heat-treating department—one of the contributing factors to Indiana Gear's unique ability to create hard-to-make parts to exacting specifications.

INDIANA GEAR

INDIANA GEAR WORKS, INC. • INDIANAPOLIS 7, INDIANA

Scott aircraft products

CONTROL WHEEL

To aircraft manufacturer's design . . . High strength aluminum, Tenite coated.

2716 Air Temperature **GAUGE**

4200 VALVE

Hydraulic Valve, for Parking Brakes and other uses.

4408 MASTER CYLINDER

Brake Master Cylinder for toe pedal installations.

WINDSHIELD CLEANER

Cleans and preserves plastic windshields.

B711 BRAKE UNIT

Master Cylinder with Heel Pedal.

A8B

Constant flow oronasal mask.

6200 Demand flow full-face mask, with or without microphone.

5500

Portable high pressure constant flow oxygen assembly.

5600

Portable high pressure constant flow and demand flow oxygen assembly.

8550

Oxygen Regulator for Scott 8500 Fixed Oxygen Systems.

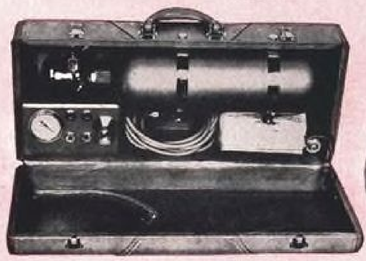
6380

Demand Flow Regulators for fixed installations.

A-21

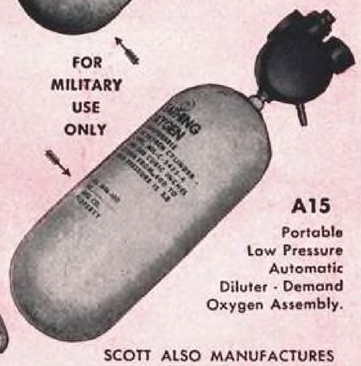
Portable, Low Pressure, Pressure-Demand Oxygen Assembly.

8540 Oxygen Flow Indicator.



AVIOX Portable Oxygen System for four persons, complete in a luggage case.

FOR MILITARY USE ONLY



A15

Portable Low Pressure Automatic Diluter - Demand Oxygen Assembly.

SCOTT ALSO MANUFACTURES DISPOSABLE MASKS AND FITTINGS.

MODEL 3-24B

Automatic, Steerable, and Full-Swivel Tail Wheel Assembly with 6 inch solid tire.

MODEL 3200

Automatic, Steerable, and Full-Swivel Tail wheel Assembly with 8 inch pneumatic tire.

Here at Scott, with our self-sufficient engineering and development laboratories, foundries and precision machinery, the already high standards of the Aviation industry are generally excelled.

Since 1932 Scott's facilities have been purposefully developed to provide exceptional quality and uninterrupted schedules, thereby maintaining extraordinary service and unusual customer satisfaction.

Scott products are available throughout the United States and the world, from capable and helpful Aviation suppliers.

Write us today for general information or the name of your nearest Scott distributor. Send for literature.

SCOTT AVIATION CORP.

275 ERIE STREET — LANCASTER, N. Y.

Export: Southern Oxygen Co., 157 Chambers Street, New York, N. Y.

Here's How This

JOY AXIVANE® Aircraft Fan

Solved a Problem of Unmatched Complexity

WHEN the Air Force and Consolidated Vultee, manufacturer of the B-36, decided it was necessary to have a pressurization booster on this king-size bomber, they really threw the design-book away. The requirements for the blower would cause any prospective fan supplier to have misgivings. Specifications called for three separate fan-duties:

a *1180 CFM at 32" W.G., with an air density of 0.044 lbs./cu. ft.*

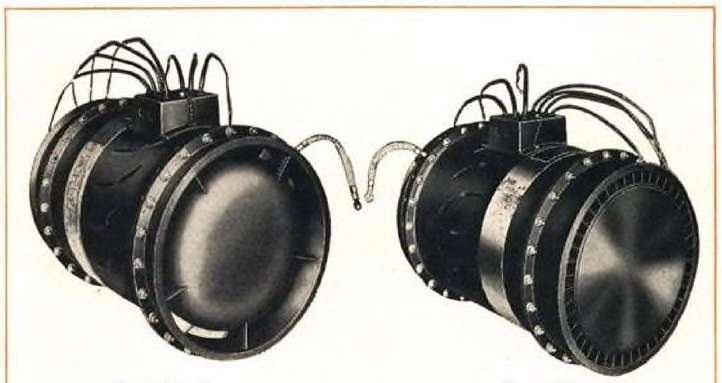
b *700 CFM at 40" W.G., with an air density of 0.10 lbs./cu. ft.*

c *680 CFM at 26" W.G., with an air density of 0.070 lbs./cu. ft.*

Space and weight limitations were stringent. The fan had to operate without excessive horsepower requirements due to a critical load on the generators. In addition, the fan motor had to be protected from hot air in the duct system.

Just about when the job seemed impossible, it was turned over to Joy engineers.

The result? Not only was the problem solved to the complete satisfaction of both the Air Force and the manufacturer, but the prototype fan was in their hands only six months after Joy received the order.



Front View **(INLET)** Rear View **(OUTLET)**

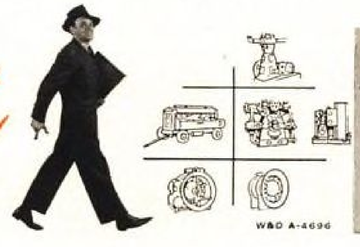
The fan exactly meets the three duties specified. It is 10" in diameter and 17" in length. Because of its combination of magnesium and aluminum construction, the fan weighs only 54 lbs. It is a two-stage unit, driven by a two-speed, 400-cycle motor. The efficiency of vaneaxial-fan design permits using a motor rated at only 12.6 H.P. continuous duty. The stationary vanes which support the motor are hollow, so that cooling air can be continuously directed over the motor. Each stage of the fan has a set of straightener vanes. Casing and hollow vanes are a single casting for shock-resistant strength.

● We freely admit that this is one of the toughest fan design-problems Joy engineers have ever tackled. On the other hand we are just as sure that, in the future, even harder problems will be taken on and solved. Even if your aircraft fan problem is not a difficult one, it is a good bet that the incomparable vaneaxial-fan design know-how which produced *this* AXIVANE fan will give you the most for *your* money. If you need an aircraft fan for any purpose, call on JOY—the world's largest manufacturer of vaneaxial fans.

SINCE 1851 . . . Over 100 Years of Engineering Leadership

Consult a Joy Engineer

for Vaneaxial Fans . . . Compressors, Vacuum Pumps and Boosters . . . Oxygen Generators

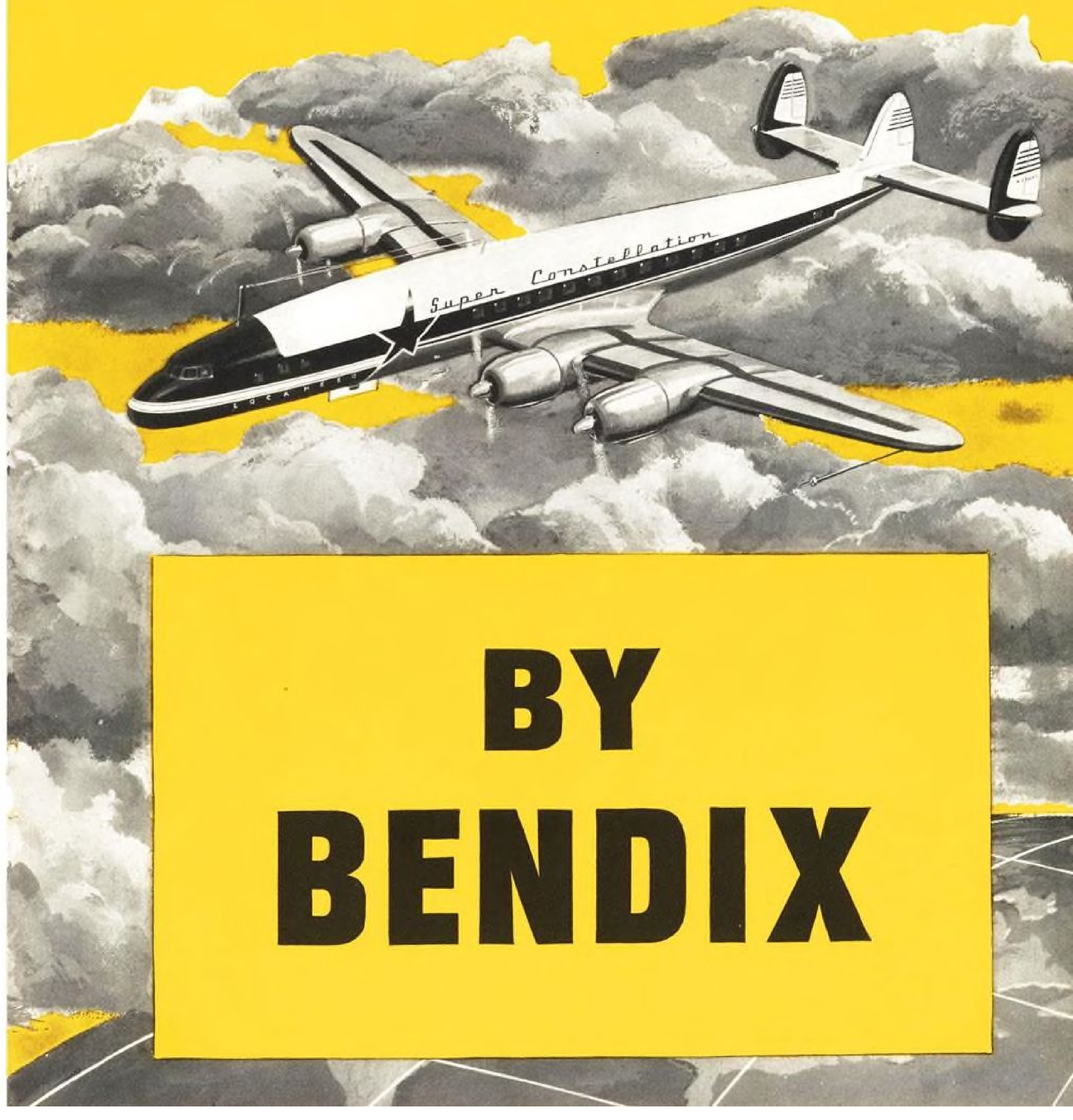


W&O A-4696

JOY

SPECIALISTS IN THE COMPRESSION AND MOVEMENT OF AIR AND GASES SINCE 1885

HERE IS COMPLETE AVIATION RADIO

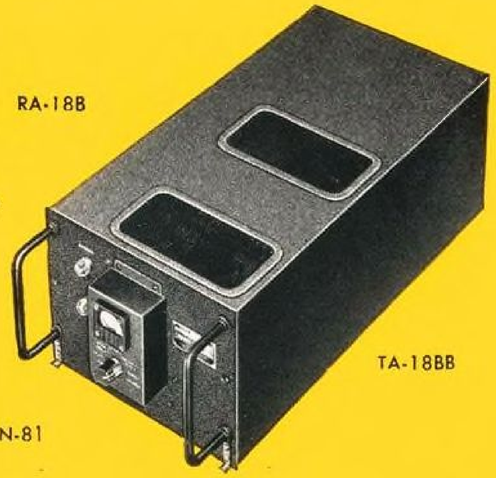


BY BENDIX

COMPLETE AVIATION

★VHF

RA-18B



TA-18BB

Now you can receive . . . and transmit on 360 channels (from 118.0 to 135.95 MC) with a **single** finger tip control. No more confusing channel letters . . . no more conversion charts.

Fifty KC channel spacing provides maximum number of channels, and eliminates possibility of obsolescence for years to come.

RA-18B Receiver weighs only 18 pounds.

TA-18BB Transmitter provides 25 watts r-f output.

MN-81 Control Panel. Instant, finger tip control.

MN-81

★ADF

MN-62

MN-60

This radio compass is the basic navigational system for all aircraft. It provides complete, automatic radio bearing information in the low and medium frequency bands.

Practically every multi-engine aircraft in the world carries the famous Bendix ADF.

MN-58 Dual Azimuth Indicator
MN-62 Radio Compass Receiver
MN-60 Hermetically Sealed Iron Core Loop Antenna

MN-58

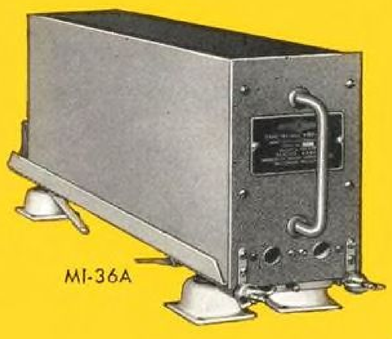
★AUDIO

Complete audio equipment for paging, announcing, interphone and passenger entertainment systems for airlines and executive aircraft.

A high fidelity audio amplifier provides 20 watts output with very low distortion.

An Interphone Amplifier and Jack Box permits selection of eight receiver and three transmitter channels. (One crew member can be on marker beacon . . . another on radio compass and still another talking to pilot etc., without cross signal interference.)

A single package cockpit loudspeaker and amplifier eliminates need for constant pilot and crew use of headphones.



MI-36A

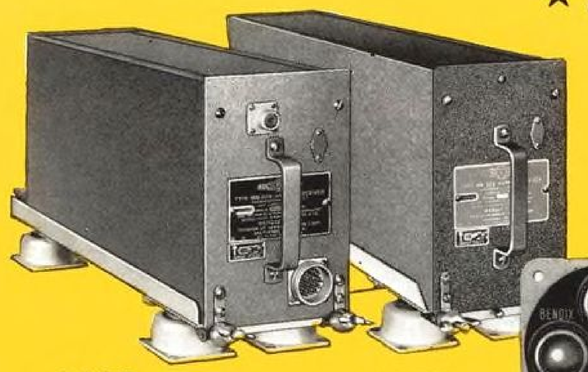
MS-92

MI-51A

MS-92 Interphone Amplifier and Jack Box
M1-36A High Fidelity Audio Amplifier
M1-51A Cockpit Loudspeaker

RADIO BY BENDIX

★MARKER



MN-53B

MN-61B

IN-5

Accurate . . . simple . . . trouble free. No wonder this Marker Beacon is the standard for all the great airlines here and abroad. Bendix uses a 3-light indicator system. White for airway markers . . . amber for inner markers . . . purple for outer.

High and low sensitivity settings.

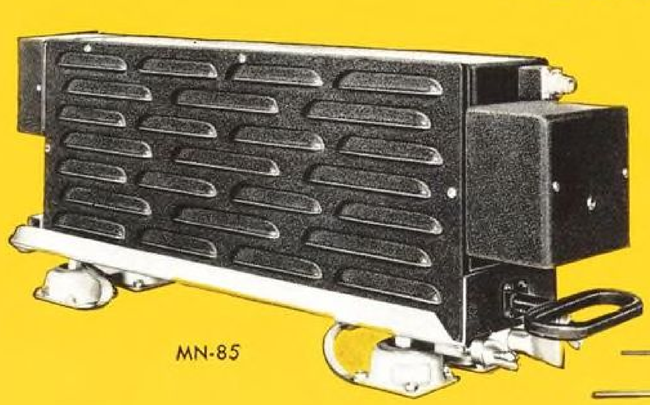
No relays used. No contact points to wear or burn out. No springs to vary in tension. No coil windings to open.

MN-53B Marker Receiver for executive aircraft. Weighs only 11½ lbs.

MN-61B Marker Receiver—½ ATR. Weighs only 13 lbs.

IN-5 Three Light Indicator

★VOR



MN-85

MN-97

MN-81

MS-192

Complete use of every present VHF navigational facility . . . with one system. The new Bendix NA-3A VHF Navigational System provides tone localizer (ILS), Visual Omni Range (VOR), Visual Aural Range (VAR), and communications reception on 280 crystal controlled channels.

RECEIVER

Furnishes continuous, clear navigational information . . . reliable, static free voice reception under IFR conditions.

OMNI-MAG

Presents a constant "moving picture" of the aircraft's position and heading relative to the selected course.

ANTENNA

The streamlined antenna in this VOR equipment is horizontally polarized. It is designed for broad band operation.

CONTROL PANEL

Finger tip control of the receiver is provided by this direct reading frequency selector. The famous Bendix "Da-Nite" system of illumination is used . . . white numerals during day, red numerals at night.

[SEE NEXT PAGE FOR MORE BENDIX AVIATION RADIO]

AND THE LATEST FROM BENDIX RADIO

★ DME

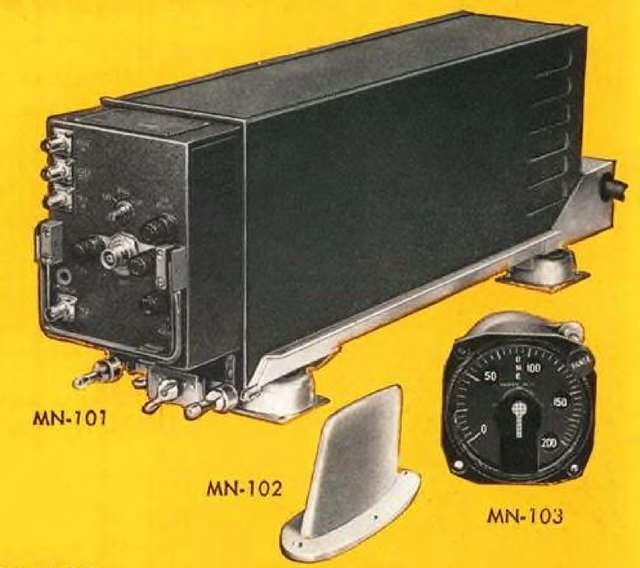
Distance Measuring equipment has long been needed. DME electronically computes distance of an aircraft from a combined DME/VOR station. The distance is shown directly in miles on a range indicator.

With DME/VOR aircraft can now hold at unmarked points . . . establish more accurate ETA's . . . fly unmarked airways . . . make instrument approaches to fields infrequently used under IFR conditions.

MN-103—Range Indicator

MN-102—DME Antenna

MN-101—DME Interrogator weighs only 29 pounds.



★ FLUSH LOOP ANTENNA

MN-104A

Completely eliminates drag. It is designed to work with Bendix ADF equipment. It provides equal or greater sensitivity than present day loops. Contributes to better anti-static performance.

MN-104A Flush Loop Antenna

★ GLIDE SLOPE RECEIVER

The new Bendix Glide Slope Receiver provides the final link for complete ILS operation.

When used with Bendix VOR equipment, both localizer and glide path information is shown on a single cockpit indicator.

A single finger tip control panel provides simultaneous selection of localizer and glide slope channels.

MN-100A—20 Channel Glide Slope Receiver

MN-92A—Glide Slope Antenna

MN-100A

MN-92A

THE NAME Bendix AVIATION CORPORATION MILLIONS TRUST

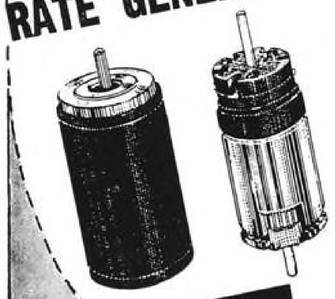
BENDIX* RADIO
BALTIMORE 4, MARYLAND
A DIVISION OF BENDIX AVIATION CORPORATION
Export Sales: Bendix International Div., 205 E. 42nd St., New York 17, N.Y., U. S. A.

Bendix THE MOST TRUSTED NAME IN **Radio**

* Reg. U. S. Pat. Off.

PRECISION

SYNCHROS
SERVO MOTORS
RATE GENERATORS



Infra Electronic Corporation is playing an important part in the precision manufacture and assembly of electronic and electro-mechanical system components for the Military.

We invite your inquiry when commercially available units will not meet your system demands.

Custom design, development, and manufacture of Test Sets, Kits and Consoles for preflight check out and ground maintenance of airborne systems.

INFRA
Electronic Corp.
Roseland, New Jersey
Manufacturers of Precision Synchros

■ CONTENTS

AVIATION WEEK

ARDC EDITION

Message from General Putt 72
■ Air Research and Development Command 73
Weapons Systems 82
Office of Scientific Research 87
Special Weapons Center 91
Wright Air Development Center 99
ARDC Research Center's Work 104
Air Force Flight Test Center 118
Test Pilot School 145
Arnold Engineering Development Center 150
Air Force Missile Test Center 170
Holloman Air Development Center 186
Air Force Armament Center 210
Cambridge Air Force Research Center 229
■ Special Report on Avionics 249
Rome Air Development Center 251
Avionics Procurement 262
K-Bombsight System 273
Avionics Technical Developments 274
Aero-Medicine 392
Parachute Development 411
ARDC Field Liaison Offices 413
■ News of the Week 416
Editorial Index 428
Advertisers Index 442

THE COVER

Research and development test aircraft and crack test pilots of the Air Force Flight Test Center are marshalled on the sun-baked surface of Rogers Dry Lake which has saved several hundred million dollars in emergency landings. The pilots are: (A) Maj. Charles Yeager, first man to fly faster than sound; (B) Maj. Harold Russell; (C) Col. Fred Ascani; (D) Brig. Gen. Stanley Holtoner, center commander; (E) Lt. Col. Jack Ridley; (F) Maj. Arthur Murray. The aircraft are: 1) Northrop X-4; 2) Convair XF-92A Delta; 3) North American T-28A; 4) Lockheed F-80; 5) Republic F-84F; 6) North American F-86D; 7) Northrop F-89; 8) Lockheed F-94C; 9) Boeing B-47; 10) North American B-45; 11) Boeing KC-97; 12) Convair B-36D.

A MESSAGE FROM ARDC

Since the Wright Brothers' achievement fifty years ago, American scientists and engineers have met the challenge of flight with the necessary perseverance, courage, and skill to continue the progress of aviation. U. S. military aviation has been an outstanding contributor, and the latest step taken by the U. S. Air Force in furthering aviation's progress was the establishment in 1951 of a separate major command of the United States Air Force, to be called the Air Research and Development Command.

The challenging mission of the Air Research and Development Command is to assure the qualitative superiority of the United States Air Force.

To accomplish this mission the Command must coordinate the work of a productive team composed of those in the Air Force, in industry, and in science, who work together for our country's air progress.

Momentous advances are being made in flight today. The success the Air Force is having with the high performance of its piloted aircraft, as with its pilotless aircraft, is reassuring to the Nation.

Our air progress has been possible in the past and will continue in the future with the teamed effort of government, science, and industry.

D. L. Putt

D. L. Putt
Lieutenant General, USAF
Commander, ARDC

ARDC Molds U. S. Air Development

New Command fights the battle for technical supremacy, fosters liaison between industry-science team and military.

A new kind of air power is in the making. Combat aircraft are already coming off the drawing boards aimed at speeds of over 1,000 miles an hour. Missiles that can bridge the gap between continents are under development. Atomic weapons with the power that devastated Hiroshima are now packaged to fit fighter aircraft and missile warheads. Man has already survived at simulated altitudes of more than 100,000 ft. Monkeys have returned safely from rocket flights to the fringes of outer space.

The technological revolution that engulfed aviation during World War II has not yet run its course. It is on this rapidly expanding technical frontier of aviation that the Air Research and Development Command is fighting its share of the battle for air supremacy.

You can sense the shape and pace of this air power of the future from the airmen, officers and civilian scientists of ARDC who are manning outposts on the new technical frontier—in the air-conditioned coolness of a concrete missile-control blockhouse half buried in Florida sand . . . in the cockpit of a B-29 flitting into the fringe of atomic bomb clouds over Nevada wastelands . . . in the shimmering desert heat of a flight test center where pilots first pierced the sonic barrier and have already climbed to 80,000 ft. at speeds of more than 1,200 mph. . . . in the hot white glare of coral sand on a Caribbean island telemeter station . . . in the frigid white glare of a floating Arctic ice island weather research station . . . in the staccato fire of rivet guns, the clang of structural steel and the snorting of the bulldozers clawing out the largest aeronautical test facility the world has yet seen from among the red clay and jack oaks of southern Tennessee . . . and in the classrooms and laboratories of a hundred odd colleges and universities.

Emergence of the Air Research and Development Command as an independent organization on Apr. 2, 1951, marked the recognition by USAF top policymakers, prodded by outstanding civilian scientists, that previous USAF research and development methods were "antiquated, incomplete in coverage, and failed badly in getting the most out of scientists in industry and universities." There was also a deep-seated conviction that USAF was losing ground in the postwar race for technical supremacy and that a fundamental and decisive overhaul of its research and development effort would be necessary to improve its position.

▶**Quantity Did It**—It is generally recognized that the war in Europe was won with a superior quantity of arms despite the fact that the quality of American equipment, particularly in the final year, was often greatly inferior to that of the Germans.

It has become equally obvious that in any future war the nature of the enemy will be such that the U. S. cannot hope to match his mass of manpower or materiel. Any hope for victory must be pinned on superior strategy and technical superiority that can offset the effect of the enemy's mass.

As Russia builds an atomic stockpile that will, for all effective purposes, match our own despite a continuing disparity in numbers, the importance of technically superior methods of bomb delivery will become increasingly decisive in the military equation. And since USAF has the dual responsibility of delivering atomic weapons on enemy targets and parrying atomic thrusts by the enemy, its acute need for technically superior weapons systems can hardly be over-emphasized.

▶**New Accent on Quality**—To do this job effectively it became necessary to elevate quality, for the first time in USAF history, to equal rank with quantity. Because the philosophy of quantity is represented by the Air Materiel Command, and most of the facilities that now comprise ARDC were formerly part of AMC, there was bound to be bitterness and dissension when the divorce occurred. Although there is still some opposition at lower levels in USAF and among some parts of the aircraft industry, the wisdom of the decision to create ARDC becomes more apparent with the passing of time.

Because it was part of Air Materiel Command, the qualitative viewpoint represented by research and development was always subordinate to the quantative viewpoint that represented AMC's primary mission of production. Just before the split, the Commanding General of AMC testified that he devoted 95% of his time to procurement problems and only 5% to those of research and development. At the same time AMC was becoming so large and organizationally unwieldly that it became necessary to split its procurement authority into a geographically decentralized pattern (AVIATION WEEK Aug. 4, 1952).

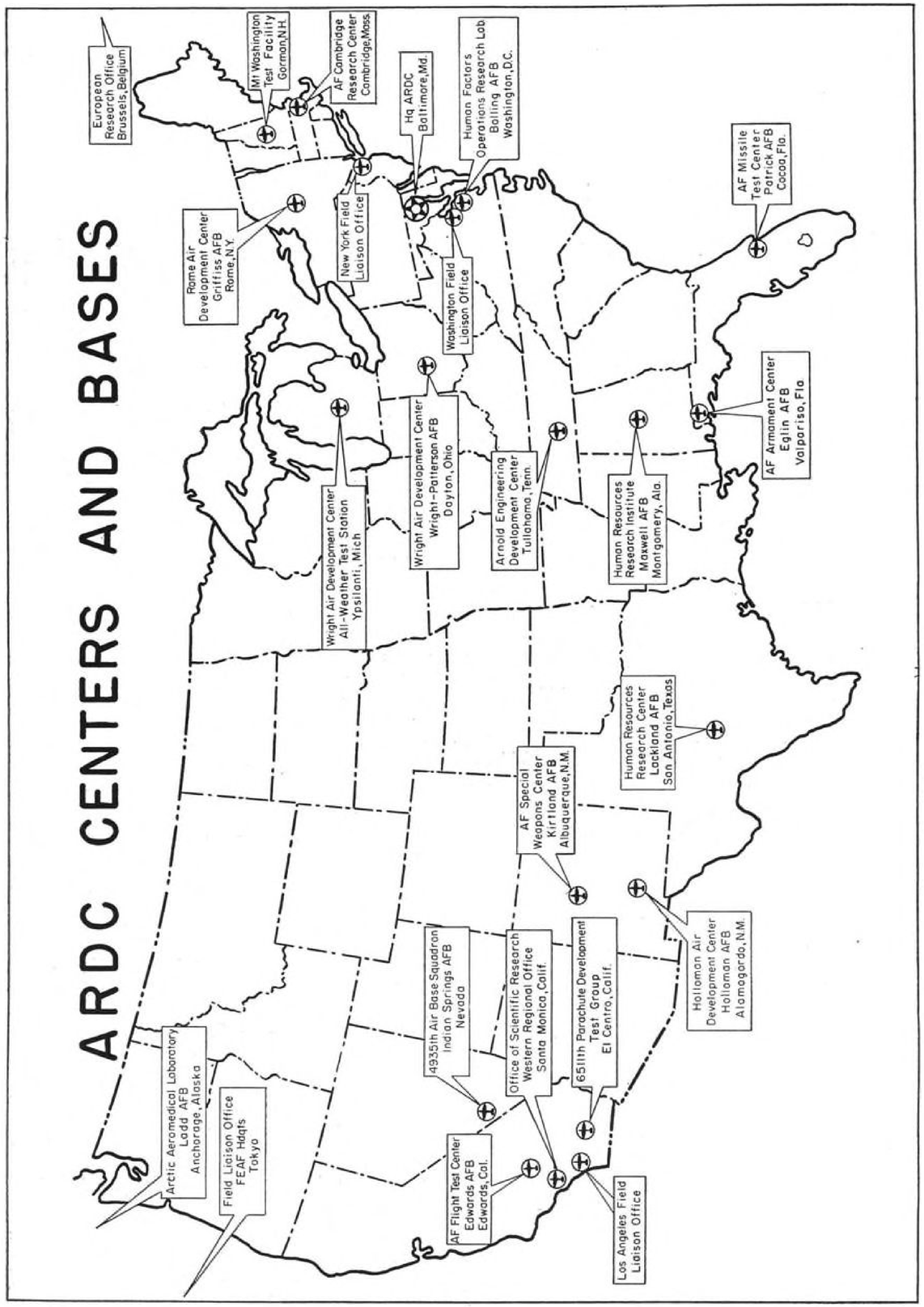
▶**Two "Vice Presidents"**—Now USAF structure more closely resembles that of any large industry with separate vice presidents for engineering (ARDC) and production (AMC) at the same level and both reporting to the president and board of directors (USAF Chief of Staff and the Air Council) for decisions on major policies.

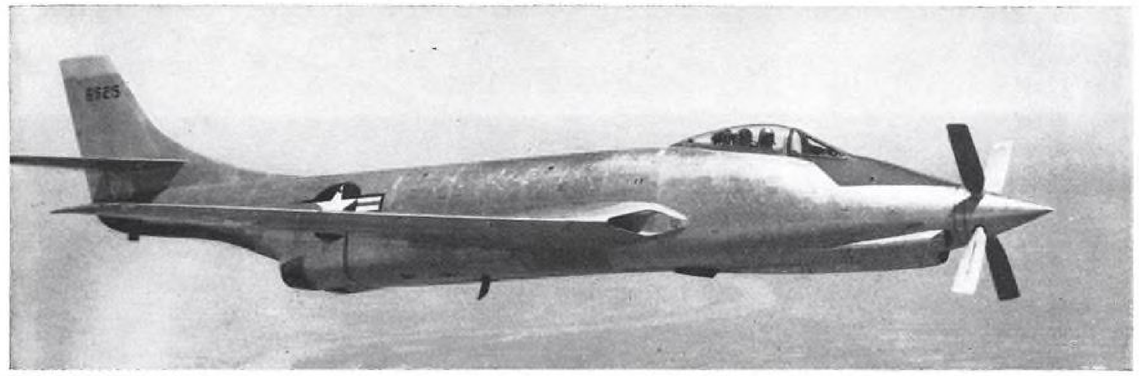
At the same time ARDC was established as a separate command, a Deputy Chief of Staff for Development was added to the Air Staff, ranking with the Deputy for Materiel. Although there remain a number of jurisdictional problems between ARDC and AMC, there is no longer any serious argument either in USAF or the aircraft industry that quality should again be subordinated to quantity or that one is more important than the other. To do its job properly USAF must have both.

▶**Air Force Job**—USAF has two principal missions:

- First, to maintain an effective air force in being, capable of immediate and powerful action.
- Second, to provide for a future force with performance that is fully abreast of the scientific and technological potential of the times and is technically superior to the enemy's weapons.

The first mission is primarily that of USAF combat commands, supported quantatively by AMC and qualitatively by ARDC. All of the USAF equipment now in production was developed





SUPERSONIC PROPELLER research is speeded by twin-jet McDonnell XF-88B flying test bed with turboprop in nose.

before ARDC existed and some of these production programs are excellent examples of excessive expenditure of time and money resulting from flaws in the former development pattern. However, ARDC also has responsibility for development work and in-service engineering on USAF equipment throughout its life in the active service inventory. Considerable effort is now being spent on specific technical fix programs required for equipment already in production or service.

The second mission is the primary job of ARDC. A sound research and development program is the foundation for a good production program. Unless quality is achieved first there is little point in compounding inferiority by multiplication.

▶ **Budget Fluctuations**—A major problem in developing a sound qualitative foundation for future production programs is counteracting the effects of the annual fluctuations of the defense budget. Unless development projects and research programs can be planned and financed over normal development cycles that will insure completion of the work involved they will produce few tangible benefits.

A good example of what budget fluctuations can do to development programs is the current USAF lack of turboprop engines. Millions of dollars were poured into turboprop development but budget fluctuations produced a start-stop effect on these programs that eventually produced nothing in the way of an operational engine.

A solution seems to be stabilization of the research and development budget over five-year periods and allowing the budget fluctuations to be absorbed in other areas where the relationship between world tensions and increased budgets is more direct. It would appear that a more stabilized budget is practical since current R&D expenditures are running about a half billion dollars annually—less than 10% of procurement funds and only about 2% of the total USAF annual budget.

Mission

In official language, USAF has defined the ARDC mission as follows:

• **Attain and maintain** qualitative superiority of materiel and conduct or supervise scientific and technical studies required for the establishment of the Air Force mission.

• **Seek basic new knowledge** from which improved aeronautical equipment materiel weapons and techniques can be developed.

• **Undertake the development** and recommend adoption of appropriate new and improved devices and systems for the conduct of and support of air warfare, including aircraft, missiles, weapons, techniques and procedures applicable to Air Force purposes.

"We are trying to function primarily as a proper liaison between the military operators who need new and better equipment and the scientific brains of the industrial and academic worlds who can develop it or contribute knowledge to the development problems," says Lt. Gen. Donald L. Putt, ARDC Commander.

"ARDC's job is not to actually do the research and development job," Putt says. "For that we rely primarily on industry, universities and civilian research organizations. Our job is to tell these groups the problems the Air Force wants to solve and to program, finance, monitor and evaluate the work necessary to solve them. In turn we keep the Air Force informed on the kind of equipment they are likely to get at any given time because of the 'state of the art' in any particular field."

▶ **Help From Outside.** The only research and development work ARDC does in its own facilities is that necessary in support of its test facilities or work to advance the state of the art in fields where industrial or academic sources are not sufficiently interested to tackle the job. ARDC now spends 87% of its R&D money with civilian contractors. This contrasts with 65% spent by the Navy and 45% by the Army.

ARDC is trying hard to avoid building a large military overhead; wherever possible, it is relying on civilian organizations which usually have more of the flexibility necessary in technical work, more and better trained personnel, and a continuity that is lacking in military organizations and is so necessary in scientific and technical work. ARDC's policy toward industry is:

• **Encourage new segments** of industry to become interested in Air Force problems.

• **Give industry** more responsibility for development work.

• **Keep industry better informed** on USAF problems and requirements.

• **Create and operate development** test facilities that industry needs for USAF work, but which are too expensive for any individual industrial group to finance and support.

Another way in which ARDC is attempting to avoid building a large military overhead is by getting civilian contractors to operate its major test facilities wherever feasible. The Arnold Engineering Development Center is operated by Aro, Inc., a subsidiary of Sverdrup & Parcel, St. Louis consulting engineering firm. Instrumentation for the Joint Army-Air Force Missile Range at Alamogordo, N. M., is operated and maintained by Land-Air, Inc., a civilian electronics contractor.

ARDC is currently negotiating with Pan American World Airways and Radio Corporation of America to operate the 1,000-mile missile test range in the Caribbean.

ARDC's Work

Most of ARDC's work falls into the following categories:

▶ **Basic Research**—Basic research is currently a $5-million annual program aimed at attempting to refill the reser-

Air Research and Development Command

Headquarters . . . Baltimore, Md.

Commanding General
Lt. Gen. Donald L. Putt

Office of Scientific Research
Col. O. G. Haywood, Jr.

Ass't for Aircraft Nuclear Propulsion
Brig. Gen. Donald J. Keirn

Vice Commander
Maj. Gen. John McCormack, Jr.

6590th Support Group
Lt. Col. R. F. Perkins

Deputy Commander

Chief of Staff
Brig. Gen. Kurt M. Landon

Ass't for Plans
Col. E. H. Wynn

Ass't for Operational Readiness
Col. Joseph R. Holzapple

Deputy for Air Defense
Lt. Col. J. A. Barrett

Deputy for Air Transport
Lt. Col. R. H. Ross

Deputy for Tactical Air
Col. H. B. Young

Deputy for Strategic Air
Col. W. S. Rader

Deputy for Training & Support
Lt. Col. K. C. Diehl

Inspector General
Col. Franklin K. Fagan

Public Information Officer
Col. Leon Booth

Adjutant General
Col. R. C. Lewis

Historian
Dr. E. G. Schwiebert

Air Surgeon
Col. F. C. Kelly

Judge Advocate General
Col. Leroy G. Cooper

Deputy for Comptroller
Col. M. E. Godfrey

Director of Procurement
Col. J. R. Martin

Deputy for Materiel
Col. W. L. Rogers

Deputy for Development
Brig. Gen. Floyd B. Wood

Ass't Deputy for Development
Col. A. A. Fickel

Deputy for Operations
Col. B. A. Lawhon

Deputy for Personnel
Col. Perry Hoisington

Ass't for Development & Management
Col. H. J. Halberstadt

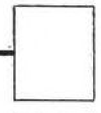
Ass't for Development and Supporting Research
Brig. Gen. Leighton Davis

Ass't for Weapons Systems
Col. E. N. Ljunggren

Ass't for Development Programming
Col. H. C. Nelson

Director of Program Formulation
Lt. Col. C. J. Reber

Director of Program Administration
Lt. Col. L. B. Smith



Director of Field Liaison Offices
Lt. Col. Walter R. Beckett

Director of Facilities & Operations
Lt. Col. O. C. Ledford

Director Nuclear Applications
Col. R. N. Isbell

Director of Equipment
Col. H. W. Randall

Director of Human Factors
Col. Don Flickinger

Director of Geophysics
Lt. Col. R. F. Long

Director of Electronics
Col R. M. Osgood

Director of Armament
Col. R. E. Jarmon

Director of Aeronautics & Propulsion
Col. D. H. Heaton

Director of Strategic Combat Systems
Col. T. S. Jeffrey

Director of Air Defense Systems
Lt. Col. L. Y. Gossick

Director of Tactical Combat Systems
Col. W. A. Hotmann

Director of Air Logistics & Training Systems
Lt. Col. R. C. Anderson

Director of Recon., Intel., Psych. Warfare Systems
Col. J. D. Kay

voir of basic knowledge in the physical sciences that was virtually drained during the frantic development work of World War II. It is administered largely by the Office of Scientific Research. The bulk of this work is done under contract by university scientists and civilian research organizations. A small portion of the work is done in ARDC centers.

Basic research is one of the most important parts of the ARDC program and perhaps the hardest to sell to higher-level Defense Department officials and Congress because it offers no specific promise of new hardware. Yet such vital items of new hardware as radar, atomic bombs and electronic transistors were possible only because of basic research in their fields that at the time held no hope for the ultimate products and was not even aimed in their direction.

Another example is the basic research done on the behavior of a bull's sperm which eventually led to the discovery of a drug that can prevent fatigue for specific time periods. The value of this for long-range bomber crews and fighter pilots is obvious, yet it is easy to imagine the irate snort of a member of the House Appropriation's Committee when asked to approve an item for bull sperm research in the defense budget.

During the 83rd Congress, an ARDC contract with Harvard for a study of the Russian social system was widely denounced as "boondoggling." Yet the lack of such basic knowledge of the German and Japanese social systems in World War II cost the lives of many airmen, the unnecessary expenditure of millions of dollars of equipment and prolonged the war.

One of the lessons learned from the German scientific success in guided missiles and failure in electronics was the value of applying all of the basic research knowledge produced by the universities and colleges to specific programs. ARDC is not only tapping the best scientific brains in this country but is also reaching out to use intellectual resources on the right side of the Iron Curtain in Europe.

► **Applied Research**—This is currently a $342-million annual program of which 85% is spent by contractors. It includes both research aimed at specific "state of the art" advancements and development work against specific military requirements. The ARDC laboratories at Wright Air Development Center, Rome Air Development Center and Cambridge Air Force Research Center do the applied research not farmed out to contractors. Applied research is all aimed at the eventual production of "hardware" necessary for the Air Force to perform its missions.

► **Testing**—ARDC is now engaged in an expensive and extensive effort to make up for the lost postwar time in providing the type of development testing facilities required by industry and the Air Force for the new spectrums of aeronautical performance. Although the dollars now piled up in a backlog of tardy construction programs is large enough to make congressmen squirm, it represents false economy to continue delaying these vitally needed facilities.

In the five years that construction of the engine test facility at AEDC was delayed by political football, USAF lost more than its cost in the poor performance of one of its jet engines at altitude. During this period there were no adequate high-altitude engine test facilities in which to work out the "bugs" that were destroying both expensive aircraft and expensive pilots.

The type of facilities required for testing modern air weapons systems are so large and complex that no company in the aircraft industry could afford to build or operate them individually. For guided missiles, a fully instrumented range at least 1,000 miles long is now required. For rocket engines alone, something that will anchor a million pounds of thrust will soon be required. For experimental supersonic aircraft, runways 15,000 ft. long for takeoff and 10 to 15 miles long and a mile wide for safe emergency landings are required to do the job properly.

USAF, through ARDC, is financing the construction and operation of such types of facilities and will offer their use to contractors who are developing hardware for USAF weapons systems. Among these facilities in operation or under construction are:

• **Windtunnels** for testing transonic and supersonic aircraft and their propulsion systems at altitudes up ot 80,000 ft., at AEDC.

• **Long-range missile test** range with 1,000 miles of fully instrumented range and a 7,500-ft. landing strip where missiles can be safely recovered after a 2,000-mile flight, at Patrick AFB.

• **Short-range missile test** range for early test work involving maneuverability, recovery and air-to-air operations, at Holloman AFB.

• **Rocket test center** that can handle motors of half a million pounds thrust now, and eventually can test a million pounds thrust, at Edwards AFB.

• **Supersonic sleds** operating on precision railroad tracks for highspeed testing of aerodynamics, auxiliary equipment and decelleration at Edwards and Holloman.

• **Armament range** for testing rockets, bombs, air-to-air missiles and new types of aircraft cannon, fire control systems, etc., at Eglin AFB.

• **Flight test center** for highspeed aircraft, with 350 flying days a year, takeoff runway of 15,000 ft. and a solid strip 22 miles long and a mile wide for safe emergency landings, at Edwards.

After ARDC has researched, developed and tested a weapons system, it goes to the Air Proving Ground Command, an independent agency, for proving out to determine its suitability as a weapon ready to be used by the combat commands of USAF.

Because so much of the development on aircraft is done after production has begun, ARDC now has the engineering responsibility for all changes in the aircraft or equipment that affect the quality of its performance throughout the life of the equipment in the USAF active service inventory. This is at present a bone of contention between ARDC and AMC. This concept may be modified from its present "cradle to grave" cycle to something approaching "cradle to maturity," with engineering responsibility switching completely to AMC once an item of equipment has left its major development behind. This would cover a variety of USAF "cats and dogs" such as C-46s, B-29s, B-25s, C-45s, P-51s and others still in the active inventory but with no significant development left in their tired old airframes.

► **Other Jobs**—ARDC has also been given two other jobs in line with its qualitative mission.

They are:

• **Engineering standards.** ARDC takes engineering specifications proposed by manufacturers of every type of USAF equipment, from B-52 bombers to office chairs, and revises and approves them as a standard for AMC procurement.

• **In-service engineering.** ARDC now handles all Unsatisfactory Reports from USAF field units that contain technical complaints. These are handled through Wright Air Development Center via a decentralized system that fits AMC's decentralized materiel areas. WADC has a technical representative at each of the 12 AMC materiel area headquarters to handle URs on equipment procured through the air materiel area.

Originally a bottleneck developed when WADC laboratories tried to handle the URs, but now the majority of them are farmed out to manufacturers of the equipment involved for solution with WADC monitoring. Increasing reliance on the industry to handle UR's has cut the average time it takes to get a "fix" to 30 days from an earlier average of 120 days.

Lt. Gen. L. C. Craigie
USAF Deputy Chief of Staff/Development

Organization

ARDC headquarters is the nerve center of the new USAF technical development program. It is now located in two downtown office buildings in Baltimore, Md., but there are plans for building a permanent headquarters on the edge of Friendship Airport, south of Baltimore.

One of the considerations in locating at Baltimore was that it would enable ARDC to maintain close liaison with USAF headquarters and other military research organizations without taxing the already overloaded military installations in the Washington area.

ARDC headquarters is organized along the same functional lines as USAF headquarters, with the exception of three offices which are peculiar to ARDC mission. They are:

• **Office of Scientific Research,** now headed by Col. Oliver G. Heywood, Jr.

• **Office of the Assistant for Operational Readiness,** now headed by Col. Joseph R. Holzapple.

• **Office of the Deputy for Development,** now headed by Brig. Gen. Floyd B. Wood.

Work of OSR is described in article starting on p. 87.

► **Readiness Teams**—The Assistant for Operational Readiness reports directly to ARDC and heads a group of "traveling salesmen" who maintain extremely close liaison between ARDC and the operational USAF commands that use weapons and supporting systems.

There is a team from this office working with every major user command: Strategic Air Command, Tactical Air Command, Air Defense Command, Air Training Command, and Military Air Transport Service.

Team's job is to get the ideas of operational personnel down to wing and squadron level "cranked in" to ARDC's technical thinking and to keep the user commands conversant with the "state of the art" in their particular fields of interest. Operational Readiness maintained a permanent liaison team with USAF combat units in Korea during the war there and sends special missions to overseas theaters on specific operational problems.

► **Development Activities**—There is a conventional Deputy for Operations on the ARDC staff, to handle normal housekeeping and management functions leaving the Deputy for Development free to handle the technical program of the Command. The character of ARDC's development activities can readily be discerned from the signs on the office doors of section chiefs under the Deputy for Development. The Weapons Systems Division has the following subdivisions:

• **Strategic Combat Systems.**
• **Tactical Combat Systems.**
• **Air Defense Systems.**
• **Air Logistics and Training Systems.**
• **Reconnaissance, Intelligence and Psychological Warfare Systems.**

► **Technical Directorates**—These offices are responsible for systems development in their particular field and draw on the seven technical directorates for specific developments in their fields to support the weapons system development programs.

The technical directorates are:

• **Aeronautics and Propulsion.** This directorate is divided into two sections. The aeronautics section handles aerodynamics, structural development, design criteria, landing gears, controls and actuating systems, escape systems and miscellaneous development. The propulsion section handles piston and gas turbine engines, nuclear propulsion fuels lubricants, and engine accessories.

• **Armament.** This directorate operates in four sections—systems engineering, air ordnance, special weapons and foreign development. It covers offensive and defense armament systems, fire control systems, nuclear weapons, gunsights, bombing and navigation systems, air-to-air and air-to-ground missiles, etc.

• **Electronics.** This includes airborne and ground radar, communications and navigational aids, electronic countermeasures, and special electronic devices.

• **Equipment.** This directorate handles the widest variety of projects in ARDC. It has six subdivisions:

1. **Ground** equipment, which includes all airbase support equipment such as refueling vehicles, tractors, snow plows, runway lighting systems, hangars, weapons and missile support equipment and training equipment.
2. **Airborne equipment,** which includes all airborne instruments, airborne electrical and mechanical systems, integral cargo loaders and tie-down systems.
3. **Uniform and personnel** equipment, which includes clothing, rescue and survival equipment, parachutes and miscellaneous equipment.
4. **Photographic** equipment, which includes photo laboratories, both fixed and portable, mapping and charting equipment, and photo-recon equipment.
5. **Meteorological** equipment, which includes all kinds of weather observing, recording and correlating equipment, except those types assigned to the Air Weather Service.
6. **Material,** which does all the applied research on all types of materials used by USAF.

• **Geophysics.** Work in the field of terrestial sciences and atmospheric physics and forecasting is aimed not only for use in weather work but also for the effects of the atmosphere on actual operations of missiles, aircraft and communications.

• **Human factors.** This directorate operates in three sections:

1. **Aeromedical sciences,** including aviation medicine, protective equipment and bio-medical aspects of radiological and chemical warfare.
2. **Human engineering,** including design, development and field evaluation work to match airmen and their equipment better.
3. **Human resources,** including social-psychological work to improve human relations and morale, utilize manpower more efficiently and improve training methods.

ARDC has also recently acquired three field stations that have been working the human factors field. They are:

1. **Human Resources Research Institute** at Maxwell AFB, commanded by Maj. Gen. Franklin O. Carroll. This center works in the field of cultural research,

Lt. Gen. Earle Partridge came from Korea to command ARDC.

studying the individual in relation to his environment. Specific fields include psychological warfare, strategic intelligence and counter-intelligence and morale factors. Dr. Carroll L. Shartle is director of research.

2. Human Resources Center at Lackland AFB, commanded by Col. Herbert Cowles. This center covers the entire field of pyschological research aimed at developing better methods of personnel classification, training and job proficiency measurement.

3. Human Factors Operations Laboratory at Bolling AFB, headed by Karl D. Kryter, evaluates the human factors under actual operational conditions encountered by air crews in specific aircraft and operating specific airborne equipment.

• **Nuclear applications.** This directorate is concerned with testing of atomic weapons and their effectiveness; defensive measures against atomic attacks and the best methods of employing fissionable materials in warfare.

ARDC also is responsible for the Armed Services Technical Information Agency (ASTIA) located at Dayton.

Procurement

USAF has defined the procurement responsibilities of AMC and ARDC so that the former buys all standard USAF equipment required by ARDC and ARDC buys all non-standard equipment peculiar to its mission. In practice this now means that ARDC buys all of its research and its development in the field of armament. On major weapons systems and specific aircraft development, ARDC assists in selection of a contractor but AMC writes the contract. For standard type USAF equipment required by ARDC, the individual ARDC centers initiate procurement requests which are funneled through the Director of Procurement at ARDC headquarters, Col. Robert Martin, and then to AMC for processing.

Buying of research and development differs sharply from buying production hardware and ARDC is trying to tailor special methods best suited for its type of procurement within the framework of the armed services procurement laws.

For example, since research contracts buy primarily the time and effort of specially talented individuals or organizations, the primary consideration in picking a contractor are his qualifications rather than price. The primary problem in buying research is to select the most qualified source to do the particular investigation required. ARDC now uses a conference-type negotiation in which prospective contractors are briefed on the technical requirements and funds available for the project and requested to submit proposals. ARDC technical officers are responsible for evaluating the proposals and ARDC procurement officers are responsible for fitting the proposals within the framework of existing USAF procurement regulations.

Fixed-price contracts are generally not suitable for buying research. Cost-plus-fixed-fee types are used when a fixed development goal is sought, while a target-ceiling-type contract is generally used when the project requires initial exploration of a subject and no fixed goal is in sight. In the target-ceiling contract, the contractor is given a dollar ceiling within which to work for a specified time period with provision for redetermination at the end of the period. If the contractor exceeds the dollar ceiling, he stands the extra cost; if he is below the ceiling, part of the difference is added to his fee.

To understand the present structure of the USAF research and development effort and the problems facing ARDC it is necessary to take a backward look to see how the present race for technical superiority developed.

Before World War II, the Army Air Corps procurement effort was so small and its inventory turn-over so slow that few industrial groups outside the airframe and engine industry were interested in doing aviation work.

Turnover of the prewar Air Corps inventory was so slow that planes delivered in 1927 were still being flown as first-line fighters and bombers 10 years later. Now the swift pace of technical development has dictated a three-year turnover in USAF inventory of first-line aircraft, with an additional three years of service in the second line—Reserve, National Guard and training units.

Trevor Gardner, Special Assistant for Research and Development on USAF Secretary's staff.

► **Was Just in Time**—When the war began in Europe in 1939 the first aerial combat indicated clearly that both British and German production-model combat planes were superior to those then coming out of U. S. aircraft factories. An attempt to organize a large-scale technical development program soon succumbed to the pressure for quantity production to produce an Air Force in being.

The wartime years saw the continued emphasis on quantity production at the expense of quality. A series of costly post-production modification programs that belatedly attempted to build in the quality required for combat that had been neglected on the production line were required for most Army Air Forces planes.

The end of the war revealed clearly that it had been won just in time since the Germans were bringing into play technically superior weapons that the AAF would have been unable to match.

Getting Started

The late Gen. H. H. "Hap" Arnold was an early missionary for increased research and development in the Air Corps and pioneered the use of civilian scientists to advise the Army Air Forces on technical methods of solving their military problems. Late in 1944 he roused Dr. Theodore von Karman from a sickbed in New Jersey to fly to Europe and make a survey on enemy technical developments in relation to those of the Allies.

In two reports, "Where We Stand" and "Science: Key to Air Supremacy," Dr. von Karman detailed where the AAF had lagged behind the Germans in technical developments and what it must do to recapture the lead in the race for technical superiority.

While U. S. had been superior in the fields of electronics, atomic weapons and the perfection of the laminar-flow wing for subsonic aircraft, the Germans clearly led in jet propulsion, rockets, guided missiles and supersonic aerodynamics. On the basis of the research of that time Dr. von Karman flatly predicted that the era of supersonic flight was just around the corner.

► **LeMay Takes Over**—To implement Dr. von Karman's recommendations, Gen. Arnold brought Gen. Curtis LeMay, who he characterized as the AAF's "finest combat leader," to the Pentagon to take the newly created role of Director of Research and Development on the Air Staff. LeMay fought a valiant battle for two years but the pressure for a force in being again submerged the effort to build future quality.

Before he left for the Strategic Air Command, Gen. LeMay had accomplished two significant things:

• **He had established** the Rand Corp., which still provides scientific guidance for USAF on military problems.

• **He organized** the Air Force Institute of technology to train the combat veterans of World War II in the technical problems of tomorrow.

► **Birth Pangs**—When USAF was created as a separate service, its immediate problems of divorce from the Army tended to obscure the critical technical problems it faced for the future. These were:

• **Lack of adequate development** testing facilities for the new generation of aircraft and missiles. During World War II the U. S. was so short on aeronautical test facilities that the basic aeronautical research facilities of the National Advisory Committee for Aeronautics were drafted to do the critical development testing for specific fixes on Air Force and Navy aircraft required for the war. The few facilities operated by the Air Force and Navy were hopelessly obsolete to cope with the post-war technological revolution in aviation.

• **Lack of adequately educated** and trained personnel in the technical fields required for the new era of aviation. A survey of Wright Field officers holding technical posts within AMC in 1947 revealed that 60% did not have the necessary technical qualifications to even qualify them for entrance to the Air Force Institute of Technology—the school that was supposed to train people for the jobs they were already filling.

• **Lack of adequate priority,** funds and command of the research and development facilities already existing. The Wright Field technical laboratories were under AMC. The Special Weapons Command, the Arnold Engineering Development Center and the Long Range Missile Proving Ground were all independent organizations. The electronics laboratories in New Jersey and Massachusetts were operating as exempt facilities with their own procurement authority although nominally under AMC control.

► **"Old Shoes"**—The aircraft industry was in a state of revolt because there were no development funds to push forward into the technical gaps already yawning in highspeed aircraft, jet propulsion and guided missile fields. Although the first piloted supersonic flight was made in the fall of 1947 as a milestone in the brilliantly planned and executed highspeed flight research program of USAF, Navy and NACA, there were no funds for new aircraft prototype development from 1947 to 1949. New aircraft development had to be financed out of production funds by modifying subsonic types already in production or "resoling old shoes," as one industry veteran cynically described the process.

The Defense Department Research and Development Board became known as the "Retardation and Delay Board," as its 16 committees, 174 panels, 284 sub-panels and 3,000 special consultants debated endlessly without decisive action. Prominent civilian scientists seriously proposed that the research and development functions of the defense department be turned over to civilians.

► **Ridenour Committee**—By 1949 the research and development issue had become a hot controversy both in the Air Force and the Defense Department, where Defense Secretary Louis Johnson was preaching his doctrine of false economy. Gen. Vandenberg, then USAF Chief of Staff, appointed a committee of the USAF Scientific Advisory Board, headed by Dr. Louis N. Ridenour, then Dean of the University of Illinois Graduate School, to study the USAF problem.

A significant member of this group was Dr. James Harold Doolittle, who combined distinguished service as an aeronautical scientist, USAF combat commander and industrial leader. Later as Special Assistant on Technical Matters to the USAF Chief of Staff, Doolittle played an important role in the establishment of ARDC and the explanation of its philosophy to the aircraft and related industries.

► **Development Deficiencies**—The Ridenour Committee report noted the following deficiencies in the USAF development program:

• **Too low a priority,** both on the Air Staff and in USAF operational command, was assigned research and development activities.

• **Research and Development** activities were diffused throughout the Air Force with no single responsible agency either at the staff or command level.

• **Too few officers and civilians** in the Air Force had the proper technical qualifications.

• **USAF facilities were inadequate** for both the research and development effort required to keep up scientific pace.

► **Recommendations**—The committee recommended that a research and development command be established in which all of the USAF R&D mission and facilities should be concentrated.

A similar study was also made by an Air University group composed of military experts headed by Maj. Gen. Orville Anderson. Their conclusions were substantially the same as those of the Ridenour Committee.

On Jan. 3, 1950, the late Gen. Muir Fairchild announced to an Air Staff meeting that a Deputy Chief of Staff for Development would be appointed, and the Air Research and Development Command would be activated. Maj. Gen. Gordon Saville was named first Deputy Chief of Staff for Development. Lt. Gen. L. C. Craigie now fills the post.

Maj. Gen. David Schlatter was transferred from the USAF atomic weapons program to organize the new command. Later a special civilian post was created for a research and development advisor to the Secretary of the Air Force. This position is now filled by Trevor Gardner.

► **ARDC Takes Over**—The process of unsticking the major components of the new ARDC from AMC dragged out for over a year. Not until long after the outbreak of war in Korea was the command finally activated as an independent organization on Apr. 2, 1951.

A few months later the appearance of the Russian-designed and -manufactured MiG-15 and La-17 sweptwing jet fighters over North Korea served notice that the Soviets were not lagging in modern aircraft development.

During the past two years, under the command of Lt. Gen. Earle Partridge, ARDC has gradually been given control of the previously scattered USAF research and development units. Gen. Partridge was recently named deputy USAF Chief of Staff for Operations and was succeeded at ARDC by Gen. Putt.

The Ridenour report warned USAF that it would be at least five years after establishment of a new research and development command before any progress could be noted. In the two years of its existence, ARDC has made substantial progress toward eliminating major defects that threatened USAF technical progress with stagnation. It still faces many unsolved problems, some inherited and some inherent in the swift technical pace of modern air power.

The real importance of ARDC lies in the fact that it has been created, organized and is working to put the technical future of USAF on a sounder foundation. How well it will do this job only the future can tell. But few will deny ARDC has made a significant start.

ARDC Insignia

Weapon System Plan Spurs Development

New military-industry relationships foreshadowed by single prime contracts, revised design study procedure and JPOs.

Success or failure of the Air Research and Development Command will be measured primarily by the quality of the new weapons developed under its auspices and the speed with which these weapons progress from the drawing board to combat units.

ARDC, with USAF approval, has already initiated a program aimed at compressing the development cycle; raising the quality of USAF weapons closer to the current technical "state of the art"; and cutting the cost required for weapons development.

While these steps will require another three to five years before their effects can be accurately gauged they foreshadow significant changes in the aircraft industry's future methods of doing business with the Air Force. They have also altered relationships between prime contractors, components manufacturers and suppliers within the aircraft industry.

The ARDC weapons development program includes:

• **Weapons system concept.** This aims at producing a complete weapons system including all of the equipment required to perform a specific military task instead of simply an aircraft with miscellaneous assortment of hardware that must be jiggered into a combat system in the field with some parts incompatible or missing.

• **New design competition procedure.** Instead of giving the industry a detailed specification for a new aircraft or missile, the procedure emphasizes the military requirement to be met and relies on the industry to produce a technical solution. It plans to compensate the industry for its preliminary design proposal work in providing solutions for weapons system contracts even though the individual firm does not win the systems development contract.

• **Single prime contractors.** ARDC plans to buy the management talents of the aircraft industry in organizing and scheduling weapons system development as well as its technical skill in developing the system.

• **Joint project office.** Establishment of the Joint Project Offices at Wright Air Development Center provides the industry with a single focal point for its relations with USAF during the development cycle of a weapons system.

• **Controlled production buildup.** This plan has been endorsed by ARDC and Air Materiel Command, and approved by the Air Council. It calls for production tooling and initial production at relatively low rates to produce a larger number of test models. It defers quantity production until sufficient data is obtained from the development testing program to insure elimination of major "bugs" that inevitably plague new aircraft and related equipment.

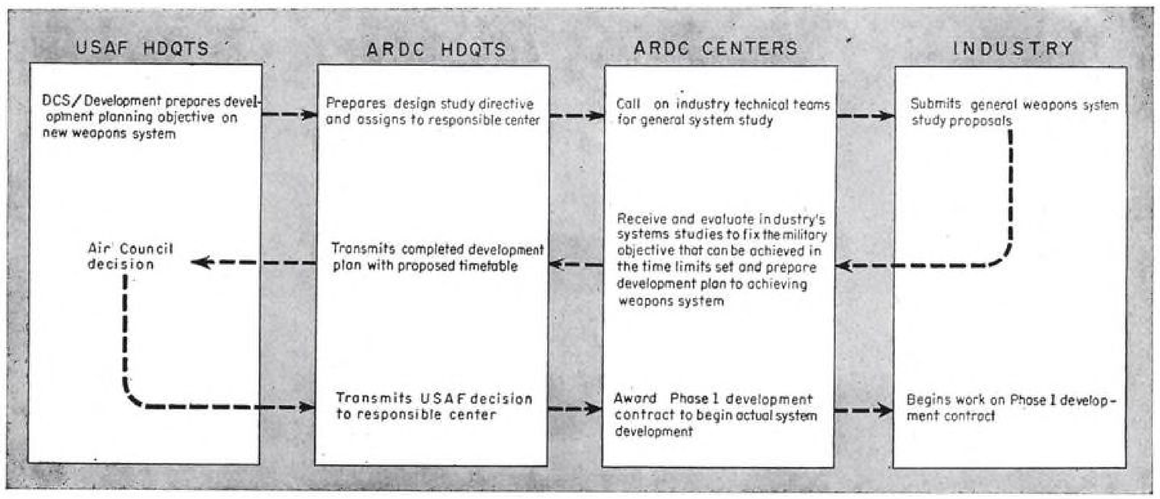
► **Missile Problem**—This program developed out of the bitter experience of USAF in World War II and has been sharply spurred by the technological revolution that hit aviation in the postwar years. The advent of guided missiles and supersonic aircraft made it evident that new development methods were required. Much of the pattern of the present development program first emerged when USAF faced the missile problem in the early postwar years.

• Since there was no previous missile experience the military could only state their requirement and rely on the industry to produce technical solutions.

• A missile by its very nature had to be a complete weapons system and had to be approached from that angle.

• Since there was no missile industry in existence the contractors pioneering the field had to be given complete responsibility for systems development.

• And since it appeared that missiles would be a one-shot affair it was necessary to manufacture a substantial quantity for testing during development before a decision could be made on the final equipment for quantity production.



► **Weapons Systems**—USAF is developing its new weapons as a complete system that will include all of the equipment needed to do a specific military mission. Development and production is scheduled so that all parts of the system are available and workable when the system is scheduled to go into use.

"You can think of the entire USAF as a large complex weapons system which is in turn a sub-system of the entire Defense Department," says Col. Ernest Ljunggren, head of ARDC's Weapons System Division. "Each command within USAF is a lower sub-system and each weapons system within the Commands a still lower sub-system. Each sub-system must operate within the restraints imposed by the next higher system.

"For example, USAF must operate within the limits of critical materials that will be allocated to it by the Defense Department. Weapons systems must utilize a certain percentage of standardized parts because of the logistical restraints imposed by USAF operations as a whole. It is the job of the contractor to develop the optimum weapons system within the restraints imposed by the next highest system. We don't plan to optimize the system at the expense of its components nor optimize the components at the expense of the system."

► **Supersonic Problem**—The achievement of supersonic flight in piloted planes made the applications of the weapons system concept mandatory to future aircraft development.

"We can no longer afford to order an airframe and then try to stuff it with government furnished equipment developed separately under separate contracts," says Col. H. A. Boushey, chief of the Weapons System Division at Wright Air Development Center. "From now on the faster aircraft go, the more exactly we must tailor our power, aerodynamics, guidance and firepower to fit each other in a single airframe package. You just can't consider less than the whole problem and be successful."

Another significant facet of the weapons system concept is the recognition of realistic development scheduling problems and the necessity for realistic planning to have all of the components of the system ready for production at the same time so that the industry can produce and deliver combat-ready equipment.

"We must recognize that it takes from seven to ten years to develop a new fire control, bombing and navigation system or powerplant type whereas an airframe can be developed in 2 to 3 years," says a top civilian technician long associated with aircraft development. "In World War II, the technical ingenuity of the combat units in the field enabled them to modify the equipment we gave them to fill in the gaps and do the fighting job. This saved the system from collapse. But modern aircraft are too complex to be modified in the field. They must be right when they roll off the production line equipped with all the hardware they need to do a military job."

► **World War II Tries**—Initial attempts to apply a systems approach to aircraft development were made during the latter phases of World War II with the B-29 as a strategic bombing system and the Northrop P-61 as an all-weather fighter system with components required for the combat mission tailored specifically to the aircraft.

The first significant stride in the direction of the present weapons system concept was made in the summer of 1949, when Maj. Gen. Gordon Saville, then Director of USAF Requirements, backed by the late Gen. Muir Fairchild, then USAF Vice-Chief of Staff, called in the aircraft industry to the Pentagon for a briefing on air defense problems of the future and asked the industry to provide technical solutions.

This resulted in the all-weather interceptor competition won by Convair with the F-102 design. The interceptor development was handled essentially as development of two separate systems: the aircraft by Convair and the fire control, electronic guidance and offensive armament system by Hughes Aircraft.

Out of this grew the full-scale systems concept now being applied to the development of strategic bombing systems, tactical combat systems, air defense systems, aerial logistics systems, and strategic reconnaissance and intelligence systems.

► **Industry's Reaction**—There was considerable aircraft industry opposition to the introduction of the weapons system concept and the proposal to utilize a single prime contractor to assume systems development responsibility. But so far Convair, Douglas, Boeing, Lockheed, Martin and others have organized systems engineering groups.

Convair has also revamped its division organization and management on a weapons systems basis with the Ft. Worth Division assigned responsibility for strategic bombing, aerial reconnaissance and aerial logistics systems, and the San Diego Division charged with handling air defense systems and Navy water-based aircraft systems. All of these activities are coordinated by a special long-range planning group charged with keeping top management informed on technical trends and military requirements in the systems fields.

► **ARDC as Monitor**—The key to the systems development is the new procedure developed by ARDC and approved by USAF for handling new weapons development. Basically it calls for USAF to define the military problem for which it requires a solution and then to rely on the industry to produce the best technical answers. ARDC's role is to monitor, evaluate and supervise the development program and, with Air Materiel Command, recommend and select competent industry management-technical-production teams to do the job.

Here in detail is how this new procedure works. The process begins with the writing of a Development Planning Objective by the Director of Development Planning (now Brig. Gen. B. S. Schriever) in the office of the Deputy USAF Chief of Staff for Development (now Lt. Gen. L. C. Craigie).

The DPO is the broad qualitative analysis on which initiation of requests for new weapons systems is based. It includes a survey of strategic, logistic and technical considerations; a study on the feasible time limits for the system development; and outlines new research and development programs that may be required for long lead time components such as bombing and navigation systems, engines and electronic fire control systems.

ARDC through its technical directorates and systems offices and centers assists the Deputy for Development in determining technical feasibility and the Rand Corp. makes studies on military problems involved.

► **Operational Requirement**—The development of a specific weapons system is initiated by a General Operational Requirement in which USAF headquarters states the military problem it wants solved and requests ARDC to develop a solution. Included in the GOR are such factors as: types of missions the system must perform; types of targets it must attack; the environment in which it must operate; the enemy capabilities it must surmount; and logistical requirements and limitations.

ARDC again draws on its technical directorates, weapons system offices and centers to organize a Design Study Directive which is prepared for the technical guidance of all military and industry organizations concerned with the effort to plan a complete systems development program. The Design Study Directive assigns responsibility for development of each system to a particular ARDC center. As a matter of actual practice, virtually all major systems are handled through Wright Air Development Center through the Weapons Systems Division, headed by Col. H. A. Boushey and operating under the WADC deputy for operations, Col.

Victor Haugen. All aircraft and missile systems are handled through WADC but some ground systems, particularly avionics, are handled through Rome and Cambridge.

► **Target Set**—The Design Study Directive sets target dates for systems completion; specifies research and development funds available to support preliminary studies; establishes priorities for the project; outlines co-ordination required between centers and lists any parallel developments that should be considered in planning the new system. Attached to the Design Study Directive is an appendix containing the original GOR, a technical guidance memo, suggested development goals, applicable projects already under development, areas that require exploration, limiting policy factors, and an intelligence annex.

The ARDC center assigned the system responsibility then calls in the industry to study approaches to the operational problem involved and this is where the ARDC-industry partnership actually begins to work. ARDC feels that bringing industry into the military development picture at this early stage will give it a better picture of the military customer's needs and give the military a better fix on what it is feasible to get technically from industry during any given time period.

ARDC functions as a liaison between the military commanders who need equipment to do their job and the industry that must provide the equipment.

► **Engineer Economy**—Usually three or four aircraft firms are asked to participate in the design study phase on a contract basis. By paying industry for this preliminary work, ARDC hopes to avoid the financial drain and waste of engineering man-hours imposed on the industry by former design competition methods.

By providing a relatively stable workload of development problems for the industry, ARDC hopes that individual firms will be able to keep their engineering teams intact even though they may be unsuccessful in a particular systems competition. The preliminary design study phase work will also help to keep the industrial groups up to date on the "state of the art" in military fields.

The responsible ARDC center takes the results of the industry studies, reviews and evaluates them to get a fix on what military capabilities can be achieved technically within the specified time limits. It uses data obtained from both industry and ARDC sources to make a more accurate forecast on the time required for the system development. The center then prepares a specific development plan for the system which includes:

Development Planning Objective

A development planning objective establishes qualitative guidance in broad terms for systems and techniques which will accomplish most efficiently USAF missions under probable future war conditions. A development planning objective results from the analysis and integration of the strategic, logistic and technological factors pertaining to each **major combat and support mission** of the Air Force. Primarily, development planning objectives will establish the broad analytical military mission base for the initiation of new developments at the systems level.

• **General design specification.** This is a blueprint for development of the system. It specifies the limits of the military capability that can be technically achieved within the time limits prescribed and it also defines the capabilities required of major sub-systems. It is evolved from the studies conducted by industry and ARDC centers.

• **Proposed development plan.** This details the new developments required to complete the system; the development timetable required to get all system components ready when needed; funds required to support development work; and a recommendation as to which of the contractors participating in the preliminary design study phase should be selected to develop the system.

• **Supporting resources.** This outlines the test facilities required by both the contractor and ARDC, flight test requirements, and the test equipment and peculiar skill requirements of the commands that will eventually test and operate the system.

Out of this development plan ARDC and the industry hope to get a complete and realistic solution to the military problem involved within a specific time period. The plan should tell what military capabilities can be achieved by the system, how long it will take to achieve them, and how much it will cost.

ARDC sends this complete development plan to USAF headquarters where it is reviewed by the Deputy Chief of Staff for Development and the Air Weapons Board and then comes up for a decision by the Air Council. If the Air Council decision is favorable the plan comes back to ARDC and is passed on to the responsible center where, in co-ordination with the Air Materiel Command, a Phase 1 development contract is awarded to a contractor to begin the system development.

The time cycle for this process from the publication of the GOR to award of a Phase 1 contract is about 11 months. The procedure was approved by USAF last October and the first industry design studies are due early this fall on a tactical bombing system. It will be at least five years before any weapons system developed under this process will appear in quantity with combat units.

► **Convair XB-58 First**—To increase the efficiency of weapons system development, ARDC is also buying industry's management ability in addition to its technical skill. This is handled by a single prime contract for a complete weapons system which fixes the responsibility for developing the system and integrating all its sub-systems into a combat-ready weapons system. First of these single prime contracts was awarded last spring to Convair for development of the XB-58 supersonic strategic bombing system.

Under the B-58 contract, Convair is not only responsible for developing the airframe of a supersonic bomber but is also charged with supervising development of virtually all other equipment required for the complete bombing system, including much of what was formerly government furnished equipment (GFE).

This additional equipment and major-sub-systems will be handled directly by contract between Convair and the component manufacturers instead of by separate contracts with USAF. Included in Convair's B-58 responsibilities are the following sub-systems: bombing and navigation; autopilot and controls; offensive armament; defensive armament; communications; reconnaissance; cooling; and ground support equipment.

► **Engines Separate**—The propulsion sub-system is exempt. ARDC feels that since modern engine development time and costs equal those of a large airframe, it cannot afford duplicate engine programs to meet the same power requirement in different weapons systems. For example, the time and cost of developing the P&WA J57 turbojet virtually equals that required for the Boeing B-52 bomber which it powers. Although the contractor will have considerable voice in the selection of propulsion systems for his weapons system, USAF through ARDC will make the final decision and handle development separately.

There has been considerable industry skepticism and opposition to the single prime contractor method. Some industry wags commented: "If that's the new USAF development philosophy, let them tell us where they want the bomb dropped and we'll do that too on a cost plus fixed fee contract."

Component manufacturers long used to doing business directly with USAF are uneasy about developing new sales relations with aircraft manufacturers and are fearful the prime contractors may expand to compete in their component fields. Present systems contracts specifically forbid the prime contractor to expand his physical facilities to do any component manufacturing and ARDC is watching the situation closely to prevent the component manufacturers' fears from being realized.

► **Effect on Prime Contractors**—ARDC will use the single prime contractor method only where a system development program requires it and a contractor appears to have the management and technical sources to handle it. If contractors decline to assume complete responsibility ARDC will act as the supervising authority.

It appears that aircraft firms interested in single prime contracts will have to expand their management resources and enlarge their technical staffs to develop competent evaluation teams for the major sub-system fields in which they will have to buy from competing component manufacturers.

► **Component Makers' Situation**—With the exception of an additional sales problem involved in selling prime contractors as well as USAF, there appears to be little change in the major components manufacturers situation under the new system. They will still deal with WADC laboratories and ARDC on the technical competence of their equipment and ARDC will retain a veto power over the prime contractor's decision on sub-systems.

If ARDC vetoes the prime contractor's selection of a subcontract source or equipment because of other USAF requirements, the sub-system will be provided as GFE.

ARDC will assume responsibility for getting the system to meet the original requirements and the prime contractor will still be responsibile for integrating the sub-system into the weapon system.

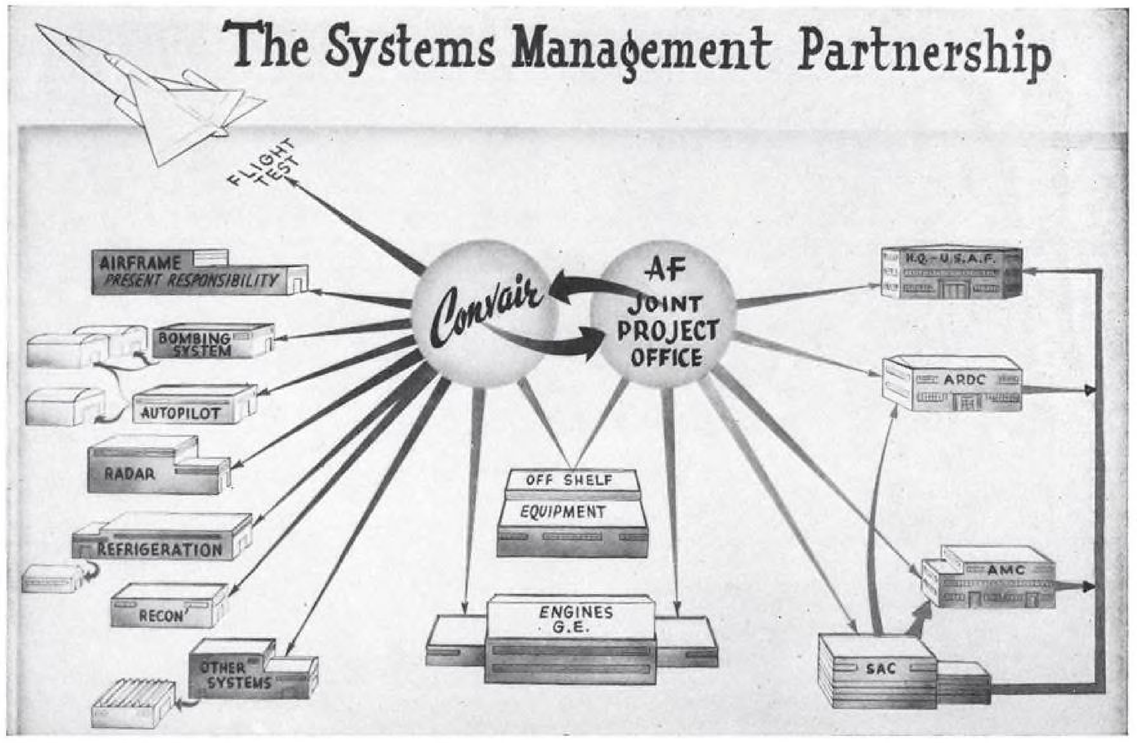
► **Working Together**—In order to make the new system work there must be a close relationship between the WADC laboratories, the prime contractor and the major sub-system manufacturers. An example of how this works is the B-58 bombing and navigation system. WADC labs helped Convair prepare performance specifications for the sub-system although the detailed specifications were written by Convair and proposals were solicited directly by Convair from the manufacturers in that field. These proposals were evaluated by Convair, with the assistance of WADC on technical matters and Air Materiel Command on logistical considerations.

After this process was completed, Convair picked Sperry to do the job which is being done under direct contract with Convair. ARDC encourages prime contractors to use the resources of both the WADC labs and the sub-system manufacturers in their preliminary design study work. On future proposals some prospective prime contractors are using the sub-system manufacturers to help in the over-all presentation to WADC.

The new system will not eliminate government furnished equipment. It will, however, restrict GFE more to standardized parts which can be used interchangeably in systems development. ARDC feels there is an acute need for an intensive campaign on standardized parts such as fasteners, bearings, vacuum tubes, etc., which can be used as interchangeable building blocks.

In these categories, where the third- and fourth-tier suppliers operate, no changes are anticipated. These suppliers will continue to get their products on the WADC approved list after passing lab tests and prime and sub-system contractors will use the WADC lists to pick their parts manufacturers.

► **Off the Merry-Go-Round**—The Joint Project Office System was established to give both USAF and the industry a single focal point for handling their mutual problems during the development cycle of new weapons systems. Earlier, the case of the contractor who talked with 72 USAF people in three days and still couldn't get a decision on his problem was by no means unique. One of the standard industry complaints was the amount of time its technical and management people wasted on the USAF merry-go-round.



The Joint Project Offices are physically located at Wright-Patterson AFB. They include representatives of both ARDC and AMC—combining the AMC buyer and the ARDC technical project officer in a single office with the authority to make decisions on projects within their baliwick.

First JPO was established in August 1951 to handle the Boeing B-52 project. First dividends from the practice will be evident in the B-52 production program. Since then, the JPO have taken over a variety of projects, ranging from completely GFE-type aircraft already under development to the single-prime-contractor B-58 systems project.

The JPO expands as the project develops, beginning with as few as two people and reaching a maximum of more than 20 as the development cycle progresses. The B-47 JPO is now the largest at Wright-Patterson and has almost reached the proportions of an aircraft type branch. Size of the JPO declines as the development problems diminish. Command of the JPO also shifts during the cycle, with the ARDC office in control during the development phase and the AMC officer taking over as the production phase approaches.

► **Settling Conflicts**—Technical difficulties between the WADC labs and the JPOs are resolved by the Director of Laboratories and the head of the Weapons System Division. Conflicts between the technical and procurement viewpoints that can't be resolved in the JPO are handled first between Gen. Albert Boyd, WADC commander, and Gen. Walter Bain, AMC procurement director.

So far none have passed this level, but if necessary they can go to the level of Gen. Putt and Gen. Rawlings, ARDC and AMC commanders respectively, or beyond that to the USAF staff level, where they would be resolved by Gens. Craigie and Cook.

► **Improving Quality**—Although it is not directly related to the weapons system concept, the controlled production build-up appears destined to play an important role in getting better quality equipment on the aircraft industry production lines and reducing the time it takes to get combat-ready equipment to USAF squadrons. The plans call for an initially slow rate of production aimed at producing a relatively large quantity of aircraft for development testing and at the same time tooling up for quantity production. The requirements of development testing have long outgrown the three X models that were long the USAF standard, and now nearly 50 B-47s are engaged in development test work in support of that production program. By keeping initial production low, all of the major development work can be done on this test quantity with major modifications available to be fed directly into the production line when the signal is given to accelerate into quantity production.

► **"Bug" Blitz**—ARDC estimates that it now takes about 1,000 hours of flight testing to work about 90% of the inevitable "bugs" from a new fighter and about 1,800 hours to do the same job for a bomber. By doing the development testing before quantity production is begun, USAF hopes to avoid the costly post-production modification programs that have continually plagued its aircraft programs and postponed the time when equipment becomes combat-ready. Among the specific postwar examples of these programs that have drained USAF procurement funds and prevented delivery of modern combat-ready equipment are:

- **A medium bomber** that has been in production for three years but was just recently pronounced combat-ready by USAF. Modification program on bombers already built is about equal to original production costs.
- **A jet fighter** that went into quantity production with less than two hours experimental flight testing of its prototype. Structural failures were experienced in flight, killing a number of pilots, requiring an expensive, time-consuming modification program and leaving a large inventory of unusable spare parts.
- **A jet fighter** currently under test at Edwards AFB that requires extensive modifications for highspeed operations. Because the plane is already in production, nearly 300 aircraft will have been built before the modifications can be incorporated in the production line.

► **Production Speed-up**—By building the test quantity from production-type tooling instead of experimental tooling and proceeding with production tooling-design and build-up during the development test phase, USAF believes it can produce better planes in shorter time. The only gamble involved is the cost of the tooling committed during the development test cycle. If the decision was made to abandon production as a result of development tests the initial production tooling would be a total loss. If the decision to proceed with production is made considerable time will be gained.

The first aircraft to try the new system is the North American F-100 supersonic Sabre, but the first full-scale application of the plan will be on the Convair F-102 which is a radically new step in aircraft development.

► **Selling the System**—ARDC has been making a genuine effort to explain its new philosophy and procedures to the aircraft industry. Teams have briefed personnel of individual firms ranging from the board of directors down to engineering groups, and ARDC played host to a conference of industry leaders in Baltimore last January to exchange ideas of mutual problems.

Naturally there are still some skeptics among the major aircraft managements who are reluctant to alter their traditional business methods and there is active opposition in some segments of the component manufacturing industry. ARDC still has an educational and sales job to accomplish on its industry relations.

But there are many people in the aircraft industry who are encouraged by the vigor and freshness of ARDC's approach to some of the longtime USAF development problems. Both the industry and the rest of the Air Force will be observing closely the progress of these new methods an attempting to evaluate the degree of improvement they bring on the major problems that have long hampered USAF weapons development.

General Design Specification

A general design specification is a statement of the limits of **military capability** that can be **technically achieved** in the time period prescribed and applies to the entire weapon system. It will define the **capability** of the **major sub-systems** that combine to make the system a **complete** operational entity. The general design specification is evolved from studies fixing the probable state of exploratory research and development within a specified time, including a complete review of the state of all applicable existing and projected component developments. The details will be of sufficient technical description of the possible military capability to permit determination whether the existing applicable exploratory research and development can be employed or new developments will be required, resulting in later availability.

Development Plan

The development plan, including the general design specification, is a schedule of the development and test phases of the system proposed as a solution. It contains realistic estimates of the funds, logistics, personnel, training, and other supporting requirements necessary to the planned systems developmental and operational objectives.

OSR: Keystone of Basic Research

- **Weapons of tomorrow need research today.**
- **This office monitors, supports such study.**

Baltimore—The men who monitor curiosity in the Air Force sit in the Office of Scientific Research at Headquarters, ARDC.

Across their desks pass contracts and reports on shock tubes, the chemistry of hydrazine, high-frequency ultrasonics, problems in global geometry.

The common denominator of all these subjects is curiosity, the key that has opened door after door in man's search for knowledge. Curiosity leads to questioning and eventual understanding; and in the words of the scientific axiom, "If you understand the problem, it's already half solved."

► **Search for Understanding**—OSR's job is to promote understanding; its policy is to advance fundamental knowledge through basic research in fields of science where there is a reasonable expectation of eventual use by the Air Force. In carrying out this job, OSR spends about six million dollars out of the $60 million total that the Air Force spends in both applied and basic research.

Chief of Scientific Research for the Air Force is Col. Oliver G. Haywood, Jr., West Point graduate and DSc. from Massachusetts Institute of Technology. He reports directly to the Commanding General, ARDC, at an organizational level that reflects the importance of basic research in the Command.

► **Now for Later**—OSR was established in November 1951 in recognition that air superiority in the future is dependent upon adequate basic research in the present.

The office approaches its mission in two ways.

- **It acts as general supervisor** over all research under way at the nine major Centers of ARDC.
- **It supports directly a program** of basic research in universities, foundations and industrial laboratories.

The total list of projects numbers about 200, with about 175 different investigators or teams doing the work. A few of these contracts are with foreign universities, where the technical competence for special problems is available. But the bulk of the Air Force's basic research program is placed in the universities and colleges of the United States.

► **Definitions**—It is no easy task to define the term "basic research." It means many things to many people. But in the Air Force, basic research is best defined by a chart which Haywood credits to Dr. Ralph Gibson of the Applied Physics Laboratory, John Hopkins University.

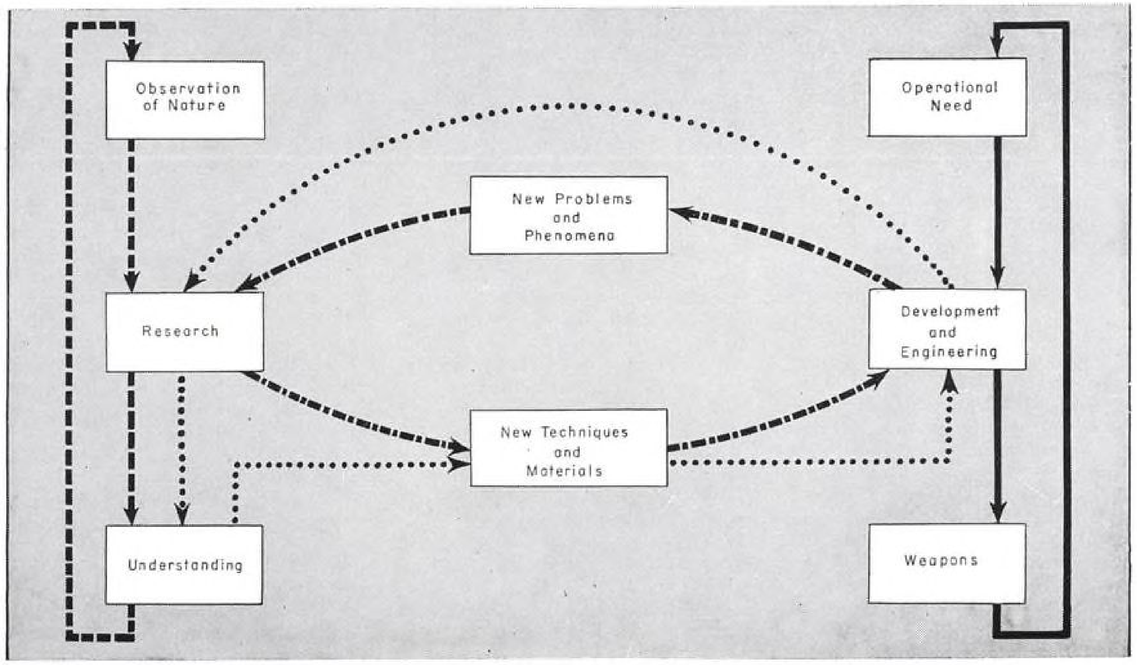
The chart—called "The Regenerative Circuits of Research and Development"—shows the continuous cycling of observation, fact and result and the way those three feed back into the closed loops of R&D.

In its left-hand circuit, the chart pictures "pure" research; in the right-hand circuit, it pictures the engineering loop.

Basic research in the Air Force arises in the dotted cycle that ties these two extreme processes together.

► **How It Works**—It works this way: A research scientist will be curious about some difficulties in the Air Force development program. These difficulties may arise because of a general lack of understanding of the underlying physical phenomena involved. So the scientist begins research, not directed at a specific solution, but rather toward

REGENERATIVE CIRCUITS OF RESEARCH AND DEVELOPMENT



the development of basic understanding.

"We expect that this understanding will help us in our development programs," says Haywood.

▶ **Examples**—As one example, OSR monitors a large number of contracts for mathematical investigations. Several of these are in topology, the study of space characteristics that are changed only by tearing or joining, and not by deformation.

"This field may seem far removed from the Air Force. Actually Dr. von Neumann developed his famous theory of strategic decision on the basis of considerations from abstract mathematics, such as topology," said Haywood.

Another broad example is in combustion. Fire has been used for eons, but the basics of flames are not yet understood. OSR sponsors six projects in the chemical kinetics of combustion, aimed at understanding the fundamental process of a reaction that has been working for and against man for centuries.

▶ **Covering the Field**—Here are some OSR projects that are being undertaken in other fields:

• **What holds atoms together in a molecule?** An OSR contract at Duke University under Dr. Gordy is seeking the answer to this question. One of their laboratory tools is radar, usually thought of only as a distant-detection device, but here working on a submicroscopic level.

• **What is the boundary layer?** Dr. Francis Clauser, at Johns Hopkins, is working with extremely thick boundary layers in a windtunnel. His studies have evolved a dimensionless parameter which—like Reynolds number for free-stream flow—is characteristic of the boundary layer.

• **Can a computer replace a human interpreter?** Dr. Perry, of MIT, has made mathematical explorations of a digital computer to translate Russian into English.

▶ **Seven Fields**—Basic research interest in the Air Force falls into seven major categories.

• **Chemistry.** The composition, structure, properties and transformation of matter; energy production; photographic chemistry; principles and theories necessary in guiding exploratory programs.

• **Fluid mechanics.** Boundary layer, turbulence, compressibility and viscosity effects, aerothermodynamics and rarefied gas problems.

• **Mathematics.** Algebra, statistics, probability, analysis, topology, geometry, computational methods and high-speed computers.

• **Solid State Sciences.** Structure of special crystals, extreme temperature studies, surface physics, structure and properties of solids.

• **Physics.** Theoretical and quantum mechanics, atomic structure, spectroscopy, optics, magnetics, electricity, heat, radiation, sound instrumentation and nuclear physics.

• **Bio-Sciences.** Biology, psychology, aviation medicine, anthropology, sociology, physiology, biophysics, biochemistry, radiobiology, aerobiology, entomology and parasitology.

• **Geophysics.** Physics of the solid earth and its atmosphere, including geodesy, geomagnetism, seismology, meteorology and atmospheric physics at all levels.

▶ **Policies**—No research is done by Haywood's office; the entire program is contracted, mostly to universities.

Programs are initiated generally by a university. Encouraged to keep OSR informed of special qualifications in one or more of the fields of Air Force research interest, the university can best speak for itself in measuring its ability to perform a task.

In rare cases, OSR may query prominent men in a certain field where there has been little activity. One of these is photographic chemistry, where according to Dr. Horner, OSR's chief of chemistry, there has been little done in the development of emulsions since the beginning of photography.

▶ **Contract Requirements**—Every contract monitored by OSR has been let on a "sole source" basis, and justified on that basis. There are four major requirements which must be met by the investigator:

• **Research must be in an area of Air Force interest.**

• **Investigator must be qualified to do the work proposed.**

• **Research should be scientifically significant—worth publication in any of the top-flight professional journals.**

• **Institution must be contractually sound.**

▶ **Small Teams**—More than half the OSR contracts are for less than $20,000. The OSR wants to continue this situation, and to avoid the "brute strength" method of applied research where large teams work toward a single goal.

After the studies have been made, OSR encourages publication of the unclassified results—almost all work is in that category—in scientific journals. Going a step beyond usual AF procedures, OSR will accept a manuscript copy, as submitted for publication to a professional journal, instead of the conventional final project report.

The contracts written by OSR normally cover one and one-half to two years of work, because the Office wants to maintain some stability in the program. "Research cannot be turned on and off like a faucet," says Haywood.

"We want scientists who can devote the bulk of their time to research, and not research administration," he added. Normally it is expected that the scientist who is designated as principal investigator in the contract will spend at least 25% of his time on the particular project.

▶ **Who Benefits?**—The policies of the Office of Scientific Research are aimed at providing the maximum benefit to the nation, the Air Force and the universities. The value to the nation and the Air Force of a strong research and development program is apparent.

The universities are enriched in a number of ways. Financially, of course, through payments to students and research workers for their efforts, and through purchase of equipment and supplies which would otherwise not be available. The publication of reports adds prestige to the university, and may aid in attracting the type of scientific workers needed in its research.

The OSR program also adds to the normal research load which is the traditional task of the university and an essential part of its graduate education program.

▶ **Duplication**—Haywood emphasizes that the Air Force has the greatest incentive to avoid unintentional duplication. One of the ways to do this is to keep information current in the field about its programs.

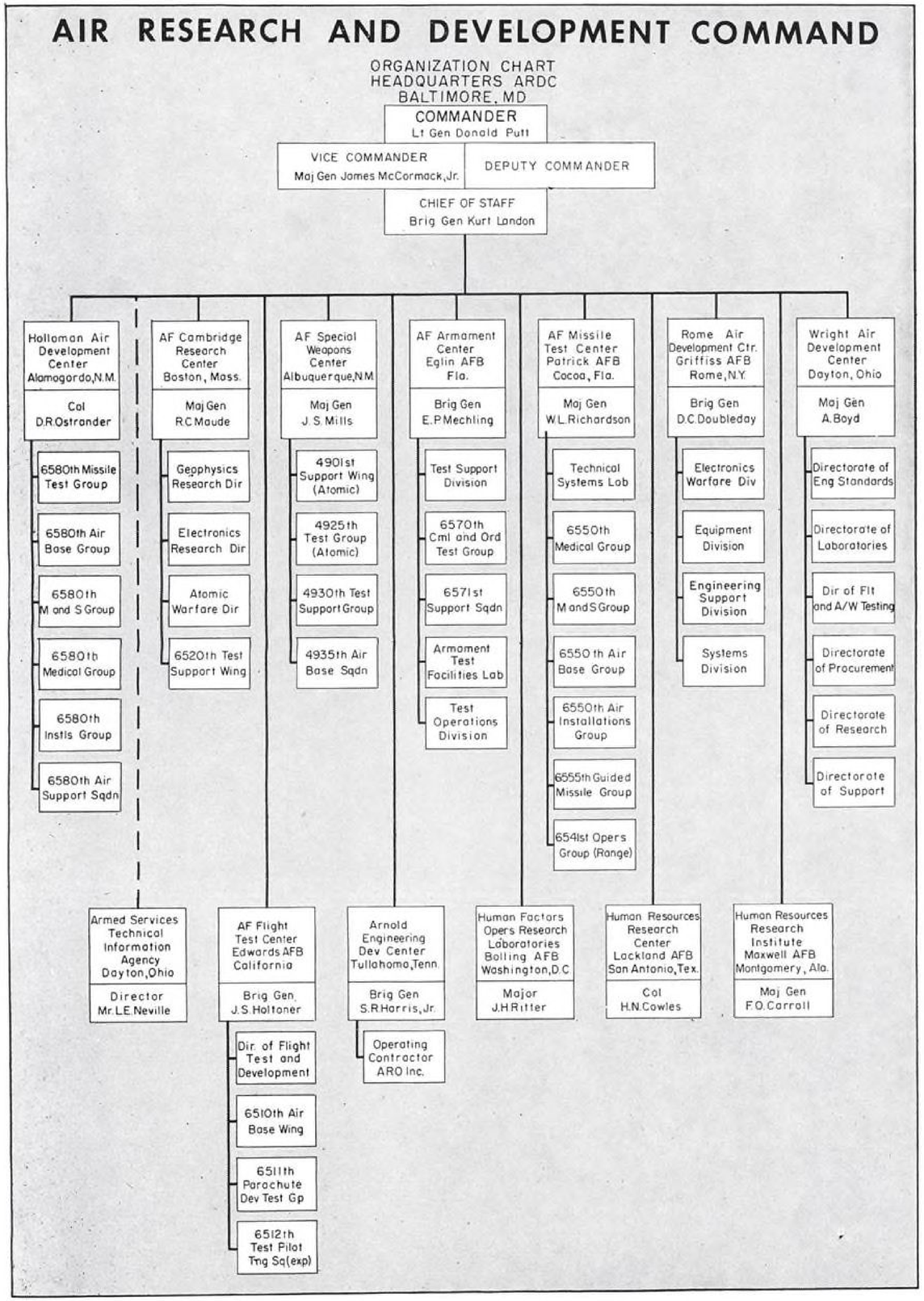
There is an OSR record book kept current on a monthly basis which tells who is doing what research and how much it is costing. Interested government offices, such as NACA, the National Science Foundation, Office of Naval Research and Office of Ordnance Research, have copies of the book. There are other formal and informal channels; the service research officers exchange copies of programs and proposals under study.

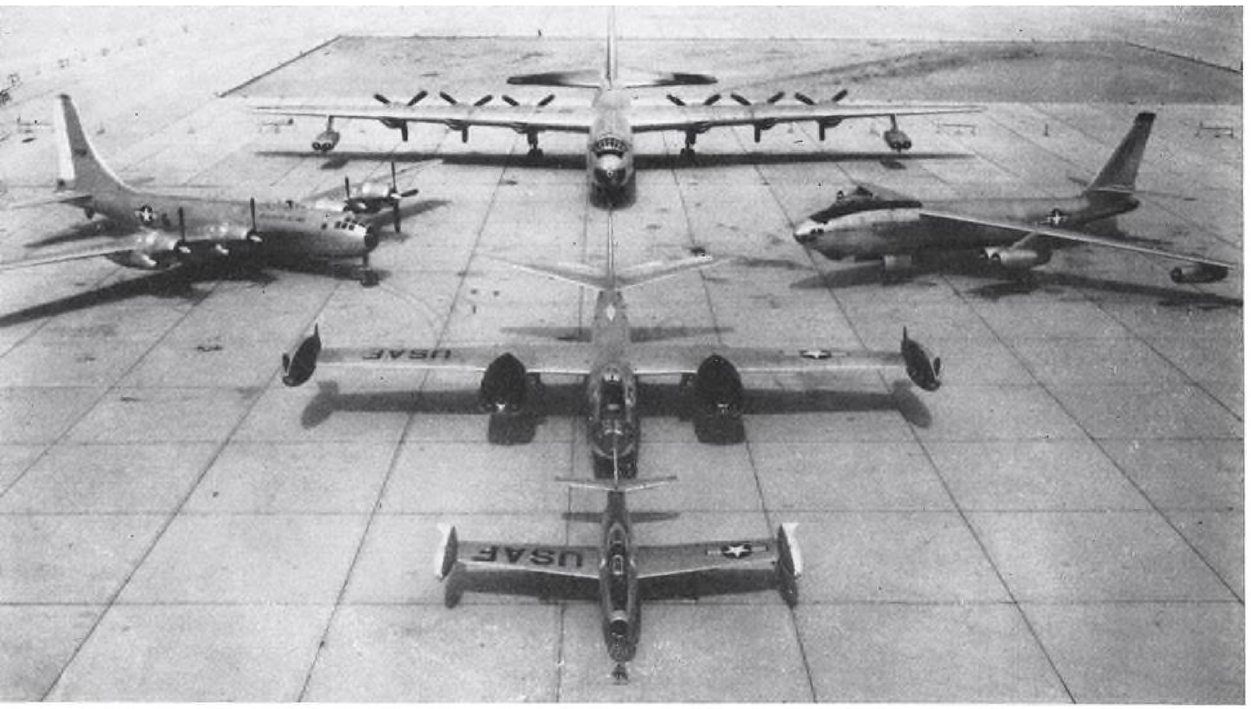
Haywood, in answering proponents of a single center for all government-sponsored research to avoid "waste and duplication" says, "It is difficult to select the geniuses of the future. Let us continue to bring to this problem, not the talents, techniques, procedures and motivation of one organization, but rather the decentralized judgments that are the true strength of democracy."

▶ **Submitting the Proposal**—Proposals for research in the first five fields listed above (chemistry, fluid mechanics, mathematics, solid state sciences, physics) should be submitted to the Commanding General, Air Research and Development Command, Attn: RDR, P. O. Box 1395, Baltimore 3, Md.

Proposals for basic research in the biosciences should be marked for the attention of RDDH.

Proposals in geophysics should be submitted to the Commanding General, Air Force Cambridge Research Center, 230 Albany Street, Cambridge 39, Mass.





USAF atomic warfare capability is represented by these five aircraft ranging from a fighter to intercontinental bomber.

Atomic Weapons Work

USAF expansion of atomic warfare capabilities is sparked by development and test work done by men and aircraft of ARDC Special Weapons Center at Kirtland Air Force Base. ARDC activities support Atomic Energy Commission on Nevada Proving Grounds and at Eniwetok Overseas Proving Grounds.

TECHNICIANS decontaminate Thunderjet radiological safety plane.

B-29 is checked for radiation with ion counter.

Center Mates Planes to Atom Weapons

Special Weapons Center's job is to match AEC's new atomic developments and the AF planes that will have to deliver them.

By Robert Hotz

Albuquerque, N. M.—A new family of atomic weapons is being mated to a new generation of supersonic aircraft and missiles by the Special Weapons Center of the Air Research and Development Command.

Located on a mile-high, sun-baked mesa overlooking the Rio Grande, the Special Weapons Center (SWC) at Kirtland Air Force Base is part of the New Mexican atomic triangle that includes the Atomic Energy Commission laboratories at Los Alamos.

This atomic triangle is guarded by the 34th Air Division of the Air Defense Command, which maintains F-86 Sabres on constant alert. A radar net carefully scans the area and rigid air discipline is enforced.

► **Atomic Weapons Bridge**—The principal job of the Center is to bridge the gap that exists between the Atomic Energy Commission and the Air Force and to match the atomic weapons developed by AEC with the aircraft and missiles developed by USAF.

AEC is charged with the responsibility of research and development on atomic and other "special weapons"—but it has no aircraft or missiles to develop or test delivery methods.

USAF is charged with the primary responsibility for delivery of AEC's weapons and it has control over the research and development of the atomic delivery vehicles.

As the chief liaison between the atomic development agency (AEC) and the atomic delivery agency (USAF), the Special Weapons Center is playing an increasingly important role in shaping the future of military air power.

► **New Factors**—Keys to the current nature of the Center's work are recent disclosures by the Atomic Energy Commission on the increasing production and variety of atomic weapons. Both the production and variety have exceeded original estimates. These facts are radically altering the traditional concept of air power in the atomic age.

"The prevailing tendency has been to think of the atomic weapon exclusively as a weapon to be used only against the largest and most expensive type of target," says Maj. Gen. John Mills, Center commander. "But new designs of atomic weapons are being developed to further our capability to permit economical use of atomic weapons against a much wider variety of targets. Because of the Atomic Energy Commission's development of a 'family of atomic weapons' the Air Force can now deliver varied kinds of atomic weapons against varied targets with varied aircraft types.

"Looking forward from the Hiroshima and Nagasaki era of eight years ago, the technological progress of the Atomic Energy Commission and the Air Force in the atomic weapons program is remarkable in the approach to universality."

► **Atomic Carriers**—This variety of atomic weapons and its influence on the rapidly expanding capability of USAF to wage atomic warfare can be gauged partially by the variety of aircraft that have already been modified and equipped by the Special Weapons Center to deliver atomic weapons. They are:

• **Boeing B-47 Stratojet bomber.** This six-jet bomber is the fastest bomber now in service with combat units of any Air Force. B-47s of the Strategic Air Command fully loaded recently have crossed the Atlantic to England in little more than four hours.

• **Convair B-36 intercontinental bomber.** This 400,000-lb. aircraft powered by six piston engines and four turbojets has demonstrated its ability to fly more than 10,000 miles and drop an atomic bomb load at the halfway point.

• **North American B-45 Tornado bomber.** This four-jet bomber was the first jet bomber to drop atomic weapons. A Tactical Air Command B-45 wing was the first jet bomber unit to be equipped for the waging of atomic warfare.

• **Boeing B-50 Superfortress.** The B-50 equipped for aerial refueling has combat capabilities almost as great as the B-36 and made an important addition to the long-range atomic striking force of SAC in the interim before large-scale production of jet bombers provided the modern equipment for atomic warfare.

• **Republic F-84G Thunderjet fighter.** Although the F-84G is a rapidly obsolescing first-line fighter aircraft, the fact

---

Maj. Gen. John Stewart Mills, Commander, Air Force Special Weapons Center . . . won the Silver Star, Distinguished Flying Cross, Air Medal, Presidential Citation and the French Croix de Guerre, for combat operations leading the 450th Heavy bombardment group in the Mediterranean Theater of Operations . . . born in Appleton, Wis. 1906 . . . graduated U. S. Military Academy, 1928 . . . served in bombers for six prewar years . . . was chief of AMC's instrument and navigation unit at Wright Field . . . after World War II served a hitch as deputy chief of the War Department General Staff's new weapons division . . . named assistant for atomic energy at USAF Hq. in 1949 after his graduation from the National War College.

JET DRONE with empty cockpit and mother plane roar down runway for takeoff.

JET formation sweeps toward atomic cloud.

DRONE carrying mice and monkeys leads T-33 mother ships and pair of F-86 chase planes that will destroy drone if controls fail.

■ KIRTLAND

that atomic weapons have been developed that can be carried by fighter-type aircraft marks a revolutionary trend in atomic air warfare. It is a concrete indication of what the increasing variety of atomic weapons will mean to military air power. In recent testimony before the Senate Foreign Relations Committee (AVIATION WEEK Apr. 7, p. 9), Gen. Alfred Gruenther, commander of the NATO forces in Europe, said the key NATO strategy was now based on the use of atomic bomb-carrying F-84Gs (standard NATO air force fighter-bomber) against enemy ground force concentrations.

► **Planes Take Longer**—Experience has proved it takes much longer to develop a new aircraft or missile with atomic capabilities than it does to develop new atomic weapons. Currently atomic weapon development is outstripping technological progress in development of the weapon's delivery system.

Center officers feel strongly the need for a longer-range and more stable research and development program for the development of atomic weapons delivery systems. Unless some methods are found to keep the research and development program from reacting violently to the annual congressional budget cycle fluctuations. Some observers feel the gap between the atomic stockpile and the capability to deliver it swiftly and certainly to enemy targets will widen.

"Atomic bombs in a stockpile won't win a war," said one Center officer long associated with the atomic program. "We must have a fast, guaranteed method of delivery. The new atomic weapons are coming along faster than the means of delivering them.

"A stable research and development program would permit more long-range planning to develop the best type of vehicle for new-type weapons when both are in the early planning stage. If we could do this it would eventually save many millions of dollars later by eliminating the need for expensive modification programs to try to tailor available vehicles to the new weapons."

► **"Cranking" Them In**—One of the important jobs of the Center now is to analyze the designs of all new USAF aircraft and missiles proposed or under development to determine their atomic capabilities. Similarly, new aircraft rolling off the production lines will go to the Center at an early stage for development of atomic capabilities. An early production Boeing B-52 Stratofortress eight-jet bomber is earmarked for the Special Weapons Center and the 10,000-ft. main runway at Kirtland will have to be widened to accommodate the outrigger landing gear of the B-52.

It is also reasonable to suppose that the new generation of USAF supersonic fighters now coming along will be "cranked in" to the atomic capability already displayed by the F-84G. Among these likely new prospects in expanding both the scope and delivery speed of USAF atomic capability are the swept-wing F-84F Thunderstreak, now in production at Republic's Long Island plant; the North American F-100, now flying in prototype form at Edwards AFB; and the McDonnell F-101 long-range escort and penetration fighter.

Early Days

The Special Weapons Center originated and developed into its present size and status as a result of the Air Force's growing postwar responsibilities for the delivery of atomic weapons. In 1947 Gen. Curtis LeMay, then director of Air Force research and development and now commander of the Strategic Air Command, sent Maj. Gen. Howard Bunker to Albuquerque to establish a field liaison office with the Atomic Energy Commission aimed at developing USAF knowledge of the AEC weapons program in order to aid USAF in planning and executing its atomic mission.

► **Transmission Belt**—Primary mission of this field office for atomic energy was to act as a transmission belt of detailed information between AEC and USAF, to keep both agencies informed on the other's progress and problems in the atomic weapons development and delivery.

Kirtland AFB was then an Air Materiel Command base, but headquarters of USAF wanted direct control of the field office so it was assigned merely as a tenant on the AMC base. In December 1949 the Special Weapons Command with Gen. Bunker in command was activated at Kirtland to succeed the field office.

Under command status the organization got better people and improved facilities but its primary mission was still liaison with AEC, the Los Alamos and Sandia laboratories.

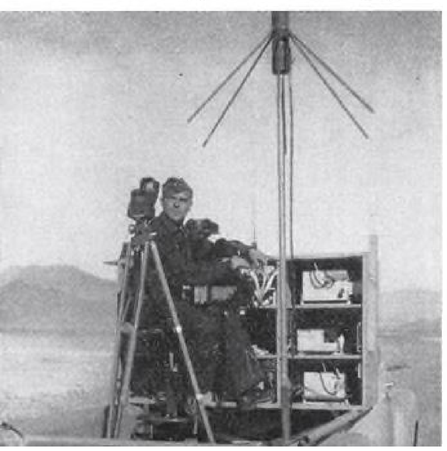
This group kept the Air Force informed on atomic weapons development and transmitted USAF requirements and problems to the AEC technicians who were working on weapons-development.

► **Assigned to ARDC**—Late in 1951 the remarkable progress in both quantity and variety of atomic weapons created an acute need for an expansion of the Command's mission to include some types of research, considerable development and an expansion of the test work in support of AEC. Because the Special Weapons Command was not a part of ARDC it was precluded from doing development work, so Gen. Mills, who succeeded Gen. Bunker as commander, proposed that the Command become a part of ARDC and take on the badly needed development program.

Keeping pace with the expanding USAF atomic capability, the Center now has about 5,000 personnel and a high percentage of all aircraft assigned to ARDC. It ranks second to Wright Air Development Center in spending ARDC research and development funds.

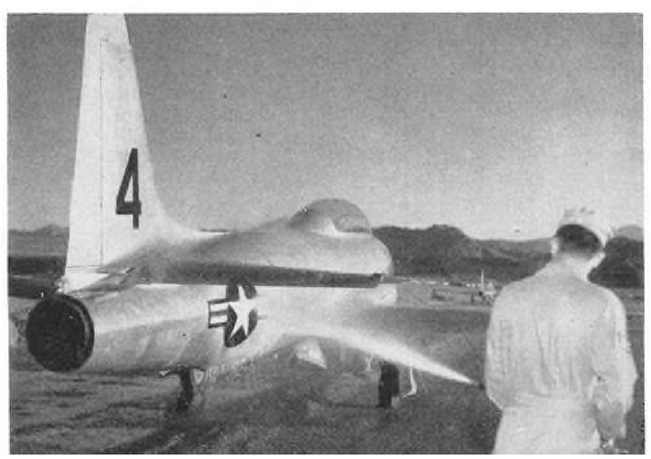
Current Center activities involve research, development and test work. Most of the Center's work is absorbed by test support operations for the AEC, both for the Nevada proving grounds and the Eniwetok overseas proving grounds.

"BEEPER" pilot with control equipment.



LOCKHEED QF-80 equipped with atomic cloud sampling tanks on both wingtips.

"GUNK" SPRAY washes radioactive debris from drone cloud sampler.



RADIOLOGICAL safety men check tanks with ion counter.

KIRTLAND PLANES track this grey atomic cloud as it sweeps eastward after nuclear test blast on Nevada Proving Grounds.

Research

All of the research done at the Center is applied research aimed at solutions to particular problems. The Research Directorate at the Center has no laboratories, farms out most of its work to industry and universities. Its principal product is paper—reports and analyses for the guidance of USAF. It is a job requiring a high degree of technical competence for USAF officers involved and 70% of the personnel assigned have advanced degrees ranging up to doctorates in nuclear physics.

▶ **Research Program**—Research activities fall roughly into three categories:

• **Providing "state of the art"** information from the field on atomic weapons programs to USAF policy makers.

• **Conducting technical analytical** studies for guidance of USAF in developing the best weapons systems with which to conduct atomic warfare. These studies are extremely broad and include such factors as potential enemy opposition, delivery capabilities and potency of the weapons against specific types of targets.

• **Conducting technical training** program for USAF personnel in Atomic Energy Commission facilities to build up an adequate technical experience level among USAF personnel who are required for work in the special weapons fields, both in the research and development program and also with operational commands that use atomic weapons, such as Strategic Air Command and Tactical Air Command.

USAF personnel with proper education backgrounds are picked to work for 2- to 3-year assignments in AEC establishments in regular technical staff jobs. Some of the top people now in special weapons work, such as Col. Lester Woodward, chief of the research directorate at the Center, who has a doctor's degree in nuclear physics, have worked in the Los Alamos laboratory detached from USAF for several years. This technical training program is regarded as an extremely valuable feature of the Center's work in building up USAF atomic capability.

▶ **Link With Cambridge**—There is a coordinating link between the Special Weapons Center and the Cambridge Air Force Research Center which has recently established a division of atomic warfare staffed largely with veterans of the SWC.

Close liaison is also maintained with the atomic and armament directorates and weapons system offices in ARDC headquarters.

Atomic Force Role

"The principal deterrent to another world war is and will remain the offensive strength of our constantly improving atomic weapons and our ability to deliver them with accuracy and certainty by strategic air power against the sources of Soviet military might.

"Unless and until peaceful Soviet actions are assured on a lasting basis, we must constantly maintain and improve our ability to strike through the air with devastating atomic force at the air bases and munitions factories of any aggressor nation."

—James Harold Doolittle, special assistant on technical matters to the Chief of Staff, U. S. Air Force.

Development

Just as the research program produces primarily paper, so the development program produces primarily hardware. The development mission began in 1952 after the Special Weapons Command became an ARDC center.

It is aimed at designing and development equipment capable of delivering atomic weapons and includes both aircraft and missiles. Col. Harry Donicht, who headed the development program until his recent appointment to command of the 4925th Test Group (Atomic), emphasizes that atomic armament poses more problems of greater complexity in handling, carrying and delivering than other older types.

Part of the development mission also involves detailing USAF requirements for atomic delivery systems, defining problems to be solved and then presenting them to the aircraft industry for mechanical solutions. The Center technicians feel strongly that the aircraft industry is the best laboratory in which to do this kind of development work.

▶ **To Reduce Modifications**—Other jobs include the development of standardized specifications and testing, monitoring and handling equipment for atomic weapons. There is still a good deal of actual aircraft modification required in the development mission since early postwar USAF aircraft were not specifically designed around atomic capabilities. In order to cram early-type atomic bombs into the bomb bay of an early jet bomber a section had to be removed from the main wing-spar.

It is now a center responsibility to review all USAF aircraft and missile designs from the earliest stage of their development. As more atomic capability is designed into these vehicles there will be a diminishing need for extensive and expensive modifications to build in atomic capabilities belatedly.

The development group works closely with the AEC Sandia laboratory and the operational commands who have the final responsibility for delivery of atomic weapons.

Test & Support

Bulk of the Special Weapons Center's resources are devoted to test work. Most of the test work is in support of the Atomic Energy Commission, although other test functions are performed for the Defense Department, Chemical Warfare Service, Army Ordnance and other ARDC centers. The center supports both AEC atomic proving grounds—the continental site in Nevada and the overseas operation at Eniwetok Atoll in the Pacific.

▶ **Test Missions**—During the AEC test operations the 4925th Test Group (Atomic) performs the following missions:

• **Dropping the bomb** or nuclear test device.

• **Providing flying laboratories** to gather airborne data on results.

• **Providing cloud sampling** aircraft. The cloud sampling aircraft are both piloted and pilotless. B-29s and F-84s have been equipped with sampling devices and have actually been flown through atomic clouds by properly protected crews. Lockheed QF-80 jet drones are also used equipped with Sperry remote control flight systems. The drones are controlled from mother planes aloft, and in recent tests flew monkeys and mice through atomic blast clouds at 30,000 ft. T-33s also are equipped with cloud sampling equipment which is carried in place of wing tanks.

• **Providing radiological safety** aircraft. These planes measure airborne radioactivity in the area of nuclear blasts and ground activity in the Nevada Proving Grounds where "fall-out" from the atomic cloud usually occurs.

• **Cloud tracking aircraft.** These aircraft track the atomic cloud as it moves eastward on prevailing winds and measure its radioactivity and radioactive fall-out to warn aircraft and civilian inhabitants on the ground in case of heavy fall-out. The atomic clouds travel eastward across the country and dissipate over the Atlantic. There is seldom any radioactive fall-out from air bursts, but this phenomenon occurs with more intensity in ground detonations since heavy earth particles are drawn up into the atomic cloud.

• **Terrain survey helicopters.** These helicopters cover the terrain surrounding a nuclear blast and chart safe approach areas to instrumentation, test equipment and damage sites.

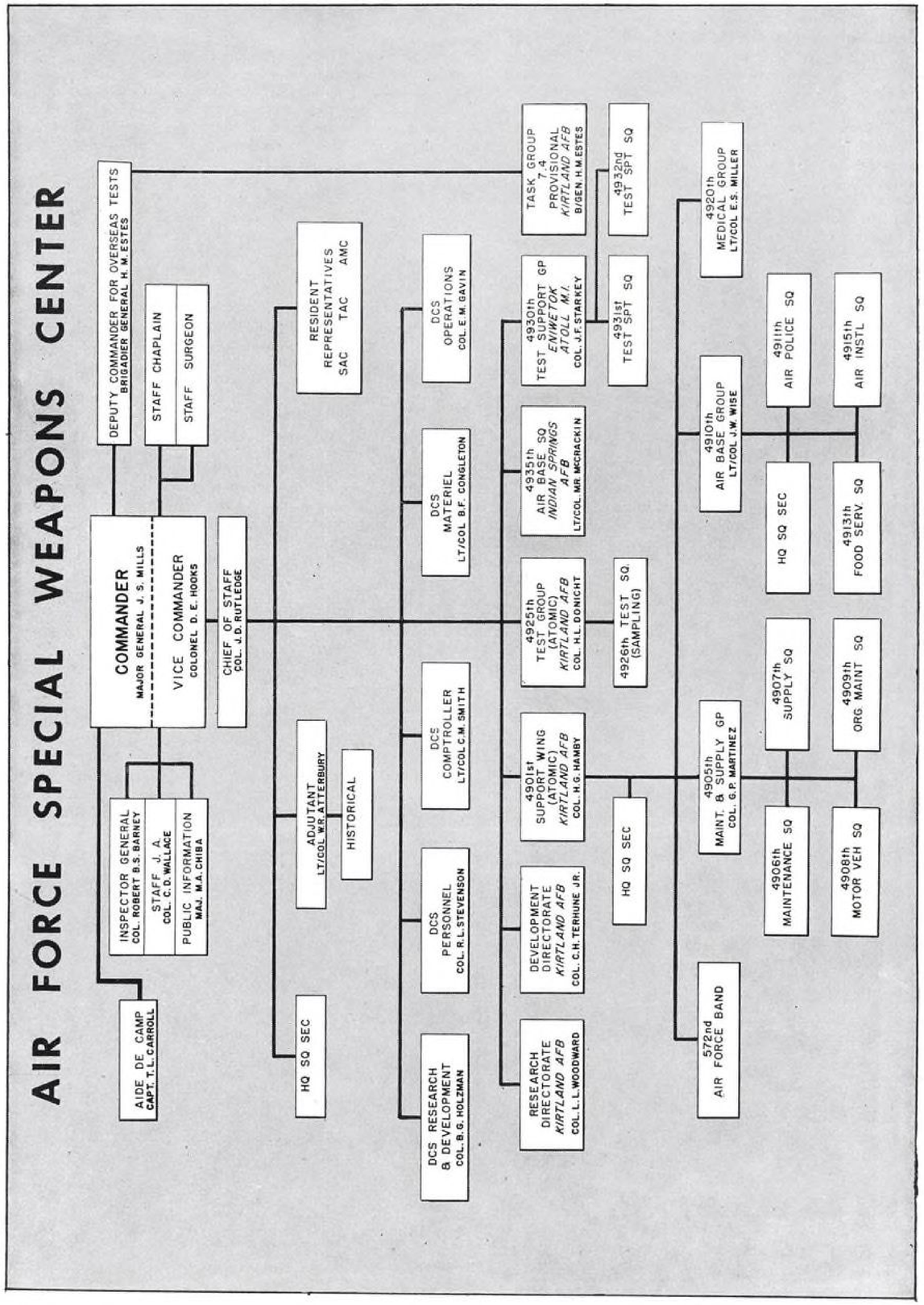
▶ **Precision Bombing & Timing**—The USAF atomic test group has dropped 17 of the atomic bombs and nuclear test devices that have been exploded by the U. S. in Japan and in continental and overseas test operations.

Air drop is considerably cheaper than a ground detonation, but to be truly effective for test purposes it must have an accuracy within 100 yards and be detonated within two seconds of a predetermined time. Attaining this accuracy is a precise team operation on the part of the air crew that comes only with long training in the special atomic delivery techniques.

Here is a rough idea how the crew of a 4925th B-50 made a drop on the Nevada proving range from 33,000 ft. that hit within 200 ft. of the target within the two-second time margin. (Key to this precision is the ability of pilots to fly exact and stable courses and make perfect precision turns, and the skill of the bombardiers using both visual and radar equipment to plan and execute the mission exactly.)

▶ **Typical Drop**—The pilot and co-pilot split the flying duties to obtain greater precision and stability. Pilot controls the attitude and airspeed of the aircraft

SPECIAL WEAPONS CENTER technicians use chemical spray to wash radioactivity from cloud-sampling plane; note sampling devices.



with normal flight controls while the co-pilot controls altitude with the throttles. Just before the bomb burst the pilot flips on dark glasses leaving the co-pilot flying the aircraft on instruments. When the bomb detonates the co-pilot is temporarily blinded and the pilot takes over behind his dark glasses.

The radar bombardier navigates most of the mission from his spot in the B-50's rear compartment. A radius-of-action problem is used to set up the bomb drop but a time pattern is flown instead of a ground pattern to cancel any instrument errors. The radar navigator also furnishes the radio operator with precise position reports that are broadcast to other aircraft in the vicinity and the test control center. He computes wind drift and acts as a clearing house for winds-aloft reports from other aircraft. He positions the aircraft for the target run where the visual bombardier takes over. After the bomb release, the radar navigator has the final task of giving the crew a count-down to the burst, warning them to take proper safety measures.

The visual bombardier guides the aircraft during the actual bomb run and releases the bomb. In the B-50 a Norden bombsight of World War II vintage was used. Three special equipment officers were carried in the crew. Their job was to install and operate the special instrumentation required by AEC. A flight engineer, radio operator and two mechanic-scanners completed the crew. On this atomic drop the crew reported they could feel the heat and blast effects at 33,000 ft. and the B-50 was "tossed about a little" by the shock. All crews flying in the area of atomic blasts are equipped with dosimeters to warn of excessive radiation.

▶ **Support Aircraft**—The Center operates the Indian Springs air base near Las Vegas for air support of the Nevada proving ground missions. It draws on aircraft from other services and commands to supplement its specialized fleet to test operations. During the Nevada tests in the spring of 1953, formations of SAC B-36 and B-47 bombers flew over the bomb bursts to give their crews familiarization with the environment of an atomic attack. Navy has also provided some piston-powered Douglas Skyraider and Grumman Bearcat drones for cloud testing, and MATS and SAC provide specially equipped transport aircraft.

When supporting overseas tests at Eniwetok, the role of the test group is the same except that instead of controlling all air operations it operates as part of a joint Army-Navy-USAF task force.

Like all of the ARDC centers, the Special Weapons Center has its problems. Personnel is an acute problem.

Because of the strict security nature of the special weapons work, the personnel problem extends down to the airman level. For example a truck driver who has been security-cleared and trained to handle nuclear weapons is still listed as just a truck driver in military personnel classifications. When he is transferred away from the Special Weapons Center he is replaced with an ordinary truck driver who has to be cleared and trained before he can drive the particular kind of trucks at Kirtland.

For officer personnel, the first year of their duty tour at Kirtland is usually required for indoctrination. A longer tour of duty in this specialized work would produce better results, personnel experts believe.

Since Kirtland AFB had been abandoned after World War II, it was necessary to completely rehabilitate the field and its surrounding installations for Special Weapons Center work. The intensive training requirements and the extensive hardware modification work of the Atomic Test Group made a new building program necessary which is still not complete or adequate.

Because atomic warfare is a top-priority mission of USAF the work of the Special Weapons Center in developing better atomic delivery vehicles and training personnel in better atomic delivery techniques is a top-priority mission for the Air Research and Development Command. A good deal of the future of the Air Force and the future of this country depends on how well the Center does its job.

Col. Daniel Hooks
Vice-Commander

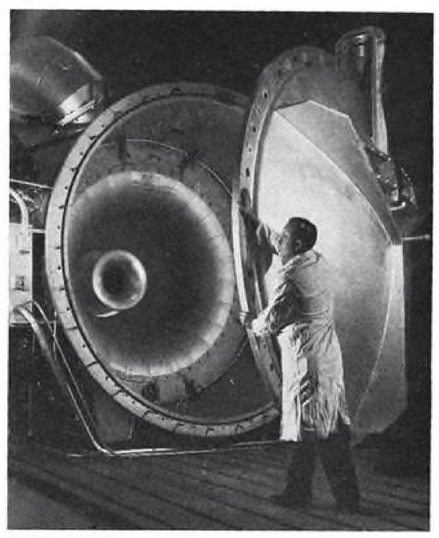
Col. Benjamin Holzman
Director of R&D

Col. Harry Donicht
Commander, 4925th Test Group

Col. Lester Woodward
Director of Research

TODAY'S TESTS begin near this memorial to the Wright brothers, located on a hilltop near the site of their early test flights.

ANECHOIC ROOM is silent cell for calibration of communication equipment.



TEST CELL is sealed for high-altitude simulation.

WADC: $200-Million Research Key

Wright tackles its biggest job: tying together Air Force research to produce the supersonic weapons of tomorrow.

By Alexander McSurely

Dayton, Ohio—Wright Air Development Center, with 12 sprawling laboratories for research and testing and its flight testing facilities, is a sturdy corner stone for the Air Research and Development Command that is building the new air weapons system for the U. S. Air Force.

Few people, even among the specialist employes assigned at the big Wright center itself, have a clear picture of the wide variety of interrelated projects which go churning through this big research and development mill. Its history is being written daily in hundreds of pages of technical reports, photographs, oscillograph records, and other recording devices.

But hidden in this vast accumulation of technical data is a fascinating story of some of the steps that must be taken between the drawing board and the complete weapons system that goes whistling through the stratosphere at supersonic velocity carrying its deadly missile under the sensitive control of an intricate electronic guidance system.

▶ **Toughest Assignment**—This $200-million concentration of aeronautical research and testing equipment, spread over a 1,325-acre tract in the Mad River valley east of Dayton, is tackling its toughest assignment in the long years of its aviation development history.

The assignment: to administer and coordinate new aeronautical research with electronic and armament research so the Air Force will have progressively better new supersonic weapons capable of achieving their combat missions at speeds and efficiencies far beyond those already being achieved.

▶ **Outside Help**—The enormous scope of this research and development job inevitably means calling upon industry and educational institutions to carry a large share of the load. WADC's laboratory men have a double job. While continuing an impressive list of research projects themselves, they are busy too as coordinators of outside work, directing research by contract for tangible use in new air weapons of tomorrow.

Contracts with industry, universities and non-profit organizations now represent 87% of the total WADC budget. And WADC's procurement directorate spends more than 75 cents of every Air Force research dollar. These contracts represent many hundreds of projects, assigned to 130 colleges and universities, in addition to large portions of the routine testing work farmed out to commercial laboratories and manufacturers.

▶ **Two Phases**—Actually the center's job breaks down into two assignments:

• **To procure and produce** advanced aeronautical scientific knowledge as rapidly as possible for tangible use in new air weapons.

• **To monitor** from a technical standpoint (through testing and evaluation) each new weapons system from earliest stage to obsolescence.

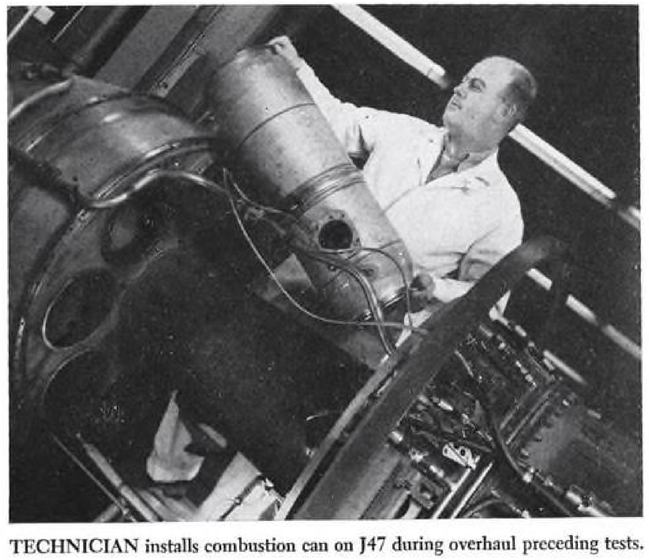
Maj. Gen. Al Boyd, commander of the center, expresses the overall idea in these simple words:

"The work we do today will definitely determine the security of this country five or 10 years from now."

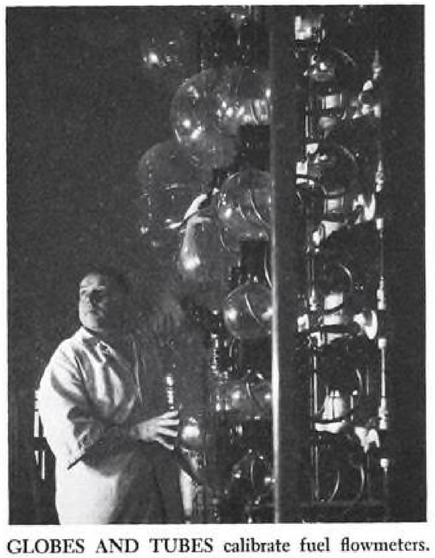
▶ **Center Layout**—To understand best the way WADC functions, a knowledge of the geographical layout helps.

• **Area B.** The center headquarters and the laboratories and test facilities are concentrated in what is called Area B of Wright-Patterson AFB. The principal U. S. Army and Air Force aviation development and testing work has been centered in this same area since 1927, when it was opened under the name of Wright Field.

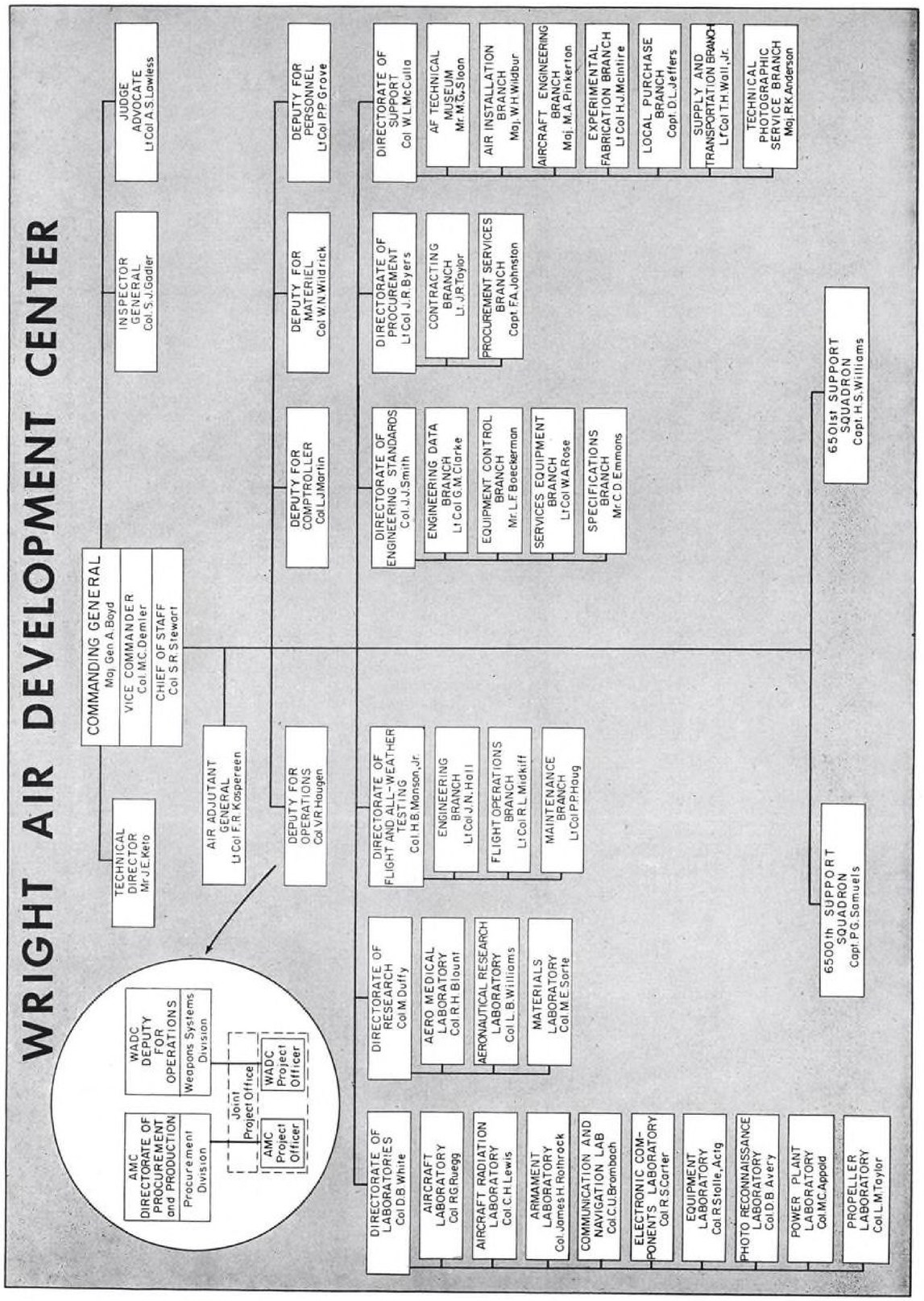
Up until the transfer of Air Research and Development Command head-



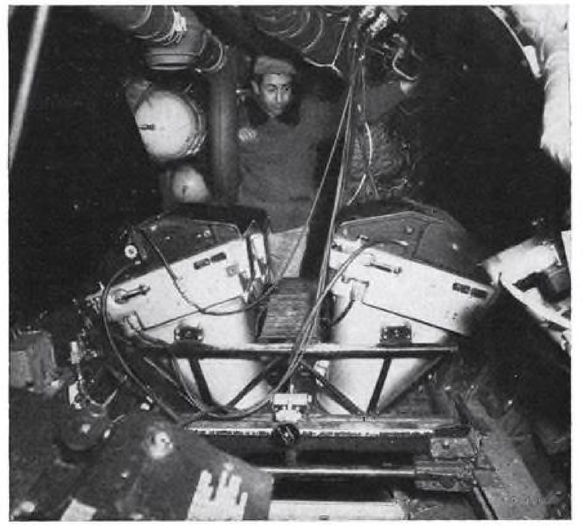
TECHNICIAN installs combustion can on J47 during overhaul preceding tests.



GLOBES AND TUBES calibrate fuel flowmeters.



HELLROARER is new continuous light source for night photography.



SPLIT VERTICAL test installation of cameras in NAA RB-45.

quarters to Baltimore three years ago, this area was also the site of command headquarters. It continues to be the largest single installation of the command, from a standpoint of personnel and value of equipment, although three of the other centers, the flight test centers for planes and missiles, are larger in acreage.

• **Area C.** Supplementing the Area B installations are the facilities across Springfield Pike, known as Area C of the Wright-Patterson base, where the Directorate of Flight and All-Weather Testing does its test flying from a 10,000-ft. runway.

Part of Area C is used by the Directorate of Support which does maintenance and special modifications for test on from 150 to 200 planes flowing through the center for special flight tests. The tests are sometimes basic to the aircraft itself, and sometimes they are carried out on equipment that is flown in the airplane.

▶ **To Get There**—Once you are in downtown Dayton, it's simple to get to "Wright Field," as most Daytonians still call it.

Drive east on either First Street or Third Street. Both streets run into Springfield Pike, and you continue east on this main highway (Route 4) until you see the flying field on your right, with the windtunnels and test buildings behind it on the hill.

If you have further business at the flight test directorate, get an Area C stamp on your pass at the Area B pass office, and continue about 4 mi. farther east on Route 4, past the big Air Materiel Command headquarters building on your left, until you come to another main gate on the left which will pass you into Area C.

▶ **Important to Taxpayer**—The terrific costs involved in today's high speed military air weapons make it necessary for the Air Force to see quite clearly where it is going on each of its new investments before it is too late to change plans.

That is why the laboratory and flight testing work here at WADC and at the other ARDC centers, and all the outside research and development contracts, represent a solid investment, even if some of the projects never prove out.

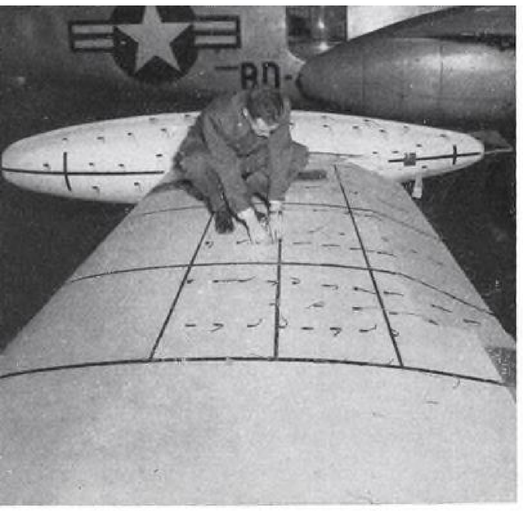
It is far cheaper to have a failure and find it out by thorough testing at an early stage, and discard it, than to carry it through to production, and then find it out.

Thus you can readily understand how a nickel's worth of research and testing can and does save the taxpayer many a dollar by insuring that something is right before it is ordered into production.

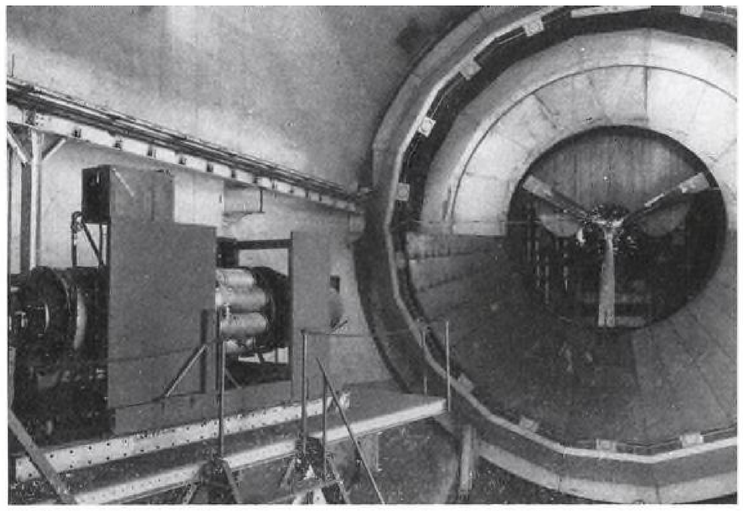
▶ **Weapons System Division**—In order to put more emphasis on the new weapons system concept in development, WADC is organized with its operating deputy charged with directing the weapons system division. Every other organization in the center, including the laboratories, is keyed in to help this division in the performance of its function.

How the weapons system division operates—through project officers assigned to each project who work cooperatively with counterpart project officers assigned by Air Materiel Command procurement division—is detailed elsewhere in this issue.

Maj. Gen. Albert Boyd, Commander, Wright Air Development Center . . . veteran USAF test pilot . . . one of the first USAF pilots to fly faster than sound in the Bell X-1 . . . recently evaluated British and French fighter aircraft for purchase under U. S. offshore procurement program . . . born Rankin, Tenn., 1906, grew up in Asheville, N. C. . . . learned to fly as aviation cadet, Kelly Field, 1929 . . . served in engineering jobs in Air Service Command . . . went to Europe as Deputy Commander Eighth Air Force Service Command supporting General Doolittle's Eighth Air Force combat units . . . returned to U. S. as chief of Flight Test Division, Air Materiel Command, at Wright Field . . . commanded Air Force Flight Test Center at Edwards, Calif., 1949-51 . . . awarded Distinguished Flying Cross.



WOOL streamers show wing, tank flow pattern.



JET ENGINE blasts against prop undergoing simulated flight vibration test.

■ WRIGHT

But it is important to realize that the various research and development projects, both those of the laboratories and of the outside contractors, have as their ultimate goal the creation of new improved weapons systems through this division.

▶ **Six Directorates**—An organization chart of WADC shows six directorates, plus the several deputies and officers who operate directly on the commanding general's staff.

This review of the center is more concerned with the directorates of laboratories, of research, of flight and all-weather testing, than with the supporting directorates of engineering standards, procurement, and support. However, it is obvious that these three last-named directorates perform indispensable functions when the overall picture is taken into consideration.

• **Directorate of research** includes three laboratories, all concerned with long-range research and serving as consultants on trends in development of weapons systems. These are organized according to scientific areas of research. Their products are research reports which can be applied to solve general problems relating to weapons systems and their components. However, the work of some of these overlaps with that more directly associated with end-item products. The three research laboratories are the aero medical laboratory, the aeronautical research laboratory, and the materials laboratory.

• **Directorate of laboratories** includes nine laboratories concerned with development of actual hardware, and with applied research to carry out definitely scheduled developments. These include laboratories specializing in aircraft, aircraft radiation, aircraft armament, communications and navigation, electronic components for aircraft, aircraft equipment, photo reconnaisance, powerplants, and propellers.

Probably the best way to understand the Wright-Patterson story is to take a look into the laboratories and watch some of the research and testing as it goes on.

Aircraft Lab

Some of the most spectacular and elaborate testing equipment at WADC includes the six windtunnels and the huge structures test building assigned to the aircraft laboratory.

This laboratory has the assignment of evaluating, studying and testing airframes of USAF planes and missiles to improve them aerodynamically, structurally and dynamically. The aircraft engineers also serve as technical consultants on aircraft and missile designs, translate results of their research and study into specifications and design criteria for use by manufacturers, and work to increase the range and performance of aircraft and missiles.

Col. M. C. Demler, Vice Commander

▶ **One of a Kind**—Unduplicated in the U.S. and possibly in the world are facilities of the structures building, which is equipped with overhead cranes with capacities up to 300,000 lb. It has a big enough clear space so structures tests could be run on the XB-36 in one piece. "We had to take it in sideways," one of the structures laboratory chiefs explains.

The tests involve applying static loads on complete airframes or on assemblies such as wings and tail surfaces.

▶ **"Whiffletree" System**—The principal method uses a neoprene tension patch cemented to the structure to be tested. Hydraulic cylinders apply the desired load through a metal plate cemented to the outside of the patch, and the result is a close simulation of the actual flight load which that part of the plane may have to take.

The patch system is sometimes called the "whiffletree" system because of the resemblance of the linkage to the familiar method of hitching a horse to a cart.

Development of this system goes back to 1938, when E. R. Weaver, veteran civilian engineer, and Col. Paul Kemmer, lab chief, were credited with developing it to replace the old loading practice of using shot bags. Although the shot bags are still used on some tests, the neoprene patch system has spread to virtually all major U.S. aircraft plants.

A fairly recent refinement of the system, credited to industry development, involves placing under the patch a vinylite blanket which is evacuated with a vacuum pump to increase the tension.

On a recent day in the structures lab, you could see simultaneously undergoing such tests: the North American F-86H (improved Sabrejet) and two

A meeting of minds... TO WIN A WAR BEFORE IT STARTS

THESE MEN ARE DISCUSSING YOUR FUTURE. They know that atomic war is for keeps. They know that tomorrow's defenses against atomic attack must be planned *today*.

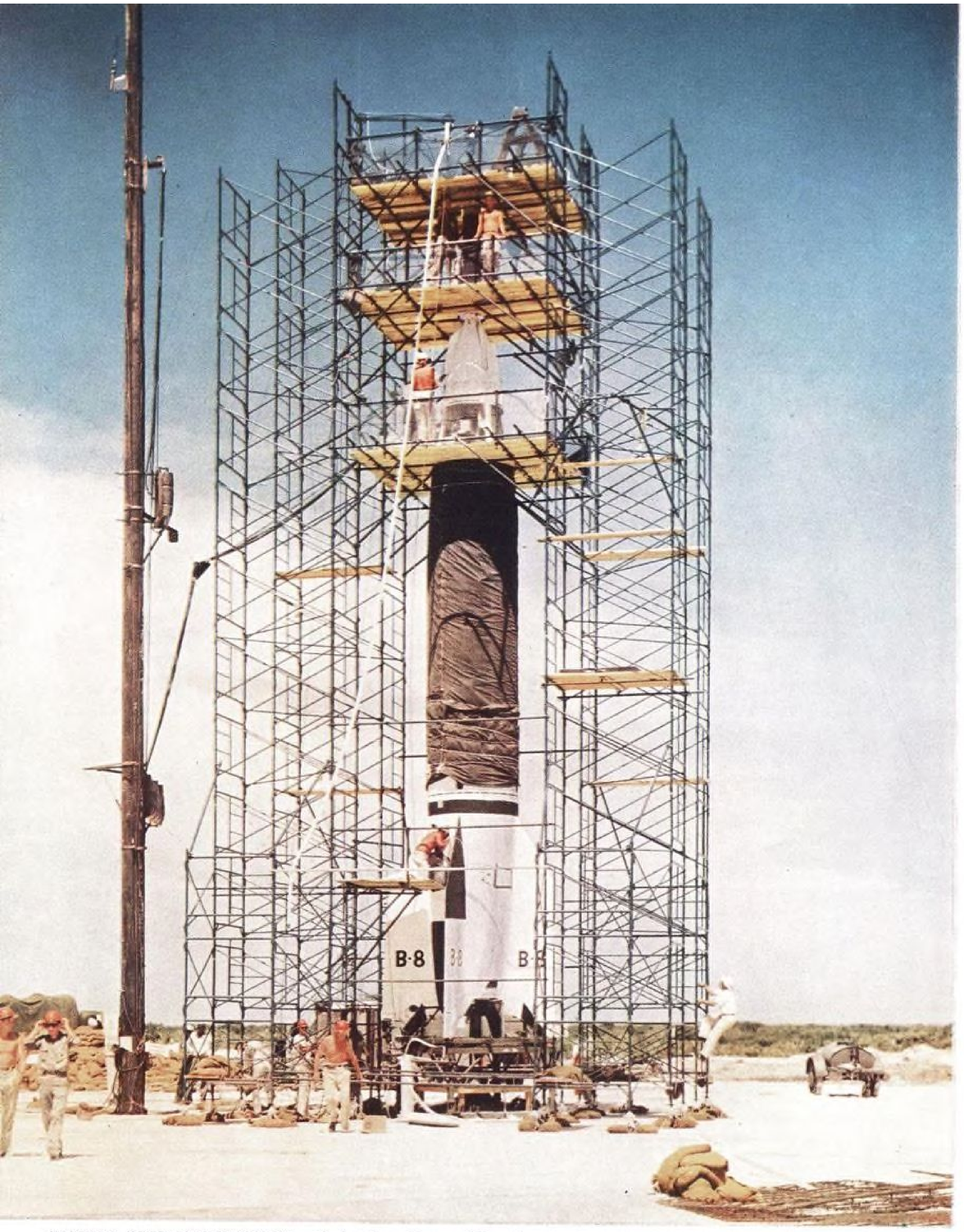
Across the seas, in other lands where freedom is a fiction, other minds are meeting. They know, too, that victory is not merely won . . . it is planned.

At Convair, *planning for tomorrow* has priority equal to *production for today*. While producing the missiles, fighters, and bombers needed today, Convair is engineering the weapons of tomorrow — weapons to win an atomic war the only way it can be won — before it starts.

Watch for new guardians of peace, built by Convair engineering that aims at the maximum of air power...**Engineering to the Nth power**

San Diego & Pomona, California
Fort Worth & Daingerfield, Texas

CONVAIR

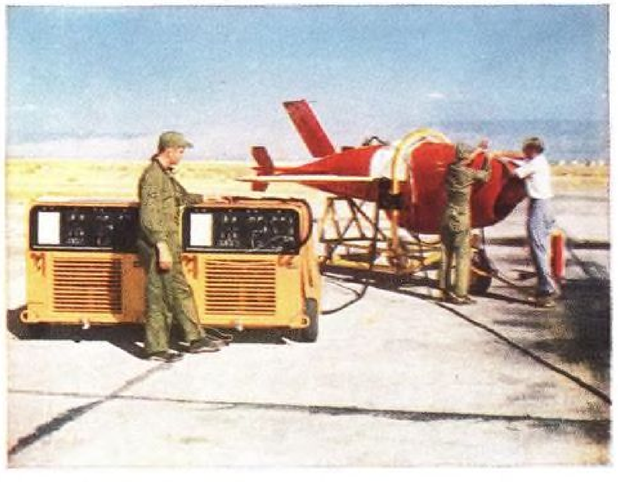


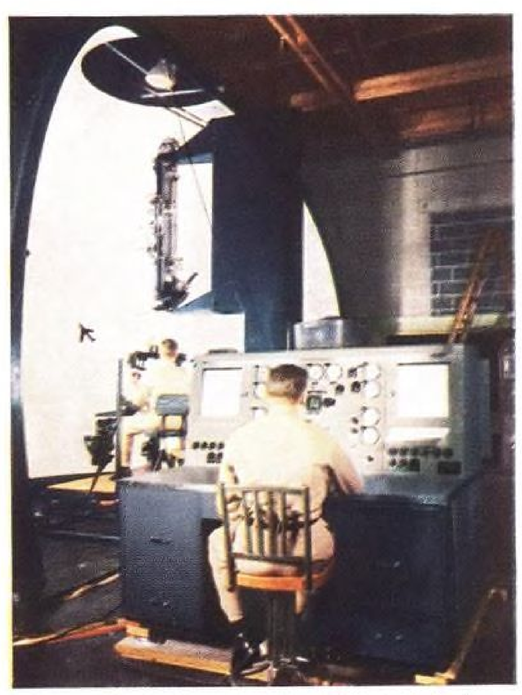
BUMPER RESEARCH ROCKET readied at Cape Canaveral launching site for horizontal flight of second-stage of WAC.

ARDC CENTERS' RESEARCH WORK

MARTIN MATADOR pilotless bomber takes off with rocket booster from zero–left field-type launcher at Cape Canaveral.

ROCKET TESTING at Edwards AFB.





NEW AVIONIC GUNNERY TRAINER checks bomber crewmen.

RYAN TARGET DRONE is checked before launching at Holloman AFB.

FROM HERE TO THERE—*IT'S FASTER BY AIR!*

You can get from where you are—to where you want to be—faster by air.

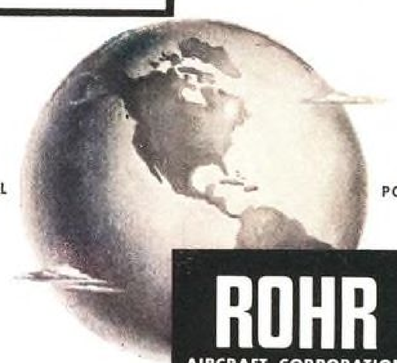
That's why—hundreds upon hundreds are joining the thousands upon thousands who yearly travel millions upon millions of miles—by air! Next time—save time—*your time*—fly!

power packages by

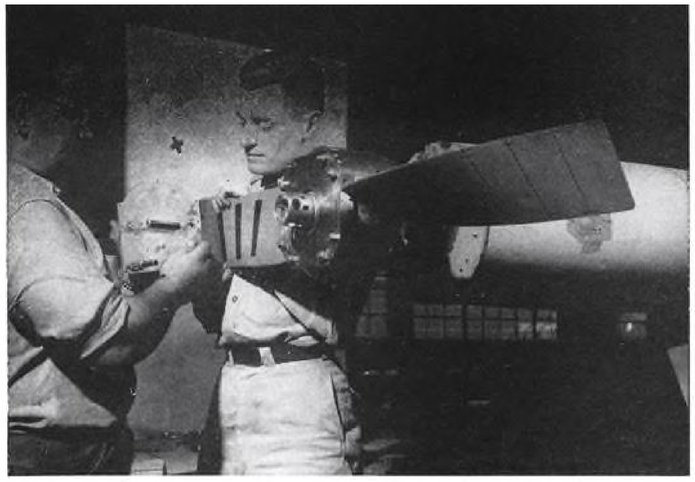
ROHR

You're boarding a United Airlines Convair-Liner 340—and there on the wing you see the Rohr-built "power packages" ready to wing you along the skyways of the world. For the Convair 240, and its successor, the Convair 340, Rohr manufactures and assembles the engine mount, cowl panels, ducts, exhaust system, tanks and other units which transform a Pratt & Whitney engine into a complete, ready-to-install "power package."

WORLD'S LARGEST PRODUCER OF READY-TO-INSTALL POWER PACKAGES FOR AIRPLANES



ROHR
AIRCRAFT CORPORATION
CHULA VISTA
AND RIVERSIDE CALIFORNIA



SUPERSONIC PROP model is checked on highspeed stand before tunnel testing.

CERAMICS are compounded for high-heat use.

versions of the Northrop F-89 Scorpion jet night fighter—the F-89C and F-89D.

► **Hot Tests**—Interesting example of how the problems are multiplying as requirements become increasingly severe is the attention now being focused on structures tests at high temperatures (similar to those that are beginning to be encountered due to highspeed friction).

The problems involve distribution of the heat over the airframe to represent different temperatures and to reproduce thermal shock due to rapid change in temperature in a structure which may be hot on the exterior and still cold inside.

Temperature changes as rapid as 10 deg./sec. are considered commonplace. Preliminary tests with heat ovens indicate that some other means of structures tests in which the heat will be applied locally probably will be required.

Corollary problems involve development of a new method of applying the loads at high temperatures, with materials that can withstand the temperatures better than the neoprene or shotbags.

► **Movable Walls**—Movable test chamber walls and welded steel windtunnel blades are innovations which the aircraft laboratory windtunnels are putting into use to get more out of their present facilities.

The moveable walls of the 10-ft. transonic tunnel can be expanded or contracted by operation of hydraulic jacks to provide subsonic or supersonic airflow under the same power conditions. (The further expansion of the air permitted by the larger opening creates higher speeds.)

The WADC tunnel uses a ventilated test section developed from work by National Advisory Committee for Aeronautics for its transonic windtunnels. So WADC engineers feel their tunnel is at least as good as any other transonic tunnel today. It operates at Mach numbers up to 1.24 with good flow characteristics at stagnation pressures up to 1½ atmospheres. Pressures of 2 atmospheres may be used at slightly lower Mach numbers.

► **Completion Cut Off**—Here is an example how cutoffs in research funds have slowed development. A new supersonic windtunnel, with a 24-in. throat, designed for speeds of Mach 1.5 to 2.3, is 90% completed. But it will not be able to go into operation without additional funds to operate it.

Although it is believed that the tunnel could be completed and put into operation cheaper than equivalent windtunnel time could be purchased elsewhere, this project has remained virtually in "suspended animation" since an economy decision by the Department of Defense McNarney committee two years ago.

John E. Keto,
Technical Director

► **Other Tunnels**—A smaller 6-in. section supersonic tunnel, built as a scale model for the 24-in. tunnel, has been pressed into actual use and has produced some excellent data. It now is being reworked to step up its top speed from Mach 2.75 to Mach 3.

Rounding out the WADC tunnel complement are the 20-ft. tunnel, capable of 400-mph. windspeeds; the 12-ft. vertical spin tunnel, one of two in the U.S.; and the old but still useful 5-ft. windtunnel in the lowspeed range, which dates back to old McCook Field.

► **Available to Manufacturers**—Any military contractor can windtunnel-test his new aircraft design in any of the WADC tunnels, if it is scheduled by the weapons system division.

Most models tested are provided by the manufacturers and are built with such painstaking attention to detail that costs run as high as $80,000 for a single unit. Models up to a maximum of 14-ft. span can be tested in the 20-ft. tunnel.

Data from the tunnel tests is obtained through tiny pressure orifices on the surface of the models, with as many as 300 orifices and 300 pressure tubes on a single model. Recording is done automatically by an International Business Machine printer and cardpunch. A computations unit reduces the data, by taking 10% of the cards, but a complete record remains available if needed. A teleplotter machine which plots eight curves at once, is another automatic aid.

It takes about two to three weeks to complete an average test, although a complete windtunnel evaluation in a single tiedown configuration may run as long as two months.

► **Every Plane**—One goal of the aircraft laboratory is to spin test every fighter and trainer before it is flown. It is felt that there is still no way to predict mathematically or empirically the spin characteristics of an aircraft and the

only way to pin this down is by the spin tunnel technique.

A restriction against intentional spinning of a plane should be the last resort, only after other modifications for improving spin recovery characteristics are thoroughly tested.

▶ **Design Branch**—Probably the most uninhibited group of engineers in WADC are the members of the preliminary design group in the aircraft laboratory. It is their task to prepare various alternate designs of aircraft and missiles based on the state of the art as it is expected to be five to 10 years hence.

They must put together design information from every available source into designs that will guide the Air Force planners on performance that expected aerodynamic and propulsive advancements will be able to provide.

Their estimates are a major basis for the formulation of actual Air Force requirements for future weapons systems, so the accuracy of their future projections is very important to the success of the weapons systems.

▶ **Various Approaches**—"We never make a finite recommendation that one configuration is the answer but we study the whole field and show various capabilities with different approaches to the problem," one of the engineers explained.

Models of enormous 500,000-lb.-gross weight aircraft—dwarfing even the Convair XC-99, largest of today's planes—and a galaxy of model configurations, many of which are like nothing flying, can be seen in this branch. In some of the older models, however you can trace many proposed innovations in design just now appearing in some of our latest aircraft.

▶ **Mechanical Branch**—Powerful inertia brake testing machines which stimulate landing speeds up to 200 mph. with tire loads up to 316,990 lb. give airplane wheel, brake and tire assemblies a rugged proving in another aircraft laboratory installation.

As a sample of experimental development, one tire tested here is designed for 325-lb. pressure. Its 5½-in. tread heats to 400F at contact.

This mechanical branch also conducts increasingly important tests on hydraulic, pneumatic and mechanical actuating systems and their components.

▶ **Special Projects**—Development of a wide range of miscellaneous projects necessary for successful operation of weapons systems—from aircraft emergency escape systems, down to cowl fasteners and rivets, pressure sealing of cabins, and integral fuel tanks—is the assignment of a special projects branch in the aircraft laboratory.

A complete laboratory unit within this branch, for example, is assigned to research and testing on bearings, considered one of the most critical problems in modern aircraft. This includes not only the jet engine bearings, which determine the actual life of an engine, but bearings on which aircraft flight controls operate, and many other types of bearings.

Here you will see odd Rube-Goldberg-type machines turning and turning, wearing out specimen bearings of chromium, vanadium steel, cobalt steel, ceramics and other materials. The bearings are tested for friction, for oxidation, for heated conditions, and are checked during the tests with special optical, electronic and mechanical gages.

One prized piece of equipment in this laboratory is a rare Zeiss interference microscope which magnifies 680 times. It is one of three in the U.S.

▶ **Aerodynamics and Dynamics**—The two other principal branches of the aircraft laboratory are concerned with the application of newly gained aerodynamic knowledge in improving flight characteristics from the standpoints of lift, drag, and stability. They work closely with the windtunnel and structures branches.

Problems of flutter—the unstable oscillation of a wing or tail surface which can build up until it destroys the aircraft—which has been a designer's bugaboo for many years, are still being studied here. Theoretical methods have been developed to predict flutter in subsonic speed ranges, but they are not yet adequate for the new aeroelastic and dynamic problems found in the transonic and supersonic speeds.

Important too in dynamic research is the study of excessive loads imposed on planes in taxiing, takeoff, landing and in flight through gusty air. The WADC engineers are directing tests to establish practical ranges for dynamic loads in these conditions for specific aircraft.

GLOBE recorder for simulated navigation.

▶ **Many Contributions**—The aircraft laboratory looks back on many contributions which its own engineers and industry engineers under its project direction have made to advance the aeronautical art.

Some contributions the lab claims:

- First stressed-skin aluminum wing.
- First investigation of rocket assist for takeoff.
- Pioneering in spin testing and development of the first spin recovery parachute.
- Pioneering in pressurization of aircraft cabins.
- Pioneering in flight testing for flutter, and in dynamic simulation of flutter on aircraft models.
- Development of vibration-isolating engine mountings for radial engine and propeller combinations to isolate the vibrating impulses of the engine from the aircraft.
- Pioneering in recording vibration in aircraft structures in flight.
- Pioneering in development of magnesium as an aircraft wing material.
- Pioneering in the field of windtunnel instrumentation, including the development of digital converters on recorders.

Powerplants Lab

The American aircraft engine industry is best qualified to do the actual design fabrication and development of aircraft propulsion. This is the policy that governs the WADC powerplant laboratory. The lab, however, reserves to itself the task of guiding and evaluating the manufacturers' development efforts and solution of powerplant problems developing in field operations.

▶ **Eight Types**—Today the laboratory is working with eight types of powerplants, plus several hybrid combinations of the basic types. These include turboprop, turbojet, piston, ducted fan, ramjet, pulsejet, rocket and atomic-power. Each type has its own problems in fuels, lubricants, installations, power transmission, ignition, starting, etc.

Development branches assigned to direct the programs in these fields include:

- **Rotating engine branch** for piston and turbine engines, starters and helicopter transmission systems.
- **Non-rotating engine branch.**
- **Nuclear propulsion branch.**
- **Accessories branch.**
- **Installation branch.**
- **Fuels and oil branch.**

▶ **Test Facilities**—To monitor the development work of the powerplant industry, the laboratory operates engine test facilities for sea level calibration, and endurance and simulated high-altitude tests. These facilities are among the largest and most varied in the world.

VIBRATION PROBLEMS SOLVED

AVIONICS

Plane, Missile Reliability Needs Differ

Vibration problems are entirely different, meeting hears; new temperature rating system is suggested.

By Philip Klass

Pasadena, Calif.—Techniques used to mount electronic components — and some of the components themselves — that have proved reliable in aircraft equipment won't stand up under the rigors of vibration encountered in guided missiles, an engineer from Cal Tech's Jet Propulsion Lab told the recent Electronic Components Symposium here.

Another symposium speaker urged the electronic component industry to scrap its present method of rating components in terms of maximum allowable ambient air temperature and switch to a rating expressed in terms of maximum allowable component surface temperature.

▶ **Thirty Papers.** Included in the 30 technical papers given before the 1,500 engineers who attended the three-day ELS were reports on:

• Transistor troubles, their causes and cures.

• New solid dielectric for improved capacitors.

• New gas dielectric for high-fidelity transformers and waveguides.

• Protective coatings for electronic circuits.

▶ **Rugged Missile Environment.** Engineers designing avionic equipment for missile use were urged to:

• More rigid chassis, designed in I beam or T beam shapes and using stand-off terminals.

• Shorter lead lengths of resistors, capacitors and similar components, to increase their resonant frequencies.

• Securely anchored components (to the chassis), with cantilevered components such as canned electrolytics and sealed relays fastened at both ends.

• More care in the selection of vacuum tube position on a chassis to minimize the effects of vibration.

• Hard mounting, i.e., no shock or vibration mounts. Paul believes that resonances resulting from shock mounts and the sharp bottoming of shock-mounted equipment are more hazardous than possible ill effects from hard mounting.

▶ **Little Correlation**—Paul reported that there appears to be little correlation between the reliability of components as vacuum tubes, long-duration vibration under low-intensity vibration (sinusoidal) and their reliability under high-intensity short-duration conditions (pulses).

For example, JPL tests under high-intensity vibration indicated that premium tubes were far superior to older JAN types. However, an earlier Signal Corps test under low-intensity long-duration conditions indicated that premium tubes had poorer survival records than [illegible]

[illegible] to determine whether [illegible] is always poor.

▶ **Better Relays Needed**—Few relays can stand up under high-intensity vibration even for short intervals, Paul reported. He cited these types of failure: chattering contacts, sticking armatures, mechanical breakage, and increasing contact resistance.

Balanced-armature type relays are particularly susceptible to failure, Paul said, adding that JPL had found only one relay of this type that could withstand the 10-20G missile environment vibration.

▶ **New Temperature Ratings?**—"Present ambient temperature type ratings [illegible] are not satisfactory [illegible]

For missile avionic equipment, Paul recommends:

[illegible] cooling by Bell Aeronautical Lab. He based this statement on extensive CAL studies of avionic heat dissipation problems under Navy BuShips contract.

Component failure or deterioration due to heat occurs because internal [illegible] have exceeded the safe [illegible] the materials used in its components. Welsh says that CAL's investigation indicates that component surface temperature is a much more significant indication of internal component temperature than is the temperature of the ambient air surrounding the component.

Ambient temperature type ratings may be suitable for an outdoor substation transformer or an industrial motor, but they are not adequate for miniature and subminiature electronic [illegible]

What They Said About Reliability

• "I cannot urge . . . too strongly the necessity for every manufacturer of electronic components for [illegible] guided missile program to install [illegible] tical quality control . . . [this] more important than any other [illegible] tor] in the whole missile [illegible] program."—Maj. Gen. Leslie E. [illegible] mon, chief of Research and Develop[illegible] ment Div., U. S. Army Ordnance.

• "Reliability of electronics equipment . . . embraces more than [illegible] ponents . . . [it] the reliability [illegible] gradient."—[illegible] phone Labs.

• "There . . . [is] a new [illegible] consciousness in the military [illegible] demed by some 200-300 reports [illegible] directed toward this end; a new [illegible] of technology which might be [illegible] 'reliability engineering'; and [illegible] tion . . . of the futility of [illegible] present integrity and reliability [illegible] ticularly in the development [illegible] through present government [illegible]"—D. A. Quarles, president of the American Institute of Electrical Engineers, vice-president of Western Electric, chairman of the committee on electronics, Research and Development Board.

• "Reliability of components used in missiles must be several orders of magnitude higher than those used in [illegible] We must abandon the old [illegible] investigating only 'epidemic' [illegible] A single component failure may indicate a serious weakness [illegible] be traced to its basic cause."—Capt. R. Lunen, U.S. Naval Air Missile Test Center, Pt. Mugu, Calif.

AVIATION WEEK, June 15, 1953 53

▶ **Better Relays Needed**—Few relays can stand up under high-intensity vibration even for short intervals, Paul reported. He cited these types of failure: chattering contacts, sticking armatures, mechanical breakage, and increasing contact resistance.

Balanced-armature type relays are particularly susceptible to failure, Paul said, adding that JPL had found only one relay of this type that could withstand the 10-20G missile environment vibration.

See where relay failures lie . . .

✔ CHATTERING CONTACTS

✔ STICKING ARMATURES

✔ MECHANICAL BREAKAGE

✔ INCREASING CONTACT RESISTANCE

with FASTAX High-Speed Motion Pictures FASTAX picture studies, with the blur of speed slowed down as much as 1,000 times, enable engineers to see plainly . . . clearly . . . study design problems leisurely. FASTAX speed range of 150 to 16,000 pictures a second literally stops motion. Viewed on the screen at the normal speed of 16 pictures per second the hand . . . the machine . . . action is no longer quicker than the eye. The magic of speed is gone.

Yes, Mr. Paul, FASTAX has helped solve design problems for hundreds of America's leading companies, laboratories, universities. It can help solve the problems you mention, too.

WRITE on your company letterhead for the new FASTAX High-Speed Motion Picture catalog. FASTAX Division, Wollensak Optical Co., Rochester 21, N. Y.

Wollensak
OPTICAL COMPANY ROCHESTER, N.Y.

- RAPTAR
- RAPAX
- FASTAX
- MIRROTEL

Turbojet engine tests stands are capable of testing engines up to 40,000-lb. thrust at sea level, or about four times the power of today's operational turbojets. Ramjet test facilities can test a small ramjet at Mach 4 at simulated altitudes in the neighborhood of 100,000 ft. under either free-jet or direct-connect conditions.

Technical problems involved in simulating the extreme altitudes and temperatures have required huge refrigeration and air conditioning systems for the stands.

Other test facilities provide for qualification test and environmental test of such items as fuel metering and control devices, ignition, engine accessories, fuels and lubricants, and components of fuel and lubrication systems including lines, seals and tanks.

One example of the test requirements is a new air preheater recently installed for ramjet tests which feeds air into the engine at 1,200F simulating temperatures encountered at Mach 4 speeds.

Rocket test facilities operated at WADC are supplemented by the large rocket engine test facilities operated at Edwards AFB, and the laboratory also works closely with other ARDC facilities for flight test of aircraft and missiles on powerplant problems.

► **Engineering Fixes**—The familiar Air Force "UR" system of unsatisfactory reports for engines comes home to the powerplant laboratory, where each case of a malfunction is referred to the branch responsible for its development.

In the powerplant teardown and machine shop section, you can see a wide variety of engines, actually called in from the field for examination and engineering fixes on specific problems. It is a costly way to trouble-shoot, but it pays substantial dividends in positive fixes.

► **Achievements**—While much of today's work is under security wraps, some idea of the part the powerplants laboratory is playing in the aircraft propulsion picture is found in study of some of the past developments in which the laboratory engineers have played important roles.

Basic patents on some of the most important features of today's powerplants are held by former and present staff engineers. Some of these developments include:

- **First internally cooled exhaust valve for piston engines.**
- **Sponsorship of the turbosupercharger.**
- **Sponsorship of high-octane-rating aviation gasoline.**
- **Invention of the oil dilution system for starting engines at low temperatures.**
- **Early work on singlepoint refueling, and on water injection for aircraft engines.**
- **Basic work on high-temperature coolants for liquid-cooled engines.**
- **Early work on individual cylinder fuel injection.**
- **Early recognition of the importance of more powerful turbojet engines at a time when 1,500-lb.-thrust engines were considered sufficient.**

Flight and All-Weather

At 45,000 ft. over a tiny island in Lake Erie, a sweptwing North American F-86 Sabre jet fighter noses down into a roaring highspeed dive in an attempt to aim the shockwave which the dive creates at another F-86 circling the island below.

Pilots of both planes are Wright Air Development Center test pilots, studying the little known phenomenon of shock waves and their effects on objects they strike. They are graduates of the Air Force Test Pilots School at Edwards AFB, Calif., and every test flight they fly is a carefully pre-planned checkout of the airplane and/or the equipment it carries, under some special condition of flight.

► **All-Weather Tests**—Since the concept of developing an all-weather air force was adopted, the Air Force has entered a new phase of flight testing, which becomes Phase V—all-weather flying—in the rigorous program which a new airplane must experience. This phase is carried out from the air base at Area C of Wright-Patterson AFB, by WADC's Directorate of Flight and All-Weather Testing.

In addition to the Phase V tests for all new airplanes, the pilots are called to fly many other project flights, testing new equipment and doing special research such as the shock wave experiments.

Currently about 150 Air Force airplanes are assigned to the Area C flight test hangars, and until recently the number was up to 200. As many as 15 Boeing B-47s have been at the base for the last year, undergoing tests related to various equipment changes and fixes, including ejection seats, drag parachutes and inflight refueling.

Col. S. R. Stewart, Chief of Staff

A check of one test pilot's log showed that he had flown tests on the following planes in the last month: B-36, B-47, B-29, B-50, B-17, B-26, and B-45, for a total of 61 flight hours.

► **Flight Refueling**—Some of WADC's bomber branch test pilots have recently made flight refueling tests of the new Boeing prototype KB-47 jet tanker with a B-47 receiver plane, and other recent tests have been made with a Convair B-36 bomber outfitted as a tanker, using both the flying boom and probe-and-drogue methods of refueling.

Example of how routine the probe-and-drogue system is becoming is found in the story of a Navy jet pilot who asked for a checkout and ran up a score of 36 connects and disconnects during a flight between Dayton and Columbus, although it was his first aerial refueling experience.

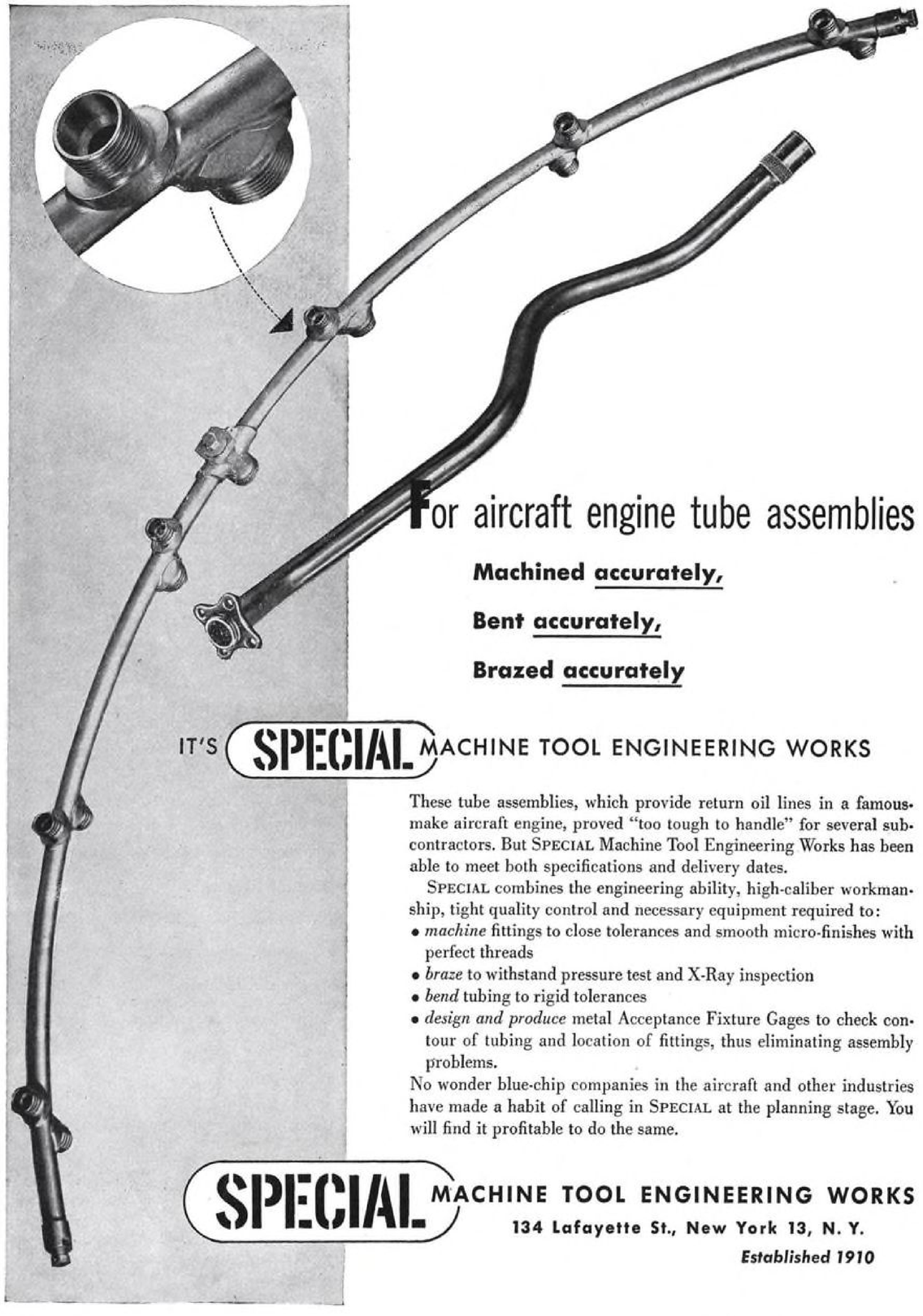
In the refueling equipment tests, the WADC pilots take the tanker and receiver planes through specified speed and altitude conditions checking out the equipment at intervals throughout this range. A jet T-33 chase plane usually accompanies the fueling tests for photographic coverage of the procedure.

► **Powerplant Test**—A fighter test pilot cited one of his unusual assignments—a flight test with a Lockheed F-94C nightfighter powered with a Pratt & Whitney J48 engine with afterburner. This particular test involved testing the temperatures in all of the combustion chambers in flight by recordings from temperature probes in each burner can.

► **Weather Variety**—The varied weather found in the Miami River valley, and the valleys of its tributaries, makes the Wright-Patterson base an ideal location for the Phase V all-weather testing. Objective of this phase is to test the ability of the aircraft to fly under adverse weather conditions, and to develop special recommendations, if necessary, for instrument and night flight operation.

Missions are flown day and night, under a variety of ceilings and visibilities, in icing and turbulent conditions. Local flights are monitored by ground radar.

Data from the flight is compiled into a comprehensive evaluation of the plane's all-weather capabilities. This data becomes the basis for operating instructions furnished with the service airplanes, outlining techniques to be used by combat pilots under instrument conditions from takeoff to land-



For aircraft engine tube assemblies

Machined accurately,

Bent accurately,

Brazed accurately

IT'S SPECIAL MACHINE TOOL ENGINEERING WORKS

These tube assemblies, which provide return oil lines in a famous-make aircraft engine, proved "too tough to handle" for several sub-contractors. But SPECIAL Machine Tool Engineering Works has been able to meet both specifications and delivery dates.

SPECIAL combines the engineering ability, high-caliber workmanship, tight quality control and necessary equipment required to:

- *machine* fittings to close tolerances and smooth micro-finishes with perfect threads
- *braze* to withstand pressure test and X-Ray inspection
- *bend* tubing to rigid tolerances
- *design and produce* metal Acceptance Fixture Gages to check contour of tubing and location of fittings, thus eliminating assembly problems.

No wonder blue-chip companies in the aircraft and other industries have made a habit of calling in SPECIAL at the planning stage. You will find it profitable to do the same.

SPECIAL MACHINE TOOL ENGINEERING WORKS

134 Lafayette St., New York 13, N. Y.

Established 1910

ing, including recommended airspeeds and power settings.

Many of the pilots are on assignment at manufacturers' plants, or on special arctic or tropic tests several months of the year.

▶ **Atomic Tests**—One told how he flew the XB-47 out of the Bikini atomic tests two years ago and made a little-known emergency landing with a drag chute on an abandoned 4,400-ft. runway on a Pacific island which had been a Japanese airstrip during World War II.

Three crews from the WADC flight test organization flew B-50 and B-29 planes in more recent atomic tests.

▶ **Maintenance Crews**—To keep the test planes flying, a maintenance organization of 700 persons is assigned at Area C. These men also handle special installations, working with laboratory technicians responsible for the equipment installed.

Aero Research Lab

In a test building at Wright Air Development Center, a model of a nose wheel landing gear is running through a series of tests aimed at eliminating the undesirable "shimmy" characteristics which have wrecked a number of Air Force planes, including a Northrop XB-49 jet flying wing and a Fairchild C-119 cargo transport.

These tests are being conducted simultaneously with contract investigations at Cornell laboratory; at Fairchild at Hagerstown, and at Bendix Aviation at South Bend, on actual aircraft.

▶ **Computers Too**—Meanwhile, the aeronautical research laboratory at WADC is running mathematical problems, involving all the parameters being tested in the actual tests, through its computers. The computation branch can make about 100 test runs to each actual run made on the model.

This is an example of the investigations being carried on by the Aero Research Lab. Its task is to examine special problems, such as the landing gear stability problem, affecting a wide range of aircraft, and determine a general practical solution which can be applied as an advancement in the aeronautical art.

▶ **Playing the Field**—The newest of WADC's 12 laboratories "plays the field" in a systematic scanning of the entire physical science horizon, area by area, looking for new and better concepts, techniques, and materials to apply to improvements in air weapons.

Its scientists work in project teams. Of its projects, 75.3% are under contract to outside organizations with specialized equipment and apparatus or with specialized technical skills. Byproducts of many of the projects, useful commercially rather than militarily, are made available to industry for commercial development.

▶ **Computer Research**—Through mathematical computation, the laboratory has found faster and cheaper means to study aerodynamic characteristics of modern air vehicles. The new methods are about 75 times faster than previous methods, and one-tenth as costly. Using the prodigious "memory" capacity of large digital computers such as a new General Electric "brain" recently installed at the laboratory, extremely long sequences of mathematical operation can be run off with rapidity.

Some of the investigations that have already been made mathematically include:

- **Study of vibrations** in delta wing airplanes and in propellers.
- **Analysis of the escape** of crew members from highspeed aircraft.
- **Analysis of parachute opening shock.**
- **Investigations of flow** in ducts and windtunnels.
- **Analysis of breaking strength** of materials.

▶ **Incalculable Aid**—The value of the computers in speeding the reduction of research data obtained in windtunnels and other testing equipment is probably incalculable.

Before the installation of these machines, a backlog of data existed on such problems as flutter analysis, design parameters for autopilots, bombing systems, propeller control systems, fire control systems, and equations of motion of aircraft in complicated maneuvers such as rolling and pullup.

Now the electronic machines are rapidly overcoming this time lag between tests and data application.

Interesting byproduct of the computing research technique is a small lightweight automatic data reduction computer for airplane installation. This is designed to reduce complex flight test programs to simple answers.

Other computing machines have been designed for demonstrating results of various war strategies, and for solving complex logistic problems.

Propeller Lab

Research facilities of Wright Air Development Center's propeller laboratory are not duplicated in the U.S. and probably not in the world. Therefore, WADC does electric whirl-testing of propellers and helicopter rotors for Navy aircraft as well as for Air Force.

▶ **Supersonic Props**—Development contracts with the principal propeller manufacturers for new types of turbine props to provide thrust for supersonic airplanes have been followed up since mid-World War II days.

The laboratory's persistence in this field, even when some Air Force policy trends were calling for bypassing the propeller completely, is now beginning to pay off. Flight tests have begun on a McDonnell XF-88B Voodoo twin-jet fighter which has been modified to carry a turbine turning a small supersonic thin-blade propeller in its nose. This work is proceeding under a development contract sponsored by the propeller laboratory. Several other supersonic propeller developments are close to flight test stage.

▶ **Rotor Rig**—Meanwhile the first large-dia. rotor blades for the new Piasecki XH-16 helicopter recently have been delivered for whirl-testing on the laboratory's rotor tower.

The tower accommodates 95-ft.-dia. rotors, and has a 4,000-hp. motor to whirl rotors at from 150 to 600 rpm. at a 50-ft. altitude, duplicating conditions in flight above or at the top of ground cushion.

▶ **Prop Testers**—Most powerful propeller whirl rig, now being completed, will be powered by a 30,000-hp. motor. Used with adapters, it will be capable of testing jet and turboprop engine compressors, as well as propellers. It will be able to turn these rotating elements at speeds up to 12,000 rpm. and develop up to 150,000 lb. thrust.

Other propeller engine test stands are provided with capacity for running engines rated as high as 8,000 hp. In addition, one of the 40-ft.-dia. stands is being modified to accommodate turbine engines up to 15,000 shp.

▶ **Other Devices**—Other interesting equipment at the propeller lab includes:

- **Fatigue testing** equipment for vibratory fatigue testing of rotor blade sections up to 10 ft. long and 28 in. wide under tension loads up to 100,000 lb.
- **Radio noise suppression** equipment for study of propeller radio interference.
- **Experimental prop and rotor** shops for assembly and modification of units for tests.
- **Propeller control testing** equipment for studying propeller hubs in temperatures of minus 97F and for vibration strain gage testing.

One interesting method of testing involves a propeller rig with the blades whirled in the blast from the tailpipe of General Electric J47 jet engine. The blast and the use of baffles make it possible to put the blades of the propeller through a complete cycle of loaded and unloaded condition, once for every revolution of the prop.

Equipment Lab

The research and development work of the equipment laboratory leads all other groups at WADC in both number and diversity of projects. It is responsible for 276 different classes of equipment items, which amount to 21.5% of all the specifications for items used by the Air Force.

Pacemaker . . . of aviation progress

The aircraft in this photograph is going places—high and fast. It is the X-1A, another in the distinguished series of special research aircraft designed and produced by Bell Aircraft Corporation for the U. S. Air Force.

Like its famous predecessor, the X-1 . . . first airplane in the world to exceed the speed of sound . . . the X-1A is symbolic of the emphasis Bell Aircraft has traditionally placed on research and development as a major instrument in strengthening the nation's air arm.

Valuable design and performance information gathered from the X-1 series is now being incorporated in the country's front line fighters and bombers.

These special research aircraft have also facilitated Bell Aircraft's transition to a new field—pilot-less aircraft, or as they are more commonly known, guided missiles.

With the company's vast experience in supersonic and remotely controlled flight as background, Bell's scientists and engineers are pushing forward the development of missiles with an intensified and diversified program of electronics, servomechanisms and rocket propulsion—providing today's research for tomorrow's air power.

BELL Aircraft CORPORATION

BUFFALO 5, N. Y. FORT WORTH, TEXAS

Principal subdivisions include:

- **Ground servicing equipment** for aircraft.
- **Electrical equipment,** both airborne and ground.
- **Instruments,** ranging from flight control and engine to meteorological units, telemetering systems, radiological, biological and chemical detection instruments, and warning signal instrumentation, together with accessories, mounting, lighting, etc.
- **Maintenance and support** ground equipment, including fire fighting vehicles, hoists, aircraft jacks, towing vehicles, etc.
- **Mechanical equipment for de-icing,** heating, cooling, pressurization, cargo handling in the aircraft.
- **Parachutes** for personnel, cargo and deceleration of aircraft.
- **Airborne lifeboats** and other rescue equipment.
- **Training equipment,** ranging from elaborate flight simulators of specific airplanes, to aerial tow targets.

► **Climatic Tests**—To test the operation of various equipment items under severe conditions similar to some they may encounter in flight, the laboratory has an extensive array of test equipment. This includes a battery of climatic condition chambers for simulating virtually any condition that can be encountered in aircraft operation any place in the world.

Some of these specialized cells will simulate salt fog for corrosion tests; sand and dust equivalent to the severest sandstorms known in nature; humidity; sun and rain alternately; extreme dryness with only 5% humidity or less; fungus growth in warm moist conditions, and high-altitude conditions up to 150,000-ft. levels.

► **Centrifugal Forces**—In other tests, equipment is exposed to terrific centrifugal forces by whirling in centrifuge machines. Two of these machines are used. One will spin a 25-lb. piece of equipment with up to 100 times the force of gravity, or a 100-lb. item at up to 25G.

A typical item under test in this centrifuge was an automatic parachute opening device, operating on an aneroid barometric pressure principle.

A larger centrifuge will subject equipment weighing up to 2,000 lb. to centrifugal forces equivalent to 40G. This includes an arrangement by which a second rotational force can be operated inside the orbit of the main rotation, so that the equipment can be exposed to two rotational forces simultaneously.

► **New Instrument**—Example of the complex specialized instruments under development as the result of higher speeds is a new type indicator to show indicated airspeed, Mach number and true airspeed, all on the same dial.

The instrument is provided in two sizes—the larger is scheduled for installation in the Boeing B-52 eight-jet bomber, and the smaller for installation in the F-101 jet fighter.

Indicated airspeed covers range of 80 to 650 knots; Mach number range is from 0.5 to 2.2; true airspeed range is 150 to 900 knots. The indicator will operate over an altitude range of zero to 80,000 ft.

A remote computing mechanism actuates a servomechanism to indicate the true airspeed on a Veeder-style counter on the dial. A remote altitude-sensitive mechanism actuates the Mach number scale, while the same pointer shows indicated airspeed on a fixed dial, and Mach number on a moving scale.

► **De-Icer Sprayer**—An example of special ground equipment developed is a de-icing sprayer, winterized to operate at temperatures down to minus 65F. It quickly removes frost and ice from parked aircraft by spraying them with chemical de-icing compounds. Device includes a high lift platform rising to 50 ft.; from this ground crews can now reach the most inaccessible exterior surfaces of the largest aircraft in service.

Photo Recon Lab

To insure that aerial photography for intelligence keeps pace with the new higher speeds and altitudes of today's and tomorrow's aircraft is a mission which has brought today's air photography a long way from World War II days. Even then it was estimated that aerial photography provided 80% of the intelligence material actually found useful.

Night operations of the Reds in Korea have been successfully exposed by USAF's night aerial photography. Illumination has come from huge photoflash bombs that provide sufficient light for good photographs from as high as 40,000 ft. and flash cartridges each providing over 100 million candlepower for use in low-altitude highspeed photographic runs.

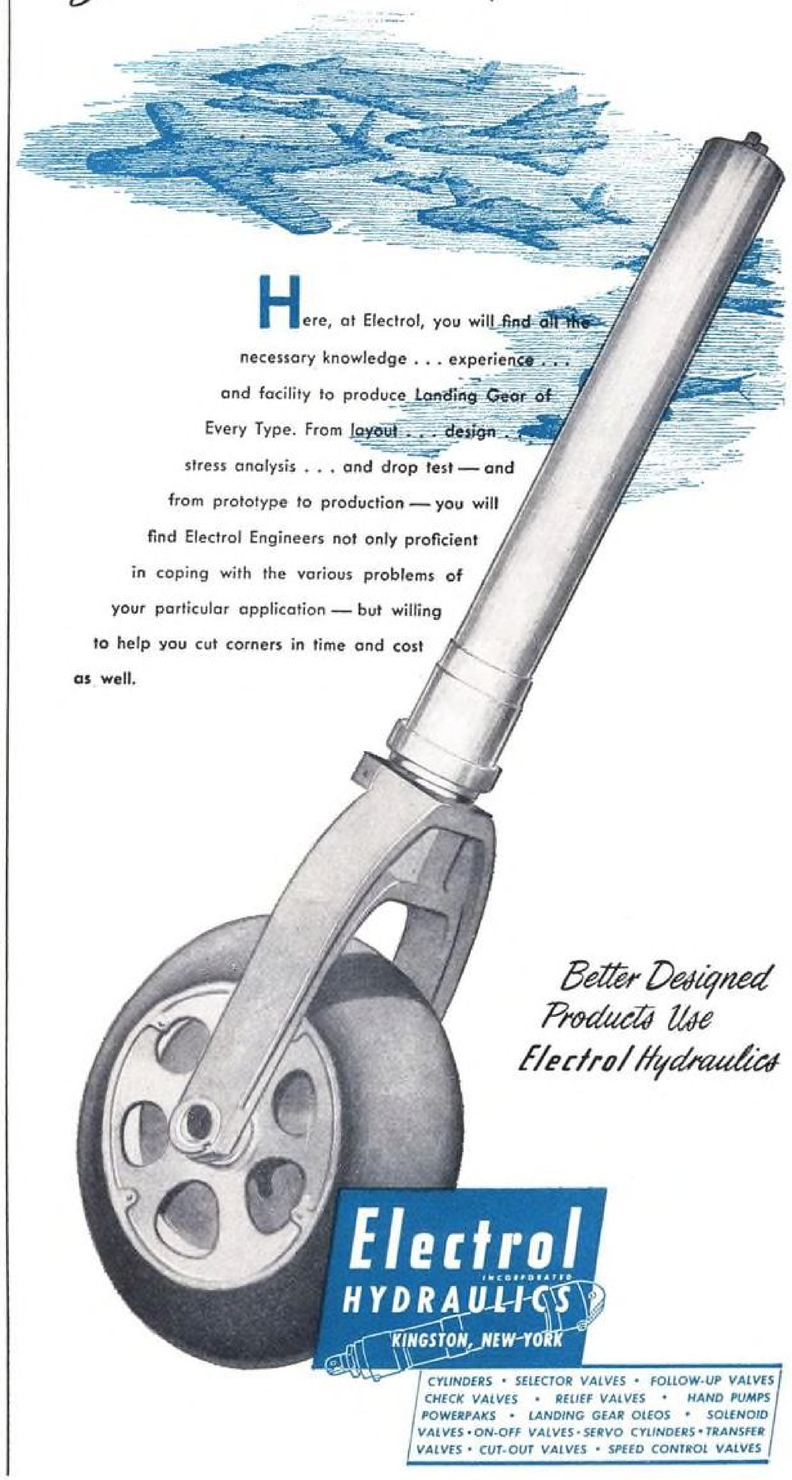
► **New Equipment**—Two new stabilized camera mounts, developed as projects of the photo reconnaissance laboratory at Wright Air Development Center, are being accepted by the Corps of Engineers as superior to previous stabilized mounts, for accurate mapping photography.

One uses a gyro-stabilization principle and the other handles the camera as part of the armature of a large motor, moving it by windings similar to those of an electrical motor field.

► **In Rockets and Missiles**—Excellent performance has already been given by cameras carried in rockets, and camera equipment is being designed for missile and robot aircraft installations.

LANDING GEAR OF EVERY TYPE

from Design to Flight



Here, at Electrol, you will find all the necessary knowledge . . . experience . . . and facility to produce Landing Gear of Every Type. From layout . . . design . . . stress analysis . . . and drop test — and from prototype to production — you will find Electrol Engineers not only proficient in coping with the various problems of your particular application — but willing to help you cut corners in time and cost as well.

Better Designed Products Use Electrol Hydraulics

Electrol INCORPORATED HYDRAULICS KINGSTON, NEW-YORK

CYLINDERS • SELECTOR VALVES • FOLLOW-UP VALVES
CHECK VALVES • RELIEF VALVES • HAND PUMPS
POWERPAKS • LANDING GEAR OLEOS • SOLENOID
VALVES • ON-OFF VALVES • SERVO CYLINDERS • TRANSFER
VALVES • CUT-OUT VALVES • SPEED CONTROL VALVES

SHOCK – VIBRATION – NOISE

ISOLATION NOTES

This **NEW** *Product Bulletin gives* **YOU**

COMPLETE ENGINEERING DATA on ALL-METL BARRYMOUNTS

Here's what's in it for **YOU:**

1. Transmissibility curves showing performance under test conditions of JAN-C-172A.
2. Curves showing reduction of transmitted acceleration and displacement.
3. Curves showing how changes in loading affect transmissibility at resonance and natural frequency for vertical motion.
4. Curves showing effect of high and low temperature on isolator performance.
5. Shock-characteristic data, including curves showing vibration isolation after 15g shock test.
6. Application data, including curves that show you how to choose isolators for unsymmetrical loads.
7. Dimensioned drawings of unit isolators, channel pairs, and mounting bases.
8. Detailed data on the construction, operating principle, and weights of mounts and bases.
9. A complete list of load ratings and catalog numbers for unit isolators, channel pairs, and bases.

We'll be glad to send you a FREE COPY of this, the first really comprehensive bulletin on knitted-wire vibration isolators. Ask for Barry Product Bulletin 534. And, if you have a special problem, count on getting the right answer from our Field Engineering Service.

THE **BARRY** CORP.

700 PLEASANT ST., WATERTOWN 72, MASSACHUSETTS

SALES REPRESENTATIVES IN

Atlanta Baltimore Chicago Cleveland Dallas Dayton Detroit Los Angeles Minneapolis New York Philadelphia Phoenix Rochester St. Louis San Francisco Seattle Toronto Washington

Materials Laboratory

New information about titanium alloys, wrapped up in a collection of 70 equilibrium diagrams that show graphically how the alloys react at various temperatures, is being made available to the U. S. aircraft industry.

Prepared by Armour Research Institute under contract to Wright Air Development Center, the diagrams make possible a selection of the best alloys from this group for possible aircraft alloy materials.

▶ **Titanium Alloy**—Next step is for industry, under experimental contracts, to make engine components—such as compressor blades—from these alloys.

Goal of this avenue of development and testing is the development of titanium alloys with satisfactory properties for use under the higher temperatures and loading conditions in the new regime of powerplants for supersonic flight operations.

▶ **WADC Projects**—The titanium research is but one phase of a large number of materials development and testing projects directed by the materials laboratory at WADC. These are some others:

• **Service tests** recently were completed on a high iron-content alloy identified as U-912, which lasted longer under severe conditions than the presently accepted jet turbine bucket alloy S-816.

• **Molybdenum tests** are continuing with promise for very high temperature applications. But the metal is susceptible to oxidation. Efforts to correct this drawback are under way.

• **Recently developed** aluminum casting alloy, which has better properties at 600F than any other known aluminum casting alloy, is being evaluated for possible use in the Curtiss-Wright J65 Sapphire engine. It is identified as ML-alloy.

• **Powdered magnesium** alloy recently developed is considered to have extrusion and forging properties far superior to those of current commercial magnesium alloys.

• **Plastics research** is centering now on high-temperature structural plastics of silicone and polyester types for extended operation at 500F as an outgrowth of development of phenolic type plastics, which can operate for short intervals in such temperatures. The plastics are used for various aircraft and missile components.

• **Rubber development** centers on synthetics with special properties of resistance to fuel, oil, acid, water and extremes of temperature but maintaining good elongation strength and abrasion resistance. Among developments in these fields are the sheathing material of polyvinyl chloride rubber for wires and cables in today's airplanes and hose used for air-to-air refueling.

Dreams span the seas sometimes

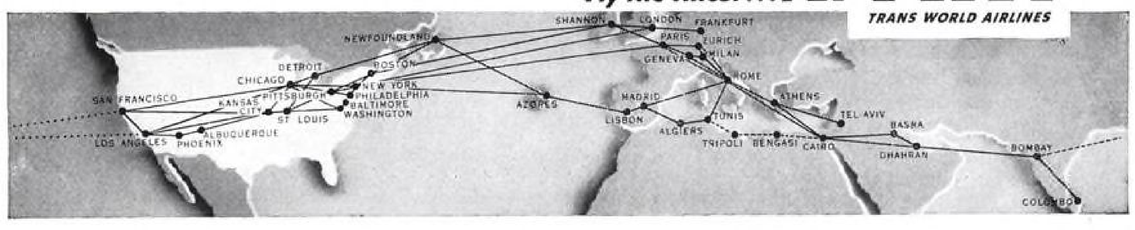
TWA DOES IT TEN TIMES A DAY

A boy and his thoughts by the side of the sea! Do you remember when *your* imagination wore seven-league boots and carried you off to fabled cities in far-off lands, where languages and distances didn't matter? Maybe it's time to *live* those dreams. For today is the age of the swift TWA Constellation—the modern magic carpet that can speed you almost anywhere a dream can go in less than a single day. Yes, today the whole world is yours to enjoy when you follow your flights of fancy . . . via TWA.

Where in the world do you want to go? For information and reservations, call TWA or see your travel agent.

Fly the finest . . . FLY TWA

TRANS WORLD AIRLINES



SABRE with special flight test boom.

Flight Test Center Probes Aviation's Supersonic Frontiers

by William Coughlin

Edwards, Calif.—Near the center of the Mojave Desert, less than 100 mi. northeast of Los Angeles, lies a huge, level expanse of hard-baked clay and silt known as Rogers Dry Lake. Its glistening surface, 13 mi. long and 5 mi. wide, throws off a blinding glare under the hot sun and occasional sandstorms swirl across the dry bed.

Located on the western "shore" of this lake is Edwards AFB. Here, the Air Force Flight Test Center sits in judgment on the aircraft products of the Air Research and Development Command.

Its diverse facilities sprawl over 200,000 desert acres to make Edwards the second largest Air Force base in the U. S., exceeded only by Eglin in Florida.

Without Rogers Lake, Edwards would not exist. For 10 months of the year, the lake is dry and its fine clay and silt surface can support pressures up to 250 lbs. per square inch. A fully loaded B-47 can land without making a wheel mark.

► **Concrete Tabletop**—"Hard as concrete and flat as a tabletop," is the way Brig. Gen. J. Stanley Holtoner, commanding officer of Edwards, describes the 65-sq. mi. surface which is used for flight testing.

The story of Edwards is a story of supersonic research craft thundering across the lakebed like strange mirages and of the world's top test pilots and scientists laboring in desert isolation to push back the frontiers of aerodynamics.

It is a story of research and testing under adverse conditions, with sand sifting through rundown wartime buildings to foul delicate avionics equipment; with facilities so crowded one contractor uses an abandoned boiler room for office space; and with a former lavatory serving as locker room for some of the nation's best military test pilots stationed here.

► **Roll of Fame**—The pilot roster includes civilians like Bill Bridgeman, who flew the D-558-II to a record speed of 1,238 mph. and a height of better than 79,000 ft.—"where I could see the curvature of the earth"—and military men such as Maj. Charles E. Yeager, first man to fly an airplane faster than sound.

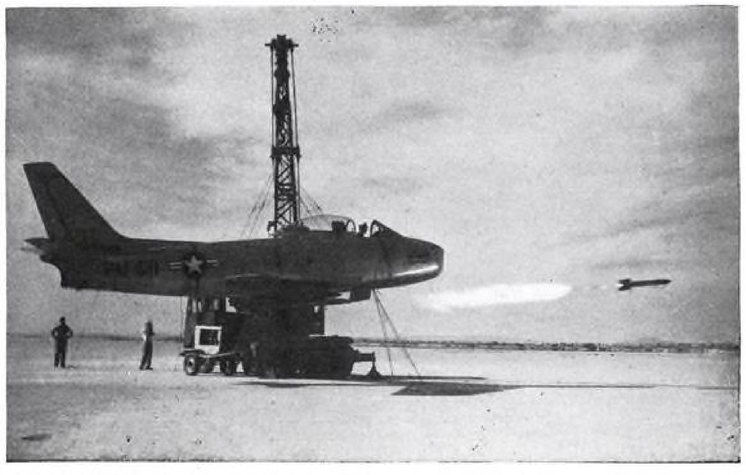
Here took place what Gen. Hoyt S. Vandenberg called the greatest aeronautical achievement since the first flight of the Wright Brothers—the flight of the rocket-powered X-1 through the sonic barrier.

Here is rising a permanent national military flight test center based on a $120-million master plan nearing one-third completion—but which could become what one officer calls "monuments in the desert" if threatened cuts in research and development funds halt its construction.

► **Nature's Work**—But it is the lake which dominates the base. "Without it, the type of experimental flight testing we do would be impossible," says Lt. Col. William D. Brady, chief of the Plans, Programs and Operations Div.

Rogers Lake is a drainage basin for much of the Mojave Desert and gentle rains cover it with up to 18 in. of water in the winter. Desert winds sweep this water back and forth during the rainy season, annually resurfacing the lakebed with a natural action which prompts Gen. Holtoner to call Nature "our best contractor."

Laid out on the lake's surface are several runways more than 5 mi. long and one runway with a length of 8 mi. Only runways such as these could accommodate aircraft like the X-3, which requires a takeoff run of 3 mi. before its stubby straight wings can carry it to supersonic speeds. The hard lake surface also provides the distance needed for highspeed dead-stick landings of rocket-propelled research aircraft.



HVAR rockets roar from Sabre suspended to simulate flight conditions.

PROTECTIVE clothing is required for crew fueling supersonic XF-91 experimental fighter from alcohol-oxygen refueling truck.

► **Plane-Saving Length**—In addition, expensive test aircraft many times have made emergency landings on the broad expanse. Republic's XF-91 made seven emergency landings on the dry lake during its test program. Only aircraft of its type built, its loss would have washed out the test program and seriously delayed development of Republic's F-103 supersonic fighter.

A running total maintained by the flight test center shows an estimated $218,246,629 worth of aircraft saved by the lake since Apr. 4, 1946. This figure is not total value of the aircraft involved but merely an estimate of amount of damage that would have been done had the dry lake not been available.

► **Clear and Open**—Other important factors also influenced the decision to locate AFFTC here. Weather while hot is so clear that flight testing is possible 350 days of the year.

The remote location not only affords security desirable for highly classified projects but avoids dangers inherent in testing experimental aircraft over populated areas. Closest town of any size, Lancaster, is 30 mi. distant.

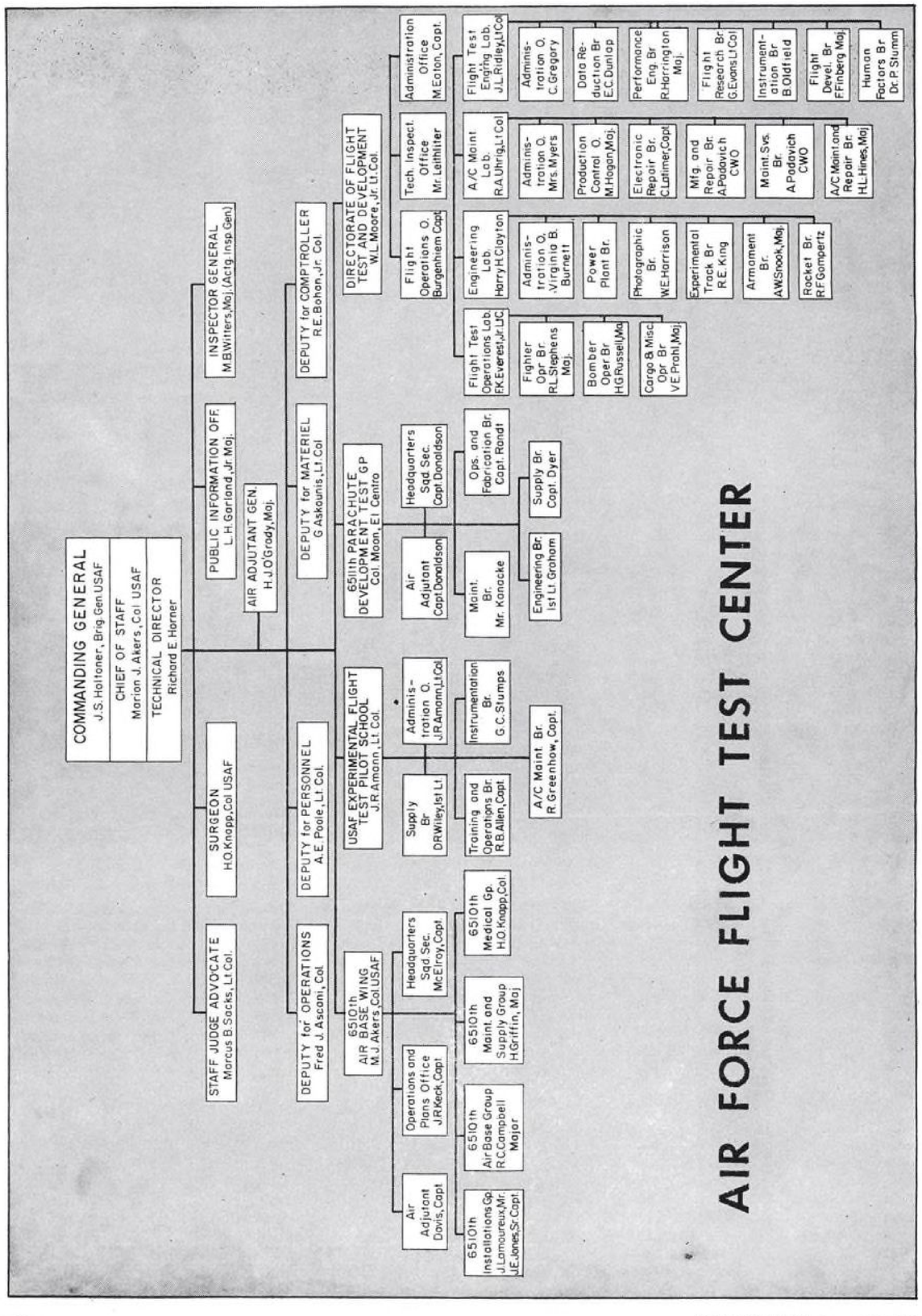
Yet in spite of its desert isolation, Edwards is close enough to Southern California aircraft production centers to bring the men testing new aircraft in close liaison with the designers and technicians who build them. North American Aviation, for example, operates up to 10 flights a day for its specialists traveling between Edwards and the home plant at Los Angeles International Airport.

The location is well summed up by Al Carder, head of Douglas Aircraft's testing unit, when he says: "The good Lord had highspeed aircraft in mind when he put that lakebed out here."

► **Varied Projects**—Edwards AFB, where the complete air weapons package is tested for the first time in its development cycle, is one of the most versatile installations in the Air Force. AFFTC flight tests all USAF aircraft, engines and components as well as Army aircraft. About 90% of its testing is done at the request of Wright Air Development Center.

Edwards also operates a number of special test facilities and the base is shared with other government agencies and almost all major Air Force contractors. Work being done by these contractors often is for the Navy.

Such varied projects may be under-



BOEING B-47 STRATOJET ROARS past Joshua trees on takeoff from Rogers dry lake bed for special ballistics mission.

way simultaneously as flight testing of Navy's XF4D and XA3D, Army's H-25 and L-23, Boeing's B-47E, North American's YF-100, Republic's F-84F, Douglas' X-3, Lockheed's F-94C and Fairchild's C-119.

Commanding officer of the test center, Gen. Holtoner, not only is responsible for flight testing but also for the Experimental Flight Test Pilot School, the base wing organization, and ARDC's parachute test facility at El Centro, half an hour's jet ride to the south. Technical director of the center is Richard E. Horner.

Test Facilities

Special test facilities include:

• **Rocket engine test station,** 20 mi. east of the main base, where static thrust facilities are provided for testing of extremely high-thrust guided missile rocket engines. The test station is operated by ARDC almost entirely for use by contractors.

• **Highspeed track** (10,000 ft. long) where supersonic sleds, pushed along by rockets at better than 1,000 mph., test seat ejection, parachute brakes and such aircraft components as tail sections.

• **Deceleration track** (2,000 ft. long) located on the northwest shore of the lake in "Agony Gulch," where human volunteers and animals are slammed into jolting braking systems to simulate G forces received in aircraft crashes.

• **All-altitude speed course,** consisting of three ILS radio beams set sideways to form perpendicular planes to the line of flight, enabling accurate speed measurements through the course at any altitude.

• **Precision bombing range,** operated by the Aberdeen Bombing Mission (ABM) of U. S. Army to compile bomb trajectory data used in Air Force bombing tables. Study of a new family of bomb shapes currently is underway with the B-36, B-47 and B-45.

• **Photo theodolite grid,** for the study of time and distance relationships during the takeoff and landing of aircraft. This installation photographs aircraft through a grid which makes possible measurement of distance required for landing or takeoff roll, climbs and descents, and acceleration or deceleration.

• **Photo range for night test dropping** of flash bombs and checking the accuracy of new photo-reconnaissance equipment.

• **Radar facility for tracking** and recording flight test data, such as airspeed during either diving maneuvers

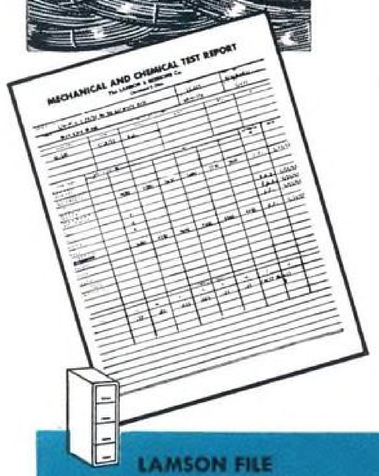
Brig. Gen. J. Stanley Holtoner, commander, Air Force Flight Test Center . . . has flown every type of Air Force fighter from the P-1 to the F-86 . . . more than 60% of his 5,500 flying hours are in fighter aircraft . . . specialist in aerial gunnery tactics . . . commanded 82nd Fighter Group in Italy in World War II . . . awarded Distinguished Flying Cross . . . born in New York City, 1911 . . . graduate of New York University . . . learned to fly at Randolph Field 1933 . . . did early flight testing on Seversky P-35, Curtiss P-36, Lockheed P-38 and Republic P-43 . . . Postwar served as chief of aircraft branch, USAF Hq. directorate of research and development, 1946-50 . . . assistant deputy for development when ARDC was organized in 1951 . . . took command of Flight Test Center in January 1952.

These Controls Guarantee in Fastener Quality and

DOI 74-1, annex 3 • MIL-Q-5923 B • MIL-B-6812 • FF-P-386 • MIL-P-5673 • MIL-S-6033 • MIL-S-7839 •

RAW MATERIAL CONTROL

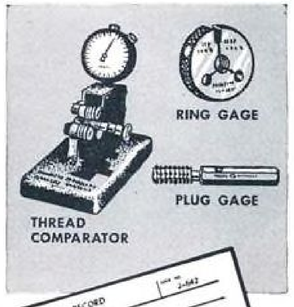
The quality of raw material is guaranteed by rigorous chemical, physical and mechanical tests coupled with mill analysis, heat number and purchase order identification. The raw material is then kept in a separate area.

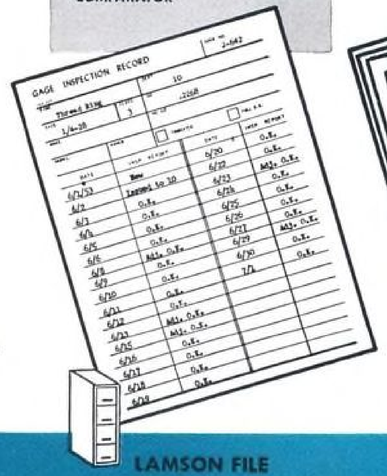


LAMSON FILE

GAGE CONTROL

Systematic gage control by periodic checks with gage masters guarantees quality throughout every phase of production and sampling.

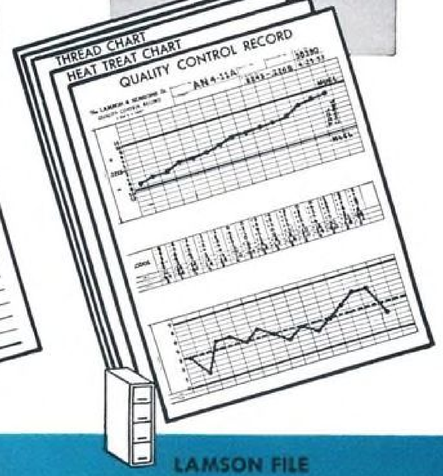




LAMSON FILE

PROCESS CONTROL

In process, quality is checked by Shewhart Control Charts of ($\bar{X}$, R, p, c, l, etc.) These charts guarantee the control of quality and products "in tolerance".



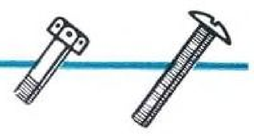
LAMSON FILE

This reservoir of information is invaluable for statistical analyses and management reports.

Studies of these records determine process averages, machine capacities, quality trends, tool and die life,

Order From Your

Lamson & Sessions



the Best Value

FF-S-91 • MIL-N-6034

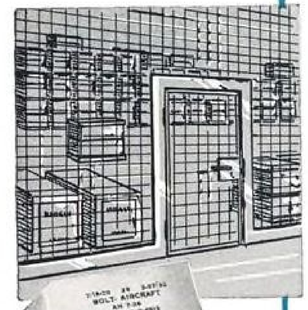
FINAL INSPECTION CONTROL

The quality of finished product is guaranteed by Lamson to specified AQL's (Acceptable Quality Levels) through MIL-STD-105A sampling plans. Source inspection is conducted by a Government resident inspector.

LAMSON FILE

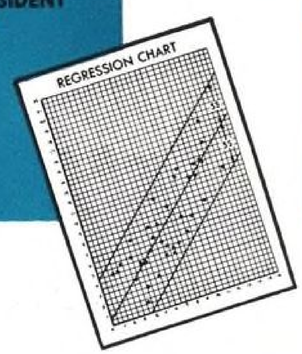
BONDED STOCK CONTROL

The finished aircraft fasteners are stored in a Government approved Bonded Area, assuring you of quality controlled fasteners. Each shipment is identified as "Bonded Stock".

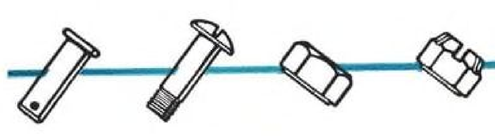


GOVERNMENT RESIDENT INSPECTORS' FILE

heat treat analyses. Special statistical techniques are: Correlation, Analysis of Variance and Significance Tests.



Authorized Lamson Distributor



LAMSON AIRCRAFT FASTENERS

BOLTS

Aircraft, AN3 to AN20
Clevis, AN21 to AN36
Aircraft, Drilled Head, AN73 to AN81, AN73A to AN81A
Aircraft, Close Tolerance, AN173 to AN186
Hex Head, AN101001 to AN101900
Hex Head, Drilled Shank, AN101901 to AN102800
Drilled Hex Head, AN102801 to AN103700
Drilled Hex Head, 6 Holes, AN103701 to AN104600

NUTS

Castellated, Airframe AN310
Plain, Airframe, AN315
Check, AN316
Plain Hex (Fine Thd.), 325
Castle (S. A. E.), 330
Plain Hex (Coarse Thread), AN335
Light Hexagon (Coarse Thread—Fine Thread), AN340—AN345
Engine—Slotted, AN355
Plain Engine, AN360

PINS

Cotter, AN380
Cotter (Corrosion Resisting Steel), AN381
Flat Head, AN392 to AN406

SCREWS—Slotted

Fillister Head (Coarse Thread—Fine Thread), AN500—AN501
Fillister Head (Drilled Head) (Coarse Thd.—Fine Thd.), AN500A—AN501A
Drilled Filister Head Machine (Fine Thd.—Coarse Thd.). AN502—AN503
Machine, Round Head (Coarse Thread—Fine Thread), AN515—AN520
Washer Head, AN525
Machine, Truss Head, AN526
Sheet Metal Round Head, AN530

SCREWS—Phillips Recessed

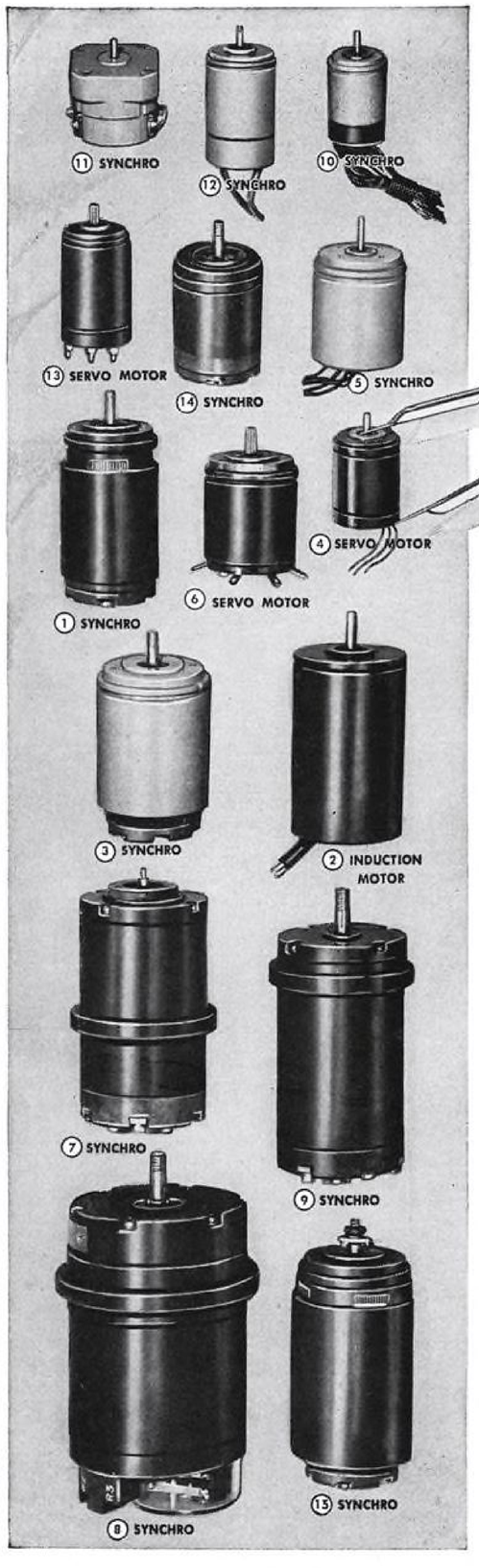
Machine, Flat Head, 82° (Coarse Thd.—Fine Thd.), AN505—AN510
Machine, Round Head (Coarse Thd.—Fine Thd.), AN515—AN520
Machine, Truss Head, AN526
Machine, Flat Head, 100°, AN507
100° Flat Head (Structural), AN509
Brazier Head, NAS220 to NAS224
Sheet Metal Round Head, AN530
Sheet Metal Flat Head, AN531
100° Flat Head, Alloy Steel, CT205 to CT208

Screw Machine Products
Special Purpose Fasteners

The LAMSON & SESSIONS Co.

General Offices: 1971 West 85th Street • Cleveland 2, Ohio

Plants at Cleveland and Kent, Ohio • Chicago • Birmingham



WHATEVER THE SPECIFICATION
...LOOK TO *Ketay*
FOR SYNCHROS & SERVO MOTORS

KETAY, the world's largest producer of government approved synchros, offers high precision rotary and instrument components for most every need. Industry, as well as suppliers to the Armed Forces, will find Ketay ready to solve their problems with a complete line of synchros, servos, magnetic amplifiers, computers and control systems.

If you are searching for a specific size or type... if availability is a problem... if engineering counsel is needed... Ketay can help. Why not join us for an exploratory discussion of your particular problem. Write today to Dept. N

WHATEVER THE NEED CHOOSE KETAY!
Available as listed

1. SYNCHRO, Size 16, O.D. 1.537", 115 V, 400 Cycles *(Transmitter, Receiver, Control Transformer)*
2. INDUCTION MOTOR, O.D. 1.750", 3 phase 2 Pole, 115 V, 60 Cycles
3. SYNCHRO, Size 18, O.D. 1.750", 115 V, 400 and 60 Cycles *(Transmitter, Receiver, Differential, Control Transformer)*
4. SERVO MOTOR, O.D. .937", 26V, 400 Cycles
5. SYNCHRO, O.D. 1.437", 14.4 V and 26 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
6. SERVO MOTOR Mk 7, O.D. 1.437", 115 V, 400 Cycles
7. SYNCHRO, Type 1F or 1HG, O.D. 2.250" 115 V, 60 Cycles *(Receiver, Transmitter)*
8. SYNCHRO, Size 31, O.D. 3.10", 115 V 400 and 60 Cycles *(Transmitter, Receiver, Differential, Control Transformer)*
9. SYNCHRO, Size 23, O.D. 2.250", 26 V and 115 V 400 & 60 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
10. SYNCHRO, O.D. .937", 26 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
11. LINEAR TYPE CONTROL TRANSFORMER, O.D. 1.625", 26 V, 400 Cycles
12. SYNCHRO, Size 11, O.D. 1.062", 26 V and 115 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
13. SERVO MOTOR, O.D. 1.062", 115 V, 400 Cycles
14. SYNCHRO, Size 15, O.D. 1.437", 26 V and 115 V, 400 Cycles *(Transmitter, Receiver, Resolver, Differential, Control Transformer)*
15. SYNCHRO, Size 19, O.D. 1.90", 115 V, 400 Cycles *(Transmitter, Receiver, Control Transmitter)*

Ketay **MANUFACTURING CORP.**
555 Broadway, New York 12, N. Y.

PACIFIC DIVISION
12833 Simms Ave., Hawthorne, California

DESIGN **DEVELOPMENT**
- *KINETIX INSTRUMENT DIVISION*
- *RESEARCH & DEVELOPMENT DIVISION*

MANUFACTURE ...of precision instruments, components, and systems.

BOEING B-29 "stork" plane carries a late model Bell X-1 research aircraft aloft for launching on supersonic flight test.

or level flight. This consists of a radar photo theodolite, an electronic plotting board, and electronic rate of change of altitude recorder and a photo recorder.

In addition, the National Advisory Committee for Aeronautics maintains a highspeed research facility on the base. A new $3-million NACA installation now is under construction.

Test Phases

Air Force flight testing at Edwards breaks down into three phases. Other phases are conducted elsewhere, either by the contractor or USAF.

• **Brief Phase II testing** is the first Air Force test of a new aircraft. After 20-50 hr. of flight testing by the manufacturer, AFFTC runs a short test to check performance guarantees and to determine potential value of the aircraft to the Air Force.

• **Phase IV testing** begins with the first of a series of production aircraft. It checks performance and stability characteristics in detail and relays this performance data to WADC for use by the Flight Data branch in checking the contractor's figures. Information on control forces and deflections is passed along to aeronautical design groups at WADC. Phase IV testing may require up to 150 hr. flight time.

• **Phase VI tests** use three or more of the first production models of a new aircraft. Commands which will use the airplane, such as Tactical Air Command or Strategic Air Command, as well as the Air Proving Ground, are invited to send pilots and maintenance personnel to take part in Phase VI tests, which simulate operational conditions on night, weather, maximum range, gunnery and other missions. Phase VI testing requires about 150 hr. per aircraft.

The AFFTC project engineer prepares a report at the end of the test in which he sets up maintenance requirements, parts consumption and inspection times. Field commands use this report in drawing up operating requirements.

Throughout these tests, information is relayed to the manufacturer for correction of deficiencies. The aircraft then goes to Air Proving Ground for tactical evaluation.

"At the end of Phase VI, we report that here is a machine or weapons system capable of doing a job," explains Lt. Col. Jackie L. Ridley, chief of the flight test engineering lab. "Air Proving Ground Command at Eglin then works out how this machine or weapons system can be used by a tactical unit. We determine its flying characteristics; they determine its combat capabilities."

▶ **The Sophisticated Approach**—Edwards aims at a mature, sophisticated engineering approach to flight testing, according to Gen. Holtoner. "This is no rowdy testing," he says. "It takes real scientific knowledge to do the job." Occasionally, however, even a scientific pilot cannot resist the opportunity to wring out his aircraft in spectacular fashion.

Maj. Chuck Yeager recalls, for instance, an early flight in the X-1 when he buzzed the tower with the rocket engine dead, then kicked in all four rockets to start up into what was to have been an Immelmann.

"The next thing I knew I was upside down at 38,000 ft., the nose fell through and I shot up to .86 Mach. It was somewhat of a surprise."

▶ **Production Models**—Most flying at Edwards, however, is not in research aircraft but in forthcoming production models. The Air Force Flight Test Center, and ARDC in general, concerns itself with the quality of aircraft production—while Air Materiel Command worries about quantity of this production. Under new USAF production concepts, testing at Edwards becomes even more important.

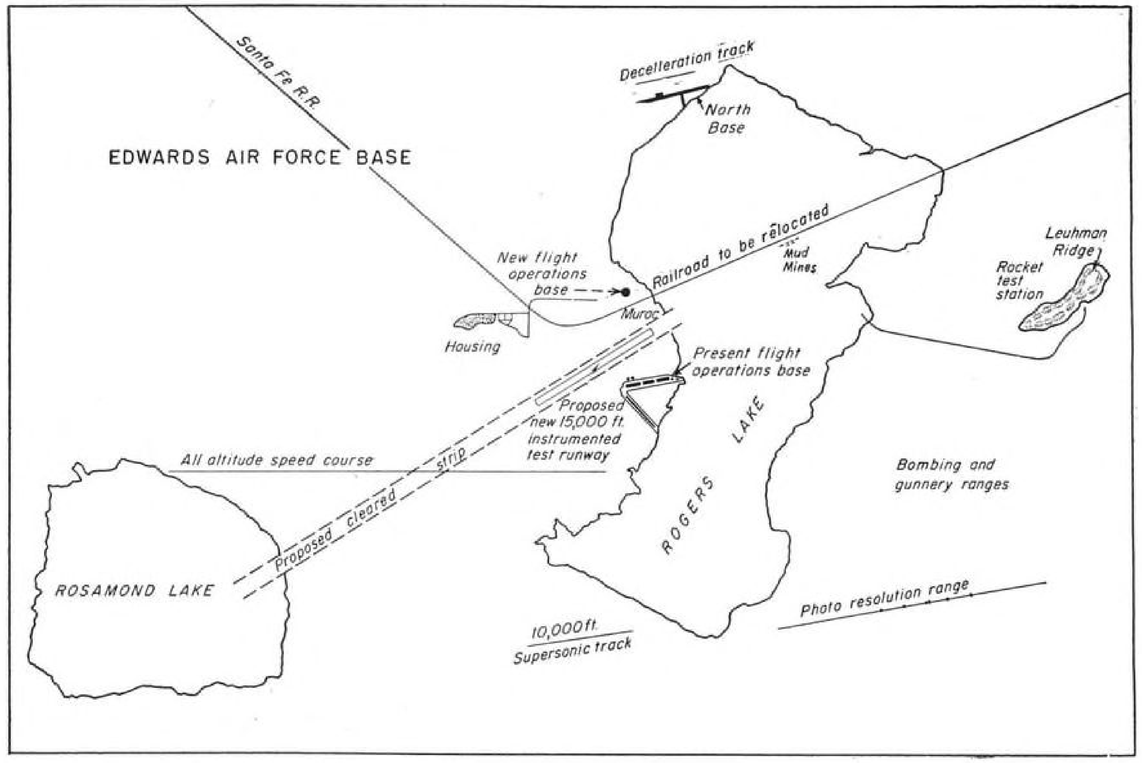
Flight testing leads the center into a small amount of actual research and development work as it devises corrections to overcome aircraft deficiencies. Much of the design development in "flying tails" and "slab tails" came as a result of Edwards flight testing when test pilots discovered that the standard combination of elevator and stabilizer failed to function as transonic speeds were approached. F-94C drag chute development work was done here.

COOK missile after free fall test.

Flight Tests And Development

Heart of AFFTC's flight testing is the Directorate of Flight Tests and De-

■ EDWARDS



velopment, headed by Lt. Col. Walter L. (Mickey) Moore. It consists of four laboratories:

- **Flight test operations.**
- **Flight test engineering.**
- **Engineering.**
- **Maintenance.**

► **Flight Test Operations**—Pilots from the fighter, bomber and cargo sections of flight test operations do the actual flight testing of research, prototype and production aircraft, as well as engines and components.

Twenty-one test pilots, all graduates of the Experimental Flight Test Pilot School, are assigned to this group under Lt. Col. Frank K. Everest. In addition to their duties at Edwards, these pilots work closely with contractors, attending mockup and technical compliance sessions and flying prototypes even before delivery to the Air Force. Their services also are available to other commands.

One Edwards test pilot departed recently for France to evaluate two French jet trainers at the request of Air Training Command.

► **Flying Degrees**—When you needed a test pilot in flying's early days, you looked around for a chap with a devil-may-care attitude, a terrific amount of flying ability and no family. Although a few specimens of the "booze, blondes and biplanes" species still roam the desert wastes of the Mojave, the job is different now.

Many of AFFTC pilots hold engineering degrees and in some cases serve as both project engineer and project pilot for a test program. In addition to testing of new production aircraft and components, the pilots fly research aircraft such as the X-1, X-4 or X-5 in a search for original aerodynamic data. They also fly pacer aircraft on airspeed calibration missions.

► **Saved by the Chaser**—One of their most important jobs is the flying of chase aircraft during experimental flight testing. A number of pilots owe their lives to the presence of these chase planes in time of trouble.

"They're a must for sure," says Bill Bridgeman. When Bridgeman was taking the Douglas D-558-II to record speeds and heights, Maj. Yeager and Col. Everest were assigned as chase pilots.

"There's no doubt that Chuck and Pete saved me from busting up my tail a couple of times," Bridgeman recalls. "I inadvertently spun the Skyrocket once. I got to thinking I knew what I was doing in lowspeed stability and got into a spin. Chuck kept calling my altitude until I worked out of it."

When Bridgeman edges the high-speed X-3 down toward the lakebed for landing, Yeager, flying his wing in an F-86, helps him overcome a difficult problem of visibility by calling off the altitude—"eight feet to go, seven feet, six feet . . . ."—as they descend.

"He's a nice quieting influence," the Douglas test pilot comments. "It's nice to have him along. I miss him when he's not there."

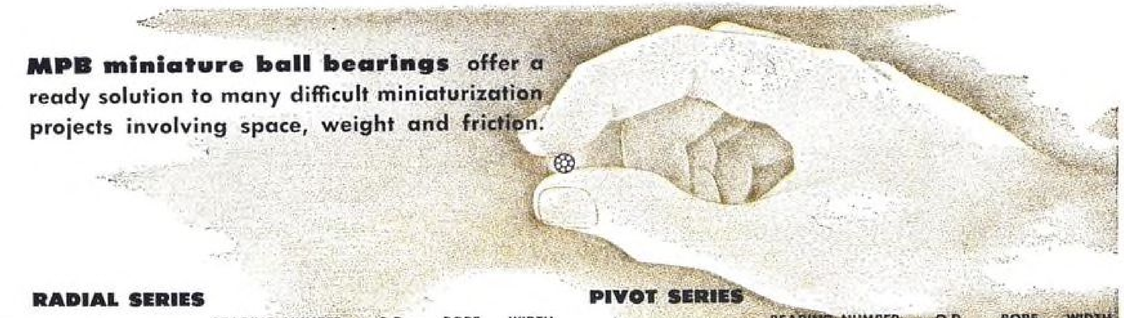
Fellow pilots say Yeager saved the life of an NACA pilot flying the X-4 when he noticed from his chase plane that the pilot was suffering from anoxia. He coaxed him down to altitudes where oxygen was more plentiful.

► **Seeing Eyes**—Everest himself tells of three blind landings in the X-1, with a chase pilot talking him down to the lake each time. The emergencies were caused by heavy frosting of the cockpit canopy at extremely high altitudes. In spite of the desert heat, the occurrence is not uncommon in testing of research aircraft which make rapid descents from altitude to deadstick landings on the lakebed.

During first flights of the YB-52, it was a chase pilot who discovered oil leaks and engine backfires before they became noticeable to the pilot. When a 10,000-lb. dummy bomb tore loose from a B-45 in flight, ripping off bomb bay doors, damaging the bomb bay and smashing the stabilizer, it was the chase pilot who reported to the pilot on damage invisible to crew members in the B-45.

"The chase pilot just about puts his head up my tailpipe to check for fire or other dangers for me," is the appreciative comment of one civilian test pilot.

► **Flight Test Engineering**—For every



MPB miniature ball bearings offer a ready solution to many difficult miniaturization projects involving space, weight and friction.

RADIAL SERIES

BEARING NUMBER	O.D.	BORE	WIDTH
100	.1000″	.0250″	.0312″
2	.1250″	.0400″	.0469″
2½	.15625″	.0469″	.0625″
3	.1875″	.0550″	.0781″
▼4	.2500″	.0781″	.0938″
▼5	.3125″	.09375″	.1094″

PIVOT SERIES

BEARING NUMBER	O.D.	BORE	WIDTH
1½ P	.0590″	.020″†	.0472″
3 P	.1181″	.030″†	.0709″
4 P	.1575″	.040″†	.0945″
▼5 P	.1968″	.050″†	.1181″
▼7½ P	.2953″	.075″†	.1772″
▼10 P	.3937″	.100″†	.2362″

SUPER-LIGHT RADIAL SERIES

BEARING NUMBER	O.D.	BORE	WIDTH
418	.2500″	.1250″	.0938″
▼518	.3125″	.1250″	.1094″
5532	.3125″	.15625″	.1094″
5632	.3125″	.1875″	.1094″
5732	.3125″	.21875″	.1094″
614	.3750″	.2500″	.1250″

GROOVED RADIAL SERIES (Full Race or Retainer Type)

		O.D.	BORE	WIDTH
3 G	3 GC	.2188″	.0550″	.0781″
4 G	4 GC	.2812″	.0781″	.0938″
5 G	5 GC	.3438″	.09375″	.1094″
518 G	518 GC	.3438″	.1250″	.1094″
5532 G	5532 GC	.3438″	.15625″	.1094″
5632 G	5632 GC	.3438″	.1875″	.1094″

FLANGED RADIAL SERIES (Full Race or Retainer Type)

		O.D.	BORE	WIDTH
2½ F	2½ FC	.15625″	.0469″	.0625″
3 F	3 FC	.1875″	.0550″	.0781″
4 F	4 FC	.2500″	.0781″	.0938″
5 F	5 FC	.3125″	.09375″	.1094″
418 F	418 FC	.2500″	.1250″	.0938″
518 F	518 FC	.3125″	.1250″	.1094″
5532 F	5532 FC	.3125″	.15625″	.1094″
5632 F	5632 FC	.3125″	.1875″	.1094″

RADIAL RETAINER SERIES

	O.D.	BORE	WIDTH
2½ C	.15625″	.0469″	.0625″
3 C	.1875″	.0550″	.0781″
4 C	.2500″	.0781″	.0938″
5 C	.3125″	.09375″	.1094″
418 C	.2500″	.1250″	.0938″
518 C	.3125″	.1250″	.1094″
5532 C	.3125″	.15625″	.1094″
5632 C	.3125″	.1875″	.1094″

ANGULAR CONTACT SERIES

	O.D.	BORE	WIDTH
2 A	.1250″	.042†	.0469″
3 A	.1875″	.062†	.0700″
▼4 A	.2500″	.085†	.0938″
▼6 A	.3750″	.124†	.1406″
6 A7B	.3750″	.150†	.1406″

THRUST SERIES

	O.D.	BORE	WIDTH
2 T	.1250″‡	.0400″§	.0625″
4 T	.2500″‡	.0938″§	.0938″
5 T	.3125″‡	.1250″§	.1250″
6 T	.3750″‡	.1875″§	.1500″
7 T	.4375″‡	.1250″§	.1875″

SPRING SEPARATOR SERIES

	O.D.	BORE	WIDTH
5 S	.3125″	.09375″	.1094″
518 S	.3125″	.1250″	.1094″
5532 S	.3125″	.15625″	.1094″
5632 S	.3125″	.1875″	.1094″

SEPARABLE SERIES

	O.D.	BORE	WIDTH
3 M	.1875″	.0550″	.0781″
4 M	.2500″	.0781″	.0938″
5 M	.3125″	.09375″	.1094″
518 M	.3125″	.1250″	.1094″

Prefixes indicate material: Standard is chrome bearing steel (SAE 52100): use no prefix. All bearings also available in 440 stainless, except #100 and #1½P. Use prefix "SS" in ordering stainless. ▼Indicates also available in 25 beryllium. Order with prefix "NM". Suffixes indicate type of bearing: F—flange, G—groove, M—separable, C—radial retainer, S—spring separator, T—thrust, P—pivot, A—angular contact, FC—flanged with retainer, GC—grooved with retainer. Complete load ratings are given in catalog. †Shaft (S) min.; ‡ O.D. clearance of opposite race .002″; §Bore clearance of opposite race .002″.

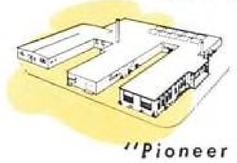
MPB ball bearings

are available in ten design series and in more than 140 different types and sizes which normally can be supplied from stock for prompt installation.

Instrument manufacturers and users of small precision mechanisms can now utilize all the well known extra advantages of anti-friction bearings (accurate alignment, long wear, freedom from attention) universally accepted in larger quality equipment.

For more than 20 years **MPB** ball bearings have contributed to the successful operation of precision mechanisms. A pioneer in designs and dimensions now being internationally standardized, **MPB** has also originated many precision manufacturing techniques. All **MPB** ball bearings are ground, lapped, honed and/or burnished in accordance with highest quality practice for optimum operating characteristics. Inspection limit tolerances are equal to ABEC 5 or better.

The most extensive engineering knowledge in miniature bearing applications is available to you. More than a million **MPB** ball bearings have been installed in precision mechanisms. Catalog 53 giving complete specifications, and additional data sheets mailed to you on request.



Miniature *Precision* Bearings

Incorporated MPB Keene, New Hampshire

"Pioneer Precisionists to the World's Foremost Instrument Manufacturers"

save space weight friction

Southwest Airmotive reports:

75% INCREASE

IN BUSINESS FORMS TYPING WITH REMINGTON *Electric* TYPEWRITERS

This startling figure came right out of an efficiency report made by J. J. Nelson, Purchasing Agent at SAC. In his own words: *"With the new Remington, we can turn out 75% more purchase orders. There are 50% more inserts and 40% more information put on each purchase order. We have clearer copies with less chance for error . . ."* This vividly illustrates how Remington Electrics are handling the flood of paperwork which swamped SAC when sales jumped from half a million dollars to six million dollars.

Increased typing production followed immediately after Remington Electrics were installed because typing is so much easier. *Electricity does the work* . . . controls the keyboard, shifts and carriage return. Typists turn out more and better work immediately.

More inserts can be used because the Remington Electric's power printing and exclusive Impression Control can provide 15 and more clear, legible carbon copies at one typing . . . sufficient copies for all departments.

United Airlines, Pioneer Airlines and Glenn L. Martin are just a few of the many other organizations which have discovered the economies of electric typing. Learn how you can obtain the same benefits. Write for free demonstration or fact-filled 16-page book, "Dividends of Electric Typing" (RE8612). Address requests to Remington Rand, Room 1024, 315 Fourth Avenue, New York 10.

Remington Rand INC.

PROFIT-BUILDING ***IDEAS*** FOR BUSINESS

Flight Test Center Insignia

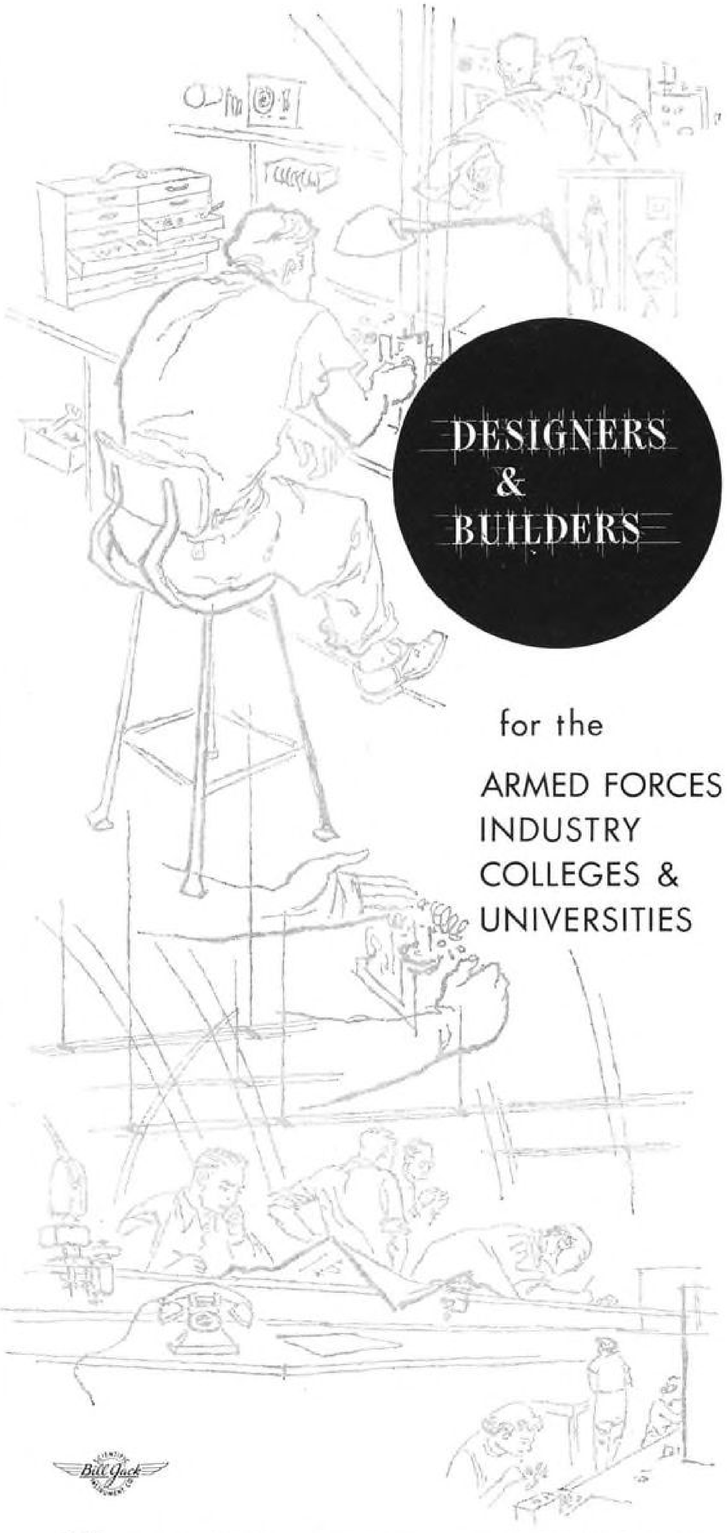
hour of flight testing at Edwards, the flight test engineering lab puts in roughly 30 hr. on the ground on the same project, determining the air maneuvers which the pilot will follow.

Most of the aeronautical engineers at AFFTC are assigned to this section under Lt. Col. Ridley. Majority are civilians but here again are found Air Force engineer-pilots who have combined their technical knowledge with an aeronautical rating.

When WADC sends out a program, it is the flight test engineers who translate the program of required data into a series of flight test maneuvers. They decide how the information must be obtained, what instrumentation is required to obtain it. They make up the test cards which the pilots follow aloft. Together with the pilot, they write the report, using IBM machines to reduce much of the data.

Flight test engineering lab is made up of six groups:

- **Flight research branch,** which decides upon flight techniques for conventional aircraft and determines criteria for testing new types of aircraft and components, such as helicopters or turboprop engines. Long before a prototype appears at Edwards the flight research branch is drawing up a test program for it.
- **Instrumentation branch,** which develops, installs and maintains the elaborate instrumentation required for flight testing. Test instruments from Edwards often are installed in the first production aircraft as it moves down the contractor's assembly line, thus saving both time and money.
- **Performance test branch,** which prepares Phase II and Phase IV flight plans —tests related to performance and flight characteristics.
- **Flight development test branch,** which prepares Phase VI flight plans—tests related to functional development.
- **Human factors branch,** which tests



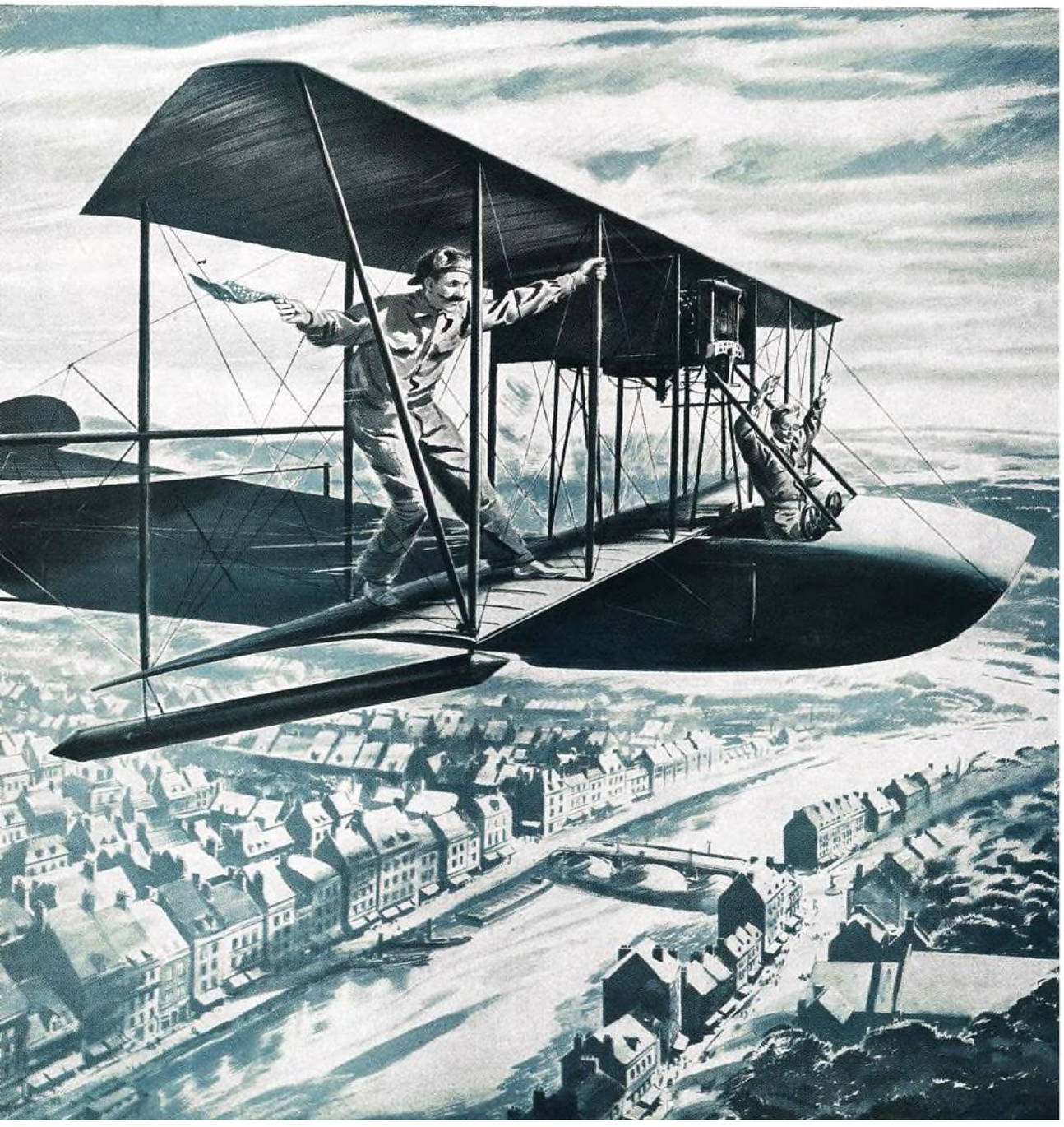
for the

ARMED FORCES
INDUSTRY
COLLEGES &
UNIVERSITIES

The **BILL JACK SCIENTIFIC INSTRUMENT CO.**
SOLANA BEACH, CALIFORNIA · TELEPHONE DEL MAR 600

1912 Lawrence Sperry, at 19, flew automatically with the first Sperry Stabilizer at Hammondsport, New York. Later, in a Curtiss flying boat, he competed in 1914 with 80 entrants for an award offered by the French for the first "stable airplane." Sperry won—in a dramatic demonstration in which the little plane flew by itself while Sperry held his hands above his head and his mechanic walked on the wing.

AUTOMATIC FLIGHT... another Sperry first... 1912



From the day in June, 1914, when Lawrence Sperry won the French War Department's 50,000 franc prize for the first "stable airplane," Sperry has taken the lead in making flying more and more automatic . . . as flying itself has required more and more precision. From the first simple stabilizers have come development after development, such as the Sperry Automatic Pilot and Automatic Approach Control to guide planes to better landings under all weather conditions.

TODAY, AS ALWAYS, SPERRY LEADS THE WAY

In production today at Sperry are instruments that give man even greater mastery of the elements. And the military demand is so great that hundreds of subcontractors are now sharing with Sperry the task of meeting these requirements.

1933 Wiley Post in the Winnie Mae made first solo, round-the-world flight. Using the Sperry Automatic Pilot, Post startled the world by stating that during flight he was able to take naps while the plane, under automatic control, flew itself. Post explained that a wrench tied to his fingers slipped from his hand to awaken him if he fell sound asleep, so he could check his course and make course changes if necessary.

1946 United Air Lines installed Sperry A-12 Gyropilot on four-engine fleet to insure precise automatic instrument approaches to airport runway. UAL President, W. A. Patterson, considered installation . . . "a definite start in eliminating weather as an obstacle to airline operations."

1953 USAF's Boeing B-47B is equipped with Sperry Gyropilot, combining the latest in gyroscopic, servo, and signal system techniques. This automatic flight control system meets strategic requirements for high-altitude, long-range missions and automatic precision bombing runs.

19?? Automatic flight of tomorrow? Sperry laboratories are now busy solving automatic control problems for jets and missiles of the future. When they fly, precision automatic devices being developed by Sperry today will control them.

SPERRY GYROSCOPE COMPANY
DIVISION OF THE SPERRY CORPORATION
GREAT NECK, NEW YORK

PROGRESS 50TH ANNIVERSARY OF POWERED FLIGHT SECURITY

One of a Series of Advertisements Commemorating the 50th Anniversary of Powered Flight.

ACTION PACKED!

Chase Assault Transports are now performing, as routine; functions which previously were deemed impossibilities—the delivery—ready for action, of heavy arms and equipment directly to front line areas, ***by landing*** in small unprepared fields.

Recent demonstrations of this new technique have proven beyond doubt that its potentialities for revolutionizing present military concepts are unlimited.

Chase Assault Transports ruggedly built to absorb the withering punishment of front line missions, stand alone.

Chase AIRCRAFT CO., Inc.
WEST TRENTON, NEW JERSEY
STROUKOFF AVITRUC

Col. Marion Akers, Chief of Staff

personal equipment and studies aeromedical problems during Phase II and Phase IV flight tests, a program aimed at evaluating the place of the pilot in each air weapons system.

• **Data reduction branch,** which transcribes and computes data for the entire flight test engineering laboratory.

▶ **Engineering Lab**—Testing not done in the air is the concern of another of the labs of the flight test directorate, the engineering lab. Major group in the engineering lab is the powerplant branch, which runs static tests of both rocket and jet engines.

Charged with the development and testing of these engines, the power plant branch also supplies engineering assistance for experimental flight testing. It recommends overhaul and inspection periods for the engines of USAF aircraft.

Described by Col. Moore as "almost a maintenance facility itself," this versatile system designs much of its own test equipment and is authorized to do major overhaul on all types of aircraft engines.

Other engineering lab branches include the photo branch, which tests new cameras, lenses and film, and the armament branch, which runs tests on bomb systems, gunsights and armament of new aircraft.

Currently the armament branch is helping evaluate the Hughes Aircraft E-4, E-5 and E-6 fire control systems in a study known as Project 456. The engineering lab also is responsible for the track branch, which controls the high-speed and deceleration tracks, and the rocket branch, which operates the rocket engine test facility.

▶ **Maintenance Lab**—Last of the directorate's four labs is the maintenance lab, which faces the problem of maintaining what is probably the most

Lt. Col. Walter Moore
Director of Flight Test & Development

varied assortment of aircraft, powerplants and avionics equipment on any Air Force base—some 33 different types of aircraft, ranging from one-of-a-kind research craft down through small Army liaison planes.

F-84F Project

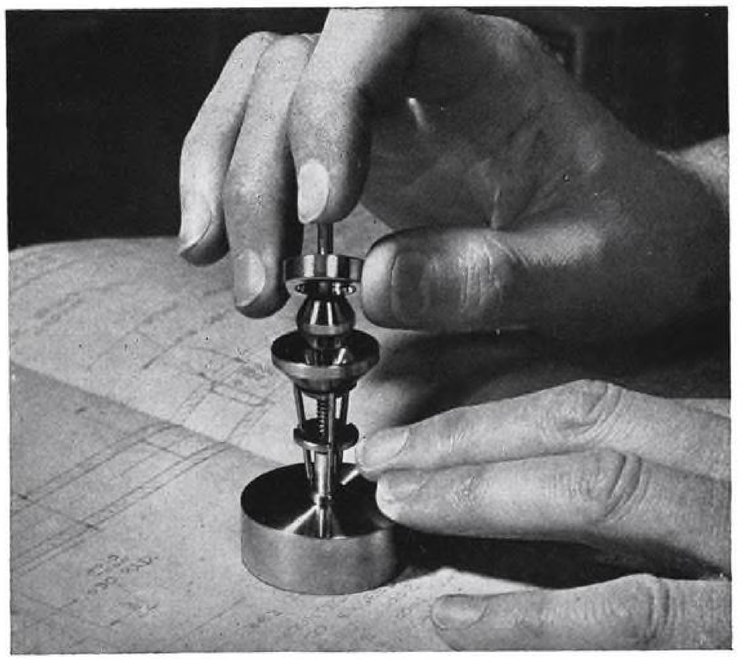
The F-84F testing serves as a good example of an actual flight test program, although more urgent than usual due to the necessity of testing both a new aircraft and a new engine under the strain of foreign commitments which give the project a 1-A priority. F-84F is slated for MDAP in Europe and Far East Air Forces in Tokyo.

▶ **Thunderstreak History**—Security covers much of the exact data revealed by the program but testing of the new Republic Thunderstreak fighter can be outlined in general terms.

When flight test engineering learned the date of delivery of F-84F production models to the Air Force for Phase VI testing, a comprehensive test program already had been outlined, listing the specific number of hours intended for gunnery, formation flying, night flying, inflight refueling and other missions. Capt. Orville Scroggins was project engineer and Maj. Ray Popson, project pilot.

Flight test operations and other facilities were alerted and scheduled the project into their workload. The necessity of close scheduling becomes clear when one realizes that the 23 project engineers in the flight test engineering lab have a backlog of more than 80 projects.

Ordinarily six aircraft are sufficient for the Phase VI tests, but, as several major problems developed, it was apparent additional aircraft would be necessary, says Col. Ridley.



SKILLED HANDS

Yours for the Asking . . . These are special hands . . . skilled hands . . . hands trained to translate creative engineering and design into production reality. These hands produce compact, high precision gyros, synchros, and servo motors providing the sensory information, the computing brain and the muscle for the automatic controls of modern industry and aviation.

These helping hands are ready, willing and able to assist by the development and manufacture of the advanced precision components you require for today's problems and tomorrow's progress.

Let us Help. Inquiries for information on standard or special units, for a particular application are cordially invited. Technical Bulletins are available and will be sent upon request.

KEARFOTT COMPONENTS INCLUDE:
Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

Kearfott
SINCE 1917
CREATIVE ENGINEERING
PRODUCTION ACHIEVEMENT

KEARFOTT COMPANY, INC., 1150 McBride Ave., Little Falls, N. J.
West Coast Office: 253 N. Vinedo Ave., Pasadena, Calif.
A General Precision Equipment Corporation Subsidiary

5

IF FLAMES COULD BE 'FROZEN'

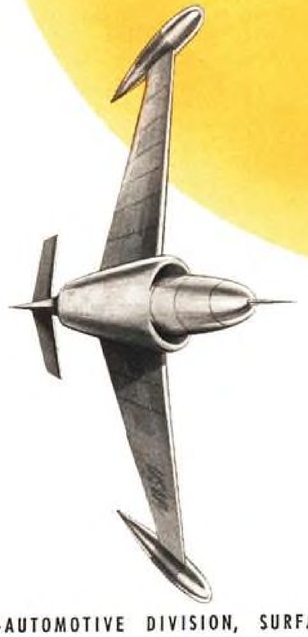
If a flame pattern could be "frozen" at simple ambient conditions, and then methodically reproduced to perform under all flight conditions—life in the combustion engineering business would be a lot simpler. The fact is, of course, that theory gives out long before the perfect picture has been drawn.

And so . . . to achieve higher-than-ever combustion efficiency . . . to locate electrodes in just the right place for positive ignition . . . to develop new tricks (like sweat cooling) for elimination of hot spots . . . to produce controlled turbulence . . . to cut down resonance . . . in short, to get flame to conform to plan is a basic objective we reach through use of the large fund of flame facts we've built over the years. If you face any of these combustion problems, your Janitrol representative can quickly show how our facilities may fit into your program.

Speaking of freezing, an article on a mysterious case of ice formation on fuel nozzles in combustion heaters—and how our engineers tracked down the cause — appears in the Janitrol Heating Digest, Vol. III, No. 3. Another Janitrol publication, "Heat in Harness," gives a broad view of how several Surface Combustion Corp. Divisions work together in the advancement of combustion engineering.
Copies of either, or both, are available on request, on your letterhead, please.

Janitrol®

36 years experience in combustion engineering



National Sales, Engineering, Production Headquarters,
400 Dublin Avenue, Columbus 16, Ohio
District Engineering Offices:
New York, 225 Broadway
Washington, D. C., 4650 East-West Highway
Kansas City, 2201 Grand Avenue
Ft. Worth, 2509 West Berry Street
Hollywood, California, 7046 Hollywood Boulevard
Columbus, Ohio, 400 Dublin Avenue
Executive Offices:
2375 Dorr Street, Toledo 1, Ohio

AIRCRAFT-AUTOMOTIVE DIVISION, SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

ERCO SUPPORTS...

DESIGN and DEVELOPMENT

with...

PRODUCTION

Since 1931 ERCO has grown steadily in the design, development and production of mechanical, electro-mechanical and electronic equipment—including production tools and component parts for aircraft.

- ELECTRONIC DEVICES
- ARMAMENT
- MACHINERY

Just a few of the items we have designed and are currently producing: ERCO Automatic Punching and Riveting Machines; Shrinking and Stretching Machines for Sheet metal work; Gun Turrets, Combination Rocket Launchers and Bomb Racks; all-electronic pilot training units that simulate instrument flight conditions in various airplanes, including the Air Force's famed F-86D Sabre Jet.

ERCO offers both Government and private industry the services of a highly versatile 500-man Engineering Department . . . plus complete manufacturing facilities occupying 200,000 square feet of floor space under one roof.

MAINTENANCE

A special group of engineers and technicians is provided for servicing and maintenance of ERCO equipment and installations in the field.

ERCO

ENGINEERING AND RESEARCH CORPORATION
RIVERDALE, MARYLAND

Lt. Col. Frank K. (Pete) Everest
Director of Flight Test

The flight test center requested an additional six.

The project engineer estimated the number of hours needed on each aircraft but this figure was kept flexible as "bugs" developed. Usual average is about 150 hr. per aircraft.

▶ **Speed-up**—When trouble developed, a hurried decision was made to place the F-84F project on a "7-day week, around-the-clock" basis. Outside personnel were called in to assist with flight and maintenance duties.

Normally, during Phase VI testing, such organizations as TAC, SAC, ATRC and ADC are invited to send pilots and maintenance personnel to participate, thus building a nucleus of experienced personnel in each command familiar with the new aircraft.

▶ **Stretching the Shoestring**—"In this case, however," says Col. Ridley, "we had to ask for definite numbers. We're operating on a shoestring, anyway, and when we go over the usual number of aircraft for a program, it's impossible to operate without outside help."

Any outside pilots who were flying in the test program the weekend four F-84Fs made emergency landings on the lakebed will carry back to their home commands a glowing report of the value of Rogers Dry Lake to the flight test center.

Unable to stockpile engines because Wright was just getting into production with the J65, the flight test center called in Slick and Flying Tigers to supplement its own cargo aircraft in flying spare engines from the East.

Although security cloaks exact details, the shattered parts of an exploded engine crated for shipment back to Wright told their own tale of trouble. Inspections were set at 15 hr., then mounted to 25 hr. as fixes began.

▶ **F-84F Fixes**—Meanwhile, test pilots

LEWIS AIRCRAFT ELECTRICAL CABLE

HIGH TEMPERATURE, MOISTURE AND FIRE RESISTANT!

Combining the . . .

- HIGH TEMPERATURE RESISTANCE OF NICKEL CLAD COPPER CONDUCTORS,
- ABRASION AND FIRE RESISTANCE OF ASBESTOS,
- INSULATION VALUE AND HIGH TEMPERATURE RESISTANCE OF GLASS FIBERS,
- HIGH TEMPERATURE RESISTANCE AND BONDING PROPERTIES OF SILICONE,
- DIELECTRIC STRENGTH AND SOLVENT RESISTANCE OF TEFLON*

. . . to give the aircraft industry an electrical cable that will withstand continued ambient temperatures over 600 F and still maintain . . .

in all sizes
From No. 20 AWG *To* No. 4/0 AWG

SUPERIOR . . . WET DIELECTRIC STRENGTH
SUPERIOR . . . ABRASION RESISTANCE
SUPERIOR . . . RESISTANCE TO SOLVENTS, OIL, FUEL, HYDRAULIC FLUID, SALT WATER
ABILITY . . . TO MAINTAIN CIRCUIT INTEGRITY IN AN EMERGENCY OF FIRE FOR SUFFICIENT LENGTH OF TIME TO COMPLETE CORRECTIVE PROCEDURES.

WRITE for complete data on High Temperature Cable to Air Force Specification 32659

THERMOCOUPLE WIRE to the latest Military Specifications

MIL-W-5846 A CHROMEL-ALUMEL
MIL-W-5845 A IRON-CONSTANTAN
MIL-W-5908 A COPPER-CONSTANTAN

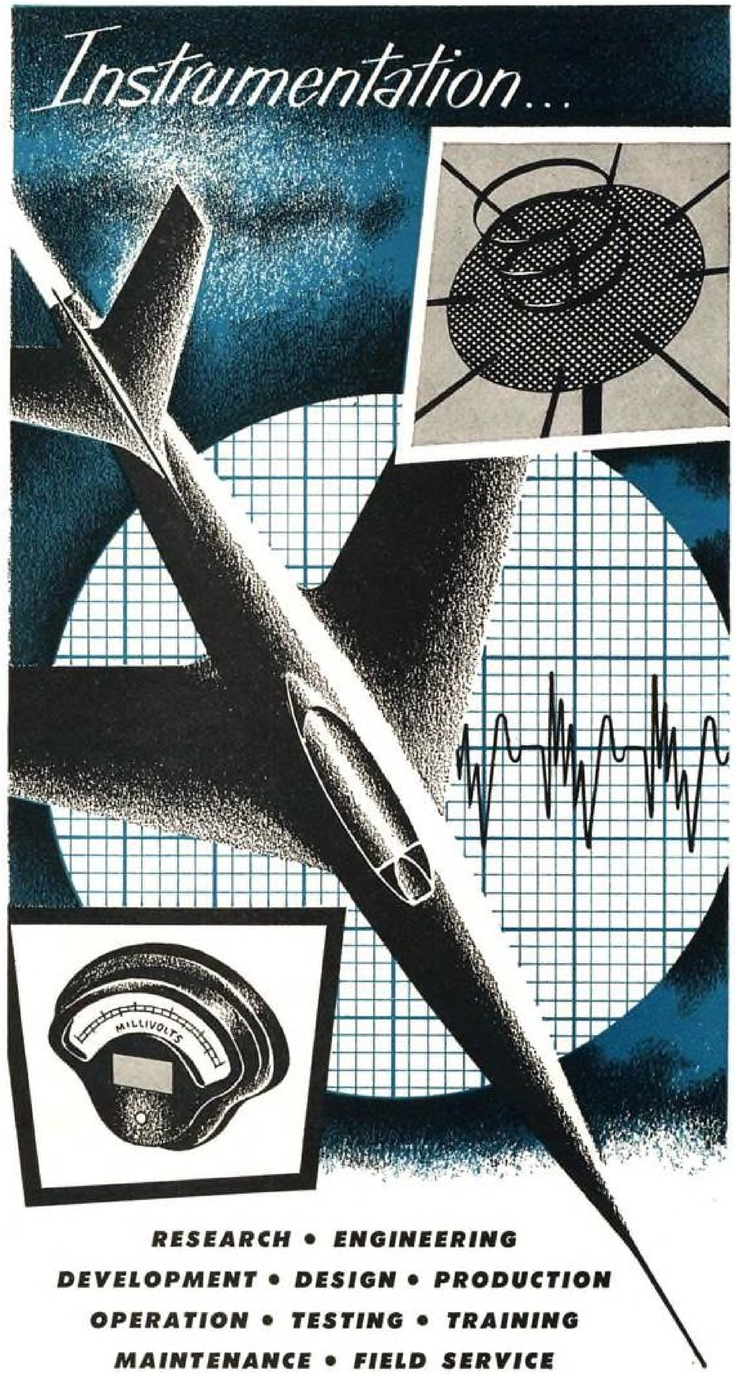
MANUFACTURED WITH THE SAME HIGH QUALITY MATERIALS AS OUR HIGH TEMPERATURE CABLE

Available in all classes and types, specify LEWIS thermocouple wire for dependable thermocouple, thermometer installations

*Du Pont trade-mark.

THE LEWIS ENGINEERING CO.

NAUGATUCK, CONNECTICUT



RESEARCH • ENGINEERING
DEVELOPMENT • DESIGN • PRODUCTION
OPERATION • TESTING • TRAINING
MAINTENANCE • FIELD SERVICE

LAND-AIR, INC.

GENERAL OFFICES • 440 WEST SUPERIOR ST., CHICAGO 10, ILL.

■ EDWARDS

were uncovering problems in the aircraft itself. These, listed by Col. Ridley, can be revealed:

• **Cracks in the duct** proved a need for reinforcing. This was relayed to Republic for a fix.

• **Landing gear redesign** was required. Kits now are out for this.

• **Heating and cooling system** changes were needed.

• **Landing gear handle** required redesigning because the detent was not large enough and pilots were pushing the handle past the down position to "emergency down."

The system of Unsatisfactory Reports (URs) was bypassed on fixes because of the time element. Daily, weekly and monthly progress reports were submitted and followed later by URs. Progress reports were supplemented by almost daily telephone conversations. Thus, Phase VI testing moved ahead on a new USAF fighter.

Edwards' Tenants

The high-pitched whine of the Sapphires dominated the Edwards flight line during the F-84F test program. But the sounds of a wide assortment of other aircraft were reminders of the many "tenants" with whom the Air Force shares its desert test base.

▶ **NACA's Stable**—One of these is the National Advisory Committee for Aeronautics, which houses its strange stable of white research craft at Edwards and is building a multi-million-dollar facility linked to Edwards' master plan.

Building aerodynamic knowledge with their highspeed research aircraft as tools is the task of NACA's 220 employes, under the direction of Walter C. Williams. Projects include the following:

• **XF-92A**, which is producing a background of delta-wing knowledge for such aircraft as the Convair F-102.

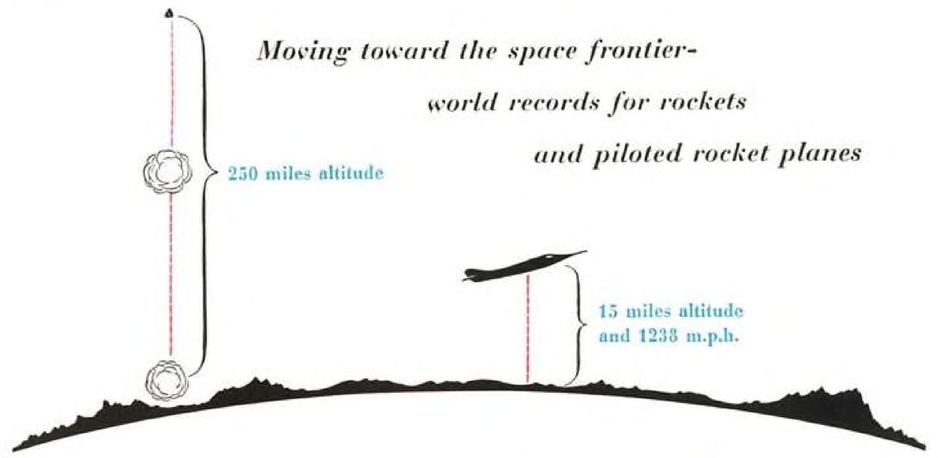
• **D-558-II**, an improved aircraft since Bridgeman returned to report wild highspeed oscillations. The Skyrocket is flying a full schedule to study these oscillations further. Although no modification of the D-558-II was designed specifically to make it go faster, those familiar with the aircraft say it now is capable of breaking its own speed record of 1,238 mph.

• **X-5**, Bell's adjustable-wing aircraft for testing variable sweep, is being used to study problems of extreme sweep in the area where drag diminishes but stability and control problems increase. NACA research is seeking the area where combination of minimum drag with maximum control exists.

• **B-47** research flights are studying aerolasticity problems.

• **X-1**, currently off flight status, is be-

No. 20 in a series:

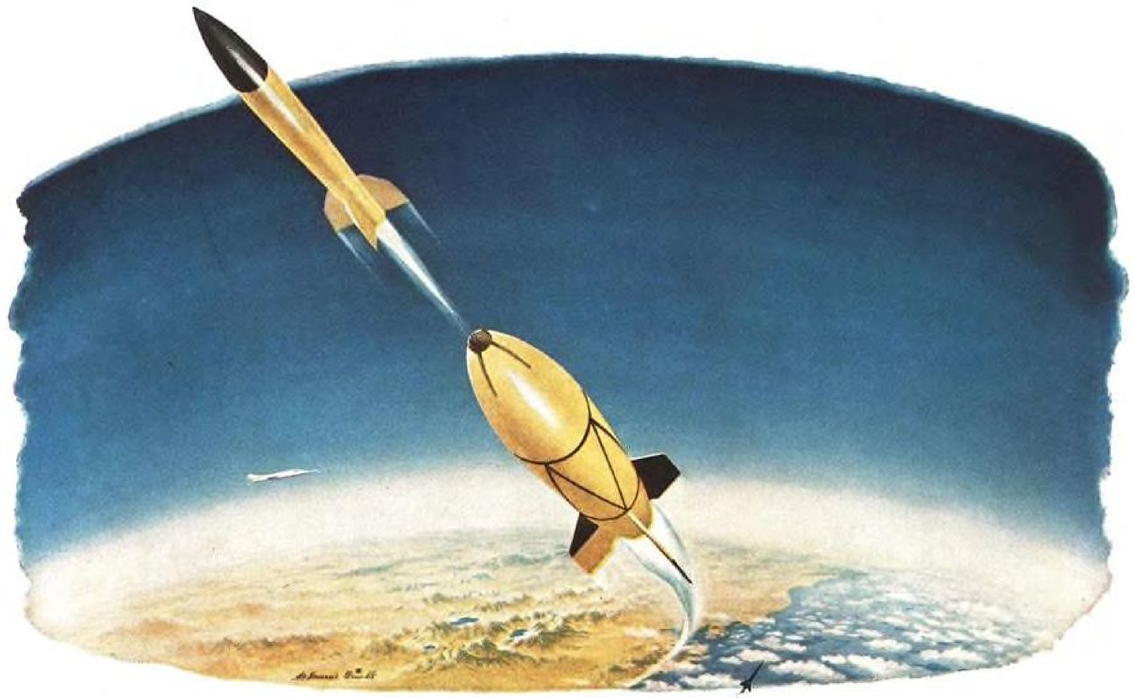


—the Douglas Skyrocket and Wac-Corporal

How soon will man cross the Space Frontier? Already, Douglas-built planes, rockets, and missiles—including the Wac-Corporal and D-558-2 Skyrocket—have probed at its fringes.

In a record climb, the Douglas D-558-2 reached an altitude where its pilot was *weightless*, as in a flight through space, while the Wac rocket, set in the nose of the V-2, travelled one-quarter of the way to the proposed orbit of a man-made satellite. Most important, both records came during *normal research*—planned to keep the United States and its Armed Forces out front in the fields of guided missiles and supersonic aircraft.

Performance of Skyrocket and Wac-Corporal is proof of Douglas leadership in all phases of flight. *Farther and faster with a bigger payload* is the basic rule of Douglas design.



Army's Wac shown leaving V-2

Depend on DOUGLAS First in Aviation

Giving Panthers the right atmosphere

Jet engines on Grumman's "Panthers" can breathe just fine at 40,000 feet. But Panther pilots can't. That's why they carry their own atmosphere with them for high altitude flight—in pressure-sealed cabin and cockpit enclosures.

As you might well imagine, it's no easy job to form and hold an air-tight seal on all the cracks and crevices of a pilot's compartment. Just finding a sealer that would remain flexible and adhesive at 60° below zero was no easy job in itself.

However, 3M helped Grumman solve this problem with EC-750—a water- and oil-resistant sealer with all the needed qualities to give Panthers the right atmosphere!

See what adhesives can do for you . . .

Owing to its remarkable properties, there's a good possibility that EC-750 can "fill the gap" on your sealing jobs. For more specific information, call in your 3M sales engineer. Or, if you would like to have a FREE copy of our Aircraft Booklet, write to 3M, Dept. 118, 411 Piquette Ave., Detroit 2, Michigan.

3M COMPANY

ADHESIVES•COATINGS•SEALERS
for the Aviation Industry

MINNESOTA MINING AND MANUFACTURING COMPANY
ADHESIVES AND COATINGS DIVISION • 411 Piquette Ave., Detroit 2, Michigan
GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 122 E. 42 ST., N.Y. 17, N.Y. • CANADA: LONDON, ONT.

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS

■ EDWARDS

ing reworked to a low-pressure fuel system.

Research programs employing the D-558-I and the tailless X-4 have been completed. Two new research aircraft, the X-2 and X-3, have not yet been delivered to the research center. NACA personnel have been assisting in Douglas flight testing of the X-3, however, and the aircraft will be turned over to NACA in December, according to Douglas sources.

▶ **Cramped Quarters**—The 18 contractors at Edwards (total personnel: 1,309) are jammed into crowded facilities that make their desert working conditions difficult. Several have taken over facilities at North Base, the original Muroc test site some 7 mi. from the main base.

In spite of Air Force and industry efforts to extend the life of World War II temporary buildings and hangars at North Base, it is more reminiscent of a forward fighter strip in Korea than a stateside installation. The 6,500-ft. runway is set counter to prevailing winds and the only taxiway joins it at the center.

▶ **Contractors' Operations**—A look at North American, Northrop and Douglas operations gives some idea of the place of the contractor at Edwards.

• **North American Aviation** uses North Base as the center of its flight test operations but also runs tests from the main base and from its home plant at Los Angeles International Airport. Northrop, on the other hand, does all its experimental flight testing at Edwards.

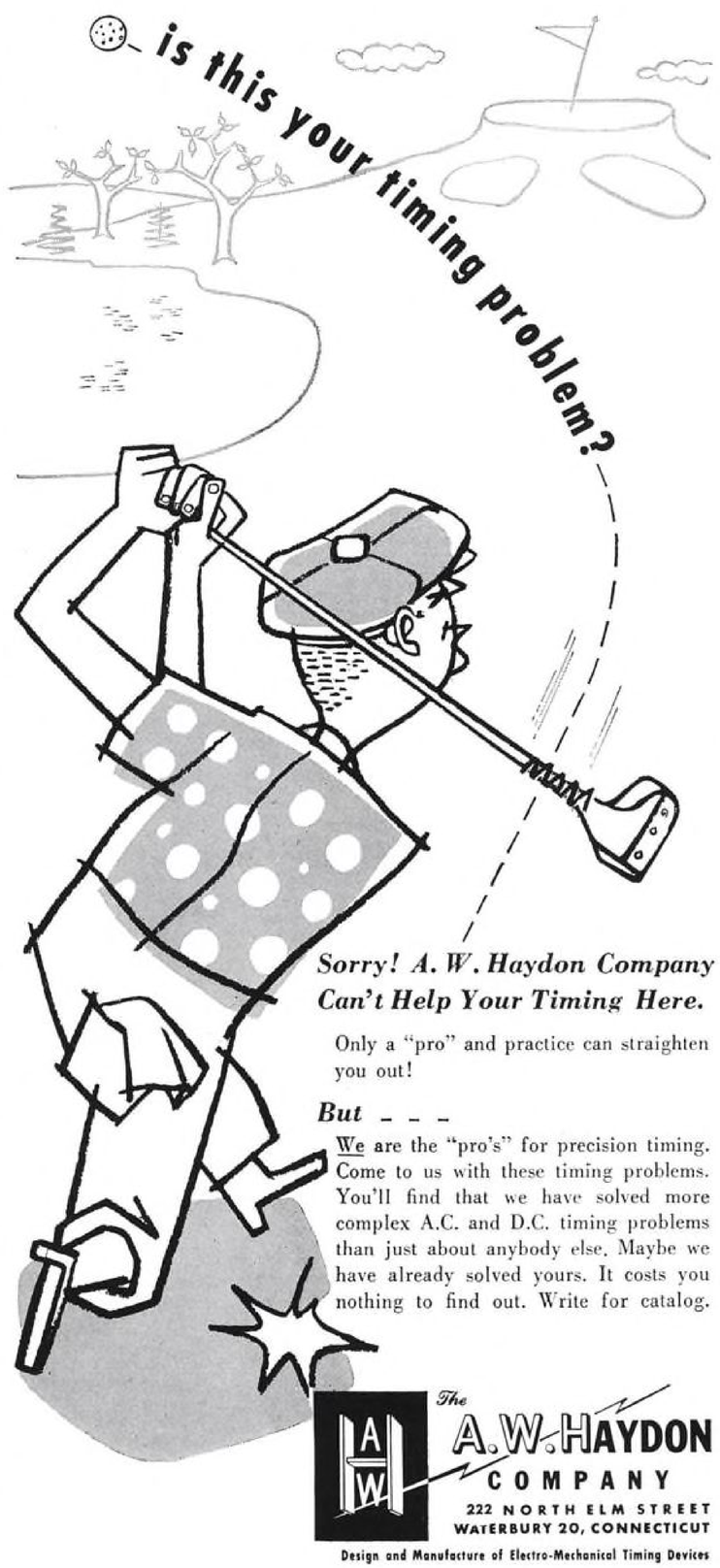
According to J. F. O'Brien, engineer in charge, NAA's 250 technicians currently are engaged in such projects at Edwards as supersonic testing of the F-100 prototype, evaluation of the F-86D fire control system, external stores testing of the F-86F fighter-bomber configuration and contract testing of the new F-86H. Other NAA projects at Edwards are classified.

• **Northrop's** 188 employes, operating out of North Base under the direction of R. W. Rolfe, are at work on such projects as flight testing the modified F-89D and components of the F-89C.

• **Douglas Aircraft** joined the group of contractors at Edwards six years ago as the result of a Navy project—the D-558-I. When Douglas and the Navy asked permission to use the lake for a testing of the Skystreak, the Air Force assigned the company to a then-empty hangar at North Base.

Since only tankage available for liquid oxygen was on the main base, it became necessary for Douglas to move to a hangar there when testing of the rocket propelled D-558-II began.

"It was a bare hangar, no water, no



Sorry! A. W. Haydon Company Can't Help Your Timing Here.

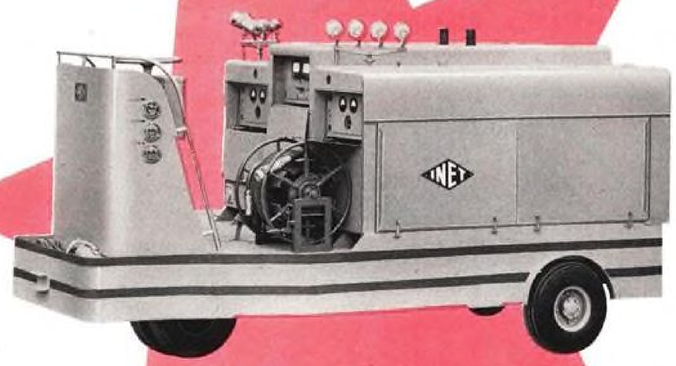
Only a "pro" and practice can straighten you out!

***But* – – –**

We are the "pro's" for precision timing. Come to us with these timing problems. You'll find that we have solved more complex A.C. and D.C. timing problems than just about anybody else. Maybe we have already solved yours. It costs you nothing to find out. Write for catalog.

The A.W. HAYDON COMPANY
222 NORTH ELM STREET
WATERBURY 20, CONNECTICUT
Design and Manufacture of Electro-Mechanical Timing Devices

Modern GROUND POWER
FOR Modern AIRCRAFT



INET'S Star Performer
FOR AIRPORTS

These efficient, compact, rugged and economical Electric Self-Propelled Engine Generators contribute to the efficiency of busy airports.

INET has the reputation . . . gained through experience . . . for the reliability of its ground power equipment . . . engineered to meet or surpass the highest standards of the aircraft industry.

Units embody the famous DUPY* Load Sensitive Governor which saves up to 30% of fuel required by fixed-speed equipment. All electrical components are the best obtainable.

GENERATOR RATINGS: 22.5 to 60 KW; 750 to 2000 AMPS; 28.5 VDC. Trailer types are also available. Write for literature.

*TRADE MARK

INET AIRCRAFT GROUND POWER EFFICIENCY MEANS AIRPORT ECONOMY

INET INC.
8655 SOUTH MAIN STREET, LOS ANGELES 3, CALIFORNIA

toilets, no offices, no anything," says Al Carder, chief of the Douglas unit. The Navy put up the money to build offices. Douglas borrowed four airmen from the Air Force and stripped a compressed air system from the Mojave Navy base for installation in the hangar. Edwards supplied utilities. Operations then began on projects which have been largely Navy.

Only Douglas USAF project now underway is the X-3 testing. But the Air Force receives a weekly report on Navy work in progress at Edwards. Carder sums up the position of all contractors on this ARDC base when he says: "We are tenants but it's a peculiar situation because the landlord is the customer."

Master Plan

The Edwards master plan already is well under way. Its aim: to convert the present wartime hodge-podge of training and test facilities into a modern flight test center for the nation's military services.

As early as 1924 such firms as Northrop and Lockheed were using the area (then Muroc Dry Lake) for testing. Sir Hubert Wilkins flight tested his Lockheed Vega at Muroc in 1924 prior to his polar flight. Jack Northrop tested his first flying wing in the area before 1930. Present military use of the dry lake began in 1943 when North Base was constructed as a secret test site for the first U. S. jet fighter—Bell's P-59A. After World War II, the test center expanded to its present location, a wartime training base.

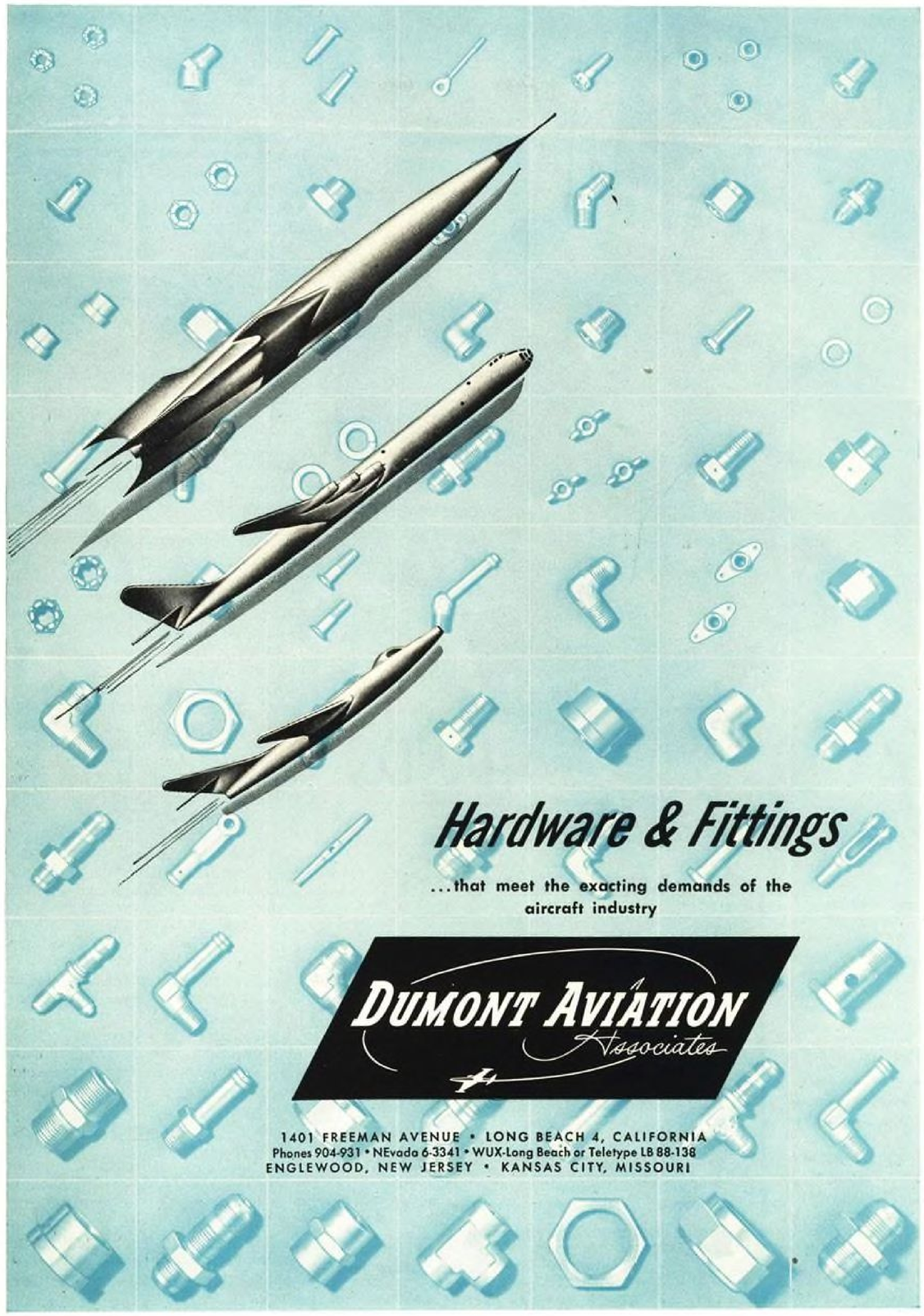
While the master plan was drawn up in 1947, it was not until 1951 that the base was designated a full-fledged flight test center. Prior to that time, AMC detachments traveled to Muroc on specific flight test projects and then returned to Dayton.

► **Modernization Needed**—Need for modernization of the base is obvious. Hangars are jammed with aircraft, forcing mechanics to do much of their major maintenance work under a hot desert sun which pushed temperatures as high as 112, when tools become too hot to pick up and aircraft surfaces blister the hand if touched.

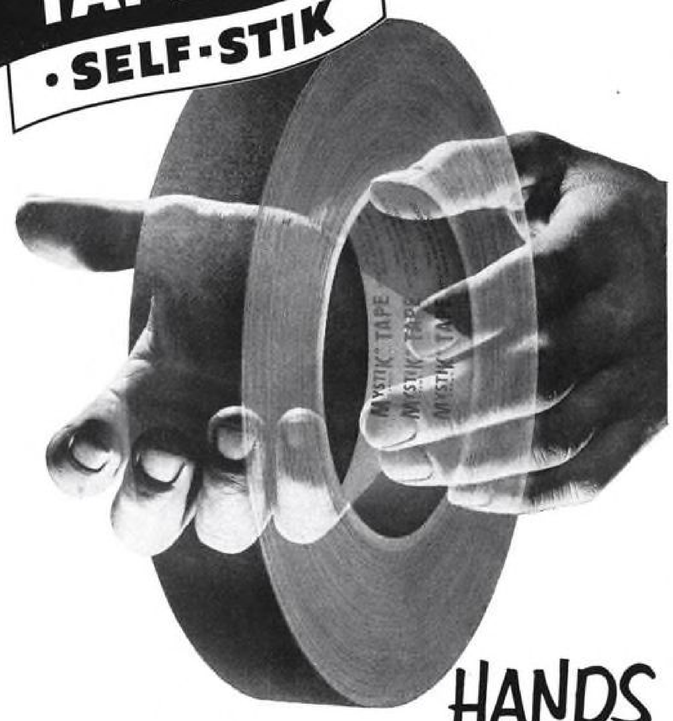
Ancient wooden buildings have been painted many times to ward off the desert climate.

The runway, designed for 35,000-lb. loads, frequently is called upon to take loads almost 10 times that with modern bombers.

It costs $1.5-million a month to operate the base in its present condition. Gen. Holtoner and his staff believe maintenance savings alone would amor-



MYSTIK®
BRAND
TAPES
• SELF-STIK



HANDS
a roll of ~~TAPE~~

TO SAVE YOU MONEY!

Self-Stik Waterproof Cloth Tapes—*14 colors!*
New Mystik Thinflex Masking Tape
New Mystik Flexstron Filament Tape
Uncoated Cloth Tapes
Mystik Protecto-Mask
Mystik Spra-Mask
Mystik Sand-Blast
Mystik Dri-Pipe Insulation
Mystik Freezer Tapes
Mystik Book Repair Tapes

The most expensive tools in your plant are *hands*. Daily they perform thousands of operations. But how many of those operations can be performed with MYSTIK Brand Tapes? A roll of "self-stik" MYSTIK Brand Tape is really a roll of *hands* . . . countless fingers that grasp, grip, hold . . . performing countless holding jobs in every phase of operation—storage, fabricating, assembling, shipping.

MYSTIK is the world's largest maker of "self-stik" cloth, waterproof tapes . . . available in *fourteen* colors . . . makes a full line of cloth and masking tapes and adhesive products to help you cut operational costs.

Write for information and samples.

© 1953, Mystik Adhesive Products

Trademarks Mystik and Thinflex Registered

MYSTIK ADHESIVE PRODUCTS, 2643 NORTH KILDARE AVENUE, CHICAGO 39.

tize the cost of a completely new base over a few years.

Some $40 million has been appropriated for new construction under the six-phase master plan. Less than $3 million of this remains unspent, according to Lt. Col. Malcolm P. Elvin, chief of the base development division.

▶ **New Runway**—Construction has started on a new 15,000-ft. runway which will be 200 ft. wide and capable of supporting 500,000-lb. loads. This will be extended by a 22-mi. freeway, bulldozed through the desert to Rosamond Dry Lake, thus giving a clear area for straight-ahead emergency landings of 22 mi.

For additional safety, there will be a one-mile clearance on each side of the broad runway. Col. Elvin questions whether even this is sufficient for experimental flight testing.

At a takeoff speed of 180 mph., Elvin points out, a pilot who swerves off the runway has only 20 sec. to get his aircraft under control before he hits the buildings.

▶ **Other Construction**—Work also is underway on new roads, barracks, an instrumentation and calibration shop, the technical engineering and administration building, engine repair building and a new hospital. Defense Department has released funds for a radar and telemetering building.

A remote storage area for unconventional fuels will handle the fuels and oxidizers necessary for rocket engines, such as nitric acid, hydrogen peroxide, liquid oxygen, alcohol and aniline. Underground pipelines will deliver these to the flight line and the 20-mi.-distant rocket engine test facility.

Other facilities planned for the new flight test center include a hangar and shop combination equipped to do major maintenance and modification, three large hangars (with room for a fourth) and a data reduction building. NACA plans two hangars in addition to shop and office space.

Target date for completion of this national flight test center? Two years ago, according to Col. Elvin.

The master plan, designed to permit rapid expansion of base facilities in the future, is planned for a personnel strength of over 28,000 on a 300,000-acre base.

Some 6,000 personnel now are assigned to Edwards, and total population, including dependents, approximates 10,000. There are 1,150 family-type houses on the base in addition to the 500 other buildings, which include two large hangars and a number of smaller ones. Lake landing area is supplemented by a concrete runway and ramp.

TEST PILOTS study stability and control problems in Edwards classroom.

Edwards' Exacting School . . .

Where USAF Trains Test Pilots

It takes only a glance at the recording instruments packed into the long needle nose of the X-3 or a look at the many technicians swarming over the glistening white craft as it squats in the hot sun on the Edwards AFB ramp to know that the job of a test pilot is not as simple as it once was.

Test flying today's complex aircraft demands pilots not only of unusual flying ability but with a strong engineering background.

That is the task of the Air Force's Experimental Flight Test Pilot School here: to turn out test pilots who are a match for the aircraft they fly, who are adept at engineering evaluation as well as flight test techniques.

It is one of five such schools in the world. The others are the U.S. Navy school at Patuxent, Md., and test pilot schools in England, France and Russia. The school here has the sole responsibility of supplying the U.S. Air Force with qualified test pilots.

▶ **Student Bridgeman**—There is one familiar name on a locker in the pilot's room of the school: Bridgeman. Bill Bridgeman, top Douglas test pilot who flew the D-558-II Skyrocket higher and faster than man has ever flown before, who currently is testing the supersonic X-3, is a student in the school.

Bridgeman, with no formal education in flight testing, is brushing up on his engineering background. He finds the school program valuable.

"It's one helluva bit of work," he admits. "It's pretty tough for us old men to go back to calculus."

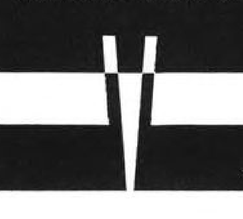
Calculus is but one tough course in a rugged six-month program of flying and ground school, divided into performance and stability phases. Going through the school is no part-time task. Bridgeman, who has finished one phase, is being held over a class because of the time he must devote to the X-3 project.

▶ **AF in Majority**—As a civilian, the Douglas test pilot is an exception in the school. While one contractor pilot and at least one RCAF pilot are accepted in each class, the majority of the students is composed of well-qualified Air Force pilots.

Entrance requirements for the school, which was moved to Edwards from Wright-Patterson AFB in 1951, are stiff. At least one combat tour, either in World War II or Korea, is a must for AF candidates. They must have at least 1,500 hours of diversified flying time, be between 23 and 33 years of age, and have a knowledge of college algebra, trigonometry, solid geometry, differential calculus, aerodynamics, and allied subjects.

School officials give preference to men with engineering degrees. If the candidate is a reserve pilot, he must agree to remain on active duty for three years after completion of the course. Qualifications are evaluated on a point system and a high-ranking board selects

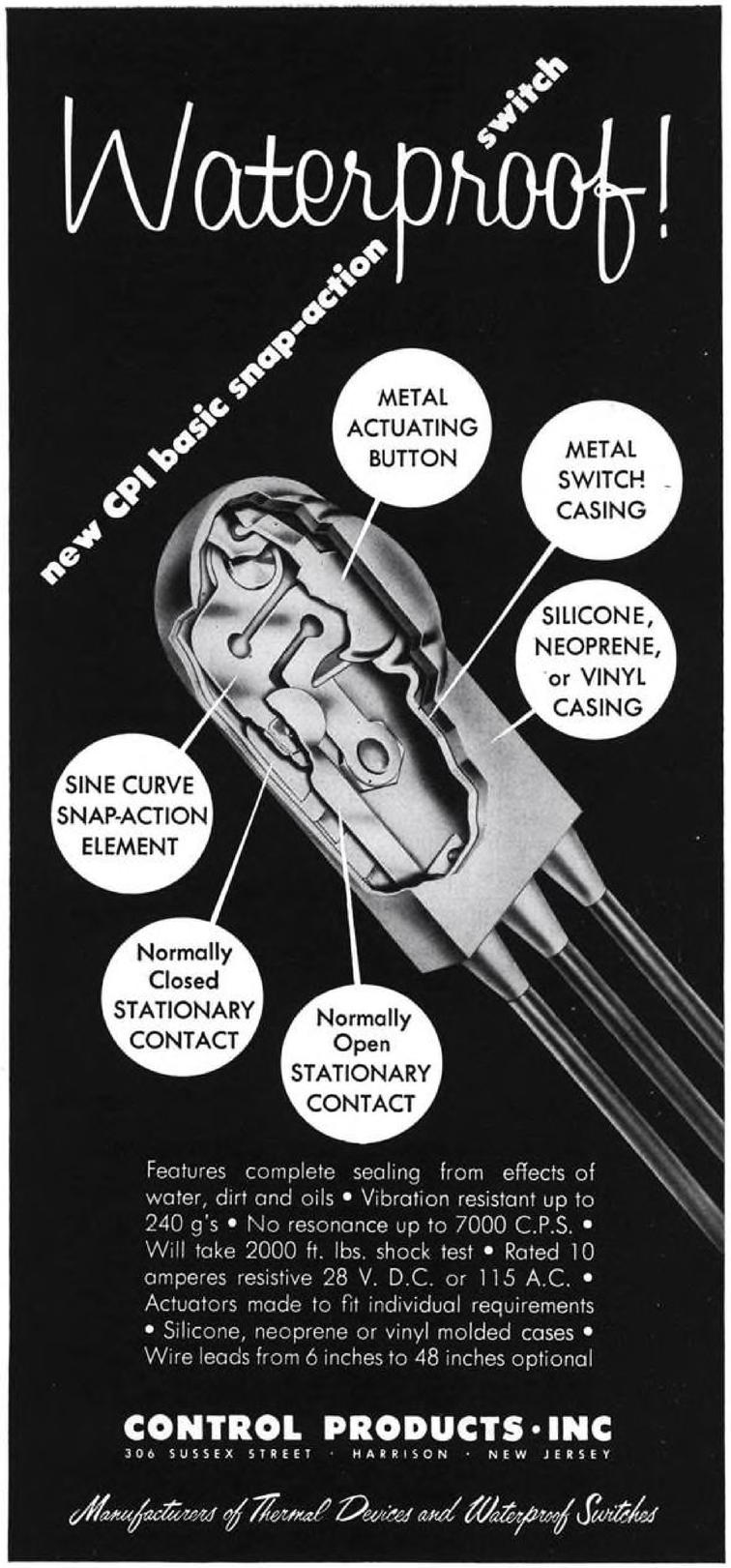
Always
SWIVEL
and ROLL
DARNELL
CASTERS & WHEELS



Specify Darnell for Complete Satisfaction

FREE
Manual

DARNELL CORP. LTD.
DOWNEY, (Los Angeles County) CALIF.
60 Walker Street, New York 13, N.Y.
36 North Clinton, Chicago 6, Illinois



the 15 pilots permitted to enter the school each three months.

► **Who May Apply**—Prior to Jan. 1, only those pilots assigned to ARDC's Air Force Flight Test Center at Edwards were eligible for the test pilot school. Now, qualified pilots in any USAF command can apply. Top graduates are assigned to flight testing at Edwards. The remainder are sent to other ARDC bases.

Graduates, awarded the Air Force specialty rating of Experimental Flight Test Officer (AFSC 8741), are qualified to perform both Phase II and Phase IV flight testing for the Air Force.

Some idea of the academic level of the courses can be gained from the fact that four of the five officer instructors presently assigned to the school (authorized strength: seven) hold master's degrees. This includes the commandant, Lt. Col. John R. Amann. A calculating machine on the desk of each student offers another measure of the difficulty of the courses.

► **Six Months = Two Years**—Since textbooks on how to be a test pilot are rare, the instructors in some instances have written their own. One of these is by Maj. James H. Polve, chief of the performance section.

"In six months a student here gets the equivalent of what a college engineering student gets in his last two years," Maj. Polve says.

Fundamentals of flight test evaluation are taught in the first three-month phase of the school, the performance course. Here the student pilot gets an intensive refresher in algebra, trigonometry, calculus, physics and applied mechanics. He sweats through ground courses in theoretical subsonic and supersonic aerodynamics. He receives instruction in flight techniques, theory of aircraft performance, flight test data reduction methods, and the writing of project reports.

► **Practical Work**—He flies timed speed runs, speed-power tests, sawtooth climbs, and other flight tests. During the performance phase, he chalks up some 30 hr. flying time.

In the stability and control course, the students learn the minimum-acceptable flying qualities of aircraft consistent with safety and acceptable control. More ground school is on the agenda plus 35–40 hr. flight time.

The school's "air force" of gaudy red and yellow aircraft includes six B-25s (for the stability course) and five T-28s, two T-33s, two F-80s and two F-84Es (for the performance course). The school, with a total personnel strength of 10 officers, 26 airmen and 42 civilians, does its own maintenance and instrumentation.

► **Instrumentation**—The aircraft in the school's hangar are carefully instrumented with such devices as yaw met-

If the unit should be struck by aircraft the ball-shaped design causes minimum damage. The break-off adapter shears off on impact and the round unit just rolls away. Rugged construction of the unit and the thermal elements insures long life.

Large door swings down, for easy accessibility. Door and lens mountings are completely dust and water tight. Since most of the operating hours are at well below maximum lamp rating, lamps give long life, require replacing only at long intervals.

Here's L-M's New High Intensity Controllable Beam Runway Light

New THERMAL BEAM high intensity runway light has 200,000 beam candlepower. Provides single current control for both brightness and beam direction. Elimination of extra circuits and auxiliaries simplifies operation and reduces installation and maintenance costs.

By R. E. MADIGAN
Manager
Airport Lighting Sales
Line Material Company

Many years of development and testing by L-M's lighting engineering staff have resulted in a new and greatly improved high intensity runway light meeting CAA specification L-818.

The new unit, known as the L-M THERMAL BEAM, is ingeniously simple. Its design is based on the principle that weather requiring maximum brightness also requires maximum "coning-in" of the beams.

Single Control for Beam and Brightness

In the THERMAL BEAM, both are controlled by a single current variation. This provides simplified automatic control of beam direction by the tower.

Current variations operate directly upon the lamp filament. They also act upon a coiled bi-metal strip which is geared to move the lamp back and forth.

When the current is raised, brightness increases, and the bi-metal strip moves the lamp parallel with the lens and reflector, so that the beam moves inward. Thus pairs of beams from units at opposite sides of the runway meet at a point much closer than in clear weather, when lamp intensity is reduced and beams are "coned" *out* to meet at a farther point.

Temperature-Compensated

A second bi-metal spiral compensates for outside temperatures, so that the beam direction remains constant at any given brightness, regardless of warm or cold weather.

Optical Assembly

The optical elements are specially designed to produce a balanced photometric distribution, meeting all practical operating requirements for landing of aircraft under varying weather conditions.

Reduces Installation Costs

THERMAL BEAM gives lower material and installation costs through the elimination of beam control circuits and auxiliary control equipment. By making use of the current variations employed in regulating lamp brightness, all auxiliary field wiring is eliminated, giving improved reliability.

Write for Bulletin

This bulletin gives more information, details on installation methods, specifications of the units. If you wish, we'll have an L-M Field Engineer call on you. Write to Mr. Madigan at Line Material Company, Airport Lighting Division, Milwaukee 1, Wisconsin (a McGraw Electric Company Division).

"THERMAL BEAM" is a Line Material Company trademark

LINE MATERIAL
Airport Lighting

LINE MATERIAL CO. AW-83
MILWAUKEE 1, WISCONSIN

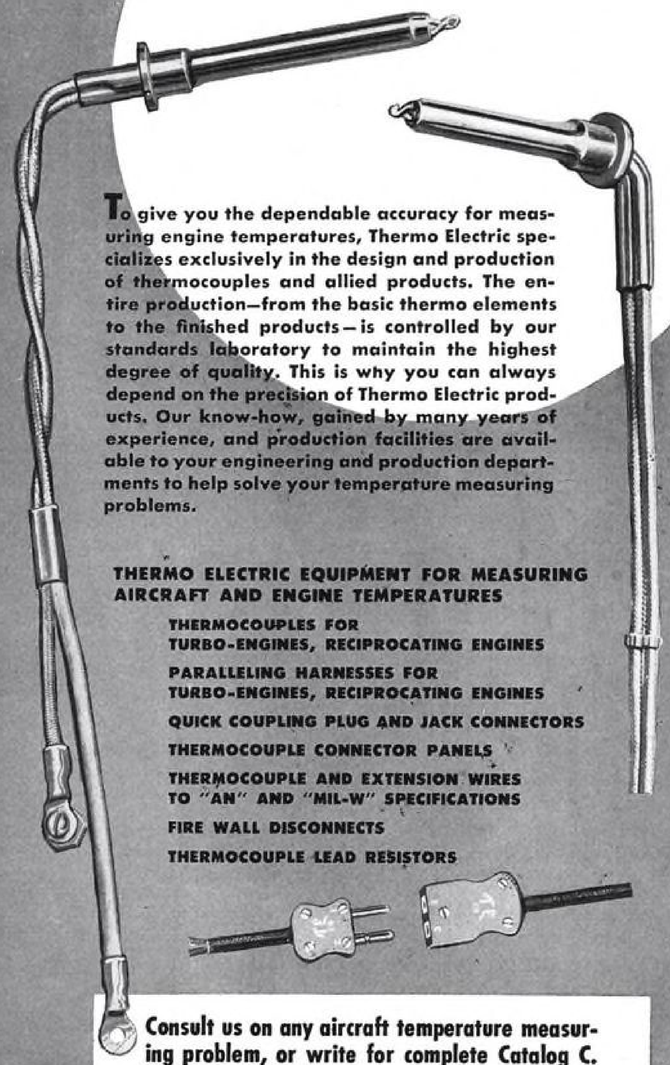
☐ Please send me, without obligation, THERMAL BEAM Bulletin.
☐ Please have a Field Engineer call.

*Name*_____
*Company or Airport*_____
*Address*_____
*City*_____ *State*_____

Engine Temperatures
MEASURED ACCURATELY

with

Thermo Electric THERMOCOUPLES



To give you the dependable accuracy for measuring engine temperatures, Thermo Electric specializes exclusively in the design and production of thermocouples and allied products. The entire production—from the basic thermo elements to the finished products—is controlled by our standards laboratory to maintain the highest degree of quality. This is why you can always depend on the precision of Thermo Electric products. Our know-how, gained by many years of experience, and production facilities are available to your engineering and production departments to help solve your temperature measuring problems.

THERMO ELECTRIC EQUIPMENT FOR MEASURING AIRCRAFT AND ENGINE TEMPERATURES

- THERMOCOUPLES FOR TURBO-ENGINES, RECIPROCATING ENGINES
- PARALLELING HARNESSES FOR TURBO-ENGINES, RECIPROCATING ENGINES
- QUICK COUPLING PLUG AND JACK CONNECTORS
- THERMOCOUPLE CONNECTOR PANELS
- THERMOCOUPLE AND EXTENSION WIRES TO "AN" AND "MIL-W" SPECIFICATIONS
- FIRE WALL DISCONNECTS
- THERMOCOUPLE LEAD RESISTORS

Consult us on any aircraft temperature measuring problem, or write for complete Catalog C.

Thermo Electric Co., Inc.

FAIR LAWN NEW JERSEY

TEST PILOT reports on F-86D flight.

ers, sideslip indicators and force instruments. Ballast water tanks in the B-25s permit shifting of aircraft CG from as much as 18% forward to 33% rear. Movie cameras monitor duplicate instrument panels to supplement data recorded by the pilot. Projects are similar to those the student will encounter when he graduates into regular test flying.

Flying begins at dawn to take advantage of morning hours when the desert air is calm; the afternoon is devoted to four hours of ground school. A two-hour examination each week helps the instructors keep track of students' progress.

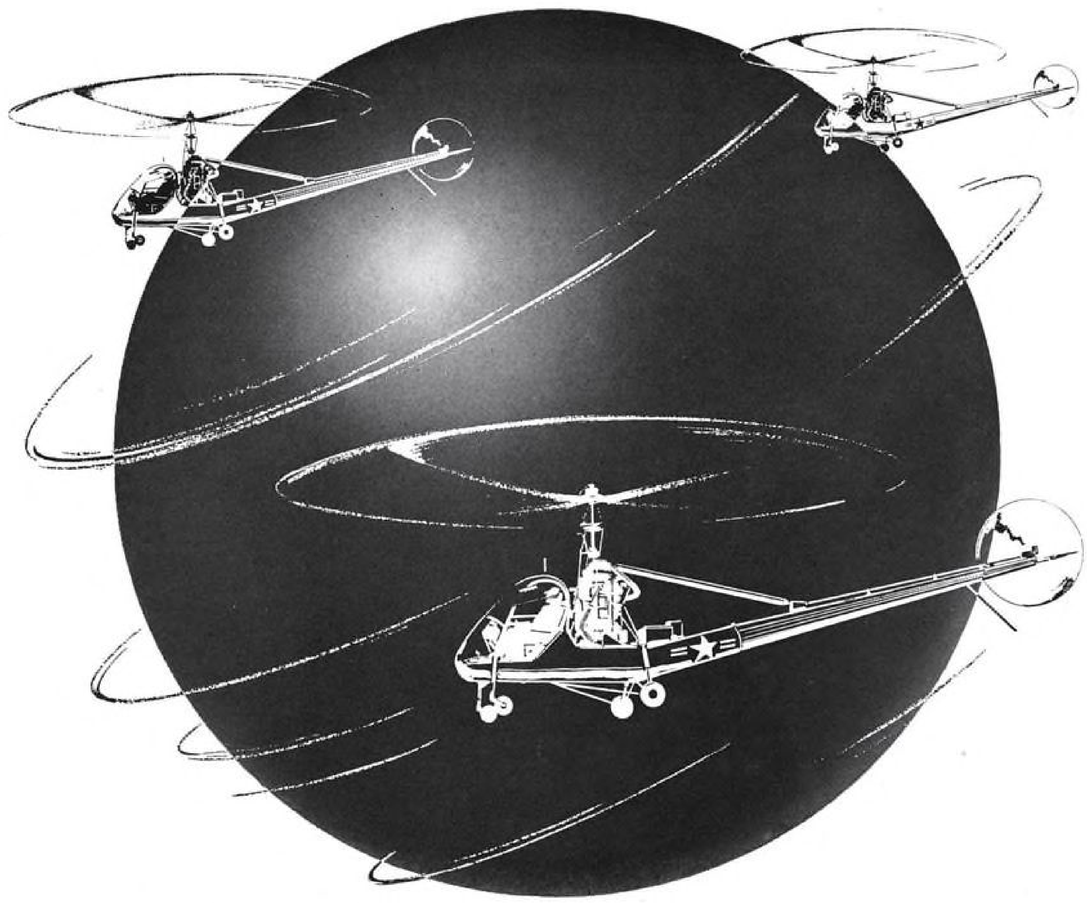
▶ **Quality, Not Quantity**—Like most Air Force schools, there is a procedure for "washing out" those who are deficient in academic or flying ability.

"Although 15 students every three months just barely take care of normal test pilot attrition due to transfers and other reasons, we are interested in quality, not quantity," Maj. Polve asserts.

An Air Force document defines the purpose of the test pilot school this way:

"Only a sound understanding of basic principles and an insight into the advanced problems of aircraft design and operation will permit the test pilot of today to gather and interpret precise data, and to analyze the new experiences he will undergo and express these experiences with clarity to test engineering personnel. The skilled test pilot, only, can correctly evaluate aircraft for use in highspeed warfare."

"If you are looking for a more dramatic way to express what we do here," adds Maj. Polve, "you might put it like this: The world depends on the U.S. Air Force and the Air Force depends on its planes. The quality of those planes depends on the test pilots who evaluate them. We supply the pilots."



Revolution in Accuracy

Rescue work . . . submarine hunt . . . aerial photography . . . the Hiller helicopter is a versatile performer. It can hover in one place, move up and down, forward and backward. That's why the Hiller demands bearings that carry all loads, that *stay* rigidly accurate, even under sudden shifts in blade speeds. New Departure meets that demand with bearings for Hiller applications shown below. Besides such heavy duty applications, New Departure makes a wide range of minute bearings for sensitive aircraft instruments. *Every* New Departure bearing—from midget to giant—is backed by the industry's most complete research and engineering facilities—all of which stand ready to serve the manufacturers' design and engineering staffs.

Main transmission of the Hiller helicopter uses New Departure bearings in the clutch assembly.

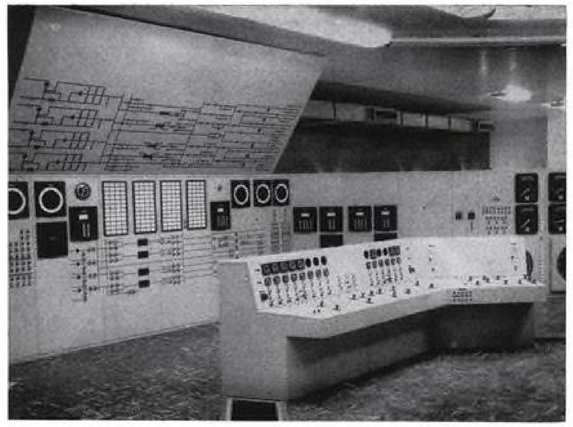
NOTHING ROLLS LIKE A BALL

NEW DEPARTURE

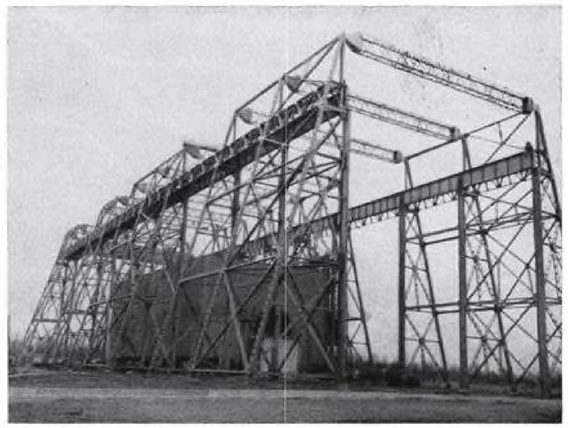
BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT
Also Makers of the Famous New Departure Coaster Brake

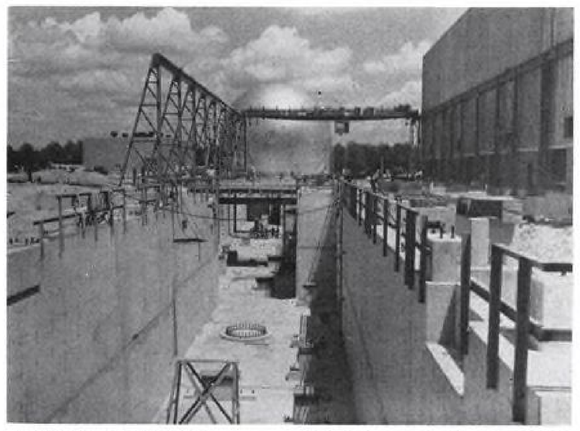
Tail rotor gear box, another of the Hiller's vital moving parts, is equipped with New Departure ball bearings.



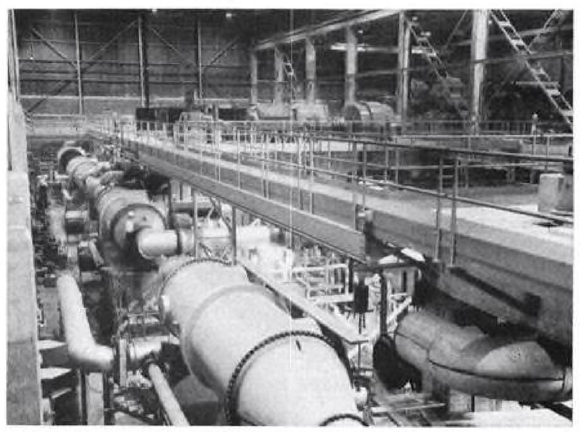
ETF CONTROL is handled by two operators from this console.



GIANT CRANE hangs over motor house for propulsion tunnel.



HEADER TRENCH houses a myriad of pipes and valves for GDF.



REFRIGERATORS cool the air heated by compressors of ETF.

AEDC Will Speed Air Development

These giant facilities that no contractor could afford to build himself will ease the 'growing pains' of new designs.

By David A. Anderton

Tullahoma, Tenn.—The combat airplanes and engines of 1960, now taking shape in nebulous outline on drawing boards, will be eased through youthful growing pains at the Arnold Engineering Development Center.

In three test installations now a-building, future airframes and powerplants will undergo their first full-scale simulation of flight at extreme altitudes and speeds.

From precise measurements of pressure and temperature, from the recorded readings of gages and manometers, designers will learn what they want and need to know without resorting to lengthy, expensive—and possibly unsatisfactory—flight tests of the equipment.

▶ **Tremendous Capabilities**—The three major units of AEDC—engine test, gas dynamics and propulsion windtunnel—will encompass a staggering range of capabilities in speed and altitude which are built around the theme of contractor service.

"The philosophy of AEDC is that it should be a development center for industry. It's something that no company could afford to build by itself," said Col. F. H. Richardson, AEDC Chief of Staff.

"The contractor who comes here to test can either operate the test unit or monitor the tests. He'll have maximum freedom to do as he pleases. His proprietary rights will be protected. We'll schedule the tests and provide support. And under present plans, all this won't cost him anything," Colonel Richardson added.

"We're just beginning to undertake our first development test project," said Richardson. "And we're blowing some air through a small supersonic tunnel for calibration purposes. We should be running some of the engine test cells this summer, and begin program tests in the fall."

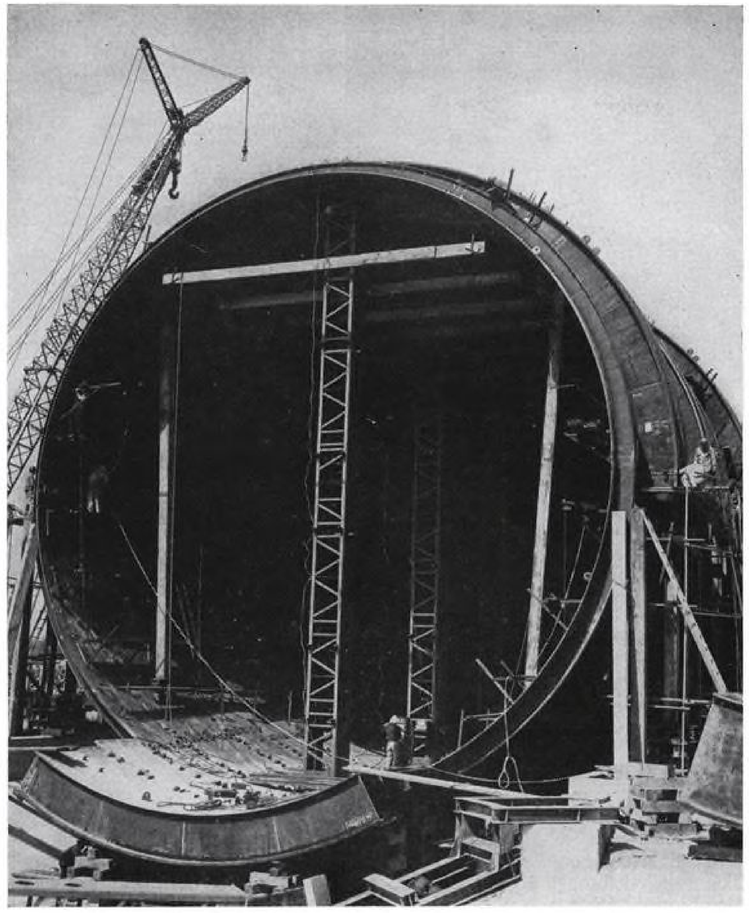
▶ **Testing Trio**—Of the three gigantic test facilities at AEDC, the Engine Test Facility (ETF) is nearest completion. Col. Richardson estimated that its design was 98% completed, and that construction was 95% along.

Construction of the Gas Dynamic Facility (GDF) is about 40% finished, and of the Propulsion Windtunnel (PWT), only about 25%.

There is a Ramjet Addition (RJA) to the ETF—currently considered as an extension of the engine facility—that will exceed it in capacity and stand in its own right as a major facility. Construction on this addition has only begun, and most of the work is still in design.

▶ **Test Cell Details**—The detailed capability of each test cell is classified information. Size and performance of each unit have been detailed in the accompanying box, as far as permissible. But it should be remembered that test section size and model size, although related, are not one and the same. The giant PWT, with its 16-ft. test section, will be able to test models of airframes or full-size engines up to a diameter of only about 4 ft.

Generally each facility has been designed to meet the test requirements of the largest foreseeable unit to be tested. Again, using the PWT as an example, its test section has four times the area thought adequate several years ago. The Ramjet Addition will be able to blast air through a single test cell in amounts far above current and near future ramjet air flows.



COOLER SECTION in return circuit of the Propulsion Windtunnel has 55-ft. dia.

Engine Test Facility

Nearest to completion at AEDC, the Engine Test Facility had a headstart in Germany during the war. It was planned as a central test unit by the German government, and located at the Munich plant of the Bayerische Motoren Werke (BMW). Completed in 1943, the test facility had an air capacity of 53 lb. per second, a single test chamber and a simulated altitude range reaching 45,000 ft.

Testing soon brought out the limitations of the BMW plant, and so a larger version was planned. Most of the machinery was completed for the newer plant, but never installed.

▶ **Postwar Import**—At the end of the war, German engineers operated the plant for British and American tests, including the first high-altitude test runs of British jet engines. Then dismantling began and the original plant together with the machinery for the new test facility, was shipped to this country as reparations.

Lt. Col. F. W. Williams, AF project officer for ETF, told AVIATION WEEK that the German plant was worth between $3 million and $10 million against the cost of AEDC, depending on whether the value was figured in the dollar equivalent of German marks, or in the replacement value of the equipment in the United States.

"All the compressors and all but one motor in ETF are German," Williams said. "We surveyed all the switchgear and used the good parts on the air side, but had to buy switchgear for the exhaust side. The test cells are similar to the original BMW cells, but are not the same units."

▶ **Higher Rating**—Redesign of the original German layout, plus more equipment built in the United States, have raised the rating of ETF from 53 lb. per sec. to about 300 lb. per sec. Altitude capability has been almost doubled from the original 45,000-ft. German limit.

Describing the flow diagram will show the general layout of the plant. Air source is a battery of four four-stage, 5,000-hp. centrifugal compressors which feeds through a heat exchanger to a cooler-drier.

Three stages of cooling—the first using lake water, the second, chilled water, and the third, ethylene glycol—are required to drop the temperature to —11F and remove the moisture from the air.

At this stage the air can be either cooled further by an expansion turbine, or heated by rerouting through the heat exchanger. Mixing valves control the temperature, and the air then enters the test cell in operation.

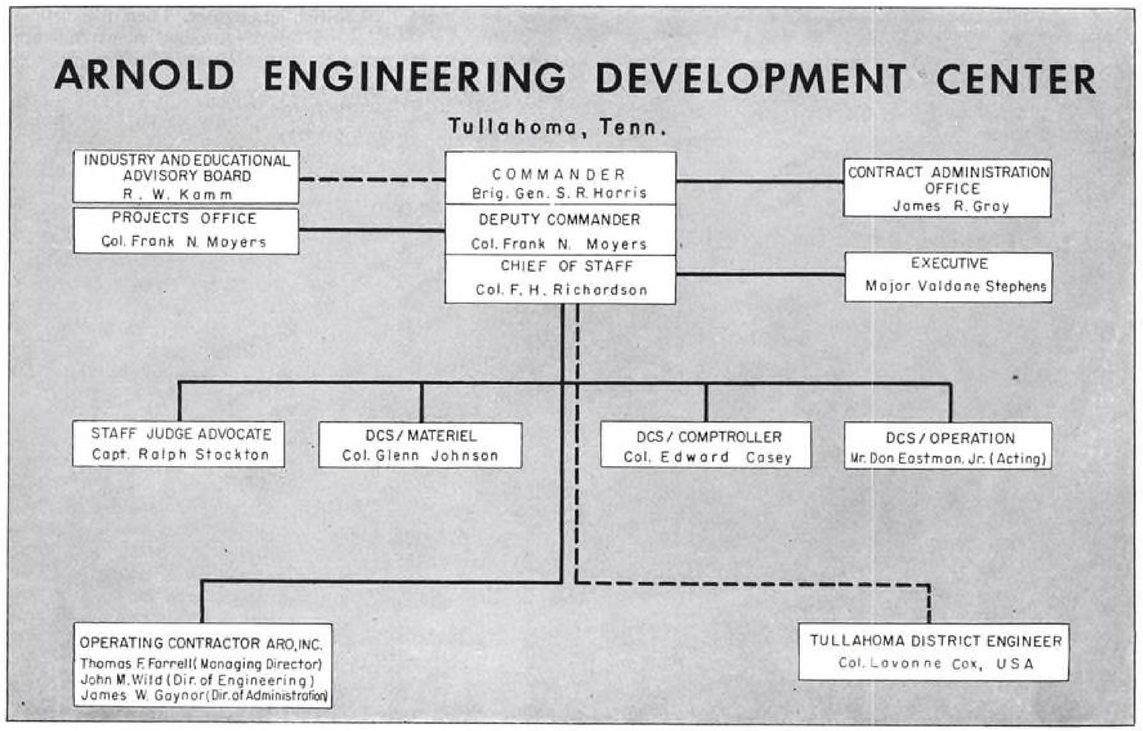
▶ **Hungry RJA**—For increased temperature, the air can be routed through the big heaters in the RJA; for increased flow, the air can be combined with the output of two 15,000-hp. compressors in the RJA.

The test cells of the RJA will be able to gulp the air capacity of the entire plant—six compressors—boosted through a second-stage 38,500-hp. compressor and heated. This flow will be far above that of the ETF.

The downstream side of the test cells is connected to a battery of six exhausters, valved so that they can be used in series, series-parallel or parallel flow.

The RJA exhaust goes through two 30,500-hp. exhausters, then back to the ETF exhausters.

▶ **Central Control**—The entire plant is controlled from a central room and console which can be manned by two, or at the most, three operators. The test



crew, located in the test-cell control rooms some distance away, ask for the flow conditions they need in the tests. Central control then goes into action, sets all the valves and starts the motors.

With stabilized flow established, central control telephones the test-cell crews and tells them to go ahead with the tests.

In the engine control rooms, the test crew mans the instrumentation and control equipment necessary to make the specific run. They cannot see the engine, which is inside the enclosed steel tube of the test cell, so observation is by direct TV connection with the cell.

The TV system—not new, although relatively unproven in test—has been received at AEDC and is under test.

These control rooms are relatively quiet, due to soundproofing and vibration isolation through floating construction. Lined with panels of instruments and huge manometers, the atmosphere is one of neatness and efficiency.

▶ **Test Cells**—Engine test cells can be lengthened to take a variety of extra installations such as afterburners or special exhaust cooling devices. The engine itself is mounted on a cart, complete with instrumentation connections. Quick disconnects on the cart, and a huge one on the entire test cell, minimize the downtime between tests.

The carts, handled on rails throughout the plant, are made up in adjoining areas for assembly and shop work. Removable partitions for these areas will be available for protection of contractors' proprietary rights.

Test measurements will be processed in digital form through a computer that will give the test crew final data within 30 seconds after the measurements have been made.

Brig. Gen. Samuel Russ Harris, Jr., commander, Arnold Engineering Development Center . . . born Pittsburgh, Pa., 1902 . . . graduated from U. S. Military Academy 1926 . . . learned to fly at Brooks and Kelly Fields . . . rated a pilot 1927 . . . served with 3rd Attack Group in Texas . . . flying instructor . . . test pilot and engineering officer, Wright Field, for nine years . . . director of technical services AAF headquarters . . . director of air traffic and safety development AAF Hq. . . . commanded 499th Bomb group on Saipan . . . commanded Panama Air Depot . . . taught at National War College . . . acting chief of programs for ARDC, Washington . . . director of plans and programs ARDC . . . chief of staff, ARDC Hq., Baltimore, where he served until taking command of AEDC.

Gas Dynamics Facility

The big feature of the GDF test equipment will be the combination of high Reynolds members with high Mach numbers, which means closer simulation—if not duplication—of full-scale missile flight.

Based on a design found in Germany at the end of the war, the GDF is intended to be most useful in the gas dynamic regime where slip flow and free-molecular flow occur. "We want to go from Mach numbers above One just as high as possible," said Lt. Col. J. A. Dodge, the project officer.

▶ **One Operating**—There is only a single tunnel of the GDF operating now, while construction goes on all around it. This tunnel, known as E-1, is a 12x12-in. supersonic setup with a speed range between Mach 1.2 and 5.0, although the higher reaches have not yet been obtained. This tunnel is an exact copy of the one at the Jet Propulsion Laboratory, California Institute of Technology, Dodge stated. Internal strain-gage balances will be used for measurement of data.

Most of the compressor equipment, ducting and ancillary equipment is still to come, so the GDF is running on a makeshift basis. Right now, four portable Diesel-driven compressors push their output through a tiny tube into a huge high-pressure storage bottle 720 ft. long with a 3-ft. inside diameter. This bottle replaces the many manifolded bottles usually used for high-pressure air storage. There is another advantage: The size and length of the bottle can make it a super-sized shock tube for studies of shock wave phenomena sometime in the future.

By operating the four portable compressors on a 24-hr. day, seven-day week, Dodge said, the facility will be able to make about 250 test runs per day at an average duration of 20 sec. per run.

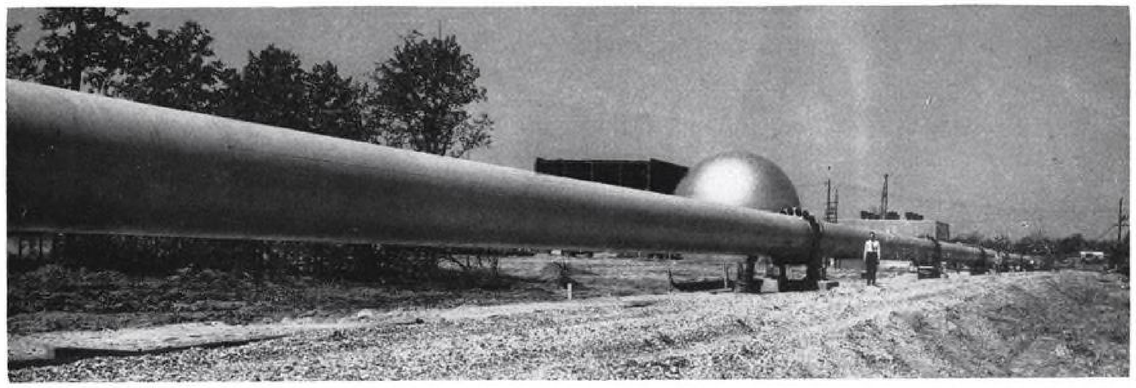
On the discharge side of the tunnel is a vacuum sphere, 72.5 ft. diameter with walls 1½ inches thick. It can be sucked down to 0.1 psi. pressure, to provide the tremendous pressure ratio needed across the tunnel to reach high Mach numbers.

▶ **Primary Plant**—Actually the high-pressure bottle and suction sphere are an auxiliary system. The main compressor battery is 12 units—six axial and six centrifugal—powered by about 100,000 hp. supplied by means of electric motors.

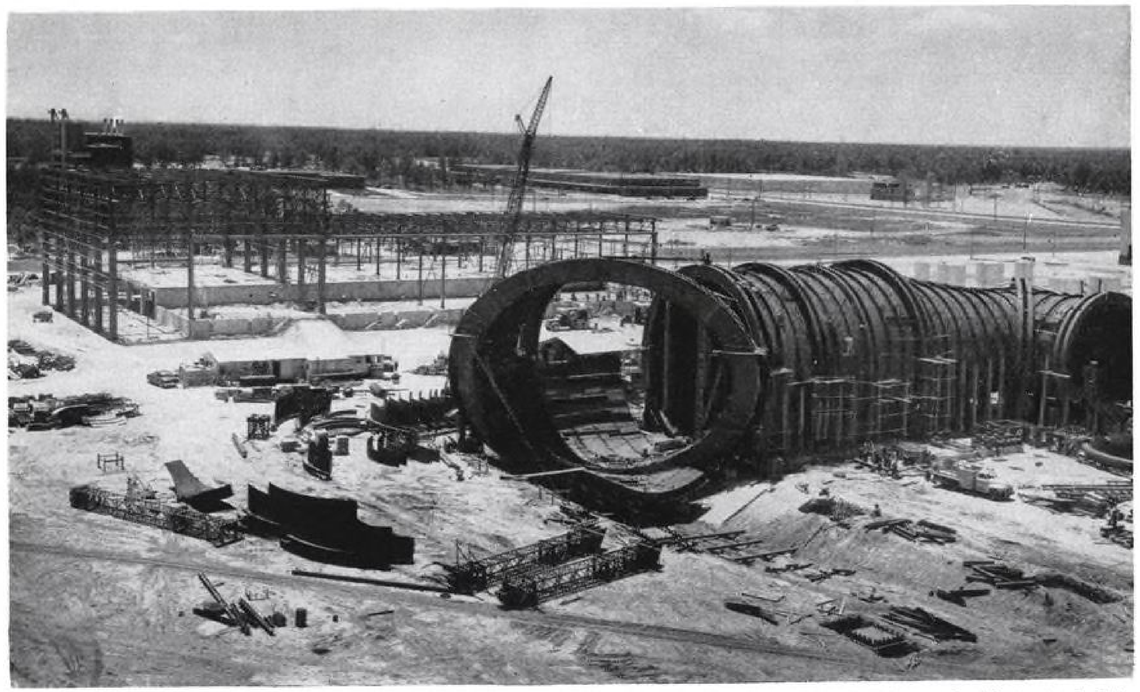
These compressors and motors are to be housed in a single building, now being completed. The size of the building, like everything else at this center, is impressive "in the flesh," and not on paper. You might compare this building to one of the main assembly buildings used by GE or Westinghouse for the assembly of giant hydro-electric equipment.

▶ **Big Trench**—Between it and the steel framework which will eventually become the test building is a great hole in the ground, lined with concrete. This is the pressure header trench, and it will contain a maze of pipes, intertwined and twisting around a myriad of valves.

This was done for several reasons:



STORAGE BOTTLE for GDF is 720-ft. long steel tube replacing many manifolded bottles usually used, could serve for shock-tube studies.



TRANSONIC CIRCUIT of the propulsion windtunnel nears completion as huge steel rings are erected and covered with structural plate.

First, there was a specified difference in elevation between air supply lines and air exhaust. Then these lines needed condensation traps, which meant digging a pit for each valve. Maintenance was a problem, too, so all things considered, the economical solution was to shovel out a big hole and put everything in there.

Propulsion Windtunnel

Back in the days when supersonic tunnel sizes were measuring around 16 inches, the proposals for AEDC asked for a supersonic tunnel with a test section measuring 16 feet.

The power requirement for the tunnel could just be met by the turbines of the largest Navy carriers. Cooling water would course through tubes at a rate that would supply Washington, D. C., with its normal daily needs.

The electric motors which were planned to power the tunnel were simply to be the world's largest rotating machinery.

In all, a collection of superlatives.

▶ **In the Offing**—Least complete of the three AEDC facilities, the Propulsion Windtunnel is still the most impressive. In mid-July, the main structural steel tube for the cooling section of the transonic circuit was standing completed. It is 55 ft. in diameter, which means that you could move an average home right through it.

The transonic circuit is one of two for the tunnel; both will share a common control and power supply. Currently about 35% complete, the transonic circuit is expected to make its first runs late in 1955.

Component work on the supersonic circuit is going ahead, but there are no funds available to construct the final circuit itself. AEDC is thus reluctant to put any completion or first-test date on this portion.

The problems of this big tunnel are being studied in a scale model known as "Pee-Wee." This model work has already proven out the second throat for the full-size tunnel.

▶ **Kinds of Tests**—This facility is not a windtunnel in the aerodynamic sense, but rather a propulsion windtunnel. The idea is that full-scale powerplants—turbojets and ramjets, mostly—will be tested as installed in their airframes. The test section will be able to handle a configuration of about 4-ft. diameter and 30 ft. long.

The entire test section will be removable from the tunnel to reduce downtime to a minimum. Test articles can be instrumented, and test sections modified without disrupting the operation of the tunnel.

Each tunnel is to feature an adjustable flexible nozzle, similar to the type developed for use in Tunnel E-1 of the GDF. The tunnels will also be equipped with a scavenging system to remove engine exhaust gases and a makeup system which will replace the lost gases with fresh air.

▶ **Motors, Drives**—The rotating machinery for the two circuits is being built by Westinghouse Electric Corp. There are four electric motors; two are rated at 83,000 hp. each, and two at 25,000 hp. each. Coupled to the tandem motor drive will be five compressors—a single unit for air to the transonic circuit, and four to blast air through the supersonic cycle.

The larger motors have been installed at AEDC; the rest of the machinery is nearing completion at Westinghouse's plant in East Pittsburgh.

Size of the compressors is impressive. The shaft is 18 ft. in diameter, and blades are six feet long by about two feet in chord. Weight is about 1,300 lb. per blade.

Westinghouse built a quarter-scale model of a compressor for vibration tests during the development of the machinery. The firm expects to complete work on the compressors in about a year.

Industry Participation

The center and the Unitary Windtunnel Plan were originally justified as being necessary for development use by industry. So it was a logical step to give industry a chance to advise on the policies, operation and design of the facility.

This was done by the creation of the Industry and Educational Advisory Board (IEAB), set up by directive from Gen. Vandenberg, then chief of Staff, USAF, in September 1950. The words of the regulation do not go much beyond establishing the Board and defining the channels it can use. Organization, meeting times, places and agendas are left completely to the membership.

Actually the Board reports to three staff levels:

- **To the Commanding General, AEDC**, on policy matters of design, construction, operation, requirements and plans of the AEDC.
- **To the Commanding General, ARDC**, on relationship of AEDC to other facilities, on advance research trends relating to test and evaluation facilities, and on progress made and problems in policy encountered during the design, construction and operation of AEDC.
- **To the Chief of Staff, USAF**, at least annually on over-all policies of design, construction and operation of the AEDC.

Executive secretary of the Board is Robert W. Kamm, formerly with the Research and Development Board, and before that with Glenn L. Martin Co. and the NACA.

▶ **Board Membership**—The Chief of

AEDC Facilities

Gas Dynamics Facility (GDF)

TUNNEL	SIZE	MACH NO. RANGE	STATUS
A	40 in. x 40 in'	1.2 to 5.0	
B	40 in. x 40 in.	4.5 upward	
E-1	12 in. x 12 in.	1.2 to 5.0	In calibration test.
E-2	12 in. x 12 in.	5.0 upward	Deferred; no funds.
-	55 in. x 55 in.		

Propulsion Windtunnel (PWT)

TUNNEL	SIZE	MACH NO. RANGE	STATUS
Transonic	16 ft. x 16 ft.	0.9 to 1.6	35% complete; first runs late 1955
Supersonic	16 ft. x 16 ft.	1.4 to 3.5	Component construction; no funds for completion.

Engine Test Facility (ETF)

CELL	SIZE	FOR TESTING	STATUS
T-1	12.5 ft.	Turbojets	Entire facility is 98% designed, 95% co mpleted.
T-2	12.5 ft.	Turbojets, turboprops	
T-4	12.5 ft.	Ramjets	
T-5	.....	Components	

Ramjet Addition (RJA)

CELL	SIZE	STATUS
1*	16 ft. dia. x 90 ft.	In design.
2*	20 ft. dia. x 60 ft.	Prelim. design.
3*	20 ft. dia.	Proposal only.

* Not AEDC designations; for identification only.

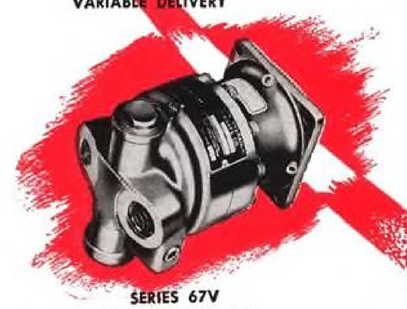
a fingertip flip...

IMPARTS POSITIVE CONTROL AT 0 MPH OR MACH PLUS!

STRATOPOWER HYDRAULIC PUMPS

SERIES 67
CONSTANT DELIVERY

SERIES 66W
VARIABLE DELIVERY



SERIES 67V
VARIABLE DELIVERY

From dropping and retracting landing gear, operating elevators and other controls on military aircraft, to steering guided missiles or controlling autogyros, STRATOPOWER Pumps offer that "fingertip control" and complete dependability under all conditions which make them an obvious choice.

STRATOPOWER Pumps are an outstanding expression of advanced engineering and precision craftsmanship. Here is power compacted into minimum dimensions and least weight . . . constant and variable delivery types with modifications to provide both oil-piloted or electrical control. Either direct engine-driven or electric motorized units in capacities from one-quarter gallon to ten gallons per minute at nominal speed of 1500 rpm, with continuous working pressures to 3000 psi (maximum intermittent operation at 4500 rpm and normal continuous operation at 3750 rpm).

The New York Air Brake Company, together with its associated and subsidiary companies, combine exceptional engineering and production facilities which are available for consultation, testing or development. Write for the answer to your problems.

THE NEW YORK AIR BRAKE COMPANY
230 PARK AVENUE • NEW YORK 17 • N.Y.

STRATOPOWER Piston Type Hydraulic Pumps

DUDCO Dual Vane Type Pumps & Motors

HYDRECO Gear Type Pumps & Motors

AIR BRAKE SYSTEMS FOR AMERICA'S RAILROADS

HYDRECO Valves and Cylinders

KINNEY Liquid Handling & Vacuum Pumps

AURORA Centrifugal and Turbine Pumps

MILLIONS OF HOURS AHEAD
in lightweight turbo-machinery!

Today, AiResearch has a backlog of *25 million hours of actual operating field experience* in lightweight turbines. These units provide auxiliary power, starting power, pressurization, heating and refrigeration for U. S. aircraft. With rpm's ranging from 10,000 to 100,000, average efficiency is 83%.

The many thousand AiResearch turbine machines now in operation are the result of a pioneering development and manufacturing program begun 9 years ago. In its course more than 2 and ¼ *million* hours were spent in engineering development, plus over 100,000 hours of laboratory tests.

This *experience* where others are still exploring is typical of AiResearch leadership in the small but highly efficient power and control units required in the many fields of modern industry.

AiResearch Manufacturing Company

A DIVISION OF THE GARRETT CORPORATION

LOS ANGELES 45, CALIFORNIA • PHOENIX, ARIZONA

AiRESEARCH—specialists in the design and manufacture of aircraft accessories in the following major categories: air turbine refrigeration • cabin superchargers gas turbines • pneumatic power units • electronic controls • heat transfer equipment • electric actuators • cabin pressure controls and air valves

■ ARNOLD

Staff appoints the eight members of the Board. Six are chosen from industry, representing the airframes, powerplant and accessories field; their nominations are made by the Aircraft Industries Assn. Two members represent educational institutions and are nominated by the chairman of the Scientific Advisory Board. Normally named for one year, members can serve for succeeding terms if necessary.

Current chairman is Prof. John R. Markham, MIT; his fellow educators are Dr. C. E. Brehm, president of the University of Tennessee, and a supernumerary member, Dr. Harold Flinsch, dean of engineering at Mississippi State College.

Industry memberships are held by A. T. Colwell, Thompson Products, Inc.; Paul J. Frizzell, Fairchild Engine and Airplane Corp.; Wright A. Parkins, Pratt & Whitney Aircraft Div.; Kendall Perkins, McDonnell Aircraft Co., Maj. Gen. E. M. Powers (USAF Ret.), Curtiss-Wright Corp.; Edward C. Wells, Boeing Airplane Co.

There are two supernumerary industry members: Neil Burgess, General Electric Co., and L. A. Hyland, Bendix Aviation Corp.

►**Internal Workings**—The complete freedom given to the Board is emphasized by its recommendations; everything from broad policy to detailed design considerations have been forwarded by the Board. As of last November, the list totaled 21 recommendations.

Although most of the Board's proposals have been received favorably, a very important one—the question of charging fees for use of the facilities—finds them at loggerheads with ARDC. The Board believes strongly that fees should be charged; Gen. Partridge, formerly commanding ARDC, decided that no fees should be charged during initial operation, and that is the way the matter stands today.

In some cases, the Board has named "ad hoc" working groups to attack the details of specific problems. These groups are chairmanned by a member of the Board, and after exploring a problem, they advise the Board on their thinking. Members of the Board may also call in experts.

Because of the affiliation of the industry members, the Board gets the official AIA viewpoint on the facilities, but does not always necessarily subscribe to that view.

Establishment of a Deputy for Operations was one of the specific recommendations of IEAB. This office, headed by Donald R. Eastman, Jr., is the connecting link between AEDC and Sverdrup and Parcel Operating Di-

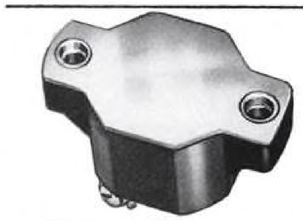
PROTECTION PERFORMANCE *Assured*

KLIXON CIRCUIT BREAKERS

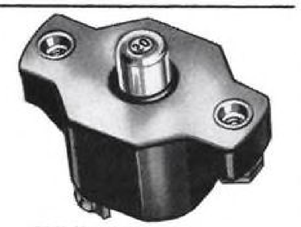
Completely Sealed for Extra Safety

PDLA Automatic Reset
Ratings: 35 to 150 Amps.
Weight: 4 oz.

PDLM Manual Reset
Ratings: 35 to 150 Amps.
Weight: 5 oz.



PDA Automatic Reset
Ratings: 15 to 40 Amps.
Weight: 1.4 oz.



PDM Manual Reset
Ratings: 15 to 40 Amps.
Weight: 1.7 oz.

- **EXPLOSION-PROOF** — *Completely sealed,* these circuit breakers provide positive protection from explosions on rupture under all flight conditions.
- **CORROSION, HUMIDITY, DUST RESISTANT** — Withstand over 100 hours exposure to salt spray and 30 day humidity test. Positive sealing completely weatherproofs and dustproofs breakers.
- **SHOCK-PROOF** — Withstand up to 100 G's.
- **VIBRATION RESISTANT** — Far exceed present military specification requirements.
- **PRECISION CALIBRATION** — Calibrated to limits of 115–125% of rating as compared to AN limits of 115–138%. Checked for ultimate trip and short time calibration.

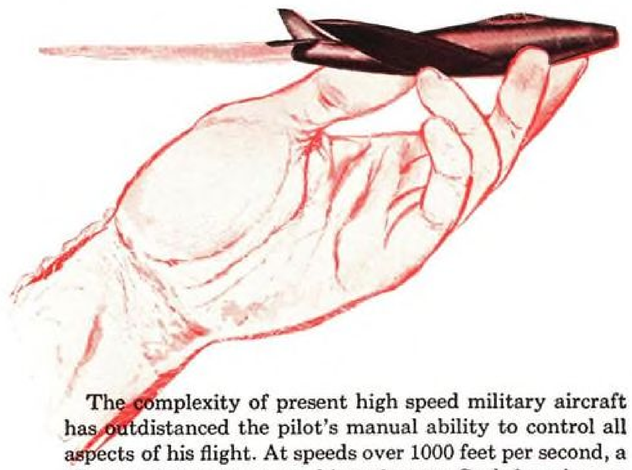
Write for complete data on these and other performance-proved Klixon Circuit Breakers.

SPENCER THERMOSTAT
Division of Metals & Controls Corporation
2808 **FOREST ST., ATTLEBORO, MASS.**

KLIXON

the pilot's unseen helping hand—

AEROTEC **AUTOMATIC CONTROLS**



The complexity of present high speed military aircraft has outdistanced the pilot's manual ability to control all aspects of his flight. At speeds over 1000 feet per second, a pilot must concentrate on his trajectory. Such functions as fuel transfer, tank-pressure regulation, afterburner eyelid control, cabin pressurization and fuel-filter de-icing must be accomplished automatically. In these functions, AEROTEC Float Switches, Valves and Pressure Switches have contributed greatly to the solution of flight problems at trans-sonic speeds—truly a pilot's unseen helping hand!

AEROTEC Automatic Controls have passed extensive qualification tests *simulating actual flight conditions* in accordance with Spec MIL-E-5272. They are installed on such high speed aircraft as the Boeing B47B and B52, Grumman F9F-6, Northrop F89D and Lockheed F94C.

Constant research by AEROTEC Engineers into problems of hermetic sealing, high-pressure actuation, corrosion and high- and low-temperature conditions has maintained AEROTEC'S reputation as progressive designers and manufacturers of the highest quality products.

Let our qualified engineering staff help solve your automatic control problems. One of our specialists is near, ready to serve you. Call or write today.

When you think of Automatic Aircraft Controls, you should automatically think of AEROTEC.

Project Engineers

THE THERMIX CORPORATION

GREENWICH, CONNECTICUT

(Offices in all principal aircraft centers)

Canadian Affiliates: T. C. CHOWN, LTD. Montreal 25, Quebec • Toronto 5, Ontario

THE AEROTEC CORPORATION

AIRCRAFT DIVISION — GREENWICH, CONNECTICUT

Designers and Manufacturers of Automatic Controls—*Valves:* Regulating, Relief and Check types—*Pressure Switches:* Gage, Altitude, Differential and Absolute Types—*Float Switches:* Top, bottom or side mounted—Single, Dual or Tandem.

■ ARNOLD

vision (SPOD), which manages, operates and maintains the facility.

► **Two Types**—Eastman said there are going to be two general types of contractor tests conducted at AEDC:

• **For government contracts,** any request for a test ought to be preceded by a discussion at AEDC between contractor and laboratory people. This would be simply an exploratory talk and would not result in any promises of tests or schedules. The contractor will get these after he passes his test proposal through his project officer to Headquarters, ARDC.

ARDC will assign broad priorities to types of tests, but AEDC will iron out any last-minute requests for changes in schedules.

• **For "proprietary" tests**—which Eastman defined as tests without specific development in mind, but which could involve a contractor's ideas for a family of jet fighters, for example—the procedure would be different.

Plans are to sell time for these tests, although the method of costing has not yet been determined. It will probably be worked out on the basis of charges for the direct cost of electricity, exclusive of overhead.

After tests have been run, the contractor will get preliminary data from automatic data reduction machines. Some early chats with prospective contractors have shown that some of them would like to test for a while and then have a chance to review the data before planning the rest of their test program. This can be worked out, says Eastman.

► **Living, Eating**—AEDC is without facilities where contractors can stay during their tests, but there are motels nearby.

The contractor personnel will be able to draw on military transportation from motel to AEDC on an as-available basis; they will also be able to use the cafeterias at AEDC.

► **Air Connections**—At present, AEDC is also without direct air connection; the airstrip is continually being deferred for lack of funds. Air transportation stops at Nashville (82 miles away) and Chattanooga (97 miles away); but the privately owned William Northern field just north of Tullahoma will take non-scheduled aircraft up to 75,000 lb.

There is no control tower, radio or lights at William Northern, so the field is available only under VFR flight plan. "Make sure you buzz the field a couple of times to clear the cattle off," said one of the engineers.

► **Industry Conference**—Both Kamm and Eastman spoke highly of the results of a conference held with 15 key people of the Glenn L. Martin Co. recently. "They told us their problems,

WEBER *Airgineering*© IN ACTION!

This is only one of many examples of how Weber airgineering works... if you have a problem why not take advantage of Weber's design-to-delivery service?

"Safety... *when seconds count!*"

PROJECT 99 specified Ejection Seats for a new Jet Bomber. These had to be designed to Military Specifications for use by Pilot, Co-pilot and Navigator-Bombardier.

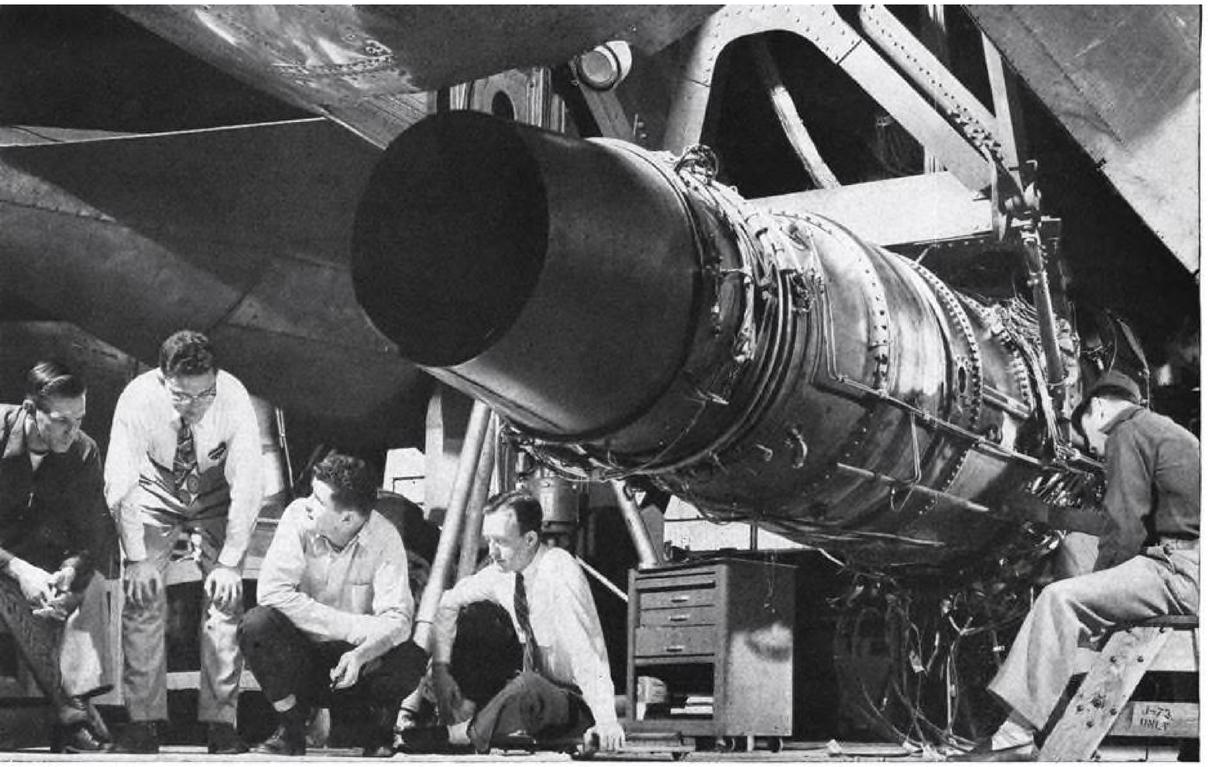
WEBER AIRGINEERING WENT TO WORK . . . complying with Military Specification MIL-S-6326, these seats were designed for 32Gs, while maintaining the lowest weight factor and bettering specification requirements. The electro-mechanical actuator gives complete uni-lateral adjustment for convenience and comfort. Ejection controls are in a compact enclosure in the arm rest, thus eliminating complex external linkages. One lever movement automatically performs the full complement of pre-ejection functions. A simple trigger squeeze accomplishes the ejection.

Airgineered by WEBER

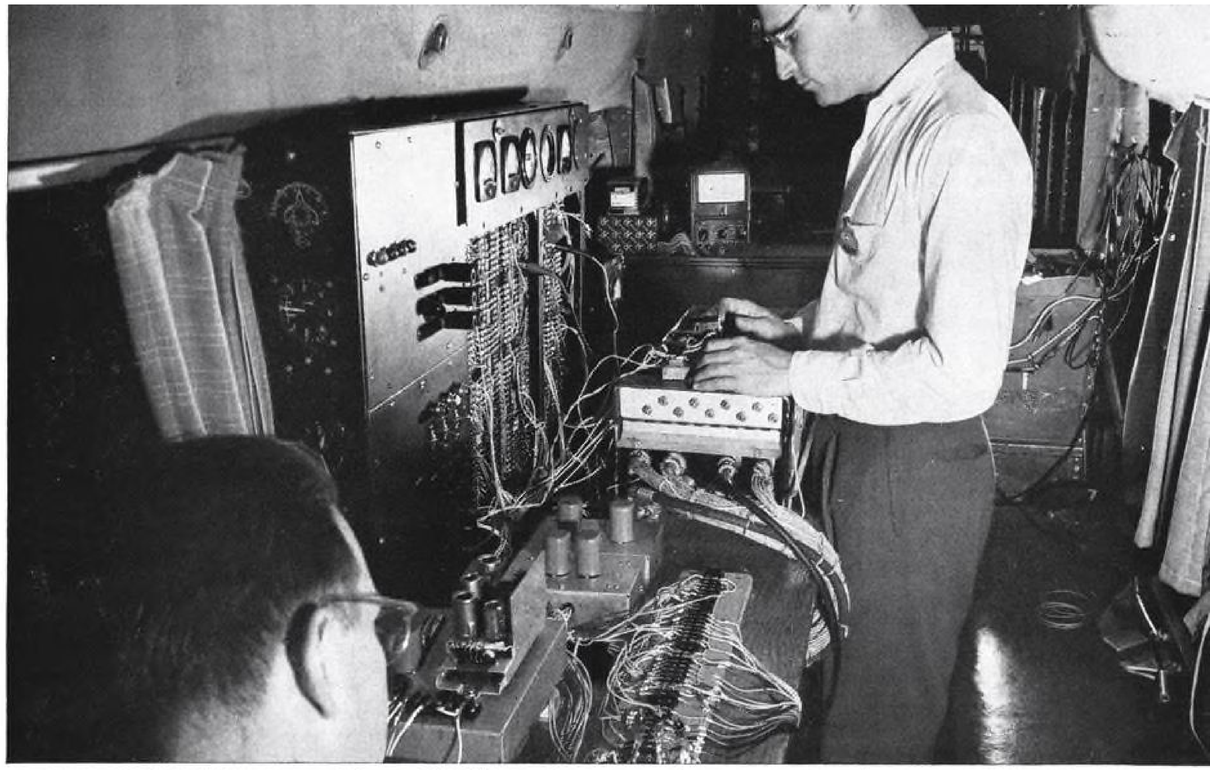
WEBER AIRCRAFT CORPORATION

2820 Ontario Street • Burbank, Calif. • CHarleston 8-5543

Subsidiary of Weber Showcase & Fixture Co., Inc.



G-E JET ENGINEERS study plans of G.E.'s new engine at Flight Test Center in Schenectady, N. Y. The big powerplant is lowered from B-29 during flight. G.E. looks forward—soon—to completely *integrated* armament, engine, autopilot, and electrical system testing.



AUTOMATIC FLIGHT SYSTEMS tests are a daily part of G-E Flight Test Center routine. Advanced model (above) gets final check before take-off. G-E flight control is now installed in Douglas F3D-2 Skynights, Grumman F9F-5P Panthers, and the new swept-wing Grumman F9F-6P Cougar.

"Integrated Testing" Will Improve U. S. Flight Equipment, Save Time and Money

"X" EQUIPMENT gets frequent work-outs in hot planes like this F-86 Sabre, on bailment from Air Force. G-E armament, flight control experts are busy helping the Air Force develop co-ordinated Sunday punches for new U.S. jet planes.

PERISCOPE? No—part of a G-E radar-autopilot-armament system. The boom (installed in B-26) measures pitch and yaw signals for determination of system performance. Such devices help G-E engineers get pin-point accuracy in flight-testing new aviation gear

SCHENECTADY, N. Y.—A dramatic new type of equipment testing is taking shape at G.E.'s Flight Test Center. G-E engineers call it "integrated testing." What it adds up to, is this:

Instead of testing G-E aviation gear "piece-meal" (the old method), General Electric is now equipping planes that can evaluate, in the air, new G-E jet engines, new accessory turbines, autopilots, armament, and radar and electrical systems.

Integrated testing—the latest concept in modern aviation engineering—speeds G-E equipment development. Military and commercial customers will receive G-E products in less time . . . at less cost. The products will be better, too, because G-E engineers can know before delivery exactly how each item will affect the over-all performance of a new plane. Here's how the tests will work.

At Schenectady, N. Y., G.E. now maintains an 8-plane "test fleet" which in recent months has included a B-17, B-25, B-26, B-29, two B-45's, F-86's, F-94's, and an A3D. Some of G.E.'s current bailment-aircraft are modified to carry whole systems of test equipment. Jet engines are slung from bomb-bays . . . armament systems set up in the fuselage . . . autopilots and radar systems are mounted in the planes' noses.

Once in the air, G-E engineers "turn on" the test equipment to determine system-performance under flight conditions. Then while sensitive instruments measure responses, automatic recording equipment notes individual *component*-performance—later the results are passed to design engineers, who make whatever system-changes are needed to assure the best, over-all performance.

Procedures like these back up the G-E saying, "Progress is our most important product." The next time you need flight equipment, talk to G.E. first. For G-E equipment is built by men who know the needs of the aviation industry. *Section 210-79, General Electric, Schenectady 5, N. Y.*

GENERAL ELECTRIC

RADOME on tip of B-17 wing at Flight Test Center now carries special apparatus. But pods were originally designed for gunners and wing-tip observers.

classified
CLEARED
by acceptance by the entire aircraft industry

close tolerance
AN and NAS standards

high tensile
cold-rolled fillet

special alloy
Monel, Inconel, stainless

special design
for high temperature applications

If it has to be "as good as a Cooper bolt," buy it from

COOPER
precision products

5625 WEST CENTURY BOULEVARD
LOS ANGELES 45, CALIFORNIA

we told them ours, and as a result, we're going to be able to get along better when they come here for tests," said Kamm.

Kamm and Eastman felt that this was a desirable way of acquainting both industry and AEDC people with mutual problems, and said that they would be willing anytime to meet with similar industry groups at AEDC.

"We can show them what we've got to test with, and the kind of data we can give them," said Eastman. "They can get acquainted around here, too, and that's important. Then they'll be able to walk in here and test with a minimum of small troubles."

▶ **Contractor's Choice**—"As far as we're concerned, the contractor can come down here and conduct his test program any way he wants to," said Eastman. "All we ask is a chance to look at his program and decide whether or not it is in the right order.

"Obviously, we don't want to crank one tunnel up for an hour, move to another for a few minutes, and then go back to the first one again."

"The only time we'll tell him he can't make a certain test," put in Kamm, "is if we feel that the test won't be safe for the facility."

Operating Division

It's difficult to talk about AEDC without mentioning the Sverdrup and Parcel Operating Division.

SPOD had been operating on an interim basis with four-month contracts, but this arrangement terminated, as expected, at the end of July. Gen. T. F. Farrell, SPOD managing director, told AVIATION WEEK in mid-July that a new long-term contract was then being negotiated and that the terms of the contract had been agreed upon by both parties. The new agreement names Aro, Inc., as the contractor for operation, effective Aug. 1.

Originally, operation of the facility was by the firm of Aro, Inc., a wholly owned subsidiary of Sverdrup and Parcel. A recent political-financial crisis resulted in the creation of SPOD.

SPOD had a separate contract, and mission and financing, and reported separately to the Air Force. Apparently things have straightened out now to the extent that the name—if not the structure—of the original operator can be worked into the contract again.

▶ **Major Effort**—Maintenance and operation of the physical plant accounts for the jobs of the majority of SPOD employes. They handle all the services of the 41,300-acre reservation—three times the size of nearby Nashville—including its six square miles of reservoir.

Why BREEZE MARK **JOB ENGINEERED BELLOWS**

. . . outperform and outlast any other types

TYPICAL APPLICATIONS

Expansion Joints
Pressure Switches
Pressure Control Instruments
High Temperatures (Exhausts)
Low Temperatures (Liquid Gases)
Swivel Type Joints for High Pressure Steam Lines
Valve Seals
Packless Valves
Flow Control
Critical Thermostatic Uses

Where ordinary formed bellows fail, Breeze welded diaphragm bellows stand up under critical conditions for a long service life.

Their dependable performance is due to the fact that they are custom made for each individual application. This permits selection of the most satisfactory metal, the correct thickness, size and shape. Each job is engineered to meet or exceed specified requirements as to deflection, resistance to corrosion, vibration and high internal and external pressures. "Strength insurance" is welded in at inside and outside diameters. If you have a bellows problem, send for our form B-100, on which you can conveniently submit your special requirements.

Sizes ⅜ to 10 inches inside diameter

OTHER BREEZE PRECISION PRODUCTS

Special Electrical Connectors • Ignition Shielding
Electro-Mechanical and Hydraulic Actuators
All Types of Flexible Metal Tubing
Aero-Seal Worm Drive Hose Clamps

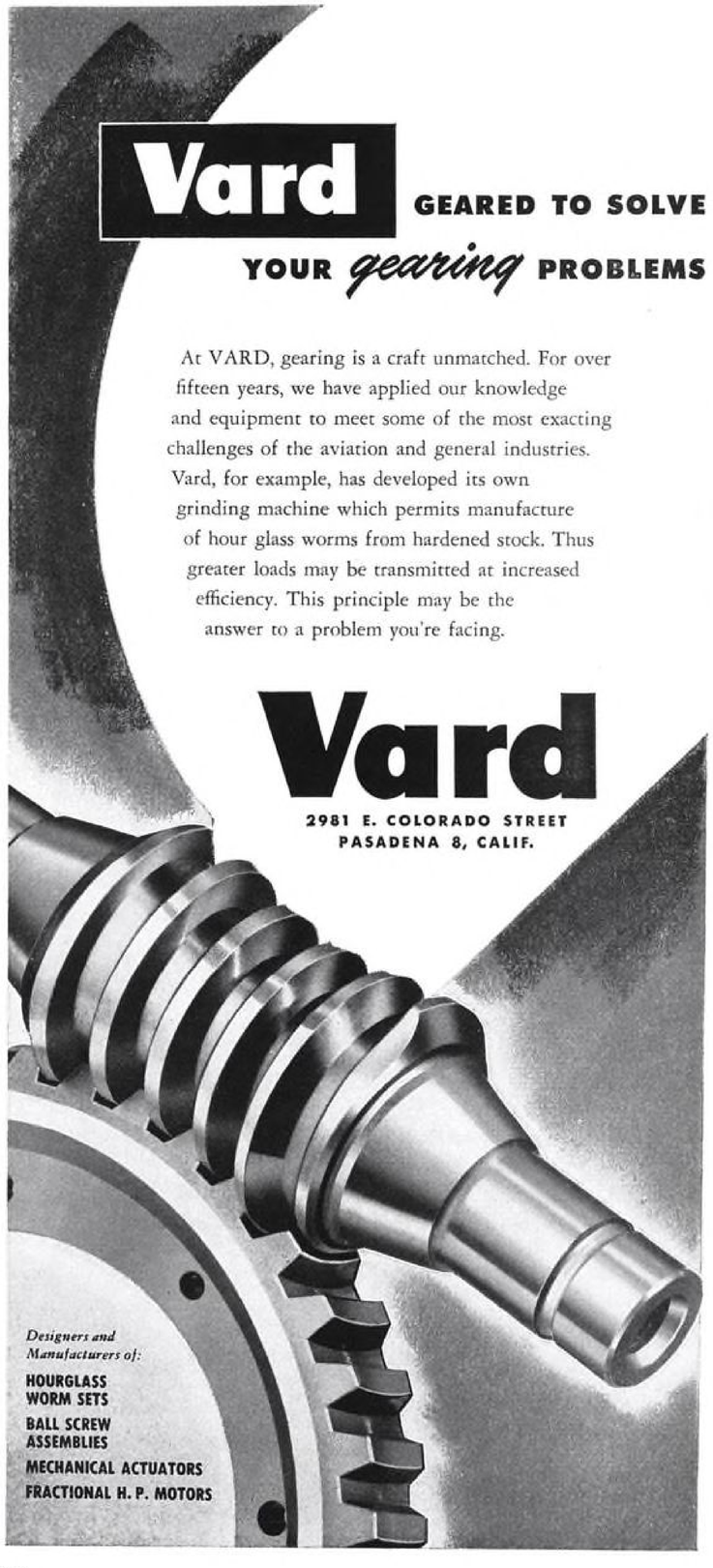
BREEZE
CORPORATIONS, INC.
41 South 6th Street, Newark 7, New Jersey

Vard GEARED TO SOLVE YOUR *gearing* PROBLEMS

At VARD, gearing is a craft unmatched. For over fifteen years, we have applied our knowledge and equipment to meet some of the most exacting challenges of the aviation and general industries. Vard, for example, has developed its own grinding machine which permits manufacture of hour glass worms from hardened stock. Thus greater loads may be transmitted at increased efficiency. This principle may be the answer to a problem you're facing.

Vard

2981 E. COLORADO STREET
PASADENA 8, CALIF.



Designers and Manufacturers of:

HOURGLASS WORM SETS
BALL SCREW ASSEMBLIES
MECHANICAL ACTUATORS
FRACTIONAL H. P. MOTORS

■ ARNOLD

Peak pumping capacity for the water system is a staggering 250,000 gpm., a rate equivalent to that of Washington, D. C. More power is distributed throughout the facility than Nashville uses.

The area is threaded with roads, and requires fire and security patrols, communications and motor and rail transportation systems. All of these tasks are done by SPOD.

The organization chart of SPOD shows two broad functions: engineering and administration. The engineers support the tests or perform them; by the loose distinction between groups, everybody else is an administrator. Total employment of as of July 10 was 1,318; in a couple of years this figure should be about 2,000.

► **Engineering Plans**—Director of engineering for SPOD is J. M. Wild. "We're buying time with this facility," he said. "We should be able to get as much as 100 test hours on an engine-airframe combination in a month, and it might take years to get that same amount of time in flight tests. I know one experimental job that put on only 27 hours of flight time in one year."

One of Wild's projects is to dispel any wrong feelings engineers may have about the type of work to be done at AEDC. "We don't want engineers to think that the job is turning valves and reading dials," he said.

"There's much more to the work than that. We'll have some research projects, for example, associated with the mission.

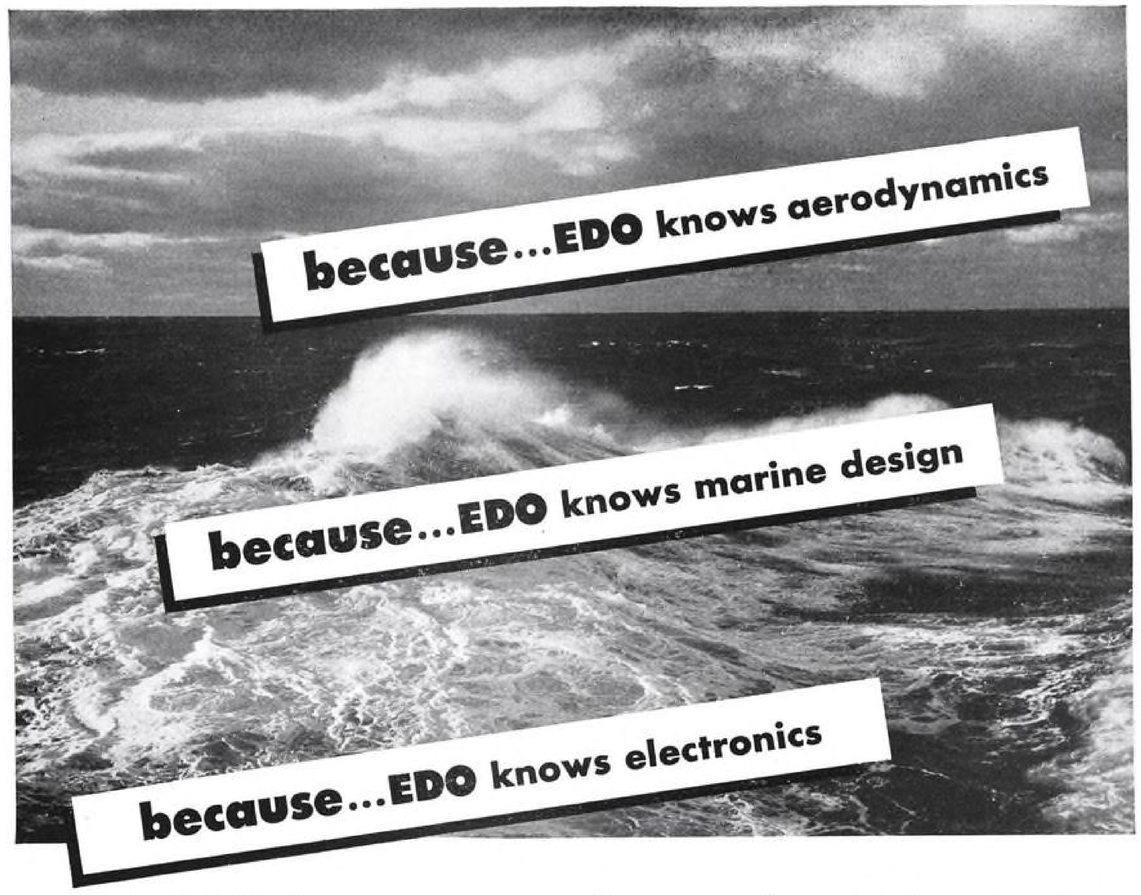
"We want to encourage ideas from young engineers. This is a young facility with no pre-conceived ideas."

► **University Plan**—Wild outlined to AVIATION WEEK a plan for advanced education which is being worked out by the Air Force, AEDC and the universities in the area.

The Air Force began the study of university affiliation with AEDC, and directed its main effort at a graduate degree program. SPOD engineers would benefit by being permitted to go on and get higher degrees; AEDC would benefit from the advanced education acquired by its staff. The universities would gain financially and scholastically from close contact with the programs and development at the Center.

Another phase of the overall plan would establish a cooperative training program, where scientists could do research under the guidance of a university staff and using the incomparable facilities of the Center.

► **Courses Start**—The University of Tennessee's Extension Division now is offering a large variety of courses to the staff of AEDC. Classrooms have been set up in Tullahoma as a service, and



let EDO house your electronic equipment

Housing intricate electronic equipment for airborne or shipboard use to withstand shocks and forces which might cause malfunction often presents problems as difficult as the design of electronic systems themselves.

Tackling such problems for electronic manufacturers, ship and aircraft builders is a specialty of the Edo Corporation. Whether your equipment must operate properly on jet aircraft or on board ship under battle conditions, its reliability is improved if mounted in Edo-designed and built cabinets or housings.

If you have a housing problem, why not talk it over with our versatile engineering staff whose three-fold experience in the marine, aviation and electronics fields is unique *and at your disposal.*

to withstand...
SHOCK
MACH 1 SPEED
VIBRATION
CONCUSSION
SPRAY
ENVIRONMENTAL

TWO TYPICAL HOUSING PROBLEMS SOLVED BY EDO

1. AIRBORNE HOUSING. A volume producer of airborne radar nacelles, Edo was asked to design a pressurized external store housing capable of being flown in the trans-sonic speed range. From wind tunnel tests to completed tooling and production, Edo relieved the electronics manufacturer and the aircraft builder of these design problems.

2. SEABORNE INSTALLATIONS. To house its own electronic equipment developed and manufactured for the Navy, Edo engineers have perfected a series of *standard* electronic cabinets admirably suited to naval electronic equipment. Capable of housing all standard electronic units, the Edo cabinets are vibration-proof and spray-proof.

Edo CORPORATION College Point, L.I., N.Y. SINCE 1925

HARTWELL
Trigger-Action

FLUSH LATCHES AND HINGES

The World's *best* and most *complete* line for every aircraft application . . .

"Make them *flush, safe* and *simple!*" was the plea of aircraft builders to the latch and hinge manufacturers.

So HARTWELL did. *Flushness* for streamlining to eliminate external load conditions. *Safe,* rugged compactness for dependable performance. *Simple,* positive-action to speed up maintenance operations.

Finger-tip pressure on the trigger of the latch releases the bolt and permits the door to open. Finger-tip pressure on the bolt, when the door is in place, locks it shut.

Aerodynamically flush and safe, they meet or surpass stringent miltiary requirements.

Investigate the advantages of HARTWELL equipment. They add up to efficency and value unsurpassed in today's aviation industry.

Write for engineering specifications and counsel.

HARTWELL
AVIATION SUPPLY COMPANY
Manufacturers of Aircraft Flush Latches and Hinges, Fittings and Cable Terminals.
9035 Venice Boulevard, Los Angeles 34, Calif.
Branch Office: Wichita, Kansas

■ ARNOLD

almost 100 engineers in SPOD are taking these courses.

Currently the only portion of these plans in operation is the extension service of the University of Tennessee; but steps are being taken to get the other phases rolling as soon as possible. SPOD management realizes the value of available advanced-education facilities as a drawing card for engineering talent.

How It Began

AEDC had its genesis back in 1944, when some engineers and military people at Wright Field realized that airframe and engine development was about to run out of facilities. In November of that year, Gen. H. H. Arnold—in whose memory the Center was named—asked Dr. Theodore von Karman to study all the possibilities and desirabilities for the future development of the Air Force.

▶ **Super Wright Field**—The end product of the man-hours put in by von Karman and his advisory group was a proposal for a new Wright Field, a super development center for rocket tests, avionic work, parachute development, armament tests, and anything else that the Air Force might possibly need. In this package, of course, were huge windtunnels and engine test cells, as well as some smaller investigatory tunnels.

The astronomical requirements for electrical power and water supply meant that such a new Center had to be built somewhere other than at Wright Field.

▶ **Deferred**—These ambitious plans were referred by the Bureau of the Budget in 1946 to the Joint Research and Development Board which started a lengthy review of the entire matter.

Because of this delay, and because the legislation for the super Center was tied up so long, the Air Force began to pull out bits and pieces.

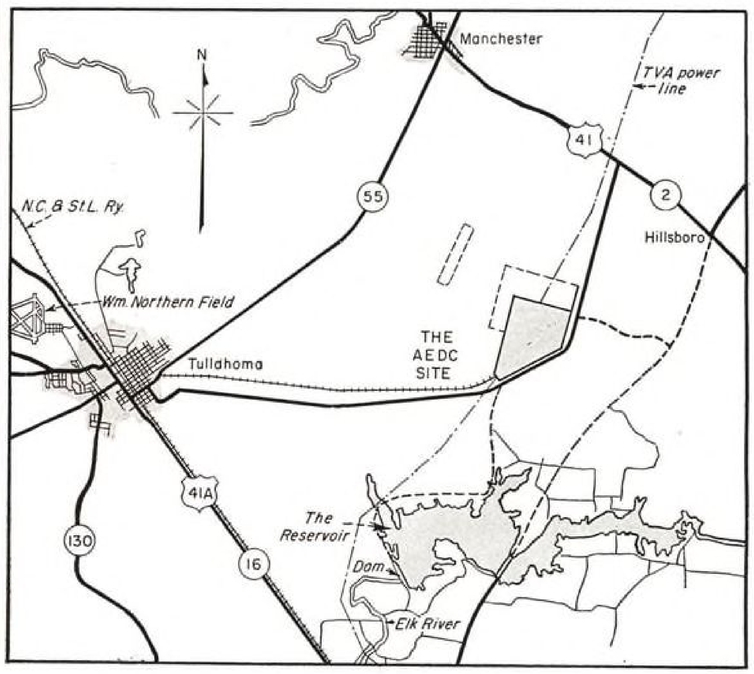
Eventually these pieces were to become—under other names and after considerable discussion—centers of the ARDC.

It was also in 1946 that an executive committee meeting of NACA named a panel headed by Arthur Raymond, of Douglas Aircraft Co., to study the national requirements for transonic and supersonic windtunnels.

The final report of this panel became the initial recommendations for the Unitary Windtunnel Plan. AEDC, because of the windtunnels planned at the Center, became closely involved with the plan and correlated its work with NACA. The gigantic propulsion windtunnel of AEDC became a part of the Unitary Plan.

▶ **Completion Date?**—There is no official date for completion of the Center. A consensus of some of the AEDC and SPOD personnel seems to point to 1957 as an estimate of completion of the currently planned portions.

But in the engineering and development business, there is always tomorrow, and as one engineer put it, "When that designer gets back to his drawing board, we've got to be there to look over his shoulder and figure out what he's going to want to test next."



TRANSISTORS AND DIODES
POINT-CONTACT AND JUNCTION

FOR CIVILIAN AND MILITARY APPLICATION

NATIONAL UNION RADIO CORPORATION
HATBORO, PENNSYLVANIA

TUBES: TV PICTURE; TV & RADIO RECEIVING; SPECIAL PURPOSE; OSCILLOSCOPE, RADAR & SPECIAL PURPOSE CATHODE RAY • ELECTRON TUBE RESEARCH • SPECIALIZED TUBE & TRANSISTOR TESTING EQUIPMENT

This Exide advertisement appeared in national magazines in 1916.

The "giant that lives in a box" gets stronger every year ... because of EXIDE RESEARCH

Exide Aircraft Batteries meet the demand for dependable power

METALLOGRAPH is another tool that is aiding our scientists in studies of metals and new alloys.

X-RAY DIFFRACTION makes possible new approaches to solutions of old problems.

Since he was first featured in Exide advertising, almost 40 years ago, the "giant in a box" has grown considerably. Exide batteries today are more powerful, more dependable, longer-lasting.

Exide Aircraft Batteries are recognized for their superior performance under any and all operating conditions. The high efficiency, dependability, long life and ease of maintenance of modern Exide Aircraft Batteries are due to years of research in the field and in the laboratory, plus the cooperation of the aircraft industry.

In military as well as in commercial and utility aircraft, Exide batteries supply a dependable source of power for starting . . . lighting . . . ignition . . . communications . . . instruments, and other battery applications.

Exide batteries today are more powerful, more dependable, longer-lasting because of a continuous research program initiated in 1889. Over the years, Exide's never-ending search for new and more efficient materials to build better batteries has resulted in improved alloys, wide use of synthetic resins, new manufacturing techniques. Consequently, specially-trained Exide technicians are able to build longer life and optimum performance into established types of batteries, and to develop specific batteries for new applications.

Illustrated on these pages are some of the men and modern equipment used in Exide's five-step laboratory operations: 1. *Research*. 2. *Product development*. 3. *Design*. 4. *Manufacturing control*. 5. *Product testing*.

Strict adherence to these five steps keeps Exide Aircraft Batteries *way out in front for dependable power*. Whatever your battery requirements for commercial, government, executive planes . . . you can depend upon Exide Batteries.

Exide is your best aircraft battery buy . . . AT ANY PRICE.

Exide
BATTERIES

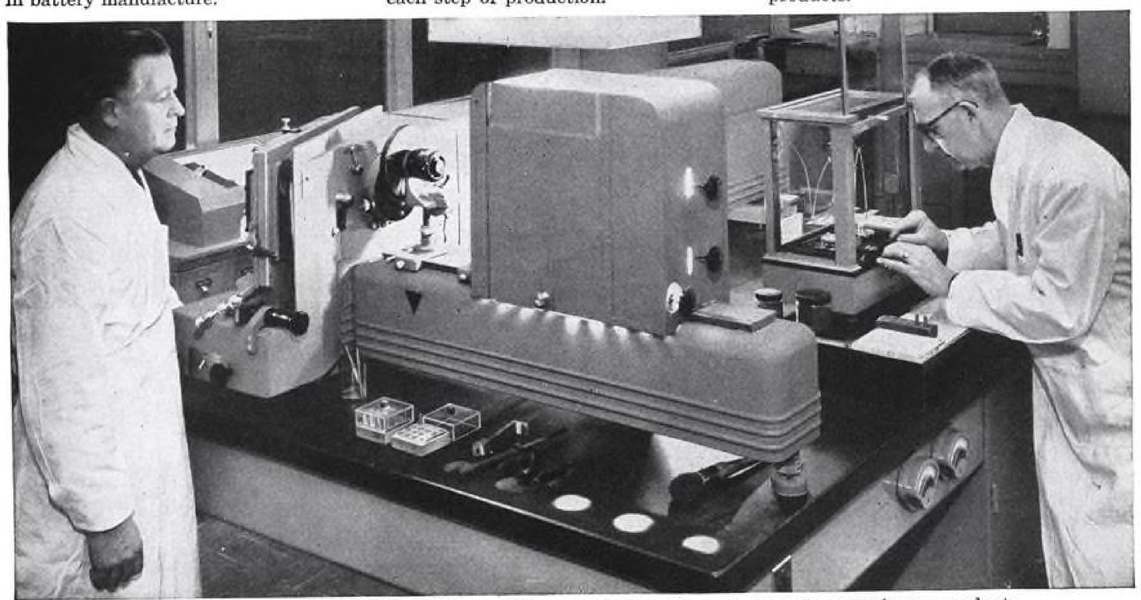
"Exide" *Reg. Trade-mark U.S. Pat. Off.*

1888 . . . DEPENDABLE BATTERIES FOR 65 YEARS . . . 1953

SPECTROPHOTOMETER aids in development and control of many materials used in battery manufacture.

QUALITY CONTROL tests are made of each component of Exide Batteries at each step of production.

LIFE CYCLE tests in the laboratory help us to determine the useful life of our products.



SPECTROGRAPHIC analysis is used for quality control of metals and other elements in our products.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 2 • ***Exide Batteries of Canada, Limited, Toronto***

■ PATRICK

Missile Center Expands For Long-Range Flights

Cocoa, Fla.—The first pilotless bombers to use the full current capability of the Air Force Missile Test Center are scheduled to roar down the Bahama island chain before winter.

The scarlet missiles, white-marked for better tracking, will speed over the heavily instrumented down-range stations for about 800 miles. Grand Turk Island will be the end of the line for some, but will serve only as a pylon for others that will turn and fly back up-range to a skid landing near their launching point at Cape Canaveral.

For practitioners in the guided-missile art, an 800-mile flight will be a completely new experience. But for the crews manning the down-range stations, it will be just like the simulated runs they have been tracking for many months.

That kind of test capability—being able to handle a range distance which has quadrupled overnight—emphasizes the policies and advanced techniques that have made AFMTC such a potentially valuable laboratory.

▶ **Range Buildup**—In the three years since the first missile—Bumper 8, a two-stage modified German V-2 and WAC Corporal—lifted off the concrete pad at the Cape, the range has been in a constant state of construction aimed at improving and extending the range.

Today the line of flight stretches from Cape Canaveral to pass between stations in the Dominican Republic and Puerto Rico which will be finished in the near future. En route, there are island way stations—fully instrumented auxiliary Air Force bases (AAFB)—about every 150 nautical miles.

Radio communications and a submarine cable link the islands to each other and to central control at the Cape, tying the entire range into a single precision instrument.

▶ **PAA May Run It**—The operation of the range has been done by Air Force technicians, specially schooled by on-the-job training. But at the time of AVIATION WEEK's visit in mid-July, the Air Force was negotiating with Pan American World Airways, in association with the Radio Corp. of America, for contractor operation of the range, presumably on a basis similar to that by which Aro, Inc., will operate the Arnold Engineering Development Center, Tullahoma, Tenn.

The Air Force decision was made on the basis of two counts: the increasing shortage of available technicians in the Air Force, and economy.

Twelve organizations submitted proposals to run the range; each was permitted to define the extent—as well as requested to estimate the cost—of the work to be done. The joint proposal of PAA and RCA received the Air Force's nod, and negotiations began.

Currently, the extent of the job has not been finally defined.

The Range

Launching sites for the range are concrete pads set into the glistening sand of Cape Canaveral. From these pads, the line of flight stretches southeast over the islands of the Bahama chain.

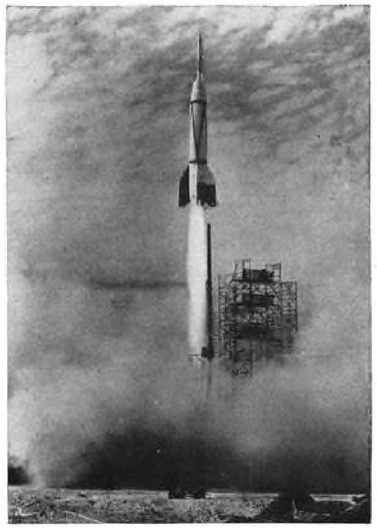
On five of these islands, as in the Dominican Republic and Puerto Rico, the Air Force is completing the installation of auxiliary bases to monitor the flight of pilotless aircraft down-range.

▶ **The Stations**—The first station is on Grand Bahama Island, about 180 miles down. Another 120 miles down is the base at Eleuthera Island. San Salvador station is 200 mi. further on, and marks roughly the 500 mile point of the range.

The site on Mayaguana Island is about 150 miles more, and the last station in the Bahama group is on Grand Turk Island, about 800 miles from Cape Canaveral.

The Dominican Republic site turns the 1,000-mile mark, and by the time the missile passes over the Puerto Rico base, it will have traveled about 1,150 miles.

This fall will see the completion of the range to Grand Turk, and within a matter of months after that, the down-range stations at locations in the Dominican Republic and Puerto Rico should be completed.



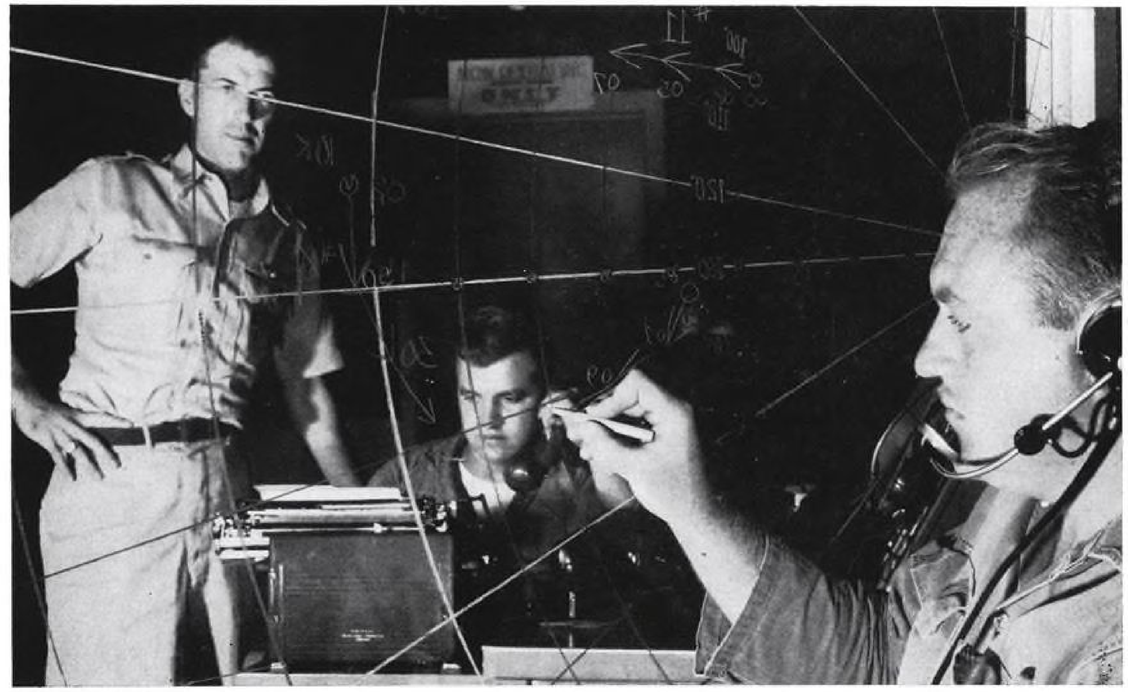
BUMPER 8 lifts off firing pad at AFMTC.

ANTENNAS receive flight intelligence.

▶ **Even Longer**—But the range needn't stop at the 1,000-nautical mile mark. If you take a globe and a piece of string, you can see for yourself the ideal siting of the range, should it require extension.

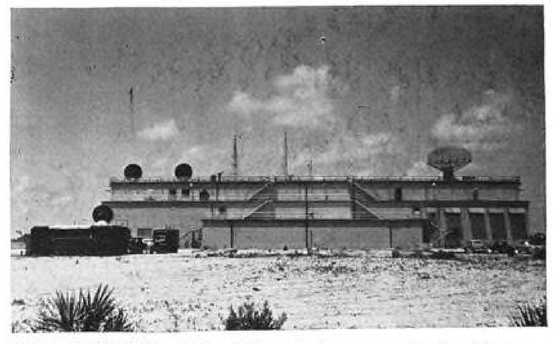
From Cape Canaveral down the chain, between the Dominican Republic and Puerto Rico, the flight line can be extended to cut across the northeast corner of Brazil. From there, the next landfall is the southern tip of Africa; the string finally intersects the west coast of Australia, half the world away!

Brazil would seem to be a practical terminus for the range for some time to come; an impact area there would be about 3,500 miles from the launch point. If the missile could be turned there and flown back, 7,000 miles is the obvious range distance.



RANGE SAFETY TEAM plots position of ships and aircraft inside flight area of missiles, stands by to destroy missile if it leaves limits.

SUBMERGED blockhouse near firing point uses periscope.



CAPE CONTROL station is largest, is nerve center for firings.

▶ **Way Stations**—The down-range stations are technical outposts, manned by 100 to 150 technicians and operated on military basis. Typically, one of these auxiliary Air Force bases will contain complete radio and wire communications, weather station, range safety center, telemetry receiving station, radar and optical tracking center, living quarters for the personnel and an airstrip.

Many small supplies needed for operation are flown in by Fairchild C-119s; there is also an airlift service operated down-range by Patrick AFB for personnel going on or off duty. Most of the bulk supplies are sent down in the holds of landing craft that are operated by the Military Sea Transport Service.

▶ **Navy Design**—Bases were designed by Navy's Bureau of Yards and Docks and built by contractors using materials from the U.S.

All buildings on the base are hurricane-proofed against a 150-knot wind. Half-an-hour after a hurricane warning, the base is buttoned up. All radar antennas and other gear have been removed and put under cover; the other antennas are guyed to withstand the blasts of the tropical fury.

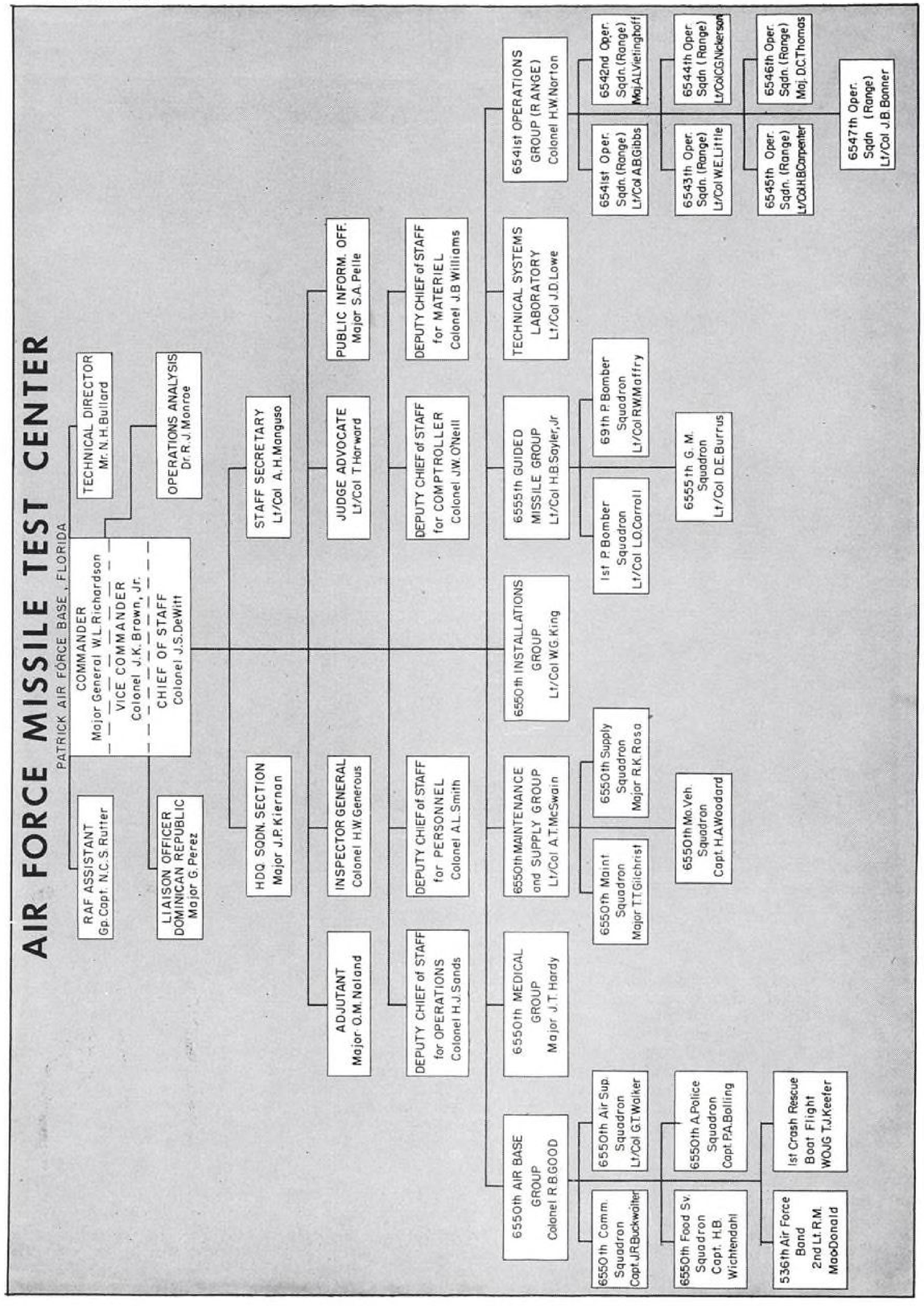
The Men

Civilization has ignored most of the areas around the bases, and native villages are all off limits to the military. In spite of the apparent lack of things to do, the airmen stationed at any AAFB have plenty to occupy their time.

Technically, they keep busy on the continual string of tests which are made down the instrumented chain. If a missile is being fired, they have the usual complement of work to handle. Otherwise a plane carrying guidance or some other kind of equipment for a simulated run will make the trip down-range almost every day.

▶ **Typical Airman**—A man assigned to down-range station has been through basic training, and in addition has had electronics training at Keesler AFB or Chanute AFB. But he will find unfamiliar equipment in his new assignment.

His first training step takes him to



de Havilland announce an improved Dove

The power is increased from 680 b.h.p. to 760 b.h.p. by the introduction of the new Gipsy Queen Mk. 2 engine of 380 b.h.p.

The gross weight is increased from 8,500 lb. to 8,800 lb.

This means more payload or more range or a combination of these two advantages.

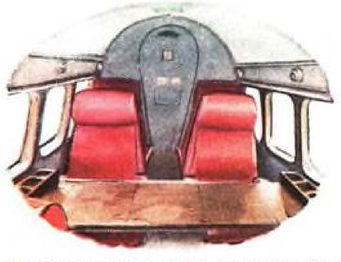
For the executive — an airliner in miniature

DE HAVILLAND DOVE

Made by the builders of the Comet, the world's first jet airliner.

Factory-scale overhaul, servicing and spare parts facilities are available in U.S.A. for the Dove airframe, engines and propellers.

de Havilland representative in U.S.A.,
Linden Airport, New Jersey.
Telephone : Linden 3-3530.
Telegrams : Havilland, Linden, N.J.

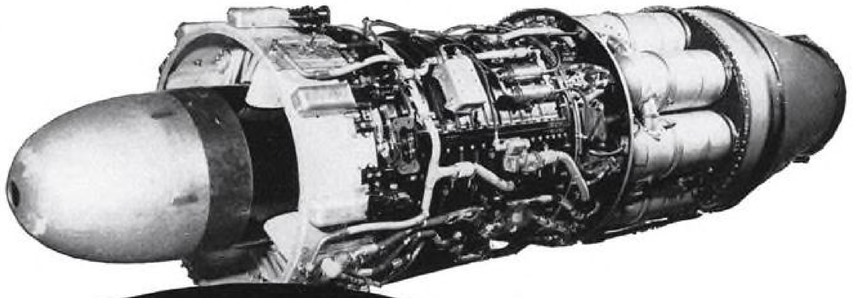


Standard executive arrangement seats four in luxury. Folding full-width table.

Facing pairs of adjustable armchairs are quickly convertible into softly upholstered couches.

Two additional seats are located forward. One is particularly suitable for a secretary.

Factories in England, North America and Australia. Distributing and servicing organisation throughout the free world.



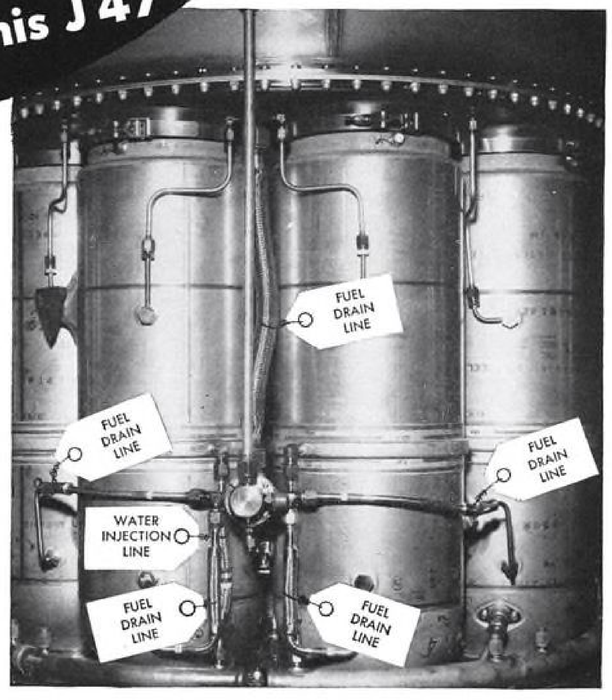
HERE'S HOW

REX-FLEX STAINLESS STEEL HOSE keeps vibration out of rigid lines in this J 47

The close-up at the right of the underside of a J 47 jet engine shows a few typical REX-FLEX applications. In services like these or wherever liquids or gases must be conveyed under conditions of vibration, offset alignment, flexation or expansion and contraction, REX-FLEX combines extreme flexibility with the heat resistance, durability and light weight of stainless steel.

Non-collapsible, non-inflammable, fatigue-resistant REX-FLEX flexible stainless steel hose, ducting and connectors are made in diameters up to 6" I.D. They can be manufactured in a variety of forms to meet your specifications.

Write for full information on REX-FLEX assemblies to fill your needs. Also see the Flexonics data in Aeronautical Engineering Catalog.



Flexonics *Corporation* AIRCRAFT DIVISION 1302 S. THIRD AVENUE • MAYWOOD, ILLINOIS

FORMERLY CHICAGO METAL HOSE CORPORATION

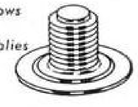
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Flexon identifies products of Flexonics Corporation that have served industry for over 50 years.

Flexible metal hose

Expansion joints

Aircraft components


Metallic bellows and bellows assemblies

Maj. Gen. William Lloyd Richardson, commander, Air Force Missile Test Center . . . artillery and ordnance expert . . . born Saginaw, Mich., 1901 . . . graduated U.S Military Academy, 1924 . . . appointed second lieutenant, Coast Artillery Corps . . . taught tactics at West Point . . . served in operations planning section of War Department general staff . . . organized airdrome defenses of 8th Air Force in England . . . trained anti-aircraft units in U. S. for combat duty . . . organized and trained 9th Air Defense Command of 9th Air Force in Europe . . . post-war chief of guided missiles division, AAF Hq. . . . transferred to USAF when it became a separate service . . . became chief of Long Range Proving Ground when it was organized in 1949 and has commanded it ever since.

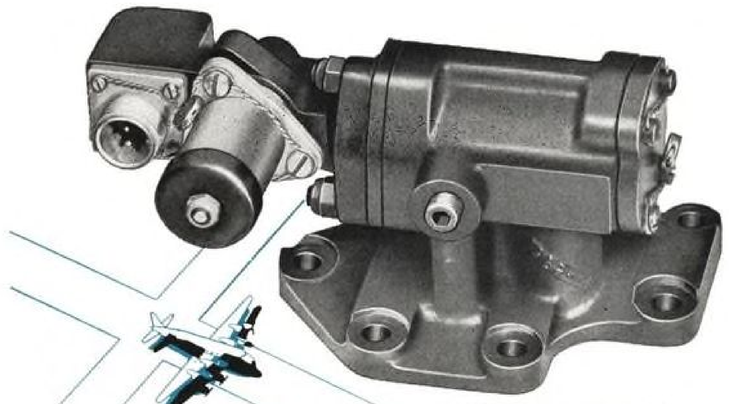
Jupiter, a training center on the Florida coast which simulates an island base. There he takes a course laid out along similar lines and taught by technicians from RCA.

▶ **Filling the Gaps**—The instructors find out what the man knows to start with; then they give him special training to fill the gaps. After that, he has a specialty; his stay at Jupiter is determined by how much extra coaching he needs, and terminates when he is considered sufficiently capable of doing his job.

An airman intended for guided-missile cadres is assigned to the Guided Missile Group and either the 1st or 69th Pilotless Bomb Squadron, which are now being formed to use the Martin B-61 Matador.

He may get extra instruction in special phases—guidance, launching, propellants handling. When the squadron as a whole is ready, it is reassigned to the Tactical Air Force.

▶ **Briefing**—Before they go down-range,



ADEL

ENGINE ACCESSORIES

Precision-Built . . . Performance-Proved . . .

USED BY MAJOR AIRLINES AND AIRFRAME MANUFACTURERS

Valves and actuators you can specify with confidence. Provide fail-safe operation in case of electrical failure. Light weight.

Operating fluid: Engine Oil.
Duty: Continuous.
Solenoid: Single-coil, internally grounded.
Electrical Range: 18 to 30 volts dc.
Current drain: 0.5 amp at 24 volts.
Corrosion resistant construction.

24730 BLOWER CLUTCH SELECTOR VALVE
For use on Pratt & Whitney R-2800 engine.
Controls operation of two-speed supercharger. Electrical control is positive in action. Current failure returns valve to normal position, placing supercharger in low gear.
Weight: 2.2 lb.

26153 SUPERCHARGER CONTROL VALVE
For use on Pratt & Whitney R4360-63 engine.
Directs oil flow from pressure supply to high blower. Rated flow—9 gpm.
Built-in stamina provides dependable performance under extreme vibration conditions.
Weight: 1.9 lb.

24793 SUPERCHARGER CONTROL ACTUATOR
For use on Wright R3350-30 engine.
Provides positive control of two-speed supercharger with complete immunity to pressure surges in the operating fluid. Durable and dependable.
Weight: 1.75 lb.

25805 SUPERCHARGER ACTUATOR
For use on Wright R1820-103 engine.
Converts hydraulic pressure to mechanical push-pull actuation. Electrically controlled. Combines reliable operation with proven design . . . rugged construction.
Weight: 1.95 lb.

Write for new, descriptive Brochure containing detailed information on ADEL's line of Aircraft Equipment and facilities. Address ADEL DIVISION, GENERAL METALS CORPORATION, 10783 Van Owen St., Burbank, Calif.

ADEL produces a complete line of Aircraft HYDRAULIC & PNEUMATIC CONTROL EQUIPMENT, HEATER, ANTI-ICING & FUEL SYSTEM EQUIPMENT, ENGINE ACCESSORIES AND LINE SUPPORTS.

ADEL PREFERRED FOR AIRCRAFT THE WORLD OVER

DIVISION OF GENERAL METALS CORPORATION • BURBANK, CALIF. • HUNTINGTON, W. VA.

CANADIAN REPRESENTATIVE: RAILWAY & POWER ENGINEERING CORPORATION, LIMITED

■ PATRICK

the airman, officer and civilian alike receive a briefing on the geography, history and background of the islands and their peoples.

The door to the briefing room has a large photograph of an aged Negro riding a donkey cart down a narrow alley; surcharged across the top of the picture is the motto, "In order to have good neighbors, we must be good neighbors."

Inside the converted Quonset hut which is the briefing room, there are relief maps of the range and of each island. On a continuous shelf around the room are samples of the products, currency, stamps and other items characteristic of the islands.

► **Well-Educated**—It's paradoxical, but man for man the natives of the islands know more about guided missiles than the natives of the United States. The reason stems from a unique tour conducted by the former public information officer at Patrick.

He organized a team of officers and men to go through the islands and explain just what was going to be done on a guided missile test range. All the safety precautions were emphasized, and everyone was urged to be on the lookout for missiles in a recoverable state.

The team took with them a set of charts showing the workings of a missile. For live demonstrations of jet propulsion, they took along a supply of balloons and a model missile, rigged to be propelled along a wire by the thrust from a tiny CO_2 bottle.

From a salvagable V-1 came a fuselage, and from another missile they snagged a pulsejet engine which fit inside the V-1 body. Wings and a Vee-tail completed the operating mockup of a full-size missile called "Liberty's Stinger."

► **The Tour**—Thus equipped, the team set out down the island chain. At each tiny settlement they stopped, unlimbered the exhibits, and presented their traveling medicine show to the wide-eyed audience.

Sometimes they spoke in the village church, sometimes in the town square. The balloons rasped erratically above the heads of the crowd, the model whistled along its wire runway, and the charts were explained. Then came the climax when Liberty's Stinger was fired up.

A pulsejet in full cry is a devastating sound, even to the man who has heard such devices before. To the natives of the islands, it was a new—and in some cases, frightening—experience. But they stuck it out, with the exception of two small boys who got too close one day when the Stinger sounded off. The pair leaped into the air, and were running before they came down. They plowed through an old board fence in their haste, but kept on right out of sight.

► **Good Show**—The results of the tour were beyond expectation. The team was received with enthusiasm; its arrival meant the equivalent of a local holiday. Every inhabitant swarmed down to the beach to help carry the exhibits, and to wave goodbye after the lecture was over.

One officer not associated with the team summed it this way:

"It was a missionary trip, and it could have made or broken our job here. We had to have the cooperation of the people in the islands in order to use the range, and we wanted to show them that we were going to do everything possible to make the operation safe. The tour team did a magnificent job."

Flight Sequence

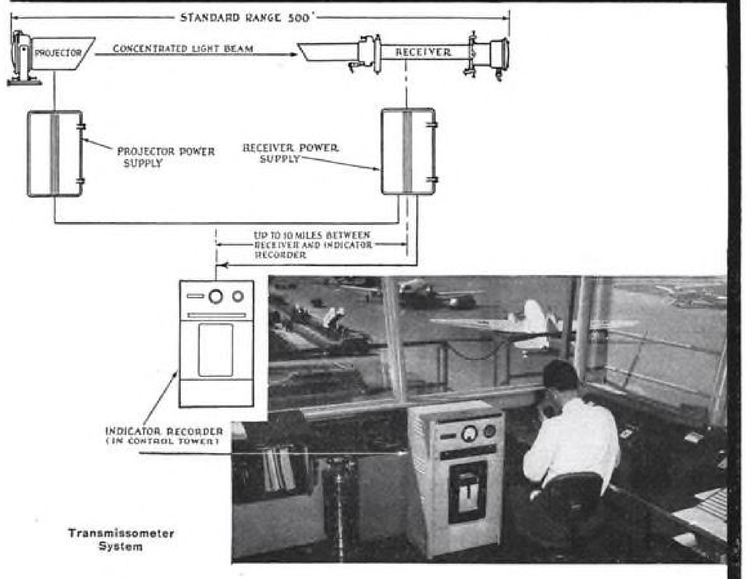
Like most of the other development test centers of the Command, AFMTC's big job is contractor service. The entire purpose of the range and supporting services is to help a missile contractor get the kind of data he wants.

Here, as in other centers, the contractor is the boss; his tests can cover

CROUSE-HINDS

research and development engineers cooperate in producing the latest

"weather measuring" equipment



Transmissometer System

The new **Transmissometer** takes the guess work out of measuring airport approachway visibility conditions. The fundamental electric design was developed by the National Bureau of Standards. Crouse-Hinds engineers adapted it to the requirements of production processes.

A projector sends a beam of light 500 feet to a photoelectric receiver where it is transformed into an electronic signal and transmitted to an indicator-recorder in the control tower. The tower can be located as far as 10 miles from the runway.

Crouse-Hinds **Automatic Ceilometer** Projector & Receiver System accurately measures the height of cloud ceilings above the earth at any time of day or night. The electrical system was developed by the U. S. Weather Bureau and Crouse-Hinds engineers cooperated in developing it for production.

Crouse-Hinds **Automatic Wind Tee** serves as a continuous day and night indication of wind direction or preferred landing direction. It is completely automatic and can be operated by remote control. All of the research and development was handled in Crouse-Hinds Engineering Department.

Crouse-Hinds offers a **complete line** of lighting and control equipment of the highest quality, including: 24 inch and 36-inch rotating beacons; medium and high intensity runway lights; tower control desks and control panels; obstruction lights and beacons; floodlights and searchlights.

Crouse-Hinds **Illumination Department** is prepared to assist in the development of new products in aviation lighting and control. Tell us your problems.

CROUSE-HINDS COMPANY
Syracuse 1, N. Y.

OFFICES: Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland — Dallas — Denver Detroit — Houston — Indianapolis — Kansas City — Los Angeles — Milwaukee — New Orleans New York — Philadelphia — Pittsburgh — Portland, Ore. — San Francisco — Seattle — St. Louis — St. Paul Tulsa — Washington. RESIDENT REPRESENTATIVES: Albany — Atlanta — Baltimore — Charlotte Corpus Christi — Reading, Pa. — Richmond, Va. — Shreveport
Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

A Nationwide Distribution Through Electrical Distributors

TRAFFIC SIGNALS · CONDULETS · FLOODLIGHTS · AIRPORT LIGHTING

PRODUCING
America's Toughest Electro-Mechanical Jobs!

GM GENERAL MOTORS GM GOOD MANAGEMENT

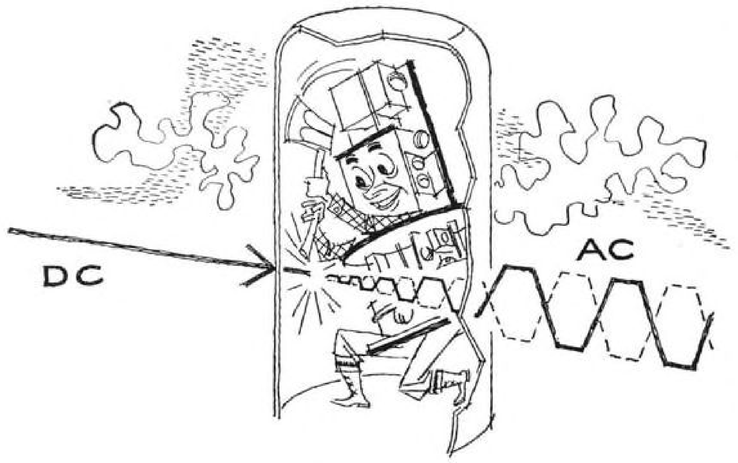
AC KNOW HOW

DEFENSE PRODUCTS
of High Quality at Low Cost
DELIVERED ON TIME

For dependable electro-mechanical devices—on or ahead of schedule—at assembly-line savings—the record proves you can always count on AC!

- **EXPERIENCE**—we are currently producing such highly complex assemblies as "A" Series Gun-Bomb-Rocket Sights—A-1A Bombing Navigational Computers—T-38 Skysweeper Fire Control Systems.
- **KNOW-HOW**—700 top-drawer engineers, scientists and technicians.
- **SKILLED LABOR**—thousands of highly trained production specialists.
- **CAPACITY**—3,000,000 square feet of floor space in three great plants.
- **FACILITIES**—35,000 modern machine tools all geared for action.
- **SOURCES**—1,468 seasoned sub-contractors and suppliers working closely with us.

AC SPARK PLUG DIVISION • GENERAL MOTORS CORPORATION • FLINT, MICHIGAN



"Most consistent 'chopper' on the market"

That's what a lot of people who use vibrators say about the Honeywell Synchronous Vibrator WG-178.

They know from experience that performance is consistent from one unit to the next—a most important consideration. This high consistency in the performance of the WG-178 is a direct result of the quality of design and workmanship that is a distinctive feature of all products manufactured by the Honeywell Aero Division.

Here are some of the other characteristics of the little "chopper":

1. **It's versatile,** can be used as a DC-AC modulator, or as a rectifier.
2. **It's longer-lived,** operating for an average of 500 hours.
3. **It's adjustable.** Open and closed times can be varied.
4. **It's tough.** When shock mounted (in any position) it exceeds rigid Air Force environmental specs.
5. **It's a precision instrument.** Quality design guarantees exceptionally clean signals.

If you'd like to know more about the WG-178 Synchronous Vibrator, we'd be pleased to send details. The address is Honeywell Aero Division, Dept. 401(AW), Minneapolis 13, Minnesota.

Specifications for Synchronous Vibrator WG-178

Coil Supply: Suggested supply voltage is 115 volts, 400 cps for WG-178A and 12.6 volts, 400 cps for WG-178B when suitable voltage-dropping resistors are included in the circuit with the field coil.

Power: Approximately 0.7 watts, excluding the phasing circuit.

Contact Rating: Contact rating depends on circuit in which units are used. All applications should be referred to our engineering department for approval. The devices have been used in circuits with approximately one milliampere (nominal) current and up to 35 volts dc supply.

Environment: When used on a shock-mounted chassis type mounting the units conform to Spec 41065B as called for in AF27500D as follows:

Humidity Test: 10 day (24-hour cycle).

Temperature Test: -65°F. to 160°F. (-54°C. to 71°C.).

Altitude Test: 55,000 feet.

Vibration Test: Up to 200 cps (5G maximum). This is a modified test.

Sand and Dust Test: As specified.

Mildew Resistance Test: 28 days.

Salt Spray Test. 50 hours.

Weight: Approximately 0.5 lb.

MINNEAPOLIS **Honeywell**

Aeronautical Controls

■ PATRICK

any reasonable ground, and he can ask for—and get—any reasonable support he needs. When his test is finished, AFMTC hands him the data and wishes him luck.

▶ **Safety First**—Safety of the range is the only consideration which can overrule a contractor's wishes. Once the missile is airborne, the Inflight Safety Officers take over, and have the power of destruction over the bird.

Similarly, if the range has not been cleared by firing time, the Range Safety Officer can hold the test beyond the contractor's scheduled zero time.

▶ **Flight Sequence**—A missile launching program starts when the contractor makes his first request to the Wright Air Development Center for a test.

WADC programs the test and schedules it into either Holloman Air Development Center (if the missile is small, short-range, recoverable) or AFMTC (if the missile is large, long-range, non-recoverable). That program is reviewed and approved by ARDC.

Project officers at AFMTC meet with the staff of the 6541st Operations Group (Range) under Col. Harold Norton to block out a firing schedule. Normally they plan one week's schedule on a firm basis and the following week tentatively, to be able to take care of any aborted tests the first week.

Alternate firing periods are figured in, during which simulated runs are scheduled. Instrumentation plans are established according to the needs specified by the contractor.

The official paperwork—Missile Test Request—is used to get the missile to AFMTC for firing; the flight plan is developed and all down-range stations are brought into the picture through the communication chain.

▶ **Fox Day**—The firing date (F Day) is established after the flight plan has been reviewed and approved by the support groups. On F-minus 1, operations receives reports on range readiness from the down-range stations by direct teletype connections.

Work begins at the launching pads around midnight before the firing. Although the best hours for launching at the Cape are the last three hours of daylight—because the sunlight streams down-range instead of into the eyes of observers and optical instrumentation—the reliability of pre-flight procedures is still not high enough to permit precise scheduling.

The usual routine is to work through the night before, counting on an early morning shoot—the next best time. Then if delays come into the program, they can be compensated for by stretching the flexible launching schedule into the early evening.

On F-Day the contractor establishes

Delivering men and bulk cargo to front line advanced combat bases calls for a rugged plane, built for a rugged job. Such is the combat-proven Fairchild C-119—workhorse of all our Armed Forces for a solid decade. Designed to handle massive bulk without dismantling, to load and unload without special equipment, to land where the going is rough and short, to paradrop men and supplies or evacuate wounded—the "Flying Boxcar is not *in* a class by itself. *It is a class by itself!* No other cargo plane can compare with the C-119!

EXCLUSIVE FEATURES FOR ADVANCE BASE OPERATIONS:

Increased payload • Better bulk Cargo Clearance and Distribution • Shorter Take-offs and Landings • Rough Field Landing Gear • Crew Bail-Out Chute • Provision for External Fuel

ENGINE AND AIRPLANE CORPORATION
FAIRCHILD
Aircraft Division
HAGERSTOWN, MARYLAND

Engine Division, Farmingdale, L. I., N. Y.
Guided Missiles Division, Wyandanch, L. I., N. Y.

Three Reasons Why

We Have Always Met Deliveries

In World War II and Since Korea

1. A plant built especially to make military pyrotechnics and load ammunition . . . and nothing else.
2. A staff of specialists in every phase of design, tooling and manufacture of military pyrotechnics and ammunition.
3. Intelligent native workmen trained to produce safely, efficiently and consistently.

Our operations are not a partial reconversion, not a sideline to some other business. For over 13 years our organization and facilities have been devoted solely to the design and production of military pyrotechnics and ammunition.

"If Aerial has the contract, deliveries will be met"

AERIAL PRODUCTS, Inc.

ELKTON, MARYLAND

FLARE AND SIGNAL MUNITIONS • SHELL AND FUSE LOADING
DETONATOR AND BURSTER COMPONENTS FOR AMMUNITION
DISTRESS SIGNALS • HAND-HELD ROCKETS

■ PATRICK

the count-down procedure, knowing how long each step of the pre-flight check takes. The communications links are checked out, and range clearance is begun.

▶**Air Support**—From the runways at Patrick stream about a dozen aircraft, a mixed group of Boeing B-17 and B-29 converted bombers for range clearance and guidance, and North American F-86s for chase and guidance and—if necessary—for destruction of the bird.

The B-17s cruise above the wedge-shaped range clearance area looking for ships and small boats. By radio and by powerful loudspeakers on the aircraft, these "Polly" planes pass the word on clearing the area. Other B-17s and B-29s check on aircraft clearances; some monitor interference control for the missiles under command guidance from the ground.

Back at the Cape, technicians complete each step of the pre-flight check on schedule, although not necessarily on time. This results from a holding procedure superimposed on the count-down; if X-minus-10 minutes comes up and fuel tanks aren't yet filled, for example, time stands still at X-10 until the tanks are filled. Then the count-down progresses.

▶**Firing**—With range and launching pad clear, the missile is ready for firing. At X-time, the controller at the console inside the blockhouse closes the firing circuit and the missile blasts off the pad.

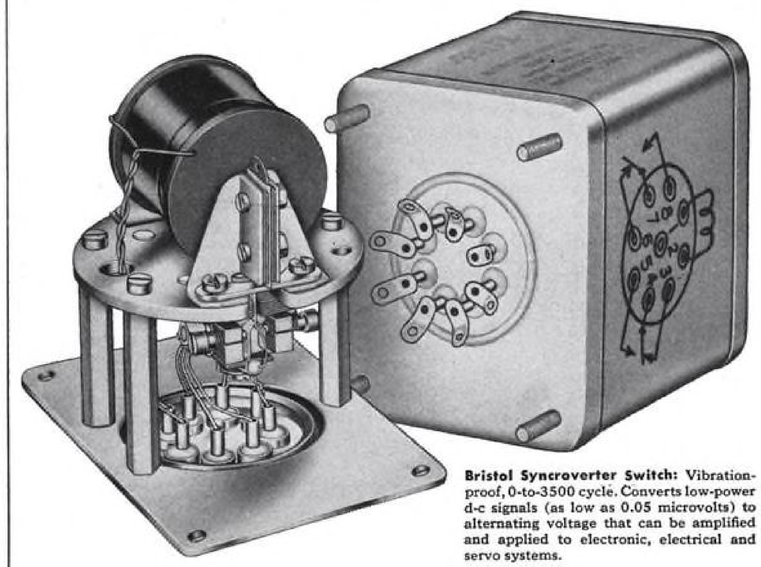
Takeoff is photographed by a ring of special cameras, and the primary data is filmed during the first few seconds of flight. Camera coverage of the launch extends to an altitude of about 4,000 ft. and picture clarity and accuracy will give missile position within three or four feet.

Immediately the Inflight Safety Officer assumes control. He is told by automatic plotting of radar data just where the missile is inside the range. Skyscreens check the radar plots by visual observation through a gridded telescope field; the operators report back to Inflight Safety.

If the missile begins to edge toward the range limits, the safety officer will generally tell the contractor to get it back on course. This failing, the safety officer has a try; if the missile still deviates, he blows it into chunks by a destructor mechanism actuated by the firing key which he holds during the entire flight.

▶**Flight Data**—Right after launching, special modifications of the Askania phototheodolite make a record of the missile angle and elevation on film. These pictures, combined with baseline calculations (for triangulation) give the missile position within 50 ft. out to a slant range of about 15 miles.

NOW AVAILABLE!



Bristol Syncroverter Switch: Vibration-proof, 0-to-3500 cycle. Converts low-power d-c signals (as low as 0.05 microvolts) to alternating voltage that can be amplified and applied to electronic, electrical and servo systems.

wide frequency-range precision inverter

can also be used as a precision synchronous rectifier or "ring demodulator"

Designed for military and industrial use: Bristol Syncroverter Switch is designed for a wide range of applications, including precision use in aircraft and guided missiles at high altitudes, gun directors, electronic computors, instruments, null detectors, and many similar devices.

Contacts: Contacts are provided for double-pole reversing switch action, or two synchronized independent single-pole double-throw actions.

Response: The switching time is in the order of 50 micro-seconds.

Effects of Thermal emf eliminated: Extremely small thermal emf's at the contacts are self-cancelling by the double-pole reversing contact arrangement.

Switching Dissymmetry: Less than ½ of 1 percent.

Hermetically sealed in a military-type case against dust and corrosion.

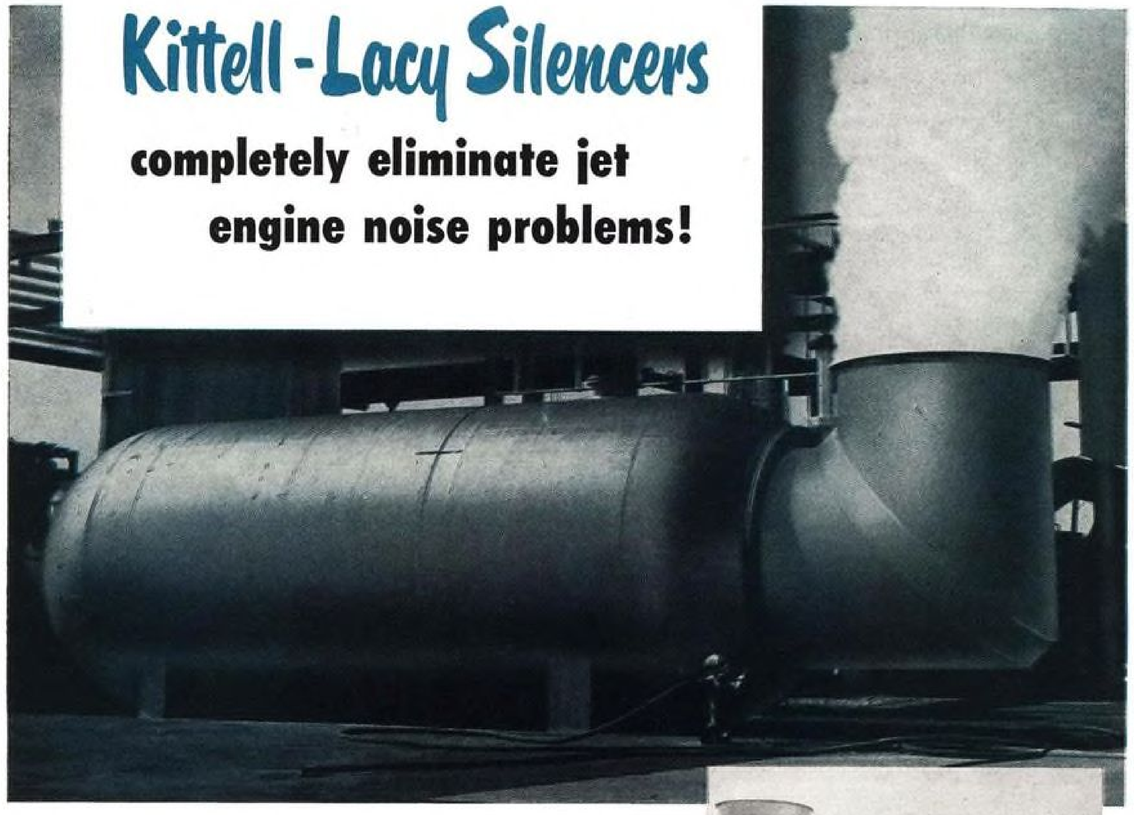
Write for complete specifications to The Bristol Company, 130 Bristol Road, Waterbury 20, Conn.

BRISTOL

FINE PRECISION INSTRUMENTS FOR OVER 60 YEARS

Kittell-Lacy Silencers

completely eliminate jet engine noise problems!



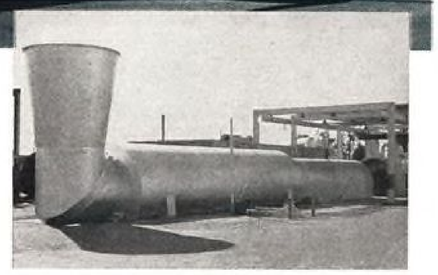
Stop neighborhood complaints... improve personnel efficiency and morale!

Kittell-Lacy Silencers reduce the ear-shattering noise accompanying ground testing of jet engines to an acceptable level. Operation is so quiet tests can be conducted *day and night* without complaints from surrounding residential areas. Operating personnel benefit, too, since reducing the noise level safeguards hearing, lessens fatigue, and increases efficiency!

Put Kittell-Lacy's experience to work for you!

Kittell-Lacy engineers, specialists in acoustic and structural engineering, were pioneers in developing sound abatement facilities *specifically for silencing jet engines.* They have designed, fabricated and installed some of the largest silencers now in use. Many of these are in continuous operation at extremely high temperatures, yet have required *no maintenance other than routine exterior painting.*

If you want to know more about Kittell-Lacy facilities and experience, a new informative brochure is yours for the asking. Write for it today.



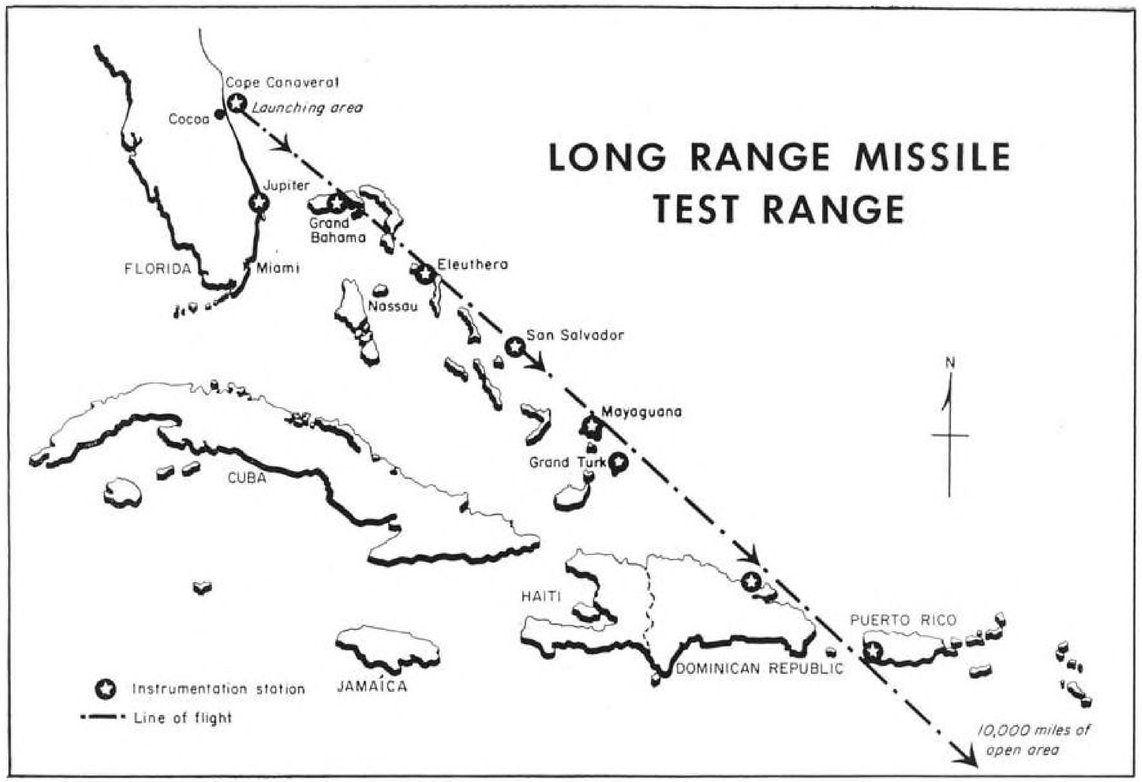
Unique sliding "dog house" on this 7'6" I.D., Kittell-Lacy silencer permits easy positioning of engine on test stand.

66 years of heavy steel fabrication experience!

Kittell-Lacy's extensive manufacturing facilities and personnel experienced in fabrication and installation of heavy steel structures assure good construction.

KITTELL·LACY, INC.

915 SOUTH SANTA FE AVENUE LOS ANGELES 21, CALIFORNIA



Mid-course flight is monitored by radar, the SCR-584 modified to record on a data box. If there is a good beacon in the missile, tracking is easy out to a slant range of about 150 mi. with an accuracy of about 200 ft. in space.

With skin tracking, the slant range is less depending on the target. Actually the mid-course data is not too critical; only the general flight path is of interest.

At the impact point at a downrange station, technicians manning the radar and phototheodolites measure missile performance as it dives toward the water. The radar acquires the target by data passed on from computed parallax data, giving the position of the Grand Bahama radar based on the radar at the Cape.

▶ **Data Handling**—The ultimate goal is a completely automatic range, insofar as data recording and reduction goes. Right now, tracking data is taken manually and punched on tapes to be fed into the SEAC computer of the Bureau of Standards. Telemetering data runs through automatic reduction equipment from the original tapes and is then fed to the computer.

The data belongs to the contractor; but in this learning stage for both range and contractor personnel, the data is shared to evaluate range instrumentation as well as the missile.

A data report for a specific flight is prepared by the 6541st Operations Group, and the 6555th Guided Missile Group writes a summary report of each week's firings.

At the end of each phase of missile flight test, the GMG also publishes a review of the phase.

Cameras

Col. Norton told AVIATION WEEK some of the details of the specialized camera installation used to track the missile at launch.

▶ **Recording Ring**—The launching pad is ringed with cameras for photographic coverage of detailed phases of the takeoff. Position, velocity and attitude are recorded on film from points to the right and to the rear of the missile and from one-quarter to one-half mile away.

Askanias and Mitchell cameras are three to five miles away, and in some instances as far distant as nine miles. Three theodolite stations are set up, one at the north and one at the south end of the Cape, and the third at Patrick AFB.

GSAP (gunsight aiming point) cameras are mounted on the missiles sometimes to photograph some detail.

Col. Norton said that these cameras were the primary source of data:

• **Clark ribbon-frame**, with a picture about five inches wide and one-quarter inch deep, aligned so that the aperture is parallel to the line of flight. It is used primarily to get acceleration, velocity and position during the launch phase. Speed is 120 frames per second, but it can do 600.

• **Hulcher ribbon frame,** essentially the same as the Clark, but with a much wider field of view. With this camera, operators can increase the area of coverage and can get data if the missile leaves its pre-selected takeoff path.

• **Mitchell highspeed** motion picture camera is used for tracking the missile from takeoff until it disappears and is useful for giving attitude data. It is also used during terminal phase into the impact. It has a 35-mm. frame size, lenses with focal lengths from 20 to 180 inches, can be used in a fixed position or for tracking. Normally run at 64 frames per second in color, it can operate from 16 to 600 frames per sec.

• **Fastax highspeed** motion picture camera is used for closeup work in color. It has been useful in studies of flame propagation, missile separation from the launcher and umbilical cord pullaway. It runs at 600 frames per second on 16-mm. film, and empties the container in about three seconds.

History

Selection of the Cape Canaveral site was the recommendation of the Committee on Long-Range Proving Ground,

■ PATRICK

named in 1946 to study the best location for such a range. There were alternates considered; the Navy site at Pt. Mugu was one, and the Gulf of California was another.

▶ **Why the Cape?**—But the Cape was picked because its climate was suitable for all-year operation and because the area was one section of Florida left untouched by the great real-estate boom of the Twenties. Land was cheap, uninhabited and isolated; safety and security would be easy and economical.

Another factor weighing heavily in the final designation was the abandoned Banana River Naval Air Station nearby, a prospective base of operations for headquarters, support aircraft, etc.

The Joint Research and Development Board approved the Committee's report in July 1947 and in December, the Air Force was told to get going on the development of the range.

▶ **Organization**—A group with equal representation from Army, Navy and Air Force, and directed by Maj. Gen. William L. Richardson, now commanding AFMTC, started the actual work to back up Board recommendations.

First they had to become experts in foreign affairs. There were treaties to be made with the governments of the United Kingdom, the Bahamas, Jamaica, Dominican Republic and Puerto Rico.

Col. H. W. Norton
Commander, Range Group

Then they had to activate interservice channels to bring in experts from the entire military establishment.

By mid-1948, NAS Banana River was transferred to the Air Force, and rehabilitation of that base began.

▶ **Starting Up**—By October of the following year, work had begun on the Cape site and island stations. The range was then known as the Joint Long Range Proving Ground, to be operated jointly by Army, Navy and Air Force under administration by USAF.

This arrangement continued until June 1951, when the range was redesignated as the Air Force Missile Test Center and placed under the Air Force alone. At the same time, the Navy was given complete control over Pt. Mugu; Army received control over the White Sands plus Holloman range.

▶ **Today and Tomorrow**—Actual missile firings on the range today are rare, but so are actual missiles.

This fall, long-range firings will begin over distances of at least 500 miles, a goal promised as far back as 1949. There are plans to fly missiles as far as Grand Turk, turn them and fly them back to the Cape for a total range of about 1,500 miles.

So step by slow step, missile progress follows the extension of the range. "If this range is to be of any value, we've got to stay ahead of the missile business. We always have to have a longer flight line than any contemporary missile can travel," said one officer.

"Today it's a piddling 200 miles; this fall it's going toward the 1,000-mile mark. Next stop? Don't forget the string and the globe."

STEEL TUBING

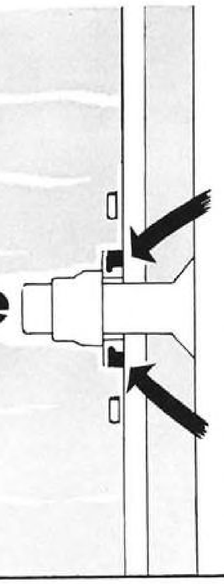
A typical example of how steel tubing can be used for strength, dependability, and safety. For dependable deliveries of your aircraft tubing requirements call Service Steel.

Just write, phone or wire for our latest list of nearby stocks.

SERVICE STEEL *Div.* **VAN PELT CORPORATION** 1437 FRANKLIN ST. DETROIT 7, MICH.

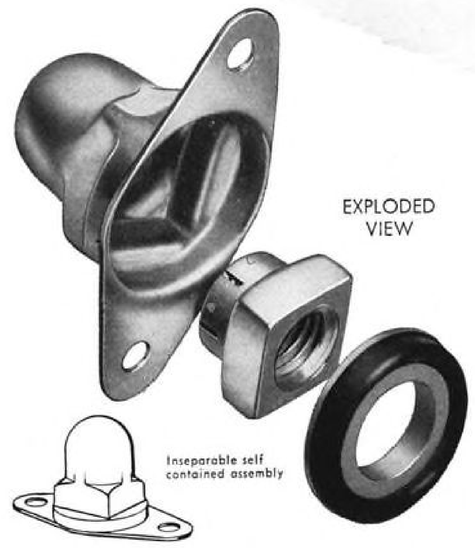
758 Hertel Ave. Buffalo 7, N. Y. | 4942 N. Western Av. Chicago 25, Ill. | 3412 Comfort St. Cincinnati 23, O. | 2444 Hunter St. Los Angeles 21, Calif.

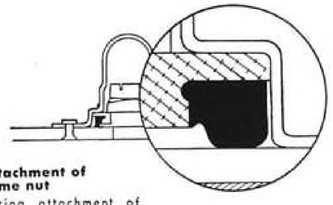
fluids can't penetrate this barrier



IN THIS SELF-SEALING DOME NUT

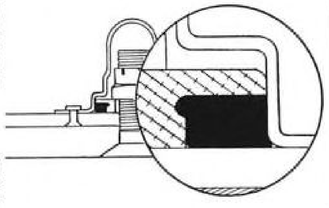
4630H SERIES





Attachment of dome nut

During attachment of dome nut, seal retracts into shell, but remains in contact with the structure. This eliminates pinching and subsequent cold flow of seal due to gaps which may exist between shell and the structure.



Installation of bolt

Installation forces the bearing surface of sealed washer to contact the structure, providing positive single point sealing.

Provides:

- ★ **High pressure sealing without sealing compounds**
- ★ **Inseparably self-contained assembly**
- ★ **Single point seal**
- ★ **Floating nut with stationary seal, unaffected by successive bolt installations**

Reduces Installation Time, Weight and Maintenance

Because seal is self contained, no sealing compounds are used resulting in reduced weight. Necessity for maintenance is almost eliminated.

SPECIFICATIONS

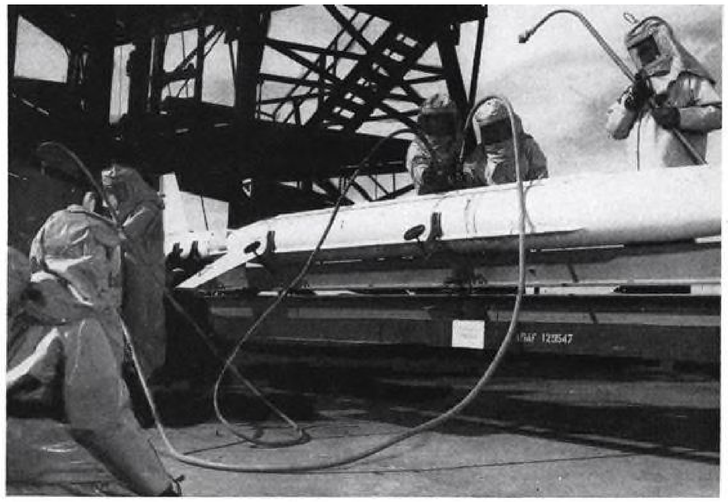
Self locking nut conforms to applicable requirements of AN-N-5. Available in 10-32 NF-3 and ¼-28 NF-3 thread sizes. Floats .025 in all directions.

Self contained seal conforms to applicable requirements for aircraft fuels type 1, 2 and 3 per specification MIL-R-6855. It is resistant to atmospheric elements, salt water, oil, gasoline and most organic solvents. Applicable temperature range: −80°F to +225°F constant or fluctuating operation. Applicable pressure range: ±50 psi constant or fluctuating operation.

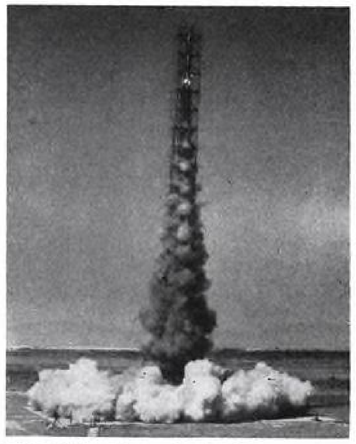
Nutt-Shel

811 AIRWAY, GLENDALE, CALIFORNIA

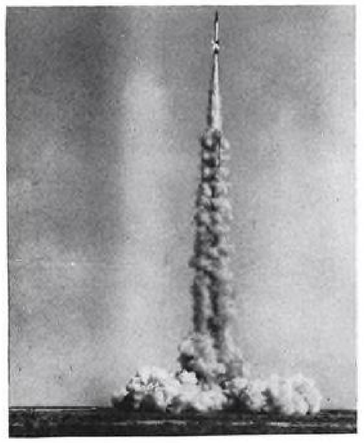
CItrus 4-4191 CHapman 5-3693



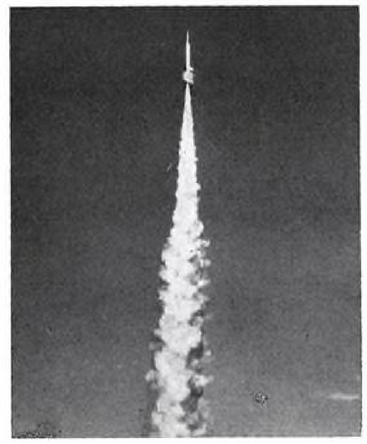
1. AEROBEE, high-altitude sounding rocket, is serviced with propellants.



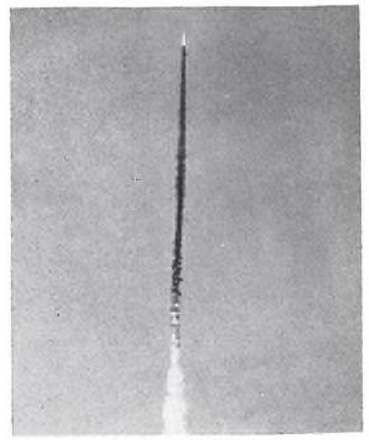
AEROBEE rides steel rails till it . . .



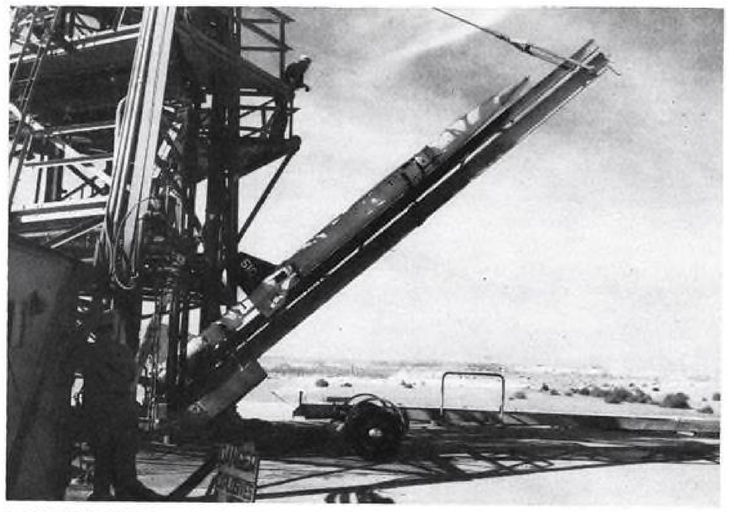
CLEARS launcher. Smoke identifies . . .



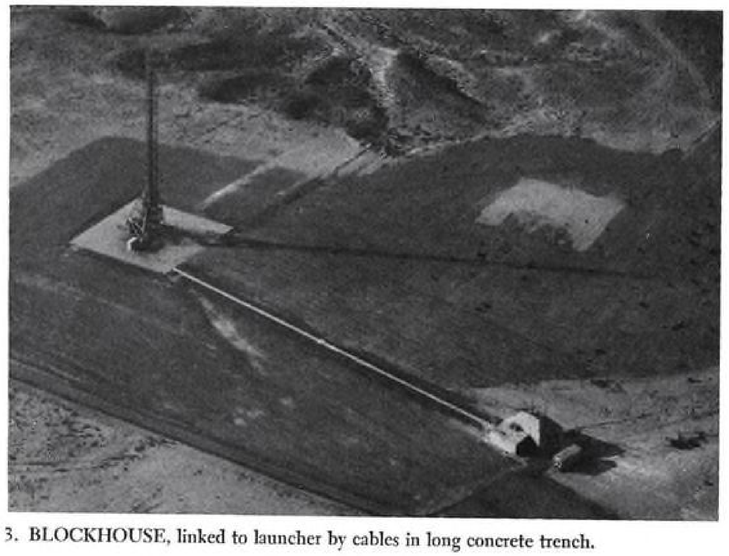
BOOST phase of first seconds. Then . . .



SUSTAINER rocket takes over for flight.



2. IT IS RAISED to vertical inside steel launching tower. Rocket is fired from . . .



3. BLOCKHOUSE, linked to launcher by cables in long concrete trench.

Holloman

Alamogordo, N. M.—North of the Rio Grande, the San Andres and Sacramento mountains rise out of the desert floor in parallel ridges, the west and east boundaries of El Paso del Norte, historic avenue between Mexico and the United States.

Halfway up the pass, the billowing dunes of the White Sands National Monument encroach on the Tularosa basin. A little further north is the greenish silica circle in the desert that marks forever the site of the first atomic blast set off by man.

This is the geography of the region around Holloman Air Development Center.

The rugged country around Holloman matches the rugged job of the Center—the testing of missiles, pilotless aircraft and various types of associated equipment.

▶ **A Busy Base**—Through the indigo skies over the base have flown, floated—and flamed—the gamut of aerial research tools. Free balloons have hung at altitudes approaching 100,000 ft., and drifted in jet streams to Norway and Algiers and the Atlantic. The Aerobee research rocket has blasted upward at supersonic speed carrying monkeys and mice 200,000 ft. above the desert crust; Martin's Matador and Northrop's Snark have orbited up along one ridge and down the other.

Holloman is a busy base. Visitors are not aware that missiles are being fired or drones launched while they are at the base. For safety, launching sites are remote and widely scattered over the desert.

But like the circus, Holloman is a performance where something is happening in every ring.

During July more than 60 firings were scheduled, not counting those run on the rocket track.

▶ **Problems**—There still are many jobs to be done at Holloman. "Right now our projects outstrip our facilities," Col. Don R. Ostrander, HADC commander, told AVIATION WEEK. "We didn't really get rolling technically until fiscal year 1952."

"Space is our problem—we're very crowded—and we're strapped in the missile test group on personnel," added Lt. Col. Harry F. Boone, deputy commander of the Guided Missile Test Group.

Lack of personnel will be helped by a group of 26 German scientists, recruited last summer. In charge of the recruiting was Dr. Ernst A. Steinhoff, formerly with the Army Ordnance missile team at Ft. Bliss, and before that head of the Steering and Control group at Peenemuende in Germany.

Steinhoff is head of the Technical Analysis Division which will absorb all the Germans. Reason for the recruiting was two-fold: The Germans had certain technical competence, and engineers are hard to get.

▶ **Why Here?**—Like some other ARDC centers, Holloman was located because of the peculiar geography. There were other Air Force bombing ranges available at the time Holloman was picked as the site for missile work, but there were disadvantages to many of them.

The whole length of this range is bordered by mountains East and West; these serve as a natural barrier to the range and their tops are dotted with down-range instrumentation stations. Far to the north, more mountains rise to block off that boundary of the range. This basin is like a gigantic bowling alley along which missiles can be fired and controlled.

Directly below the southern border of the Holloman area is the Army Ordnance White Sands Proving Ground, site of most of the ex-German V-2 firings in this country, and crater-dotted by impacts of hundreds of test rounds. Still further south is located the Army's Ft. Bliss Anti-aircraft Test Range.

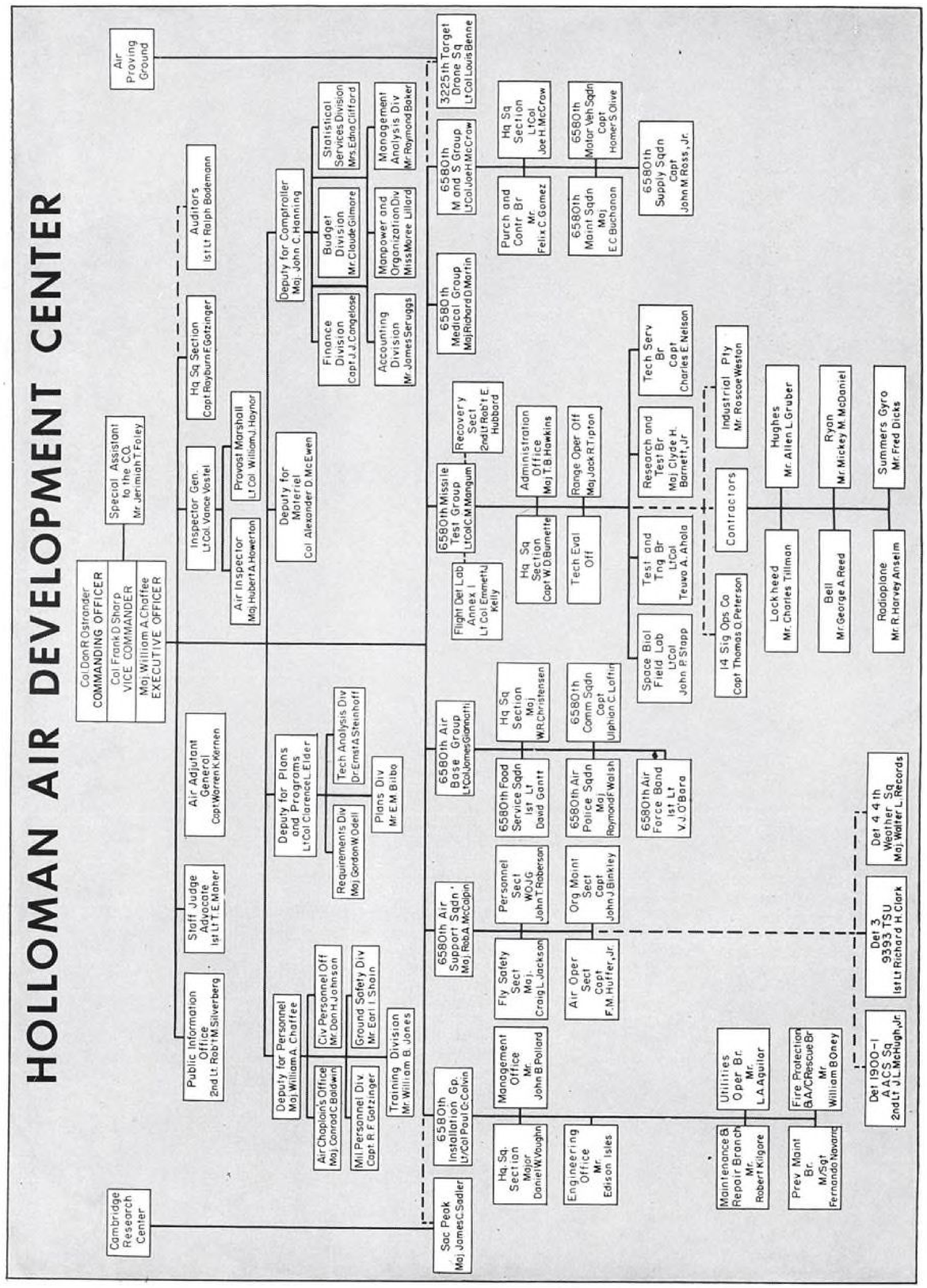
▶ **Joint Effort**—These three ranges—Holloman, White Sands and Ft. Bliss—are now consolidated into a single strip 128 miles long, 38 miles wide, operated by a joint Air Force-Army committee.

Odd buildings are scattered through the desert area. They are concrete blockhouses, strong points for missile launchings, or telemetering vans or other instrument housing. Nearer the base is a high board enclosure to protect the Moby Dick balloons at launching. In the technical areas there are large hangars with contractors' names—Lockheed, Ryan, Hughes, Bell, Radioplane—painted on signboards outside.

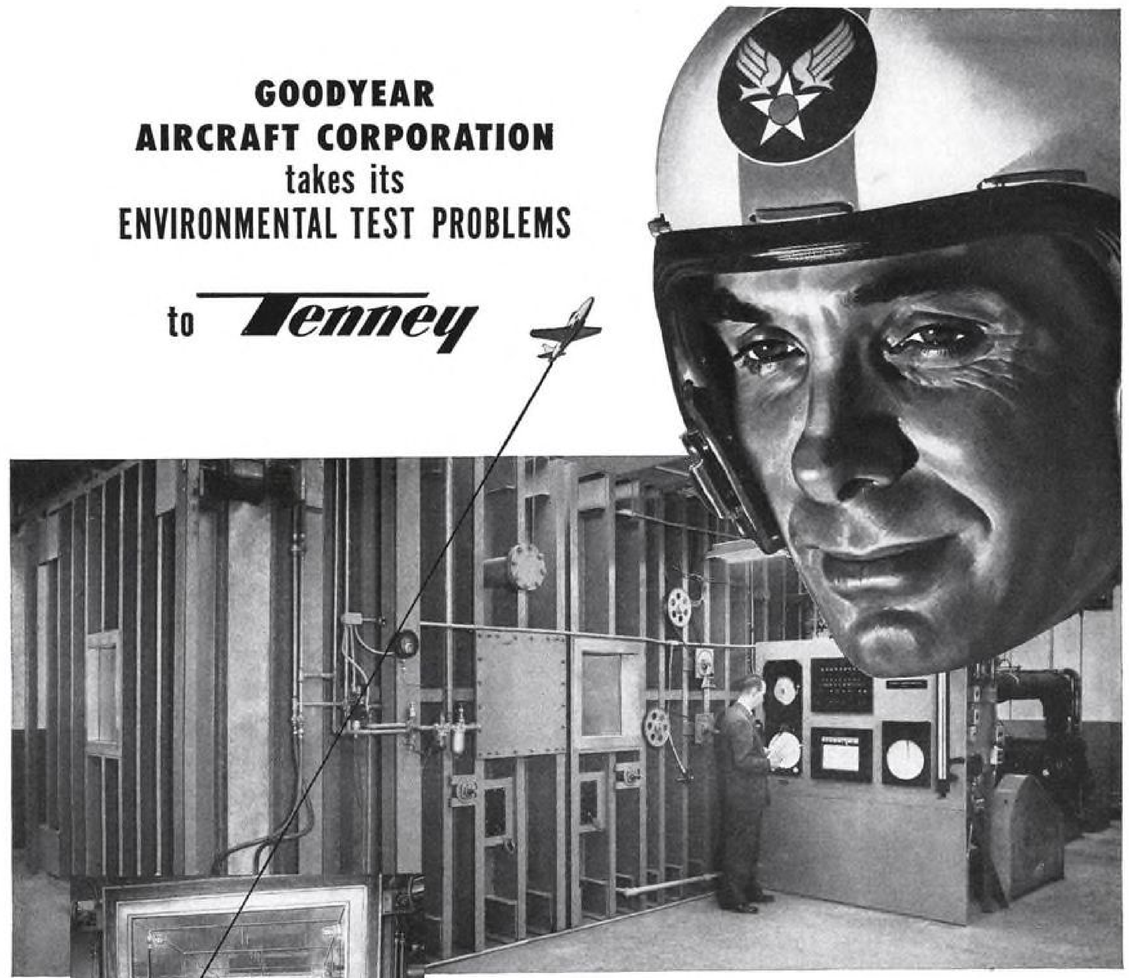
Off to the north, standing alone in the middle of the valley, is Tularosa Peak. Its flattened top is man-made,

Tests Missiles and Pilotless Aircraft

Col. Don Ostrander, commander, Holloman Air Development Center . . . ordnance expert . . . born Stockbridge, Mich., 1914 . . . graduated U. S. Military Academy, 1937 . . . began military career in aviation ordnance, serving at Ft. Bliss, Langley Field, Aberdeen Proving Ground and Selfridge Field . . . became ordnance and armament officer 8th Fighter Command in England . . . developed "droop snoot" P-38 high-altitude bomber . . . flew as bombardier on first P-38 "droop snoot" mission over Europe to test Norden bombsight modified for fighter-bomber use . . . postwar, served in armament laboratory, Wright Field . . . became special assistant to the commanding general, ARDC, at Wright-Patterson AFB . . . took command of Holloman June 5, 1952.



GOODYEAR
AIRCRAFT CORPORATION
takes its
ENVIRONMENTAL TEST PROBLEMS
to Tenney



For all types of testing – development, research, environment, specification, and production—a Tenney-engineered chamber will insure dependability and precisely controlled test data for your requirements. For full information write
Tenney Engineering, Inc., Dept. G,
26 Avenue B, Newark 5, N. J.

Plants: Newark, N. J., Union, N. J. and Baltimore, Md.

Trouble-free performance of electronic circuits, . . . smooth operation of servo-mechanisms, auto pilots, and complete guidance systems – upon these things depend the accurate flight of guided missiles and the accomplishment of their mission. Goodyear is one of the many members of the great industrial team behind the U. S. Air Force Guided Missile Program. To meet rigid Air Force requirements, many electronic components – as well as cross-sections and complete missiles – undergo complete environmental testing under accurately simulated operating conditions . . . in this Tenney Altitude Chamber.

SPECIFICATIONS

Altitude:	80,000 ft., rated
Humidity:	20% to 95%
Temperature:	—100°F. to +200°F.
Pull-down:	to —85°F. with 1000-lb. mass load in 90 minutes
Dissipation:	3 kw at —100°F. and 50,000 ft. altitude
Dimensions:	(inside) 7'w x 9'd x 7'h (outside) 10½'w x 18'd x 10½'h

Temperature and humidity program control instrumentation for this chamber produces moisture resistance cycles according to JAN-C-25 or Mil-T-27, and other conditions to meet other government specification cycling tests. Air-tight door slides on tramrail and is sealed by pneumatic closing device. Accessories include frost-free viewing windows, power shafts, terminal pads, provision for inside monorail for heavy equipment, and externally operated conditioning dampers.

8527

Tenney ENGINEERING, INC.
Engineers and Manufacturers of Automatic Environmental Test Equipment

HPM

100,000 TONS+

NEW H-P-M PRESSES FOR PLANE PRODUCTION

Fifty high-powered years forward into the age of flight . . . achievements beyond number . . . it's a record of which the American Aviation Industry, the United States Air Force and Navy Bureau of Aeronautics have every right to be justifiably proud.

In the past, present and future progress of air power, H-P-M has and will continue to play an important role. We are proud of the many contributions H-P-M *All-Hydraulic* Presses have made in solving specialized production problems of the Aircraft Industry.

Today, these many new H-P-M presses, *over a dozen of which are in the 5,000 ton to 7,000 ton range,* are at work with hundreds of other H-P-M presses in this great industry which is virtually the backbone of our peace through preparedness program.

Looking ahead to the production requirements of the Aircraft Industry for high-tonnage presses up to 200,000 tons capacity, H-P-M teamed with the Austin Company and have organized the Throatless Press Company to design, build and install these economical, high-tonnage units.

If it's hydraulic pressure processing, make it a point to talk to an H-P-M engineer.

WATCH FOR THE ANNOUNCEMENT OF THE

H-P-M DIAFORM

FIRST CHOICE OF THE AIRCRAFT INDUSTRY FOR ALL-HYDRAULIC HIGH TONNAGE PRESSES

CONVAIR · DOUGLAS · NORTH AMERICAN AVIATION, INC. · LOCKHEED AIRCRAFT CORPORATION · Martin AIRCRAFT · Republic · Grumman · BOEING · EMCO AIRCRAFT CORPORATION · GENERAL ELECTRIC · Cessna · Edo · CHANCE VOUGHT · Beechcraft · SOLAR · CURTISS-WRIGHT · McDONNELL Aircraft Corporation · GOODYEAR AIRCRAFT · Westinghouse · Allison DIVISION OF GENERAL MOTORS INDIANAPOLIS INDIANA

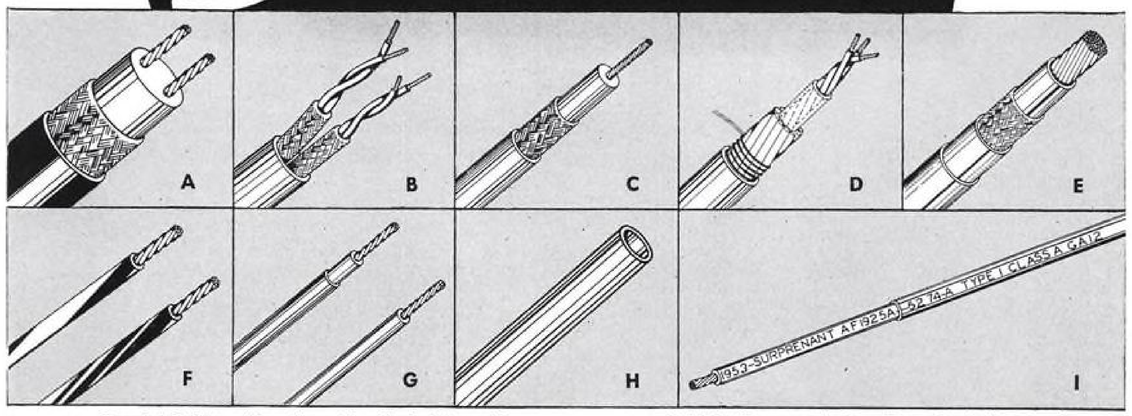
HPM **THE HYDRAULIC PRESS MFG. CO.**

1092 Marion-Road, Mount Gilead, Ohio, U.S.A.

Presses for Every Pressure Processing Application

Surco WIRE · CABLES · TUBING

OPERATING TEMPERATURES FROM -60°C TO 210° C SIZES FROM 32 TO 4/0



A Coaxial Cables—"Surco" coaxial cables include a wide variety of types, such as low capacity, extra flexibility, small diameter, microphone 2 conductor, and high temperature "Teflon". Conform to Military Spec. Jan-C-17A. Many special designs. If you have a coaxial cable problem consult us.

B Miniature Wire & Cable—"Surco" miniature wire and cables are made in conductor sizes down to No. 32 AWG in stranded and solid. Close control in manufacturing permits small finished diameters on both single and multi-conductor cable. Available in standard colors with and without nylon jacket or shielding in the various vinyl or polyethylene compounds.

C "Surflene" Insulated Hook-up Wire—"Surflene", extruded monochlorotrifluoro-ethylene, has excellent resistance to heat, abrasion, and most chemicals, including nitric acid. Having high dielectric strength and insulation resistance, it is especially useful in totally enclosed applications with continuous temperatures up to 135°C. "Surflene" is available in 15 solid colors and wall thicknesses down to 0.008". "Spiralon" colors presently under development.

D Multi-Conductor Cables—"Surprenant" multi-conductor cables are available with conductor sizes from No. 32 AWG and larger, with or without nylon jacket or shielding and can be made to specification for special design and applications. Close tolerances permit unusually small over-all diameters and "Spiralon" color coding permits easy identification even when hundreds of conductors are involved.

E New Improved Aircraft Wire—Surprenant new lightweight, smaller diameter MD wire-(vinyl-glass braid-nylon) and the standard Surprenant sandwich construction (vinyl-glass braid-vinyl-nylon) give excellent overload safety, high and low temperature performance, good electrical properties and have a nylon jacket giving greater resistance to abrasion, fungus, moisture, hydraulic and other oils (nylon braided jacket on sizes 10 AWG and larger for greater flexibility) and are made to conform to MIL-W-5086. "Surprenant" also offers nylon jacketed–polyvinyl-chloride construction made to conform to Military Spec. AN-J-C-48A.

F "Spiralon"—"Surco-Spiralon" color coding is available on all vinyl, polyethylene, and nylon insulated wires, with or without nylon jackets. One, two, or three color stripes are available in the standard Nema colors providing almost unlimited color identifications.

Solid color insulation is also available in the 10 standard Nema colors.

G "Surco" A-10 For (105°C) Hook-up Wire—A-10 is an unusually high grade vinyl insulating compound developed in our own laboratories for a better hook-up wire. It has excellent resistance to deformation, soldering, high temperature, low temperature and aging; high electrical properties; Underwriters Lab. approved for continuous operation to 105°C without fibrous covering. A-10 insulated wire made to conform to MIL-W-16878.

JAN-C-76 Hook-up Wire—Made to conform to Military Spec. (WL-SRIR-SRHV-SRRF) in all sizes. WL available with nylon jacket or glass braid. The nylon jacket has greater abrasion resistance and high surface resistivity under adverse conditions. SRIR-SRHV-SRRF available with primary insulation only or with the addition of a glass braided covering. All standard colors including "Spiralon" spiral striping.

H "Surco" Tubing—"Surco" vinyl tubing is available in special formulations to provide low temperature (−65°C), high temperature (U.L. approved for 105°C), high dielectric strength, flexibility and colors. Standard compounds are carried in stock in regular sizes. Polyethylene and nylon tubing are also available and are carried in stock in natural color, limited sizes.

I MIL-W-5274A Radar & Electronic Hook-up Wire—Made to conform to Air Forces Spec., this wire offers excellent low temperature performance. Nylon jacketed, it has high abrasion resistance and superior surface resistivity even under adverse humidity conditions, making it very adaptable for high impedance circuits.

Extruded THIN-WALL Teflon INSULATED (210°C) HOOK-UP WIRE

Extruded Thin-Wall Teflon Insulated (210°C) Hook-Up Wire—Continuously operable over the range from −90°C to 210°C without appreciable deterioration, extruded "Teflon" (polytetrafluoroethylene) is now available in walls as thin as 0.010" (type WTE) and 0.015" (type RTE). Teflon combines non-flammability, chemical and solvent resistance, high volume and surface resistivity with extremely low electrical losses. This wire is available in all flexible strandings from AWG 30 to AWG 10 and conforms to performance requirements of MIL-W-16878. Colors conform to MIL-STD-104.

Surprenant MFG. CO.

"Engineered Wire and Cable for the Electronic and Aircraft Industries"

199 WASHINGTON ST, BOSTON 8, MASS. Plant CLINTON, MASS.

chopped off and leveled for instrumentation. Buildings and tons of recording equipment now crest the peak and make it one of the most completely instrumented areas in the United States.

► **Coordination**—All instrumentation on the range is the responsibility of Army Ordnance. The development of new or special kinds of instruments is also a task performed by the Army, although the ARDC development centers might get into the job at different levels. There is liaison and coordination between the instrument makers and the instrument users.

- Land-Air, Inc. operates the test instrumentation under contract.
- Range safety is handled by a joint AF-Army committee.
- Missile recovery is the province of Army.
- Missile scheduling is handled by a unit within the Missile Test Group. They consider requirements jointly with Army; there is considerable give-and-take with the staff of the White Sands Proving Ground.

► **Link to AFMTC**—The connecting channel between the work of the Holloman Air Development Center and that of the Air Force Missile Test Center at Patrick AFB is determined primarily by the type and status of the particular missile.

Currently accepted policy says that Holloman will worry about any recoverable missiles or test vehicles and short-range weapons. The AFMTC will take over when missiles become "semi-reliable," go on an operational status or are required to undergo long-range testing.

"Training guided-missile outfits is going to be a tough job," says Col. Ostrander. "We have such a limited number of ranges in this country and their use is heavy enough now."

Another tough job for the Center has been getting and keeping the military and civilian personnel with experience in guided-missile work. Turnover of such people hurts, Ostrander says.

► **Helping Hands**—Contractor support is one of the big jobs at Holloman, although it is the last task defined in the statement of mission.

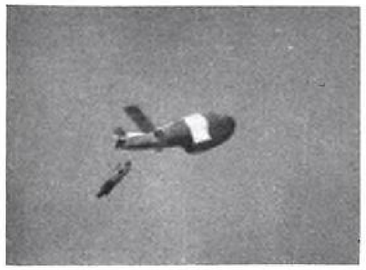
In effect, the contractor moves in as a tenant. Holloman furnishes building space for missile assembly and checkout, and office space for technicians. If the contractor needs airplanes for flight test work or for airlifting a missile from his home plant, Holloman supplies them.

When the missile is ready for firing, Holloman takes over the administrative worries that go with the task. They arrange transportation to the launching site, handle scheduling of the firing with the joint committee. Channels of communication and radio frequencies

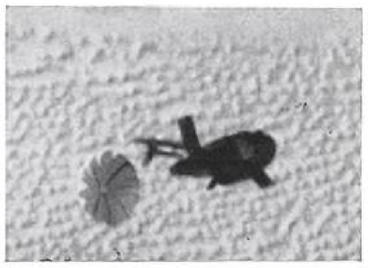
RYAN FIREBEE pauses at the end of launching track for count-down before firing.

BOOSTER blasts Firebee off track and . . .

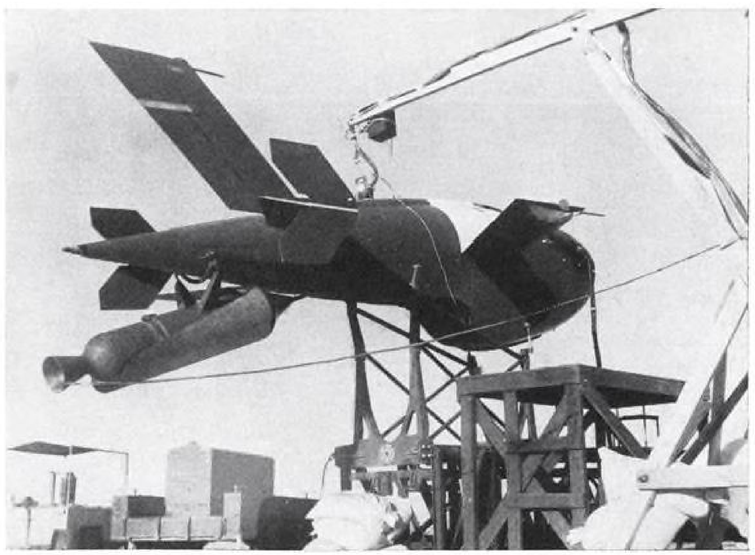
INTO FLIGHT. After boost phase . . .



EMPTY RATO leaves Firebee in flight.



PARACHUTE recovers drone after test run.



FIREBEE on zero-length launcher shows unusual configuration of triple tail.

AIRBORNE

Controls and Control Systems

Do you have a control, or control system, problem? If so, we'd like to help you solve it. We've enlarged our research and development section so as to be of greater service to the aircraft industry. One project, now under way, is development of an even better control system for positioning an actuator by manual remote control or keeping two or more actuators in the desired relative positions. Another is widening the applicability of 26 volt DC control and control systems. A third is the perfecting of a 400 cycle control to operate with our 400 cycle, 110 volt motor and new actuators.

Our broad experience in the design and manufacture of electromechanical actuators, coupled with our expanded facilities for research and development work, enables us to give you more help. Let us develop a control system to exactly meet your application. Our recommendations will be based on an analysis of your needs.

A full statement of your requirements will permit us to study your problem and estimate our ability to solve it.

AIRBORNE
ACCESSORIES CORPORATION
1414 Chestnut Avenue
Hillside 5, N. J.

■ HOLLOMAN

are assigned by HADC personnel; they also rule on range safety and missile recovery.

A project officer is fed into the system by Holloman for on-the-job training. His main task is military liaison and he gets his authority from the contracting officer.

▶ **Hands Off**—Beyond acting as aides to the contractor, Holloman personnel aren't authorized to do anything else. "It's the contractor's missile, and when it's ready to fire, we just stand back and watch."

This hands-off approach is typified by the routine for asking the contractor to make a specific test. HADC can't do this directly; the questioning agency is Wright Air Development Center, and through this channel must go any requests for contractor activity from HADC.

Holloman, however, can use a stop-order on a firing and make the contractor wait while the questions are routed to him formally through WADC.

Final task of the base personnel is to report on the firing, although this is not the official report which contains the test data. The HADC report is more on the lines of a summary, with no conclusions drawn from data or observations. The report says whether the missile worked.

▶ **Missile Recovery**—After impact, the Army swings into action with its recovery teams. Liaison aircraft—Cessna L-19s, a Convair L-5 and a Sikorsky H-5 helicopter—scoot along the valley searching the area around the predicted and plotted impact point.

"We fly around 500 ft., generally with a single search plane, although sometimes we have used three," said Lt. Robert Hubbard, one of the Army's pilots. "Once we've spotted the impact point, we radio back to the ground parties and circle the area or lead them to the impact site.

"It's not easy to find a missile that's scattered itself over the desert floor or bored its way in. We've flown over an area several times before spotting the missile lying in plain sight on the ground.

"It may be so far from base that the ground parties have to camp out overnight and go on in the morning. We can land anywhere and stay with them or go on back to base and fly out again the next day."

▶ **Retrieving**—Hubbard said they needed a bulldozer on occasion to dig out bombs or missiles, and often there would be a special trailer required to haul the missile back to base. These vehicles are all Army equipment.

One other job done by the group is range safety. They set up road blocks with the radio trailers for air-to-ground communication.

Hubbard is a walking example of the joint operation of the range. He's stationed at Holloman, assigned to Army Ordnance and attached to the Air Force.

Complement of the Army's "air force" at Holloman is five L-19, one L-5 and one H-5.

Research Test Branch

The research test branch, said Maj. Ernest P. Luke, has the job of furnishing three test facilities: the Aerobee rocket; balloons for high-altitude flights, and the high speed test track.

Research test branch is divided into operations or test section and an engineering and development section. The latter group handles all electrical and mechanical installations, all electrical development, and all aerodynamic and mechanical problems in the development of new test items.

Capability of the section to do original work is developing now but only the initial stages of such a capability have been reached.

▶ **Aerobee**—One of the most versatile of test vehicles is the Aerobee high-altitude sounding rocket (RTV-A-1A), developed and manufactured by Aerojet Engineering Corp. Thirty-seven rounds have been fired out of the tilting firing tower since Dec. 2, 1949.

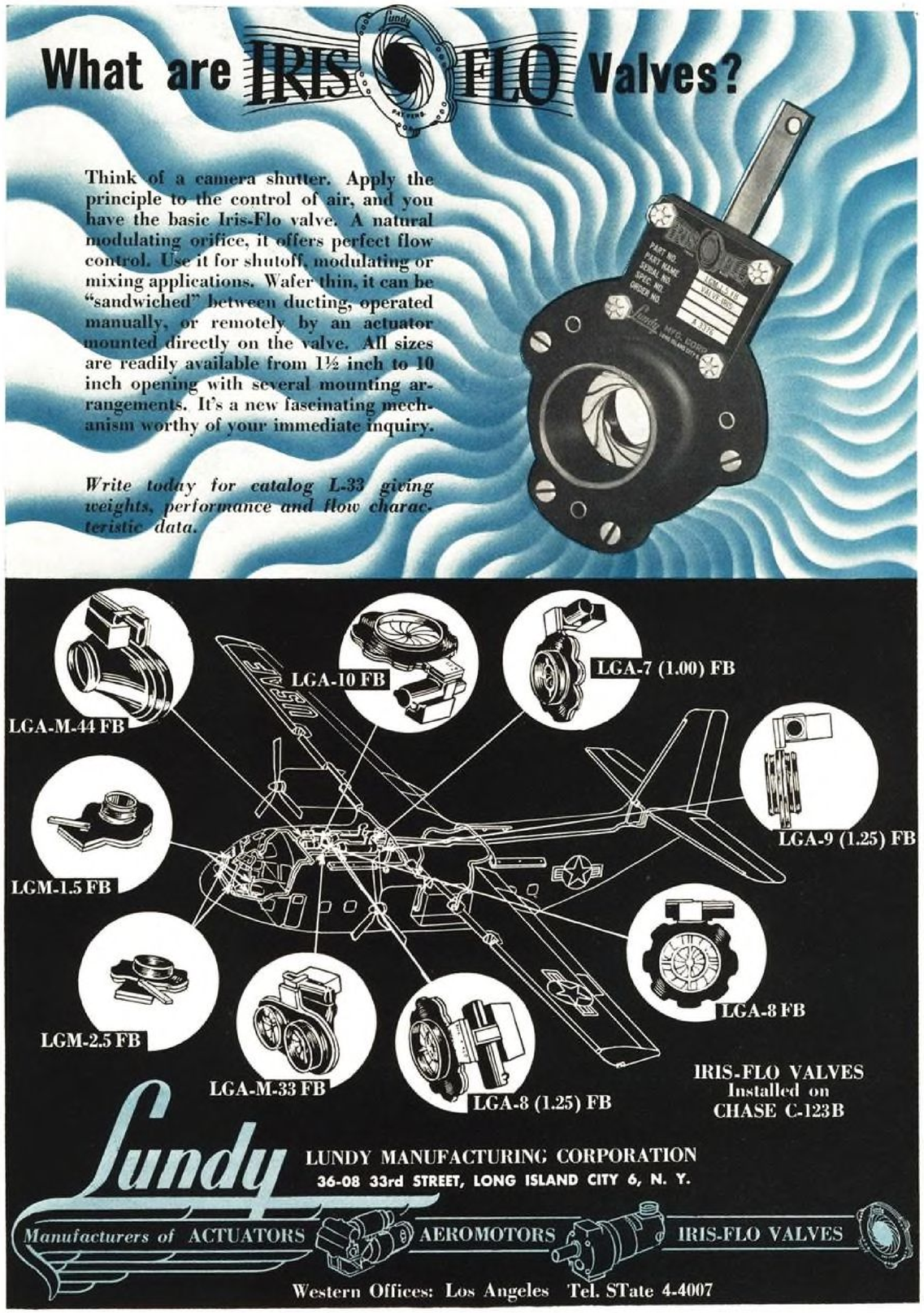
It is not a cheap program. Each round costs about $20,000 to buy and nearly $500,000 to launch, including everything and everybody involved. Test results from this workhorse rocket have proven its value.

Aerobee is 26-ft. long and most of its slim 1,100-lb. bulk is propellant, piping and powerplant. The small remainder is concentrated in the ogival nose section where instruments, telemeter equipment, fruit flies, mice and monkeys have made the trip to altitude.

▶ **Leaning Tower**—The 120-ft. high steel launching tower is visible from far off. It juts skyward, its red steel trusswork tied to a concrete base, and leans permanently one degree to the North. This tilt gives initial guidance to the Aerobee, which has no means of guidance or control once it leaves the tower.

Two legs of the tripod base are on a North-South line, with the northern leg shortened to give the permanent list. The west leg is mounted on a hydraulic cylinder, which serves to tilt the tower through an arc between two degrees East and one degree west. Initial deflections in these directions can compensate for the earth's rotation and wind drift.

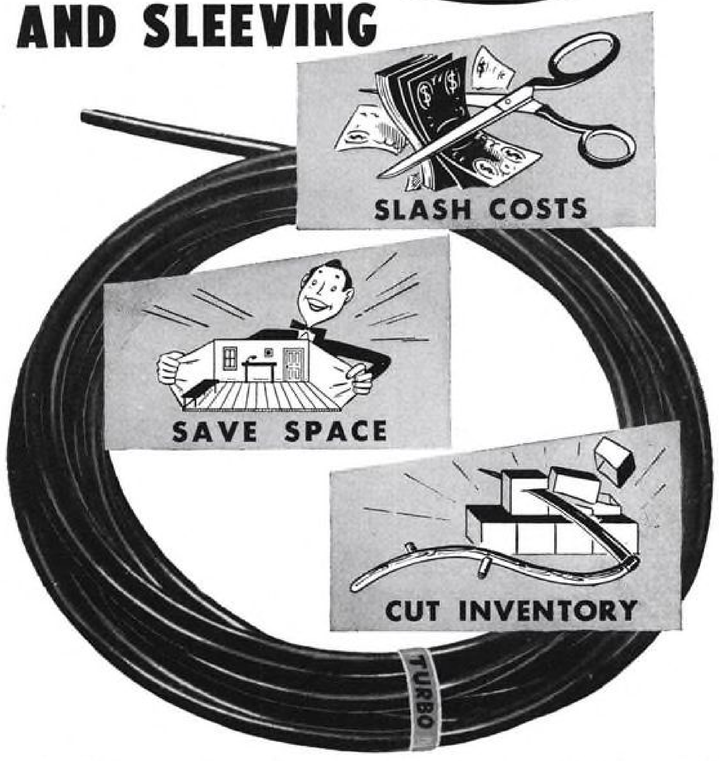
▶ **Firing**—Firings are generally at dawn. Aerobee and its booster are loaded into the tower vertically, bearing laterally on



USE "Double Feature"

INSULATING TUBING AND SLEEVING

TURBOTUF



Easily the most economical insulating tubing and sleeving for commercial use . . . equally and ideally suitable for the insulation demands of Classes A & B. Separate A & B inventories unnecessary — space and dollars saved when you use TURBOTUF.

Easily the finest insulating tubing and sleeving — Meets exacting specifications for durable resistance to icy or sweltering temperatures . . . made of superior materials to give long wear — won't crack, bend, chip, or peel under rigorous abrasion . . . excellent pliability — can be knotted, bent, tugged at, stamped on — springs back in perfect condition . . . easier to handle because of its uniformity . . . won't fray . . . not affected by oils, alcohols, alkalies and weak acids — high dielectric strength and long life.

PROTECT YOUR EQUIPMENT — SAVE MONEY — GET "DOUBLE FEATURE" TURBOTUF

Insulating Material TURBO Specialists Since 1920

The William BRAND and Co., Inc.

Dept. A8-17, Willimantic, Conn., U.S.A., Tel. HArrison 3-1661

TURBOTUF Insulating Tubing and Sleeving • TURBO Insulated Wires • Wire Markers • Extruded Tubing • Varnished Saturated Sleeving and Tubing • Cambric Cloths, Tapes, Papers • Mica

SALES REPRESENTATIVES IN PRINCIPAL CITIES

three rails extending the height of the tower.

After the conventional warnings and countdown, the booster is fired. Initial acceleration of the missile is 14G, and in a split second it is clear of the tower and blasting up. In a few seconds the booster has burned out, the sustainer rocket engine in the Aerobee itself has fired, and separation of booster and vehicle takes place.

► **Flight Path**—Between 33 and 34 seconds after firing, the sustainer engine has exhausted its propellants. By then Aerobee is ripping along at about 4,600 fps., and has passed 75,000 ft.

From there on, it coasts to zenith, which depends on the payload and the operation of the engine. Peak altitudes run close to 80 miles. With the mice and monkeys inside the Aerobee, 40 miles was reached.

Once over the top, Aerobee begins to fall, tail down, towards the earth. At about 200,000 ft. the tail cone is blown off. This makes the rocket unstable; it begins to tumble and the drag is increased, slowing its plunge. The body free-falls to about 20,000 ft., where the nose cone is blown off. That section, which contains the instruments and recorded data, is lowered to the ground by a gaudy orange and black parachute, to make for easy spotting by the Army recovery groups.

► **Free Balloons**—The original purpose of free balloon flights at Holloman has been expanded to a large collection of research projects.

In 1950, the idea was to use the balloons as a pre-flight checking vehicle for the expensive rocket instruments that had to work right the first time. Now balloons carry payloads of several hundred pounds to altitudes around the 100,000-ft. mark, and investigate a variety of altitude phenomena.

The many tasks performed by these versatile vehicles and the manner in which the organization of the balloon flights cuts across almost all of the ARDC centers sets them apart as unique tools.

► **Rocketing Railroad**—The original purpose of the supersonic test track at Holloman was to launch guided missiles, such as Northrop's Snark, and target aircraft. But like the balloons, the original purpose has since been swallowed up in a formidable list of tests that can be performed conveniently and cheaply with the track.

Special test vehicles, called sleds, ride the steel rails on stellite slippers, carrying equipment down the 3,600-ft. run.

Space Biology

Five hundred fruit flies hold the current free-balloon altitude record, set

WRIGHT BROTHERS 50 YEARS ANNIVERSARY OF POWERED FLIGHT 1903 1953

LIQUIDOMETER

Section of Early Bird mural located in the Administration Building of The Liquidometer Corporation depicting some of the pioneers and craft that played an important part in the advancement of aviation.

• *(Color reproduction and descriptive key sent on request)*

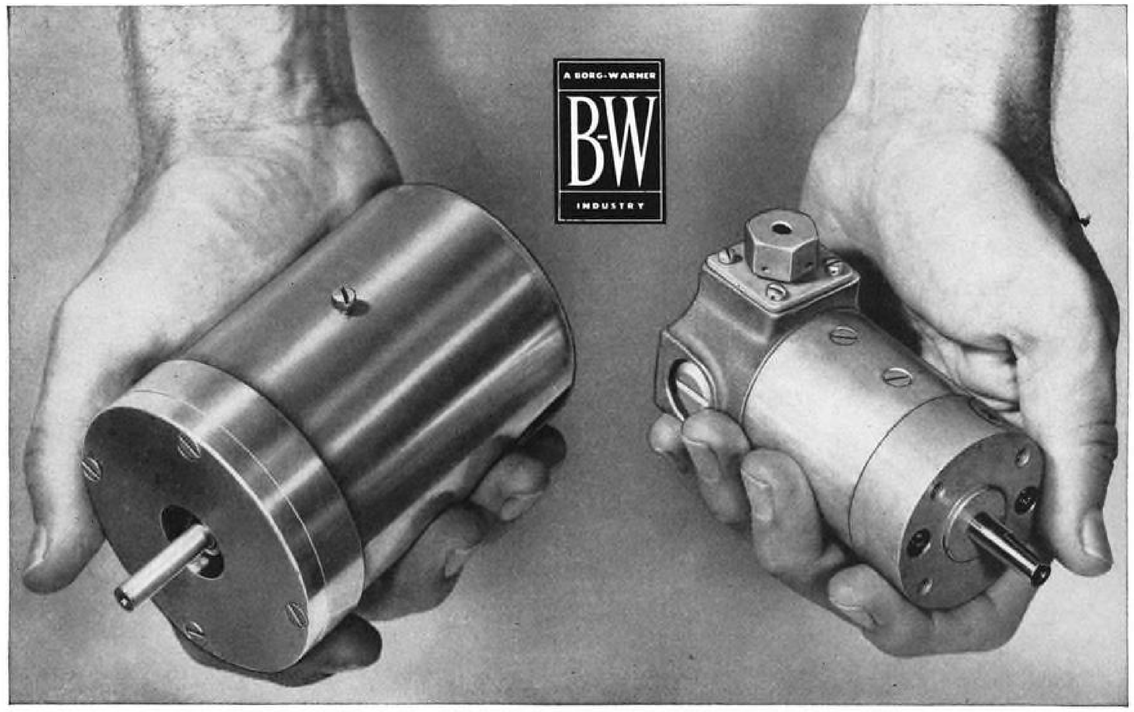
For more than 30 of the 50 years since the Wright Brothers' first powered flight, The Liquidometer Corporation has led its field in important "firsts":

FIRST Temperature and Altitude Compensated Fuel Gage.
FIRST Automatic Indication and Fuel Level Control.
FIRST Totalizing of Tanks.
FIRST Voltage Compensated Fuel Gage.
In researching capacitance gaging methods since 1940, Liquidometer introduced the:
FIRST Characterized Tank Units for different shaped tanks to provide uniform dial graduations.
FIRST Fuel Dielectric Compensation.
FIRST Double Concentric Pointer Motor Driven Indicator.
FIRST Hermetically Sealed Indicator-Power Unit Combination, eliminating separate intermediate unit between tank unit and indicator.
FIRST True Fuel Weight Indicating System automatically derived by the independent measurements of density and volume.
FIRST Spiral Scale Indicator.
FIRST Repeater indication from Motor Driven Indicator to remote D.C. Indicator.
FIRST Motor Driven Indicator with auxiliary ratiometer scales.
FIRST Use of Sub-miniature Tubes in Fuel Gage Systems.
FIRST Sub-miniature Coaxial Cable Connectors effecting large weight reduction in intercommunicating wiring.
FIRST Fuel Gage System not requiring coaxial cable.
FIRST Weight and/or Volume Indication from the same system.
FIRST Tubeless Power Unit.
FIRST Tubeless Indicator-Power Unit Combination.

Liquidometer takes pride in its accomplishments of "firsts" and no less so in its sound engineering designs, precision workmanship, rigid inspection system and the use of the highest quality materials obtainable.

BE FIRST WITH LIQUIDOMETER

THE LIQUIDOMETER CORPORATION LONG ISLAND CITY 1, NEW YORK



Compact, powerful, custom-built A.C. or D.C. motors for ELECTRONICS and ELECTRO-MECHANICS

Wherever you need electric motors for maximum power in minimum size, Pesco has the basic co-ordinated frame sizes and power elements you'll require.

For example—Pesco motors are now in use for: cooling (blowers for electronic equipment), tuning (radios and automatic finders), scanning antenna (civilian and military), antiaircraft radar fire control, as well as pump drives and mechanical actuators.

By using standardized parts in a series of six co-ordinated frame sizes, Pesco can provide you with electric motors for electronic applications with voltages from 6 to 120 volts D. C.; from 1/100 to 6 H. P. for operating speeds up to 15,000 R. P. M. Special, high-altitude design will operate from −65° to + 165° F.

Pesco high-frequency A.C. induction motors, squirrel-cage type, are built in a series of 5 co-ordinated frame sizes to meet horsepower requirements of .01 to 9.0, at 400 cycles per second.

Motors in these frame sizes can be built for *your* specific frequency, using standard parts to obtain the speed and power rating desired. Consult our Engineering Department concerning your requirements. Strictest confidence—and no obligation, of course!

engineering Pesco production

PRODUCTS DIVISION

BORG-WARNER CORPORATION
24700 NORTH MILES ROAD • BEDFORD, OHIO

HOLLOMAN

during routine flights to study radiation effects.

They are the subjects in a program conducted by the Space Biology lab at Holloman to determine effects of primary cosmic radiation.

Reason for the studies is that manned flight is beginning to reach the altitude belt—70,000 ft. to 90,000 ft.—where cosmic ray intensity is appreciable. It is necessary to determine what those rays will do to man. Current scientific opinion varies from "some effect" to "possibly lethal."

Fruit flies are used because they are so well known genetically. Their life cycle is only two weeks, which is brief enough so that a short period of time after the flight will produce enough offspring and successive generations to make statistical studies.

▶ **Flight Details**—The general research program and details of the tests were explained by Maj. David Simons, a former flight surgeon now assigned to the work of the laboratory.

Simons explained that primary radiation is made up of the stray nuclei of heavy elements like iron, carbon, oxygen and nitrogen. These can't be duplicated at ground level, although the lighter nuclei of hydrogen and helium can be to some extent.

The chief field of interest is in the "bullet" effect of the cosmic particles. These particles can rip through tissue and out again without doing much damage. It is when they begin to slow down that they get dangerous, because radiation is strongest when the particle has nearly stopped.

When these nuclei begin to slow down well below the speed of light, they collect electrons and ionize at a high rate. The net result—as far as tissues are concerned—is that they are hit with a cylinder of highly ionized material about 100 microns in diameter and a very few millimeters long. This is the "bullet."

▶ **Gene Damage**—The particular study now under way at Space Biology is to find out whether or not the bullet causes any particular damage to the genes of the flies. (Genes are the units of inheritance; they determine presence or absence of such characteristics as black bodies or red eyes in successive generations of the flies.

The bullet can cause both genes of the fruit fly to split, and a phenomenon known as translocation takes place.

Simons said that translocation was something like a double-cross in tree grafting. You graft a limb from tree A to tree B, and a limb from tree B to tree A. The fruit you got from tree A would be mostly fruit A with a little fruit B thrown in; the opposite would be true for tree B.

FOR YOUR "AN" OR STANDARD

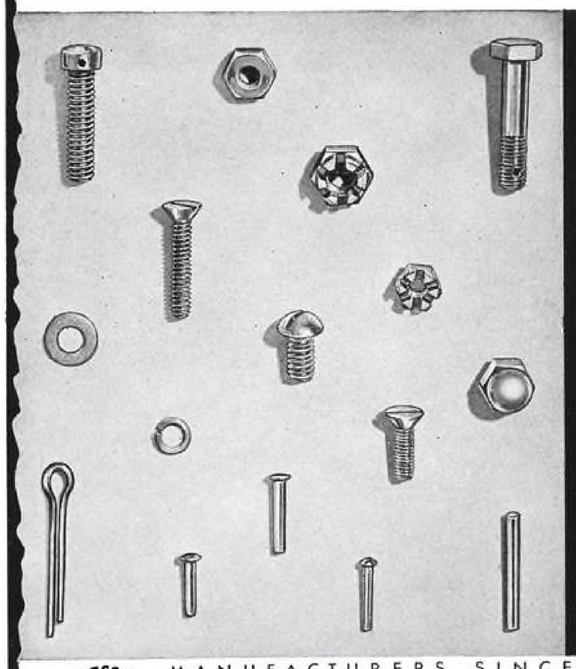
STAINLESS STEEL FASTENERS . . . IT'S ALLMETAL

For quality and delivery

ALLMETAL, Specialists in Stainless, Produce Stainless Products exclusively

Place your orders with Allmetal for Stainless Steel Fasteners that meet the rigid specifications of the Aviation Industry. All types and sizes, "AN" or STANDARD, in stock. Stainless Phillips Recessed Head Screws and Specials available too. Complete facilities under one roof assures prompt delivery.

WRITE FOR CATALOG S



ALL MADE TO "AN" SPECS • MACHINE SCREWS • NUTS • BOLTS • PINS • RIVETS • WASHERS •

STAINLESS STEEL FASTENERS

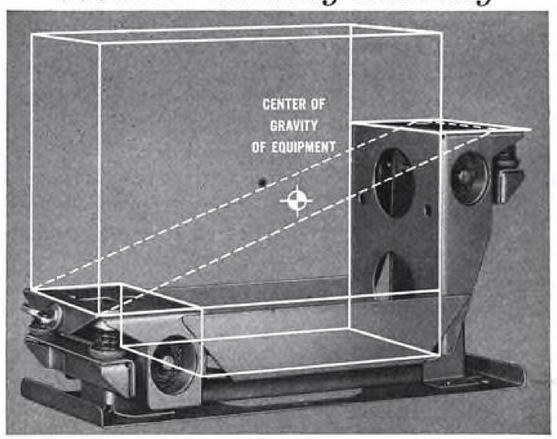
MANUFACTURERS SINCE 1929

ALLMETAL

SCREW PRODUCTS COMPANY, INC.

33 GREENE STREET NEW YORK 13, N. Y.

this *created a stir*
... with nothing stirring



VIBRATION and **SHOCK**

Problems raised by the enormous horsepower and speed of today's aircraft, and increasing use of electronic equipment, have been solved with surprising results by **Robinson Vibration Control Systems.**

These mounting systems keep equipment free-floating and motionless under almost unbelievable conditions of vibration and shock.

Built to last a lifetime

Robinson Mounting Systems employ all-steel, load-carrying cushions of Met-L-Flex*. By an exclusive method of fabrication, Robinson Met-L-Flex cushions are inherently damped, and they do not pack down or wear out.

They are the most durable Mounts ever built for air-borne equipment.

**Met-L-Flex is the copyrighted designation for the all-metal resilient cushions developed and pioneered by Robinson.*

Meets exacting requirements

Some vibration problems are solved with standard Robinson Mounts. Others call for specially designed systems to give the greatest efficiency and economy. An example is the "center of gravity" type (illustrated above) developed for **Minneapolis-Honeywell Regulator Company.**

This mounting system provides utmost stability for equipment which is narrow and tall and has a high center of gravity location. In this case the center of gravity lies in the diagonal plane of the mountings.

Do You have a problem in Vibration Control?

Robinson Mounts are designed for light precision instruments, electronic equipment of any size or weight, for aircraft, ground vehicles and heavy machinery.

If you want to know how this new development in vibration control can be applied to your problems, write us immediately, attention of Dept. AW2.

ROBINSON AVIATION INC.
TETERBORO, NEW JERSEY
Vibration Control Engineers

■ HOLLOMAN

This program has been running for more than a year, and countless male flies have made the trip aloft, have been recovered and mated to virgin females for genetic studies. It is definitely not encouraging to look at the charts of inherited characteristics plotted from these test runs and to see long lines drawn through an occasional generation. The lines are marked "Lethal."

► **Fly Carrier**—A bright orange sphere is the balloon gondola on these tests. Inside the zippered canvas covering is about three inches of Fiberglas insulation and an aluminum sphere. Four screened cages are supported inside the sphere on plywood bulkheads, and in these boxes, of course, are the flies, 125 per box.

No oxygen is added to these containers for the flights, but Simons said that they do throw in some soda lime to keep down carbon dioxide.

Almost all of the flights use balloons for the test vehicles, because—at the lower surface of the cosmic ray layer—a long exposure is necessary to make sure that some flies will get hit by the stray nuclei. During a 24-hr. exposure, Simons said, only one or two flies are apt to get struck.

► **Recovery Problem**—The maximum transition from primary radiation to secondary—which occurs when a primary collides with another particle—is at about 70,000 ft., but Simons said that flights have to go to 90,000 ft. to get any kind of results. He would like to get exposures of at least 72 hr. duration in order to speed up the data gathering.

Simons explained that the problem in all the tests is recovery of the container; there is some difficulty yet in working out the tracking of the sphere.

On the use of rockets, Simons said that they were used occasionally for the studies of excessive or zero gravity, but that the short duration at altitude made them undesirable for radiation studies.

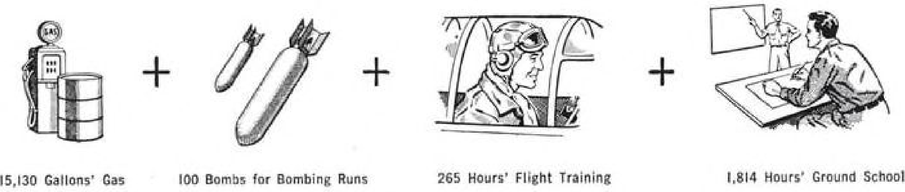
Drones

Part and parcel of the development of any weapons system is the parallel development of targets to prove the system. At Holloman, among the several types of target drone aircraft two are available in quantity: Radioplane's OQ-19 and Ryan's Q-2 Firebee.

The OQ-19 is the latest in a long line of target drones built by Radioplane, originally the property of actor Reginald Denny and now owned by Northrop. Perhaps more than any other contemporary aircraft, the OQ-19 owes its success to long backgrounds in model building and flying on the part of its developers.

► **Life Span**—The best illustration of

What it takes to train a bombardier!



15,130 Gallons' Gas | 100 Bombs for Bombing Runs | 265 Hours' Flight Training | 1,814 Hours' Ground School

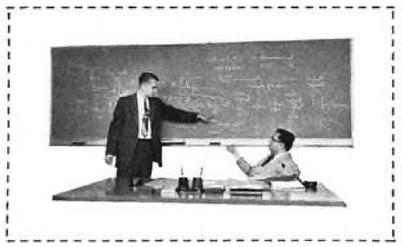
This tremendous investment in time and materials is necessary to turn an airman into a skilled bombardier! But costly as it seems, it's a bargain compared to what it would be without radar training devices that ground-train aircraft observers. These devices simulate actual flight conditions and enable Air Force personnel to learn to hit the target... before they ever leave the ground!

These new electronic trainers not only do a better job of training much more quickly, but effect tremendous savings in fuel, personnel, airplane maintenance, practice ammunition and bombs.

The Electronics Division of American Machine & Foundry Company, working closely with the Air Force through its various Commands, derives great satisfaction from the part it plays in keeping our Air Force the best-trained in the world.

AMERICAN MACHINE & FOUNDRY COMPANY
Executive Offices, 511 Fifth Avenue, New York, 17, N.Y.
AMF does it better—automatically!

CREATORS AND PRODUCERS OF ELECTRONIC AND MECHANICAL EQUIPMENT FOR THE ARMED SERVICES : Radar antennae and drive units • automatic loaders for Army and Navy weapons • elevating and azimuth mechanisms • cooling fans for Army tanks • airplane parts • mobile ovens • electronic training devices • naval ordnance • rolled and welded steel products • shell components • silver-zinc batteries • special military projects



PLANNING THE RIGHT ANSWERS

The complexity of modern air defense—extreme aircraft speeds, highly complex weapons, new combat strategies, the advanced state of today's technology—poses serious problems for the scientist and engineer.

One significant solution lies in the extensive use of airborne automatic equipment, including electronic digital computers, to augment or replace the human element in aircraft control.

At Hughes Research and Development Laboratories each problem is attacked basically, beginning with systems planning and analysis. This consists of an exhaustive examination of the requirements of a problem, together with an evaluation of the best means for satisfying these requirements. The objective is to design the simplest possible mechanization consistent with a superior performance.

These techniques, employing many special talents, are responsible at Hughes for the successful design, development *and* production of complexly interacting automatic systems for all phases of electronic control of interceptor navigation, flight control, and fire control. Similiar accomplishments may be pointed to in the guided missile field.

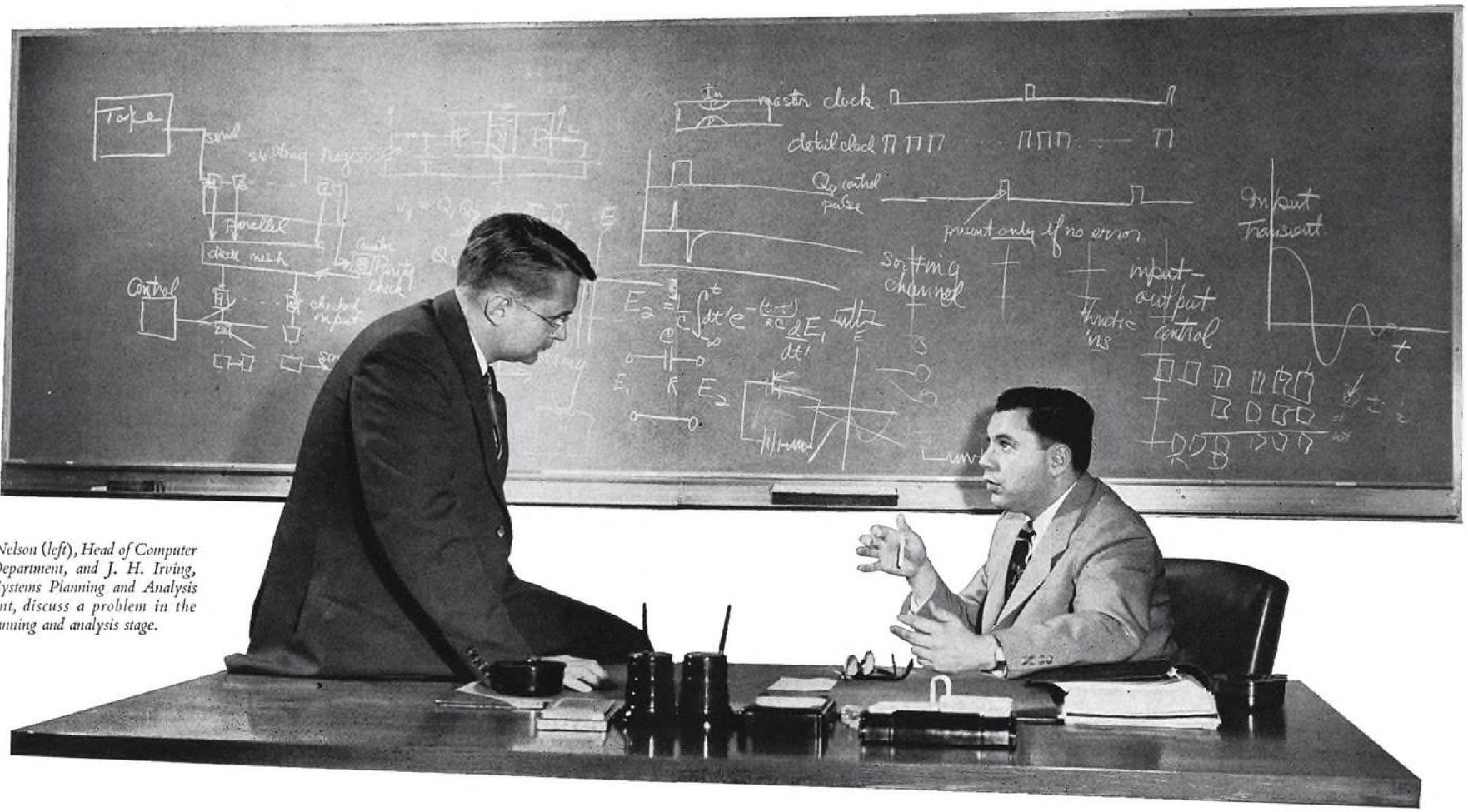
Methods of systems planning and analysis responsible for achievements in the military area are also being applied at Hughes to adapt electronic digital computer techniques for business data processing and industrial controls.

HUGHES

Research and Development Laboratories

CULVER CITY,
LOS ANGELES COUNTY,
CALIFORNIA

ADDRESS:
SCIENTIFIC
AND ENGINEERING
STAFF



Dr. E. C. Nelson (left), Head of Computer Systems Department, and J. H. Irving, Head of Systems Planning and Analysis Department, discuss a problem in the systems planning and analysis stage.

PHYSICISTS AND ENGINEERS

Hughes activities in the computer field are creating some new positions in the Systems Planning and Analysis Department. Experience in the design and application of electronic digital computers is desirable, but not essential. Analytically inclined physicists and engineers with a background in systems work are invited to apply.

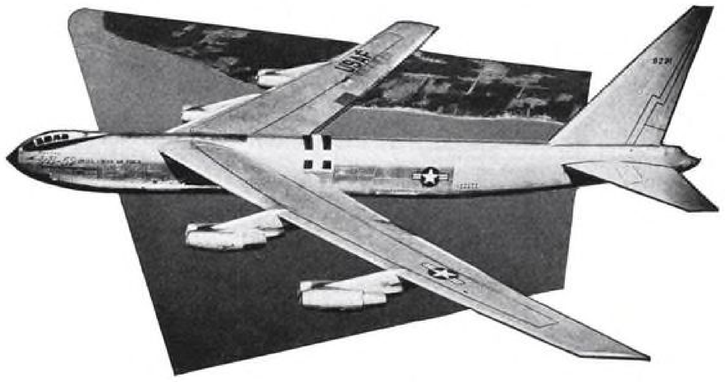
ASSURANCE IS REQUIRED THAT RELOCATION OF THE APPLICANT WILL NOT CAUSE DISRUPTION OF AN URGENT MILITARY PROJECT.

We Are Proud

THAT MISCO PARTS ARE USED IN THE

BOEING B-52

STRATOFORTRESS



Its EIGHT

Powerful PRATT & WHITNEY AIRCRAFT J-57

Engines employ INVESTMENT CASTINGS by

MISCO

PRODUCERS OF AIRCRAFT AND INDUSTRIAL INVESTMENT CASTINGS

Today, when aircraft and aircraft engine builders alike demand the utmost in dependable precision castings, they look to Misco for accuracy, large volume, and substantial production savings.

Pioneers in the precision casting of heat and corrosion resisting metals, Misco has years of experience in this highly specialized field.

The Misco Precision Casting Process, with rigid dimensional and metallurgical control, X-Ray and Zyglo inspection, affords every assurance that customer requirements are met.

Misco Precision Casting Company

WHITEHALL, MICHIGAN

PLANTS AT: DETROIT AND WHITEHALL, MICHIGAN—OFFICES IN ALL PRINCIPAL CITIES

TELEPHONE: WHITEHALL 2-1515

■ HOLLOMAN

this is the launching technique. Often fired from a catapult or even one of the rocket track sleds, the OQ-19 has recently been flown off the ground on a control line.

▶ **Firebee**—Ryan's Q-2 drone was launched initially from a modified Douglas B-26. Later techniques have made it possible to ground-launch the Firebee using a solid-propellant Rato unit.

Most of the Firebees now operated are powered by the Fairchild J44 turbojet, a lightweight engine of monocoque design.

A few of the Firebees have been flown with French Marbore jets which have a lower fuel consumption.

▶ **Engine Mounts**—The Fairchild engine as mounted in the Q-2 needs no extra tailpipe other than that supplied with the engine. The Marbore has a long and angled tailpipe to compensate both for the engine's shorter length and the direction of flow through the turbojet.

"Getting at the power plant for maintenance or removal is a cinch with the cowling design Ryan developed," said Walter Andre, civilian engineer in the drone section.

A wedge-shaped piece lifts out of the upper cowl about two feet behind the nose. At the pointed ends of this wedge are hinges with their hingeline across the fuselage from right side to left. The mechanic unlatches the cowling at the rear of its lower surface, and the whole cowling swings down, rotating around the hinge line until the wedge-shaped open segment is closed.

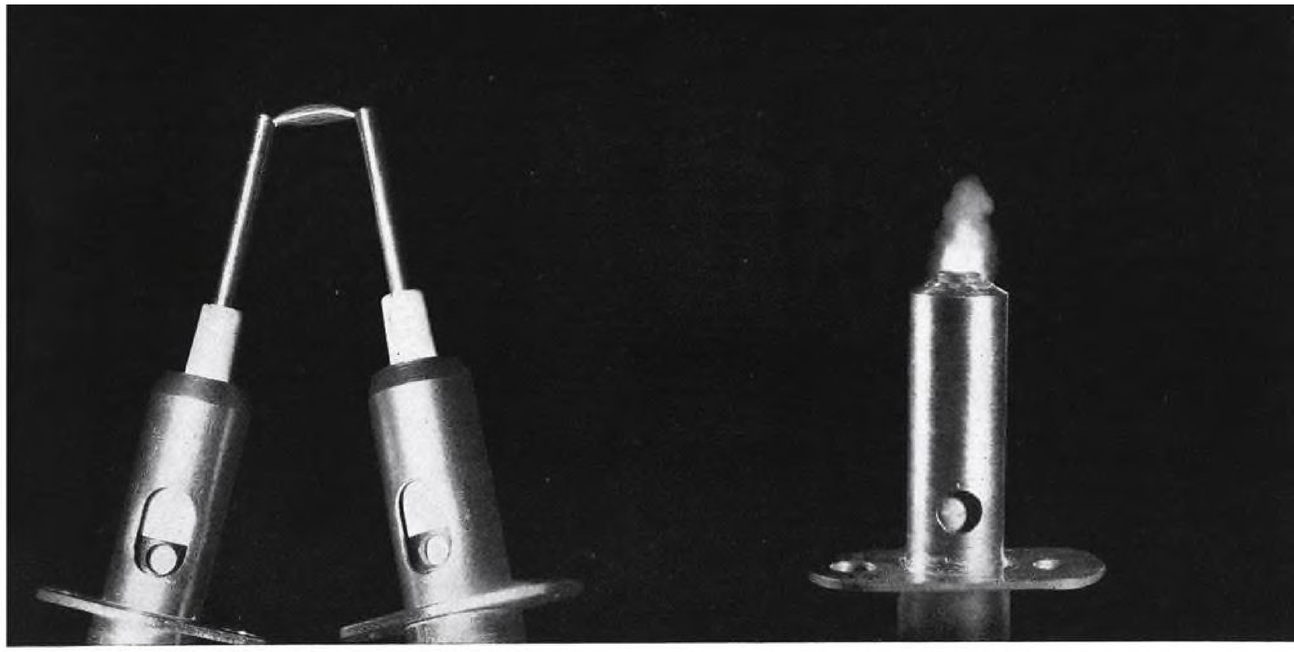
▶ **Recovered Birds**—A line of Firebees in various states of teardown and assembly indicated the endurance of "birds" which had already flown and been recovered. Their red noses bore white stencils of the Firebee under a parachute for each successful recovery. Top score for any drone in the hangar was nine recoveries.

Andre said recovery of the bird has been highly successful. Capt. Jay Smith of the Parachute Branch said that the Firebee was a good example of a fine installation of a parachute recovery system.

Only two of 71 flights cracked up instead of floating down under the silk. On the two that failed, post-mortems uncovered the reasons and there aren't likely to be any more failures from that cause.

Parachutes

If there is a parachute problem, the chances are that Capt. Jay V. Smith can help. He is head of the Parachute Branch at Holloman, and his group is set up to manufacture, repair and test



NEW G-E Capacitor Discharge Ignition System (right, above) gives more effective spark than "opposite polarity" ignition system (left).

New G-E Ignition System Gives Jets Fast High-altitude Starts

Exact performance data is classified, but this much can be said about G.E.'s new Capacitor Discharge Ignition Systems for jet aircraft:

1. These systems assure fast, reliable ignition at high altitudes. Full-scale engine tests have now proven that these G-E systems fire jet fuel at extremely low temperatures—at altitudes far above 30,000 feet.

2. G-E Capacitor Discharge systems, through a unique use of capacitors, provide a terrifically powerful, *effective* spark. Because C-D systems have a sealed spark gap in their discharge circuits, energy output remains constant at all altitudes.

3. The main components are housed in aluminum boxes with removable covers. Maintenance is easy, for components are readily accessible for overhaul or replacement.

4. These G-E systems are built to Radio Interference Specification MIL-I-6181.

If you would like more information on this outstanding new G-E product, just send in the coupon below. For immediate projects, of course contact your nearest G-E Aircraft Specialist. *Section 210-73, General Electric Company, Schenectady 5, N. Y.*

LIGHT WEIGHT of G-E capacitor discharge ignition system (right, above) is clearly evident, compared to "opposite polarity" system. New system is about 50% lighter.

You can put your confidence in—

GENERAL ELECTRIC

Section 210-73
General Electric Company
Schenectady 5, N. Y.

Please rush me your free bulletin on G-E Capacitor Discharge Ignition Systems for aircraft (GEA-5996).

.....Reference.....Immediate project

Name.....Position.....

Company.....

City.....Zone.....State.....

FOR ELECTRICAL CIRCUITS . . .

Leach CONTACTORS

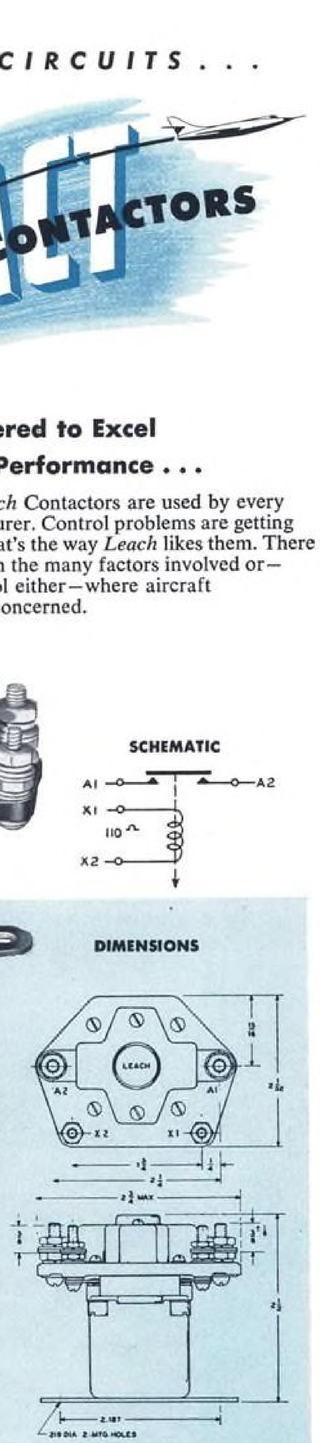
. . . are Engineered to Excel in Control Performance . . .

In Aircraft, *Leach* Contactors are used by every major manufacturer. Control problems are getting tougher—and that's the way *Leach* likes them. There can be no gaps in the many factors involved or—in quality control either—where aircraft performance is concerned.

Leach Part No. 7064-758

SCHEMATIC

DIMENSIONS



CHARACTERISTICS

APPROVAL:
Approved as AN-3350-1 per Spec MIL-R-6106 (inverted terminals and side mounting).
Approved as AN-3350-2 per Spec MIL-R-6106 (supersedes AAF B-11, B-5B and NAF 1204-1 for new design)

CONTACTS:
Arrangement—Single pole, single throw, normally open, double break.
Rating—50 amps resistive, inductive, and motor load at 29 v d-c.

COIL:
110 ohms, 24 v d-c continuous duty.
Pick-up—18 v d-c max.
Drop-out—7 v d-c + 0, —5.5.

WEIGHT:
0.54 lbs. approximate.

For your specific requirements and for BETTER CONTROLS THROUGH BETTER CONTACTORS—*Specify Leach.*

Write for new Brochures

LEACH RELAY CO.

5915 AVALON BOULEVARD, LOS ANGELES 3, CALIFORNIA
Representatives in Principal Cities of U. S. and Canada

■ HOLLOMAN

chutes from 10 in. in diameter to 150 ft. across.

Do you want a reliable barometric pressure switch? Smith's outfit has one. He says that it is a little too heavy and a little too complicated for personnel chutes right now, but it works every time.

▶ **They Find Answers**—Do you need to know the drag characteristics of a WAKO spherical chute? Smith's group can probably dig out the figures.

Are you stuck for space in the chute compartment? Try pressure packing, an innovation in technique for squeezing out all trapped air during the packing process.

Do you want some design advice for that recovery system for your next missile? Smith makes a fervent plea to allow for altitude enough and space enough to accomplish the task.

▶ **Branch Mission**—The job of the parachute branch is to provide service for the contractors, to install and modify parachute recovery systems, and to conduct tests to improve the systems.

To accomplish this job, the branch is scheduled to make about 30 drops per month, based on 22 working days per month. But Smith said that aircraft availability cuts that figure down by as much as 25%.

Two general types of tests come under the work schedule of the group:

• **Proving tests** of a new item in a system, a recovery modification or a functional component test.

• **Service tests** of parachutes before they are used in a recovery system, or any new or repaired chutes.

They have developed a standard container for chutes by modifying several general-purpose bombs. They take a bomb, chop off the portion behind the rear mounting lug and replace that portion with a sheet-metal tailcone. By using the nose shapes from 500-, 1,000- and 2,000-lb. bombs, they can get a range of containers that will handle loads from 240 to 3,000 lb.

▶ **Instrumentation**—The container is rigged in the bomb-bay or under the wing of one of the drop aircraft—Douglas B-26, Boeing B-17 and B-29, or Douglas C-47—taken to altitude and dropped.

Instrumentation is GSAP cameras to photograph the deployment of the chute, and accelerometers to measure the opening shock and impact shock. Base instrumentation gives the space-time relationship during the drop.

In spite of the 600-year history of the parachute, there are plenty of problems which time has not solved. Smith says there is as yet no catch-all parachute system; each type has to be developed on an individual basis. This

VOI-SHAN
MANUFACTURING COMPANY, INC.
Serving the Aircraft, Automotive, Marine, Rail, and Oil Tool Industries
8463 HIGUERA STREET • CULVER CITY, CALIFORNIA

MILITARY NEWS from the world's largest light plane producer

VETERAN CESSNA L-19s SERVE ARMY, MARINES AND NATIONAL GUARD

Combat-proved Liaison Planes Used To Teach Reservists Flying, Observation, And Fire Direction

Introduced to U. S. Army and Marine fighting units in Korea 2½ years ago this month, the Cessna L-19 observation plane is now being used in increasing numbers by National Guard units, too, it was announced recently by Cessna officials in Wichita, Kansas.

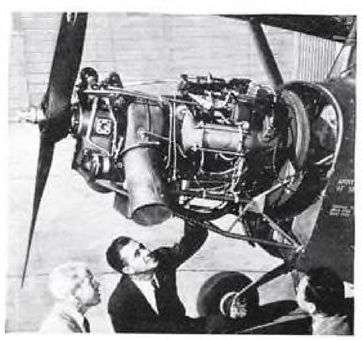
The versatile 2-place, 213 H.P. plane—nicknamed the "Bird Dog"—is used in teaching selected Reserve Infantry officers to fly. In addition NG Infantry regiments each receive two L-19s which are used for training personnel in aerial observation of targets and direction of air and ground fire.

Flexible as the L-19 "Bird Dog" has proved to be, Cessna engineers have now done it one better in the new XL-19B—a turbine-powered version of the L-19 that flies on *any* grade of fuel, *even diesel!*

Other current Cessna projects are development of a new Navy helicopter, production of assemblies for bomber and fighter planes and research in Boundary Layer Control which greatly shortens the take-off and landing distances required by high-speed aircraft.

CESSNA AIRCRAFT COMPANY, WICHITA, KANSAS

IN ARMY OBSERVATION PLANES AND TURBOPROP RESEARCH . . .



Cessna

SETS THE PACE

■ HOLLOMAN

means time, and what seems like duplication of effort. Smith is the exact antithesis of the guy who has a book and doesn't want another; parachute systems come in libraries.

There isn't any system big enough for the recovery of really heavy objects, Smith pointed out. Right now they use multi-stage recovery where one parachute is used to slow the package down and others are used for the letdown.

History

Many an Air Force pilot today remembers lifting B-17s, B-24s and B-29s off the runways at Alamogordo Army Air Field. This was the original name of the base that is now Holloman.

The field was deactivated at the end of the war.

►**First Missile Work**—Meantime, the Air Force had been making its first steps in the direction of guided missiles at the Air Materiel Command base at Wendover, Utah.

By the end of 1946 the old bombing range at Alamogordo was selected as a good missile test area. The available land was about 64 miles long and 38 miles wide, and sparsely populated.

So Col. Paul Helmick, who had been in charge of the First Guided Missile Group employed overseas for combat, was sent to Alamogordo in charge of a field party to start the base missiles activities. Other airmen and officers were transferred from Wendover, which was being closed, and Holloman began to grow.

In six months—on Sept. 17, 1947—the first test round was fired.

►**Now Holloman**—One year later the base was renamed Holloman AFB in honor of Col. George V. Holloman, a pioneer in the guided missile research field.

When the Air Research and Development Command was formed in 1951, the base was taken under the Air Force Missile Test Center at Patrick AFB, Fla., and was known as the 6540th Missile Test Wing. In September 1952 the base was taken from AFMTC and redesignated the 6580th Missile Test Wing. A month later, Holloman was named one of the development centers of ARDC, and the range was consolidated with those of the Army in a joint cooperative.

North of the Rio Grande, between the enclosing arms of the San Andres and Sacramento mountains, fly the shape and substance of tomorrow's missiles.

Now, as in the past, pioneers are traveling the length of the historic pass to the north.

CONSTANT RESEARCH and DEVELOPMENT

HAS ENABLED US TO PRODUCE ONE OF THE FINEST COMPUTERS AVAILABLE TODAY.

AMPLIFIER GROUP, TYPE 16-31C—provides 28 contact stabilized operational amplifiers for use as summers, differentiators, integrators, and inverters. Also in the cabinet are all necessary power supplies and a complete test panel.

MULTIPLIER GROUP, TYPE 16-31L—is a servo-mechanical multiplier and incremental function generator. There are 20 channels, each of which is capable of multiplying four variables by a fifth.

RESOLVER GROUP, TYPE 16-31D—furnishes 4 resolving channels and 12 operational amplifiers. Each resolving channel may also be used for multiplying three variables by a fourth. Furnished complete with test panel, reference supplies, and power supplies.

CONTROL CONSOLE, TYPE 16-24E—Houses the grounded metal problem board and its bay, attenuators, initial condition potentiometers, networks, limiters, and all operating controls.

SERVO GROUP, TYPE 16-31P—For the operations of resolving and multiplying when used with external amplifiers. There are two resolving and four servo-multiplying channels. The equipment is furnished with test panel and power supplies.

ELECTRONIC ASSOCIATES Incorporated

INQUIRE SALES DEPARTMENT
LONG BRANCH, NEW JERSEY

FIREPOWER demonstration showers targets with napalm, rockets, bombs and bullets. Lockheed F-80 roars over wrecked vehicles as . . .

Center Tests USAF Armament Systems

AFAC gives developers of new weapons systems a place to proof-test their work, get the 'bugs' out of components.

Eglin AFB, Fla.—"Without armament, there is no Air Force."

Emblazoned in offices and hallways, on walls and bulletin boards, these seven words by Lord Trenchard (regarded as the father of the Royal Air Force) summarize the philosophy, the job definition and the attitude of the Air Force Armament Center, located on Choctawhatchee Bay on the Gulf of Mexico.

• **As a working philosophy,** the sentence expresses the position of armament in the complex picture of contemporary aerial warfare.

• **As a job definition,** it draws the broad outlines within which officers, airmen and civilians work at this Center.

• **As an attitude,** it reflects the opinions of the armament experts, starting with AFAC's commander, Brig. Gen. Edward P. Mechling, and extending right on down through the ranks.

► **Analogy**—Unlike their medieval counterparts, these armorers don't forge any weapons themselves. Their work is today's equivalent of the proof test, used to satisfy the customer of the Middle Ages as to the adequacy of his armor.

In effect, AFAC runs a shooting gallery. It operates the range, gives the customer a place to stand and bullets to shoot. It marks his targets, and gives him the results.

Right now, it is not a very ornate shooting gallery. It is not even complete. AFAC is a very busy proprietor, trying to keep as many customers shooting as possible, while building an addition to the gallery next door and setting up new and different targets in the original range.

But within the next eight months, the Center will have completed the lion's share of its facilities, and will be able to show the biggest change yet in capability.

At that time, AFAC will be well along in its plan to develop an all-weather capability for testing any armament system or any of its components.

► **Not Just the System**—Almost every time the phrase "weapons system" is spoken around this Center, it is followed by "and its components." That is a clue to the stress which has been placed upon sub-items of a system, and not on the system alone.

"The weapons system concept can't be fully successful unless it's based on the availability of tested components," Gen. Mechling told AVIATION WEEK.

"A weapons system has about a five-year lead time, and the initial choice of components must be made on the basis of some experience. So it is important that the full scale of component developments be sponsored and adequately tested for the state of the art so that systems engineers will have suitable equipment and test components.

"It's true that everything in the component line will not be used, but we must test sufficiently. Right now we are creating a technical capability and capacity; our ability will contribute to the success of the weapons system plan.

"Remember that testing has to be done in time to be effective."

► **War Baby**—The Air Force Armament Center was really started by the minor multitude of weapon failures during World War II. Because there had been no central test facility set up by the Army Air Force, much new armament used during the war years had been committed to production ahead of time.

The AAF was embarrassed by being forced to rework or refit equipment on aircraft, and also lost money and precious time.

Out of these failings grew the realization that an armament test center would be a valuable asset.

Both the Air Staff and the Air University made studies of the problem. Some of these were aimed at opening a new test area but somebody discovered that—at that time—Eglin AFB near Valparaiso, Fla., was not being utilized to capacity.

The decision to put armament testing in with the work of the Air Proving Ground at Eglin was made by Gen. Vandenberg, then USAF Chief of Staff, in early 1949.

One reason behind this decision was the availability of the facilities of the APG. Charged with operational suitability tests of all AF armament, the Air Proving Ground requires test ranges which are the same as those required by AFAC. The only difference between them is that generally there is more instrumentation required for an AFAC mission than for an APG mission.

Construction began during fiscal year 1950. In December 1951, the Air Force Armament Center was officially designated, placed under the Air Research and Development Command, and Gen. Mechling was named commander.

► **Advisers**—There were two deterring factors: First, experienced people to form a strong nucleus were not plentiful; second, the prestige of armament in the Air Force was pretty low.

Immediately after his appointment to the command of AFAC, Gen. Mechling—with 18 years experience in Army Ordnance before transfer to the AF—set up a Technical Advisory Group of 20 consultants.

These men—armament specialists from industry and technical schools—advise Mechling on modification or extension of the Center and its organization. They meet about annually as a group; individual members may be asked for specific answers to special problems.

As an example, a Group member might be asked to comment on the validity of conclusions drawn from certain test data; another might be asked to recommend the most practical method of utilizing the range data.

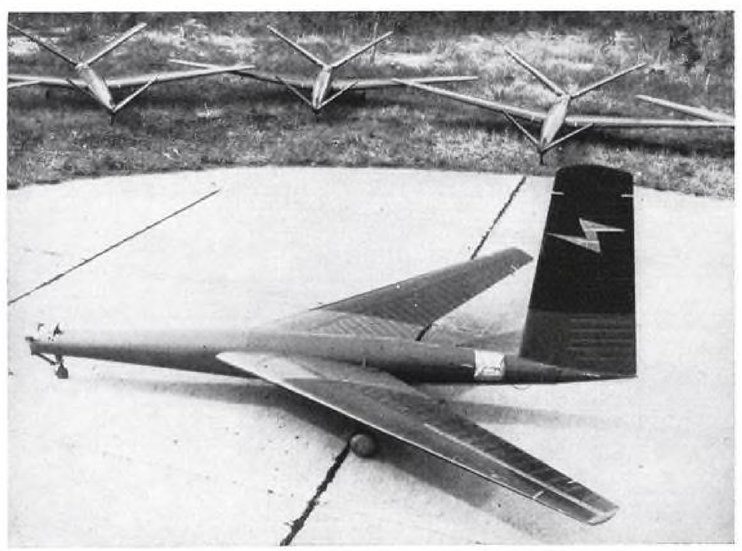
Although the organization calls for a full-time executive director of the Group, there was none as of mid-July. Gen. Mechling wanted to get the best person available, but was not in a great hurry to fill the job until he was satisfied personally with the prospective candidate.

Brig. Gen. Edward Pont Mechling, Commander, Air Force Armament Center . . . ordnance expert who transferred to USAF when it became a separate service . . . born Knoxville, Tenn. . . . graduate U. S. Military Academy 1927 . . . graduate of Army Ordnance school . . . bachelor's degree in mechanical engineering from Massachusetts Institute of Technology . . . served as ordnance officer with 8th, 12th and 15th Air Forces in Europe during World War II . . . deputy director of armament in USAF Hq. 1948-51 . . . assigned as deputy director armament, Hq. ARDC before taking command of USAF armament center . . . author of field manual on electric and gas welding . . . wrote articles on ordnance and logistics . . . awarded Legion of Merit and Air Medal.

► **Advisory Group Members:** Current roster of the Technical Advisory Group comprises these armament experts:

Dr. H. H. Bailey, Bell Telephone Labs; R. R. Beachler, Jr., George Bussiere, and W. E. Swanson, all of North American Aviation, Inc.; Dr. C. S. Draper and Dr. J. P. den Hartog, Massachusetts Institute of Technology; F. W. Godsey, Jr., Westinghouse Electric Corp.; Dr. Walter Bartky, University of Chicago; Henry A. Berliner, Engineering Research Corp.; Homer H. Ewing, E. I. du Pont de Nemours & Co., Inc.

Also, Col. R. L. Goetzenberger, Minneapolis-Honeywell Regulator Co.; Dean L. E. Grinter, University of Florida; Donald B. Houghton, the Franklin Institute; Dr. Norman C. Peterson, Rand Corp.; Roderic M. Scott, the Perkin-Elmer Corp.; Oram C. Woolpert, MD, Ohio State University Research Foundation; H. T. Hokanson, General Electric Co.; Col. H. N. Marsh, Hercules Powder Co., Inc.; Joseph Pinsky, Illinois Institute of Technology.



RED BIRD is sweptwing tow target modified from straightwing version at rear.

► **Circular Circuit**—Armament is a merry-go-round. Requirements lead to development, then testing. Procurement follows, and then a period of service life. The experiences learned here lead to new requirements, and the carousel goes round and round.

At four stations of the circular path, AFAC has a chance to grab for the brass ring:

• **In the development phase,** it supports the contractor and tests components of the final system.

• **In the testing phase,** the system and components are evaluated as insurance before entering an all-out procurement program.

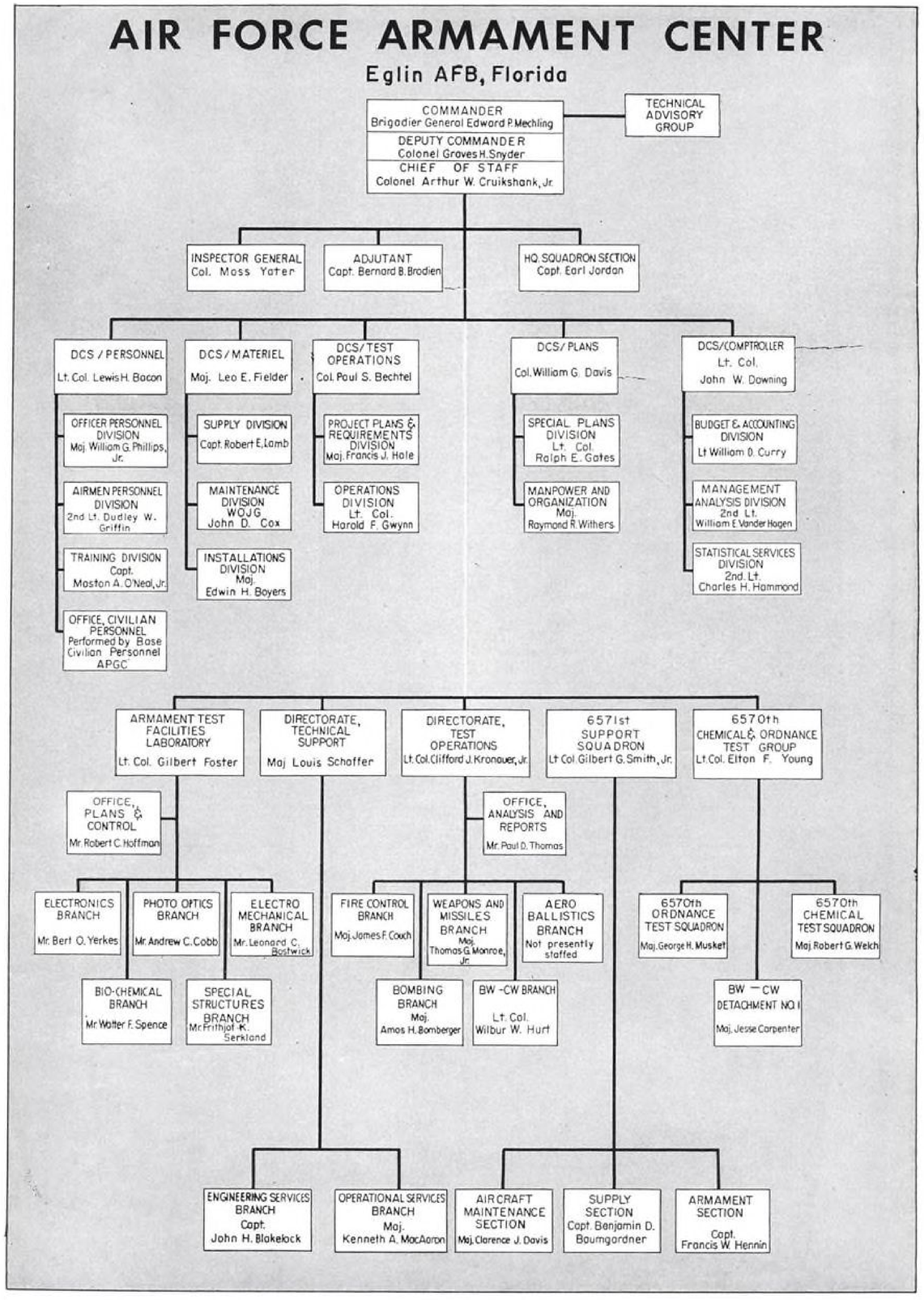
• **During procurement,** the armament system, the tactical aircraft and the pilot are evaluated together as a weapons system.

• **During service life,** unsatisfactory reports may come in on the performance of an item in combat; inservice testing is the result.

All these tests feed back into the development circuits, and, coupled with changes in the state of the art and practice in tactics, help determine future requirements.

► **The Channels**—These are the steps between ideas and tests in the present development of weapons systems:

• **Development Planning Objectives** are the prime movers. These originate in the office of the Deputy Chief of Staff



■ EGLIN

for Development, HQ USAF, and rise out of continual reviews of the state of the art in aerial warfare. These documents lead to:

• **General Operational Requirements,** which define in outline a weapons system or a component. GORs go to HQ ARDC, where a solution is proposed; the package of GOR plus whatever help can be added is forwarded as a:

• **Design Study Directive** to the proper Centers for study. The Centers make up their version of the proposal, which must be approved at HQ ARDC and HQ USAF before work can start. That document is called a:

• **Development Plan;** approval of it constitutes the authority to go ahead and means money is set aside for the project.

"About here is where we get into the act," said Col. Paul S. Bechtel, Deputy Chief of Staff, Test Operations, for AFAC. "My office is responsible for acceptance, programming, planning, control and reporting of all test programs. We work with the Deputy for Plans here all the way through.

"We get in the program as early as several years ahead of the tests, when Wright Air Development Center is working out the Development Plan. We help write the test annex to the Plan after WADC has laid out the test objectives.

"We choose the type of test and techniques, and plan ahead so that once the hardware arrives, we can start work," Bechtel added.

► **Second Phase**—Development type testing, usually called Phase One, is not the job of the Center. AFAC work starts in the second phase of engineering evaluation, when the contractor brings his weapon down to the Center to use its facilities.

The Center will test in Phases Four, Six and possibly Five; it is also possible that all six phases of tests may be done on a particular item.

In general, AFAC tries to monitor the development phase by watching tests while the contractor runs them; in like manner, Center personnel work with Army Ordnance. They might handle special applications or special aspects which would put the Air Force in the Ordnance act.

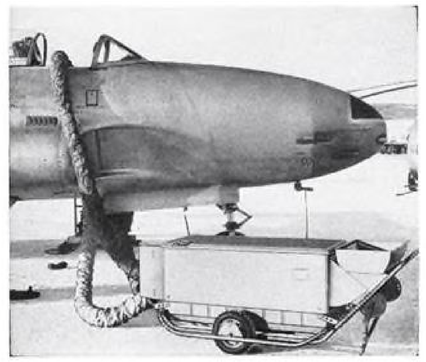
Any minor troubles which can be fixed with a minor change are handled at the Center to keep from interrupting the test program. If some major trouble appears, the item goes back for development work. The Center will recommend changes to the Armament lab at WADC or request that the project officer come down and look the situation over.

"Right now we're only doing a little bit of contractor support," said Bechtel.

AAF Engineering Skill
Produces **New** *and Better*

Aviation Industry Equipment

Products designed by Herman Nelson and American Air Filter engineers are making a major contribution to the country's rapidly expanding aircraft industry in both the civilian and military spheres. Long experience and exhaustive research has paid off in practical equipment for a wide variety of uses in these fields.

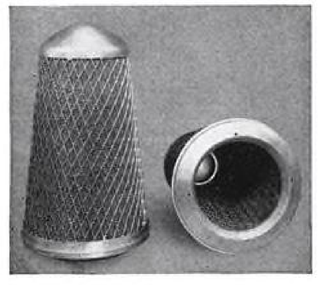


B-T SERIES PORTABLE HEATER . . . *designed to meet four basic needs of the aircraft industry.*

Here is the latest of the famous Herman Nelson line of compact high-capacity units. Produces over *400,000* BTU of clean, uncontaminated air for Space Heating, Personnel Heating, Aircraft and Engine Pre-heating and all Standby Utility Needs.

ENGINEERED METAL SHIPPING CONTAINERS . . . *in standard or special designs to fit your needs.*

The model illustrated here was developed by AAF engineers to guarantee safe shipment of the complicated Jet Engines. Modifications of this container or a container engineered and designed to handle the safe shipment of any product is available. Just tell us your problem . . . and we will design and supply the container.

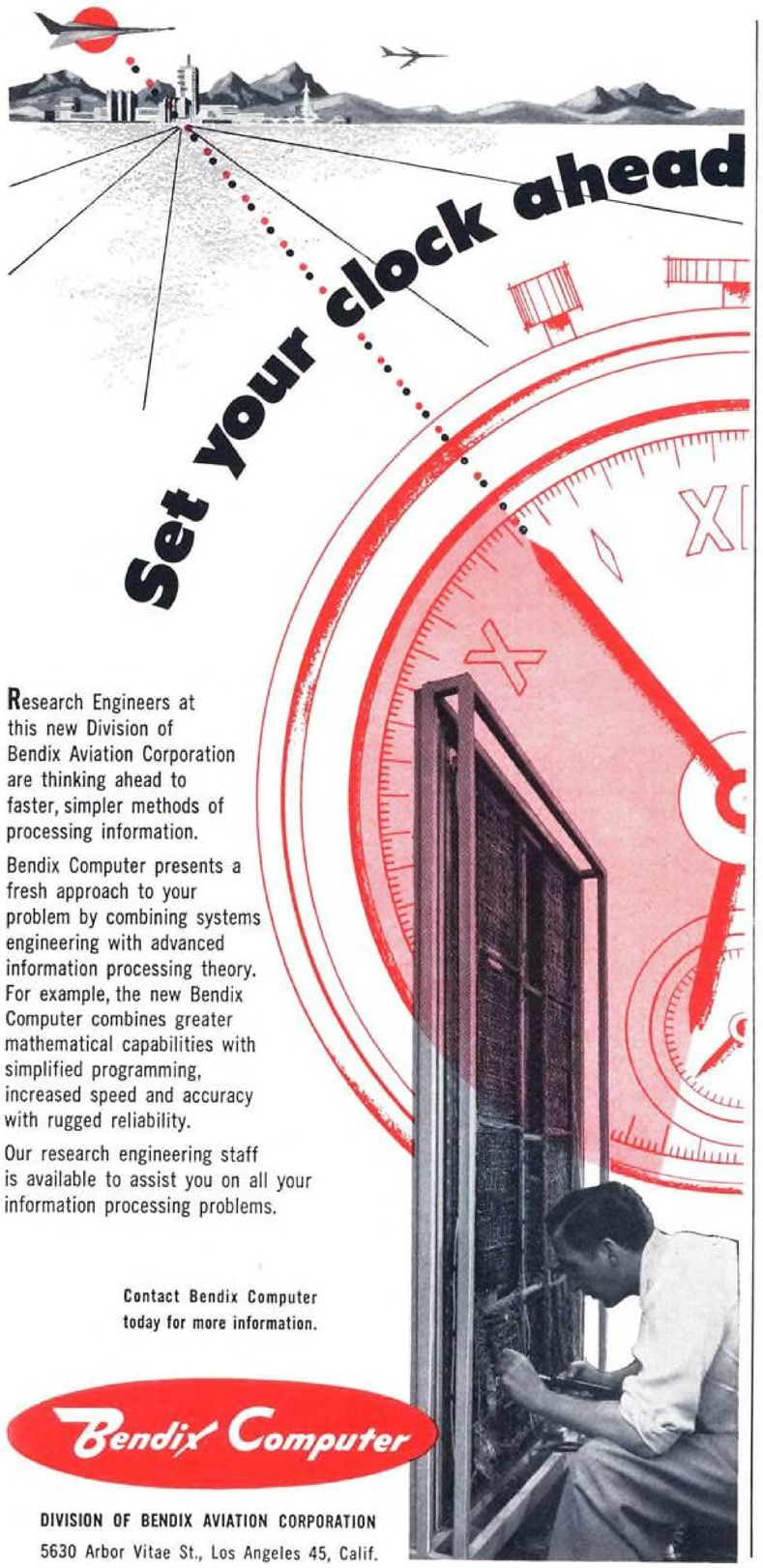


AIR FILTERS—FOR RECIPROCATING ENGINES . . . *custom-designed to the installation requirements.*

Experience acquired by AAF from years of leadership in the complicated design and production problems of high efficiency—low drop air cleaning equipment has enabled us to solve many critical problems for air frame manufacturers. Our engineering staff is familiar with all phases of air cleaning. We invite inquiries and experience reports.

AAF herman nelson

American Air Filter
COMPANY, INC.
215 Central Avenue, Louisville 8, Ky.
American Air Filter of Canada, Ltd., Montreal, P. Q.



Research Engineers at this new Division of Bendix Aviation Corporation are thinking ahead to faster, simpler methods of processing information.

Bendix Computer presents a fresh approach to your problem by combining systems engineering with advanced information processing theory. For example, the new Bendix Computer combines greater mathematical capabilities with simplified programming, increased speed and accuracy with rugged reliability.

Our research engineering staff is available to assist you on all your information processing problems.

Contact Bendix Computer today for more information.

Bendix Computer

DIVISION OF BENDIX AVIATION CORPORATION

5630 Arbor Vitae St., Los Angeles 45, Calif.

■ EGLIN

"We'd like to have them come down and get a little extra insight into development problems, whether or not they've got anything to test. We expect that contractor support will grow as the word gets around on the facilities we have."

► **Procedures**—"It might be easier on a contractor if he comes here first for preliminary discussions," said Maj. F. J. Hale, head of the Project Plans Division under Col. Bechtel. "Then he makes the formal request through the project officer at WADC."

As in other Centers, there are no charges to the contractor for the use of the facilities; costs are budgeted as part of the normal operating expense of the Center.

Final data may be widely distributed —in the case of Phase Two tests—or may go only to the specific contractor and the military. "Contractors' rights are respected," said Hale. "We may reduce the data for him, and we'd like to keep copies because we have to be able to make technical comments that are well-founded."

Hale explained that human factors in test programs are taken into account by using more than one pilot. "We get a pilot through routine channels," he said. "He may get checked out at the Air Force Flight Test Center for special deals first, but usually he comes in here. We do our own training, and end up with engineering pilots."

Pilots from the Air Proving Ground Command are encouraged to come across the street and observe or fly.

► **Climate and Problems**—"The climate doesn't hold us back much," said Lt. Col. L. E. Winebrenner, Deputy Chief of Staff. "We can bomb from any altitude about 50% of the time, and do most of our test work 85% of the time.

"But we've got problems of location," he added. "When APG first came down here, there was practically nothing. They could bomb and shoot all they wanted. In 1936 you couldn't find your way through the swamps; streets weren't even paved around here until near the end of the war. Now look at it—the whole area has built up and they've got towns and paved roads.

"Fisheries are getting to be a range problem. If we want to extend out over the Gulf, we're going to be right over the area that supplies most of the red snapper and lots of the shrimps and that's a big industry.

"Now the air is getting so full of radio, it's another big problem getting the communication channels squared away. You can see the need for secure communications around here," he said.

► **Development Program**—The Center is now building toward the goal of an all-weather, 24-hour test facility. By the end of next spring, the bulk of the planned instrumentation and construction should be finished.

This buildup has been laid out in three steps.

• **The first** was to get the ranges in limited operation while the buildup was progressing, and to get a headstart on the special kinds of instrumentation that would be needed later.

• **The second step** is construction of the major technical facilities—three buildings and six ranges—needed to make the Center capable of fulfilling its basic mission.

• **The third** will put the finishing touches on the Center and give it all-weather capability by adding precision electronic instrumentation to the optical systems that make up the bulk of the data-gathering equipment now.

Until the buildup is complete, AFAC will continue to use some ranges jointly with the Air Proving Ground Command, and some of its own ranges at a capability level somewhat below the planned ultimate.

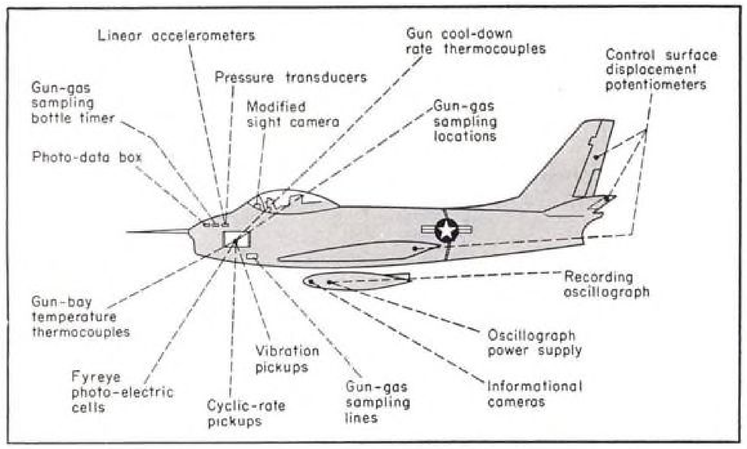
► **Completed Center**—The six ranges to be completed in the second step will shape up like this:

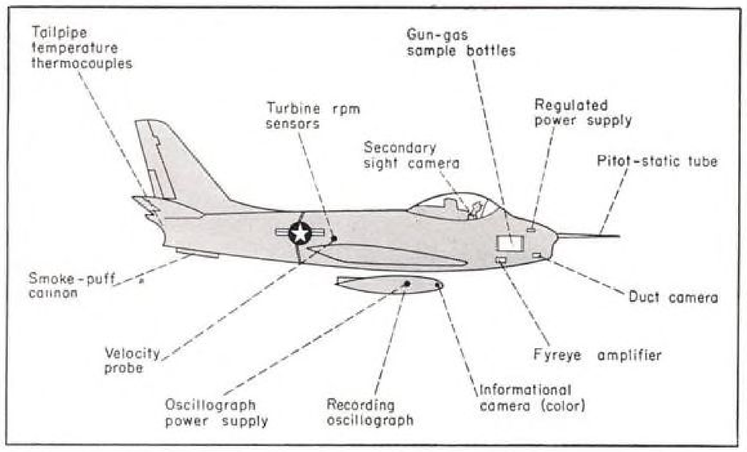
• **Precision bombing range.** This range will study one side of the bombing problem—the characteristics of bombs and bombing systems. Data gathering will start at the release point and follow the time history of the system until burst or impact.

• **B-line range.** This is a laboratory to study the other side of the bombing problem—the value of the aircraft as a bombing platform. Instrumentation based on shoran (short-range navigational radar aid) will pinpoint the position of the drop aircraft within five feet in space at all altitudes and speeds. From this kind of data will come better computers for bombing systems.

• **Air-to-ground rocketry and gunnery range.** Fire-control systems will be put through their paces on this range, designed to take gunnery, rocketry, skip, dive and toss bombing missions with equal case. The data from test runs will be used to determine magnitude of the several factors that cause dispersion of projectiles.

• **Rocket ballistics range.** Static testing





INSTRUMENTATION for typical armament system test as installed in NAA F-86 Sabre.

Glass to Metal Vacuum Seals

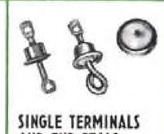
Hot tin plating at 530°F. means easy soldering, less rejections during assembly. Special plating supplied on request. Glass to Kovar seals made under Westinghouse patents. Blue prints furnished upon request.

HIGH COMPRESSION SEALS AVAILABLE IN ALL TYPES

TRANSISTOR MOUNTS
Glass to metal vacuum seal provides complete protection from moisture, dust, varying heat conditions and shock. Germanium can be sealed in vacuum or inert gas.

AN CONNECTORS
Precision construction throughout. Glass to metal vacuum seal assures protection against varying atmosphere conditions. Available in most JAN specs.

MULTIPLE HEADERS
Plug and standard types. Built to withstand thermal shock and provide stabilized atmospheres. Available in various configurations.



SINGLE TERMINALS AND END SEALS
TERMINALS available in all combinations of hooks, eyes, tubes, and pierced flats. SINGLE END SEALS available in various sizes for items requiring stabilized atmospheres.

CRYSTAL HOLDERS
The rigid metal bridge unit is designed to withstand strain without deformation. The one piece sealing medium minimizes stresses on the pins, thus reducing internal strain.

CUSTOM ENGINEERED COMPONENTS
Constantin is capable of manufacturing any glass to metal sealed requirement. Free engineering assistance given upon request.

L. L. Constantin & Co.

MANUFACTURING ENGINEERS

RT. 46 and FRANKLIN AVE., LODI, N. J.

The most modern machine shop and facilities for die construction, stampings, bending, and wire cutting — a glass department for compounding, tableting and sintering — ovens for fusing — advanced plating methods — skilled engineering. These combined features mean TOP QUALITY products completely manufactured on our premises.

■ EGLIN

of armament systems as mounted in aircraft will be the big job of this range. The damage potential of armament will be determined during the testing program.

• **Moving-target range.** Tactical weapons will be the big users of this range, intended to evaluate forward-firing systems against the kinds of moving targets encountered in battle.

• **Pattern bombing range.** The name is explanatory; the range is to be used for studying the pattern of multiple or cluster drops and skip bombing. Water and land area will be included in this range.

These are the three major buildings presently nearing completion at AFAC:

• **Armament engineering building,** a three-story fireproof and air-conditioned building. Engineering testing, instrumentation development, design and modification will be carried out at this unit.

• **Heavy systems building,** a two-story layout, will handle the items too big or heavy for the armament engineering building, and on its second floor will house the centralized flight and range data processing equipment and flight operations communication center.

• **Armament installations building** is a workshop for installing weapons in all kinds of aircraft. Basically, the layout is that of a hangar more than 300 ft. square. This kind of a building is dictated by the stringent requirements for installation of bombing systems now under development. Those requirements say that the airplane must not move more than one degree of arc about any axis during the installation of the bombing system.

▶ **Armament Lab**—The complex instrumentation at AFAC originates in the Armament Test Facilities Laboratory.

"We're working toward an instrumentation setup that will let us follow the progress of a flight test during the test. We can avoid a lot of data reduction that way," said Lt. Col. Gilbert Foster, Chief of the lab.

Instrumentation can be developed or designed at the lab; it may be procured from other ARDC centers or other defense agencies. But over three-quarters of the supply comes from contracts with industry.

The general policy calls for the lab to produce its own items with in-shop capability only when industry—through lack of available instruments or reluctance to produce a small quantity—is not able to do the job.

Guidance for the lab comes from the Deputy for Plans, and there is coordination between the lab and the test support and test operations groups.

▶ **Problems**—"You can get some idea of the complexity and accuracy of the instruments we have to develop," said Foster, "when you consider the desired accuracy of the systems we have to test. Instrumentation accuracy has to be one order of magnitude greater than that of the test system."

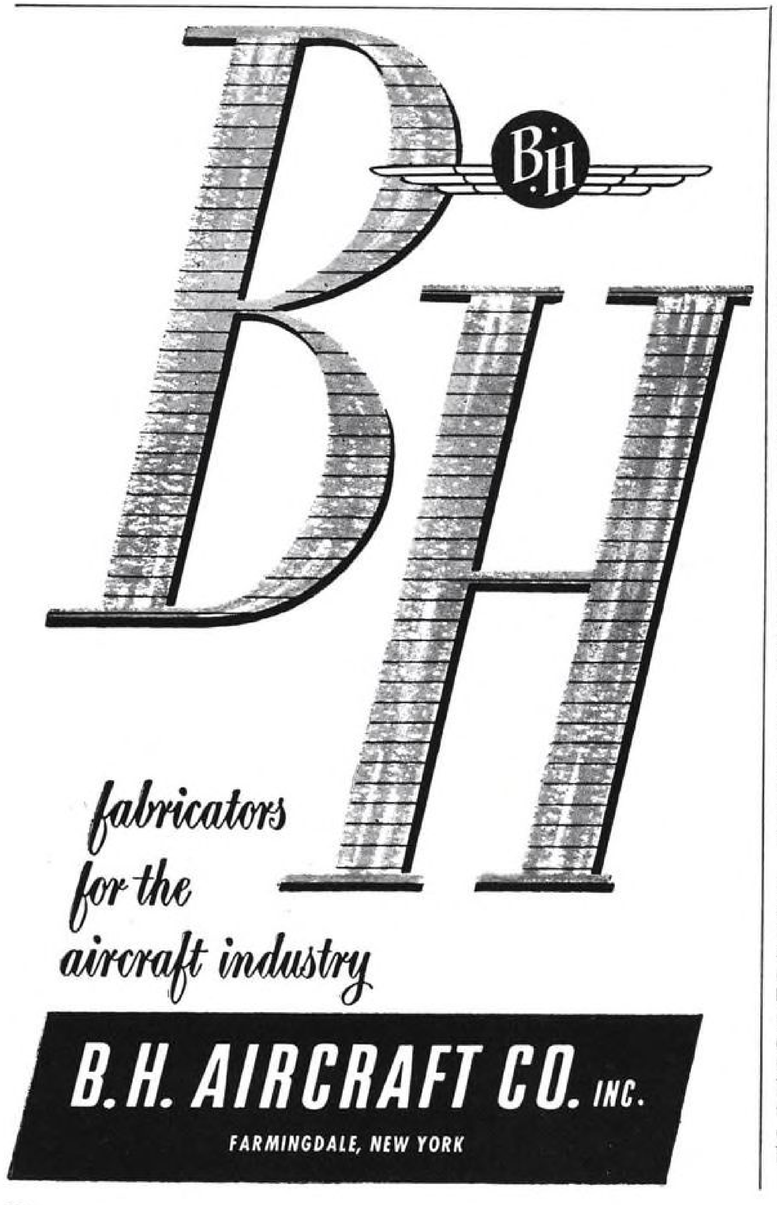
"We depend heavily on photo-optical data now because it's more accurate than modifications of electronic devices that were originally designed for other purposes," he added. "But photo-optics systems are going to be superseded because of the man-hours necessary for data reduction."

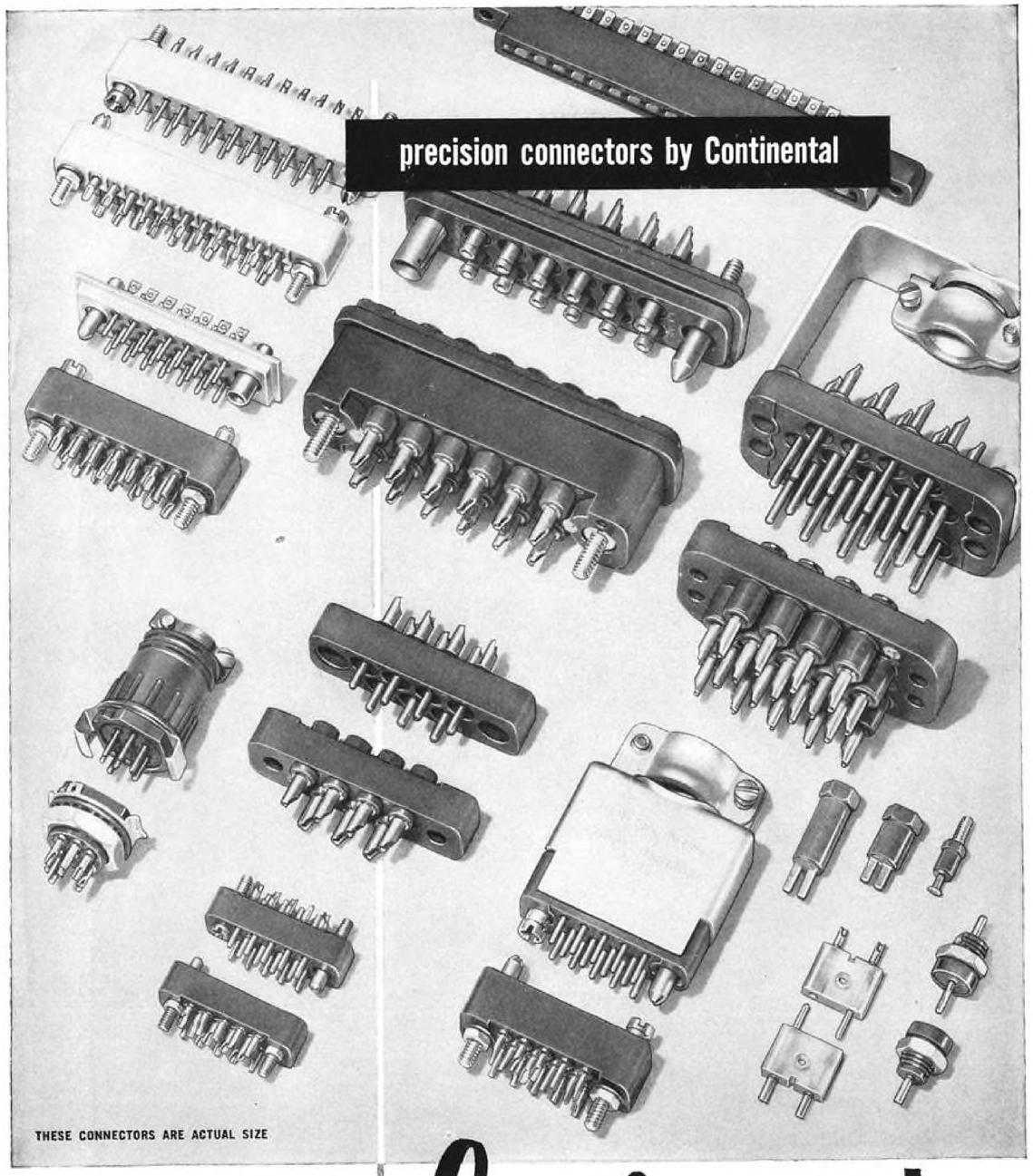
"We need a system that will give us trajectories," put in Robert C. Hoffman, ex-Navy submarine commander now heading the Office of Plans and Control in the lab. "In this business, you have to know about the misses as well as the hits; path data will give you that kind of information.

"Then there's a problem in evaluating airborne fire-control systems. We've got to have the relative distance and time orientation of the aircraft involved at extreme speeds and altitudes," he emphasized.

▶ **Time Standard**—Hoffman explained the timing system which provides the common datum line for all instrumentation on all ranges. A time code, calibrated by Station WWB in Washington and with a minimum time interval of 0.1 millisecond, is broadcast from the base.

Each range has its own rate selector





Series SM-20.....Sub-Miniature Rectangular Connectors
Series 20.....Miniature Rectangular Connectors
Series H-20 .....Hermetical Seal Miniature Rectangular Connectors
Series C-20.....Miniature Hexagonal Connectors (Vibration Proof)
Series EZ-16.....Easy Release Power Connectors (Spring Loaded contacts)
Series 16.....Rectangular Power Connectors
Series 14.....Rectangular Power Connectors
Series PC.....Printed Circuit Connectors
Miniature Precision Stand-offs
SPECIAL DESIGNS—submit your connector problems to our engineering department.

Continental Connectors

ELECTRONIC SALES DIVISION DeJUR-AMSCO CORPORATION

Write Dept. AWC-8, DeJur-Amsco Corporation
45-01 Northern Blvd., Long Island City 1, N. Y.

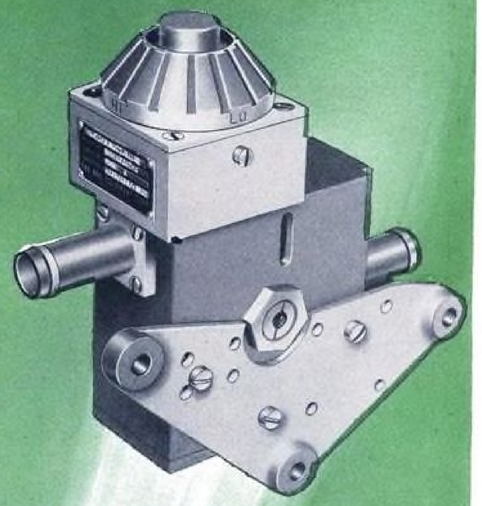
PILOT PROTECTION AGAINST "G" FORCES

Aro's new "Anti-G" Valve plays a vital role in today's protection of jet pilots.

This valve links the pilot's "Anti-G Suit" to a supply of compressed air. Any sudden change in "G" force (gravity or centrifugal force caused by turns, dives or climbs) opens the valve. Air accurately metered for the existing flight conditions is admitted to the "G" suit bladders, creating pressure on the legs, thighs and front abdomen. This pressure prevents the pilots blood from rapidly draining from his head down into his body thus preventing "blackout".

For further details on this "Anti-G" valve and other high-precision aircraft products produced by Aro write:

The Aro Equipment Corporation,
Bryan, Ohio
Offices in All Principal Cities



MODEL 10050
"ANTI-G" VALVE
½ SCALE

ARO

AIRCRAFT PRODUCTS

"ANTI-G" VALVES . . . OXYGEN REGULATORS . . . AIR AND OXYGEN SYSTEM ACCESSORIES . . . ACTUATING CYLINDERS . . . VACUUM, FUEL AND BOOSTER PUMPS

■ EGLIN

which is used to control or actuate the instruments.

The basic time accuracy is 0.0000001 second.

Hoffman expected that within three years the Center would have available a central computing station to present reduced data concurrent with sensing it. Although an expensive item, Hoffman said that such a station would probably pay for itself several times over in the first year's operation.

Heart of the station will be an electronic digital computer. Instant control of a test run will be simplified by a variety of graphic presentations of the data.

▶ **Typical Tests**—The special instrumentation which gathers data during test runs is largely optical. Development of this equipment is one of the functions of the Photo-optics Branch of the Laboratory.

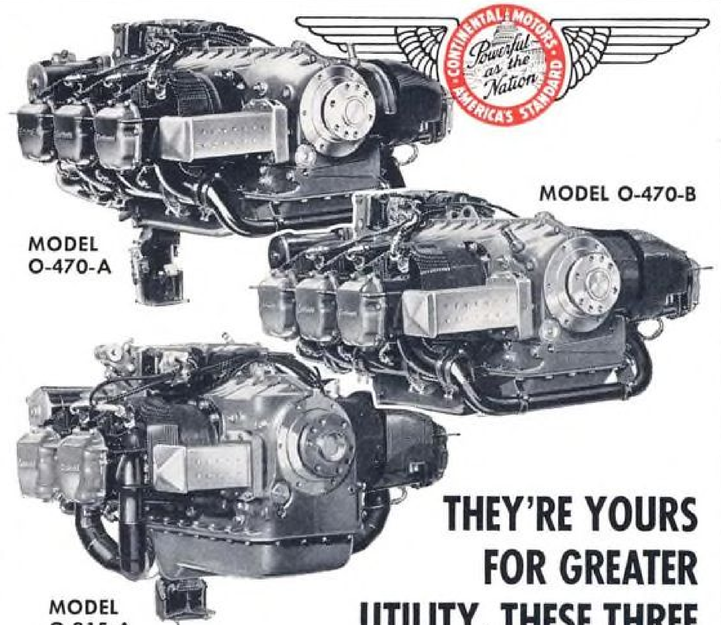
"On a typical level bomb run," said Andrew C. Cobb, Chief of the branch, "we use photo-theodolite tracking for position of the aircraft. Inside the plane there is a camera fixed to the gimbals of the bombing system being tested. As the plane comes in for the run, pictures are taken of the photogrammetric range to determine the attitude of the plane. The pattern of the bomb drop we can get by seismic instrumentation or by photography."

Cobb explained that a typical dive-bombing run required clearing out a line which might extend for 50,000 yd. as an upper limit. At the target center is a camera array, and along the flight line is a series of cameras placed so that their line of sight is about at 90 degrees to the plane's line of flight path. No bombs are dropped in such a test.

"Data reduction from photographs

Col. A. W. Cruikshank, Jr.
Chief of Staff

THREE MORE GOOD REASONS FOR CHOOSING THE PLANE WITH CONTINENTAL POWER



THEY'RE YOURS FOR GREATER UTILITY, THESE THREE GREAT NEW CONTINENTALS

Here's What They Provide:

1. **DEPENDABILITY** reflecting more than 50 years' engine-building experience.
2. **SIMPLICITY** for maximum ease of installation, adjustment and repair.
3. **COMPACTNESS** adapting them to modern airframe design.

...and like every Continental, they're backed by *established* parts and service facilities all over the world.

For free bulletins with full specifications, performance curves and installation diagrams, address:

Continental Motors Corporation
Aircraft Engine Division
MUSKEGON, MICHIGAN

■ EGLIN

takes weeks," Cobb said.

► **Camera Methods**—Pictures of dive and level bombing runs used to be taken with four K-24 aerial cameras mounted in tandem. But flight speeds got too high for the 10-frame-per-second speed of the K-24 and the center has switched to 35-mm. Flight Research synchronous cameras which will handle up to 40 frames per second.

The lab has under development two cameras that can be operated by a remote radio link, and will use these in bombing tests as soon as they are available.

Aircraft attitude, obtained from pictures of known patterns on the photogrammetric range, is found after a seven-hour computation per picture to determine angles and distance.

As a result of this tedious analytical method, the lab has gone to a vertical photogrammetric rectifier, which is a mechanical-optical projector. The projector can be rotated until the picture corresponds with a master plan of the ground pattern; then the angle of the sightline can be read directly.

Current estimates make the processing time per picture only 30 to 40 minutes instead of seven hours.

► **Vision Aids**—As might be expected, weather and altitude combine to make tracking of dive-bomb runs quite difficult. Even though the plane starts down a 10-deg. conical corridor, that's a lot of sky at 40,000 ft.

The lab has under study the feasibility of using a visible light or infrared seeker to locate the aircraft so that the cameras can be zeroed in. It would also aid the phototheodolites and eliminate some of the effects of haze on that equipment.

New Contraves cine-phototheodolites, ordered two years ago from the Swiss subsidiary of Oerlikon, are now being delivered to AFAC. These will be set up on the range for pattern and skip-bombing. Automatic computation circuits will give corrected true azimuth angles and corrected angles of elevation and azimuth. Ancillary equipment for reading the Contraves film record is under development by a contractor in the United States.

► **In-Shop Development**—Cobb said that the collimation device was an example of the in-shop capability of the lab. A collimator gives parallel light beams with a reticle superimposed, and is used for providing a fixed reference for photographic data methods.

He cited the case of fixed-gunnery camera data where the camera moves because of the impact loads during firing. But the collimator provides a fixed set of crosshairs unaffected by camera jump and permits much easier assessment of the armament system.

These are some of the ground instruments developed by the Photo-Optics Branch. But evaluating air-to-air weapons is an entirely different problem. There the problem is to measure, from one moving object, the path of a second moving object fired from a third moving object possibly at a fourth moving object.

► **Targets and Misses**—Back in the earlier days, a pilot went up, fired at a sleeve target and and came down to count the holes. This was a fine system for his pair of .30-cal. machine guns; it leaves something to be desired now that he shoots projectiles that can destroy the entire target with a single hit.

The technicians at AFAC figured that one good way to evaluate airborne systems and not clobber too many expensive targets would be offset the sight by a known amount and then shoot. If you could record the misses and compare them with what they should have been due to the offset, you could get a reading on the sight system effectiveness.

This is done with one or more of several devices known as Firing Error Indicators. Carried aloft in tow targets, these FEIs work by electronic or acoustical means to collect or transmit data on the projectiles that miss the target.

MINIATURE FLOTATION gyros

TWO AXIS GYRO
3¼ in. dia., 5 in. long
Weight 3.5 lbs.

AIRCRAFT RATE GYRO
2⅛ in. dia. 3 in. long
Weight .85 lbs.

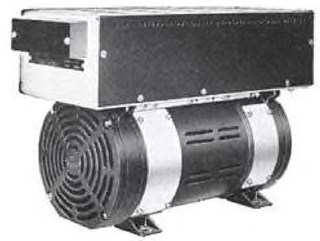
RATE & FREE GYROS

Fully Floated Construction
Hermetically Sealed
No Heating Required From -65° to 200° F
Satisfactory Operation Under Extreme Vibration And Acceleration Conditions
Designed For Maximum Performance With Minimum Accessory Equipment

MISSILE RATE GYRO
2⅛ in. dia. 2¼in. long
Weight .70 lbs.

AMERICAN GYRO
CORPORATION
1509 COLORADO AVE.
SANTA MONICA, CALIFORNIA

For the most complete line of AIRCRAFT INVERTERS



The Red Bank Division of Bendix Aviation Corporation is the logical place to find your answer to aircraft inverter needs—and for three significant reasons. First, we offer the widest range of inverters. Second, we design and build each inverter as a complete, unified mechanism. Third, we are equipped to design and produce inverters for all kinds of special-purpose applications . . . and, in fact, are now engaged in developing inverters up to 5000 VA and for high temperature, high altitude applications.

For "RELIABLE" ELECTRON TUBES

With electronic controls taking over more and more operational functions in aircraft, it's becoming increasingly important that the electron tubes used be dependable under conditions of high altitude, continuous vibration, varying voltages and frequent shock. Because of their advanced design and construction . . . born of never-ceasing research and special production skills . . . Bendix Red Bank Regular and Special Purpose Reliable Electron Tubes have the dependability necessary to meet severe operating conditions.

For complete details on our aircraft inverters or electron tubes . . . or on our dynamotors or fractional D.C. motors . . . write:

Bendix Red Bank

EATONTOWN, NEW JERSEY

DIVISION OF THE NAME Bendix AVIATION CORPORATION MILLIONS TRUST

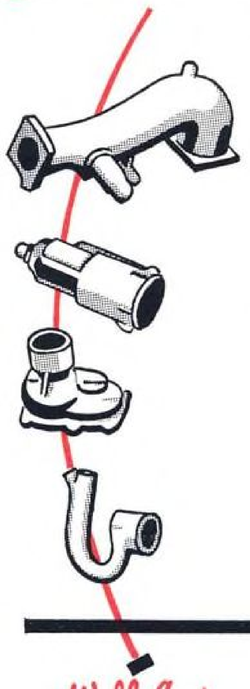
Export Sales: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

Depend on Bendix Red Bank

The freezer's automatic
The stove and TV too
The washer shuts itself off
Then starts itself anew

The car's a Mushomatic Eight
Remote controlled by knee
And who's in charge of all
this stuff?
Unautomatic me!

CASTINGS on the lighter side by WELLMAN



If weight is a factor in the product *you're* in charge of purchasing, engineering or manufacturing, turn *automatically* to WELLMAN.

We've been in charge of producing castings on the lighter side, aluminum and magnesium, for almost half a century. Our four complete plants assure you the controlled quality and the easy machinability that help shut off your production problems.

Catalog No. 53 will fill you in on the details.

Well-Cast MAGNESIUM AND ALUMINUM CASTINGS
Well-Made WOOD AND METAL PATTERNS

THE WELLMAN BRONZE & ALUMINUM CO.
Dept. 5, 12800 Shaker Boulevard Cleveland 20, Ohio

■ EGLIN

New systems with the ability to measure a 50-ft. miss by a .50-cal. bullet will be coming along shortly.

▶ **Red Birds**—There has been one problem in the use of towed targets for firing tests: The targets often disintegrate before they are shot at. This was discouraging, and so the Electro mechanical Branch of the lab was asked to look into the situation.

The Center had been using the A-1 target, a Vee-tailed midwing monoplane with a Vee-shaped towing arm. These could be towed at Mach 0.6 above 30,000 ft. only on rare occasions; more often, they came apart. A modification program produced no great improvement.

The basic faults were instabilities resulting in oscillations. After a series of tests to isolate some of these and to observe them, the engineers in the EM Branch developed a mockup of a redesign which they thought would do the required job.

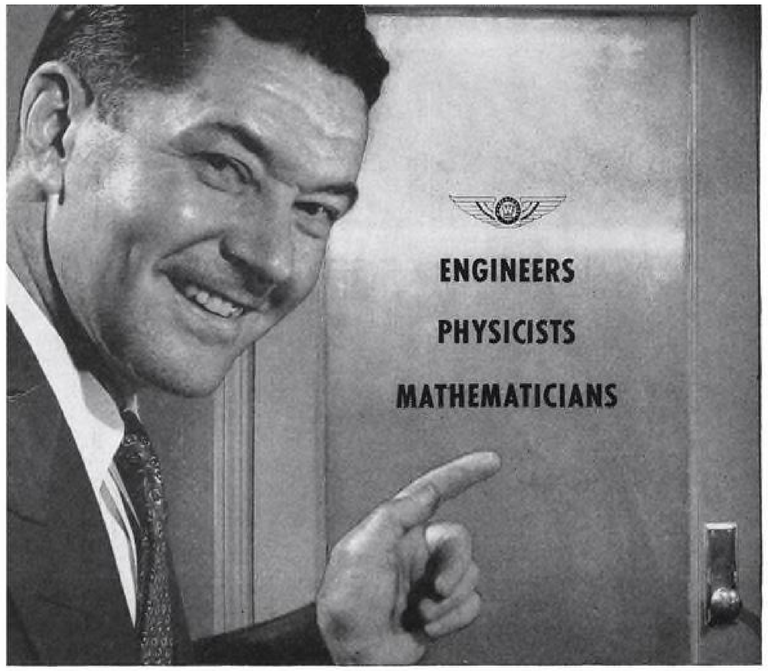
What they did was to take the standard target, and sweep its wings back at a 45-deg. angle, by cutting out a wedge at the trailing edge and making a fairing for the leading edge. Then they chopped off one of the Vee-tails and rotated the other on the fuselage to a vertical position. The result was the Red Bird, a trim modern-looking tow target.

After three flight tests, the Branch got the go-ahead to produce a few experimental versions. The targets have performed up to the limits of Mach 0.82 and 42,000 ft., imposed by the particular type of Republic F-84 Thunderjet used for tow planes.

A production contract for the new Red Bird has been let to East Coast Aeronautics.

▶ **Instrument Men**—The technicians

Lt. Col. C. J. Kronauer
Director, Test Operations

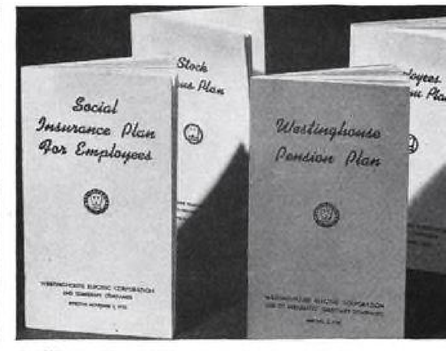


1. Immediate openings in research, development and manufacturing at our Aviation Gas Turbine Division in Philadelphia or Kansas City, Mo. Salaries are good, varying with experience and ability. You'll enjoy working with us.

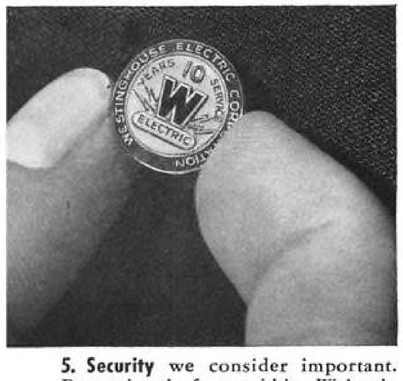
Look at these new opportunities in jet engineering at Westinghouse

2. Challenging work offers the opportunity of joining with Westinghouse, a long-time leader in jet engineering.

3. Incentive awards are given for inventions and ideas. Creative work is recognized and rewarded. We even pay your tuition for graduate study.

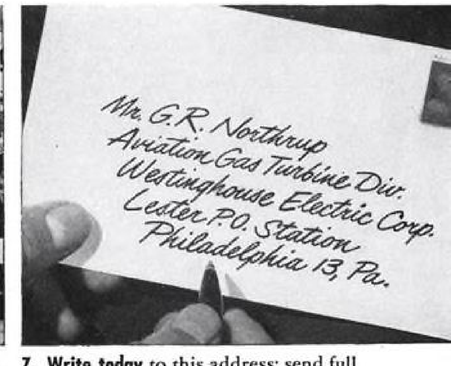


4. "Extras" include a modern pension plan; low-cost life, health, and accident insurance; company stock bonus.



5. Security we consider important. Promotion is from within. We're in this new, expanding industry to stay.

6. Living conditions in our suburbs are good with easy access to Philadelphia's many cultural and sports events. We will help you find housing.



7. Write today to this address; send full details. We'll arrange for a confidential interview for all qualified applicants.

J-54023

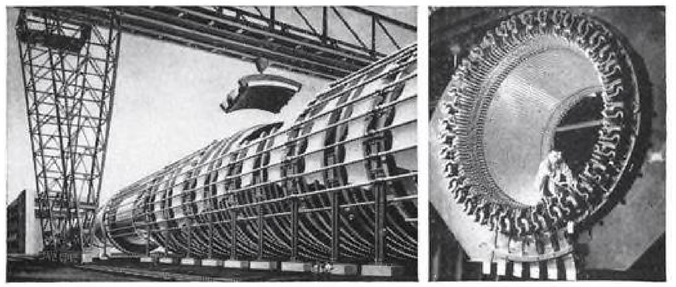
YOU CAN BE SURE...IF IT'S Westinghouse

Now turn the page for an example of Westinghouse aviation leadership ▶

The largest rotating system in the world is now being built by Westinghouse for installation in the United States Air Force, Arnold Engineering Development Center's Propulsion Wind Tunnel at Tullahoma, Tennessee. This giant wind tunnel will accelerate the full-scale testing of turbo- and ram-jet aircraft engines as well as components of planes and missiles, in the 2000-mph range . . . well into the supersonic speeds of tomorrow's air age.

Westinghouse applied a new concept in wind tunnel engineering by designing a single axial flow compressor to feed both the transonic and supersonic tunnels from a single drive shaft. Most powerful of its kind ever built, it uses four motors in tandem—delivering over 200,000 hp to drive five giant compressors whose full output is translated into wind speed. This single-unit system is an imposing spectacle of man-made machinery, barely suggested by its over-all length of 575 feet and 7000 tons of weight!

Thus, Westinghouse creative engineering and productive skill are assisting the U. S. Air Force in providing a facility which will simulate flight under a wide range of transonic and supersonic conditions, greatly expanding the horizons of aircraft and missile development. And the experience and ability devoted to such an installation demonstrate once again the unique capabilities in the wind tunnel field . . . all paving the way for new research beyond today's barriers, basic to continued military and commercial air leadership. Proving, above all else, that you should look to Westinghouse when you have a problem in aviation. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-91008



Above is an artist's sketch of Propulsion Wind Tunnel in which Westinghouse's 200,000-hp driven compressors will create supersonic speeds. Compressor blades are over two feet across the face, six feet long, weigh some 3500 pounds and have a tip speed of 650 mph with a centrifugal force of 800 tons constantly pulling at their roots! At the right is a stator for one of the two massive 83,000-hp synchronous motors which are over 21 feet high, weigh 225 tons and are at least one third larger than any other synchronous unit ever built.

THE SCOPE OF WESTINGHOUSE IN AVIATION

Basic aircraft systems

Turbojet Engines, Fire Control, Radar, Autopilots, Communication Equipment and Electrical Systems.

Ground equipment

Wind Tunnels, Airport Lighting, Industrial Plant Apparatus.

Air-borne system components

Transformers, Rectifiers, Instruments, Gyro-motors, Temperature Control Panels, Generating Equipment and System Control, Circuit Breakers, Contactors, Motors, Actuators and Hoists, Electronic Tubes, Magamps, Micarta®.

YOU CAN BE SURE... IF IT'S

Westinghouse

Standard-Thomson
Barometric
VENT VALVES

for safe, accurate pressurizing

For dependable control of crankcase and oil tank pressures at all altitudes, Standard-Thomson vent valves are the approved answer. By means of a spring-loaded, aneroid type bellows suspended in the valve body, these valves accurately vent pressure through a given altitude range . . . and maintain pressure constantly above that range. A relief valve provides automatic pop-off for emergency pressures. End fittings and calibrations can be varied for a wide range of applications. For full details and specifications, write:

STANDARD-THOMSON CORPORATION • DAYTON 2, OHIO

Standard-Thomson

Makers of USAF-approved bellows • valves • lights

Shut-off Valves | Tech-Forge Flexible Couplings | Cockpit Lamp Assembly | Vaporproof Cabin Lamp

■ EGLIN

who install, operate and maintain the range and aircraft instrumentation used at AFAC are in the branches of the Technical Support Directorate headed by Maj. Louis Schaffer.

Directly responsible to the commanding general, Maj. Schaffer has under his jurisdiction the instrumentation, data programing and technical services.

Schaffer said that the instruments that have to be installed are often bulkier than the installation to be tested, and more numerous than those needed to determine aircraft performance. While he talked, he pointed out on two charts of typical installations in a North American F-86, the kinds of specialized instruments.

"One of the things that worries an armament man is gun gas", said Schaffer. "You can ruin an airplane with a single explosion of accumulated gases. So we have to sample the gases in the gun bay of a fighter during the firing tests. To do that, we need these sampling bottles and collector tubes.

"Another item is the camera installation in the modified drop tanks and inside the duct. They're there to photograph flames," he said.

"When you have a gun layout like the Sabre, with muzzles close to the air inlets, you have flames playing around where the air is supposed to go in. The designers want to know if the flames enter the intake.

Project Officers—The men who head the investigating teams during tests are project officers from the Test Operation Directorate under Lt. Col. Clifford J. Kronauer.

They get their test directives through Col. Bechtel's office, and the project engineer sets up the test plan. Where the officer is a pilot, he is encouraged to fly the missions himself.

When the data comes back, the project officer has it analyzed, writes the report, draws conclusions and makes recommendations.

In contractor-support tests, the project officer is merely a liaison man. His job is to see that the support given is sufficient.

Kronauer's organization is a functional one, broken into five branches: Fire control, bombing, weapons and missiles, biological warfare-chemical warfare, and aero-ballistics. The last group has yet to be activated.

In addition, there is an Office of Analysis and Reports set up as a pool of consultants for extremely difficult problems. Now composed of four people, and aiming toward a total of 10, this group can supply men with a large amount of formal training in mathematics and physics plus a great deal of test experience.

Another outstanding development from HYDRO-AIRE RESEARCH *the* **HY-V/L*** *fuel booster pump!*

The elimination of inherent vapor-stall characteristics has long been an objective of Fuel Booster Pump Engineering. As a result of years of research and testing by Hydro-Aire an entirely new principle was applied which resulted *in vapor being forced into the fluid* rather than the vapor being *separated* from the fluid. Here was the answer to the problem. The result—Hydro-Aire's HY-V/L Fuel Booster Pump which today is delivering unequaled operating efficiency even when subjected to ultra-high altitude operations.

Proof again that at Hydro-Aire, there are *few* projects too large...*no* project too small. Whatever your problem—complicated as a Fuel Booster Pump or simple as a Check Valve—call your Hydro-Aire Field Engineer.

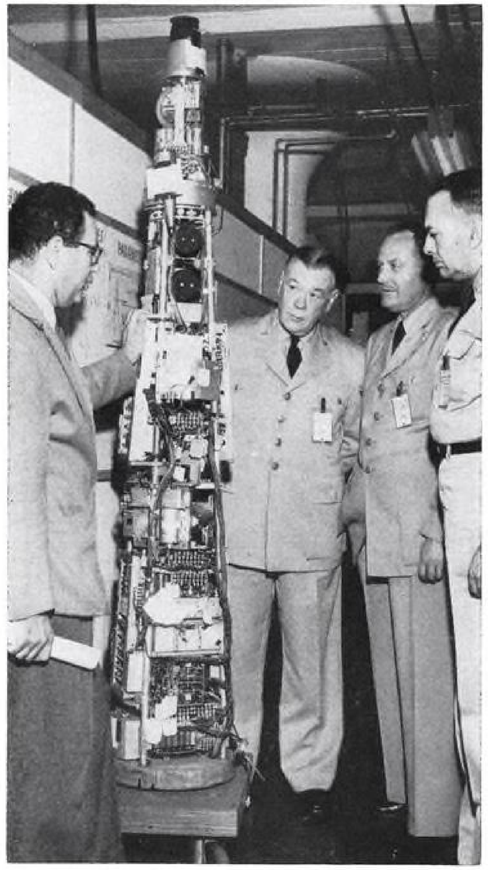
*Vapor-liquid ratio

never an ornery attitude ...*even when you hit the ceiling!*

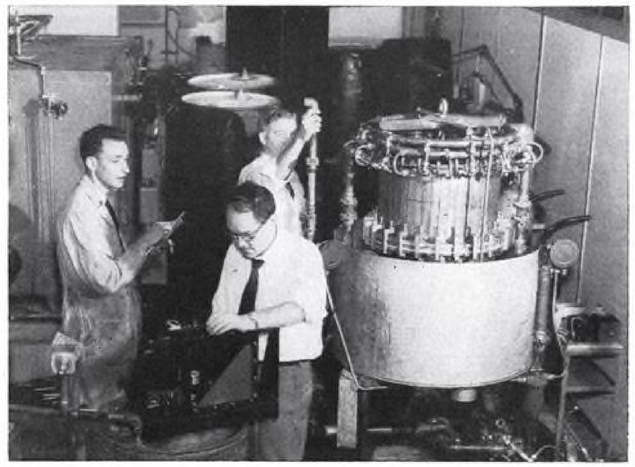
Promising careers for Engineers to work on projects in fuel pumps, turbodrives, hot-air valves, etc. Phone or write Personnel Department.

Every fighter, every bomber, every transport is HYDRO-AIRE *Inc. equipped!*

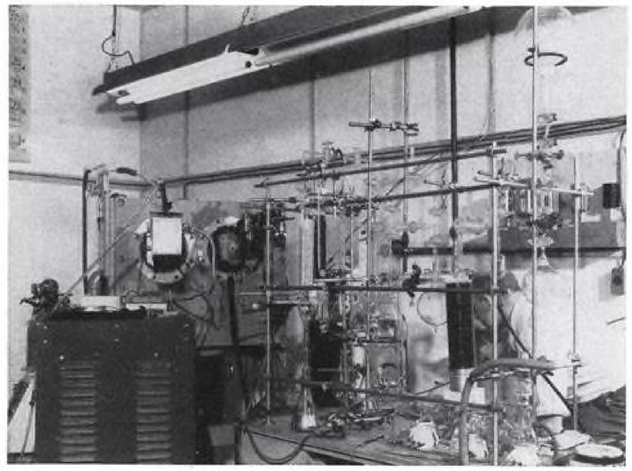
SUBSIDIARY OF CRANE CO., BURBANK, CALIF.



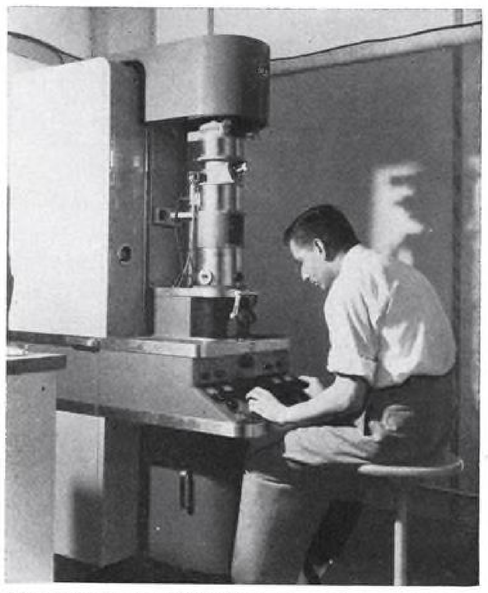
WARHEAD INSTRUMENTATION of Aerobee sounding rocket returns data for atmospheric physics studies.



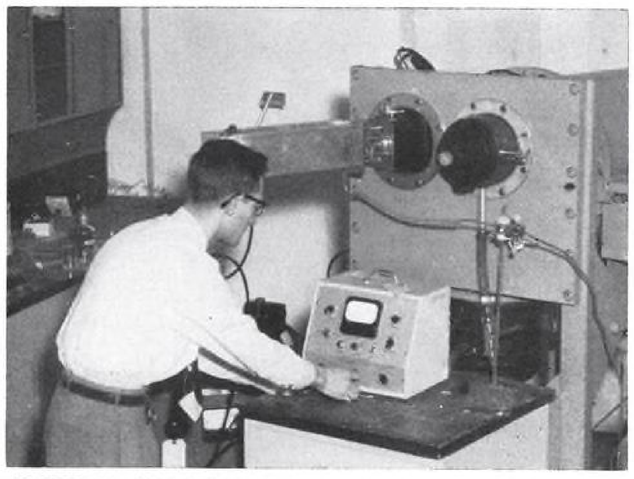
CLOUD CHAMBER, research tool in cloud physics section, simulates conditions from surface to 15,000-ft. altitude.



OXYGEN ABSORPTION SPECTRUM is studied in this laboratory. Gas-filling systems (foreground) control pressure in absorption cell.



ELECTRON MICROSCOPE gives cloud nuclei data. Photos enlarge particle diameters 75,000 times.



VACUUM MONOCHROMATOR is used to check ultra-violet spectrum of hydrogen. Ionization gage (foreground) shows vacuum in chamber.

Cambridge's Bailiwick: Earth, Sky, Sea

AFCRC's three directorates study geophysics, atomic warfare, electronics; research center also administers Project Lincoln.

By Irving Stone

Boston, Mass.—One of the big factors contributing to progress in general scientific research is the Air Force Cambridge Research Center (AFCRC), Cambridge, Mass.—one of the nine major centers of the Air Research and Development Command (ARDC).

AFCRC's mission is to accomplish research, development and tests in three vital fields, each the responsibility of a directorate:

• **Geophysics.** This activity encompasses work in terrestrial sciences, upper air research, atmospheric devices, atmospheric physics, atmospheric analysis, and ionospheric considerations.

• **Atomic warfare.** This work encompasses factors of radiobiology, radiochemistry and nuclear physics. Included in this activity is a field experimental branch and a physical instrumentation laboratory.

• **Electronics.** Included in this activity is the study of communications, RF components, antennas, propagation factors, and computers. Work of this directorate is described elsewhere in this issue.

▶ **Other Groups**—In addition to these three research divisions, AFCRC is charged with the administration of Project Lincoln (an air defense study), and its necessary air support, including that required for systems-wide testing. This project is centered at Lincoln Laboratory, operated by Massachusetts Institute of Technology (MIT), under contract with the Air Force.

AFCRC also has established the 6520th Test Support Wing at Hanscom AFB, Bedford, Mass., with two flight squadrons and an aircraft control and warning squadron to provide specialized support to Project Lincoln and the three research directorates. Eventually, all AFCRC activities will be centered at Bedford.

History

When it became apparent, after World War II, that the Office of Scientific Research and Development (OSRD) would not continue to operate its contracts on a civilian basis at Cambridge, the military felt that some of these projects should be carried on.

Two of the activities doing electronics research for the (then) Army Air Force under OSRD were MIT's Radiation Laboratory and Harvard's Radio Research Laboratory. Military personnel started interviewing people in these organizations in August 1945. The staffs of these laboratories included some of the country's most capable men in their specialized fields.

▶ **First Station**—In September 1945, the Air Technical Service Command (now Air Materiel Command) established the Cambridge Field Station under the supervision of Watson Laboratories, Red Bank, N. J.

In April 1946, a research division (radio physics) was established at the station. In October 1946, J. W. Marchetti, who previously was the commanding officer at the station, was designated acting chief of the Research Division.

Geophysical research was transferred from Watson Laboratories to the station in November 1948. Initially, headquarters for this new addition were set up at Watertown, Mass., but were later removed to Summer St., Boston. (Additional geophysics facilities are located in Roxbury, Mass. and Boston.)

▶ **Name Change**—In July 1949, the name of the station was changed to the Air Force Cambridge Research Laboratories. In June 1951, it became the Air Force Cambridge Research Center under the command of ARDC.

In August 1951, Maj. Gen. J. F. Phillips took command of AFCRC, with Marchetti as his technical deputy (top civilian). Dr. Edwin G. Schneider became director of electronics research, and Dr. H. E. Landsberg was made director of geophysics research.

Appointment of these civilians to chief posts meant that the center was fundamentally established as a scientific organization, as distinguished from a purely military setup. These civilians still hold their top positions. The commanding officer now is Maj. Gen. R. C. Maude.

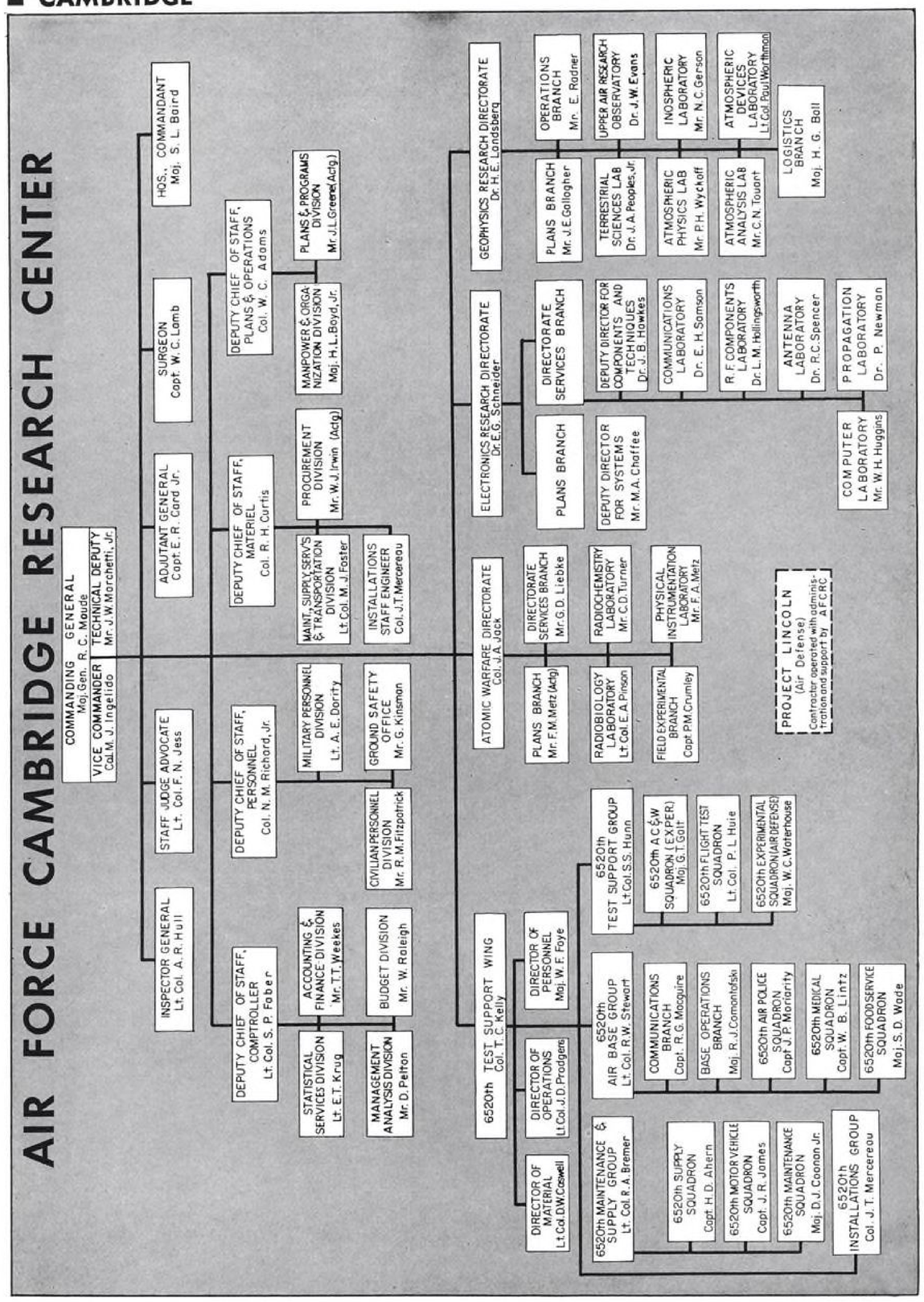
▶ **Atomic Division**—The Atomic Warfare Division was set up in October 1951 under Col. J. C. Jack, at Hanscom AFB. He still heads this activity.

Early in 1951, the Command started planning for the construction of permanent laboratory buildings for all three directorates, plus an airbase facility, at Hanscom Field, Bedford, Mass. Early last year, the premises were leased from the state.

Meanwhile, the 6520th Air Base Group was established at the field. This organization became the 6520th Test Support Wing in the spring of 1952, for the function of providing flight tests and other support for AFCRC and also for Project Lincoln.

Work in the Atomic Warfare Directorate so far has been concerned largely

Maj. Gen. Raymond Coleman Maude, commander, Cambridge Research Center . . . communications expert . . . born Framingham, Mass., 1902 . . . graduated U. S. Military Academy and commissioned in Signal Corps 1926 . . . served with signal troops attached to infantry and cavalry unit . . . got into aircraft warning work 1940 . . . in 1941 was chief of the Signal Corps aircraft warning division . . . communications officer 9th Bomber Command and 29th Tactical Air Command in Europe, World War II . . . asst. dir. of requirements for deputy USAF chief of staff for development . . . commanded 1009th Special Weapons Squadron . . . director of communications in the office of deputy USAF chief of staff for operations . . . took command of Cambridge March 1953.



with planning and organization phases. Only a small part of the manpower now alloted to this function has been specifically authorized for it—the bulk of the authorization has been withdrawn from the other research directorates.

▶ **Project Lincoln**—Work being done in Project Lincoln—basically a research and development program—is a broad study of air defense designed to improve the capabilities of the Air Force, Army and Navy in parrying an atomic air attack on the U. S. The investigation is slanted to permit these three branches to accomplish a better air defense. The work encompasses a multitude of activities and is in no way limited in scope.

MIT's effort at Lincoln Lab is conducted on a tripartite arrangement, with the Army, Navy and the Air Force contributing in the furtherance of the Lab's objectives. The contract for Project Lincoln is between the Air Force and MIT.

The Project actually is not a part of the AFCRC organization, which is charged only with rendering to it administrative and logistical support. Nevertheless, its impact on the administrative and support (manpower, facilities, aircraft, and other services) programs of the Center is at least the equivalent of the impact of the three component research directorates combined.

Almost all of the support manpower authorization of the Center in the past 21 months has been furnished specifically because of Project Lincoln. Additional manpower will have to be furnished before the full requirements in support of Project Lincoln are satisfied.

Activities of the Electronics Directorate are covered elsewhere in this issue.

Geophysics Research

Some of the highlights of activities in the Geophysics Directorate, covering the functions, projects and aims of this activity, are related here.

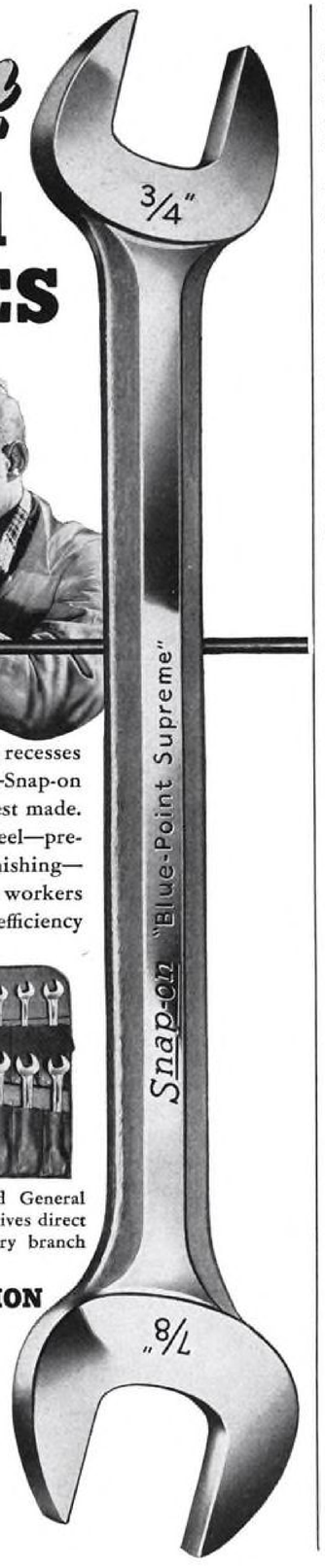
Basically, the geophysics activity functions to study the medium in which any kind of aircraft—manned or unmanned—will operate. Only about one-third of the work done by the Geophysics Directorate is handled by its own personnel. Two-thirds of the organization's annual expenditures are funneled into private organizations for study.

About 93% of GRD's efforts is directed in studying the atmosphere from the ground up to such heights that can be reached directly or indirectly. The other 7% of the studies is concerned with special projects. On these, GRD is just picking up the ball because there is some specific AF interest in these phases, which basically are being conducted by other defense agencies.

Snap-on*

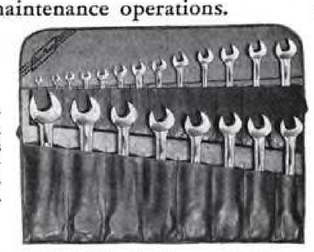
"Blue-Point Supreme"

Open End WRENCHES



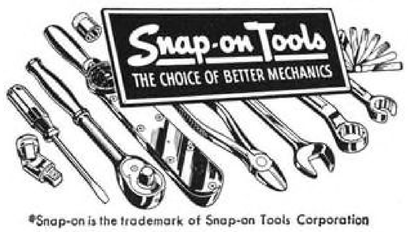
For jobs like this—or where nuts are set in recesses too narrow for other types of wrenches—Snap-on open end wrenches are the strongest, safest made. Every detail of design—the tough alloy steel—precision machining—heat treatment and finishing—are highest quality. In the hands of your workers Snap-on wrenches will contribute greater efficiency to assembly and maintenance operations.

OE-821-K.
21 WRENCH SET
in kit as illustrated. Contains all standard sizes, ¼" to 1⅜". Most sizes duplicated on different handles to meet requirements of many jobs. Complete set, **$56.60**



Write for Snap-on Industrial Catalog and General Catalog of 4000 hand and bench tools. Snap-on gives direct service to industry everywhere through factory branch warehouses in 42 industrial centers.

SNAP-ON TOOLS CORPORATION
8020H 28th Avenue, Kenosha, Wisconsin



*Snap-on is the trademark of Snap-on Tools Corporation

■ CAMBRIDGE

►**Broad Scope**—The scope of GRD's work is extensive. Each year higher altitudes are reached in flights of all types of vehicles. With each new height reached, new phenomena appear.

In low-level flight, the most important problems include fog, thunderstorms, rain and icing.

In the 30,000 to 100,000-ft. altitude range—the region of today's and tomorrow's jet flights—turbulence and high winds are important considerations.

Above 100,000 ft., atmospheric composition becomes important. Here, problems stem from the existence of ozone and other gases, solar radiation, aircraft skin temperature considerations, irregular-ionozation difficulties which put limitations on radio wave propagation, and other suspected factors which could affect flights.

►**Looking Up**—To ferret out some of the answers, the searchlight technique is used for scanning atmospheric densities up to about 50 mi. Above this altitude observations are made of meteorite trails—bringing the observation up to about 90-100 mi. Both of these are indirect methods.

For direct observations, about every three weeks an instrumented sounding rocket (Aerobee) is pushed up to about 70-80 mi. Results are used to calibrate indirect methods.

Data obtained are digested and forecasts are made for requirements which may exist now or in the foreseeable future.

►**Publications**—To insure that research results get the widest possible dissemination—first, among Air Force components and the other branches of the Armed Services to whom such information is pertinent, and then to scientists of other government agencies, universities and research institutions—GRD issues or sponsors a number of publications.

A single type of publication could not answer the many requirements for which the research results of the laboratories and the nearly 150 university contracts are intended. Accordingly, GRD tailors these reports to fit the needs of the Air Force in the field, the design and instrumentation people, or the laboratory scientists who desire certain data on which to base further research.

Atmospheric Physics

The Atmospheric Physics Laboratory is headed by Peter H. Wyckoff. The function of this activity is to study the composition and physical structure of the earth's atmosphere. This is done by measurements on the ground, in aircraft, in balloons and in rockets. The field of work is broken down into five classes:

►**Cloud Physics**—In this activity, interest is in the physics behind the formation of clouds, how they grow, how rain forms and falls, and the general theory behind cloud seeding, for the opening of holes in cloud decks for visibility. Another consideration of this laboratory is the suppression of ice fogs in the Arctic, as well as ordinary water fogs.

These atmospheric physics studies are attacked in two ways.

• **First, in the laboratory,** where certain fundamental experiments are conducted to find out how water droplets form from nuclei (dust, sea salt, sulphuric acid droplets in industrial areas) in the atmosphere.

• **Secondly, in the field,** where the basic information is taken for correlation. An aircraft is flown into the clouds, and measurements are made of all cloud parameters—droplet size, liquid content, temperature structure, and the number of nuclei in the air mass surrounding the cloud. This procedure is a check on the theoretical understanding of the process in the cloud. Certain critical experiments, such as actually seeding the cloud on a small scale, are conducted to see if it can be made to behave the same way as in the laboratory.

In addition to the aircraft studies, there is a cloud radar group which investigates clouds by means of microwave radar. The wavelength employed is very sensitive to clouds.

►**Visibility**—The problem of visibility is primarily one of seeing in the atmosphere, from the viewpoint of air-to-ground, air-to-air and ground-to-air.

The physical problem of detection depends on contrast of the "target" against the background. For this reason, the atmospheric physics lab studies the brightness of the sky, illumination of the target, and the scattered light between observer and target.

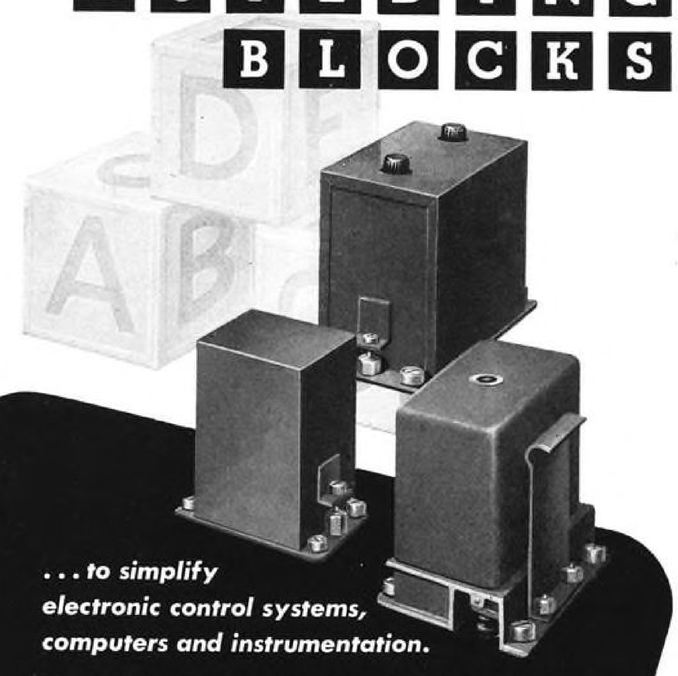
Sky brightness is studied especially around the sun. Measurements are made from the ground and from instruments carried aloft by balloons, some of which go to 100,000 ft.

Illumination of the target is presently measured on the ground, especially during twilight and night. The illumination at night, when the moon is above the horizon, has been studied to determine the minimum conditions of target detection.

Scattering of light in the atmosphere is due to air molecules and dust particles. The theoretical study of the scattering of dust particles is only partially understood. Accordingly, an extensive thoretical program is under way.

Since these dust particles are very numerous up to 30,000 ft., the number and sizes of the particles are measured

Electronic BUILDING BLOCKS



. . . to simplify electronic control systems, computers and instrumentation.

Servomechanisms, Inc. "building block" or packaged function technique reduces intricate "all in one" systems into simple, standard electronic components which plug into pre-wired chassis. This advanced design philosophy provides ***reliability, interchangeability, and ease of maintenance.***

The same concept has been applied to Servomechanisms, Inc. expanding line of transducers.

Universally accepted and proven in combat, these "building blocks" are available for 60 and 400 cycle applications . . . Write to Dept. CLO-4 for complete information.

A typical Servomechanisms, Inc. analog computer and transducer for aircraft instrumentation.

SERVOmechaNISMS INC.

Westbury Division
Post and Stewart Aves., Westbury, N. Y.

El Segundo Division
316 Washington St., El Segundo, Calif.

POSITIONING MECHANISMS • SERVO AMPLIFIERS • MODULATORS • POWER SUPPLIES
SERVO MOTORS • ADAPTERS • TRANSDUCERS • MECHANICAL DEVELOPMENT APPARATUS

less
opening shock

less
oscillation

less
side drift

jumper descends
straight down
landing on his feet

Jumper clears plane and pulls ripcord.

Pilot chute begins to draw canopy out of the pack.

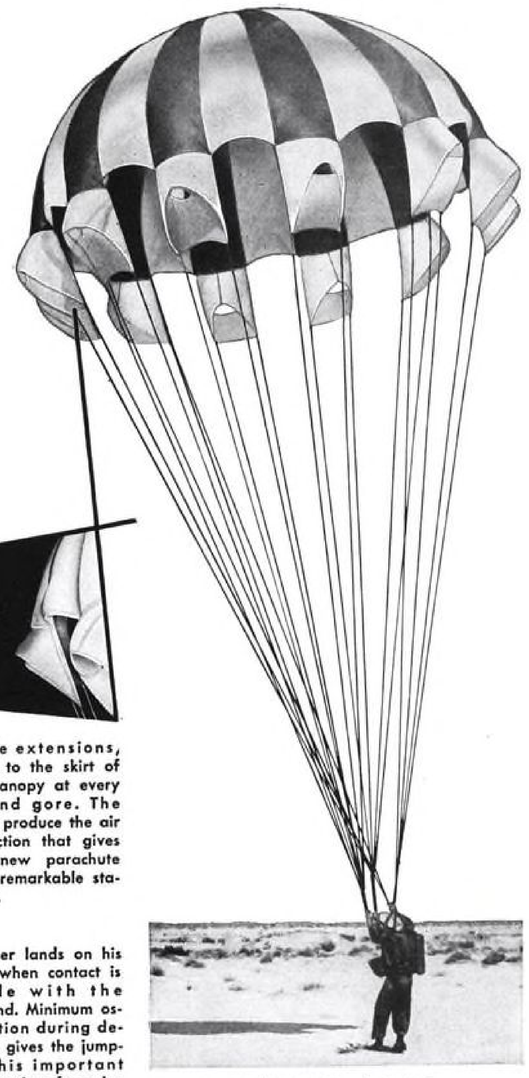
The canopy has begun to open.

Canopy swings to a vertical position.

Jumper descends straight down.

P7-B*
P9-B*

PIONEER
Guide Surface
Personnel
Parachutes



Guide extensions, sewn to the skirt of the canopy at every second gore. The vents produce the air deflection that gives this new parachute such remarkable stability.

Jumper lands on his feet when contact is made with the ground. Minimum oscillation during descent gives the jumper this important protection from injuries.

*Patents applied for in U.S. and principal countries throughout the world.

Once again, Pioneer Parachute Company's manufacturing facilities, as well as its development and engineering experience, work for the advancement of the aviation industry. The Pioneer P7-B* and P9-B* Guide Surface Personnel Parachute now makes more certain the saving of lives during emergencies at higher aircraft speeds — and safer than ever before in the history of aviation.

The Guide Surface Personnel Parachute is now standard equipment of the U. S. Air Forces and is available, through the Pioneer Parachute Company, to other governments and commercial flyers.

PARACHUTES MAKE THE DIFFERENCE!

PIONEER PARACHUTE CO. INC.
MANCHESTER, CONNECTICUT, U.S.A.
CABLE ADDRESS: PIPAR, Manchester, Conn. U.S.A.

■ CAMBRIDGE

from aircraft. The technique employed uses what is known as an impactor. This is a film strip coated with an oily substance over which a measured volume of air is directed during flight. The dust particles stick to the film and the size and number are examined under a microscope. From the experimental results, the amount of scattered light can be computed, using theoretical data as a base reference.

The practical importance of the scattered light study is the determination of the effect of reduced visual range in dusty atmosphere as compared to a dust-free atmosphere.

As part of the visibility program, experiments have been carried out with a searchlight technique to measure atmospheric density and temperature up to 250,000 ft. altitude. In this work, a searchlight beam is modulated by a rotating, venetian-blind-type shutter.

At a distance of about 10 mi. from this first searchlight, a second light is installed, in which the light source has been replaced by a photo-sensitive receiver. This second searchlight scans the beam of the first searchlight and measures the light scattered by the original beam. The scattering is proportional to the atmospheric density. The modulation is used to reduce the noise level caused by light sources of the surrounding area, as well as the permanent emission of light occurring in the higher layers of the atmosphere.

From the density data obtained, the temperature profile in the atmosphere can be computed. Thus, it has been determined by these experiments that the temperature is about −60C at 40,000 ft. At about 160,000 ft., the temperature has been determined to be 10-20C.

▶ **Atmospheric Composition**—On the earth's surface and up to about 60 km. (37½ mi.), the composition of the atmosphere is pretty much constant with respect to percentage of gases, except for variation in pressure and temperature conditions. Above the 37½-mi.-altitude, changes in composition occur.

One reason is because of diffusive separation, where the lighter gases rise and the heavier gases settle (Signal Corps project).

Another reason is the effect of ultra-violet rays on the gases in the higher upper atmosphere above 37½ mi. (This condition is the basis for a large portion of GRD's composition work.)

The ultra-violet rays from the sun produce chemical changes in the gases of the upper air and cause formation of new compounds which do not exist in any appreciable quantity at ground level. Some of these gases are ozone, nitric and nitrous oxide. They shield

When the pressure's on
your best bet is
FLEX-O-TUBE®

Supplied in Assemblies

Flex-O-Tube will help you determine the assembly needed or work to your own specifications. In either case, modern facilities and latest inspection techniques assure you a uniformly high quality product delivered promptly.

Supplied for Field Assembly

Flex-O-Tube hose is also supplied in bulk coils with reusable fittings for field assembly. Complete range of sizes and types.

Any way you look at it, when the pressure's on, your best bet is Flex-O-Tube. That's because Flex-O-Tube stands for a dependable product, delivered promptly and uniform high quality.

When the pressure's on for production, aircraft men know that Flex-O-Tube deliveries are dependable . . . they know, too, that Flex-O-Tube stands for uniform high quality. And that's mighty important when tight schedules must be met and every hose assembly counts.

Aircraft engineers can relieve the pressure, too, by calling on Flex-O-Tube's broad experience in determining designs of new hose assemblies.

And in the air, where it really counts, Flex-O-Tube is a top performer under pressure. Miles and miles of Flex-O-Tube used in all types of aircraft have proven this beyond question.

Why not call in Flex-O-Tube on your requirements . . . you can rely on the product —you can rely on the service.

Please send me your free ☐ aircraft catalog. ☐ industrial catalog.
Name .....
Company .....
City ..... Zone ..... State .....
Address .....

FLEX-O-TUBE
DIVISION OF MERIDAN CORP.
758 FOURTEENTH • DETROIT 16, MICHIGAN

■ CAMBRIDGE

the lower atmosphere from any ultra-violet wave lengths shorter than 2,900 Angstrom units.

The effect of the ultra-violet rays on the gases is resolved both in the laboratory and by means of rockets.

• **In the rocket study,** the Aerobee is the primary missile used.

• **In the laboratory,** mixtures of atmospheric gases are made at the pressures comparable to that which would normally be found above 37½ mi. These gas samples are exposed to ultra-violet radiation in the region from 1,000 to 2,000 Angstroms. This is done in a partial vacuum to duplicate upper atmospheric conditions. After ultra-violet radiation exposure, the gases are analyzed and the new products formed are determined.

Knowing the intensity and wave length of the ultra-violet in the high upper atmosphere, the concentrations of the products which should exist at about 37½ mi. can then be predicted. (The reason for lack of conclusive existence is that rocket time at altitude is very short and conclusive data is very difficult to obtain.)

This study of composition change is important because it determines the temperature structure of the upper air and will have considerable bearing on "future" high-altitude flight of manned aircraft, since some of these gases are corrosive to aircraft materials, could be harmful to breathing by humans (under conditions for possible conservation of oxygen carried), and could affect engine performance if supercharging methods were used.

To determine the amount of ultra-violet present in the high upper atmosphere, rockets with small spectrographs are flown to altitudes of 37½ mi. or higher and spectral distribution of these radiations are obtained as a function of altitude.

▶ **Atmospheric Electricity**—Earth-air electric currents are another phase of work in the atmospheric physics laboratory. The earth and the ionosphere surrounding it may be considered electrically as a huge spherical condenser. There is a constant flow of approximately 1,800 amp. between the ionosphere and the earth. This current flows through the atmosphere and is carried by ions which exist in the atmosphere due to cosmic radiation and natural radioactive materials.

The source of this charging current is believed to be the thunderstorm, of which there are several hundred in existence throughout the world at any moment.

Laboratory personnel are studying the distribution of these air-earth currents and are attempting to explain how they arise and how they distribute themselves throughout the earth's surface.

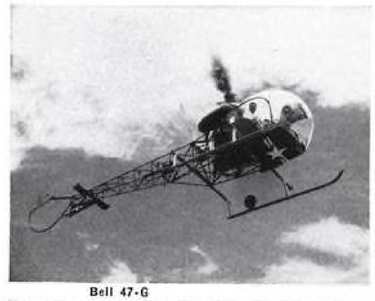
Here again, this work is done in the laboratory and in the field.

• **In the laboratory,** distribution of ions present at the earth's surface is studied, and how the ions behave under the influence of the earth's electrostatic field. Through this approach, familiarity is gained with the size range of the ions and the charges they carry. Cosmic ray intensities are correlated with the generation of these ions in the atmosphere; from this stems the prediction of the number of ions that will be present at any particular altitude and latitude.

• **In the field** (6520th Test Support Wing), there are a number of aircraft instrumented for measuring the conductivity of the atmosphere, the earth's electrostatic field gradient and the intensity of the air-earth current at all aircraft altitudes. Conductivity and field strength equipment is also sent aloft in large plastic balloons up to 100,000 ft.

This work has been important to the meteorologist because it has established an extremely sensitive method that may be used for detecting turbulence and mixing.

It has been learned, for example, that the boundary layer of atmosphere near


Bell 47-G

McCulloch MC-4

Sikorsky S-52

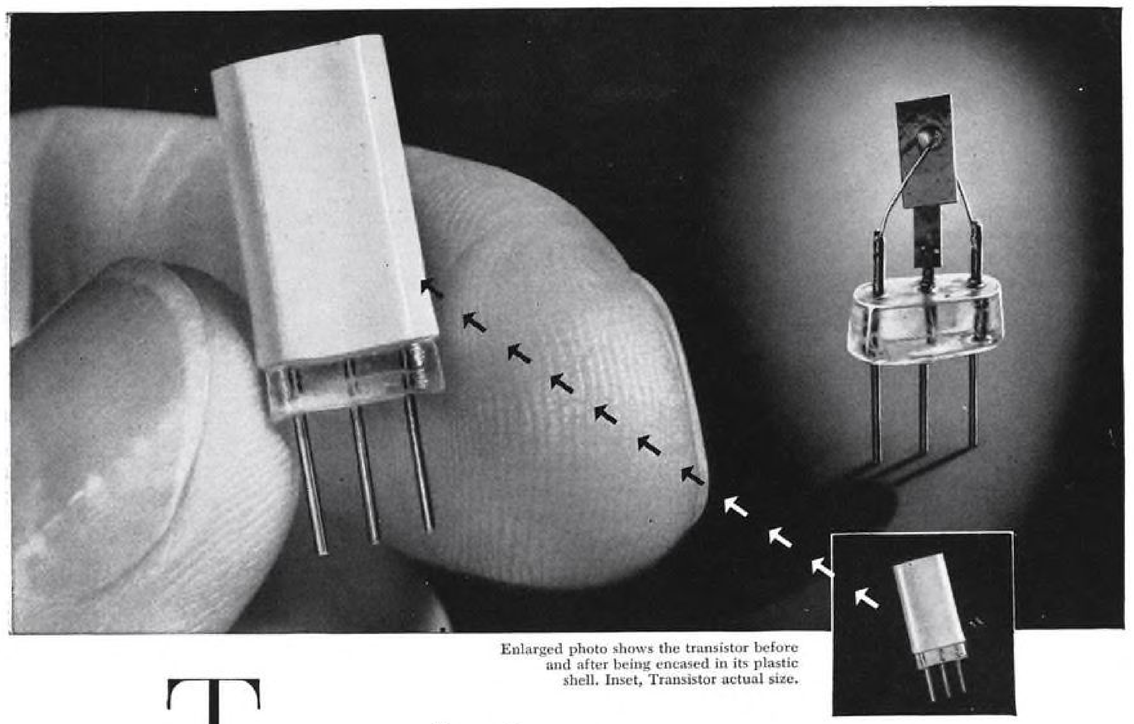
Hiller 360

4 out of 5

CAA- Certificated Helicopters under 400 h.p. have

Franklin POWER

AIRCOOLED MOTORS, INC. SYRACUSE, N. Y.



Enlarged photo shows the transistor before and after being encased in its plastic shell. Inset, Transistor actual size.

Transistor_

mighty mite of electronics

Increasingly you hear of a new electronic device—*the transistor.* Because of growing interest, RCA—a pioneer in transistor development for practical use in electronics—answers some basic questions:

Q: ***What is a transistor?***

A: The transistor consists of a particle of the metal germanium imbedded in a plastic shell about the size of a kernel of corn. It controls electrons in solids in much the same way that the electron tube handles electrons in a vacuum. But transistors are not interchangeable with tubes in the sense that a tube can be removed from a radio or television set and a transistor substituted. New circuits as well as new components are needed.

Q: ***What is germanium?***

A: Germanium is a metal midway between gold and platinum in cost, but a penny or two will buy the amount needed for one transistor. Germanium is one of the basic elements found in coal and certain ores. When painstakingly prepared, it has unusual electrical characteristics which enable a transistor to detect, amplify and oscillate as does an electron tube.

Q: ***What are the advantages of transistors in electronic instruments?***

A: They have no heated filament, require no warm-up, and use little power. They are rugged, shock-resistant and unaffected by dampness. They have long life. These qualities offer great opportunities for the miniaturization, simplification, and refinement of many types of electronic equipment.

Q: ***What is the present status of transistors?***

A: There are a number of types, most still in development. RCA has demonstrated to 200 electronics firms—plus Armed Forces representatives—how transistors could be used in many different applications.

Q: ***How widely will the transistor be used in the future?***

A: To indicate the range of future applications, RCA scientists have demonstrated *experimental* transistorized amplifiers, phonographs, radio receivers (AM, FM, and automobile), tiny transmitters, electronic computers and a number of television circuits. Because of its physical characteristics, the transistors qualify for use in lightweight, portable instruments.

* * *

RCA scientists, research men and engineers, aided by increased laboratory facilities, have intensified their work in the field of transistors. The multiplicity of new applications in both military and commercial fields is being studied. Already the transistor gives evidence that it will greatly extend the base of the electronics art into many new fields of science, commerce and industry. Such pioneering assures finer performance from any product or service trademarked RCA and RCA Victor.

RCA®

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

Six facts every engineer and scientist should know about the new

CRC 102-A

Electronic Digital General-Purpose Computer

1. LOW INITIAL COST—The CRC 102-A is one of the lowest priced, large scale, digital electronic computers now available commercially. It may be purchased, rented, or leased with an option to buy. Performance guarantees are given as part of every lease contract.

2. FAST AVAILABILITY—Applying production-line techniques to the construction of the CRC 102-A has resulted in the shortest delivery time of any fully electronic, digital, general-purpose computer. Production schedules call for completion of one CRC 102-A every eight working days.

3. WIDE CHOICE OF INPUT-OUTPUT DEVICES—Data in either octal or decimal form may be entered into the CRC 102-A manually from a typewriter, automatically or semi-automatically from punched paper tape, and automatically from IBM cards or from computer-controlled magnetic-tape units.

The computer will print output data automatically on its typewriter in octal, decimal, or alphabetic form, perforate paper tape in octal or decimal form for reproducing hard copy or for re-entering data into the computer at some later time, punch octal or decimal data on IBM cards for use with punched card equipment, or record data on magnetic tape for later use.

4. HIGH RELIABILITY—The unique circuit design and relatively small number of vacuum tubes and other critical components in the CRC 102-A result in less down time due to machine failure. Complete plug-in circuitry and easily adjusted mechanical components speed up preventive maintenance checks. Each machine undergoes extensive shakedown tests and is operated under actual customer conditions in CRC's Computing Center before delivery to further assure high reliability.

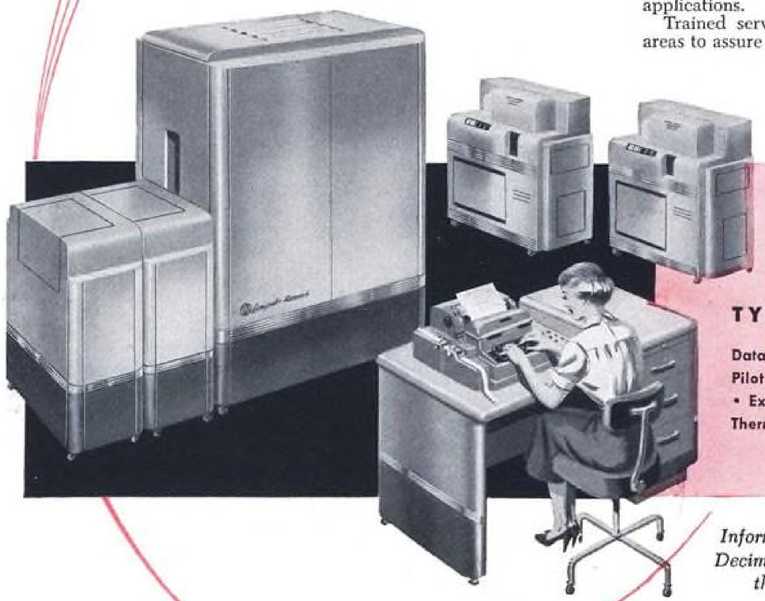
5. EASY PROGRAMMING—Addition of "programmer's" commands, a test switch for program debugging, faster speeds, greater flexibility, and the wide selection of input-output equipment has greatly simplified programming procedures and increased the computer's capabilities.

6. ADDITIONAL SERVICES ARE NOW AVAILABLE—Programming sub-routines, application studies, and training courses on computer operation, are now available from CRC's Applications Division.

Facilities of the new Computing Center enable potential computer users to evaluate the CRC 102-A for their specific applications.

Trained service personnel are now available in most areas to assure proper maintenance of all CRC computers.

For complete, detailed information on the new CRC 102-A write to the Director of Applications.



TYPICAL APPLICATIONS

Data Reduction • Trajectory Analysis • Auto Pilot Studies • Optimo Performance Analysis • Exterior Ballistics • Fuel Burning Studies • Thermodynamic Problems.

Information is also available on the CRC 105 Decimal Digital Differential Analyzer and the CRC 107 Data Processing Computer.

FIRST IN ELECTRONIC COMPUTATION

CRC **Computer Research** CORPORATION

3348 WEST EL SEGUNDO BLVD., HAWTHORNE, CALIFORNIA

■ CAMBRIDGE

the surface of the earth (called the exchange layer) can be detected with ease and accuracy using conductivity methods, and normally is found at an altitude of between 4,000-6,000 ft.

It was formerly believed that high mountain peaks extended above this exchange layer, but recent conductivity tests have shown that this layer is warped by the mountains and covers them completely. The boundary layer governs the energy exchange between the air and the ground and is important in forecasting weather at the surface.

The atmospheric conductivity method is also extremely sensitive to radioactive contaminants in the atmosphere and is used to trace the distribution of radioactive waste products from any ground-based nuclear source.

Also, as a result of work in atmospheric electricity, it has been possible to develop a method for discharging aircraft in flight and reducing this charge to essentially zero. The charge is led from the aircraft surface to a static discharger in the tail. This equipment is heavy and experimental, but indicates possibilities for practical aircraft application in suitable size and weight.

► Rocketsonde Group—The sounding-rocket activity is primarily interested in the temperature-density structure of the atmosphere up to rocket altitudes of about 85 mi. Measurements are made by means of spark gap modulators, shock-wave effect on the missile, and by alphatron (radioactive) gages.

In addition, measurements are also being made of meteor trails to determine the wind structure of the high upper atmosphere in regions not accessible to rocket flight. This is a supplementary study continuing where rockets leave off.

The rocketsonde group is also interested in studying the ionosphere, and sends rockets into the lower ionosphere to obtain recordings of ion density as a function of altitude. This work is directly related to design criteria for guided missiles, since knowledge of the density structure is necessary to design control surfaces. Ionospheric densities are necessary also to determine the possibility of radio guidance systems for such a missile.

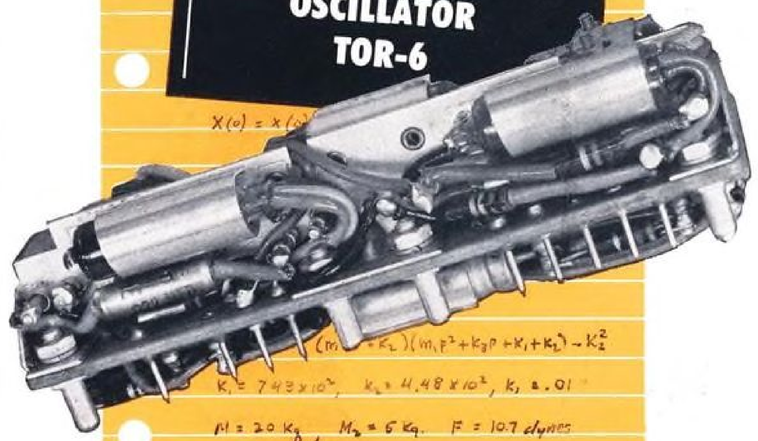
This phase is all field work—actually done at Holloman AFB. Equipment is built at GRD and at various universities and institutions under contract.

Ionospheric Physics

Head of the Ionospheric Physics activity is N. C. Gerson. Most of the laboratory's work is concerned with the atmosphere above 50 km. (about 32 mi.) and may extend to 15,000 km.

To telemeter changes, Specify the new...

Bendix-Pacific RESISTANCE BRIDGE OSCILLATOR TOR-6



The new Bendix-Pacific TOR-6 Oscillator gives improved performance with resistance type strain gages and variable resistance type temperature pickups. The unit operates with unusual stability under extreme conditions of environment.

Unbalance of the resistance bridge provides a voltage which is used to change the frequency of the oscillator. The magnitude and direction of the frequency change is proportional to the magnitude and phase of the bridge output.

SPECIFICATIONS

Bridge Impedance: 120 ohm*
Sensitivity: ±7.5% change of f_0 for 0.125% change in resistance in each of four active arms*. (This is RDB specified subcarrier bandwidth)
Frequency Response: Flat within ±2.0% from DC to 10% of bandwidth.
Linearity: Within 1.0% of best straight line.
Stability: Drift less than 0.5% of bandwidth (0.07% of f_0) for 8 hours at 25° C. after 15 minute warmup.
Temperature Effect: f_0 changes less than 0.08% of bandwidth per degree centigrade.
Vibration Effect: 1.0% maximum noise at 10 g, 20 to 1000 cps.
Supply Voltage Effect:
Plate Supply: Drift does not exceed 1.0% of bandwidth for ±10% change of plate supply voltage.
Heater Supply: Drift does not exceed 1.0% of bandwidth for ±10% change of heater voltage.
Output: 1.5 volts rms into 100 kilohms resistive load. Generator impedance 750 kilohms.
Harmonic Distortion: 2.0% maximum.
Power Requirements:
0.015 A at 108 volts DC
0.800 A at 6.0 volts DC or rms AC.
Bands of Operation: Standard RDB bands 1.7 through 14.5 kc*.
Size: 4.5" long x 1.45" wide x 1.35" high; occupies 2 sections of Bendix TJS Component Mounting Assembly.
Weight: 0.4 pounds.

*Available for other bridge impedances, sensitivities, and bands of operation on special order. For temperature measurement, ±0.5% change of resistance in one arm produces ±7.5% change of f_0.

Write for complete information.

Pacific Division Bendix Aviation Corporation NORTH HOLLYWOOD, CALIF. Bendix

EAST COAST OFFICE: 475 FIFTH AVE., NEW YORK 17, N.Y.
EXPORT DIVISION: BENDIX INTERNATIONAL, 72 FIFTH AVE., NEW YORK 11 N.Y.

■ CAMBRIDGE

(about 9,500 mi.)—right to the end of the exosphere.

The ionospheric region is important for various reasons.

• From 50 km. up, there are ionic layers which make possible long-distance radio communications.

• From 50 to 1,000 km. (about 625 mi.) there are the auroral effects. This phenomenon is important for radio communication work, particularly in the arctic; and secondly because of its relationship to activity of a geomagnetic nature.

• A third reason for ionospheric study is that the region from 50 km. up is considered to be the operating medium of the "future" Air Force.

There is also the possibility of extracting energy from the high atmosphere. For example, it might be possible to send a missile (air worm) up into the outer reaches and have it extract energy from all the charged or dissociated particles it encounters, either for storing this energy or to make the missile ascend higher.

▶ **Radio Factors**—One of the studies which the Ionospheric Physics Laboratory has made was done in cooperation with radio amateurs over both North and South America, including the Caribbean Islands. The hams reported to the laboratory whenever they encountered certain types of special radio conditions. This permited laboratory scientists to determine the existence and location of an abnormal condition of the ionosphere—known as sporadic E (E_s).

It has been determined that with E_s occurrence the range of radio communication can be increased appreciably—in effect, new channels of radio communication are opened up. By the movement of these E_s areas, the existence of winds can be determined near the 100-km. (about 60-mi.) level and up. This helps in the study of the global circulation patterns.

The E_s formations affect communications in the 20 to 300-mc. band. These E_s clouds are those with either high electron concentration or concentrated turbulence, and one of them can cover an area half the size of the U. S. They occur mainly during the summer months.

▶ **Aurora Effects**—The aurora permits study of radio blackouts in the arctic. One of the Geophysics Research Directorate's jobs is to predict the occurrence of the aurora.

For long-distance communications, reflections come from the ionospheric F_2 layer at about 300 km. (about 190 mi.). The aurora comes down to a level of about 60 mi., so that when this phenomenon is present, it intercepts the radio waves (8-15 mc./sec.) between the transmitter and receiver and the radio waves are lost through scattering and absorption.

However, when a frequency of 50 mc./sec. (VHF) is used, then the auroral screen can be used as a reflecting screen and it becomes possible to communicate with stations which could not be contacted before.

The real benefit of using the auroral phenomeon is to permit the use of lightweight, long-distance, high-frequency sets for communication.

The spectra of the aurora are being studied also. This gives an indication of the constituents of the high atmosphere. The study is important in amassing a general background picture of the atmosphere—its extent, and the particles and streams coming into it. It also aids in the prediction of formation and types of aurora.

Terrestrial Sciences

Dr. James Peoples heads this GRD research phase. This group studies the interaction of the atmosphere and the earth's crust. It also investigates the earth itself, and the oceans and ice. All of this work is for aircraft support and guidance. For a good part of the work, reliance is placed on seismology.

▶ **Sonic Tools**—One project is concerned with the determination of stra-

Pilot's Choice... FOR LEADING EXECUTIVE AIRCRAFT!

FLITE-TRONICS
CAA APPROVED
MB-3
VISUAL — AURAL
Marker Beacon Receiver

Professional pilots flying America's industrial air fleet of fast, modern executive transports are rapidly making the Flite-Tronics MB-3 their first choice in marker receiver equipment. Its small size, low weight (under 3 lbs.), reliability and economy are features-in-fact which meet their rigid requirements for a 3-light visual-aural marker receiver providing sure, accurate light and audio signals . . . extra navigational safety for their owner-executive passengers . . . at a reasonable cost without sacrifice in quality!

This popularity trend to the MB-3 for company-owned Beechcraft D18's, Aero Commanders, DeHavilland Doves and many other single and multi-engine type aircraft is significant of the outstanding performance of the Flite-Tronics MB-3.

Write on company letterhead for complete product information on the MB-3 Marker Beacon Receiver and CA-1 Audio Distribution Amplifier and name of Flite-Tronics dealer nearest you.

FLITE-TRONICS, inc.
3303 BURTON AVENUE
BURBANK, CALIFORNIA

They asked for the moon...and got it!

APCO Pressure Regulators
accessory products company

MAIN PLANT: 617 Putnam Drive • Whittier, California • OXford 4-6097
EASTERN ENGINEERING REPRESENTATIVE: Russell & Co. • Bay Shore, New York
MIDWEST ENGINEERING REPRESENTATIVE: Lyons-Coleman, Inc. • Dallas, Texas

When asked by a customer to produce an "impossible" job, we at APCO welcome the challenge. Like other serious young men in our stimulating aircraft industry—we look to tomorrow for our answers today.

Here's a typical example of how APCO met the test for Convair's new advanced delta winged interceptor.

CONVAIR SPECIFICATIONS called for a demand type hydraulic pressure regulator allowing for (1) a wide variation in inlet pressure, (2) a close tolerance on outlet pressure, (3) a wide range in flow, (4) a wide temperature range. (5) a high flow relief valve.

APCO'S ENGINEERING SKILL resulted in a small, lightweight pressure regulator that not only met the rigid specifications but produced a composite of characteristics never before achieved in one hydraulic pressure regulator.

We invite your request for bid for a pressure regulator or valve, no matter how rigid your specifications may be.

Ask these customers about our modern production methods, speedy deliveries and competitive prices:

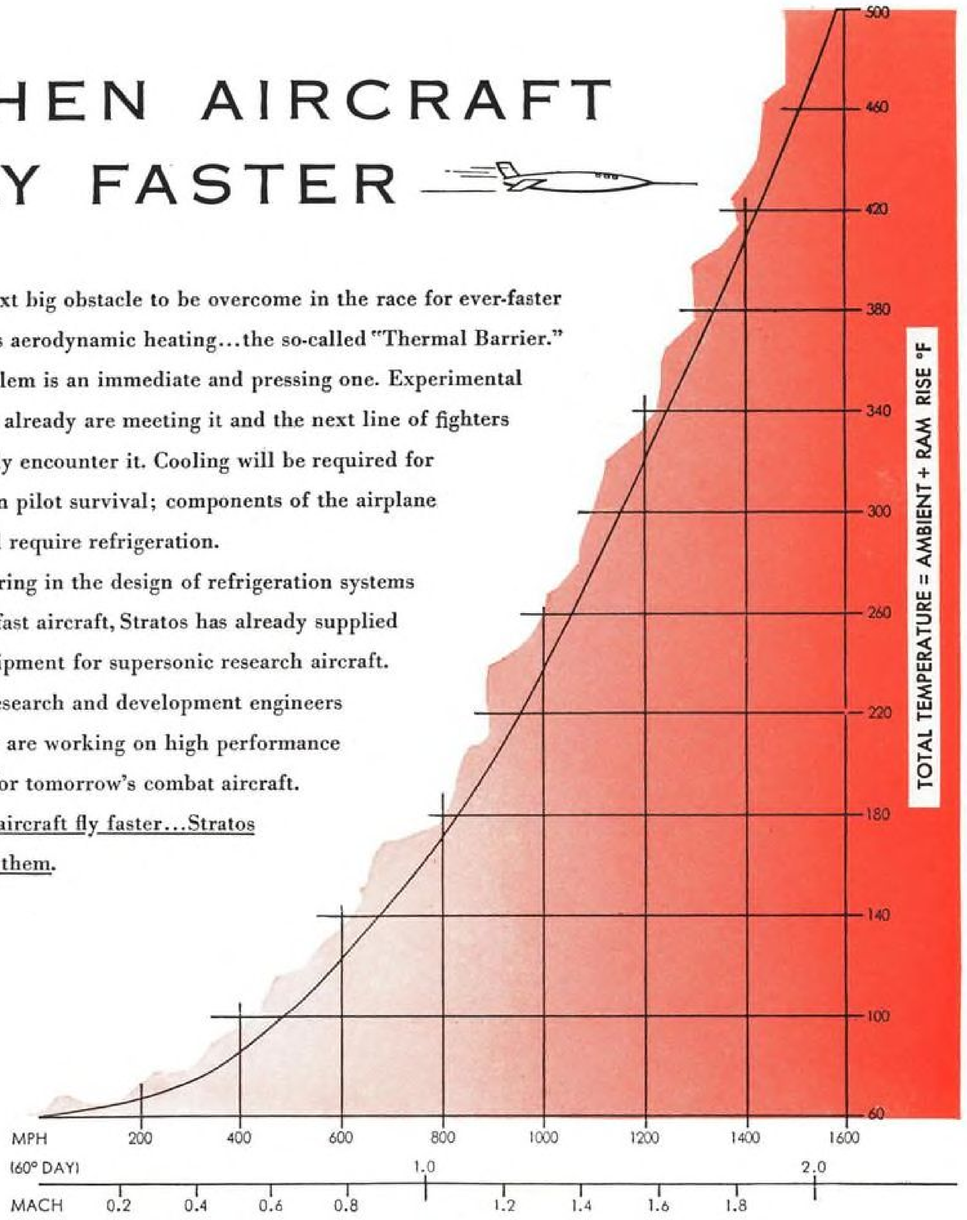
CONVAIR BOEING GOODYEAR
NORTHROP SPERRY CHANCE VOUGHT
LOCKHEED HUGHES CANADAIR
DOUGLAS ROHR AEROJET
FLETCHER WRIGHT McDONNELL
NORTH AMERICAN GENERAL ELECTRIC

WHEN AIRCRAFT FLY FASTER

The next big obstacle to be overcome in the race for ever-faster aircraft is aerodynamic heating...the so-called "Thermal Barrier." The problem is an immediate and pressing one. Experimental airplanes already are meeting it and the next line of fighters will surely encounter it. Cooling will be required for more than pilot survival; components of the airplane itself will require refrigeration.

Pioneering in the design of refrigeration systems for very fast aircraft, Stratos has already supplied such equipment for supersonic research aircraft. Stratos research and development engineers currently are working on high performance systems for tomorrow's combat aircraft.

When aircraft fly faster...Stratos will cool them.



STRATOS

A DIVISION OF FAIRCHILD ENGINE & AIRPLANE CORP.

Main Office and Plant: Bay Shore, L. I., N. Y. • West Coast Office: 1355 Westwood Blvd., Los Angeles 24, Calif.

TYPICAL STRATOS PRODUCTS

REFRIGERATION TURBINE FOR F-86 "SABREJET"

REFRIGERATION PACKAGE FOR B-47 "STRATOJET"

AIR-TURBINE DRIVE FOR OPERATING ACCESSORIES

BOOTSTRAP COOLING UNIT FOR TRANSPORT AIRCRAFT

CABIN SUPERCHARGER FOR TRANSPORT AIRCRAFT

■ CAMBRIDGE

tospheric winds and temperatures by sonic measurements. TNT charges are set up on the earth and sound waves reflected from the temperature inversion levels in the atmosphere up to 80 km. (50 mi.) are noted. By observing the travel time and azimuth of the reflected waves, the wind effects at these altitudes can be determined, as well as the temperatures that cause these reflecting layers.

This atmospheric acoustics method is not as direct as balloon observation, but it eliminates the toting of instruments to altitude, and the technique can be performed at any location and at all seasons—at times when balloons would not be employed. Also, height can be reached that cannot be attained by balloons.

Advantages over rocket flight are that the latter method is done infrequently and is expensive.

In actual practice a site is chosen and rung for about a 200-mi. radius from the shot point with a series of recording stations.

The technique was developed at GRD, whose field parties participate in the work along with personnel from the University of Denver and the University of Alaska, under contract.

► **For Tomorrow**—This particular research is not directly applicable to everyday flight, but it will fit the future flight picture for both planes and guided missiles. Primarily the work is done to gather data for establishing a scientific background of the general physics of the atmosphere—how winds and temperature vary with the seasons.

The project has been under way for about six years and is just about complete. It indicates that the atmospheric acoustics method is scientifically valid. Results have agreed very closely with the National Advisory Committee for Aeronautics' altitude-temperature curve. The work has also verified the assumed portion of the NACA data.

► **Pack Ice Study**—Another project of the laboratory is the investigation of arctic pack (permanent) ice north of Alaska, to determine thickness, structure and breakup characteristics.

Landings were made with ski-equipped aircraft for setting up seismometers and surface charges to determine relationship of salt water ice thickness to air-coupled shock wave transmission. From the reflected wave analysis, ice thickness could be determined as well as presence of ice faults and ocean depths.

Data tell whether the ice is sufficiently strong to support landing aircraft and whether it will stay intact or break up—important information for establishment of a camp, rescue or operating

AVICA
LIGHTWEIGHT
CORROSION RESISTANT
Stainless Steel
FLEXIBLE
TUBE ASSEMBLIES

For Aircraft
Missiles
and Rockets

FUEL SUPPLY
OXIDENT SUPPLY
GROUND CHARGING
CONTROL SYSTEM UNITS
FUEL and OIL SYSTEMS
AFTERBURNER INSTALLATIONS
BOOST INJECTOR SYSTEMS
DRAIN LINES
VENT and BREATHER LINES
FIRE EXTINGUISHER SYSTEMS
ELECTRICAL HARNESS
TURBO-STARTER ASSEMBLIES

FIRE RESISTANT
Compressor Bleed
Air Lines for:—
CABIN SUPERCHARGING
GUN and CAMERA HEAT
DE-ICING, DE-MISTING

SIZE RANGE 3/16"—4" I.D.
MECHANICALLY *Applied*
Reusable END FITTINGS

AVICA is always ready to discuss special applications with customers and to develop hose assemblies to deal with unusual operating conditions.

WRITE TO SPECIAL PROJECTS DEPT. A. W.
FOR FURTHER INFORMATION

AVICA CORPORATION
P. O. BOX 1090
PORTSMOUTH, RHODE ISLAND
TEL. PORTSMOUTH 479
WEST COAST REPRESENTATIVE
AIRSUPPLY COMPANY, 9815 WILSHIRE, BLVD.
BEVERLY HILLS, CALIFORNIA

■ CAMBRIDGE

air base and weather stations.

To extend this type of survey to all the ice over which flight could be made, the laboratory has developed a radio seismometer which can be dropped by parachute so that it will telemeter data back to the plane when a 100-lb. bomb is dropped on the ice in the general area of the seismometer. A recorder in the aircraft pen-charts the shock wave characteristics. Analysis of the data provides ice thickness, ice faults and ocean depths.

▶ **Other Projects**—Other studies of the laboratory include investigation of microseisms—minute earthquakes on the earth's crust caused by atmospheric fluctuations.

To aid in landing operations on unimproved fields, the laboratory is conducting soil-bearing studies (trafficability).

To promote navigation knowledge, the laboratory is investigating geomagnetic fields.

Interest is already projected in the solar eclipse due in 1954. This should provide data for mapping the earth's surfaces and promoting navigation and guidance.

A project concerned with a floating ice island in the arctic is under study to determine feasibility of base establishment. This work is described in another article in this issue.

Atmospheric Analysis

Head of the atmospheric analysis activity—a weather forecasting group—is C. N. Touart.

This coordinated and directed effort for the solution of weather forecast problems has never before been available on such a scale in the history of meteorology.

The feeling is that the art of forecasting has been leveled off on a plateau while knowledge is gathered for a move up to a higher plateau of understanding weather phenomena.

▶ **Numerical Prediction**—One of the present considerations of the atmospheric analysis lab is the operational testing of the numerical prediction technique that is based on the numerical solution of the fundamental laws of motion. These are the laws which govern the motion of all material bodies.

The ability of meteorologists to modify and specialize these laws so they can be applied to the atmosphere has only come about in the last 10 years. This achievement makes meteorology a branch of the physical sciences and the laboratory capitalizes on all the data generated by the various phases of these sciences instead of starting from scratch.

▶ **Balloons Help**—For its numerical prediction technique, the laboratory uses data obtained by balloons released all over the country on a routine basis by the U. S. Weather Bureau, Air Weather Service and the U. S. Navy. These are equipped with radio transmitters and send back reports of temperature, wind and pressure conditions in the upper atmosphere. These balloons may range to altitudes between 10 and 15 mi.

The data collected are fed to GRD, where the computing machines go to work and return a forecast for 24 or 36 hr. in advance. The computer can accomplish this because it has been instructed to take into account more details than the human forecaster can concerning the state of the atmosphere.

At present, it is fairly clear that the computer can significantly improve on the performance of the field forecaster in predicting the field of motion in the atmosphere. It can forecast unexpected developments—birth of new storms, irregular motions, and sudden changes of weather.

▶ **Long-Range Forecasting**—The laboratory aims to extend the time-range of weather forecasts. The objective is to forecast accurately by from three days to one month.

Long-range forecasting reduces the limits of accuracy with which a forecast is phrased, both with respect to space and time. It is in a much more primitive stage than short-range forecasting, and the problem is "how accurate is it at the moment?" This question is what the development and evaluation group at the laboratory is trying to answer.

For the past five years the lab's personnel have been studying the general circulation of the atmosphere—the gross feature of its motion. Forecasting this general circulation is the key to the long-range forecast, according to many meteorologists.

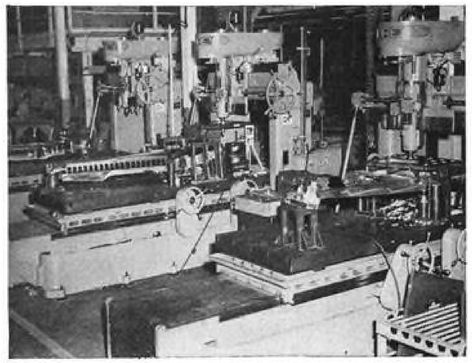
Atmospheric Devices

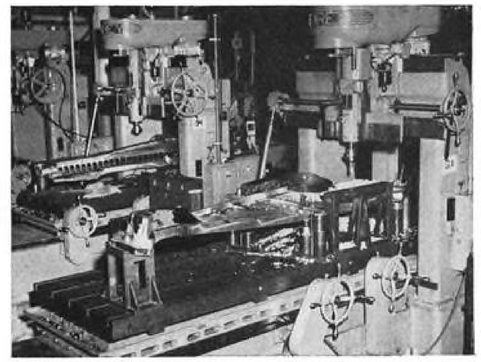
The atmospheric devices activity is headed by Lt. Col. Paul Worthman.

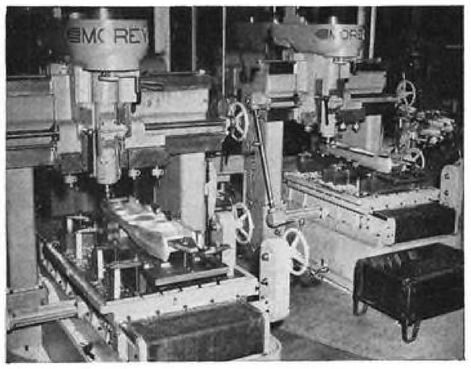
The function of this group is to develop balloon systems, including the carrier and its instrumentation. The instrumentation covers both ground and airborne equipment for recording temperature, pressure and turbulence up to 100,000 ft. The laboratory is also charged with test-proving of large and small instruments which are developed, before acceptance by the Air Force for production.

One of the laboratory's big projects, known as Moby Dick, uses large plastic balloons to carry research instrumentation to altitudes between 50,000 and 100,000 ft. for the investigation of wind fields.

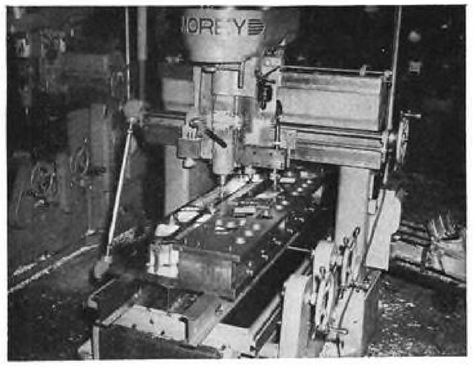
MOREY
NO. 40M "AEROFRAME"
PROFILER and MILLER
Multiplies your production of difficult parts by 4!

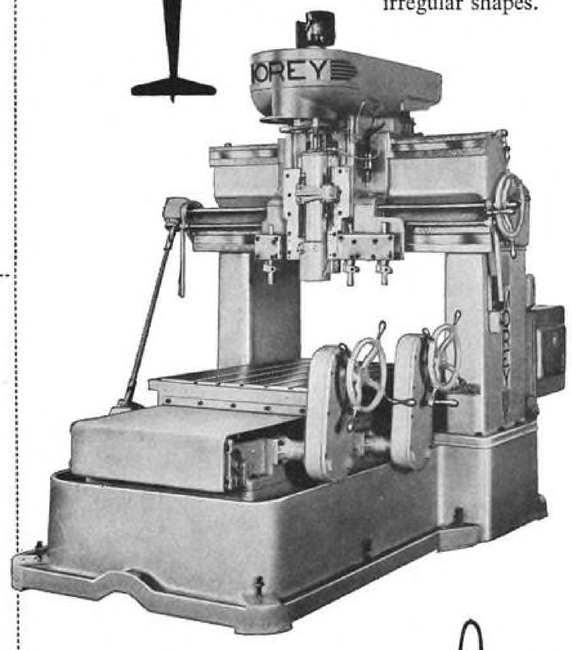






An original development for manufacturing your intricate and irregular shapes.





ATTRACTIVE DELIVERY!

MOREY
...for machine tools!

MOREY MACHINERY CO., INC.
Manufacturers • Merchants • Distributors
410 BROOME STREET • NEW YORK 13, N. Y.
CANAL 6-7400 • CABLE ADDRESS: WOODWORK, N. Y.

PHEOLL offers you all types and sizes of

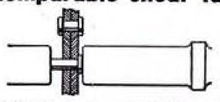
hi-shear® AIRCRAFT RIVETS

TRADEMARK REGISTERED U. S. PATENT OFFICE

REGULAR, CLOSE TOLERANCE and INTERFERENCE-FIT TYPES

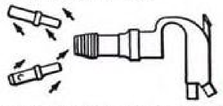
Manufactured from alloy steel, stainless steel and 75ST aluminum alloy

FASTER than any comparable shear fastener!



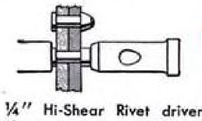
LIGHT GAGE RIVETING

5/32" AD aluminum rivet driven with 4½-lb. gun and rivet set. Shear strength—518 lbs. Speed—17 rivets per minute.



5 SEC. TOOL CHANGE

Remove previous rivet set—insert 1-piece Hi-Shear Rivet set in same gun. Set change time—5 seconds.



HEAVY GAGE Hi-Shear RIVETING

¼" Hi-Shear Rivet driven with same gun. Shear strength—3,681 lbs. Speed—17 rivets per minute.

LIGHTER than any comparable shear fastener!

A Hi-Shear Rivet weighs only *one-third* as much as an AN bolt-nut-washer combination having the same shear strength and grip.

CLOSE TOLERANCE HEADS are upset to finish dimensions

CLOSE TOLERANCE SHANKS are ground to required limits

Pheoll gives you prompt service on Hi-Shear Aircraft Rivets in all types and sizes . . . *many available from stock.*

HEAD STYLES—100° flush head or protruding head are standard; other head styles can be furnished.

DIAMETERS—From ⅛ in. to ⅝ in., inclusive.

HEAT TREATMENT—Alloy steel rivets are heat treated to either 125,000-150,000 psi or 160,000-180,000 psi.

Special types of Hi-Shear Rivets can also be supplied where required.

Rely on Pheoll for the *complete* line of Hi-Shear Aircraft Rivets!

Catalog and engineering data sheets available on request

PHEOLL MANUFACTURING COMPANY

5700 ROOSEVELT ROAD . . . CHICAGO 50, ILLINOIS

SCREWS BOLTS NUTS

Directorate

Cambridge—Complex geophysical problems are being resolved here in a concentrated research, development and test program aimed at simplifying operational difficulties of present and future aircraft.

This work, being conducted by the Air Research and Development Command's Air Force Cambridge Research Center (AFCRC), Cambridge, Mass., is being pushed by the Geophysics Research Directorate (GRD), one of the center's three research divisions.

GRD's overall study embraces both laboratory and field investigations. Its laboratory phases, together with some of the numerous studies under way, are outlined elsewhere in this issue. Some examples highlighting the many field projects—aimed to unravel threads of geophysical phenomena—are related here.

Mountain Wave

GRD's Atmospheric Analysis Laboratory is conducting a study known as the Mountain Wave Project, with field work under the direction of Dr. J. P. Kuettner. The project contract was signed in the fall of 1950, and is still continuing.

The broad aim of the study is to explore airflow over mountains, and its implications to aviation. The Sierra Nevada mountain range area was selected for the field experiments, because previously glider pilots had used the mountain wave in this region to climb to over 35,000 ft., which indicated that the wave was more pronounced in this area than over other mountain locales in the U. S.

In addition to GRD personnel, the entire project has involved the University of California personnel under the direction of Prof. Holmboe, Meteorological Department Head; the Naval Ordnance Test Station, Inyokern, Calif.; the Air Weather Service; U. S. Weather Bureau; Southern California Soaring Assn.; and other participants.

▶ **Basis of Study**—Airflow over a mountain range forms a system of waves downwind of the mountain. It is this phenomenon which is the basis of the project study. Both gliders and powered planes have been used in the study to take advantage of the ascending part of the wave to gain altitude.

In the project, the powered Convair BT-13 has been used for flights close to the ground (where glider operation would not be feasible) and up to altitudes of 18,000 ft. Pratt-Read gliders used have been taken to considerably higher altitudes, limited only by the lack of a pressurized cabin in the sailplane.

Field phases have involved determination of the magnitude of updrafts and downdrafts and their positions with respect to the mountain. Pressure disturbances have also been investigated, since these are responsible for altimeter errors. Another phase of study is turbulence phenomena, especially high-level turbulence under jetstream conditions. During trial flights a glider pilot has been lifted into a jetstream.

▶ **Record Set**—During the project, a world altitude record for gliders was set —44,500 ft.—in one of the Pratt-Read sailplanes. This flight had to be discontinued at this altitude because there was no cabin pressurization, although the air was still rising at 1,000 fpm.

The instrumented and calibrated gliders have been tracked by cinetheodolites, radar and Raydist. Radiosonde and meteorological stations were set up in the Sierra Nevada and adjacent areas to record atmospheric conditions during wave situations.

A number of accidents have been attributed to the hazardous conditions produced by the mountain wave. From the data that have been collected in this project there are indications that new safety altitudes would appear advisable.

Excessive turbulence and altimeter error over mountain regions are other aspects in which the Air Force is interested. The project is expected to determine the magnitude of these altimeter errors and give a better understanding of the phenomena of high-level turbulence.

Ice Island

A massive floating ice island, known as T-3, in the Arctic waters, is the scene of another special project in which GRD's Terrestrial Sciences Laboratory is participating. Huge ice masses such as this offer interesting possibilities for Air Force use.

Large ice islands were first discovered in northern waters in 1947 during weather reconnaissance flights from the Alaskan Air Command. In 1951, T-3 ice island was located, when it was in a position to be occupied for camp purposes. Its area was 45 sq. mi.

In March 1952, the first aircraft landing was made. In the subsequent landing a GRD scientist was put down on the island and then others from GRD followed. On this floating weather station, the GRD personnel will remain until October of this year. Other service representatives on the site include weather observers of the Alaskan Air Command, representatives of the Aero Medical Laboratory, and communications personnel.

▶ **Island Under Study**—Studies are being made to determine the character of the island—why it is there, how it was formed, its thickness, structure, and breakup and drift characteristics. Already, the main cause of movement has been found to be the wind, with ocean current effect being negligible.

Plains Turbulence

An extensive study now being conducted by GRD's Atmospheric Analysis Laboratory is the Great Plains Turbulence Field Project. This month, on the plains of Nebraska, GRD is making concentrated field observatoins to test certain established theories of air turbulence and heat transfer occurring between the air and the ground, between different atmospheric layers and that involved in such processes as evaporation and condensation.

These trials climax four years of diversified investigations of the diffusive processes in the lower atmosphere.

▶ **Results Expected**—It is expected that considerable new data will be amassed on the portion of the atmosphere nearest to the ground, and new theories should be developed. About 125 scientific personnel from 12 universities, institutions and military agencies are participating in the project phase.

The results of this field experiment primarily will be of military interest, but commercial, agricultural and public health activities should also benefit.

During the field trials, some groups will make observations of windspeed and direction at numerous elevations up to about 5,000 ft., with cup-type and cylindrical anemometers, photo-theodolites, and smoke puffs. Fluctuations and stress of the wind on the ground and at various levels will be measured by other groups.

▶ **Measuring Temperatures**—Temperature profiles up to about 10,000 ft. will be measured by aircraft observations and radiosonde. Fluctuations of temperature up to 75 ft. will be recorded by cable-anchored radiosonde.

Profiles and fluctuations of moisture —one of the most important constituents of the atmosphere—will be observed and evaporation rates for hourly and daily periods will be measured.

Quantitative and qualitative diffusion measurements will be made to check on the rate of spread and dissipation of smoke puffs near the ground and at heights of 5,000 ft.

Probes Air and Weather

PHEOLL hi-shear RIVETS JOIN VITAL AIRCRAFT PARTS FASTER-BETTER

Heat treated alloy steel pin with malleable aluminum collar

REGULAR, CLOSE TOLERANCE AND INTERFERENCE FIT TYPES INSTALLED 5 TIMES AS FAST AS BOLTS

Save both weight and time in aircraft assembly by using Pheoll Hi-Shear Rivets. These precision made fasteners are easy to install and provide maximum shear strength when critical parts are joined.

PHEOLL'S EXTENSIVE MANUFACTURING FACILITIES provide the aircraft industry with a constant source for alloy steel, stainless steel and 75ST Aluminum Alloy Hi-Shear Rivets in all types and sizes.

Partial List of Styles Available

NAS 177 100° Countersunk Head
NAS 178 Flat Binding Head
HS 2R7 Close Tolerance 100° Countersunk Head
NAA 2R6 Stud Rivets
HS 11 Brazier Head
HS 23 Close Tolerance 100° Countersunk Head—75ST Aluminum Alloy
HS 26 Flat Binding Head—75ST Aluminum Alloy
HS 27 Close Tolerance 100° Countersunk Head—Close Tolerance Shank
HS 28 Flat Binding Head—Close Tolerance Shank
HS 37 Close Tolerance 100° Countersunk Head—Close Tolerance Shank—Minimum Tensile Strength 160,000 p.s.i.
HS 38 Flat Binding Head—Close Tolerance Shank—Minimum Tensile Strength 160,000 p.s.i.
HS 47 Close Tolerance 100° Countersunk Head — Interference Fit — Minimum Tensile Strength 160,000 p.s.i.
HS 48 Flat Binding Head—Interference Fit —Minimum Tensile Strength 160,000 p.s.i.

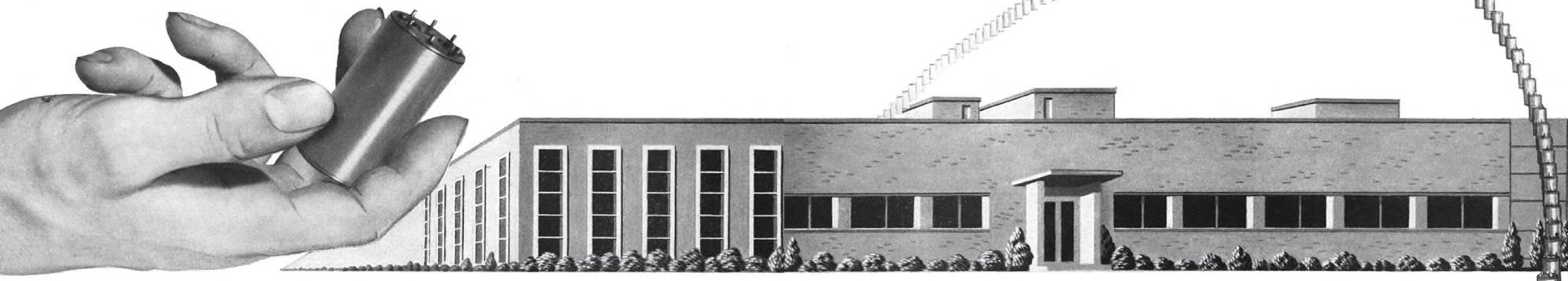
NOTE: Other types made to customer's specifications. Ask about Hi-Shears for industrial use.

Write for Free Catalog and Engineering Data Sheets

PHEOLL MANUFACTURING COMPANY

5700 Roosevelt Road, Chicago 50, Ill.

SCREWS BOLTS NUTS



THE UNITED STATES TIME CORP. and SANDERS ASSOCIATES, INC. join hands

to make available for the first time on a mass production basis . . . at volume prices—

WORLD'S SMALLEST SUBMINIATURE PRECISION RATE GYROSCOPES

LESS THAN 1 INCH DIAMETER

LESS THAN 2 INCHES LONG

LESS THAN 3 OUNCES

These gyros, developed and perfected by Sanders Associates, are now made available in volume through the close-tolerance, mass production techniques and facilities U. S. Time has acquired in nearly a century of precision manufacturing experience.

U. S. Time is the world's largest manufacturer of wrist watches and mechanical time fuses. Twelve years ago it began manufacturing precision gyroscopes for the armed forces. During this period, it has produced gyros at the rate of *17,000 per month* in its ultra-modern, completely air-conditioned plant.

Now—the skills and experience gained in attaining this outstanding record in mass precision production are being applied to the manufacture of Sanders Associates' Rate Gyro—the ultimate in subminiaturization, flight proven in production missiles.

another design

SUPERIOR PERFORMANCE CHARACTERISTICS RELIABILITY ACTUALLY INCREASED

- temperature compensated
- hermetically sealed
- fast starting
- high resonant frequency
- unusually insensitive to shock and vibration

CHARACTERISTICS

Range	420 degrees/sec.	40 degrees/sec.
Resolution	better than 0.05 degrees/sec.	better than 0.005 degrees/sec.
Linearity	approximately 0.1%	
Sensitivity	5.6 volts RMS AC output at 420 degrees/sec.	5.6 volts RMS AC output at 40 degrees/sec.
Resonant Frequency	85 CPS	30 CPS

Nominal Damping	0.5 critical	0.5 critical
Motor Excitation	6.3 volts, 400 cycles, 2 phase, 3 watts 26.0 volts, 400 cycles, 2 phase, 4 watts	
Pickoff Excitation	6.3 volts, 400 cycle	
Starting Time	15 seconds	
Max. Operating Linear Acceleration	60 G any axis	20 G any axis

ENVIRONMENTAL CONDITIONS

Altitude — 0-60,000 feet
Max. Survival Shock Acceleration — 1000 G any axis
Temperature Operating Range — -55C to 85C
Tested Operating Life — over 1000 hours
Max. Vibration (0-300 CPS)...5 G any axis

VARIATIONS IN DESIGN POSSIBLE TO MEET SPECIFIC REQUIREMENTS

INQUIRIES INVITED. **Write to Dept. B**

The United States Time Corporation

500 FIFTH AVENUE, NEW YORK 36, N. Y.

Main Plant — Middlebury, Connecticut

Other Plants — Waterbury, Connecticut; Little Rock, Arkansas, Abilene, Tex., Dundee, Scotland

ACTUAL SIZE

SUITABLE FOR:

GUIDED MISSILES
FIRE CONTROL SYSTEMS
AIRCRAFT INSTRUMENTS
ANTENNA STABILIZATION

US TIME

Faith *in the sky*

Bright new wings on a proud blue uniform—another young man has put his faith in the sky! Our job is to back him up—give him the best we have to offer, then figure ways to give him better still.

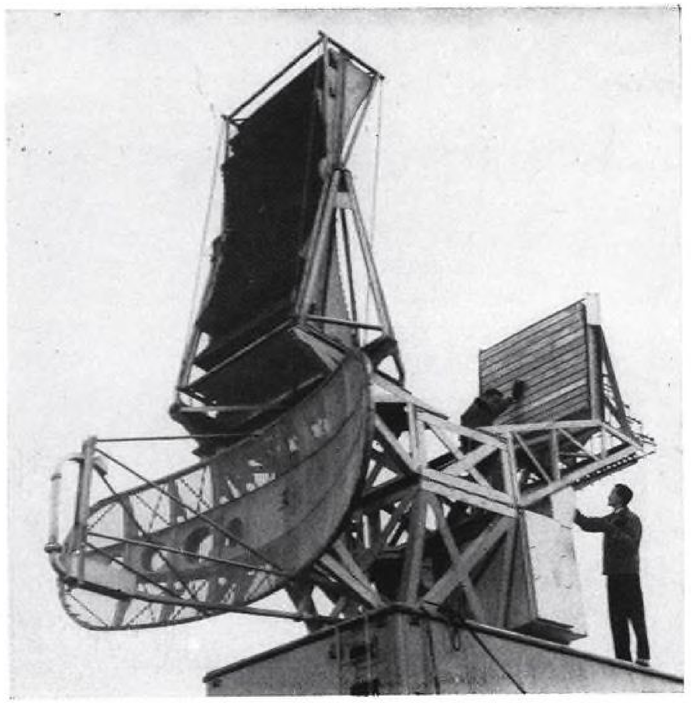
OSTUCO, makers of the first "Chrome-Moly" for aircraft, has continuously served the aircraft industry since its inception . . . and designers have consistently specified OSTUCO Tubing for fuel lines, landing gear, engine mounts, and other applications. Major reasons for its industry-wide preference are its uniform high quality, strength-without-weight, ease of machining, and exactness in forming and fabricating.

Your own requirements will be dependably met when you specify OSTUCO. Contact your nearest OSTUCO Sales Office or write us for a new informative catalog, "OSTUCO TUBING," and our latest A-2 Handbook.

OHIO SEAMLESS TUBE DIVISION
of Copperweld Steel Company
Manufacturers and Fabricators of Seamless and Electric Welded Steel Tubing
Plant and General Offices: SHELBY, OHIO

ostuco AIRCRAFT TUBING

SALES OFFICES: Birmingham, P. O. Box 2021 • Chicago, Civic Opera Bldg., 20 N. Wacker Dr. Cleveland, 1328 Citizens Bldg. • Dayton, 511 Salem Ave. • Detroit, 520 W. Eight Mile Road, Ferndale • Houston, P. O. Box 17007 • Los Angeles, Suite 300-170 So. Beverly Drive, Beverly Hills • Moline, 617 15th St. • New York, 70 East 45th St. • Philadelphia, 2004 Packard Bldg., 15th & Chestnut • Pittsburgh, 1206 Pinewood Drive • St. Louis, 1230 North Main St. • Seattle, 3104 Smith Tower • Syracuse, 2350 Bellevue Ave. • Tulsa, 245 Kennedy Bldg. • Wichita, 622 E. Third St. • *Canadian Representative:* Railway & Power Corp., Ltd.



AVIONICS IN THE AIR FORCE

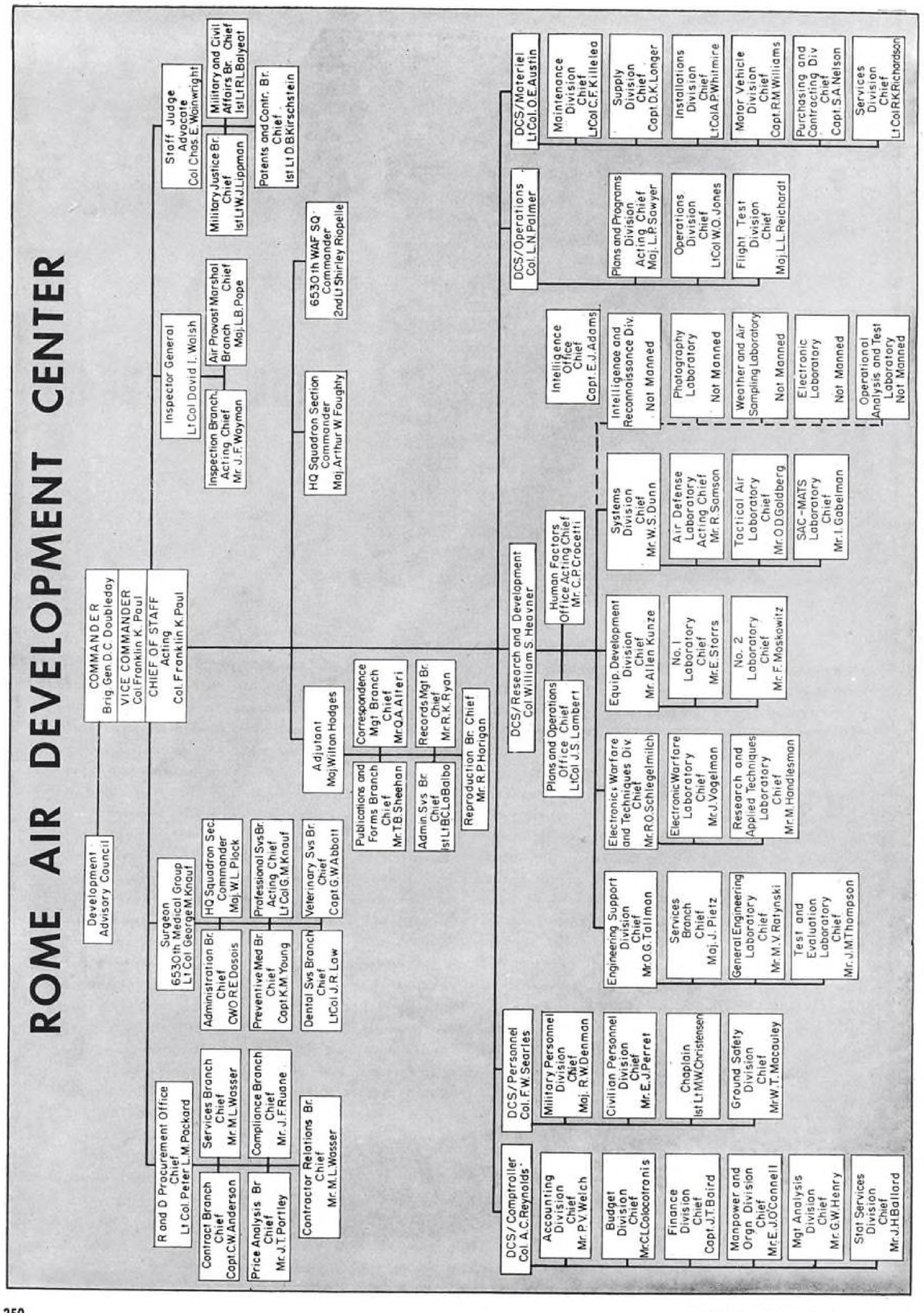
Avionics has altered the techniques of aerial warfare during the past decade and now promises to completely reshape the character, equipment and tactics of military air power during the next decade.

As a result, avionics—electricity and electronics in aviation—is one of the fastest-growing segments of the modern aviation industry. Firms well-established in aviation for decades are expanding to develop new capabilities and finding new tasks in avionics. Many new firms never before associated with aviation are becoming an important part of the industry through their technical contributions to avionics. Although the basic expansion program for the airframe, engine and accessory manufacturers for current military air power needs is reaching its peak, there is still an acute need for additional avionics resources, both in research and development and in production facilities. Already nearly half the total cost of a modern jet bomber can be accounted for by its avionics equipment.

Avionics now provides the radar eyes, the radio ears, the computer brains and the servo system muscles for individual aircraft and missiles. In addition to expanding and perfecting these roles, avionics is also destined to provide the central nervous system to knit together the many complex aerial weapons systems into the over-all super weapons system of military air power.

The Air Force's program in avionics handled through the Air Research and Development Command is the most important single force behind some of the major technological advances now being made in avionics.

Because of the growing importance of avionics and the key role in its technical progress played by the Air Research and Development Command, AVIATION WEEK presents this special report: "Avionics in the Air Force." This report was written by AVIATION WEEK'S Avionics Editor, Philip Klass, after a personal tour of all the major Air Force avionic research and development centers and personal interviews with the leading military and civilian technicians in this field.



Rome Guides AF Avionics Development

Ground-based avionics is RADC's broad assignment; new program aims at developing an integrated system for tactical air power

By Philip Klass

Rome, N. Y.—The Air Force has recently launched an important new program to develop an integrated avionic weapons system for tactical air power. The system will be specifically designed around Tactical Air Command's assigned mission of local combat area defense, interdiction, and ground support.

The responsibility for this significant new program has been assigned to the Rome Air Development Center here at Griffiss AFB under the command of Brig. Gen. Daniel C. Doubleday—AF's Cambridge Research Center and Wright Air Development Center support this effort.

► **Centralized Intelligence**—The system will be designed to provide a TAC field commander with centralized intelligence and control. Data on enemy disposition will be funneled automatically into this control point from far-flung mobile radar stations and processed in automatic computers.

The commander will analyze this digested intelligence and decide his strategy and tactics. Aircraft will then be directed from this central control point, possibly automatically via a radio data link (telemetering).

► **Logical Choice**—RADC, with its experience in ground and ground-air electronics, was a logical choice for this TAC control system assignment because the system will involve ground-based radars, communications, and automatic computers, all of which are right up RADC's alley. Also, TAC's local area air defense problem closely resembles the continental air defense problem on which RADC has been working for several years.

A recent top-level USAF decision merged RADC's air defense activities with those of the AF Cambridge Research Center and Project Lincoln, under the over-all supervision of Cambridge.

Many of the air defense system techniques can be applied to the TAC system although it must be designed to provide greater mobility for use in forward combat areas.

► **Airborne vs. Ground-Based**—The prevailing philosophy at RADC is that many navigation functions now performed by airborne equipment should be handled by ground-based avionic equipment. Airframe manufacturers, always glad to get weight out of their airplanes, are bound to applaud this philosophy, although there is another side to the argument which will be discussed elsewhere in this issue.

RADC says that the necessary techniques are now available to eliminate most of the airborne navigation and landing-aid equipment from future TAC aircraft. RADC intends to apply this philosophy to the fullest in its TAC system.

Rome Responsibility

Rome's broad assignment in the ARDC is to develop and/or guide the development (by outside contractors) of all Air Force ground-based avionic equipment—with several exceptions.

Thus RADC responsibility includes ground-based equipment for navigation, communication, direction-finding, missile guidance, electronic countermeasures and airborne IFF (identification, friend or foe).

► **Wide Range**—RADC's activities encompass a variety of equipment: from huge million-dollar radar stations for air defense to tiny UHF radio transmitter/receivers which a ground controller can pack on his back and use to direct ground-support aircraft from the front lines.

Last year RADC sponsored $18 million in outside avionic developments. During the same period, the Air Materiel Command purchased over half a billion dollars worth of production items in the ground-based avionic field.

► **Exceptions**—One partial exception to this broad statement of RADC responsibility is found in certain equipment used by two or more branches of the military service.

However, even here RADC is not completely relieved of responsibility.

The Air Force uses standard Signal Corps-developed HF gear for fixed ground stations, but the equipment is too heavy and bulky for some vehicular applications such as mobile controllers mounted in small jeeps. For these vehicular uses, RADC must provide suitable equipment. In the interest of standardization, RADC adapts small airborne HF equipment developed by Wright Air Development Center in Dayton for vehicular use.

► **Project Lincoln**—Another exception is found in the air defense program where overall system responsibility has been assigned to AFCRC.

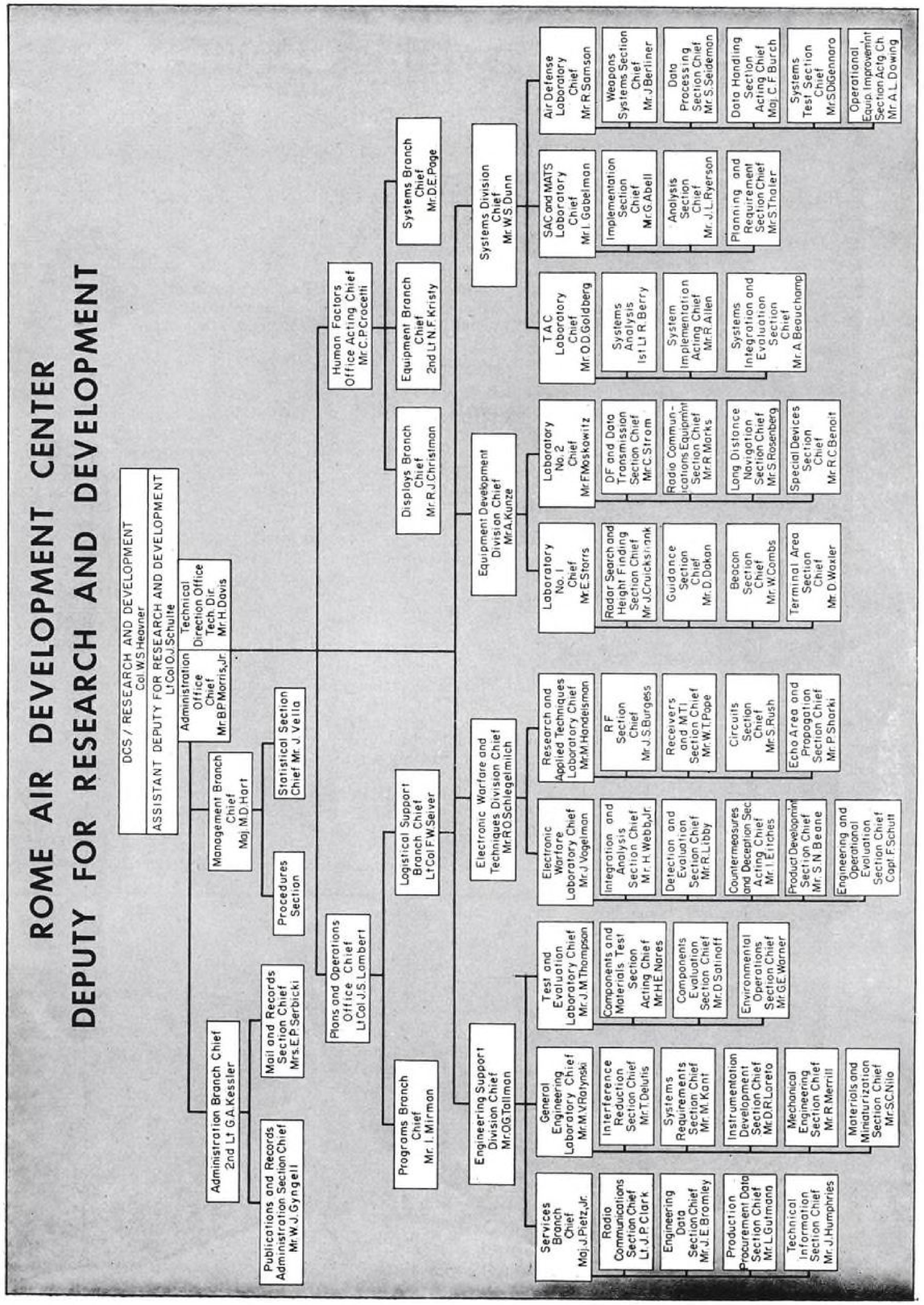
Production engineering of specialized equipment developed by Project Lincoln will in the future be sponsored by AFCRC, although some of it may be supported by RADC.

AF Experiment

Griffiss AFB at Rome represents an Air Force experiment in centralized operations.

Approximately two years ago the Air Force decided to move its Air Materiel Command functions (purchasing, sup-

Brig. Gen. Daniel Campbell Doubleday . . . commander, Rome Air Development Center . . . specialist in electronics and atomic weapons . . . born Johnstown, N. Y., 1905 . . . graduated U. S. Military Academy, 1929 . . . flew fighter in prewar pursuit squadrons . . . was chief of radio and radar section in AAF Hq. . . . served overseas as deputy communications officer of the Far East Air Forces . . . was postwar chief of scientific liaison section in AAF Hq. research and engineering division . . . director of R&D division of Armed Forces Special Weapons Project (atomic) . . . appointed deputy director of special weapons development at Sandia and later was chief of the development field command there.



at 30,000 feet over
Enemy Territory

-it's got to work!

Pilots of Republic F-84F Thunderstreaks Depend on Soreng Solenoid-Operated Valves to Change Fuel Tanks . . .

Mission accomplished . . . time to head home . . . fuel gauge reads "empty." The pilot flicks a switch . . . and a small valve takes over—cuts a full tank into the fuel line without interruption of flow.

Not just an ordinary valve—but a specially designed Soreng Solenoid-Operated Valve. Engineered to the exacting specifications of the Air Force for the famed F-84F Republic Thunderstreak. It's built to Soreng's own high standards—built to work, *without fail.*

Like all Soreng electrical components, Soreng solenoid-operated valves are custom-designed, custom-engineered and custom-built *at production line prices* in our own extensive plants. Here at Soreng—with more than a quarter century of experience—we have the engineering talent and research facilities to help you develop dependable electrical components for *your* product. Why not get all the facts—*now?*

SORENG PRODUCTS CORPORATION
9545 Soreng Ave., Schiller Park, Ill. (Chicago Suburb)

Eastern Representative
O. K. Gardner Company
8-219 General Motors Building
Detroit 2, Michigan

Western Representative
Burla Engineering Company
1124 North LaBrea Avenue
Los Angeles 36, California

PLANTS : SCHILLER PARK, ILLINOIS • FREMONT, OHIO • SPRING VALLEY, ILLINOIS

1903

Alcoa® Aluminum "took wings" with the Wright Brothers. Aluminum from The Pittsburgh Reduction Company (later to become Alcoa) was used in the crankcase and water jackets of their plane.

1927

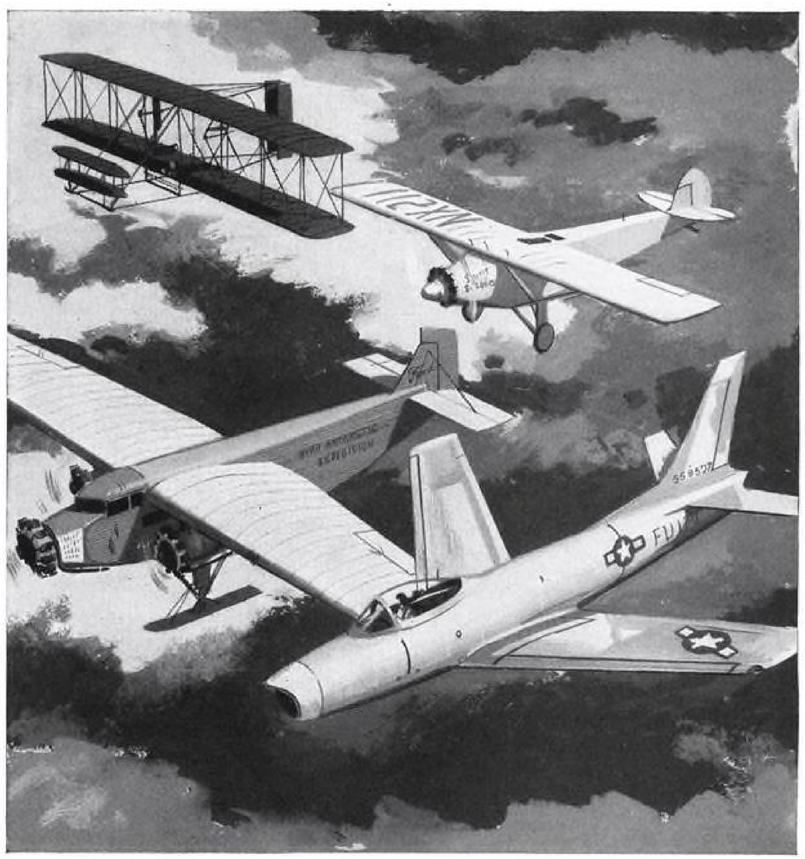
Alcoa Aluminum flew with Lindbergh to Le Bourget Airport—in the form of nose cowl, pistons, propeller, cylinder heads and crankcase of his famous "Spirit of St. Louis."

1929

Alcoa Aluminum helped conquer the bleak, white world of the antarctic with Admiral Byrd. On that eventful flight over the South Pole, Byrd's plane was built lighter, stronger with spars, bulkheads and skin of Alcoa Aluminum.

1952

Alcoa Aluminum sheet, plate, forgings, castings, extrusions and fasteners fly on every fighter sweep . . . every bombing mission in Korea. And as the growing aircraft industry has imposed new demands, Alcoa has met them with expanding facilities.



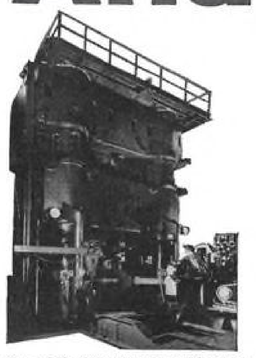
And Now

The new Alcoa-operated 14,000-ton *extrusion press* will produce larger extrusions, thinner and more intricate than ever before. Maximum extrusion size is increased from a 15-inch to a 23-inch circumscribing circle . . . and from 600 to 2,300 pounds per piece!

Removing residual strains and straightening extruded parts are accomplished with Alcoa's new 3,000,000-pound *stretcher*. The machine will be fully capable of handling pieces of metal up to 110 feet in length!

Complete airframe subassemblies are forged in a single unit on Alcoa's *forging presses* that have capacities of up to 15,000 tons!

If you'd like to know more about Alcoa's facilities, call your local Alcoa sales office. They have all the information and will be glad to sit down with you and discuss your problems . . . large or small. The number is listed under "Aluminum" in your telephone directory. Or write: ALUMINUM COMPANY OF AMERICA, 1800-H Alcoa Bldg., Pittsburgh 19, Pa.



One of the Alcoa-operated forging presses —and a part of the company's "big press program." Here, a 15,000-ton "squeeze" gives aircraft designers a new freedom in design concept.

Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA

■ ROME

ply, and maintenance) for ground-based avionics from Wright-Patterson AFB, Dayton, to Griffiss. For a little over a year now these AMC activities have been centered in the Rome AF Depot under the command of Col. M. F. Summerfelt.

►**Engineer "Midwives"**—There were many logical reasons for such a move. When an equipment has gone through its development phase, and the Air Force wants to put it in production, AMC must lean heavily on ARDC engineers. These men have lived with the project since its inception and thus can give AMC technical guidance in preparing equipment specifications.

Later the ARDC engineers may move into the contractor's factory to act as "midwives" until the first units have come off the line.

Still later, the ARDC engineers serve as consultants on major maintenance and field usage problems for the service life of the equipment.

General Doubleday sums up RADC's responsibilities: "We live with the equipment from the 'cradle to the grave.'"

History

The majority of RADC's technical personnel were members of Watson Laboratories, set up as a Signal Corps lab at Ft. Monmouth, N. J., during World War II to handle ground-based avionics for the then-Army Air Force.

After the war, Watson Labs were transferred to the newly formed USAF, and in the winter of 1950, this group was transferred to Griffiss AFB at Rome.

►**Congested Airways**—A major purpose in relocating the Watson operation was to get it away from the congestion of main airways in order to prevent experimental radar, communications, and flight test aircraft from interfering with commercial air traffic.

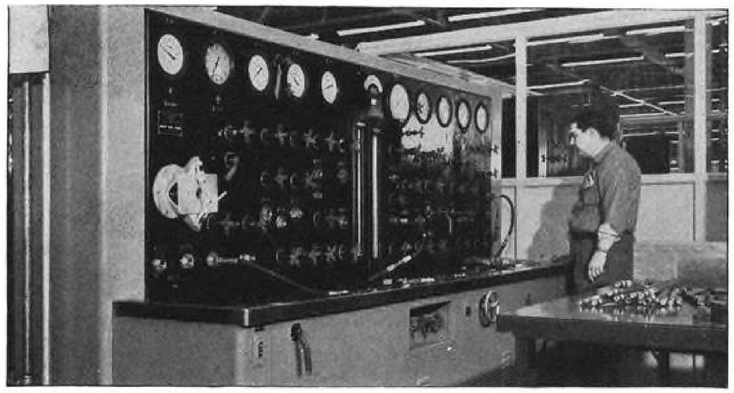
Griffiss AFB at Rome, which had been built in 1941 as an AF maintenance depot, met this off-the-way-airways requirement and was available. In 1950, GAFB was serving primarily as a storage facility.

►**Dissension in the Ranks**—When the move was first proposed in 1948, several groups of employes went to Rome to scout the area. When they returned they reported that the community compared unfavorably with their existing suburban living on the fringe of greater New York.

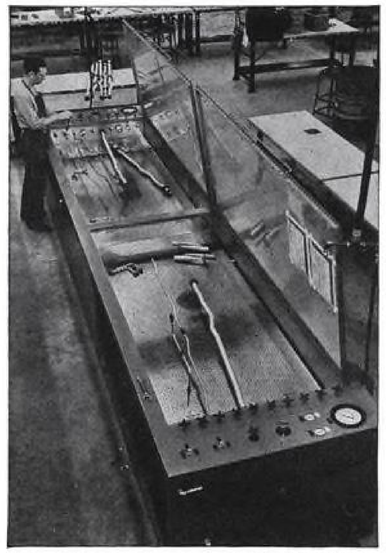
As a result of these reports, some of the employes organized to lobby against the move and raised enough opposition to block it temporarily. The invasion of Korea served to break this roadblock

GREER TOPICS

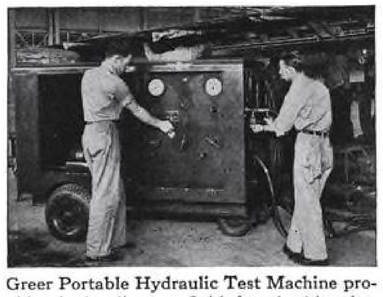
Important News of Aviation & Industrial Test Equipment



Greer Stationary Hydraulic Accessories Test Stand, shown here in Ford's Kansas City Aircraft plant, provides a shop type machine to fully check hydraulic system accessories including system pump at flow rates up to 20gpm and at pressures up to 3400psi.



Greer Dual Hose Tester, used for B-47 hose lines, checks from one to six hose lines or similar production components with pressures to 25,000psi in covered burst chamber.



Greer Portable Hydraulic Test Machine provides hydraulic test fluid for checking hydraulic systems of modern aircraft. Handles flows up to 20 gpm and pressures up to 3400psi.

How Greer Helps Ford

Greer Test Machines check complex B-47 components at Ford's Kansas City plant

This year is the fiftieth anniversary of the Ford Motor Company. Their entire history is one of quality products, economically produced. One of the reasons for Ford's extraordinary record has been its high standards of quality control.

To help maintain these high standards in the manufacture of aircraft components, Greer test equipment is at work in Ford's Kansas City aircraft plant. Complex B-47 components are put through rigorous inspection to determine their air-worthiness.

Walk into virtually any plant in the aircraft industry and you'll find Greer equipment at work. Most of the units are standard equipment ordered directly out of a catalog (yours on request). Other units were specially built to out-of-ordinary specifications by the famous Greer engineering department. These men are ready to go to work for you.

GREER TEST EQUIPMENT

Greer Hydraulics Inc. 454 Eighteenth Street, Brooklyn 15, New York

Field Offices: 1908 West Cermak Road, Chicago, Illinois • 25 South Main Street, Dayton, Ohio 2832 East Grand Boulevard, Detroit, Michigan • and sales representatives in all principal cities

■ ROME

and the move to Rome began in November 1950 and was completed by spring the following year.

When the chips were down, almost 75% of the technical and professional employes decided to move to Rome.

▶ **When in Rome**—After two years in this medium-size up-state community, conversations with RADC personnel give the impression that many now would be reluctant to return to Ft. Monmouth. Rome is only a few minutes drive from many lakes and the Adirondack Mountains.

A local chapter of the Institute of Radio Engineers has been formed, and the University of Syracuse sends professors to Rome to conduct classes for advanced degrees.

RADC people are becoming active in local community and civic affairs.

Personnel

Today there are approximately 7,500 military and civilian personnel stationed at Griffiss, of whom roughly 4,000 are assigned to RADC. The remainder belong to such tenant organizations as the AMC depot and the 27th Fighter Squadron (flying F-86s) of the Air Defense Command.

Col. Franklin Paul
Vice-Commander

There are approximately 800 civilians and 100 military personnel who are directly involved in RADC's technical mission. under the command of Col. W. S. Heavner, Deputy for Research and Development. The rest of the RADC manpower performs supporting functions and operates the base.

▶ **Technical Degrees**—A breakdown of the 900 people under Col. Heavner shows there are about 300 civilian engineers and scientists, and 60 officers, most of whom have degrees in engineering or science.

Col. Heavner himself has a master's degree in electrical engineering and in management.

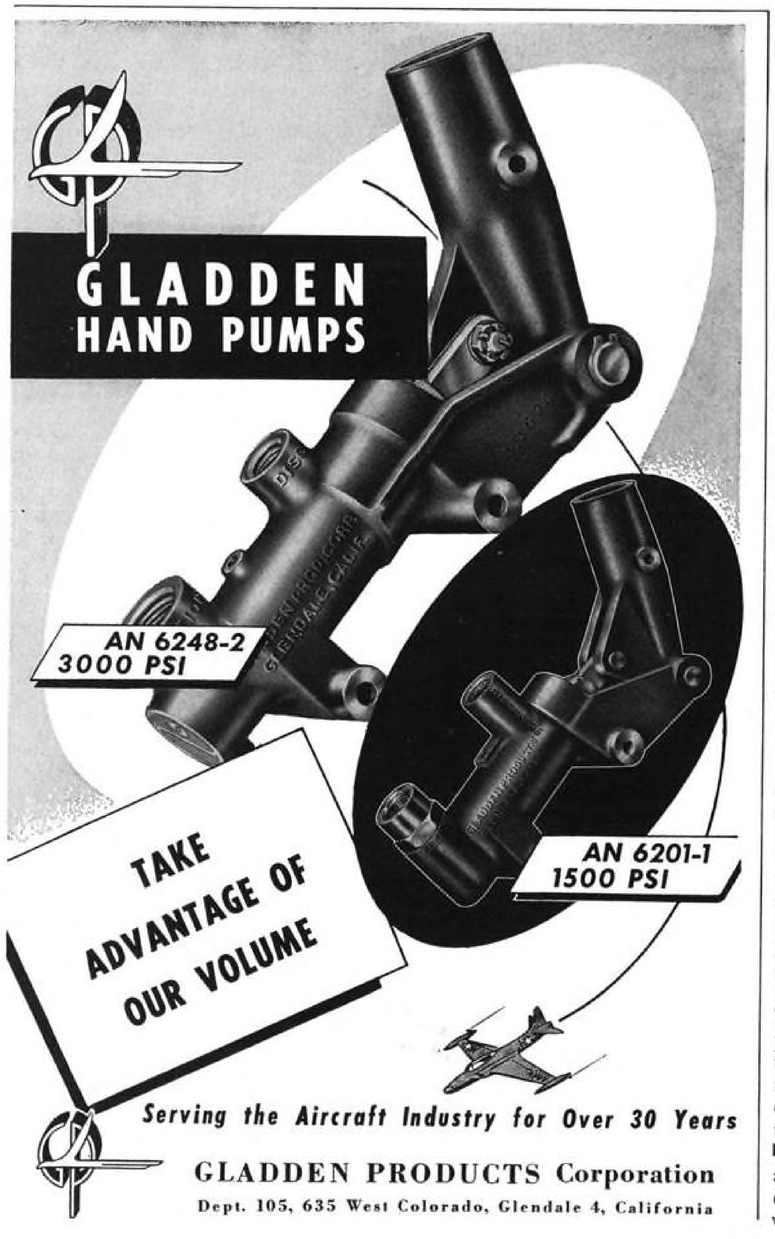
Lt. Col. O. J. Schulte, assistant deputy, has a B.S. in E.E. The civilian technical director of R & D is Harry Davis whose record shows a B.S. in physics and an M.S. in electrical engineering.

RADC Activities

RADC's technical manpower is applied to three major types of activities in approximately the following proportions:

- 50%: Guidance of developments of outside contractors and analysis of the results of outside study contracts.
- 12%: In-the-house development of new ideas and techniques to establish their merit.
- 38%: Support of AMC procurement. This involves preparing specs, following pilot runs of new equipment at contractor's plant, introducing new equipment in the field, and helping to set up off-shore procurement in foreign countries.

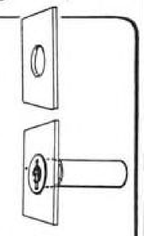
▶ **More in the House**—Although RADC acknowledges the need and importance of its AMC support and outside development guidance activities, its people



DILL LOK-SKRU
THE BLIND ANCHOR NUT OR/RIVET

ONE MAN INSTALLATION IN SECONDS

THE AVIATION STANDARD
for Screw Locking Anchor Nut Uses and Metal to Metal Fastening.



1 Drill one (1) hole.

2 Insert Lok-Skru with either Hand or Power Lok-Skru Tool.

3 With Lok-Skru Tool draw barrel over shoulder of Lok-Skru and flush with metal. This provides a Blind Anchor Nut for Secondary Attachments.

4 TO FASTEN ATTACHMENTS insert standard Machine Screw through hole in attachment and into Lok-Skru. As machine screw is tightened into Lok-Skru it is securely locked by means of the "Specially Crimped" locking-end of the Lok-Skru.

Crimped internal threads of Lok-Skru provide secure locking device for attachment screw.

Write for Folder
Handy information on the many uses and application of Lok-Skrus in airplane construction with complete data on types and sizes.

THE **DILL** MANUFACTURING CO.

FACTORY
700 East 82nd St.
Cleveland 3, Ohio

BRANCH
1011 S. Flower St.
Los Angeles 15, Calif.

■ ROME

wish they could do more in-the-house development. For one thing, RADC recognizes that such development is necessary to maintain the technical competence of its personnel.

Unless RADC (and other ARDC centers) engineers have a first-hand knowledge of new technical developments and techniques in the fast-moving avionic field, they can't do the best possible job of guiding developments by outside contractors.

Another equally important justification is that RADC engineers can try certain new ideas on a "haywired breadboard" basis in their own labs in less time and at less cost than if the work were contracted out.

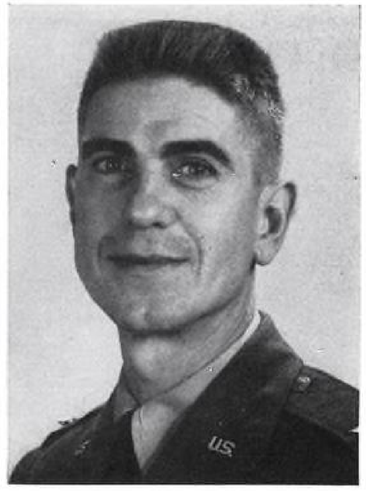
▶ **Convincing "Doubting Thomases"**—Davis points out that in-house developments can be used to convince doubting contractors that it is possible to meet RADC requirements or that an idea is feasible. As an example, Davis cites a tracking computer which originally used 125 vacuum tubes.

Despite RADC's urging that the device could and should be redesigned to reduce the number of vacuum tubes (and thus its size, weight and complexity), the manufacturer was unconvinced. So RADC engineers stepped in and redesigned the computer themselves and now it requires only 15 tubes.

▶ **One Big Workbench**—The very nature of RADC's radar and radio work demands that much of its laboratory experiments be performed out-of-doors. RADC now has 11 test sites located around its 2,500-acre base and another eight sites off-base—two of these are located more than 1,000 mi. away.

All of the on-base sites are supplied with base power and communications, and major sites are interconnected with coaxial cable to permit remote transmission of radar/microwave signals.

"The whole base is a great big workbench," Gen. Doubleday says.



Col. William Heavner
Deputy for R&D

Off-Base Sites

Most of the outdoor sites had to be carefully selected for their topographical layout and/or location, as well as their technical characteristics, such as being free from man-made static. For example, the 1,200-ft.-high radio tower which RADC constructed for low-frequency, long-range navigation work, presents an obvious hazard to low-flying aircraft and so is located at Forestport, N. Y., some 40 miles northeast of the air base.

RADC needed a unique site to check the radiation patterns of radar and radio antennas without picking up stray reflections from the ground. They found an ideal spot about 20 miles east at Newport, N. Y. The transmitting antenna under test is placed on one high cliff and the receiving antenna on another. The intervening gully prevents ground reflections.

▶ **Other Off-Base Sites**—In addition to the Forestport and Newport facilities, RADC operates the following off-base sites:

- **Floyd, N. Y.:** An unobstructed "static free" location approximately three miles east of GAFB used to check direction-finding and communications equipment.
- **Verona, N. Y.:** Primarily a ground radar test site 12 miles southwest of GAFB, which is used for TAC weapons system and electronic countermeasures studies.
- **Jervis Ave. (Rome):** An omnirange and short-range navigation test facility located about two miles west of GAFB.
- **Adamston, N. J.:** A long-range, low-frequency navigation test facility.
- **Carrabelle, Fla., and Cape Fear, N. C.:** Test sites for navigation system studies.

Environment Chambers

When new environmental test chambers now under construction are completed this year, RADC will be able to drive a large trailer, housing a mobile radar or other avionic equipment, into a test cell and run the temperature down to −70F or up to 190F, under humidities of 10% to 95%. This 16 x 32 x 17-ft. temperature-humidity room will have a volume of approximately 8,750 cu. ft.

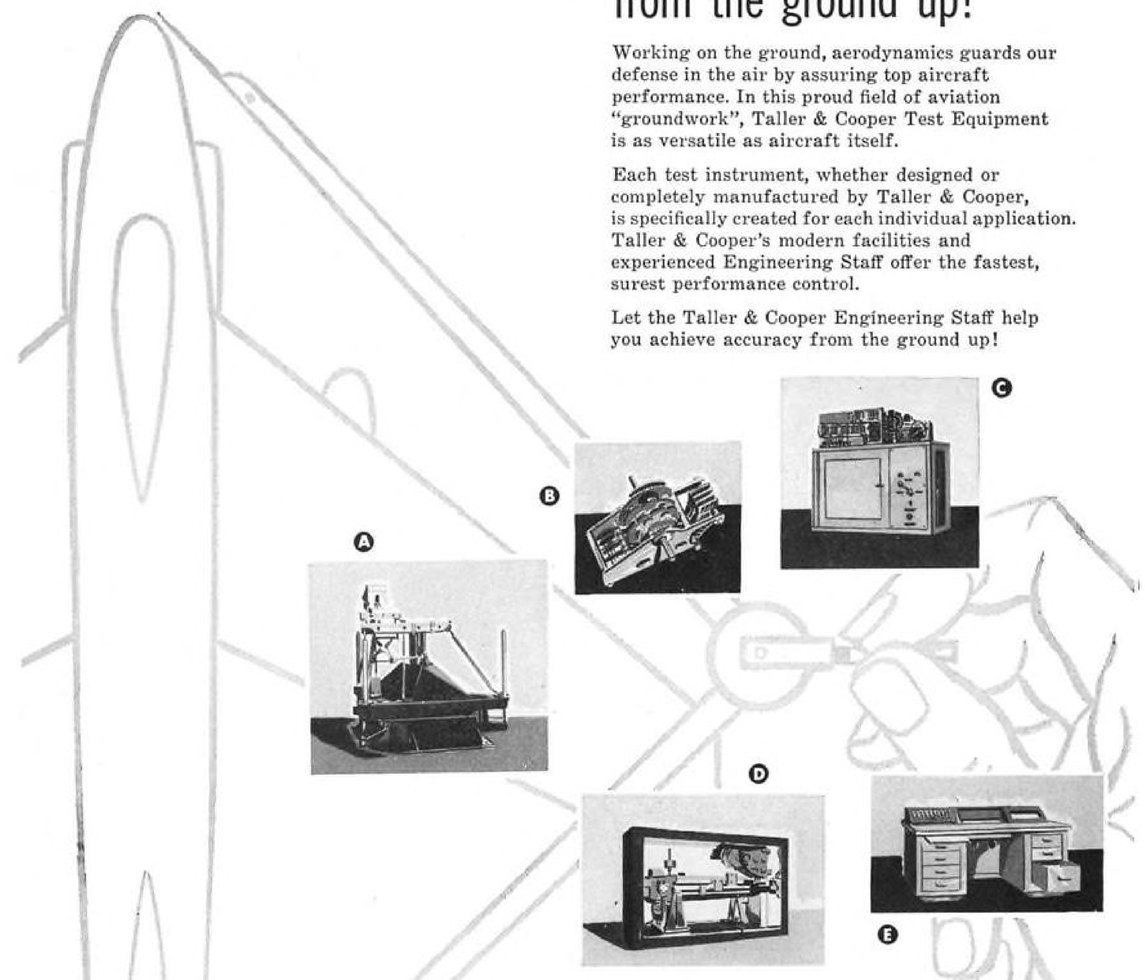
▶ **Hot and Cold**—Eight other large walk-in type chambers are under construction in the same building, formerly used as a test cell for aircraft engines. These include four arctic rooms and four tropic rooms, varying in size from 400 to 1,200 cu. ft.

aircraft performance measured and evaluated from the ground up!

Working on the ground, aerodynamics guards our defense in the air by assuring top aircraft performance. In this proud field of aviation "groundwork", Taller & Cooper Test Equipment is as versatile as aircraft itself.

Each test instrument, whether designed or completely manufactured by Taller & Cooper, is specifically created for each individual application. Taller & Cooper's modern facilities and experienced Engineering Staff offer the fastest, surest performance control.

Let the Taller & Cooper Engineering Staff help you achieve accuracy from the ground up!



A WIND TUNNEL BALANCES
SUBSONIC • TRANSONIC • SUPERSONIC
PRECISION-AUTOMATIC-ELECTRIC-REMOTE

B DIGITAL CONVERTER

C PRECISION DYNAMOMETER TORQUE & THRUST MEASURING AND RECORDING EQUIPMENT

D INDICATING AND RECORDING SCALES
FOR STATIC W. T. PRESSURES
DIFFERENTIAL W. T. PRESSURES
MACH METER, TORQUE, THRUST, FORCES, MOMENTS

E REMOTE PRINTING DATA RECORDERS
FOR FORCES, MOMENTS, TEMPERATURES, PRESSURES, PHYSICAL QUANTITIES, ELECTRICAL QUANTITIES

WRITE TODAY for complete information

TALLER & COOPER, INC.
ENGINEERS • MANUFACTURERS
64 WASHINGTON ST. • BROOKLYN 3, N. Y.

■ ROME

The tropic chambers will provide temperatures of 34F to 190F and humidities of 10% to 95%, except for one which can create 100% humidity conditions (rain).

The four arctic rooms can be operated at temperatures of —70F to 72F, and one of them can also provide simulated altitudes up to 70,000 ft.

▶ **Explaining the Altitude Chamber**—An altitude chamber may seem like an unnecessary addition at a center devoted to ground-based avionics, but there's a logical explanation. Much of RADC's ground-based equipment must be capable of being transported by air and thus must be able to withstand exposure to high altitudes.

Current AF ground-based avionic equipment specs call for withstanding exposure at 60,000-ft. altitudes, although this is considerably beyond the normal cruising altitudes of existing AF transports.

There is still another altitude factor to consider. Ground-based equipment may be used on terrain many thousands of feet above sea level, and so must be capable of operation "at altitude."

▶ **Chamber Facilities**—Test chamber temperature and/or altitude conditions will be capable of being programmed in advance to give any desired cycle of environmental conditions.

Lt. Col. O. J. Schulte
Asst. Deputy for R&D

Observation rooms adjoining the chambers will enable engineers to observe the equipment under test. These rooms are air conditioned so that test equipment can be operated under controlled conditions.

Many types of power are available in the test chambers to accommodate a variety of equipment. Supply voltages and their frequencies can be adjusted over a range of 10-20% to check equipment operation under low- and high-voltage and frequency conditions. In addition to 28-v. d.c. power, 120/208-v. a.c. power will be supplied at 400 cps., 120 cps., 60 cps., and 25 cps.

Harry Davis
Technical Director

APPLICATIONS UNLIMITED

Klincher LOCKNUT

. . . Wherever High Frequency Vibration, Tensile Strength and Re-usability Are Factors

There's no end to the fastening problems engineers are solving with Klincher Locknuts . . . in the aviation, automotive, electronics and other fields. Designed to reduce high stress concentration and torsional load common in first two or three threads, Klincher Locknuts distribute the load to more threads. Result: you take advantage of all the strength designed in your bolt, stud or axle shaft.

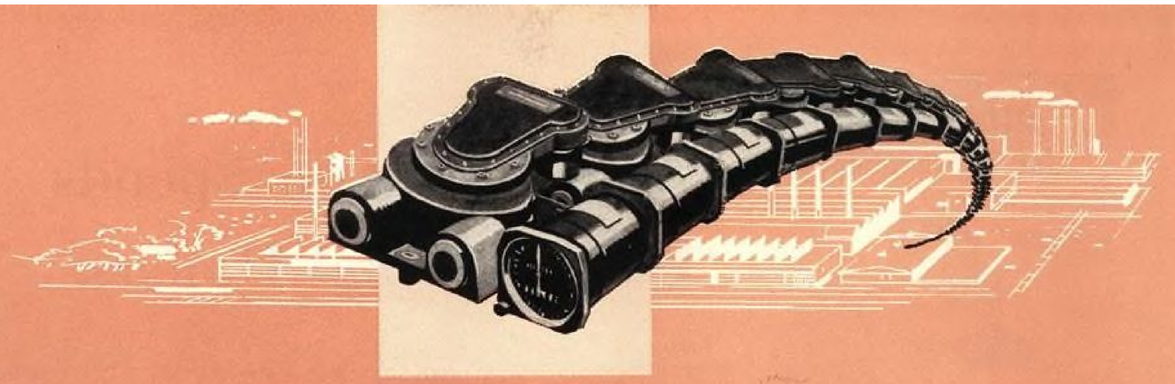
KLINCHER ADVANTAGES

Withstands temperatures to 1600° F.
Easy to inspect for positive assurance of tight connection.
Free running feature reduces assembly time.
Only one piece to stock and handle.
Ideal for hand and power wrenches.
Manufactured in stainless and other materials, in machine screw sizes No. 4 and up, and all fractional sizes.

UNLOCKED ...BEFORE TORQUE
LOCKED ...AFTER TORQUE
Free Running
Prevailing Torque
Shank Nut
Weld or Rivet
Free Running
Gang Channel
National Fine and National Coarse Threads.

Klincher LOCKNUT CORPORATION
2153 HILLSIDE AVE.
INDIANAPOLIS, INDIANA

Write for data and experimental samples, giving size and application. Address Dept. AW-8-3.



Where Flowmeters Are Concerned...

Eclipse-Pioneer gravimetric fuel flowmeter systems are standard on all military aircraft and on 80% of all commercial planes. There are two solid reasons for this overwhelming preference. First, Eclipse-Pioneer flowmeters measure consumption in terms of pounds—the basic reference of fuel energy. This means the readings on the panel-mounted indicator may be used direct without the necessity of calculating and applying corrections for specific gravity changes as in a volumetric system. Second, the accuracy of Eclipse-Pioneer flowmeters is safeguarded by the most extensive, most precise test facilities in the industry—facilities which include specially-built calibration stands capable of testing flowmeter accuracy *to within 3 ounces per 100 lbs. of fuel.* Eclipse-Pioneer flowmeters are available for single- or multi-engine aircraft . . . reciprocating or jet . . . for on-board consumption or in-flight refueling purposes, and in capacities ranging all the way from 30 P.P.H. to 360,000 P.P.H. Where flowmeters are concerned, Eclipse-Pioneer stands alone. That's because only Eclipse-Pioneer has the quantity and quality of facilities to build the types of flowmeters demanded by the industry.

PRECISION PRODUCTS* MADE BY ECLIPSE-PIONEER

Automatic Pilot and Flight Path Control Equipment
Airplane and Engine Instruments
Flight and Navigation Instruments
Power Supply Equipment
Air Pressurization and Ice Elimination Equipment
Engine Starting Equipment
Oxygen Equipment
Precision Components for Servomechanism and Computing Equipment
Sand, Permanent Mold and Die Castings of Magnesium and Aluminum
Plaster Mold Castings

*Manufacturing capacity is now available for a great many models of these products.

Eclipse-Pioneer
TETERBORO, NEW JERSEY • DIVISION OF Bendix AVIATION CORPORATION
Export Sales: Bendix International Division
205 East 42nd St., New York 17, N. Y.

World's Largest Producer of Aviation Instruments and Accessories

ALLEN AIRCRAFT
for dependability

SELF-LOCKING DRAIN VALVE
Straight or Pipe Threads

CHECK VALVE
Poppet Type

OXYGEN COUPLER
AN 6009-2A or -1B

PLAIN DROP TANK VALVE
Self Sealing, Right Angle Flow

Allen offers complete engineering, designing and production facilities for custom engineered Aircraft Valves. Write us for our latest CATALOGUE or contact one of our authorized representatives with your special requirements and specifications.

WEST COAST: The Thorson Co., Los Angeles, Calif.
SOUTHWEST: Adco Industries, Ft. Worth, Tex. and Tulsa, Okla.
MOUNTAIN: Fred Pease, Phoenix, Ariz. and Denver, Colo.
EAST: W. M. Hicks & J. A. Keeneth, Long Island City 1, N. Y.

Allen Aircraft Products, Inc.
Phone 7533
P. O. Box 29 Ravenna, Ohio

■ **ROME**

Avionics Team Spends Half a Billion Dollars

Rome, N. Y.—From a contractor's viewpoint, the location of both Air Research and Development Command and Air Materiel Command ground-based avionics functions here at Griffiss AFB means that "all roads lead to Rome."

In a single visit, a contractor interested in ground-based avionics can talk with Rome Air Development Center engineers, RADC procurement people, and/or AMC procurement, supply, and maintenance personnel.

▶ **Two Groups**—The two procurement groups at Griffiss are separate and distinct. One, under Lt. Col. P. L. M. Packard, is a part of RADC and buys only research and development. The other, under Lt. Col. J. M. Cryer, is a part of AMC and buys production versions of ground-based avionics equipment developed under RADC sponsorship.

In addition to its obvious convenience, the Griffiss AFB centralized arrangement makes it easy for a contractor to round up all persons involved in a knotty production problem to obtain a quick on-the-spot decision.

RADC Procurement

Last year approximately 125 prime contractors, including 25 colleges and universities, shared the $18 million in development and study contracts let by Rome Air Development Center, Packard told AVIATION WEEK. The typical R & D contract price is in the neighborhood of $50-100,000, although a few very large contracts would raise the average price to a slightly higher figure.

▶ **Industry and University**—Generally speaking, contracts that involve development (and delivery of prototype equipment) are awarded to industry while basic research and study contracts go to universities, although there are exceptions in both cases. The typical industrial R & D contractor has 100-1,000 employes, Packard says.

Asked about the types of contracts used for RADC procurements, Packard gave the following breakdown of last year's contracts:

- 51% Fixed price with redetermination.
- 11% Fixed price.
- 25% Cost plus fixed fee (CPFF).
- 13% Cost reimbursement.

The cost reimbursement type contract is similar to the CPFF type but involves no fee or profit to the contractor. This type is frequently used for basic research contracts with universities.

▶ **R & D Buying Philosophies**—All Rome Air Development Center research and development procurements are negotiated types (rather than bid types frequently used for less complex, standardized production items). In selecting contractors, RADC uses the following philosophies established by ARDC headquarters:

- **Basic research.** Technical evaluation of contractor's capabilities and know-how should override price considerations.
- **Development.** Technical evaluation plus business evaluation and production capabilities (where appropriate) should be major considerations.

Price should be of secondary importance in evaluating both research and development proposals.

Another guiding philosophy is that research procurement functions should be in the closest physical proximity to the RADC project engineer and the engineer should have full responsibility for the program.

To assist the engineer in carrying out this responsibility, the procurement office administers all R & D contracts it negotiates. This is designed to assure quick, efficient coordination among the three parties involved—the contractor, the project engineer and the contracting officer.

▶ **Contractor Relations**—Prospective new contractors interested in ground-based avionic R & D work may register at RADC's contractor relations branch, which will in turn arrange for conferences with RADC engineers in the contractor's field of activity. In this way a contractor can learn of RADC's present needs and projected programs.

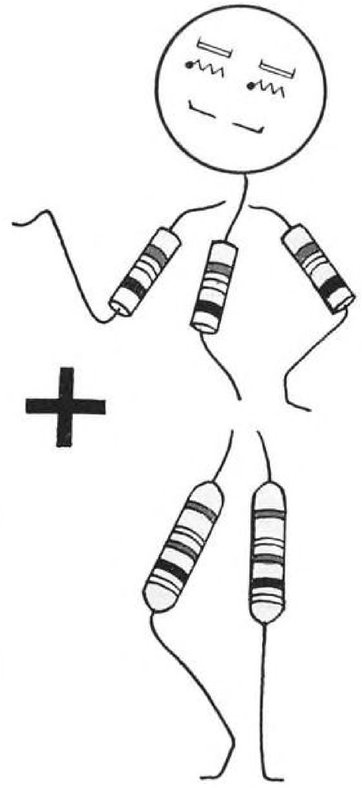
The list of registered contractors is cross-indexed according to their fields of interest. When a new R & D program comes up for procurement, the procurement office sends out Requests for Proposal (RFPs) to qualified contractors on its list.

Should a manufacturer fail to submit a proposal or to acknowledge receipt of three or four successive RFPs by writing to decline to submit a proposal, the

The **PERFECT** *Wedding*

TYPE 2003 FREQUENCY STANDARD

The Type 2003 contains, in addition to the tuning fork, all circuit components which are selected or critical.—The tube and remaining components — three resistors and two .01 capacitors — are external and can be laid out and integrated with your equipment.



TUNING FORK STANDARD, hermetically sealed.
SIZE — 4½ inches long. 1½ inches diameter.
SIMPLE EXTERNAL CIRCUIT, 1 tube, 3 resistors, 2 capacitors.
TUBE — Choice of 12AT7, 6201, 5751, 6BF7, 6BG7 or 6021.
POWER REQUIRED, 75 to 300 V at 1 to 5 m.a. — 6.3 V at 300 or 350 m.a.
AVAILABLE — in 400 or 500 cycles
ACCURACY guaranteed to .002%, 15° to 35° C.

Write for descriptive literature, specifying Type 2003.

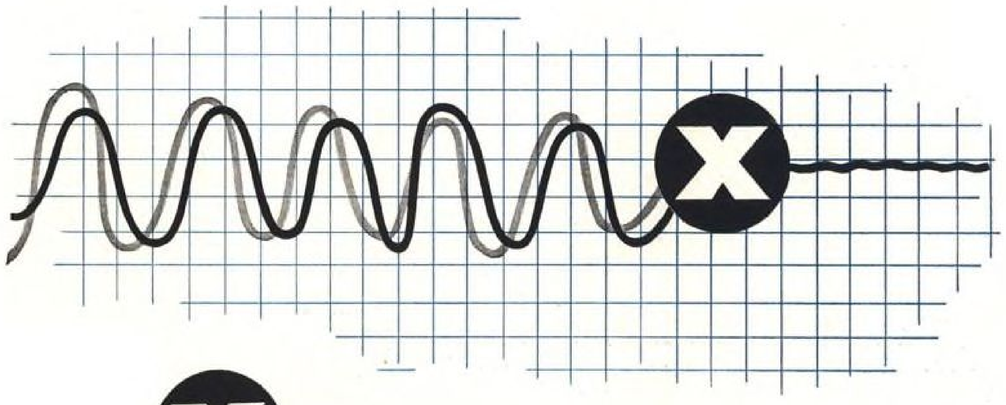
Also TYPE 2007
(4½" x 1½")
COMPLETELY SELF-CONTAINED INCLUDING VACUUM TUBE

Manufacturer of high precision frequency and timing instruments controlled by tuning fork oscillators.

American Time Products, Inc.
580 Fifth Avenue ***New York 36, N. Y.***

OPERATING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY

To CUSHION SHOCK



X IS WHERE WE CAN STOP YOUR GALLOPING ENERGY

If your design—your product—or your project—is endangered by vibration or uncontrolled impact, we can adapt our principle of oil-air shock absorbing to remove the unwanted force.

Whether you want to control the accelerating effect of multiple bounces which begin to coincide; or the landing of tons at high velocity; or continuous vibration—this is the realm for our impact-absorbing engineers.

The principle is applied now in every American aircraft landing gear. It has made Cleveland Pneumatic the world's largest manufacturer of aircraft shock absorbers.

Size doesn't matter. We can engineer shock absorbing, ton-size or pound-size, stopped to *precise industrial tolerances.*

Our free booklet gives enough description of our equipment and applications to show why we have become the world's largest engineers of this principle. Write for it.

CLEVELAND PNEUMATIC
TOOL COMPANY
DEPT. C-8 • CLEVELAND 5, OHIO
BALL-SCREW ACTUATORS AIR-OIL SHOCK ABSORBERS
AUTOMOTIVE SHOP EQUIPMENT

To MOVE with less EFFORT

Combining the screw with balls enables Cleveland Pneumatic's patented ball-screw actuator to drive with as little as 10% friction . . . compared to as much as 50% for ordinary screw drives. You can cut the weight of a drive system, reduce its space, lessen its cumbersomeness, increase its control accuracy and provide metal-to-metal positioning. Work out your ideas with our engineers.

WORLD'S LARGEST MANUFACTURER OF AIRCRAFT LANDING GEARS

■ ROME

procurement office usually contacts the contractor to see whether he still wants to remain on the RADC lists.

Normally a contractor is given 30 days to submit a proposal, and up to 60 days may be allowed if the program involved is extremely complex, Packard says.

► **Specification Conferences**—Upon receipt of the RFP and its associated exhibit (technical specification), contractors frequently send their representatives to Rome for discussions with RADC engineers. The purpose of such meetings is to get answers or an official interpretation to their questions on the specifications.

New techniques are being tried involving very complex equipment where all interested contractors are invited to attend a joint spec conference at RADC, according to Packard. Engineers from several companies go over the specs line by line with RADC engineers, asking questions and suggesting minor revisions. The latter are incorporated in a revised spec which goes out with the RFPs shortly afterward.

As a result of this preliminary conference, the prospective contractors are ready to go right to work on their proposals from a common starting point and with uniform interpretations when the RFP and revised spec arrived.

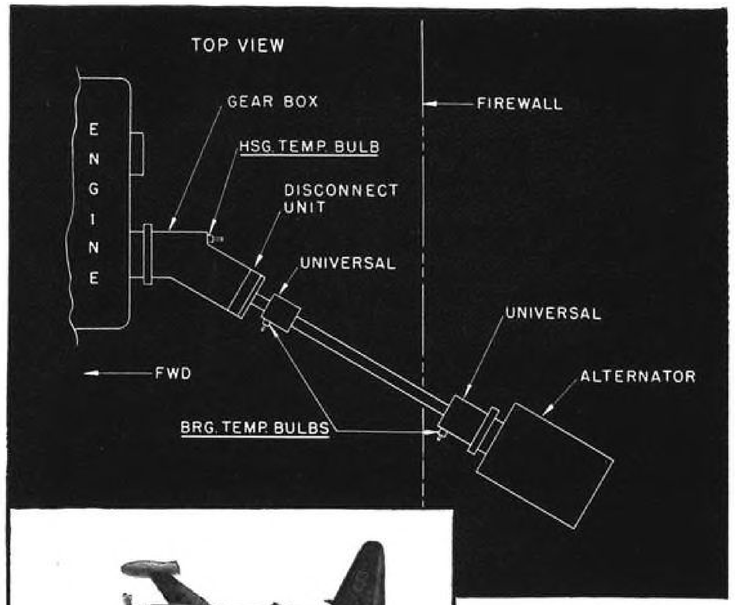
RADC Evaluation

"How do you evaluate these technical proposals?" AVIATION WEEK asked Packard. He indicated that the technical proposals, which have no pricing information in them, are submitted to the project engineer to be rated on the following points:

Lt. Col. P. L. M. Packard
Chief, R&D Procurement

Lockheed Neptune Gets New

Temperature Warning System



Newest version of the U. S. Navy's Neptune is this P2V-5, developed jointly by the Navy and Lockheed for use in anti-submarine warfare. Above shows a diagram of the points protected by the Edison alarm system.

A NEW EDISON Temperature Alarm System keeps its sensitive "fingers" on three spots in the alternator drive system. Should the temperature at any or all spots rise to 150°C, an alarm automatically signals in the flight compartment. The alternator drive system is so designed that it can be immediately disengaged before serious damage can happen.

THREE STANDARD resistance bulbs, a small control assembly (wgt. 1.5 lbs.), and a panel light make up the system. The bulbs are installed as shown in the diagram. Each bulb continuously "feels" the temperature at each point. When the temperature reaches its critical level, the alarm comes on, and, if the temperature returns to normal, automatically shuts off.

THE SYSTEM can be adapted to any number of circuits and still retains its basic simplicity. For information concerning specific applications, write to—

EDISON INSTRUMENTS
YOU CAN ALWAYS RELY ON EDISON

Thomas A Edison
INCORPORATED
Instrument Division
Dept. 49, West Orange, New Jersey

KOHLER
PRECISION CONTROLS
Aircraft · Industrial · Automotive

Airplanes of outstanding performance require equipment of outstanding quality. The Douglas Skyshark shown, first American attack type fighter to utilize turbine-propeller power successfully, has Kohler precision controls.

Kohler quality in precision valves and fittings is known and specified by leading manufacturers of jet engines, commercial, military and private aircraft. Facilities for aluminum forging and casting, machining, anodizing, cadmium plating and heat treating are all maintained in one Kohler plant—with a precision-skilled organization.

Call on us for your next requirements. Write for booklet.

Kohler Co., Kohler, Wisconsin. Established 1873

KOHLER OF KOHLER

PLUMBING FIXTURES • HEATING EQUIPMENT • ELECTRIC PLANTS
AIR-COOLED ENGINES • PRECISION CONTROLS

■ ROME

• **Feasibility of approach** proposed by the contractor.
• **Insight into problem,** as evidenced by contractor's proposal.
• **Previous experience** of contractor in this or related fields.
• **Contractor's reputation** in research and development. (Does he normally meet delivery dates? Specifications? Does he habitually ask for spec waivers after the program is under way?)
• **Effect of spec exceptions** (requested by contractor) on the end item.
• **Production capabilities** of the contractor in the event production is eventually planned and the developing contractor might be logical producer.

After rating each proposal on the six points cited above, the project engineer evaluates their over-all technical merit and rates them relatively, i.e., first, second, third, etc. There is no predetermined weighting factor for any of the six points. This will depend upon the RADC engineer's evaluation of their importance for the particular project.

▶ **Business Evaluation**—Meanwhile the procurement office has been analyzing the business aspects of each proposal, taking into account such things as price, type of contract requested, and the profit or fee percentages sought. The PO in turn ranks the proposals in order of overall business merit.

When both ratings are complete, the procurement office and project engineer sit down and compare results. If the best technical proposal is also the lowest priced, or nearly so, the decision is easy. Sometimes the comparison is more difficult because one contractor has made his proposal based on a CPFF type contract and another has based his on a fixed-price-with-redetermination type contract.

▶ **Hard Choice**—In this case, if the race is close, the PO may ask each contractor to submit a new financial proposal based on the other type of contract—to put the comparison over a common denominator.

Packard says that his office is considering steps to broaden the base of technical assessment of RADC proposals by seeking evaluation by the responsible section, laboratory, and division chiefs as well as the project engineer.

AMC Procurement

Processing of a purchase request for ground-based avionic equipment which used to take 30-60 days has been cut to 7-10 days since AMC moved its procurement, supply, and maintenance functions to Rome, according to Col. M. F. Summerfelt, commander of the Rome AF Depot.

He attributes the speedup to new contract-paper routing techniques that

Need low starting friction and long bearing life?

here's how leading manufacturers of business machines get them with **NEEDLE BEARINGS**

Torrington Needle Bearings are essential design features of many business machines because of their low starting and running friction, their long trouble-free service.

They have been *performance-proved* by years of day-in and day-out service on such machines as electric typewriters, addressing and duplicating machines, accounting machines, rotary card file systems, etc.

On the conveyor rolls, sprockets, gears, tape and feed roll shafts of duplicators, for example, Needle Bearings help reduce power requirements and keep motor size to a minimum. The Needle Bearing's turned-in outer lips effectively retain lubricants to keep these precision machines running for long periods without servicing.

The Torrington Needle Bearing has become "standard equipment" on countless products throughout industry since its introduction nearly twenty years ago. Its small size and infrequent lubrication needs are of great advantage in compact, tightly encased designs.

Perhaps the Needle Bearing can solve your anti-friction problems. Our engineers will be glad to work them out with you.

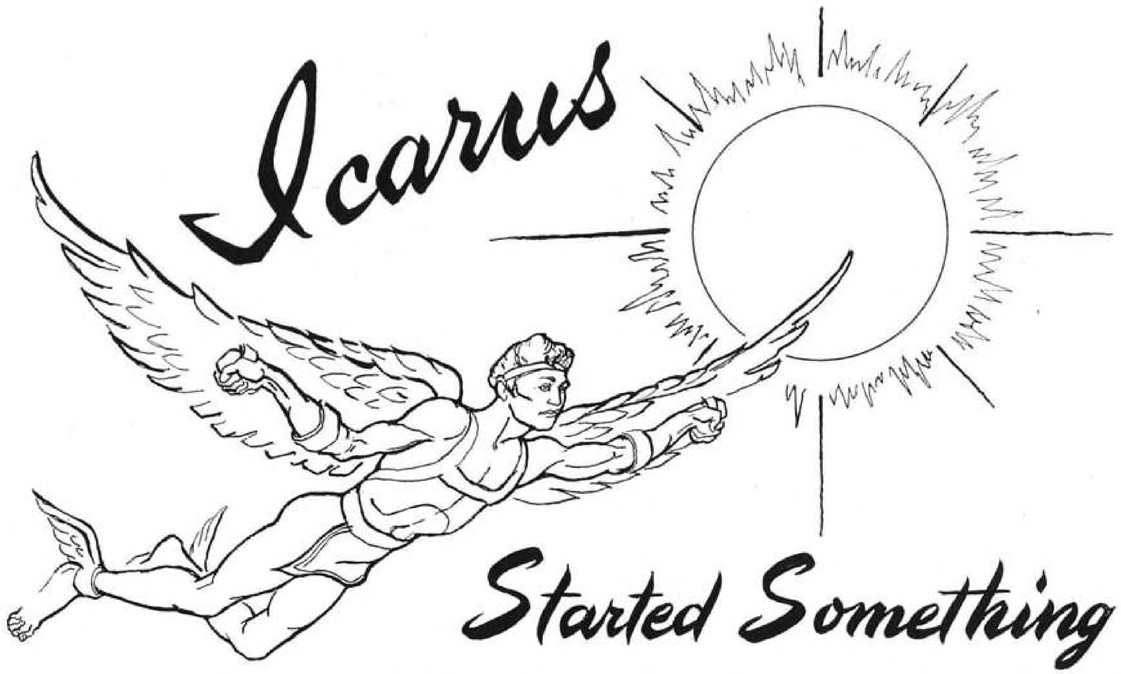
THE TORRINGTON COMPANY
Torrington, Conn., South Bend 21, Ind.

TORRINGTON NEEDLE BEARINGS

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

Trade-marks of some of the business machine manufacturers whose products enjoy the benefits of Needle Bearings.

DITTO · IBM · UNDERWOOD · Remington Rand · PITNEY BOWES · Burroughs · Diebold · Addressograph-Multigraph · Cummins-Chicago Corp. · A·B·DICK DUPLICATING PRODUCTS · National



FBT-2 Basic Trainer

CQ-1 Target Control

PQ-11A Target Drone

FL-23 Experimental Liaison

Man has yearned to fly since the beginning. Each attempt has held its own lesson. Only by trial and proof did he learn the secret.

Icarus taught us one thing,—that if man were to fly his wings should be made of the best possible materials. Icarus according to Greek mythology, flew too near the sun and his wings melting, he fell into the sea.

The greatest strides in improved materials have been made since the wood and muslin days of the Wright Brothers.

Endless research and development have gone into the material from which today's fast flying planes are made.

Exemplifying two stages in the development of usable materials is the 1939 Fletcher FBT-2 of plywood construction as compared to the present day Fletcher FD-25 all magnesium airplane.

Fletcher Aviation is proud of the contributions it has been enabled to make in the research and development of better materials for Aircraft manufacture.

FD-25 Ground Support Tank Buster

FLETCHER
AVIATION CORPORATION
PASADENA, CALIFORNIA

AMERICA'S FOREMOST PRODUCER OF JETTISONABLE FUEL TANKS

■ ROME

are possible in a smaller tightly knit operation and to the close proximity (two minutes walk) of RADC engineers.

Prior to the move from Dayton about a year ago, RAFD was a small supply depot handling three classes of material. Today the Rome Depot stocks 12 classes. Summerfelt compares the task of expanding the previous Rome Depot to the problem of "converting a country store into a supermarket."

Only about half of the present 2,200-man Rome Depot staff made the move from Dayton. The rest had to be recruited locally and trained, a big job according to Summerfelt.

RAFD Job

Rome AF Depot has the triple responsibility of procurement, supply, and maintenance for ground-based electronics, certain electrical items like lights and cable, and photo supplies. A breakdown of RAFD personnel shows approximately 150 in procurement, 500 in maintenance, and 1,500 in supply.

▶ **Half a Billion**—Last year RAFD purchased approximately $540-million worth of production equipment and items from about 500 prime contractors. The majority of these contracts were fixed price, although some of the larger ones included provisions for price redetermination, Summerfelt says. RAFD's contractor relations office lists about 3,100 prospective contractors.

The Rome Depot pushes competitive bidding wherever possible, but the complex nature of some of the avionic equipment it buys restricts this objective, Summerfelt admits.

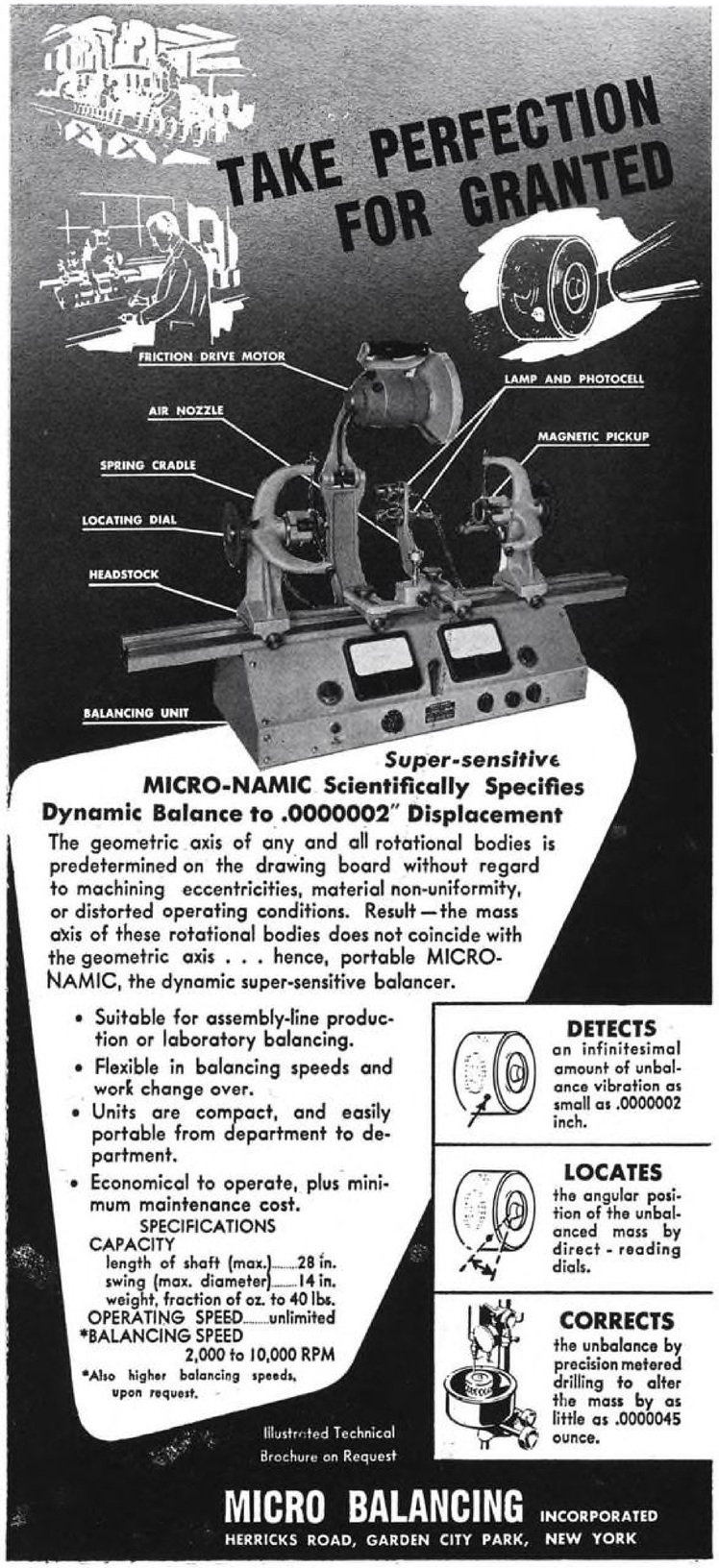
Last year approximately 85 RAFD contracts were let on the basis of Invitations for Bid (IFB) and approximately 1,200 were awarded on the basis of Requests for Proposal (RFP) or Requests for Quotation (RFQ).

Maintenance Engineering

RAFD's directorate of maintenance engineering has the responsibility for directing equipment overhaul shops, located at Rome and monitoring the overhaul of similar items at other AMC depots.

Presently, studies are underway to determine the feasibility of absorbing a larger workload here.

▶ **Other Responsibilities**—In addition, maintenance engineering has the responsibility for engineering review of communications and radar installations, on a worldwide basis; preparation of handbooks (operation, maintenance, and spare parts catalogues), and the handling of unsatisfactory reports (URs) on equipment failures in the



(*Advertisement*)

Valve Talk

for WM. R. WHITTAKER CO., Ltd.

by Marvin Miles,
Senior Member, Aviation Writers Assn.

"The Air Research and Development Command does an outstanding job..."

Dell Phillips spoke slowly and emphatically, then added:

"We couldn't function without their continuous help. They keep our thinking straight. The concepts of aircraft can change so rapidly — supplier development phases can gain or lose importance so quickly — that we must keep in close touch or we might sneeze and miss something."

A Whittaker vice-president, the tall, matter-of-fact engineer is the company's idea man. His spotless lab, filled with watch-like intricacies, is called the "Dream Room" and represents the company's own research and development command.

Here, through the medium of humming machines and precision work, the Phillips ingenuity is transformed into actuality, abetted by a select crew of technicians chosen not only for exceptional mechanical ability, but for what Dell calls "development perspective."

Usually there are half a dozen projects going on at once, developments conceived by Dell to meet specific needs in keeping with aircraft progress or to better existing units. Here, too, you're likely to see innovations that may change entire concepts in valve and related fields. And from these projects may come unanticipated developments, some born of necessity in furthering creation or test in the major lines of Dream Room work.

ARDC on a small scale

In a small way, Dell's lab is somewhat like ARDC. The Air Force command is exploring years ahead of the field, delving, testing, proving, charting a course for military aviation to follow in achieving performance with safety.

Performance with safety — these words characterize the ever-demanding goal of ARDC. Their daily routine probes the many challenges of flight, in streaking aircraft, in wind tunnels and laboratories, on drawing boards and in the minds of men with vision and courage.

Intrigued by the challenge and restless with ideas, Dell, himself, works far ahead of the field with quiet determination to turn out performance — and with it safety through dependability.

In his laboratory today, for instance, an amazing new fuel pump is under development, the result of his impatience with the cumbersome weight and inefficiency of standard types. Compact and revolutionary, it's already drawing widespread interest.

And from this project came a by-product in the form of a highly sensitive meter for measuring vapor/liquid ratio. Designed and created out of necessity to check the pump's performance, it's the only instrument of its kind and has been turned over to the Wright-Patterson engine division.

"Try to remedy it first"

Dell has the typical zeal of the inventor, combining curiosity and skill, patience and perception, with a sort of sixth sense in ideas. These he mixes with a philosophy that he shouldn't beef about a situation until he's tried to remedy it. That's why one of his current projects is to develop a bearing that will take high r.p.m. and extreme temperatures — without lubrication.

"For years we've been far too close to temperature maximums in bearings for hot air valves," he explained. "Why not find something that will give us ample leeway and eliminate lubrication? We're working on it . . . and it looks like we've got it."

The laconic 39-year-old engineer welcomes challenge, like the time when an Air Force engineer asked him if there was any possible way to split a flow stream evenly. Dell didn't know, but he was eager to try. After kicking the problem about in his mind for a time, he started by simply bolting a couple of standard water meters together. From this evolved Whittaker's current flow divider used on the Douglas C-124 oil system.

But Dream Room projects are not all successes — far from it. Dell is the first to admit his failures. He points to what he calls his "junk pile" representing ideas that haven't worked out.

"In a way it's a measure of how we're doing," he explains. "If we keep the ideas going, we're bound to hit now and then. No junk pile means no ideas. When we don't have a pile, I'll really start worrying."

■ ROME

field. When URs indicate a fundamental shortcoming in equipment design, maintenance engineering sets up a project to investigate the necessary "fix" with RADC engineers who in turn bring in the equipment manufacturer.

RAFD likes to contract out much of its overhaul work to the original equipment manufacturer.

In many cases, however, manufacturers find it difficult to gait their normal production-line operations to handle the sporadic overhaul work load, Summerfelt says. This is one reason why RAFD does some of its own overhaul work; another reason is that the Depot must have a capability of maintaining every type of equipment for which it is responsible. This also enables local engineers to examine equipment in detail.

Thus, RAFD has a "fire brigade" shop for what is required here or overseas.

Depot Supply

The RADF directorate of supply and service has the task of seeing to it that an adequate stock of ground-based avionic equipment is always on hand, as well as a sufficient quantity of the right spare parts to keep operating.

▶ **Guessing Right**—A bad guess on future Air Force needs could be disastrous. If you find yourself short of, say, a dozen radars, you don't go out and buy them off a dealer's shelf like TV sets. Lead time on big radar sets is currently running about 2-2½ years.

To establish a sound basis for its future procurement, the supply directorate examines:

- **Last year's usage.**
- **Present inventory.**
- **Repairable equipments on hand.**
- **Programmed AF size.**

If the equipment is new, and there is no previous experience to work from, Rome Depot seeks advice from RADC engineers and manufacturers.

This directorate also operates the warehouse at Rome and monitors the Western AF Depots in distribution of their prime classes of property. RAFD is currently building a $2-million warehouse and overhaul shop for avionic equipment at Rome. When completed next year, RAFD will have over two million sq. ft. of warehouse floor-space.

Everyone, both in Rome Air Development Center and Rome Air Force Depot (AMC) seems to like the integrated Griffiss AFB set-up.

The single mission at GAFB—developing, producing, and fielding the best possible ground-based avionics—produces a unity of purpose. The base is small enough for individuals to see how their efforts dovetail into the over-all operation. These are factors which produce good esprit de corps.

By testing motors "twenty miles up"— G.E. gives you more for your motor dollar

In this reinforced tank six feet long by eight feet wide G-E engineers watch motor performance at altitudes as high as 100,000 feet. Motor speed is checked by a stroboscope through a reinforced side window and a dynamometer inside the chamber acts as the motor load—as tank temperatures go as low as −80° C with controlled humidity.

In other similar tests your special problems of heat, cold, vibration, acceleration, etc., encountered in aircraft operation are detected and solved. Here, G-E engineers learn the facts about motor performance, resulting in better fhp motors for you.

Whatever your aircraft motor problem, remember that G-E engineers are equipped and ready to solve it. General Electric's Specialty Motor Sub-Dept. can design and build precisely the motor you need to meet your most demanding requirements . . . solve your toughest problems.

For more information or engineering assistance, contact your nearby G-E Apparatus Sales Office, General Electric Company, Schenectady 5, N. Y.

704-17

You can put your confidence in—

GENERAL ELECTRIC

MISSILE CONTROL
BY SUMMERS

DOWN GOES PRICE...
YET QUALITY REMAINS!

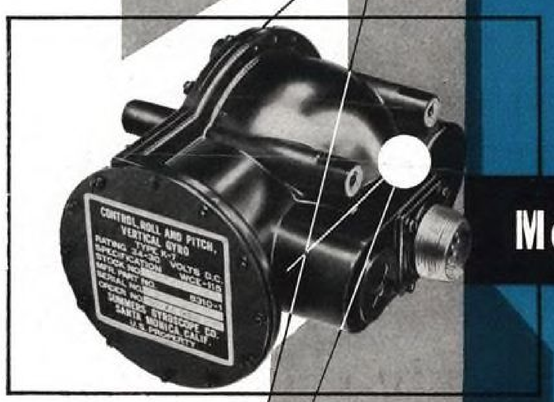
Volume production now overcomes
Cost and Delivery barriers
on high performance Gyroverticals

With Model 69, Summers now offers an accurate, responsive, lightweight, rugged gyrovertical—at a price heretofore unheard of. Model 69 is used to establish the basic reference element for aircraft and missile automatic control systems. It incorporates revolutionary Summers principles that are government proved and accepted. To read the specifications is to recognize the quality.

Model 69 is now in volume production in the Summers plants. Quantities of 200 or more shipped within 10 days; smaller quantities immediately. Write today to Department A-2.

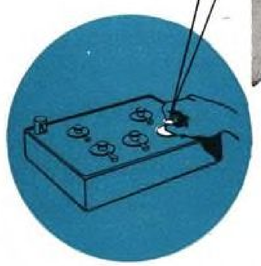
price $580* fob Factory

*in lots of 200. Slightly higher in smaller quantities. Prices firm to January, 1954.



Model 69 GYROVERTICAL

Meets MIL Spec E-5272
Power: 28 V DC
Two 2000 ohm Potentiometer Pickoffs
Avg. Running Current: 375 mils
Resolution: .12%
Gravity Erection: 1° of Vertical
Weight: 3¼ lbs.
Size: 5 13/32" long x 4½" dia.
Shock Resistance: 30 G's
Roll Axis Freedom: ± 80°
Pitch Axis Freedom: ± 60°
Erection Cutout: Optional



SUMMERS
GYROSCOPE COMPANY

2328 BROADWAY, SANTA MONICA, CALIF.

FIRST CLOSE-UP of K-System shows optical sight (center) and radar scope (left).

Ten Years for a Bombing System

In 1953, Gen. James H. Doolittle announced: "We have progressed in our bombsight development to the K-System, long a secret. It weighs 1,700 lb., contains 365 vacuum tubes, costs $200,000. It links automatic sighting with automatic navigation; permits highspeed bombing at night through the overcast with greater accuracy than former daylight methods at half the altitudes and speeds."

Here, for the first time, are photographs of the K-System, developed by Sperry Gyroscope Co. together with a date-by-date history of the birth of the bombing system used in our B-36s and B-47s. The chronology that follows shows that it takes almost 10 years to develop, design, get into production, and place a new complex avionic system in tactical use.

1942-43: Extensive use in World War II of three existing bombsights demonstrated their limitations for modern use.
- Missions sometimes return without ever finding the cloud-covered target.
- Even with fair visibility, camouflaged targets make recognition difficult.
- Straight and level bomb run of 30 seconds or longer is needed, making airplane vulnerable to air and ground fire.

1943: Sperry Gyro seeks entirely new concept, in close collaboration with Air Force. Forms special group to initiate "high-altitude bombing studies" and research—with Sperry funds. Studies point to need for completely automatic system, to eliminate complex human manipulations, with navigational computer as part of the system.

1944: Sperry reports findings and proposes an automatic bombing and navigation system to Air Materiel Command. AMC awards letter contract to Sperry for two experimental "K-Systems."

1945: Design and development underway on first prototype K-System. Complex electro-mechanical design indicates need to develop new manufacturing techniques.

1946: Detailed layout and bread-board stage, with last-minute design improvements to aid producibility.

1947: Engineering consultations on radar sighting with Bell Telephone labs; on optical components with Perkin-Elmer, Farrand Optical Co., and Massachusetts Institute of Technology. AMC awards Sperry a production contract to build 13 additional systems.

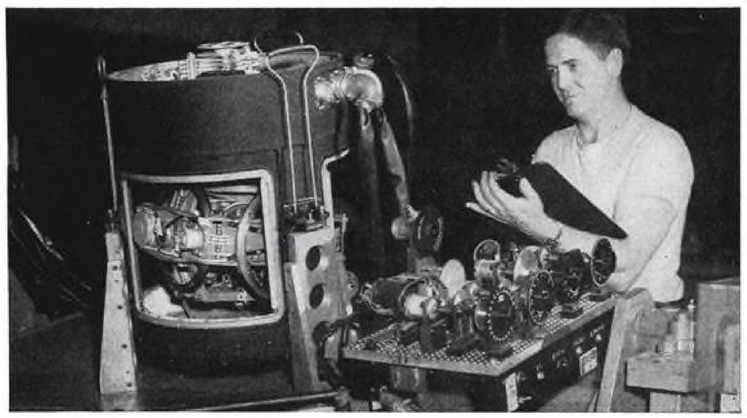
1948: First K-system installed in a B-29 and tested by Sperry engineers at MacArthur Field, L. I., dropping 100-lb. practice bombs. "Amazing precision" achieved, with a single operator functioning as navigator, radar man, and bombardier. This is followed by evaluation tests at Eglin AFB, Fla. Five preproduction K-systems sent to AMC.

1949: Improved system, incorporating polar navigation control for use at high latitudes, installed and tested in B-50. Polar navigation control performs very accurately. First 13 production systems delivered and AMC orders hundreds more. To broaden production base, Sperry assists AMC in setting up A. C. Spark Plug, National Cash Register, and International Business Machines, as well as General Mills and Eastman Kodak, on optical components.

1950: Accelerated service test on early production K-system in first B-36. Other B-36s, equipped with early K-systems, assigned to SAC 7th and 11th Bomb Wings at Carswell AFB, where operational shakedown shows need for certain improvements.

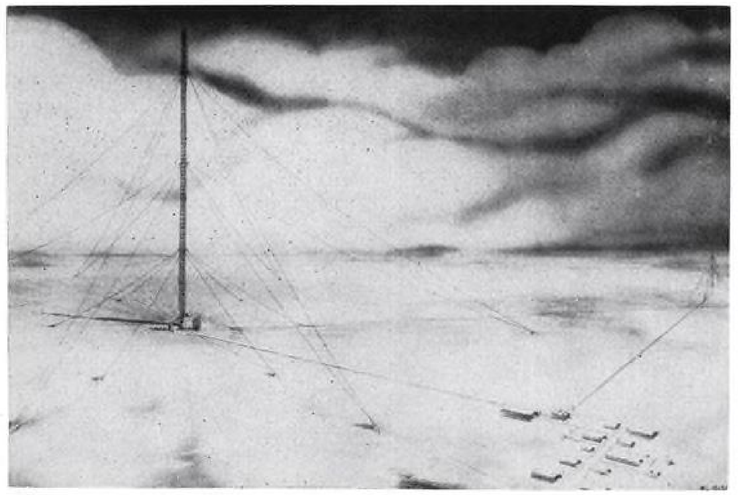
1952: More than 300 K-systems now installed in USAF aircraft.

1953: Air Force and Sperry finalize designs for a new, improved bombing system to succeed the K-series.



GYRO STABILIZER cancels out bomber pitch and roll motions in K-Series bombing system. It is shown undergoing calibration at Sperry Gyro factory.

POLAR NAVIGATION converter makes possible accurate world-wide navigation.



WIDE RANGE of RADC activities is evidenced by 1,200 ft. antenna, left, and tiny portable transceiver, right, used to instruct ground-support aircraft.

Rome Expands Role of Ground Avionics

RADC's advances will have a major impact on military air power, may soon spill over into civil air operations.

Rome, N. Y.—Important new and expanded roles for ground-based avionic equipment are being created here at the Rome Air Development Center which will have a major impact on military air power and could, within 10-15 years, have a similar effect on civil air operations and traffic control.

► **Landing Jets**—RADC is working on a major problem plaguing all of the Air Force's operating commands and one which will worry the airlines, on a somewhat milder scale, when they start flying jets.

The military problem is this: How do you schedule the orderly approach of dozens of jet aircraft, returning to their bases with near-empty fuel tanks, so that each plane arrives in position for its final approach at the proper time?

If you can save five minutes of low-altitude delay in landing, you give a jet fighter another 10-15 minutes in combat. Or if you can double the number of bombers which can be landed at one airfield in a given interval, you eliminate the expense and trouble of building additional runways and/or airdromes.

► **Return-to-Base Computer**—In cooperation with WADC and AFCRC, Rome is engaged in development of a return-to-base computer which instantly and continuously calculates the optimum flight path and arrival time for every aircraft within a suitable distance of an airdrome to assure a close and orderly sequence of arrival. The computer operates from data provided by ground-based radar giving information on the position, heading, speed, and altitude of every aircraft in the area.

Individual guidance instructions to bring each airplane in at its prescribed time will be transmitted automatically via radio telemetering equipment (data link) and will be displayed in the cockpit. These signals also can be fed to the plane's autopilot, enabling the ground station to maneuver each airplane automatically in the desired flight path.

This computer is only one portion of an overall automatic traffic control and landing system.

As planes are funneled into the final approach position, an automatic ground-controlled approach (AGCA) system will take over and give the pilot ILS-type cockpit guidance as well as aural talk-down instructions. Or the AGCA will control the plane's approach path via its autopilot approach coupler. (AGCA, developed by Gilfillan Bros., Inc., under RADC sponsorship, is currently going into pilot production.)

To provide completely automatic all-weather landings, RADC is also investigating a ground-based system to provide automatic flare-out and landing at the point where AGCA control terminates (normally 50-100 ft. from the ground).

► **TAC Weapons System**—RADC has recently taken on an even bigger assignment: to develop an integrated weapons system for the Tactical Air Command. TAC's tasks of interdiction and ground support pose serious problems which will require RADC to dig deeply into its bag of avionic tricks.

The TAC system will give RADC an opportunity to prove its basic philosophy that many navigation and guidance functions now performed by airborne avionics equipment can be better performed by ground-based avionics. RADC officials say their objective is to make a single airborne black box—a transmitter/receiver—to provide the pilot with all required guidance, navigation, communications, and landing information via a radio data link.

► **Sub-System Efforts**—A major portion of the R&D efforts at RADC go into ground-based sub-systems such as radars, computers, communications, and data links. These are the building blocks from which the "super-systems" are constructed. Approximately 80% of this R&D work is performed by outside contractors, under RADC guidance; the balance is done "in the house."

Broadly stated, these sub-system efforts are directed toward:

- **Improving performance** of existing techniques and equipments.
- **Developing new techniques and equipment** to meet present tactical needs.
- **Exploring new areas** to build up know-how to be able to meet future tactical needs quickly.

► **Range and Resolution**—In the first

Leadership Demands Constant Achievement

Lockheed's huge Marietta, Georgia, factory speeds output of U.S. aircraft

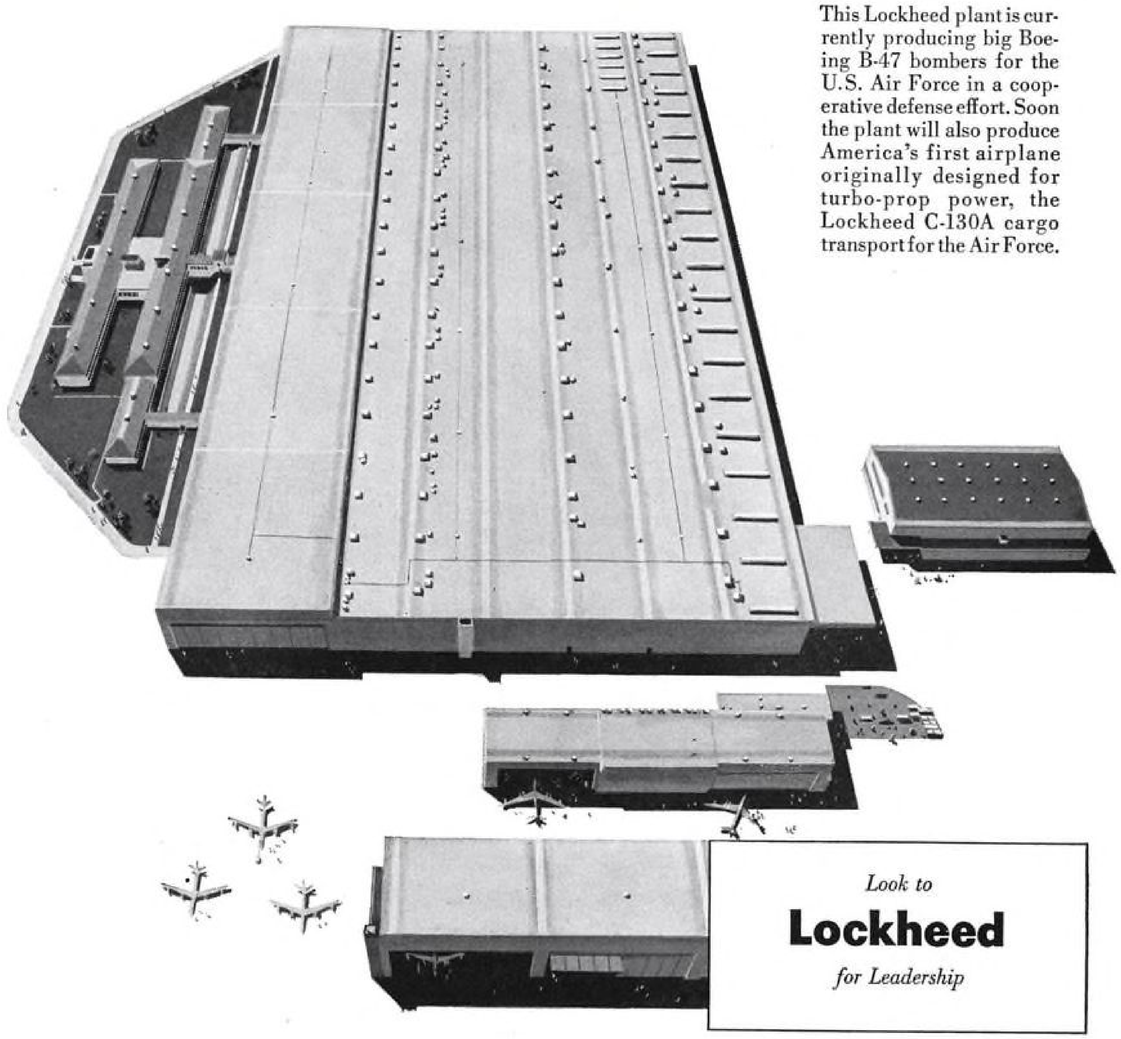
EXPANDS DEFENSE PRODUCTION IN INDUSTRIAL SOUTH

Lockheed and the growing Industrial South today provide the U.S. with one of the world's largest aircraft factories—Lockheed's huge Marietta, Georgia, plant.

A short distance from Atlanta, this factory complements Lockheed's California Division, providing the industrial dispersal now considered vital to U.S. defense.

Lockheed's Georgia Division employs over 13,000 people and has an $800 million backlog of plane orders. That's big business—and an excellent example of new production in the fast-growing Industrial South.

This Lockheed plant is currently producing big Boeing B-47 bombers for the U.S. Air Force in a cooperative defense effort. Soon the plant will also produce America's first airplane originally designed for turbo-prop power, the Lockheed C-130A cargo transport for the Air Force.



Look to

Lockheed

for Leadership

LOCKHEED AIRCRAFT CORPORATION • MARIETTA, GEORGIA, AND BURBANK, CALIFORNIA

Lockheed

C-130A Transport— One Plane for 3 Jobs

Soon in production at Lockheed's Marietta, Georgia, plant, the U.S. Air Force's new turbo-prop transport, the Lockheed C-130A, will fly higher and faster than any other military transport and perform a great variety of missions.

The C-130A is the first transport specifically designed for turbo-prop engines, which harness jet power to propellers.

Air Force Competition Winner

Winner of an industry-wide Air Force design competition, the C-130A transport will perform three different jobs:

1. Carry soldiers, paratroops, patients and all types of ground force equipment up to items weighing twelve to twenty tons.

2. Fly high-altitude, high-speed missions as a tactical airplane for the Air Force.

3. Transport passengers on long-range flights for the Air Transport Command.

Unique Construction

The C-130A has a floor as strong as a concrete warehouse floor a foot thick. Its fuselage is only 45 inches off the ground—level with truck-bed height for easier loading and unloading. The pressurized cabin permits ground-level comfort for military personnel at high altitudes.

Of special importance to the Air Force, the new transport will require only short take-off and landing runs. Special tandem-wheel tricycle landing gear permits it to use emergency landing fields in forward areas, or even unfinished air strips.

Prototypes of the airplane are nearing completion at Lockheed's Burbank, Calif., plant. The plane will go into quantity production at Lockheed's Georgia Division, in Marietta, where giant B-47 jet bombers are currently being built.

■ AVIONICS

area, for example, RADC is devoting much effort to improving the range and accuracy (resolution) of ground-based radars. In the second area, to meet the needs of automatic control systems which must operate from radar signals without human interpretation, RADC is working to improve radar's ability to discriminate between real targets and spurious signals from the ground or other fixed objects.

Other developments in this area include long-range, high-accuracy navigation systems, aimed at pinpoint accuracy for bombers and guided missiles. Also, data link techniques for transmitting guidance and navigation information to a multitude of aircraft without cluttering the narrow radio spectrum are being developed here.

The third area, developing know-how to meet future needs, is typified by RADC's work in electronic countermeasures, where it must develop knowledge and techniques to be able to counter quickly any enemy jamming.

▶ **Handling "Super Systems"**—Developing, and guiding the developments of industrial contractors, in this comparatively new field of "super systems" has raised serious organizational problems. Close integration of the characteristics of all sub-systems is imperative to assure their compatibility when connected into super systems. Yet there can be no deemphasis on the individual subsystem developments since their performance limits that of the "super system."

Last January RADC completely revamped its research and development organizational setup to handle the new super systems without neglecting the vital sub-system building blocks.

Under the old setup, R&D had been divided into five laboratories: communications, navigation, radar, data handling (computers), and general engineering. The trouble with this organization structure was that the new super systems cut across the lines of responsibility of all of these laboratories, making it difficult to place overall system responsibility in any one.

▶ **Streamlined Organization**—For many months RADC personnel studied the organizational structures of military and industrial laboratories, looking for a suitable organization pattern, Lt. Col. O. J. Schulte, assistant deputy for R&D, reports. These included the Signal Corps, Naval Research, General Electric, Radio Corp. of America, and Bell Telephone Laboratories.

RADC found no pattern which suited their specific needs, Schulte says, but it received many ideas that could be useful in developing the new R&D structure.

THE BIG

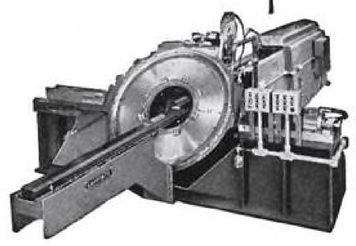
NEWS!

IN AVIATION PRODUCTION is what

LAPOINTE BROACHING

is doing for

GAS TURBINE PARTS



Literature is available describing Lapointe Broaching Machines, Tools, and Fixtures — and telling what they will accomplish in your plant to *speed production and reduce costs.*

Ask for Bulletin AW-19

LAPOINTE

MACHINE TOOL COMPANY

HUDSON · MASS · U. S. A.

THE WORLD'S OLDEST AND LARGEST MANUFACTURERS OF BROACHING MACHINES AND BROACHES

SURE
Permanent
SEALING!
FOR BOLTS AND STUDS
STAT-O-SEAL
FRANKLIN C. WOLFE CO.
3644 Eastham Dr.
Culver City, Calif.
"Sealing Design Specialist"
This one-piece, non-directional bolt and stud sealing device is the answer to perfect sealing. No loss of sealing from cold flow, full metal to metal contact, and many other exclusive features. Mechanically connected O-Ring will seal both low and high pressures—air, gases, or fluids. WRITE TODAY FOR CATALOG SOS-53.
(Before Fastening)
AT LOW OR HIGH PRESSURES!
By the makers of: LOCK-O-SEAL GASK-O-SEAL TERMIN-O-SEAL, etc.

■ AVIONICS

The new streamlined R&D organization consisting of eight laboratories and one services branch is grouped into the following four divisions:

• **Systems.** Responsible for integration of sub-systems into super systems and tailoring these super systems to the needs of various operating commands (TAC, ADC, SAC, and MATS).

• **Equipment Development.** Responsible for developing and supervising the development by outside contractors of sub-systems such as radar, direction-finders, radio communications, long-distance navigation, and data link.

• **Electronic Warfare & Techniques.** Responsible for developing ground-based electronic countermeasure techniques and equipment as well as exploring new techniques applicable to all types of ground-based avionic equipment.

• **Engineering Support.** Responsible for providing general engineering services such as drafting, test instrumentation and mechanical design and test laboratory facilities for evaluation of equipment developed for RADC.

▶ **Semi-Autonomous Operation**—RADC has set up each division to operate with the greatest possible autonomy. Whereas administration functions previously had been performed for all labs by a single separate division, each of the four divisions now has its own administrator and Plans and Operations section for handling administrative and financial affairs of the division. A central P&O office, under the deputy for R&D, handles only those problems that cut across divisional boundaries, Schulte indicates.

Wherever possible R&D functions have been decentralized. For example, representatives of the operating AF commands (SAC, TAC, and ADC), who were formerly in the Requirements Branch of the Central Plans and Operations Office, recently have been transferred to the Systems Division where they can be closer to systems planning to direct R&D activities toward their tactical needs.

When the new R&D structure went into effect, RADC reshuffled as many as possible of its existing programs to fit them into the new setup. A few programs, which would have suffered by a midstream transfer, were continued under the old setup. However, all new projects that have come in since January have been assigned under the new organization structure.

▶ **Meets Individual's Needs**—Schulte believes the new organization is better suited to the professional needs of individual RADC engineers. He points out that some technical people like to become long-haired researchers in a

Less Weight
Less Cost
Faster Assembly
STAT-O-SEAL
FRANKLIN C. WOLFE CO.
3644 Eastham Dr.
Culver City, Calif.
"Sealing Design Specialist"
This one-piece, non-directional bolt and stud sealing device is the answer to perfect sealing. No loss of sealing from cold flow, full metal to metal contact, and many other exclusive features. Mechanically connected O-Ring will seal both low and high pressures—air, gases, or fluids. WRITE TODAY FOR CATALOG SOS-53.
(After Fastening)
AT LOW OR HIGH PRESSURES SEALING Permanently!
By the makers of: LOCK-O-SEAL GASK-O-SEAL TERMIN-O-SEAL, etc.

narrow segment of their field; they don't want to be "bothered" with converting ideas into tactically useable "hardware." This type of man would find the Research and Applied Techniques Laboratory of the Electronic Warfare and Techniques Division to his liking, Schulte says.

Other engineers want to be specialists in broader fields, like traffic control radar, communications, or computers. These men usually like to get their hands on actual equipment and work it; they find their niche in the Equipment Development Division. There are still others who are not too interested in the internal design details of a radar, or a computer. Instead, these engineers prefer to apply these sub-systems to the solution of large-scale tactical problems. These men find a home in the Systems Division.

To get a more detailed picture of RADC's current activities and accomplishments, AVIATION WEEK talked with many of the division and laboratory chiefs. Here, within the limits imposed by security, is the picture.

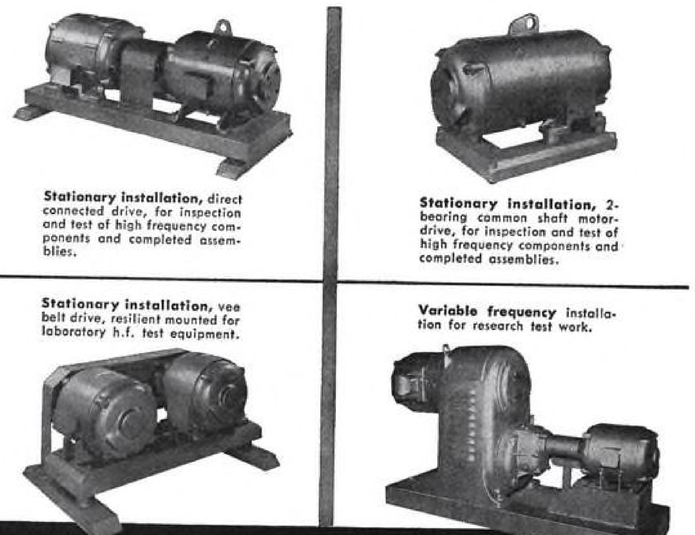
Systems

The Systems Division functions, in many respects, as an engineering staff for the various AF operating commands, i.e. Strategic Air Command, Tactical Air Command, Air Defense Command and Military Air Transport Service. The Systems Division's job is to find out what tactical problems face the operating commands and then to figure out how ground-based avionic techniques can be applied to solve them.

Another major objective for this division is to see that RADC sub-system de-

Warren S. Dunn
Chief, Systems Division

ORDER FROM
Airwork
Aviation's most personal service
AIRWORK maintains a million dollar inventory of *factory new* aviation supplies from 21 leading manufacturers. For example, we are Factory Distributors, maintaining one of the largest, most complete stocks of parts for Pratt & Whitney Aircraft. Rapid turnover assures you of up-to-date parts.
AIRWORK has an exclusive follow-up system on those scarce parts that must be back ordered. This system guarantees on-time delivery without the need of a re-check on your part.
ORDER HERE
★ Millville, N. J.
★ Washington, D. C. 2707 South Oakland St. Arlington, Va.
★ Miami, Florida 5425 N. W. 36th St. Miami Springs, Fla.
Airwork CORPORATION
MILLVILLE, NEW JERSEY
(FOR DIRECT WIRE SERVICE FROM NEW YORK CITY : PHONE RECTOR 2-0166)



Stationary installation, direct connected drive, for inspection and test of high frequency components and completed assemblies.

Stationary installation, 2-bearing common shaft motor-drive, for inspection and test of high frequency components and completed assemblies.

Stationary installation, vee belt drive, resilient mounted for laboratory h.f. test equipment.

Variable frequency installation for research test work.

FOR STANDARD AND SPECIALIZED

HIGH FREQUENCY

POWER REQUIREMENTS

Get one of these **AMERICAN ELECTRIC** *"Packaged" Units!*

Whatever your ground power supply requirements—standard or special—you can get the *exact unit* best suited to your needs from American Electric. These high frequency power supplies are built with many motor-drive variations. Units are complete with d.c. exciter-regulators, ready to connect to your 60 cycle mains.

Exclusive inductor-alternator design eliminates all springs, slip rings and brushes . . . *maintenance-free as its grease-sealed ball bearings!* Light in weight, compact, quiet!

Correct Power Supply for Every Installation

Portable, semi-portable or stationary types, open models or completely enclosed for weather protection. Caster or pneumatic tire mounts, skid mounts and resilient rubber mounts on stationary types.

Wide Frequency Ranges

Fixed Frequencies from 250 cycles to 2400 cycles (up to 4000 cycles in the lower ratings).

Variable Frequencies from 380 cycles to 1200 cycles and 1200 cycles to 2400 cycles.

Excellent Voltage Regulation: Standard ± 1% to as low as ± .5% depending upon choice of drive. Electronic regulators or magnetic amplifier regulators supplied.

Motor Drives—Common shaft, direct connected, Vee belt or positive, no-slip timing belt types. Variable speed on variable frequency models.

Low Harmonic Content
Less than 2% on single phase.
Less than 1% on three phase.
Exceedingly low harmonic content results directly from alternator design without use of filters.

Output Ranges
single phase—½ KVA to 15 KVA
three phase—½ KVA to 30 KVA
(outputs up to 75 KVA available in other alternator designs.)

WHATEVER YOUR GROUND POWER SUPPLY REQUIREMENTS

ASK American Electric for quotation

Engineering Representatives:

TRAVCO ENGINEERING CO.

Silver Spring (Md.) • Chicago
New York • Los Angeles

Manufacturers Also of Miniature A.C. (All Frequencies) Electric Drive Motors, Blowers and Fans

AMERICAN ELECTRIC MOTORS
TRADE MARK

4811 Telegraph Road, Los Angeles 22, California

■ AVIONICS

velopment efforts are directed toward specific tactical needs. The Systems Division will be able to exercise this control by drawing the pursestrings tight on any project which has no potential tactical use. On the other hand the division must be constantly alert to areas where development work is needed in order to provide the necessary building blocks for its super systems.

▶ **Systems Division Organization**—Warren S. Dunn, a veteran of a dozen years with RADC and its predecessor labs, heads the 100-man Systems Division. Of this number, approximately 50 are civilian engineers and 10 are military personnel with technical backgrounds. The group is subdivided into three laboratories, according to the operating command for whom they work:

- **Tactical Air Command lab.**
- **Strategic Air Command and Military Air Transport Service lab.**
- **Air Defense lab.**

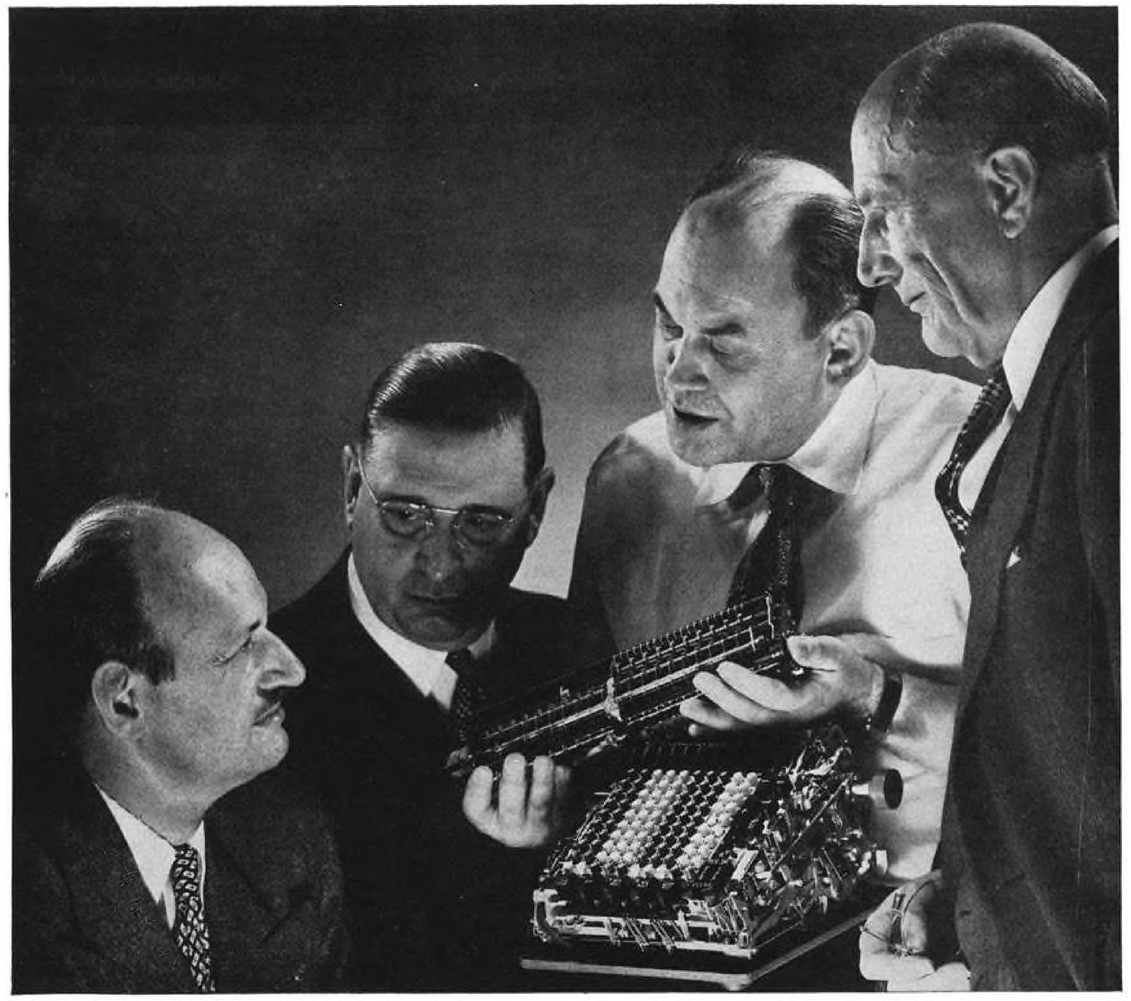
The TAC lab gets approximately 50% of this division's efforts, and the other half is divided approximately equally between the other two labs, Dunn reports. However, he adds that this breakdown is subject to change as new programs come in and old ones are finished off.

The Systems labs normally look to the Equipment Development Division and its outside contractors for all of the basic building-block subsystems which make up the super (weapons) systems. One exception is what RADC people call "green boxes." These are special "black boxes" needed to tie together standard equipments into super systems. By allowing Systems Division engineers to develop or guide the outside development of "green boxes," systems engineers maintain their technical competency and avoid becoming mere paper-planning engineers.

▶ **TAC Lab Activities**—The new weapons system under way in the TAC lab is intended to keep a TAC field commander continuously informed as to the disposition of his own and enemy aircraft and ground forces. Information from mobile radars and ground observers will be funneled into a central intelligence point.

By means of automatic computers (data handlers), this information will be correlated and digested to give the field commander a single presentation on the status of the battle area. From this same central point, the field commander will be able to exercise control over aircraft at his disposal.

The broad objective of the program is to obtain greater centralization of battle intelligence in less time, with more automaticity. Dunn doesn't expect the TAC system to have as much automaticity and consequent com-



If Complex Mechanisms are your Problem . . .

THESE MONROE MEN CAN HELP YOU!

Have you ever seen the complex assembly of thousands of cams, shafts, gears, levers, springs and screws that enable the modern desk calculator to perform its lightning computation? Or the infinitely more labyrinthine innards of today's electronic computer?

The Monroe Calculating Machine Co. has been making arithmetic mechanisms for 40 years and is a pioneer in the development of the electronic computer. We are superbly equipped to create, develop and produce the most complex devices, as witness the ruggedly reliable electronic computers now in use by the Air Force.

If you need help in this vital and specialized field—research, development or manufacture—write to our Armed Forces Liaison Dept.

MONROE CALCULATING MACHINE CO., ORANGE, N. J.

Forging

GREATER STRENGTH FOR HIGHER SPEEDS AND HEAVIER LOADS

Republic's new fighter has a top speed much greater than the 600 mph of its sister model, the F-84G. It also carries more armament than the record-breaking loads of the F-84G. Its wing span of only 34 feet must support a take-off weight of about 25,000 pounds, requiring structural strength undreamed of only a few years ago.

The speeds and loads of the Thunderstreak, and of other modern aircraft, are made possible through increased use of forgings . . . in the power plant and in the airframe . . . because forgings alone can provide the strength required.

A pioneer in forging titanium, Consolidated Industries is proud of its record as a supplier of forgings for the Thunderstreak . . . and for dozens of other aircraft and jet engine manufacturers. Consolidated Industries has the practical knowledge and experience to help you. Please write Dept W6.

CONSOLIDATED INDUSTRIES, INC.

West Cheshire, Connecticut, U.S.A.

West Coast Representative: A. C. Stearns Co., 3911 San Fernando Rd., Glendale, Calif.

■ AVIONICS

plexity as the air defense system under development by AFCRC and Project Lincoln.

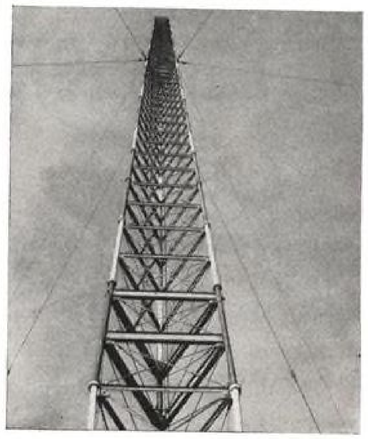
► **Mobility the Keystone**—For one thing, the keystone of the TAC system must be mobility, giving it freedom to move with the fluid battle area. The stationary, U.S.-based air defense system can set up equipment in duplicate or triplicate in the event that complex primary equipment fails. However the mobile TAC system won't be able to afford this luxury and so must forego unnecessary automaticity.

Secondly, the air defense system can have a permanently based well-trained set of specialists, test equipment and spare parts always available for maintenance; whereas maintenance and supply are much more difficult in forward combat areas where TAC must operate.

Because of the similarity of portions of the ADC and TAC missions, RADC will be able to use some of the ADC sub-system equipments, although in some cases these must be repackaged for vehicular use. Dunn cites a particular type of computer, now going into production, which, with minor design compromise, was made suitable for both the TAC and ADC weapons systems.

► **Within the TAC Lab**—The TAC lab is divided into three sections. One, called Systems Analysis, works closely with TAC to determine its operating needs and requirements. For example, how many targets must the system be capable of handling? How big an area of interdiction must the system be capable of covering? If TAC asks for the impossible, or states requirements beyond the present state of the art, the Systems Analysis section must negotiate a satisfactory compromise with TAC on its requirements.

► **Implementation**—When this has been done, the Analysis section draws up a system specification and turns it over to the Systems Implementation section. This group is charged with guidance of the Equipment Development Division to bring needed development along at the proper pace so that all subsystems will be available when they are needed.



RADC's 1,200-ft. antenna is used in long-range navigation system studies.

If certain new airborne equipment is needed for the system, the Implementation section engineers see to it that Wright Air Development Center launches the needed development and then coordinates WADC and RADC efforts.

► **"Green Box" Group**—If special "green boxes" are needed for the system, the third lab section—System Integration and Evaluation—initiates the necessary development, either within RADC or by outside contractor.

When portions of the super-system are developed, this same section tests and evaluates their performance, to see how closely they meet the system specifications.

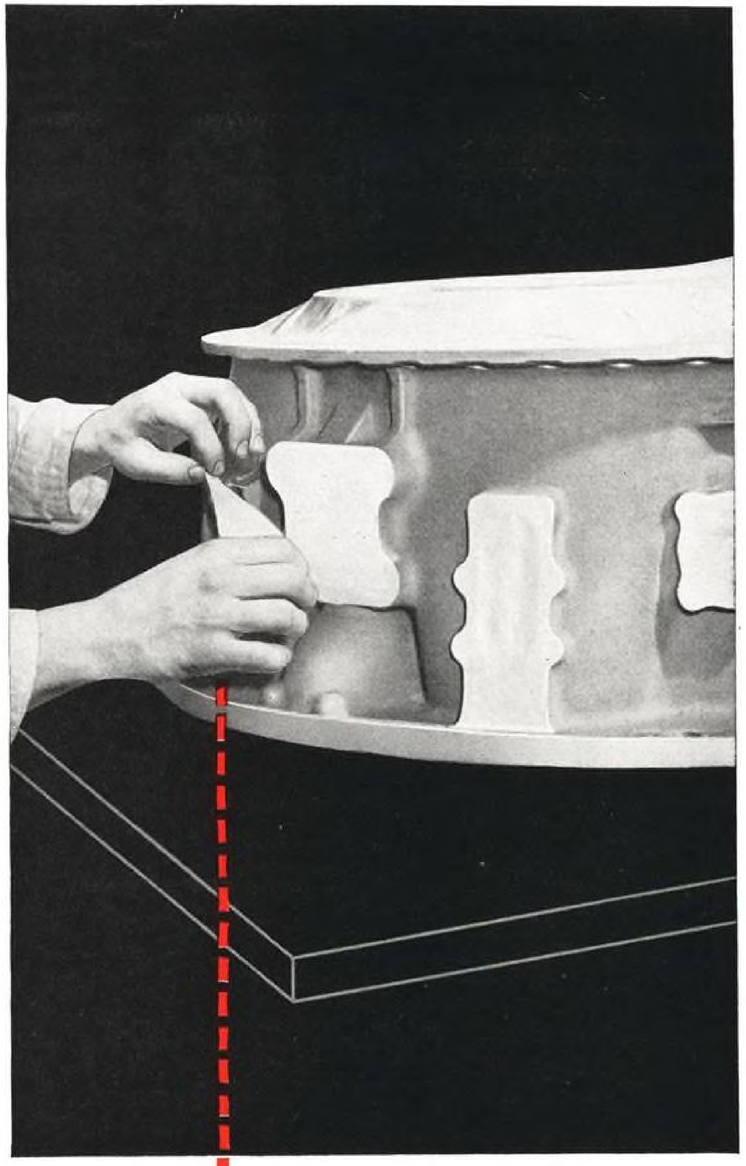
During the course of the program the Analysis section is continuously working with TAC, revising specs where necessary to meet new-found TAC needs, or modifying the specs when new developments in the art make improvements possible.

► **Inside the SAC & MATS Lab**—Overall weapons system responsibility for SAC is assigned to WADC, which in turn subcontracts the long-range communications and navigation and some IFF problems to RADC's SAC and MATS lab. MATS work is thrown into the same "hopper" because its long-range communication and navigation problems are somewhat akin to those of SAC.

The most interesting system project in this laboratory (at least the most interesting one about which RADC is willing to talk) is the automatic traffic control and landing system with its return-to-base computer. This system has application to all of the AF's operating commands despite the fact it is assigned to this lab.

► **Getting Them Home**—The return-to-base phase of military jet operations is called one of the "most critical" by I. J. Gabelman, chief of the SAC and MATS lab. Military jets can be expected to return to base with little fuel in their tanks and many may have suffered battle damage.

Because jet fuel consumption runs 2½ to 3 times greater at sea level than at high altitudes, jets must stay at high altitude until ready to land and then make a very rapid descent, approach, and landing. For example, jet fighters descend at the rate of about 4,000 ft./min.; jet bombers at about 2,500 ft./min.



Guarding vital finishes . . . of Wright jet housings with **PERMACEL** Paper Tape. No doubt there is an important use for **PERMACEL** on your jobs. Our Tape Engineering Service can give you the answer . . . without obligation.

PERMACEL®

PRESSURE SENSITIVE

PAPER TAPES

PERMACEL TAPE CORPORATION, NEW BRUNSWICK, N. J.

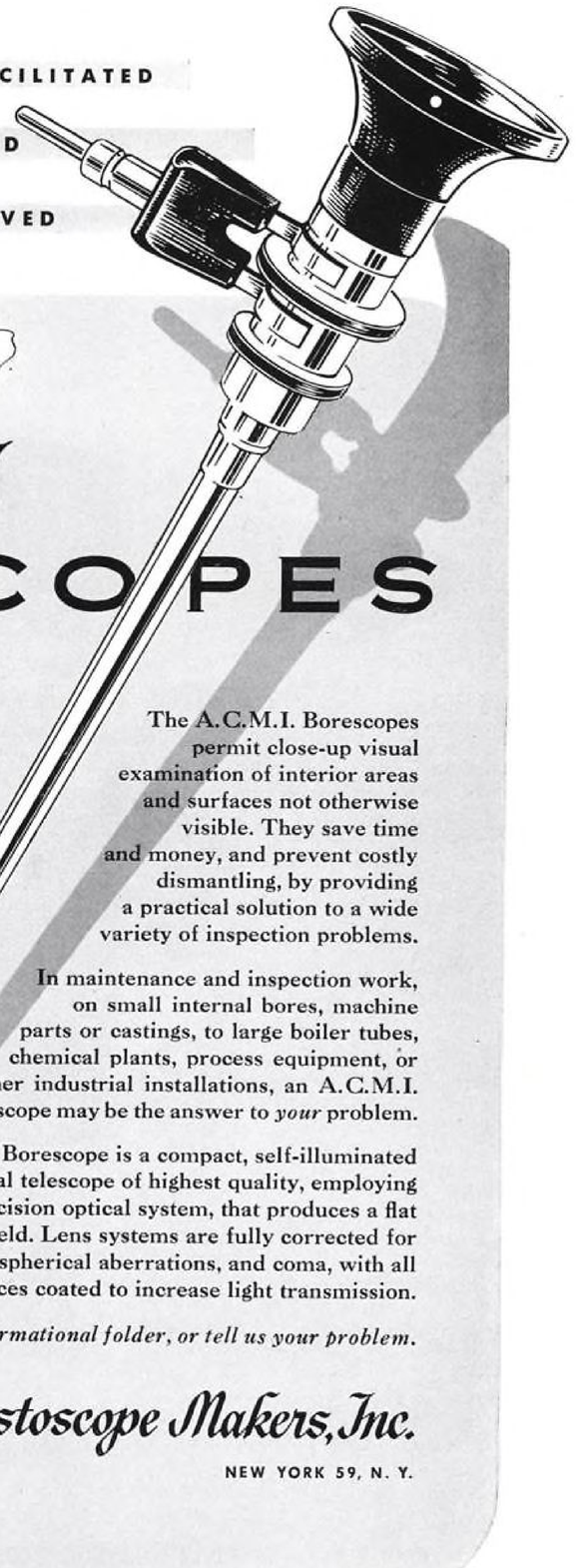
INSPECTION OF CONFINED AREAS FACILITATED

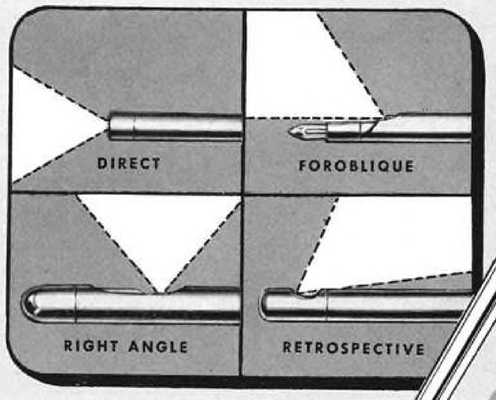
NECESSITY OF DISMANTLING AVOIDED

TIME SAVED—MONEY SAVED

A.C.M.I.

BORESCOPES





A.C.M.I. Borescopes are available in 4 angles of vision (as above)— in diameters of .120" to 4.00"— in lengths of 4" to 720". Special models for special problems.

The A.C.M.I. Borescopes permit close-up visual examination of interior areas and surfaces not otherwise visible. They save time and money, and prevent costly dismantling, by providing a practical solution to a wide variety of inspection problems.

In maintenance and inspection work, on small internal bores, machine parts or castings, to large boiler tubes, chemical plants, process equipment, or other industrial installations, an A.C.M.I. Borescope may be the answer to *your* problem.

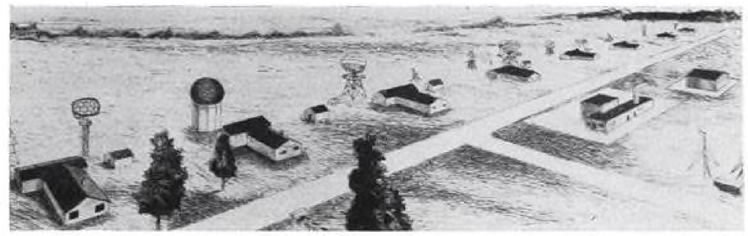
Each Borescope is a compact, self-illuminated industrial telescope of highest quality, employing a precision optical system, that produces a flat visual field. Lens systems are fully corrected for color, spherical aberrations, and coma, with all lens surfaces coated to increase light transmission.

Write for free informational folder, or tell us your problem.

American Cystoscope Makers, Inc.

1241 LAFAYETTE AVENUE NEW YORK 59, N. Y.

■ AVIONICS



TACTICAL AIR COMMAND weapons systems and electronic counter-measures will be tested at this new RADC site near Verona, N. Y.

▶ **Deft Traffic Control Needed**—Traffic control for military jets must be efficient, speedy, and certain. If a jet fighter or bomber misses his first approach, he may not have enough fuel left to make a second attempt. Approach and landing must be speedy so that an entire flight can be landed before the last-in-line planes run out of fuel. Gabelman says RADC is shooting for a landing rate of two aircraft per minute per runway.

The problem can be viewed this way: Every 30 seconds a "slot" becomes available for landing an airplane. Unless an airplane is ready to fill that landing slot, it is gone and lost forever, and the penalty may be the loss of one or more aircraft that run out of fuel.

RADC believes the solution must be an automatic computer which continuously can take into account the many variables involved and program a close-order approach of dozens of aircraft without danger of collision.

RADC expects to have a single-channel experimental return-to-base computer ready for flight test this fall and plans to award a contract for a multi-channel unit during the present fiscal year. Gabelman hopes to be able to demonstrate this unit by early 1955.

▶ **How It Works**—Ground-based radars will provide the computer with information on the position, speed, heading, altitude, and identity of every aircraft approaching within "X" mi. of an airdrome.

As soon as the plane enters this area, the computer will determine instantly the plane's earliest possible time of arrival at the GCA Gate (start of the final approach path.) The computer will then scan its memory for the first vacant landing slot which will be assigned to the aircraft.

▶ **New Heading**—The assigned landing slot might be 30 sec. later than the earliest possible time of airplane arrival, in which case the computer calculates a new flight path heading which will bring the airplane to the GCA gate at the desired time. The new heading can be transmitted by radio to the plane's flight crew, and this is what will be done in the early phases of the program.

The next step is to make the system more foolproof by giving the ground station control of the airplane's flight path via a radio data link whose signals control the plane through its automatic pilot.

▶ **Continuous Monitoring**—The return-to-base computer will monitor continuously the position of all aircraft and may, on occasion, have to revamp the previously assigned schedule of arrival because of unforseen events. Human operators on the ground will be able to cause the computer to give special landing priority to disabled aircraft, when so notified by the plane's crew.

RADC hasn't been able to dream up a way to detect battle damage automatically yet.

AUTOMATIC GCA can provide automatic approaches through the autopilot in addition to giving pilot normal GCA talk-down.

Asked whether the return-to-base computer would be the analog or digital type, Gabelman replied that it would be either pure analog, or a mixture of the two, but not pure digital. "We can't afford any down time," Gabelman said, voicing a frequently heard complaint about the present state of digital computer reliability.

▶ **Automatic Approach and Landing**—RADC has one portion of its super traffic control system already "under its belt." This is automatic GCA, an expanded version of ground-controlled approach radar which permits an automatic approach via the airplane's autopilot approach coupler and simultaneously gives the pilot ILS-type steering information in the cockpit.

Gilfillan Bros., Inc., is currently going into pilot production on AGCA, following several years of test. AGCA is capable of handling simultaneously up to six aircraft in final approach.

▶ **Flare-Out and Landing**—The third portion of the system under investigation at RADC is an automatic flare-out and landing system. An extremely-high-frequency ground-based radar will be used to determine the plane's height above ground (to an expected accuracy of two feet) and this information will be transmitted to a small flare-out computer in the airplane.

This device will operate through the autopilot to bring the aircraft in for its landing. Because of its intimate relationship to other parts of the system, the airborne flare-out computer is considered a "green box" and is therefore under development by the SAC and MATS lab.

The SAC and MATS Lab, like the TAC Lab, is divided into three sections, each with responsibilities similar to their TAC counterparts. These sections are: Analysis, Implementation, and Planning & Requirements.

▶ **Air Defense Lab**—RADC is a major subcontractor to AFCRC and Project Lincoln in the area of air defense. Systems supervision and guidance of this work is concentrated in the Air Defense Laboratory under J. Walsh. The five sections of the laboratory include: Weapons Systems, Data Processing, Data Handling, Systems Test,

and Operational Equipment Improvement. The latter section reflects the current philosophy of Project Lincoln and AFCRC to use existing equipment wherever possible.

Equipment Development

Largest of the four R & D divisions at RADC is Equipment Development which is responsible for bringing through new and/or improved radar, communications, data handling, direction finder, and navigation equipment projects.

Most of the developments are performed by outside contractors. The division numbers approximately 300 people, including 100 engineers, and is divided into two laboratories, identified simply as "No. 1" and "No. 2."

Lab No. 1 is essentially a radar/microwave group and Lab No. 2 is largely devoted to lower-frequency communications and navigation, according to Allan A. Kunze, division chief, who has spent more than 10 years in RADC and predecessor Signal Corps labs. However, there are enough exceptions to these broad definitions of lab responsibility that RADC decided it would be better to identify the labs by nonrestrictive and undescriptive numbers rather than by names.

Alan A. Kunze
Chief, Equipment Development Div.

A list of only a few of the Equipment Development Division's current or recently completed projects includes:

• **Communication zone indicator.** A device for determining the best frequency to use for communications under existing atmospheric conditions.

• **Precision long-range navigation.** Systems for use in missile guidance or determining the point of bomb release from a piloted aircraft.

• **Speech compressor.** A system designed to squeeze more useable channels into the crowded radio frequency spectrum by compressing the required bandwidth from ±3,000 cps. to a mere 100 cps.

• **Data link.** A narrow-bandwidth radio telemetering technique designed to transmit steering and guidance information to individual aircraft for display in the cockpit or for controlling the airplane's flight path through its automatic pilot.

• **More secure IFF:** A much improved system to enable ground radars to identify aircraft as friend or foe with greater assurance that the enemy has not broken the IFF system code.

• **Multi-runway GCA.** A new technique for mounting GCA on a turntable which can be rotated to allow a single GCA to cover instrument approaches from either direction and on more than one runway.

► **Lab No. 1 Activities**—Knowledge of what the enemy is doing is the key to military strategy. In aerial warfare, radar is the most important source of such military intelligence. This explains why so much RADC effort is going into ground-base radar developments, according to Ernest Storrs, chief of Lab. No. 1, which guides developments in this field.

This lab is divided into four sections:

Facts and figures!..

Figure:

Now, cloud-clobbering classmates, gather 'round and we'll show you the difference between a lure and allure. Obviously, Rosemary Gowen (21, 118 lbs., 5'7", brown hair and eyes) has both. She has hooked herself with one, while reserving the other to angle for, say, a bass-voiced flying fish at the beautiful concrete beach of Southwest Airmotive in Dallas.

Fact:

For hundreds of pilots throughout the Western Hemisphere, there's allure aplenty in the quality, dependability and reasonable prices of the Southwest Airmotive Instrument Shop. Recently expanded and newly-equipped, this shop can do everything from setting a clock to custom-building a complete executive aircraft panel. Write for details and prices.

Southwest Airmotive COMPANY
COVE FIELD DALLAS

aluminum extrusions

can improve your lead time

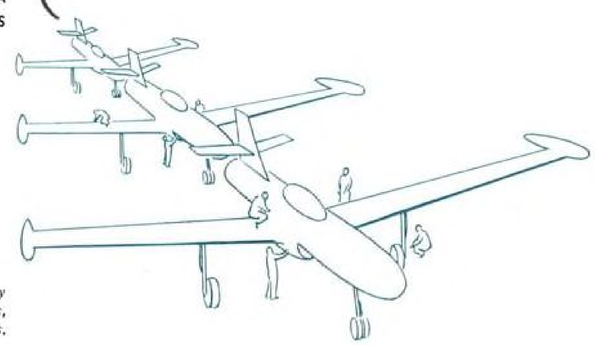
The ever increasing demand for airplanes with more speed, higher altitude and longer range, multiplies assembly operations and slows down production. To keep abreast of these demands progressive aircraft manufacturers make fullest use of the speedup potential inherent in aluminum extrusions. Harvey Aluminum is a completely integrated facility with long experience and a special interest in the special problems of the airframe industry. Our staff of research engineers, metallurgists and designers will help you from the inception of your idea to final installation of your finished extrusion. Why don't you call a Harvey Field Engineer?

Adherence to specifications is a must at Harvey. Every foot of every extrusion passes numerous rigid inspection barriers before leaving the Harvey plant.

MAKING THE MOST OF ALUMINUM ... FOR INDUSTRY

HARVEY Aluminum

DIVISION OF HARVEY MACHINE CO., INC.
TORRANCE, CALIFORNIA
BRANCH OFFICES IN PRINCIPAL CITIES



An independent facility producing special extrusions, pressure forgings, bar stock, forging stock, tubing and related mill products.

Many products... One Standard I.Q.*

*Instrument Quality

ACCELEROMETERS
Linear Transmitting

ANGULAR TRANSMITTERS
Pitch, Yaw, Pitot Static

GYROS
Free • Rate
Vertical • Directional

POTENTIOMETERS
Low Torque • Many types and resistance values

PRESSURE SWITCHES
Absolute • Differential Gage

PRESSURE TRANSMITTERS
Absolute • Differential Gage • (Resistance type)

STEPPING POSITIONERS
Intermittent Rotary Power

TEMPERATURE DEVICES
For high or low temperature

There is one characteristic common to all Giannini instruments—they are built to rigid, instrument-quality standards. They are instruments with an earned reputation of offering the utmost in mechanical and electrical fineness—resulting from outstanding craftsmanship and rigorous calibration, testing and inspection procedures. Your job requirements can be met or exceeded by Giannini IQ instruments.

For catalog and engineering data on these and other fine instruments write:

INSTRUMENTS
CONTROLS

Giannini

G. M. GIANNINI & CO., INC., PASADENA, CALIFORNIA, EAST ORANGE, NEW JERSEY

■ AVIONICS

Radar Search & Height Finding (Surveillance), Guidance, Beacons, and Terminal Area.

Although there has been considerable improvement in radar precision and range since World War II, Storrs says that there is a continuous program for further improvement.

Current work is directed toward higher powers for greater range and improved MTI (moving target indicator) techniques to discriminate better between time targets and ground or atmospheric clutter. Another objective is to improve equipment reliability through better components and by cutting the numbers of tubes required.

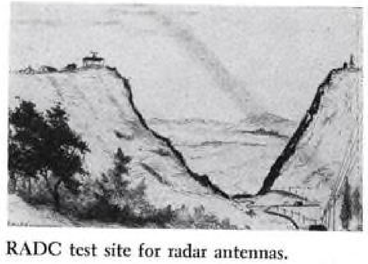
▶**Step-by-Step Process**—Radar improvement is essentially a slow step-by-step process which must await the development of more powerful magnetrons, more sensitive receiver circuit designs, higher-gain antenna designs and the like, says John Cruickshank, head of the Radar Search and Height Finding Section.

The TAC weapons system program has raised new problems. Radars and their associated operators and maintenance shelters and power supplies must be repackaged for mobile front-line use and redesigned to withstand its rigors.

Cruickshank likes the new Systems Division role of giving guidance on the tactical requirements for new equipment. In the earlier postwar days, he says, there was too little tactical usage information available for engineers charged with drawing up equipment specs.

▶**Big Business**—The size and complexity of ground-based surveillance radars usually limits their development to a few of the larger companies. A single surveillance radar may cost up to $1.5 million, and a recent production contract amounted to $50 million, Cruickshank says. Major ground-based radar suppliers are General Electric and Bendix Radio Division of Bendix Aviation. Other principal suppliers include RCA, Westinghouse, Crosley, and Hazeltine.

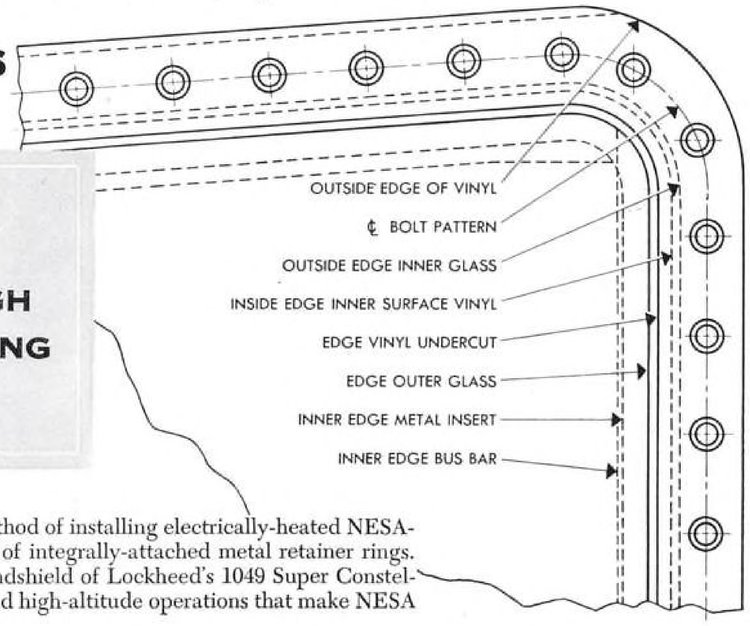
Military security prevented Storrs from saying much about the activities of the Guidance Section of Lab. No. 1, except that the precision being sought for missile guidance is higher than



RADC test site for radar antennas.

How the windshield panels of Lockheed's Super Constellation are glazed with electrically-heated "NESA" Glass

A report from
THE PITTSBURGH AIRCRAFT GLAZING FILE

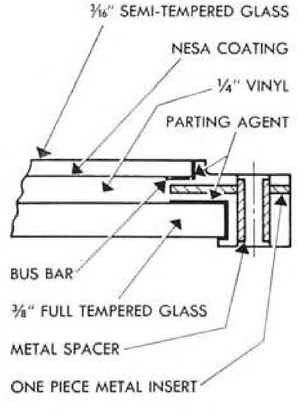


THESE drawings show you a method of installing electrically-heated NESA-coated Glass without the use of integrally-attached metal retainer rings. They are details of the center windshield of Lockheed's 1049 Super Constellation, a plane with high-speed and high-altitude operations that make NESA Glass particularly suitable.

The NESA windshield used here consists of one piece of semi-tempered and one piece of full-tempered glass with a vinyl filler between. Electrical current, carried by the NESA coating of the inboard surface of the outboard glass, prevents ice formation and gives freedom from frost and fogging. NESA is also used on the adjoining forward glass areas, and the other four cockpit openings are glazed with Pittsburgh Flexseal.

The vinyl surface is undercut to achieve flush mounting of the external retainer ring. This method of installation permits the use of narrow posts that provide the least possible obstruction to vision. This bird resisting assembly is engineered for maximum "double" safety as the vinyl filler is capable of carrying flight loads and the pressurization of 4.5 p.s.i. even though one or both pieces of glass were accidentally broken.

Working together, Lockheed engineers and Pittsburgh Plate Glass Company technical representatives designed this installation, and the same kind of technical assistance is available to you from Pittsburgh representatives. Your glass and glazing problems will be carefully considered in the light of our years of experience with the nation's major aircraft manufacturers. For complete information, write to Pittsburgh Plate Glass Company, Room 3316, 632 Fort Duquesne Boulevard, Pittsburgh 22, Pa.



PAINTS · GLASS · CHEMICALS · BRUSHES · PLASTICS · FIBER GLASS

PITTSBURGH PLATE GLASS COMPANY

IN CANADA: CANADIAN PITTSBURGH INDUSTRIES LIMITED

■ AVIONICS

RADC has yet achieved. Storrs points out that a radar system used in missile guidance could also be used in tactical bombing to determine the point where bombs should be released.

▶ **Radar Beacons Improved**—The IFF system now in use is "far superior to that used in World War II" from a security standpoint, Storrs says. (The present airborne and ground-based IFF equipment were developed under RADC sponsorship but WADC has the responsibility for packaging the airborne unit to its own requirements.)

▶ **World War II Models**—The IFF hurriedly developed during World War II had only four different codes, Storrs says.

The Germans were able to get details on our IFF design from aircraft shot down over occupied Europe and duplicate it for their own aircraft. Then they had only to determine the "code of the night" by monitoring our aircraft, and they could notify German intruder aircraft to set their U. S.-copied IFF beacons to give a "friendly" response to our allied radar interrogations.

▶ **Better Beacons**—Ground-based radar beacons, used for bombing and navigation landmarks by radar-equipped aircraft, have been reduced to about one-quarter of their World War II size, as a result of miniaturization techniques, Storrs says. In addition, these beacons now operate at higher peak powers giving longer-range operation.

Possibly the most important improvement, however, is in increased beacon reliability.

▶ **Terminal Area Aids**—The Civil Aeronautics Administration's air surveillance radars (ASR) and precision approach radars (PAR), which have done so much to improve traffic control and instrument approaches at our larger civil airports, are adaptations of similar radars first developed by RADC and its predecessor, Watson Labs, according to Storrs.

Another RADC development, airport Surface Detection Equipment (ASDE), a high-frequency radar used at night and during bad weather at large airports to "see" taxiing aircraft on runways and taxiways, evoked very favorable comment during a year's trial at the large N. Y. International Airport. (AVIATION WEEK Sept. 29, 1952, p. 87).

These and similar airport aids are developed under the guidance of the Terminal Aids Section, headed by D. E. Waxler. One recent development, disclosed here for the first time, may also hold considerable promise for civil air operations.

▶ **Multi-Runway Type GCA**—Permanent GCA installations normally are sited and aligned for conventional upwind landings based on the prevailing wind direction which most frequently exists under instrument weather conditions. A sudden reversal or change in wind direction under these conditions either requires a more hazardous downwind landing or results in landing delays.

Mounting GCAs in mobile trailers is not a satisfactory solution to this problem because of the time and trouble involved in moving and realigning them.

RADC's solution is a large turntable which mounts and can rotate an AN/FPN-16 precision approach radar through 360 deg. (in its production version) in a little over 3 minutes, making the instrument runway usable from either direction. For many airports, the turntable can be sited so that it serves additional runways, making them all instrument runways.

The device, built by Craig Machine, Inc., of Danvers, Mass., is calibrated when installed to accurately align itself to any serviceable runway at the push of an appropriate button. The original development model is presently installed at Griffiss AFB in Rome and production versions are currently going in at the important military air bases.

▶ **B-29 or F-86?**—If ground-based radar engineers had their way, they'd hang propellers on jet fighters, because props present a large effective surface to bounce radar energy back to its source, compared to the small frontal reflecting area of the jet fighter airframe and wings.

Since airframe manufacturers would take a dim view of such an addition to their sleek airframes, RADC has had to come up with other fixes. The problem is aggravated for PARs which operate at three centimeters (wavelength) because at that wavelength radar energy is seriously attenuated under conditions of moderate rainfall.

The Terminal Area Section has devised a gadget which makes an F-86 jet fighter show up as well as a B-29 on a PAR radar scope, Waxler says, and it adds only one pound to the weight of the fighter.

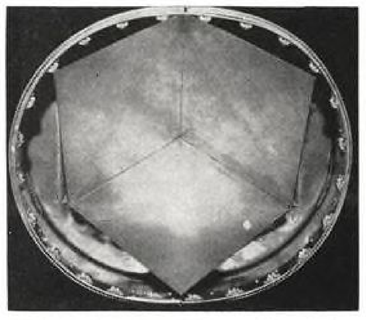
▶ **Corner Reflector**—The gadget is a small "corner reflector" which is attached to the airplane in such a way that it is extended during the final approach but retracted at all other times so as to present no aerodynamic drag and so that it won't serve as a target for enemy radars.

A corner reflector, consisting of three mutually perpendicular intersecting metal plates, beams back all radar energy striking it within an angle of 40 deg., thereby creating the effect of a much larger target.

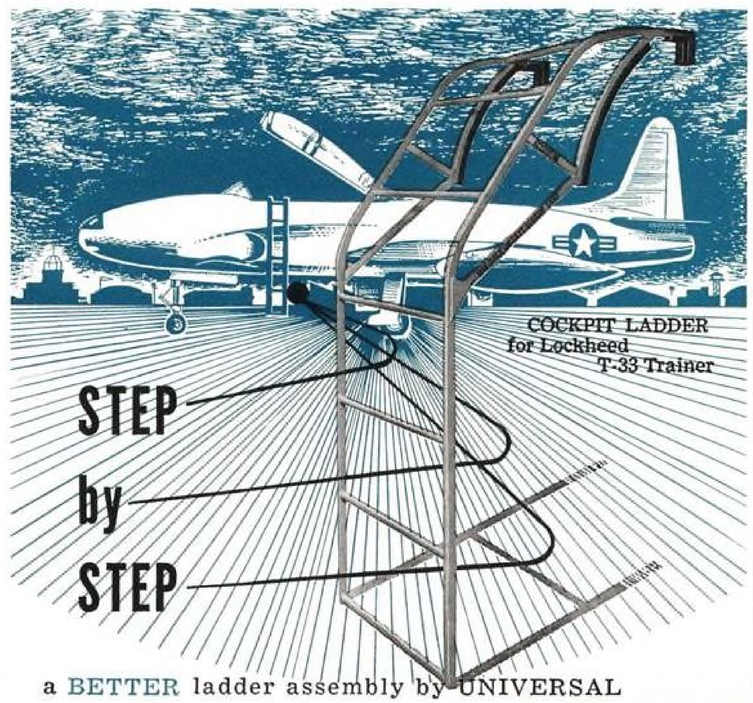
Waxler admits that aircraft manufacturers were skeptical of the idea at first, but he says that they now are giving excellent cooperation in the production of the reflector.

▶ **Large Transports Too?**—RADC is currently trying out a larger corner reflector on a large piston engine MATS transport to see if it will improve radar pickup during heavy rainfall. However, Waxler cautions that the sizeable radar echoes from the airplane itself might get out of phase with those from the corner reflector, in which event the two would tend to cancel each other, giving a poorer target on the scope than would ordinarily be required without the reflector.

If RADC works out a satisfactory



REFLECTOR attached to the airplane makes radar echoes stronger.



a BETTER ladder assembly by UNIVERSAL

It's pure logic to expect complete satisfaction from a complete shop! With well maintained, modern equipment we take charge, then do the entire job. Designing, layout, tooling ...forming, stamping... welding (heliarc, continuous seam, spot)... complete assembling — It's *all* at Universal.

Write, phone, wire... let us help develop and quote your complete assembly... either on production or experimental runs! Join hundreds of satisfied UMPCO customers. Act today!

"A WORLD OF KNOWHOW"

UNIVERSAL METAL PRODUCTS, INC.

Tools • Dies • Metal Stampings • Aircraft Parts

Serving America's Aircraft Industry

2311 West Orange Street
CUmberland 3-3115
Alhambra, California

ENGINEERED and MANUFACTURED AS A PRECISE TOOL

ENTIRE CHUCK BODY HARDENED INSIDE and OUT... TAPERED CHUCK BORES HARDENED AND GROUND TO CLOSE TOLERANCES

SUPREME Brand CHUCKS are expertly engineered to give top performance in the field. Jaws are of nickel chrome moly alloy steel expertly heat treated ... key holes do not extend into body cavity thereby sealing out dirt ... entire chuck is hardened inside and out ... one piece geared nut construction. Careful precision manufacturing produces a chuck that gives long trouble-free service in the field.

Your investment in Supreme brand Chucks is a wise one for they will give the kind of service that stretches your dollars.

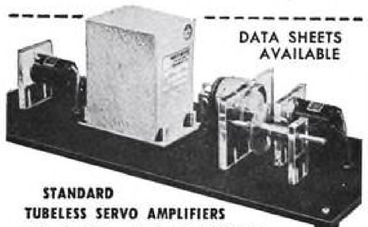
SUPREME BRAND **CHUCKS**

Supreme Products, Inc., 2222 South Calumet Avenue, Chicago, Illinois

THE CHUCK THAT LIVES UP TO ITS NAME... SUPREME

STANDARD PACKAGED PUSH-PULL MAGNETIC AMPLIFIERS by MA

MAGNETIC AMPLIFIERS—These high gain, high performance Magnetic Amplifiers are especially suitable to drive two phase induction servo motors requiring from 0.1 watt to 20 watts per phase on either 400 cps or 60 cps powerlines. The output power is either in phase or 180 out of phase with the powerline depending on the D.C. input signal polarity.



DATA SHEETS AVAILABLE

STANDARD TUBELESS SERVO AMPLIFIERS

with built-in adjustable SERVO LOOP STABILIZATION. Packaged, completely self-contained, magnetic servo amplifiers for position servo systems where either A.C. or D.C. error signals are available. Designed for instrument type and power type servo systems to work with synchro control transformers or potentiometers and two phase induction servo motors.

New Automatic Universal
TRANSISTOR CURVE TRACER

USES—Designing transistor circuits—comparing, matching and selecting—detecting anomalies—studying effects of temperature, age, normal usage, over-loading—detecting failures and cause.

WRITE FOR COMPLETE INFORMATION

FEATURES

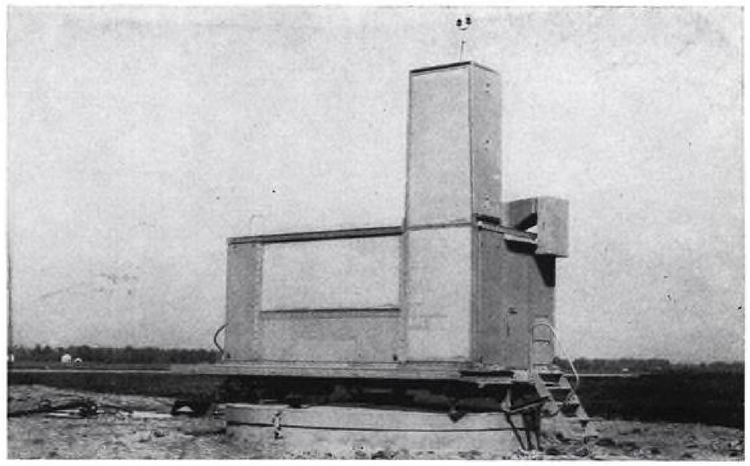
Tests NPN, PNP, Junction, Point Contact Transistors—flexible to accommodate new types. Dynamically plots entire family of curves simultaneously on standard laboratory DC oscilloscope. Function switch selects: output or transfer curve in grounded base or grounded emitter connection. Calibrating axis generated internally as integral part of display are always in correct quadrant.

MAGNETIC AMPLIFIERS • INC

An Affiliate of General Ceramics & Steatite Corp.

632 TINTON AVE., NEW YORK 55, N. Y.

Telephone: CYPRESS 2-6610



LARGE TURNTABLE enables this GCA to be quickly aligned to several runways.

solution, it would be applicable to air liners and CAA PARs which have similar problems during heavy rainfall.

►**Targets in the Rain**—Meanwhile RADC has applied other techniques to improving the target return of all sizes of aircraft during heavy rain. One is the use of quarterwave plates to give PAR radar energy circular polarization instead of its normal horizontal polarization. When this is done, radar echoes from aircraft return in normal fashion, but those from raindrops find it almost impossible to reenter the radar antenna from which they earlier emerged. This greatly reduces rain haze on radar scopes, making the target stand out more prominently.

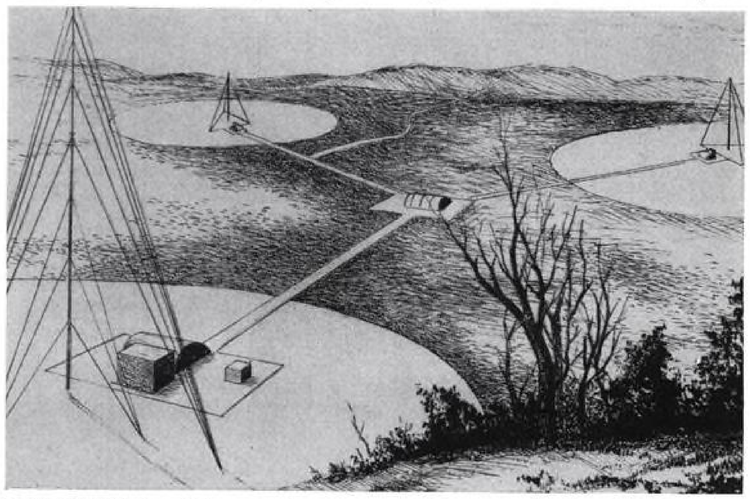
Circular polarization is being used in AN/CPN-18 surveillance radars and in the CAA's newest ASR-3s, built by Bendix Radio, Waxler says. Another RADC technique for reducing rain clutter is the use of new-design MTIs, applying information theory developed by Wiener of MIT and Shannon of Bell Telephone Labs.

►**Automatic GCA**—Automatic GCA, first constructed after the war in Watson Labs, according to Storrs, consists of a conventional PAR (AN/FPN-16) plus a set of tracking computers and accessories. These enable the AGCA to give the pilot an ILS-type cockpit indication and furnish automatic steering signals to the plane's autopilot in addition to the familiar aural talk-down. AGCA, identified in official parlance as GSN-2, can simultaneously handle up to six aircraft in final approach.

The "G" in GSN-2 indicates that the equipment is ground based; the "S" that it is a mixture or combination of radio and radar, and the "N" that the device is used for navigation.

Another RADC conception is the radio direction finder indication presentation on ASR radar scopes, to make it easier to identify individual aircraft.

►**Scope Indication**—As the airplane



NAVAGLOBE, long-distance omnirange-type navigation system, is under RADC test.

REM-CRU TITANIUM

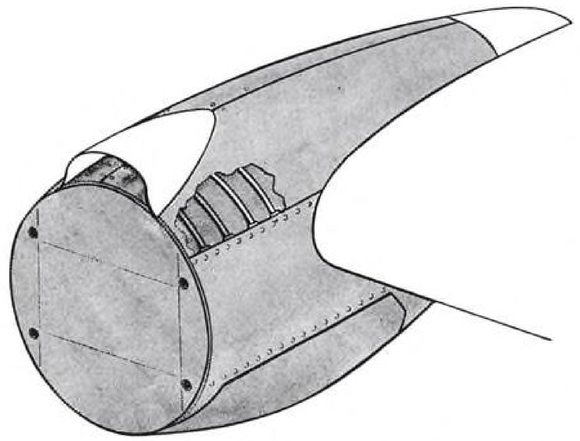
facts about a new metal for the aviation industry

TITANIUM is superior to other structural metals in terms of strength-to-weight ratio. And its corrosion resistant properties are remarkable, too. To acquaint you more fully with its characteristics, here are other facts about this new ductile metal.

Engine nacelles and firewalls of the new Douglas DC-7 superliner will consist of Rem-Cru RC-70 titanium sheet.

Forming Properties—You can form airframe sections of titanium on the same equipment you use for forming stainless steel. Most forming of RC-70, the standard commercially pure grade of REM-CRU titanium, is done at room temperature. More difficult forming operations with RC-130A, a titanium alloy, are usually carried out at moderately elevated temperatures such as 500-900 F. The forming is best done slowly, without rapid or severe deformations.

You can also shear and punch titanium with the same die setup as you use for stainless steel. Titanium parts can be stretch-formed, or formed on a hydropress or drop hammer. But in these cases, too, you should perform the work at moderately elevated temperatures.



Shaded areas show where Rem-Cru titanium is used in DC-7 nacelles

Application to DC-7—A good example of the use of titanium is provided in the new Douglas DC-7 airline transport. Here the use of REM-CRU titanium in place of aluminum alloys and stainless steel in nacelles and firewalls effects weight savings for the Douglas Aircraft Company of approximately 200 pounds per airplane. These sections are formed from RC-70 sheet, in gauges varying from .016" to .060" and lengths up to 120". Douglas stretch-forms the nacelle skin at room temperature. They shape ribs and stringers by brake or roll-forming, then stretch-form them to the proper curvature. In the assembly operations Douglas both spot welds and rivets the titanium sections.

Availability—REM-CRU—a principal producer of titanium—makes bars, plates, sheet, strip, wire, tubing, forgings and billets in four grades. RC-55 and RC-70 are commercially pure grades; RC-130A and RC-130B are titanium-base alloys. We are currently expanding melting and mill facilities so that within a year our production will increase several fold.

To keep abreast of the latest developments on this vital metal, write for the Rem-Cru Review—a free periodical devoted to the application and fabrication of titanium and its alloys.

REM-CRU TITANIUM REM-CRU TITANIUM, INC., MIDLAND, PENNSYLVANIA

transmits over its communications set, a ground-based direction finder orients the direction of the broadcast and creates a thin radial line on the radar scope which passes through the airplane's target blip, thereby identifying it.

The Terminal Area Section is guiding the development of the very-high-frequency radar which is to be used with RADC's automatic landing system. The device must accurately establish the height of an aircraft from the ground during the final phases of landing and flare-out. Other section responsibilities include consoles for control towers and radar air traffic control centers.

► **Making Failure Pay Off**—People normally don't talk about the developments that turned out to be impractical, but Fred Moskowitz, chief of Lab. No. 2, freely brings up one that failed badly to meet its original, but undisclosed, objectives—and turned out to have very important uses which no one had conceived of at the time the development was launched.

Somebody recognized that the sporadic and unpredictable signal return from the skywave could provide vitally important information. If there was heavy skywave signal return at some particular range and operating frequency, that meant radio energy (skywave) was getting through under existing atmospheric conditions to that distant point; little or no return—the signal was not getting through. This phenomenon could be used to determine the optimum frequency to use in radio communications.

So the device was renamed COZI (communications zone indicator) and designed to permit rapid switching of its operating frequency over the band. It, for example, an operator wants to find the best frequency for use in radio communications with England, the antenna is pointed in that direction and its elevation angle adjusted until the range or distance of the ground clutter echo corresponds to the distance to England (corrected, of course, for the geometry of the problem). Then the transmitter frequency is varied until the maximum returning signal is obtained—and that is the optimum communication frequency at that time.

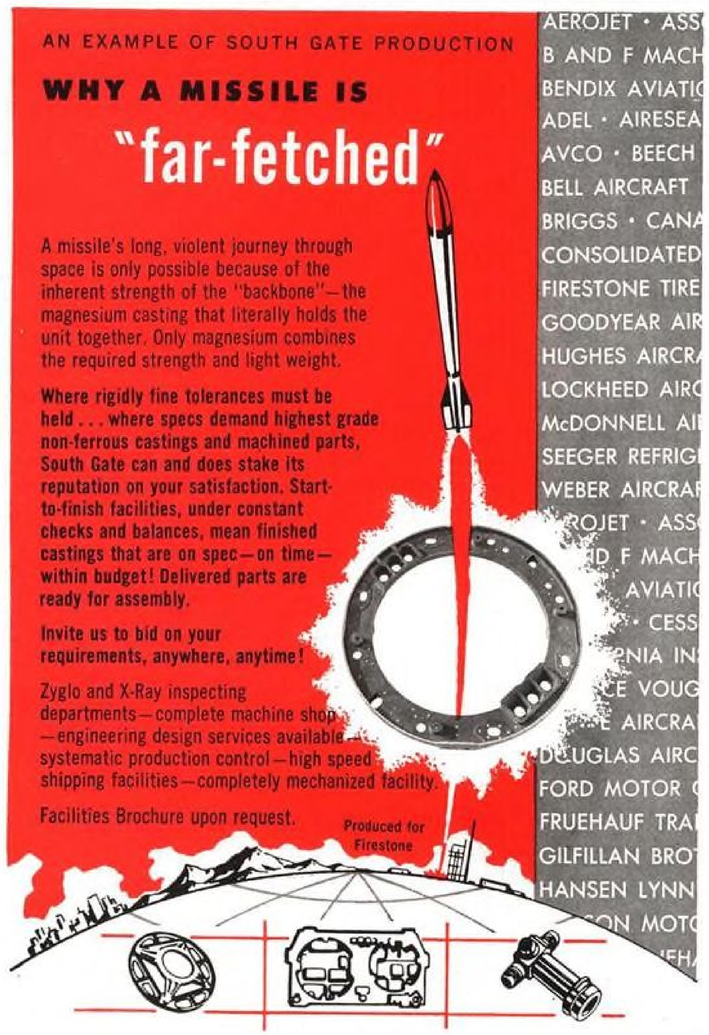
► **Lab No. 2 Activities**—Most of the efforts of the 42 civilian engineers assigned to Lab. No. 2 are spent in guiding outside developments and assisting the AMC in production liaison, Moskowitz reports. Only 10% of lab efforts go into in-house development. The laboratory is divided into the following four sections:

- **DF & Data Transmission.**
- **Radio Communications Equipment.**
- **Long-Distance Navigation.**
- **Special Devices.**

► **Versatile DF**—One product of the DF & Data Transmission Section is the AN/CRD-6, a complete UHF direction finding station capable of working more than six aircraft simultaneously and designed for remote operation. The station can be remotely tuned to any one of 10 pre-set crystal-controlled channels and can transmit its "findings" by cable up to five miles. Another section project is devoted to decreasing the bandwidth requirements for transmitting radar scope presentations from remote radar sites. By converting radar intelligence into a pulse code, RADC hopes to trade time for a narrower bandwidth to permit the use of conventional telephone wires for transmission instead of requiring expensive coaxial cable.

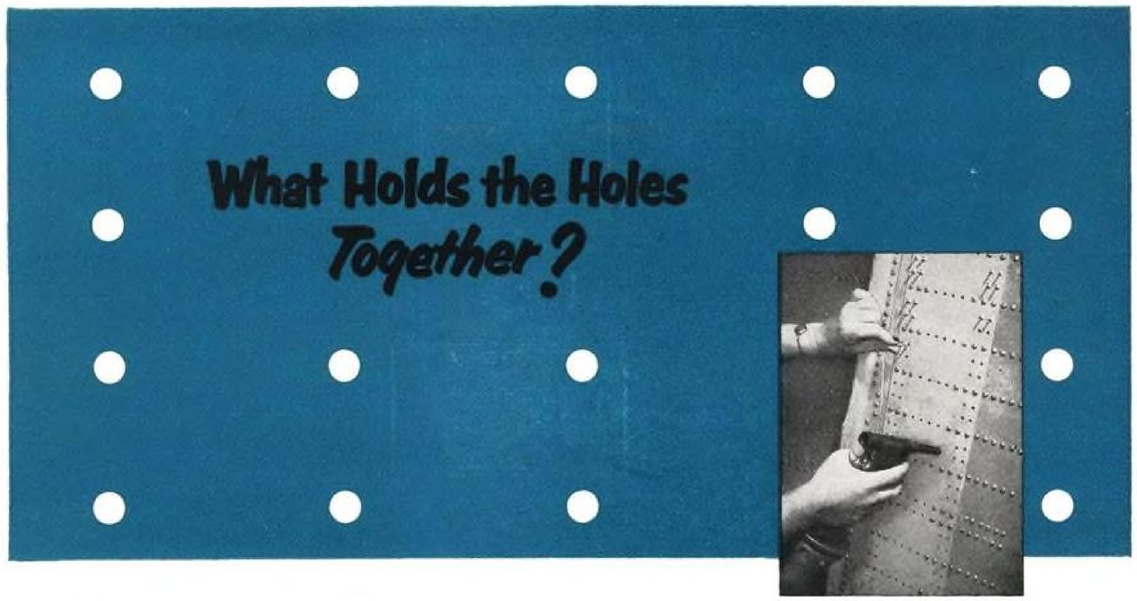
► **Radio Communications**—The Radio Communications Equipment Section of Lab. No. 2 has responsibility for AF ground-based UHF and HF communications gear, although the Signal Corps develops most of the ground-based HF equipment used by the three services. Wherever Air Force needs are unique, such as in mobile controllers, the work falls to this section.

Great progress has been made in unifying the radio communications needs



New York—Bank of Manhattan Bldg. • 29-27 Bridge Plaza • Long Island City 1, New York
Tulsa—Bob Ward Bldg., Rm. 202 • 1341 So. Boston • Tulsa, Oklahoma

SOUTH GATE ALUMINUM & MAGNESIUM CO.
The only mechanized light metal foundry West of Chicago
5331 TWEEDY BLVD. • SOUTH GATE, CALIFORNIA • LOrain 6-5161

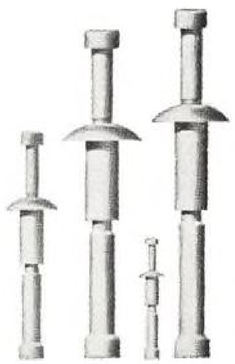


"A plane is a collection of aluminum holes held together by rivets," an aircraft designer once said jokingly in emphasizing the importance of rivets to aircraft construction. The majority are solid rivets which are driven and bucked by conventional methods. But a vital minority are actually precision parts, such as Cherry Blind Rivets, of which as many as 250,000 are used in one super-bomber—60,000 in a smaller fighter or transport.

These ingenious fasteners are set quickly and easily by one man from one side of the work with a special tool that pulls the rivet tightly into place without bucking, hammering or exploding. Blind rivets are virtually indispensable to modern plane construction as their use makes possible riveting in difficult-to-reach places, thus permitting freedom of design not possible with other types of fasteners. This feature also enables manufacturers to cut unit costs and speed production.

Townsend's Cherry Rivet Division at Santa Ana, California, is dedicated to the production and perfection of this single product. Here, highly trained personnel using Townsend designed and built equipment devote their entire attention to the manufacture of these precision rivets which are matched and tested against an elaborate set of specifications in order to give the excellent performance required. The greatest portion of Cherry Rivet production goes into military aircraft and will continue to do so as long as the nation's aircraft needs remain critical.

Cherry Blind Rivets are only one of some 10,000 different types, sizes and kinds of Townsend fastening devices produced at its several plants. With all these items at their command, Townsend engineers are able to give you unbiased advice—help select or design the fastener best suited for your product or assembly methods. A folder describing Townsend fasteners which are used to increase efficiency and improve products is yours for the asking.



Townsend
COMPANY • ESTABLISHED 1816
NEW BRIGHTON, PENNSYLVANIA
Sales Offices in Principal Cities
Cherry Rivet Division • Santa Ana, California

THE FASTENING AUTHORITY—Experience: *over 137 years*—**Capacity:** *sixty-million parts daily*—**Products:** *over ten-thousand types of solid rivets—cold-headed parts—Cherry Blind Rivets—Twinfast Screws—self-tapping screws—tubular rivets—locknuts—special nails—formed wire parts.*
Plants: *New Brighton, Pennsylvania—Chicago, Illinois—Plymouth, Michigan—Santa Ana, California.*

Ni-Span Diaphragms by Bendix-Friez

ARE HEAT TREATED IN A VACUUM FURNACE...THEN TUKON TESTED FOR HARDNESS

The vacuum furnace in our laboratory radiantly heats diaphragms to obtain proper hardness and correct thermo-elastic properties. The extremely high vacuum prevents oxidation.

Then we Tukon test our diaphragms for hardness. This is precision testing. It is a mechanized check, with an optical reading.

Other Bendix-Friez Advantages

In our engineering laboratory, that is devoted exclusively to diaphragm development work, we have electronic micrometers for measuring motion. We have a mass spectrometer leak detector.

We have hot and cold pressure chambers that permit us to simulate the extreme conditions to be found in industrial applications. We have automatic barometers. We use a primary standard barometer for ultra precise indicating and recording, against which are calibrated working standards. All this equipment and our sources of supply are yours. All yours too, is our years of experience starting with our original research on radiosondes.

For further information, write to L. E. Wood, Chief Engineer, address below.

BENDIX FRIEZ

FRIEZ INSTRUMENT Division of Bendix Aviation Corporation
1422 Taylor Ave., Baltimore 4, Md.

EXPORT SALES: Bendix International Division
72 Fifth Avenue, New York 11, New York

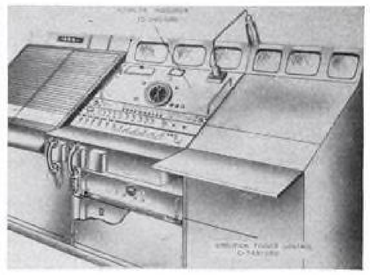
of the three services, particularly in ground-based gear, reports Ralph Marks, section chief.

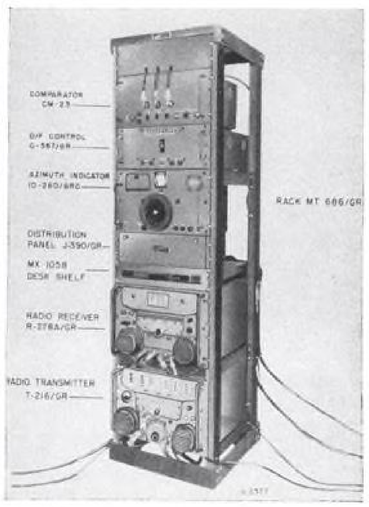
▶ **Exalted Carriers**—RADC is carrying on considerable in-house investigation of "exalted carrier" techniques (a dual side-band system in which the carrier is suppressed only when there is no modulation). Advantage of exalted carrier, Marks says, is that it permits a boost in peak power rating without increasing average power rating or consumption, which in turn cuts equipment weight and size. Another by-product advantage, Marks says, is that the exalted carrier technique practically eliminates the danger of overmodulation.

Marks says that RADC is quite interested in single-side-band transmission to give better reception under high noise conditions and to provide more communications channels.

The Signal Corps is doing much of the SSB work, Marks says, because SSB finds its greatest application to the HF band. However RADC is sponsoring some SSB research at General Electric and Stanford University.

▶ **Long-Range Navigation**—One of several long-distance navigation systems





AN/CRD-6 UHF direction finder console (top) and receiver transmitter (bottom).

JEEP-MOUNTED mobile radio station has HF and UHF communications.

under test by the section of the same name is called Navaglobe. This low-frequency 100-150 kc "omnirange," conceived and developed by Federal Telecommunications Lab, has an effective range of 1,500 nautical miles and normally gives a bearing accuracy of one-half to one degree.

A single station is capable of covering approximately seven million square nautical miles. Navaglobe's advantage over loran is that it gives Great Circle bearing directly without reference to charts.

The ground station consists of three antennas ("A," "B," and "C") located at the vertices of an equilateral triangle whose sides are 0.36 to 0.4 times the operating wavelength. In operation a constant amplitude and constant carrier frequency pulse is transmitted first from antennas "A" and "B," then, after a brief pause, a similar pulse is transmitted from antennas "B" and "C," followed by transmissions from antennas "C" and "A." Finally, a synchronizing pulse is transmitted simultaneously by all three antennas. The entire cycle takes one second.

Because of its relatively low pulse-switching rate, Navaglobe gets by with comparatively narrow bandwidth, assuring a good signal-to-noise ratio.

An airplane's bearing relative to the Navaglobe station will determine the relative amplitudes of the three signal pulses received (ratio of AB to BC to CA). An airborne receiver compares these pulse magnitudes to establish automatically the plane's bearing relative to the station.

A production-designed airborne Navaglobe receiver would be comparable in size and weight to present VHF omnirange receiver, Moskowitz says.

▶ **Consolan**—RADC has been working on an improved version of the Sonne system used by the Germans during the war, and the similar Consol system developed by Britain. RADC calls its system Consolan. Its big advantage, like that of its predecessors, is that it requires no special airborne equipment for aircraft carrying a communications receiver and direction finder.

RADC's Consolan operates at 193 kc. from a two-antenna site, has a usable

AVAILABLE IMMEDIATELY

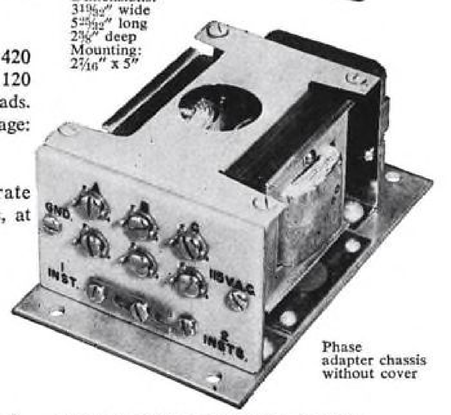
NEW, TYPE P-1, U.S.A.F. APPROVED

PHASE ADAPTERS

115 VOLT—400 CYCLE—SPEC. 32547A

All Components JAN approved

Dimensions:
3 19/32" wide
5 25/32" long
2 3/4" deep
Mounting:
2 7/16" x 5"



Phase adapter chassis without cover

White Phase Adapters are fully approved for aircraft use. Type P-1 meets Air Force specification 32547A. No moving parts, thus requiring virtually no maintenance. Type P-1 converts single-phase power to 3-phase power at relatively low power levels.

Will operate either one or two — GE KB-1 or Sperry B1 Gyrohorizon. GE C-1 or Sperry C-1 Directional Gyro. Attitude Gyro, Gyrosyn Compass, Roll Stabilizer or Pitch Stabilizer (with starting loads up to 125 VA)

Input — 110 to 120 volts. 380 to 420 cycles. Single phase. **Output** — 120 volts ± 15 volts at 30 or 60 VA loads. 3 phase, delta connected. Test Voltage: 1000 volts RMS.

Climatic Conditions: Will operate from −60°C to +71°C ambients, at altitudes up to 50,000 feet.

Meets USAF spec. 41065B:
Vibration — Method 61
Salt Spray — Method 51
Humidity — Method 31
Fungus — Method 71

White Industries, with many years of experience in the field of electro-mechanical equipment, offers you complete design, engineering and manufacturing facilities for producing to your specifications phase adapters, voltage regulators or other electromechanical devices. For prices on the P-1 phase adapter illustrated or for special quotations on your requirements write or wire our nearest sales office...

PLANT HEADQUARTERS:
421 West 54th Street
New York 19, New York
Plaza 7-2798

MID-WEST SALES:
Caine Sales Co.
3020 N. Cicero Avenue
Chicago 41, Illinois
Spring 7-4022

WEST COAST SALES:
M. B. Gilbert Co.
6214 W. Manchester Ave.
Los Angeles 45, Calif.
Oregon 8-5767

Suppliers to U.S.A.F., Lockheed, Glenn Martin, R.C.A., Republic and Westinghouse

WHITE INDUSTRIES INC.

DESIGNERS, ENGINEERS AND MANUFACTURERS OF PHASE ADAPTERS, VOLTAGE REGULATORS AND ELECTRO-MECHANICAL EQUIPMENT FOR AIRCRAFT

Announcing...

I.E.R.C. TUBE CLAMPING SHIELDS

Patents Applied For

for INCREASED RELIABILITY of MINIATURE and SUB-MINIATURE VACUUM ELECTRON TUBES!

I.E.R.C. shields meet environmental requirements for today's military electronic equipment.

NEW DESIGNS GIVE BETTER TUBE HEAT DISSIPATION, LOWER BULB OPERATING TEMPERATURES & LONGER SERVICE LIFE!

I.E.R.C. tube clamping shields are the newest and best answer to electron tube heat and vibration problems. Extensive bulb temperature reduction is made possible by conducting heat directly away from the glass envelope to the chassis or heat sink.

The I.E.R.C. design provides greater reliability, positive clamping and better cooling than any other type of shield or mounting method used with electron tubes. Tube clamp shields for all sizes of miniature and sub-miniature tubes are, or soon will be, available. We invite your inquiries on special design requirements.

FOR COMPLETE INFORMATION on I.E.R.C. tube clamping shields, write: International Electronic Research Corporation, 175 W. Magnolia Blvd., Burbank, Calif.

International electronic research corporation

BURBANK, CALIFORNIA

MANUFACTURED FOR INTERNATIONAL ELECTRONIC RESEARCH CORPORATION BY GRIMLEY ENGINEERING CORP.

signal range of about 3,000 mi. and an accuracy of approximately one-half degree, Moskowitz reports. This is a 50-100% improvement over World War II performance.

▶**Dots and Dashes**—To use Consolan, the pilot (or navigator) first DFs on the Consolan station to locate himself within a 5-10 degree sector. Then he listens to the station, counting the number of dots (short pulses) followed by the number of dashes (long pulses) or vice versa. This information is referred to a chart to establish his position within the sector established by DF. An alternate method involves the use of a stop watch to time the period during which dots or dashes are heard.

Disadvantages of Consolan are the errors introduced by skywaves (or the necessity for additional compensation chart) plus the fact that the system offers the chance for human error. Airborne equipment capable of performing these duties automatically could be designed, Moskowitz says, but its weight and complexity would then negate Consolan's basic advantage of simplicity.

This section is also working on several other long-range navigation systems of undisclosed nature.

The Long-Distance Navigation section is also experimenting with a novel type of long-range distance measuring equipment. (DME now in use on the civil airways is limited to line-of-sight ranges.) If the new DME proves out, it can be used with Navaglobe to provide input signals for offset track (rho-theta) computers, Moskowitz says.

▶**Special Devices Section**—As its name suggests, the Special Devices section is a sort of "catchall" for nondescript, but important, Equipment Development Division projects. For example, RADC had limited need for CAA-type VHF omnirange stations, but found that the CAA antenna array was too difficult and time-consuming to site and align, particularly for mobile use. Also, it wanted a broadband antenna which would permit a change in omnirange transmitter frequency without requiring antenna retuning.

Under RADC guidance, Federal Telecommunications Lab developed the "caged dipole" antenna which meets AF needs. This antenna consists of a small ½-wave dipole which rotates inside a cage, exciting the bars of the cage which in turn radiate the RF energy. Original problems with excessive vertical polarization in this antenna have now been solved by means of a small cap on top of the antenna, Moskowitz reports.

▶**Crash Locator System**—A system designed to locate crashed aircraft automatically to permit immediate rescue has been developed jointly by RADC and WADC. A small radio beacon (carried in the tail of an airplane) is catapulted out after a crash, and transmits an SOS, a special "crash code" as well as identifying the plane and the elapsed time since its crash. A series of ground-based stations developed by RADC will monitor the beacon wavelength continuously via an alarm receiver which is "sensitive" to the beacon's code despite high noise levels and low beacon power.

When the alarm receiver hears a beacon code, it automatically will turn on a tape recorder to record the beacon signals and a direction finder which takes a bearing on the crash beacon. This bearing is then converted into code and automatically teletyped to a remote plotting board which is also being fed by other crash locator stations. From two or more DF bearings, (only two would be needed if the beacon signal is coming through good and strong), the plotter calculates the most probable location of the crashed airplane, and plots a contour indicating the most likely area where the disabled aircraft may be found.

This system, slated for test this summer, is an interesting example of intercenter cooperation. WADC and RADC work together through a steering committee and there has been no need to assign overall system responsibility to

Looking beyond today's horizons

TWIGG

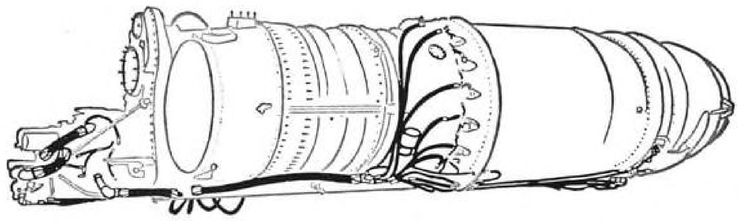
means precision and skill in the fabrication of components and assemblies for AMERICA'S FINEST JET ENGINES

Combustion chambers
transition liners
turbine casings
tail cones
burner supports
brackets
all types spinnings
other essential components

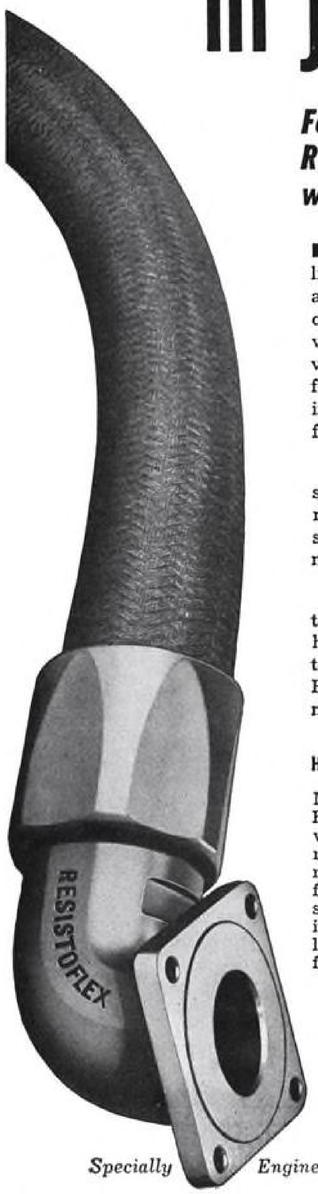
Foresight prepares Twigg Industries to meet America's future needs with modern methods, technical knowledge and professional skill.

TWIGG INDUSTRIES INC.

BRAZIL • INDIANA



fits close quarters in jet engines



For best space factor, "plumb" with Resistoflex Hose Assemblies fitted with integral aluminum elbows

■ Jet engines have little space to spare for hose lines. For these close quarters, Resistoflex hose assemblies with integral elbows seem made to order. Fittings are compact, close-coupled – yet with ample wrench clearance. Available in a variety of useful angles, they also eliminate need for combinations of swivel nut assemblies with individual adapters. This not only improves space factors further, but also eliminates extra parts.

Forged and machined in one piece from high strength aluminum, Resistoflex fittings offer extra resistance to fatigue. True internal turns and smoothly finished interiors assure full flow with minimum turbulence.

Extra tough to start with, and in mass production for over 4 years, these Resistoflex fittings have had 100% trouble-free service. Flanged fittings are USAF and BuAER approved. Send for Resistoflex Aircraft Products Catalog – it gives more data.

HOW YOU BENEFIT WITH "FLUOROFLEX-T" BACK UP RINGS

Made from "Teflon" resin, Fluoroflex-T anti-extrusion washers for use with "O" rings (1) resist heat . . . (2) reduce friction . . . (3) don't fray, swell, shrink, harden or soften in oils . . . (4) simplify installation . . . (5) increase life of the assembly. Write for bulletin FR-1.

RESISTOFLEX
CORPORATION
Belleville 9, New Jersey

Specially Engineered Flexible Resistant Products for Industry

■ AVIONICS

the one center, Allan Kunze reports.

► **Speech Compressor**—Another Special Devices project is a speech compression system to convert speech into a pulse code in order to transmit it over a 100-cps. bandwidth instead of the usual 3,000-cps. bandwidth. Similar techniques are employed to transmit radar scope presentations over a narrower bandwidth.

Kunze reports that the receiving end of the speech compressor is working at present and the transmitter is under way. One of the major problems is to reduce the present large equipment size, Kunze says.

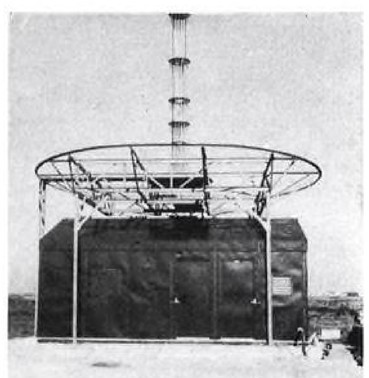
► **Data Link**—RADC is currently flight testing a data link system for transmission of guidance and navigation instructions via the communications receiver, without disrupting normal voice communications.

The object is to permit automatic control from ground stations and to relieve the voice channels as much as possible. The RADC system requires only an adapter to existing communications receiver to sort out steering signals for presentation on cockpit instruments or for transmission to the plane's automatic pilot.

► **Conversation Interrupter**—Anyone who has tried to make an urgent phone call only to get repeated busy signals from a seemingly endless conversation on the other end, will applaud another Special Devices project. It is a device which will permit a priority caller to interrupt a telephone conversation in an emergency and cut out the unwanted party.

Electronic Warfare And Techniques

Electronic warfare, sometimes called electronic counter-measures, is a new domain of warfare which substitutes electromagnetic radiation for the bul-

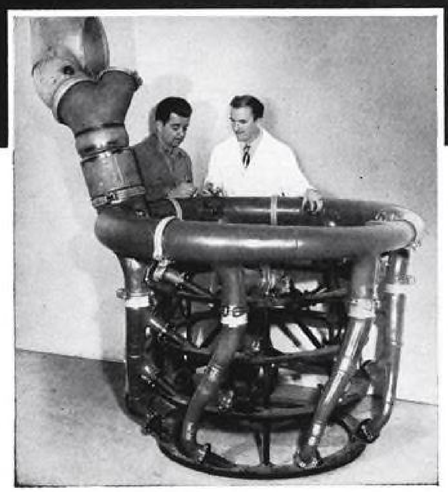


CAGED DIPOLE omnirange antenna.

RYAN
Aircraft and Aeronautical Products

Leaders in High-Temperature Metallurgy

for
JET, PISTON AND ROCKET ENGINES



In fabricating stainless steel and other heat- and corrosion-resistant alloys, Ryan's leadership has been established by proved techniques and long experience in this specialized field. With ceramic coating, continuous metallurgical research, and development of new alloys, Ryan is extending its research toward substitution of less critical materials for jet, piston and rocket engine components.

Typical of Ryan's high-temperature developments is this ceramic-coated exhaust system for Boeing Stratocruisers. The first company to put ceramic-coated engine parts into production, Ryan has proved they are highly successful in inhibiting corrosion and carbon absorption, thereby extending service life. Now ceramic coatings are available for jet engine components, too.

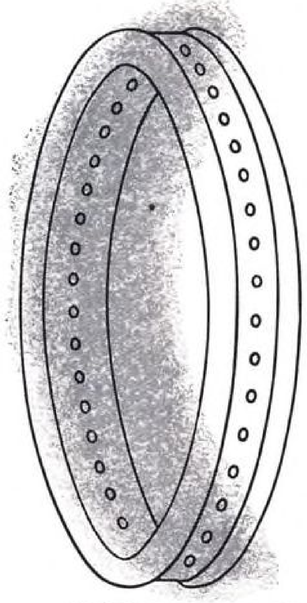
Ryan SINCE 1922

Metal Products Division • Jet Engine Components • Exhaust Systems • Rocket Assemblies

RYAN AERONAUTICAL COMPANY • LINDBERGH FIELD • SAN DIEGO, CALIF.

In tomorrow's
JET POWER PLANTS

CIRCLE L
LEBANON Castings
are at work



Lebanon Steel Foundry, the largest producer of centrifugal castings for jet engines, is proud to have collaborated with the Wright Aeronautical Division, Curtiss-Wright Corporation, in developing this unusual one-piece casting. It incorporates many holes cast to size and in accurate locations, requiring no machining. Of special high-strength alloy steel, this piece is quite large in size and is designed to operate satisfactorily under high temperature conditions in one of Wright's newly-designed power plants.

Lebanon Steel Foundry supplies castings to Wright for the J-65 (Sapphire) turbojet engine, which is now in production, and is producing experimental parts for the company's other advanced jet power plants.

LEBANON Castings
CARBON, SPECIAL ALLOY AND STAINLESS STEEL
CIRCLE L
LEBANON STEEL FOUNDRY LEBANON, PA.

AVIONICS

lets, bombs and shells of conventional warfare.

▶ **New Coordinates**—Instead of being fought in the familiar battle coordinates of space, electronic warfare is fought in the coordinates of frequency and time.

Responsibility for developing equipment to permit the Air Force to wage electronic warfare from the ground, and for investigating new techniques for application to this and other fields of RADC activity, falls to the Electronic Warfare & Techniques Division.

The division, headed by R. O. Schlegelmilch (also a veteran of 10 years in RADC and predecessor labs), is staffed by approximately 140 persons, of whom about half are engineers and scientists.

Manpower is almost equally divided between the division's two laboratories: Electronic Warfare, under Joseph Vogelman, and Research and Applied Techniques, headed by Morris Handelsman. Both labs, and particularly the Research and Applied Techniques group, do more in-house development than other RADC labs.

▶ **Fighting With Radiation**—Electronic warfare may be divided into two forms, both closely related:

- **Active.** Influencing, disrupting or deceiving enemy electromagnetic transmissions by active countermeasures (such as jamming).
- **Passive.** Intercepting enemy electromagnetic radiations to learn his future battle plans and/or to determine enemy techniques and operating frequencies for use in developing our active countermeasures.

▶ **"Fire Fighting"**—Most of the countermeasures used during World War II were developed to meet specific needs and not as a part of a coordinated system of electronic warfare, according to Richard Libby, chief of the lab's Detection and Evaluation section. It was usually a case of "fire fighting"—putting out individual blazes," is the way Libby describes it. RADC is directing its current work toward more overall integration of electronic warfare techniques.

Postwar interrogation of former enemy military and scientific personnel has produced conflicting testimony as to the effectiveness of such World War II countermeasures as our use of chaff—large quantities of metal foil ribbons dropped from aircraft, which slowly flutter to earth creating a large radar echo on ground radars, aimed at masking intruding bombers.

▶ **Great Unknown**—One of RADC's tasks is to develop techniques to prevent our ground radars from being fooled by enemy-dropped chaff, but this is only a small part of the problem.

Enemy bombers may carry devices to generate electromagnet radiation to jam our ground radars and communications. Equally important, we want to jam their bombing radars to make them ineffective. This lab must be able to counteract enemy radiation through the entire electromagnetic spectrum, "from d.c. to the frequency of light," is the way Libby expresses it.

Deception is another in EW's bag of tricks. One technique reportedly used by the Reds in Korea is to set up a radio beacon operating on the same frequency as those which we set up near airbases for homing purposes. An unwary U. N. pilot is apt to home on the enemy beacon and fly into a mountain top.

▶ **In Readiness**—Uncertainty on what avionics equipment or countermeasures an enemy may throw at us poses an obvious problem to the EW lab. The lab recognizes that it would be far too expensive to build up vast quantities of equipment to combat anticipated enemy equipment that might never be used against us. Yet they recognize that it takes five to six years to research, develop, design and get new equipment into production.

For this reason RADC spends its limited EW resources mostly on research and development. The idea is to have a large number of equipments completely designed and ready for production, when and if needed. Actual production time is then only a matter of months. Operating on this philosophy, RADC is building up a reservoir of electronic warfare knowledge in industry, universities, and the Air Force, to enable it to counter the unexpected.

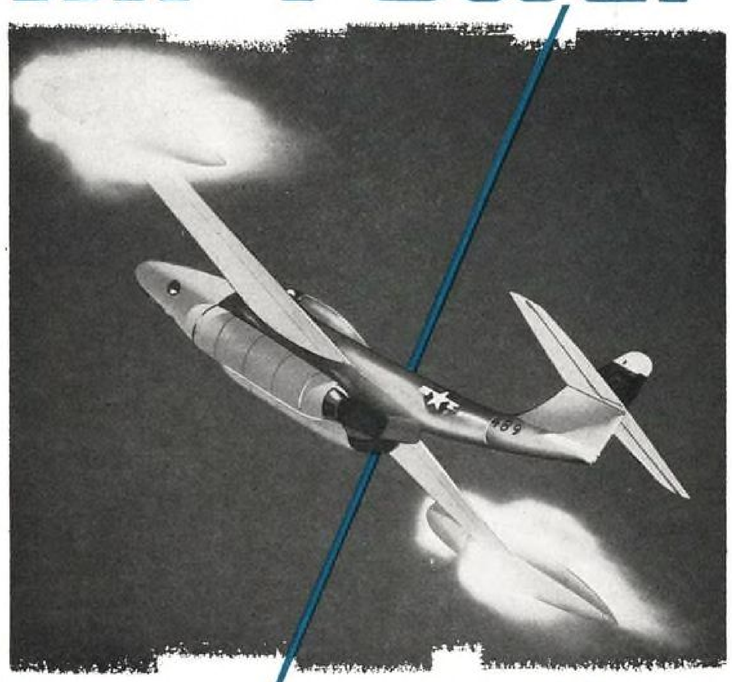
▶ **Seek the Weak Link**—Engineers designing EW equipment need a strong background in a variety of equipment techniques, to enable them to seek out the most vulnerable spot in the equipment they seek to counteract or jam. They must also consider the economics of the problem and employ techniques which will be least expensive to manufacture.

Not knowing what the enemy might use, the engineer must make a realistic appraisal of the probability of an enemy using or not using certain types of avionic equipment.

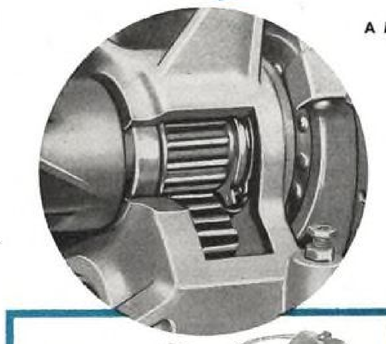
▶ **We vs. Us**—Lacking knowledge of enemy capabilities, there is a tendency for us to design our EW equipment to "fight" our own airborne equipment, Libby says. This is a healthy situation because it pits all the ingenuity of our airborne equipment designers against our ground-based electronic warfare designers.

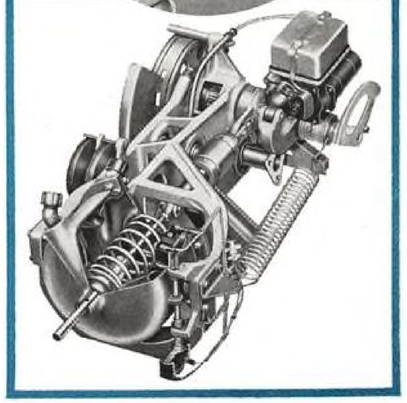
When, for example, tests show that RADC developed techniques will jam WADC-developed bombing radar, WADC engineers are spurred to greater efforts on "jam-proofing." Similarly if WADC develops a "jam-proof" air-

Air Power



you can see and feel!





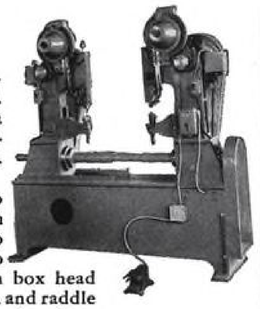
A MUFFLED ROAR... a wisp of smoke and a barrage of rockets blast from the wing tip pods of the U.S. Air Force's "grand slam" Northrop Scorpion F-89D as this all-weather interceptor streaks across the horizon at a speed of 600 miles per hour. Behind the feel of the stick in the hands of the pilot as he sweeps through space, is an elevator trim and force producer assembly made by ADVANCE GEAR & MACHINE CORP.

Precision engineering has marked every detail of construction on this assembly. ADVANCE is proud to have contributed to the outstanding success of the F-89D. Since 1936 ADVANCE engineers have been working hand in hand with aircraft manufacturers, supplying intricate gear assemblies to meet the most exacting specifications. We invite your consideration of our facilities.

Advance Gear & Machine Corp.
5851 Holmes Ave., Los Angeles 1, Calif.
Phone JEfferson 8103

Speed Production.. Automatically with **T-J**

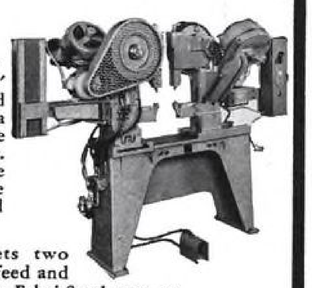
RIVITORS



T-J RIVITOR used for automotive clutch plate assembly. Saves time and labor doing a four-fold job—assembling, setting, inspecting and ejecting.

DOUBLE RIVITOR sets two rivets at a time! Equipped with 10″ hoppers, and tooled to automatically feed and set two ¼″ diam. x ⅝″ long wagon box head rivets at a time in elevator chain and raddle or elevator flight assemblies for farm implements. Controlled by one foot pedal.

CLINCHORS



T-J CLINCHOR . . one of six special 8″ throat Underfeed Clinchors used by a large automotive body manufacturer. Feeds and sets 11/16″ square cased nuts in outside quarter panels, left and right hand.

DOUBLE CLINCHOR sets two nuts at once! Tooled to feed and set ⅜″ x ½″ x 1/16″ thick Fabri-Steel nuts at each operation. Both Clinchors tripped by same foot-operated valve. Adaptable to wide range of clinch nut setting problems.

Boost production . . . save labor with T-J Rivitors and Clinchors for many assembly jobs today . . . in aircraft, automotive, farm machinery, stampings of all kinds.

T-J CLINCHORS set clinch nuts 3 to 5 times faster! Fully automatic . . . controlled by a single foot pedal! Available in Underfeed and Gravity feed models, throat depths 8″ to 36″.

T-J RIVITORS automatically feed and set solid rivets . . . with high production! Electrically-powered Rivitor sets 1/16″ to ¼″ diam. solid steel rivets up to ⅞″ long. Air-powered Rivitor sets aluminum alloy rivets up to ¼″ diam. or steel rivets up to ⅛″ diam. and up to ¾″ long. Throat depths 8″ to 36″.

Write for Clinchor bulletin 847; Rivitor bulletins 646 and 847. The Tomkins-Johnson Co., Jackson, Mich.

37 YEARS EXPERIENCE T-J

TOMKINS-JOHNSON

RIVITORS . . AIR AND HYDRAULIC CYLINDERS . . CUTTERS . . CLINCHORS

borne bombing radar, RADC engineers must develop new techniques.

▶ **EW Lab Operation**—When a military requirement for new EW capabilities arrives in the lab, it is evaluated by the Integration & Analysis section to establish the technical requirements. From here the program moves to the Detection & Evaluation section and the Countermeasures & Deception section.

These groups sponsor the development of experimental equipment, either within RADC or by contractors, to establish the EW techniques needed.

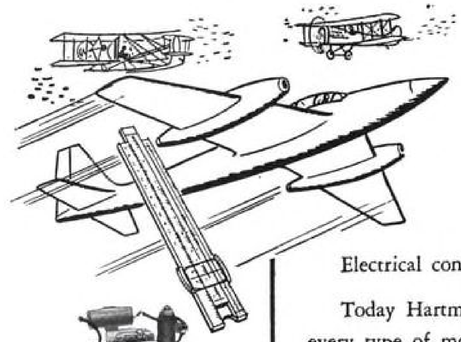
The Production Development section is responsible for guiding the development of prototype equipment by industrial contractors, and for building up industrial interest and potential in EW. Evaluation of this prototype equipment for tactical suitability is accomplished by the Engineering & Operational Evaluation section.

As an additional objective the EW lab is trying to establish itself as a place where industry engineers designing avionic equipment can come for consultation on the latest anti-jamming techniques.

▶ **Research & Applied Techniques**—Approximately half of the efforts of the Research & Applied Techniques lab are devoted to developing components and techniques which will find use in ground-based avionics five to 10 years from now; the other half is devoted to solving RADC's current problems and meeting its current needs.

Prior to the January reorganization, the R&AT Lab was part of the Radar lab, which explains why much of its current work is in the field of radar and microwaves. However the lab is fast expanding its activities into the lower

R. O. Schlegemilch, Chief
Electronic Warfare & Techniques



RIGHT
from the beginning

Electrical controls are Hartman's business . . . and have been for over 50 years.

Today Hartman makes relays, cutouts or contactors for nearly every type of modern, high-speed aircraft, both multi-engine transport and military jet. Hartman designs, engineers, develops, and produces these highly specialized controls in its own plant.

So if you have a problem involving electrical control—*either AC or DC*—turn it over to Hartman where it will be analyzed and engineered with an efficiency that comes from half a century of controls specialization. Then you'll know you'll be Right—from the beginning. A-7265

the Hartman Electrical Mfg. co.
"CONTROL HEADQUARTERS"
MANSFIELD, OHIO

Phase Sequence and Phase Failure

400 Cycle Under-frequency Relay

600 Ampere Contactor

High Interrupting Capacity Cutout

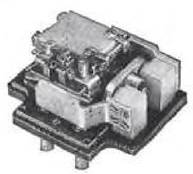
USAF Type T-1 High Interrupting Capacity Contactor

600 Ampere Reverse Current Cutout AN3025-2

Control Relay *(without cover)*

Equalizer Relay

1000 Ampere Reverse Current Cutout


Jet Starter Relay

Undercurrent Relay

Fault Sensing and Generator Control

Overvoltage Relay

Generator Field Relay or Exciter Control Relay

300 Ampere Reverse Current Cutout AN3025-1

HARTMAN ALSO MANUFACTURES

Polarized Relays • Selector Relays • AC and DC Contactors • Differential Relays • Fault Relays • Time Delay Relays • Automatic Paralleling Relays • Reverse Power Relays • Complete Control Assemblies

ENGINEERS
AND
SCIENTISTS

You are invited to write regarding long-range projects at Northrop Aircraft, Inc. Exceptional opportunities now exist to join the company's engineering and scientific staff. If qualified, you may select important developmental work, or equally vital production engineering.

Example of positions open are:

BOUNDARY LAYER RESEARCH SCIENTISTS
ELECTRONIC PROJECT ENGINEERS
ELECTRONIC INSTRUMENTATION ENGINEERS
RADAR ENGINEERS
FLIGHT-TEST ENGINEERS
STRESS ENGINEERS
AERO- AND THERMODYNAMICISTS
SERVO-MECHANISTS
POWER-PLANT INSTALLATION DESIGNERS
STRUCTURAL DESIGNERS
ELECTRO-MECHANICAL DESIGNERS
ELECTRICAL INSTALLATION DESIGNERS
ENGINEERING DRAWING CHECKERS

Qualified engineers and scientists who wish to locate permanently in Southern California are invited to write for further information regarding these interesting, long-range positions. Include an outline of your experience and training. Allowance for travel expenses.

Address correspondence to

Director of Engineering,
Northrop Aircraft, Inc.
1003 E. Broadway, Hawthorne, Calif.

AVIONICS

frequency regions and into the new fields of transistors and ferrites, according to Morris Handelsman, chief of this lab.

▶**Study Is Cheap**—Analysis and study are comparatively cheap, Handelsman says. That is why he encourages his group to do as much analytical and study work as possible to prove out fundamentals before letting contracts for the development of hardware. Approximately half of the current-problem development work is done in the lab; the balance outside.

In the field of advanced research, roughly 80% of the work is performed by outside contractors. In the past, industry has done the majority of this work, Handelsman says, but such universities as Brooklyn Polytech, Carnegie Tech, Syracuse and Cornell are edging farther into the field.

R&AT lab's applied research activities take it into the realm of AF Cambridge Research Center activities so there is considerable coordination between the two to prevent duplication of efforts, Handelsman says.

The R&AT Lab is divided into the following four sections:

- **Radio Frequency.**
- **Receiver & MTI (moving target indicator).**
- **Circuits.**
- **Echo Area & Propagation.**

▶**Improvements Bring Problems**—The greatly increased power of today's radars, coupled with the use of more sensitive mixer crystals to obtain better signals in the face of extraneous noise, raised the need for improved duplexers —fast-acting electronic switches which alternately connect the transmitter and receiver to the common radar antenna so that high-powered transmitter pulses don't swamp the receiver and burn out the mixer crystals.

Several years ago, satisfactory duplexers were "a real bind," Handelsman says, but not today, as a result of RADC sponsored developments.

▶**Stable Klystrons**—The RF section also sponsors the development of higher powered klystron tubes as possible replacements for the previously used magnetrons. Klystrons look attractive because of their greater frequency stability.

Handelsman reports considerable progress in this area, although he declines to say what output powers have been achieved.

Another area of great improvement is in antenna rotary joints. These have gotten increasingly complex with the use of additional antenna feeds, but new rotary joints with excellent characteristics have been developed, Handelsman says.

▶**High-Power Radar Lab**—The R&AT lab is quite proud of its new high-power radar lab, a research facility which can generate very large amounts of microwave power at any desired frequency. Just how much power this lab can generate was not disclosed for security reasons.

The lab, which is available to military contractors for testing high-power duplexers, rotary joints, klystrons, dummy loads, and the like, was constructed on a shoestring budget, largely from components scavenged from old obsolete radar sets, Handelsman says.

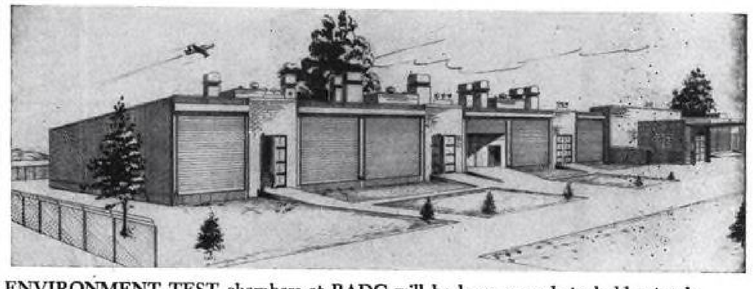
▶**"Cloak & Dagger" Antennas**—The RF section's work includes antennas for radar, navigation, communications, electronic warfare, and what Handelsman obliquely refers to as "cloak and dagger" applications.

In radar antennas, this section has sponsored an outside development which will permit the use of very rapid antenna scan rates and very narrow beam widths, an ideal combination for precision radars.

▶**Wanted: An Easy Formula**—A development and study program designed to save the government money and save its radar contractors many headaches is under way at Syracuse University.

The program is aimed at this problem: When mechanical tolerances are not held sufficiently close in the manufacture of large radar antennas, the beam shape is distorted; if held to theoretically desirable values, the fabrication of these antennas becomes an extremely expensive and exasperating job, Handelsman says.

What RADC wants is an easy-to-use formula which will allow mechanical designers to predict in advance the over-all effect of minor variations in various parts of the antenna. This should enable the antenna designers to establish acceptable mechanical fabrication tolerances.



ENVIRONMENT TEST chambers at RADC will be large enough to hold a truck.

Syracuse University has already completed part of the program: The relationship between electrical phase relationship of the radar energy and the antenna beam shape. Now it is working back to correlate this phase relationship and minor deviations in antenna configuration. End product is expected to be a design handbook for radar antenna engineers.

Other work in this group includes development of broad-band communications antennas to ease tuning problems and studies of the effect of radar feed horn defocusing in parabolic antennas.

▶**Target Discriminators**—As a result of RADC-sponsored developments, the moving target indicators (MIT) used in present radars are much better able to discriminate between real targets and spurious clutter than were World War II radars, Handelsman says.

This is partially attributable to improved circuitry, and partly to new devices like the quartz delay line which replaces the older mercury delay lines. Advantage of the quartz lines is that they are much smaller, lighter, and only one-third as sensitive to temperature change as mercury delay lines, Handelsman says.

▶**Reducing Cross Interference**—The Receiver & MTI section has developed circuitry called "video blankers" which reduce the cross interference from two or more radars, operating in close proximity.

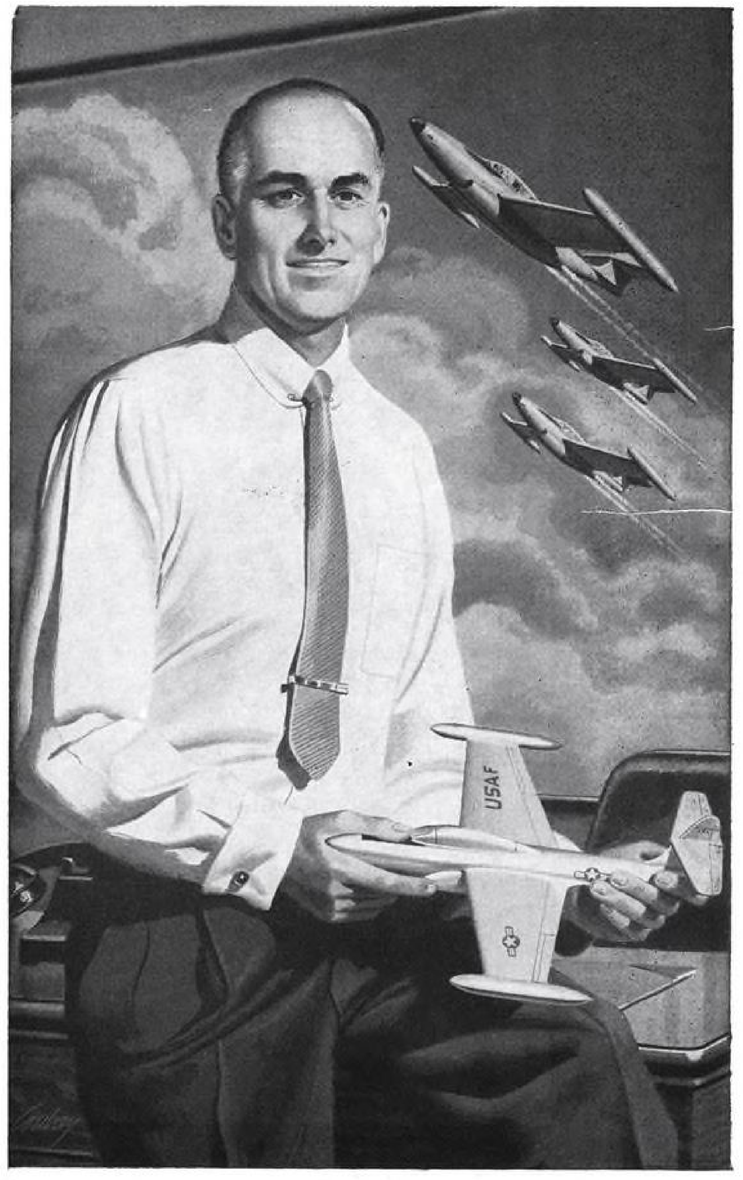
Another in-house development of which Handelsman is proud is a simplified technique for measuring incremental pulse time jitter to within 0.002 microseconds. This jitter is the short period variation in the firing time of hydrogen thyratron tubes used as modulators in MTI-equipped radars.

▶**Position Prediction**—One interesting development of the circuits section is a velocity-tracking circuit for GCA designed to give stronger target signals in the presence of much spurious noise.

The device is a combination memory and predictor. Based on the past velocity of the airplane (target) being tracked, and its last position, the velocity tracking circuit in effect predicts approximately where the plane will be during the next scan and then attenuates signals from outside the area of this predicted position.

▶**Investigating New Materials**—New devices and materials, such as transistors and ferrites, are also under exploration here. There are several programs under way to experimentally transistorize existing vacuum-tube devices.

Another outside program is pointed



Northrop's Prime Equation

Northrop *boundary-layer research scientists*, like the man above, are concerned with complex problems aimed at achieving the maximum efficiency in aerodynamic surfaces at high speed.

Equations are used to solve problems. At Northrop Aircraft, the prime equation combines teams of administrators, outstanding scientists and production specialists with modern industrial and research facilities. The combination efficiently converts imagination and knowledge into actual matériel of advanced design and incalculable value.

NORTHROP AIRCRAFT, INC.
HAWTHORNE, CALIFORNIA
Pioneer Builders of Night and All Weather Fighters
5A12

toward the use of ferrites to control the plane of polarization of microwave energy. The major problem here, Handelsman says, is to find techniques to enable ferrites to handle the very large powers involved. The use of ferrites for magnetic modulators and digital computer work is also under investigation.

This section also does advanced thinking on data handling, data gathering, and computer memory systems to determine what components will be needed five to 10 years hence.

► **Predicting Radar Range**—The Echo & Propagation section has developed an empirical technique which makes it possible to predict the range and performance of new pulse-type radars while they are still in the paper design stages. Handelsman reports that accuracy of prediction usually runs better than 15%.

The technique is based on an extensive analysis of the performance of a variety of existing radars against different size targets, to establish the performance of a "standard radar." From this known standard, the range of a new radar design can be extrapolated, based on the differences between it and the standard radar, Handelsman says.

The technique is applied, for example, to the design of new GCA or GCI radars to determine the optimum frequency and other design parameters based on the performance that will be required for the specific radar application.

► **Beyond Line of Sight**—Recent investigations have shown that microwaves can be propagated considerably beyond line-of-sight distances, previously considered their practical limit. This is particularly attractive for use in microwave communication networks in over-water areas where it isn't always possible to install microwave repeater stations within light-of-sight distance of each other.

There still remains considerable disagreement among the experts as to how antenna size, operating frequency, and pulse length affect beyond-line-of-sight performance, Handelsman reports. For this reason, RADC is sponsoring a program at Cornell University to investigate the effect of these parameters on long-distance performance. The E & P section is currently building equipment to test out Cornell's conclusions.

Engineering Support

RADC has located all of the technical supporting activities for its three other divisions, and their seven laboratories, in a single division, called the Engineering Support Division. RADC labs turn to this division whenever they need:

- Environmental test facilities.
- Radio interference reduction know-how.
- Investigation of new materials.
- Preparation of specifications.
- Mobile radio stations for flight test activities.
- Special instrumentation.

These are but a few of the many services provided by this division.

► **Support Labs**—The Engineering Support Division is staffed by approximately 270 persons, of which about 25% are engineers, according to O. G. Tallman, division chief. Tallman is a 12-year veteran with RADC and the earlier Signal Corps labs from which it was formed. The division is broken down into two laboratories and one branch. These are:

- General Engineering Laboratory.
- Test & Evaluation Laboratory.
- Services Branch.

► **Mechanical Engineering**—All mechanical design activities are centered in the Mechanical Engineering section, one of five sections in the General Engineering lab.

As originally set up, project engineers in other laboratories were to bring their mechanical design problems to this section. Recently it was decided to place a liaison engineer from this section in each of the seven development

the BIG NAME
IN FLUID PRESSURE CONTROLS
Pressure Switches • Regulators • Warning Controls
In-Flight Refueling Systems • Pressure Valves

Gorn Aircraft Controls Company are specialists in designing and mass producing accurate, sensitive, pressure-actuated devices that are compact, light in weight and simple in operation. Our reputation is based on the dependability of our products in service — plus our engineering ability to meet every specification in performance, delivery and price. The Republic F-84 is but one of the numerous modern planes equipped with Gorn Aircraft Control devices.

We can save you engineering and production time by applying our specialized knowledge, test equipment, model and manufacturing facilities to the development of pressure-fluid controls of any type.

If it's Fluid Pressure Controls
It's Gorn Aircraft Controls

AIRCRAFT DIVISION CONTROLS
Gorn ELECTRIC CO.
STAMFORD CONNECTICUT
EST. 1923

WEST COAST REPRESENTATIVES: Western Aircraft Supply Co., 8845 West Olympic Blvd., Beverly Hills, California.

DELIVERIES ON SCHEDULE

Grand Central Aircraft Co. at its Tucson, Arizona Division is dramatically demonstrating its capabilities, in its modification operations on the B-47 stratojets. New techniques, machines and procedures become routine in these constantly changing operations to better and step-up deliveries for our country's defensive strength. Production teamwork and departmental cooperation with its "pulling together" spirit has made possible the smooth integration of the Grand Central organization, that enables it to deliver a quality product to the Air Force on schedule.

View of B-47s being processed through a Grand Central Tucson hangar.

Experienced ENGINEERS WANTED

Experienced and qualified men of integrity are invited to write for information regarding positions in the long range B-47 stratojet modification program, at our Tucson, Arizona Division. We especially invite Electronic, Hydraulic and Aeronautical Engineers to contact us. Full employee benefits, high wage scales and excellent opportunities.

Grand Central employees enjoy the advantages of fine facilities and healthful working conditions — Their work over the past 25 years has given them tremendous prestige. Join the "Grand Central" family and share that prestige. You'll work on a long range project now under way, for the defensive strength of our country.

There is a better job for you with a real future, in the healthful climate of Arizona.

MAIL COUPON TODAY
Personnel Manager, Grand Central Aircraft Co.
Post Office Box 5072, Tucson, Arizona
5

name
address
city and state

I am qualified in the category checked below and wish further information
☐ Electronic Engineer ☐ Hydraulic Engineer
☐ Aeronautical Engineer

GRAND CENTRAL AIRCRAFT CO.
GLENDALE, CALIFORNIA — Grand Central Airport
TUCSON, ARIZONA — Municipal Airport

DON'T JUST LONG FOR IT!

Success begins when longing stops and action starts! The important thing for engineers in these times is to look to the future. Do you feel that perhaps there might be a place for you in an industry that offers exceptional advantages today, and even greater opportunity for tomorrow? Longing won't get it for you!

Perhaps you are not employed at your highest skill. At Westinghouse, top management philosophy dictates that every engineer be provided with challenging assignments . . . that management potential be quickly recognized and developed . . . and that inventive abilities be stimulated and encouraged.

For many years, Westinghouse has been setting the pace for the electronics industry. Westinghouse engineers have profited from this . . . in the form of excellent pay . . . liberal patent awards and stock-purchasing plans . . . and all of the usual personal security benefits, plus!

Opportunities exist for men with experience as—

RADAR DESIGN ENGINEERS

TRANSFORMER DESIGN ENGINEERS

SERVOMECHANISM ENGINEERS

MISSILE GUIDANCE ENGINEERS

DON'T just long for these things . . . write today and tell us about yourself. We'll reply by return mail.

Write to — DEPT. AVA

Westinghouse

ELECTRIC CORPORATION

109 WEST LOMBARD ST., BALTIMORE 1, MD.

■ AVIONICS

laboratories, to live more closely with the problems of that particular lab.

This section has specialists in such fields as shock and vibration, structural concrete (for large antenna and radio towers), antenna mast design, vehicular design, and shelters. Large radar and radio antennas pose major structural problems, Tallman points out, because they must be designed to withstand winds of very high velocity.

The ME section does all drafting for the other labs, and monitors drawing practices used by outside contractors to be sure that they conform to government and AF standards.

► **Interference Reduction**—Whenever project engineers encounter radio or radar interference problems, they can bring them to the Interference Reduction section. Ignition interference problems in vehicular equipment have been fairly well solved Tallman says.

Current work is devoted to basic studies on the character of noise, the sources of radar interference, and its tolerable limits. Some of this study work is being done in the house but much assistance is rendered by Purdue University.

This section is also working on techniques for improving radar modulators, connectors and other components, to eliminate sources of interference between radars operating in close proximity.

In the course of its interference reduction work, this section has developed field intensity measuring equipment, for both the lab and the field, as well as noise generators and calibrators, Tallman says.

► **Systems Requirements**—One of the responsibilities of the Systems Requirements section is to determine how much test equipment should be built into ground radars and other avionic equipment for use by line maintenance personnel. This involves a study of the equipment's design and field maintenance practices.

On some very important projects, this section works directly with the equipment manufacturer, Tallman says. On others, it works through the RADC project engineer.

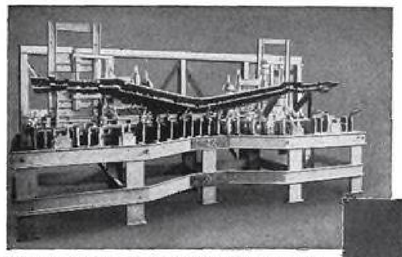
The Systems Requirements section also determines what new types of separate test equipment will be required. Supervision of a contractor's development of such equipment falls to another group, called the Instrumentation Development section. This section also serves as a consultant to other laboratories for specialized lab or flight test instrumentation and maintains a standards and calibration center for RADC instruments.

► **New Materials**—Investigations of the properties of new materials which have

TWIX

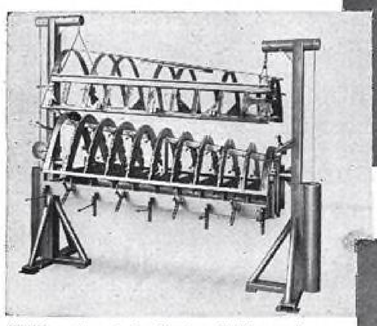
for ALL aircraft tooling!

TWIX, with over twenty years in aircraft tooling, offers its Engineering staff, Experience and Manufacturing facilities for the development of your Tooling Program. One of the largest tool and die plants in the East, TWIX has produced tools, dies, jigs, and fixtures of *every type and size* to precision aircraft requirements and to the closest tolerances. TWIX services includes PROCESSING, coordination and tooling of parts, sub and complete assemblies — individually or collectively.
Staffed by Professional Engineers.

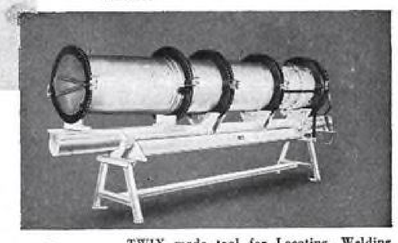


TWIX made Drill Jig & Locating Fixture: Drills the rivet holes and Locates and Holds all parts that make-up the Main Beam of the Aircraft. (Jig: 20' long x 4' wide x 10' high)

TWIX made Die to make a Hat-Sectioned Longeron in one operation. Longeron Dimensions: 72" long x 7" wide having Double Contour.



TWIX made tool for Routing, Drilling and Assembly of a Turtle Deck. (6' long, 4' high, 8' wide)



TWIX made tool for Locating, Welding and Riveting for assembly of Jet Tail Pipe. (20' long x 5' high x 3' diameter)

All Sizes
• Dies • Jigs • Fixtures
• Templates • Press Blocks • Dollies

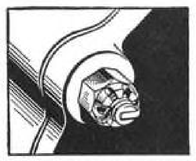
Write, wire, phone for FACILITIES LIST & TWIX OPERATIONS FORMAT.

TWIX MANUFACTURING CO., INC. *Aircraft Tooling Division*
40-11 Twenty-first St., Long Island City 1, N. Y. STillwell 4-0530
SPECIALISTS IN AIRCRAFT TOOLING FOR OVER 20 YEARS

FASTENER PROBLEM

How Piasecki cut costs

and assembly time on transmission fastenings



Castellated nut and cotter pin combination . . .

. . . replaced by one-piece, ELASTIC STOP nut.

Helicopters demand dependably vibration-proof fasteners for all critical applications. This once meant expensive and cumbersome castellated-nut and cotter pin combinations. Now Piasecki Helicopter Corporation uses ELASTIC STOP nuts on transmission housings and attachments in aircraft like the HUP-1 shown above.

By using standard AN-365 ELASTIC STOP nuts, Piasecki cut parts costs and speeded assembly. These self-locking nuts stay tight, right where you put them, in spite of vibration and stress reversals. They form a tight seal against the threads to prevent corrosion and seepage, yet can be removed and re-used many times.

Mail the coupon below for further information on ESNA self-locking fasteners.

ELASTIC STOP NUT CORPORATION OF AMERICA

ROLLPIN

Dept. N41-825, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey

Please send the following free fastening information:

☐ Elastic Stop nut bulletin
☐ Rollpin Bulletin
☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____

Firm_____

Street_____

City_____ Zone_____ State_____

■ AVIONICS

application to ground-based avionics are carried out in, or sponsored by, the Materials & Miniaturization section. This includes ceramics, plastics, metals, as well as plating techniques and encapsulating compounds for miniaturized avionic construction.

The objective of this section is to keep abreast of the current state of the art so as to spot potential RADC applications for new materials.

One example of the M&M work is in the use of bi-metals to fabricate radar waveguides, thereby greatly reducing weight and cutting the use of strategic materials. Another example is the high-strength plastic radome covering which is inflated around a large ground radar antenna like a rubber balloon, but is capable of withstanding wind and ice.

Once the initial groundwork is done, development of the new materials is normally contracted out to industry, Tallman says.

▶ **Test Equipment Service**—To avoid unnecessary duplication of test equipmen in the various RADC labs, the General Engineering lab provides a centralized test equipment supply service for all other labs.

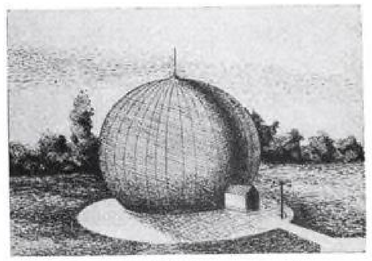
When an individual project engineer needs a specific piece of test equipment, he phones this centralized supply. If the lab has such equipment, and it is in stock, it is delivered to the engineer (and picked up when he's finished).

If the equipment is in use elsewhere, the lab has a record of who has checked it out and can refer the project engineer to that individual.

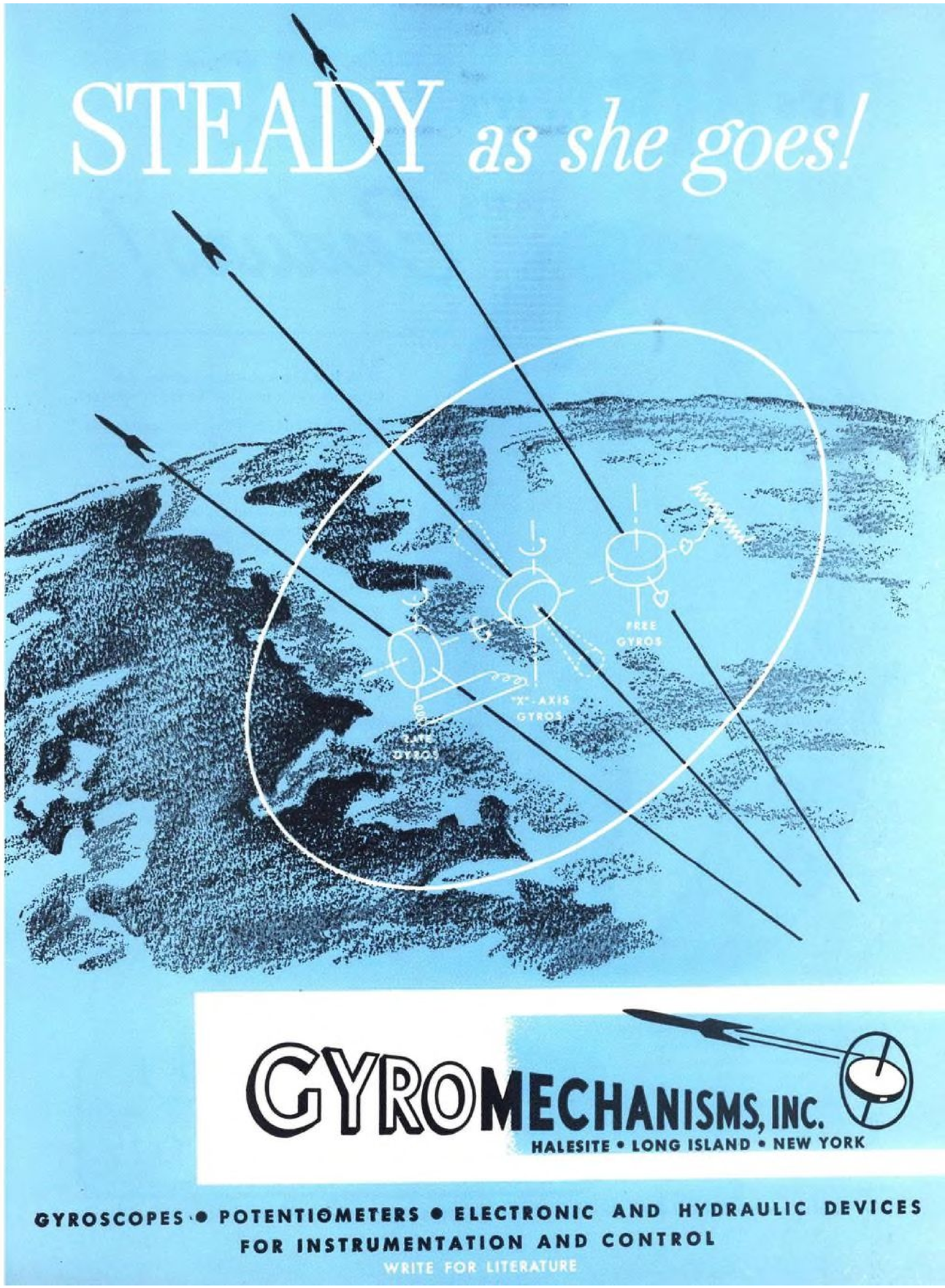
▶ **Services Branch**—One of the functions of the Services Branch is to provide mobile radio stations and crews which can be transported to other bases or to a contractor's plant to provide flight test communications facilities. The Radio Communications section of this branch also operates the GAFB radio stations which provide HF, VHF, and UHF communications for flight tests.

In addition, this section coordinates radio frequency allocations and secures any additional ones whenever they are needed.

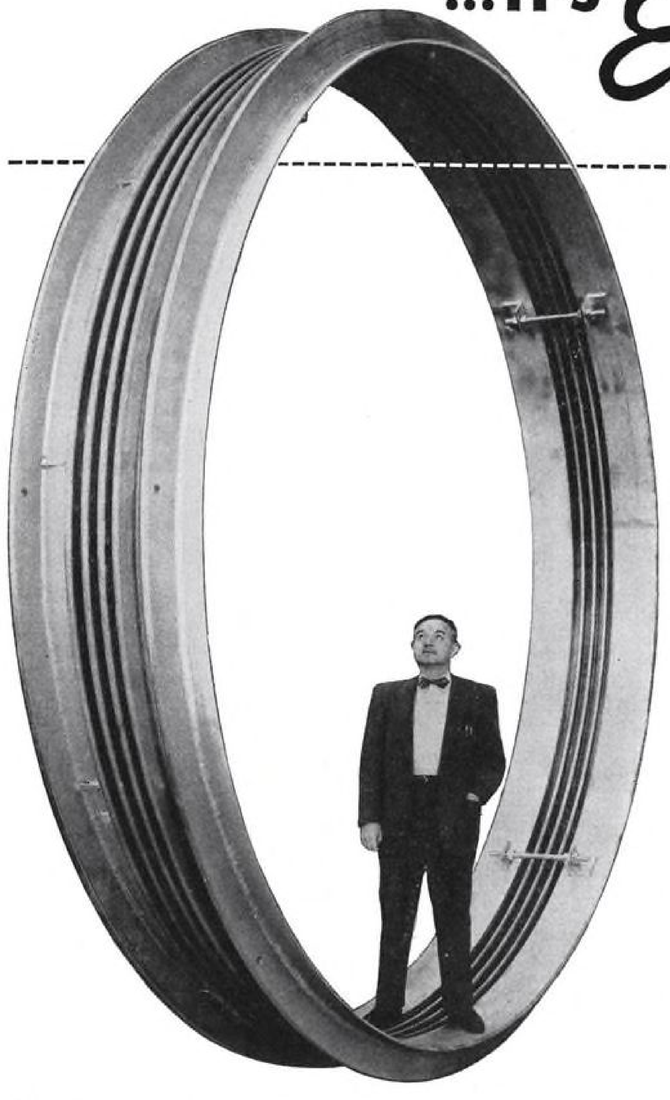
▶ **Spec Uniformity**—To achieve uni-



RUBBER BALLOON protects radars.



IT'S BIG ... IT'S TOUGH ...IT'S *Enduro!*



Yes, it is big and it is tough—it has to be! It's in a modern "torture chamber".

This ENDURO Stainless Steel expansion joint—thirteen feet in diameter—is part of an aircraft laboratory wind tunnel.

Eight of these giants are installed in the header between primary and secondary coolers of altitude exhaust ducts. They handle gases from full scale thermal jet engines, reciprocating engines, turbines, burners and other equipment tested in simulated high altitude conditions. Working pressures range from vacuum to 60 pounds... temperatures as low as –50° F. There's punishment aplenty.

Here's another application in which Republic ENDURO Stainless Steel demonstrates its great strength, toughness, resistance to heat and to corrosion . . . and its fabricating possibilities. Where can you next use these qualities? Republic metallurgists are ready to help you apply ENDURO to all types of aircraft development. Just write:

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Bldg., New York 17, N.Y.

Zallea Brothers, Wilmington, Delaware, use ENDURO Stainless Steel in manufacturing expansion joints of all sizes. Under the Zallea process, there are no circumferential welds in the corrugated section subject to flexing stresses.

Republic REPUBLIC STEEL
ENDURO® STAINLESS STEEL

Other Republic Products include Carbon and Alloy Steels—Pipe, Sheets, Tubing, Lockers, Shelving, and Fabricated Steel Building Products

■ AVIONICS

formity in RADC specifications, they are processed through the Engineering Data section of the Services branch. This same section also:

- **Prepares MIL-type specs** for RADC-developed test equipment used by all three services.
- **Checks the contractor-recommended** spare parts list for development equipment.
- **Issues authorization** for purchase of new developments.
- **Establishes type classification** (development, tentative standard, etc.) which tells tactical commands the status of the equipment from the standpoint of its use in the field.
- **Requests assignment** of standard JAN identification for new RADC-developed equipment.

► **Procurement Data**—The Production Procurement Data section is the focal point between the AMC unit here and RADC engineers engaged in supporting procurement programs.

Equipment specifications prepared by the RADC project engineer are run through this section to put them into accepted and uniform style before transmitting them to AMC.

This section, after consultation with RADC project engineers, makes engineering recommendation to the AMC, indicating whether it is feasible to break the procurement down into small contract chunks, whether it is a sole-source item, and whether a negotiated-type procurement is desirable from a technical view point.

► **Tech Information Group**—All information on foreign technology received by RADC funnels through the Technical Information section where it is evaluated and then disseminated to interested labs. This section also:

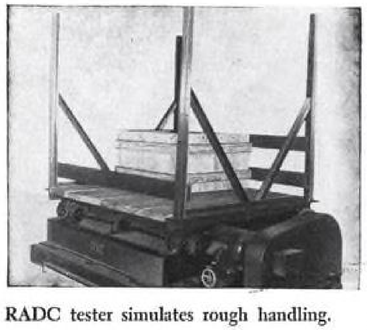
- Determines security classification of all RADC prepared reports.
- Processes progress reports on all laboratory projects.
- Operates a technical library and performs reference work.
- Receives all reports from outside contractors and acts as a repository for USAF and other military reports.
- **Provides editing,** art, and publication services for getting out RADC technical reports.

► **Test & Evaluation**—When RADC engineers want to evaluate new materials, test the performance of new equipment, or check its ability to withstand environmental rigors, they turn to the Test & Evaluation lab of the Engineering Support Division.

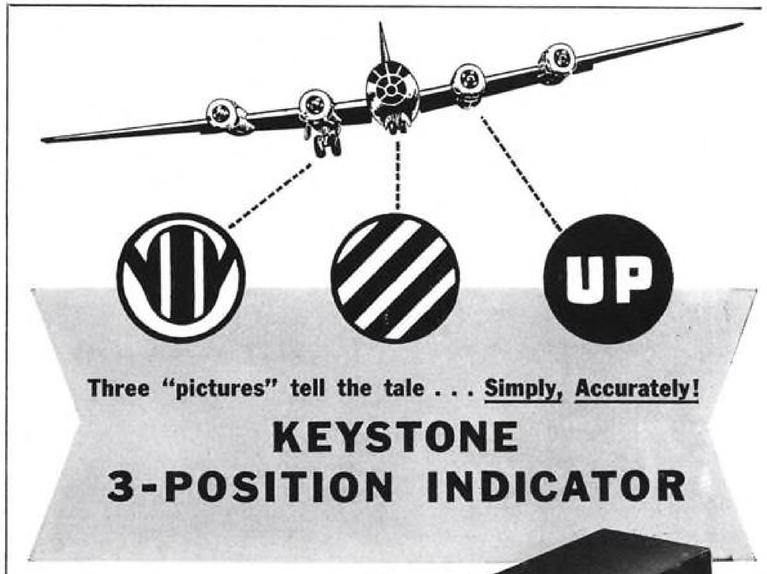
T&E lab personnel will perform these tests for RADC engineers (or RADC contractors) evaluate the material or equipment, and write a final report. Or, if the project engineer desires, the T&E lab will make available its climatic test chambers and facilities for him to conduct his own tests.

Typical T&E lab capabilities include the following types of testing:

- **Electrical.** Life tests, temperature rise, and suitability tests on small components, such as transformers, capacitors, relays, etc.
- **Electronic.** VSWR of RF transmission lines, phase shift at audio frequencies, servo system performance tests, spurious radiation intensity, analysis of audio frequency output.
- **Chemical,** Quantitative and qualitative analysis, quality control of plating solutions.
- **Physical.** Corrosion, hardness, tensile strength, impact, fatigue, elongation.
- **Various facilities** for mechanical and environmental tests.



RADC tester simulates rough handling.



Three "pictures" tell the tale . . . Simply, Accurately!

KEYSTONE 3-POSITION INDICATOR

Requires but a Small Space —Gives a "BIG PICTURE" on Operating Conditions

The landing gear markings shown above are but *one* of *eleven* different instrument applications. Tells the story "at a glance" on *flap positions, oil pressure or temperature, fuel supply* and other operating conditions. Economical, easy-to-install in both small and large planes.

Actual Size

High Quality Construction

- **Impervious to dust, moisture, gases**
- **Hermetically sealed brass case**
- **Filled with inert gas**
- **Optically clear glass window**
- **Corrosion resistant finish**

RIVERSIDE

For additional information, write to:

KEYSTONE WATCH CASE DIVISION RIVERSIDE METAL CO.
Riverside, New Jersey

SUPERIOR PERFORMANCE

On 3 Cycles to 20 megacycles

The LA-239C OSCILLOSCOPE

The Lavoie Model LA-239C has been designed to surpass the high performance of the Lavoie TS-239 A/UP, which has been the standard test oscilloscope for the Armed Services since its introduction. Model LA-239C is the result of a long period of research and development which has included the study of new tubes, new techniques.

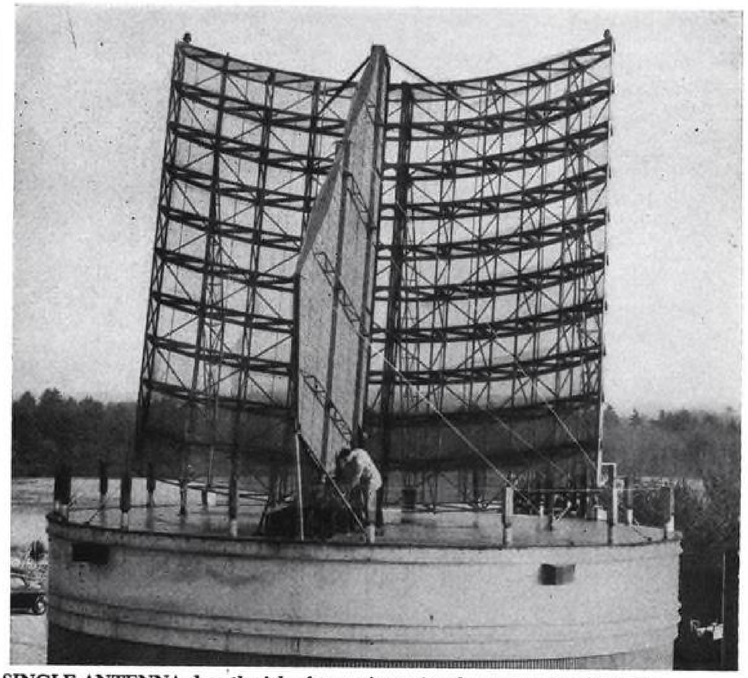
Send today for special bulletin which describes in detail these unusual features:

1. Wider Bandwidth
2. Extended Sweep Frequencies
3. Square Wave Response
4. Greater Stability
5. Higher Signal Sensitivity
6. Improved Timing Markers
7. Amplitude Voltage Calibration
8. Sweep Delay

Lavoie Laboratories, Inc.

Morganville, New Jersey

West Coast Rep. T. Louis Snitzer
5777 West Pico Blvd. — Los Angeles 19, Calif.



SINGLE ANTENNA does the job of two: gives azimuth, range and height data.

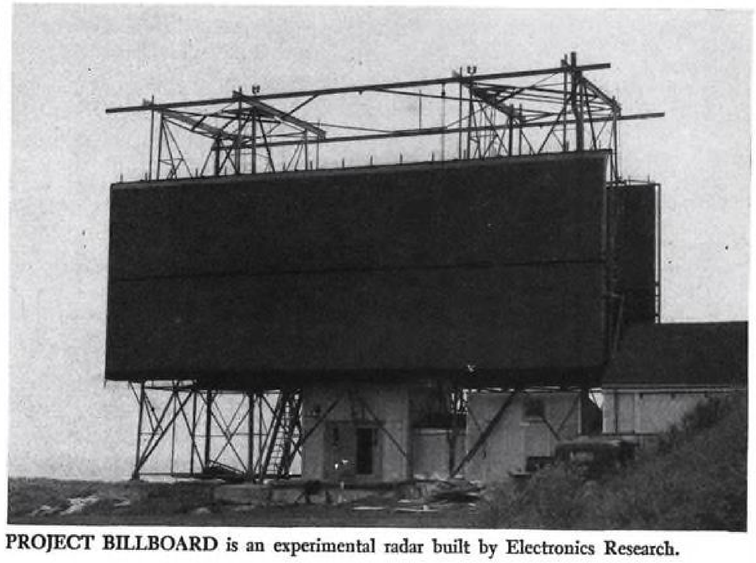
Electronics Research Directorate's Job:

Putting Avionics Research to Work

Cambridge, Mass.—There may be a radical change in spelling in the American language, at least in military and business circles, as a result of studies now under way at the Electronics Research Directorate of the AF Cambridge Research Center here.

Within five to 10 years, it should be possible to dictate a message directly to an automatic electric typewriter, via a microphone, and have the machine instantly type out the message with the words spelled phonetically, i.e. "fonetikly."

This AFCRC research program has far more important military uses than merely to help the harassed military or business man who has trouble getting



PROJECT BILLBOARD is an experimental radar built by Electronics Research.

TEFLON now in 14 COLORS*

Featuring

Tensolon HI-TEMP HOOK-UP WIRE

- EXTRA FLEXIBILITY
- FREE STRIPPING
- HIGH DIELECTRIC
- RATING-90 TO +250°C

*Black, brown, red, orange, yellow, green, blue, violet (purple), grey (slate), white, tan, pink (flesh), light green, light blue.

Built to meet rigid government requirements, Tensolon Hook-up Wires are available in sizes from AWG30 through 20 with stranded silver-plated copper conductors and the patented **Tensulated** Teflon® covering which eliminates pin holes and other irregularities.

TEFLON KIT FOR LABORATORY REQUIREMENTS—

Twelve 100 ft. rolls of AWG 22, in assorted colors in convenient compact container $124.00

TENSOLITE INSULATED WIRE CO., INC., TARRYTOWN, N. Y.

LEADING MANUFACTURERS OF SPECIAL INDUSTRIAL FABRICS TO EXACTING MILITARY REQUIREMENTS

- GLASS
- COTTON
- VINYON
- DYNEL
- ORLON

Our staff of engineers is at your service to help solve your fabric and tape problems.

Write for Swatch Folders

FLIGHTEX FABRIC
REGISTERED U.S. PAT. OFFICE

FLIGHTEX FABRICS, INC.
93 Worth Street New York 13, N. Y.
Leading Manufacturers of Fabrics and Tapes for the Aircraft Industry
Dayton Representative: Kurt W. Schmidt Associates, Van Cleve Hotel, Dayton, Ohio

AVIONICS

secretarial help. Nor does the AFCRC have any quarrel with accepted word spelling, inconsistent though it may be.

► **Three-Fold Objective**—The fundamental research into speech analysis and synthesis under way at AFCRC is pointed toward:

• **Cramming more information** into narrower radio-frequency bands, to create more communications channels in the crowded spectrum.

• **Speeding communication** to allow voice instructions to be instantly converted into printed instructions in one or more distant locations, without the delays and chance for error involved when humans must convert the oral message to hand-written notes and then transfer these notes to a teletype machine.

• **More effective cryptography.** By converting the spoken word into a series of pulses necessary to achieve the other objectives, the message can be "scrambled" in a greater variety of ways making it more difficult for an enemy to decipher.

► **Microtronics**—Although AFCRC's Electronics Research Directorate (ERD) doesn't scorn present subminiature avionic construction techniques for some current needs, it is researching new techniques which might permit a 100-fold decrease in equipment size compared with that possible with present subminiature techniques.

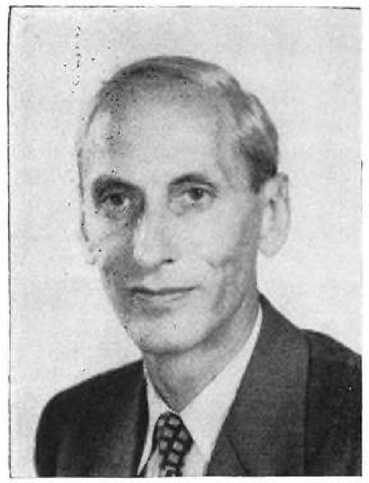
ERD is aiming at such extremely subminiature techniques that it has coined a new word to describe them: "Microtronics."

ERD's research in microtronics is still in its early stages. If the program pans out, the wristwatch radio transmitter/receiver which Dick Tracy uses in his comic strip adventures would be an easy accomplishment. Even a wristwatch television receiver is not beyond the realm of possibility, although this is not the objective of the work being done by ERD.

► **Research Its Mission**—ERD was originally set up as an Air Force applied electronic research center. However it is impractical, if not impossible, to draw a firm line of demarcation between applied research and development, according to Dr. E. G. Schneider, director of ERD.

Broadly stated, avionic equipment developed by Wright and Rome Air Development Centers is usually pointed toward a specific tactical need and is frequently the prototype of production equipment to follow. Until recently, any equipment developed at AFCRC was used primarily to conduct research or to prove out fundamental principles.

ERD's research activities run the gamut from tiny transistors, smaller



Dr. E. G. Schneider, Director
Electronics Research Directorate

than the head of a pin, to huge radar antennas, as tall as a four-story building.

One of the characteristics of applied research is that not all the ideas tried prove practical. But since the objective of research is to obtain knowledge, ERD frequently learns as much from "failure" as from "success."

Occasionally researchers discover something early in their investigation which actually proves more interesting than their initial objective. This may deflect the program from its originally intended purpose.

► **Important New Role**—Within recent months, ERD has assumed an important new role in the ARDC setup—overall responsibility for "ground environment" (ground-based avionic equipment to be used in the continental air defense system—Project Lincoln). This system is under development in the AF's Lincoln Laboratories, operated by the Massachusetts Institute of Technology in the Boston area.

Unlike RADC and WADC, which of necessity devote a sizable part of their manpower to monitoring developments by outside contractors and supporting AMC procurement, most of ERD's research and development have previously been performed within its own laboratories, Dr. Schneider says.

Dr. Schneider considers lots of in-house work imperative for an activity like AFCRC in order to attract top scientific personnel and to maintain their technical competence.

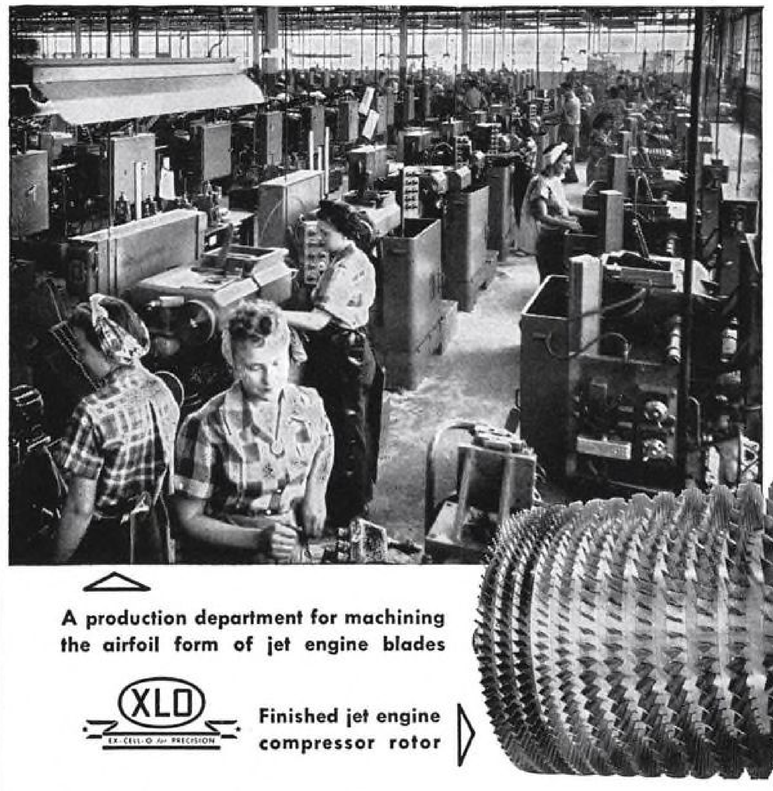
► **Keep It Small**—The Electronics Research Directorate has a staff of approximately 150 scientists and engineers, plus 50 technicians capable of doing engineering work in narrow fields of activity.

Even if budget limitations were not confining, Dr. Schneider wouldn't want to expand ERD much beyond its pres-

AIRCRAFT ENGINE BUILDERS LOOK TO

EX-CELL-O

For Volume Machining of Jet Blades



A production department for machining the airfoil form of jet engine blades

XLO EX-CELL-O for PRECISION

Finished jet engine compressor rotor

A complete line of automatic blade finishing machines, designed and perfected at Ex-Cell-O, turns out large volumes of jet blades to the specifications of engine builders. In addition, Ex-Cell-O, through its subsidiary, Robbins Engineering Company, machines rotor wheels, inserts the blades, and assembles the complete rotors.

Plant facilities have been expanded and added employees have been trained in the machining and inspection of these precision parts and assemblies.

As one of the world's largest producers of precision parts for aircraft engines, Ex-Cell-O can help you eliminate bottlenecks and meet production schedules. For information or a quotation on your precision parts, contact Ex-Cell-O in Detroit.

52-19

EX-CELL-O CORPORATION • Detroit 32, Michigan

MANUFACTURERS OF PRECISION MACHINE TOOLS • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS
DRILL JIG BUSHINGS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • DAIRY EQUIPMENT

ent size. He strongly believes in keeping laboratories relatively small and tightly knit, to avoid intra-lab communications problems.

Dr. Schneider cites the wartime MIT radiation lab (of which he was a member) which assembled a technical staff of thousands to work on radar, as an example of staff size exceeding the point of diminishing returns.

▶ **In the Beginning**—The MIT and Harvard wartime radiation laboratories provided the nucleus from which AFCRC was formed. When the war ended, these laboratories were disbanded. Recognizing the need for continuing efforts in the radar field, the Air Force moved quickly to provide facilities for those scientists who wished to continue in the same type of activity—which became the present Cambridge Research Center.

Dr. Schneider says ERD has been very successful in hiring needed scientists. He attributes this to ERD's geographic location—near MIT, Harvard, and Boston University—which enables AFCRC men to do advanced study, something close to the hearts of most researchers. If this advanced study is directly connected with a scientist's work at AFCRC, the government foots the tuition, Dr. Schneider says.

▶ **ERD Organization**—As ERD grew, it found itself trying to carry out applied research, component development and some systems engineering activities within its laboratories. The result was a tendency to divert efforts from research into systems engineering activities, Dr. Schneider says. The present organizational setup is intended to separate the two types of activities.

The Electronics Research Directorate is divided into two groups, one devoted to components and techniques, and the other to systems. From a manpower standpoint, the ERD staff is split approximately 50/50 between the two.

▶ **Components and Techniques**—The Components and Techniques group's area of activity is covered by five labs:

- **Communications.**
- **Propagation.**
- **RF components.**
- **Antennas.**
- **Computers.**

▶ **Systems Projects**—Project Lincoln is by far the biggest and most important program in the Systems Project Office, headed by M. H. Chaffee.

AFCRC is also investigating automatic control of traffic around an airdrome along with RADC and WADC.

Communications

The Communications lab might more aptly be called a "transmission of information lab," according to Dr. E. W. Samson, its chief.

It doesn't concern itself with conventional radio or telephone problems, but delves deeply into long-haired philosophies and theories behind the transmission of information. Its research activities are pointed toward an automatic typewriter which operates from the spoken word, a very advanced type of IFF system (identification, friend or foe), and microtronic techniques, which are necessary if the former equipment is to be small and light enough to carry in an airplane.

The Communications lab is divided into four sections:

- **Speech.**
- **Analysis** (largely IFF).
- **Microtronics.**
- **Circuitry.**

▶ **Speeding Flow of Information**—If World War III should come, the life of the nation may depend upon split-second decisions and split-second transmission of these decisions and commands to aircraft and air defense centers.

All the efforts now going into complex systems designed to funnel data on enemy aircraft into central control points will be for nought if it takes 5-10 minutes to transmit tactical decisions to their many destinations, or if aural transmission causes the message to be misunderstood.

This points up the importance and

No Skid! WITH WESTINGHOUSE DECELOSTAT® CONTROLLERS

● Rain, sleet, snow, fog—*regardless* of weather—your wheels cannot lock if your plane is equipped with Westinghouse Decelostat Controllers. When a wheel begins to slow down too rapidly, the controller momentarily reduces the braking so that the wheel does not lock, and skid. When the danger is over, full braking is restored instantly.

You can actually stop a plane faster with Decelostat Controllers than if you locked your wheels and *skidded* to a stop. You get the most efficient braking pattern possible. This materially reduces the danger of ground loop or over run on slick, water-soaked runways.

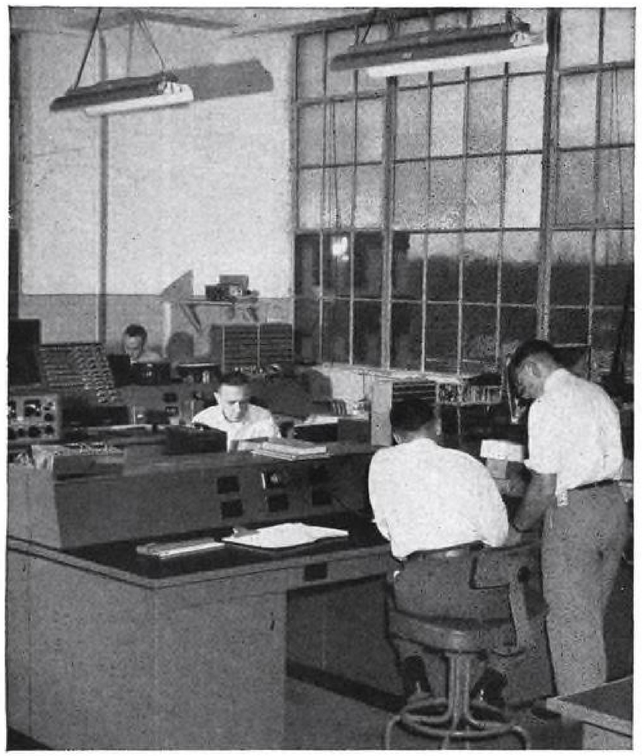
Decelostat Controllers save you money too. Better braking performance cuts down tire wear and makes casings last longer. This increased service more than pays the small cost of the controllers.

Write for complete information.

Westinghouse Air Brake COMPANY
AIRCRAFT SECTION
INDUSTRIAL PRODUCTS DIVISION
WILMERDING, PA.

FOR QUALITY EQUIPMENT TO FILL YOUR TECHNICAL NEEDS...

Enlist the skills of General Mills



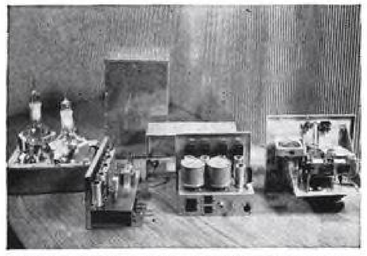
The superbly equipped Engineering, Research and Development Department of General Mills' Mechanical Division has a staff of over 200 experienced engineers, designers, technicians, analysts and skilled machinists. The department's plant area of over 50,000 square feet is devoted to engineering offices, electronics and mechanical laboratories and a machine shop geared to prototype and pilot production.

Research and development in the fields of...

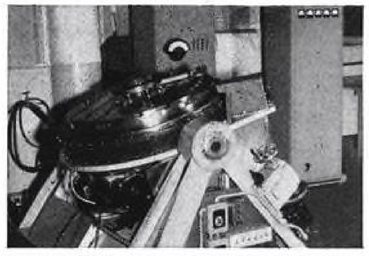
- **Aircraft systems**
- **Industrial instrumentation and control**
- **Specialized precision instrumentation**
- **Communication, navigation, and missile control systems**
- **Electro-mechanical computers**
- **Remotely-controlled manipulators**
- **Telemetering (radio and wire)**

Also available are manufacturing facilities of the Mechanical Division for production of precision mechanical and electronic instruments. A General Mills specialty is the production of analogue computers and similar high precision electro-mechanical assemblies.

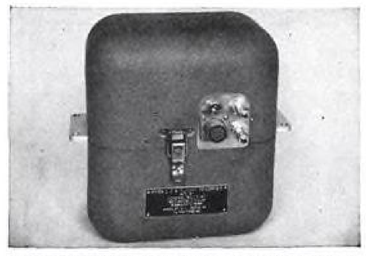
RECENT GENERAL MILLS ACHIEVEMENTS:



RADIO COMMAND CONTROL systems engineered, designed and built to meet specific requirements.



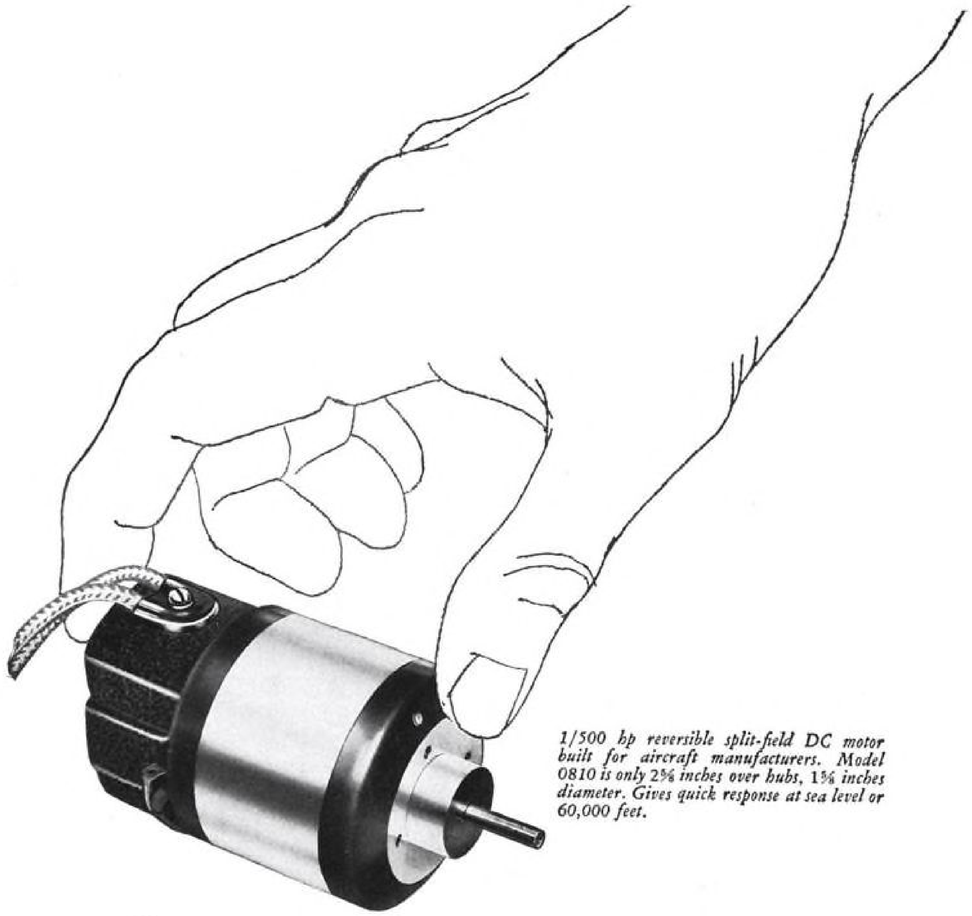
RATE TABLE, a versatile instrument that tests and evaluates performance of gyroscopic and other instruments.



FLIGHT RECORDER, for maintaining complete flight record of velocity, acceleration, altitude. Lightweight, self-contained.

Further details will be sent on request, or a representative will be instructed to call if you prefer. Write to . . .

Mechanical Division
ENGINEERING RESEARCH AND DEVELOPMENT DEPARTMENT
General Mills, Inc.
1620 CENTRAL AVE. • MINNEAPOLIS 13, MINN.



1/500 hp reversible split-field DC motor built for aircraft manufacturers. Model 0810 is only 2⅝ inches over hubs, 1⅝ inches diameter. Gives quick response at sea level or 60,000 feet.

Any electrical rotating equipment— we'll make it!

What the controls call for, a Holtzer-Cabot motor will do.

Whatever electrical rotating equipment you need, Holtzer-Cabot will design and build it for you.

We've been building fractional and miniature motors for the best part of a century . . . and for the aircraft industry during the last two wars. Our present facilities for engineering fhp motors, servo and servo-mechanisms are at your service.

The 0810 (shown here) illustrates the work we do and *can* do for you, in the field of aircraft actuators — autopilot systems, wing flaps, trim tabs, gun charging, computor systems, all types of timing devices.

Send us your fhp motor and actuator problems. Size? We know how to make them small. Power? We make bantams to do the work of brutes. Dependability? Our experience in special motors goes back for generations. Service? We have the capacity. So — let our engineers work on the projects *you* are working on. Write us about the motor and actuator problems that are worrying you now.

HOLTZER-CABOT
DIVISION OF
NATIONAL PNEUMATIC CO., Inc.
BOSTON 19, MASS.

■ AVIONICS

usefulness of a system in which vocal commands could be instantly converted into the kind of electric signals which can operate an electric typewriter in order to convert human speech directly into printed messages. This involves the conversion of the complex speech waveform (with its varying intensities and frequencies) into groups of individual pulses—the type of signal from which an electric typewriter can operate.

Research on such system is under way in the Speech section of the Communications Lab.

► **It's Not Easy**—The problem is a tough one because of the wide variations in speech characteristics between individuals. The system must be capable of operating whether the man at the mike speaks with a Southern drawl, a New England twang, or speaks "Brooklynese."

There are a variety of ways to produce speech code patterns, Dr. Samson says, but the lab is digging deeply into fundamentals to find a sound basis upon which to build its system. This involves finding those speech characteristics which are unique to a specific word (or bit of information) and which are common to the word regardless of the individual speaking it.

Considerable effort during the past several years has gone into the study and design of an "audio speech spectograph"—device to analyze human speech. This device will soon be ready for use and Dr. Samson expects to obtain much significant data during the coming year.

► **Pulse Coding Advantages**—There are several important by-product advantages to converting speech into coded pulses. One is that it can compress individual communication channel bandwidth from its present 3,000-cps. requirement to a mere 300 cps., and possibly even as low as 100 cps.

That means that 10-30 times as many communication channels can be squeezed into a spectrum now providing only one channel.

Dr. Samson believes that bandwidth requirements could be reduced below 100 cps. if the system were designed to eliminate unnecessary letters from words —what he calls "redundancy within a word." For example, the word "repeat" might be cut down to "rpet."

However this type of "shorthand" could cause some confusion in interpretation. The lab is not working toward this degree of bandwidth compression at present, Dr. Samson says.

► **"Scrambling" Aid**—Another important advantage of coded pulse communication is that it allows a very large variety of "scrambling" techniques to

prevent an enemy from deciphering its meaning.

Pulse coding requires extremely high-Q (very selective) filters and the lab is doing considerable work in this field, including both piano-wire type filters and the use of transistors as active-element filters, Dr. Samson says.

▶ **Better Reliability Needed**—Coded pulse communications will force us to improve the reliability of radio transmissions, Dr. Samson believes.

In voice communications, failure to hear an occasional word or syllable, due to interference or fading, normally doesn't prevent understanding the message. For example, if a wife calls in to her husband: "John, dinner is on the table" just as a truck rumbles by, he may only hear "ner z on the able," yet he'll probably grasp its full meaning.

If one or two pulses in a group are obliterated by interference at frequent intervals, the entire transmission may be garbled beyond understandability. "Unless we can largely eliminate fading and interference in pulse code transmissions," Dr. Samson says, "we may have to introduce redundancy in our transmissions."

The Communications lab first got into pulse coding activities when it was given the problem of reducing the bandwidth needed to transmit a radar scope presentation to a remote location. The lab developed a pulse transformation process which cut bandwidth requirements from the original one megacycle to only several kilocycles, Dr. Samson says.

▶ **Digitizing & Microtronics**—There is a growing interest and activity in the field of applying digital computer techniques to certain airborne equipments. However, these digital techniques involve the use of many complex matrices, each made up of hundreds or thousands of diodes, transistors, and associated wiring and components.

What is needed is a brand new microscopic type of construction and such a program has been launched in the Microtronics section.

▶ **Transistors Too Big**—Although transistors are small compared to vacuum tubes, the germanium crystal, which is really the heart of the device, occupies only a tiny portion of the volume. The leads, supports, case, and other associated paraphernalia, add the bulk.

To eliminate this "waste" volume, the Microtronics section is working on a process to build up large numbers of tiny transistors and diodes by depositing successive layers of germanium (and impurities) on a small postage-stamp sized card which has razor-thin interconnecting conductors engraved or printed on it.

By stacking these cards in sandwich style, a matrix consisting of as many as 1,000 transistors, diodes and associated wiring and components may be constructed to occupy a volume of only one half a cubic inch.

▶ **Outside Help**—These microscopic matrices need equally tiny resistors, capacitors and other components. AFCRC has launched a research program at the Mellon Memorial Research Institute and Battelle Research Institute to develop microtronic techniques for making these components.

Inductors may be the most difficult to "microtronicize," Dr. Samson says, and so thought is being given to using other circuit elements to achieve phase shift, eliminating the need for inductors.

▶ **Solid-State Physics**—AFCRC has built up its technical knowledge in the field of solid-state physics to carry out its work in microtronics, but there is also another reason.

When new transistor developments or techniques are announced by Bell Telephone Lab or others engaged in transistor development, it normally requires a year or more before the new product is commercially available.

By having its own capabilities in this field, AFCRC scientists are able immediately to fabricate a new-type transistor

FAMILIARIZATION REPORTS ON FILM

THE PROBLEM

Familiarization Reports, prepared by prime or subcontractors, perform the vital function of introducing product characteristics, abilities and limitations. In a broader sense, Familiarization Reports, properly conceived and effectively presented, mentally condition members of the Armed Forces to accept with greater assurance equipment placed at their disposal. These Reports should not be confused with training aids, since their function is primarily one of indoctrination and not instruction. They also can be used to explain product and facilities to procurement officials and other interested parties.

THE MEANS

Wilding experience in the production of commercial and educational films encompasses a quarter of a century. Its conveniently located studio facilities in Chicago, Detroit, and Hollywood include everything necessary for the creation of quality sound motion pictures from the writing of scripts to the developing and printing of film. Wilding's writers are men of long and varied experience, and its directors, cameramen, technical experts and laboratory personnel are among the most skilled in the commercial film industry. At Wilding, all of these facilities are in one organization, under one management, where the important element of security can be controlled at all times.

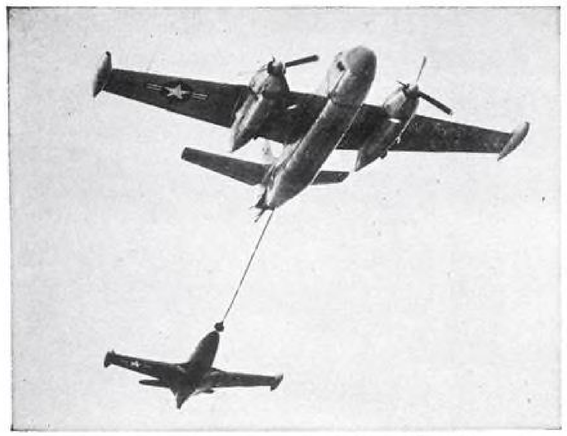
THE APPROACH

While many Familiarization Reports have been prepared in the form of graphic materials, an ever-increasing number of firms are now utilizing sound motion pictures for this purpose. This is not because of any weakness in brochures, booklets or pamphlets, but because of the greater inherent strength of the audio-visual medium as a means of mass communication. Motion pictures, implemented by dramatic action, appeal to both the eye and the ear, and command the audience's undivided attention. For this reason, the information they impart is more deeply impressed on the mind of the viewer and remembered longer.

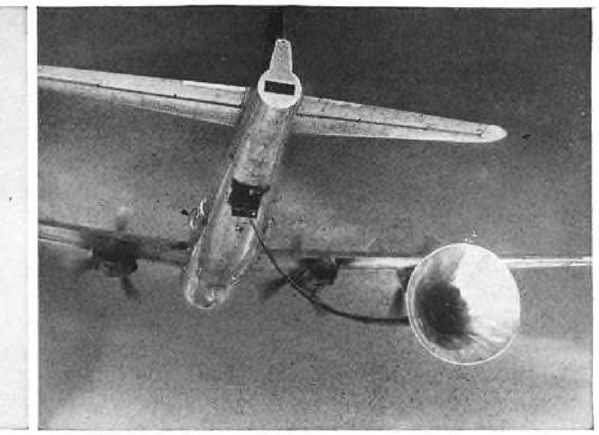
WILDING PICTURE PRODUCTIONS, INC.

1345 Argyle Street **Chicago 40, Illinois**

TELEPHONE LOngbeach 1-8410 **TELETYPE CG 1058**

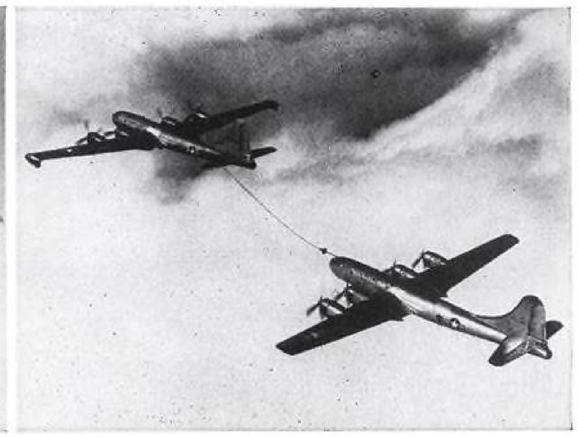


FLEXIBLE. Requires only normal formation flying proficiency, even in rough air, to maintain contact.



PRACTICAL. No special operator required; contact is simpler than making a landing.

MULTIPLE. Several fighters can be refueled simultaneously with wing-tip hose units.



ECONOMICAL in weight and cost; far simpler than any other refueling system.

The System that Makes Mid-Air Refueling Routine

Flexibility, ease of operation, and the ability to refuel more than one plane at a time are reasons why the Flight Refueling, Inc. mid-air fueling system is proving to be so practical in military usage and why its later commercial use holds so much promise in the future.

Consisting of a simple hose reel, easily installed or removed from the tanker aircraft, a funnel-shaped drogue and a retractable probe in the receiving plane, the system is simplicity itself. No special crew training is necessary. Pilots report contact is simpler than making a landing.

Because of the flexible nature of the system, refueling can be accomplished in rough air and the rapidity of fuel transfer under pressure reduces the contact time to but a few minutes.

For the United States Air Force and the United States Navy, aircraft are now being equipped with FR refueling equipment to give our fighters and bombers virtually limitless range and/or duration.

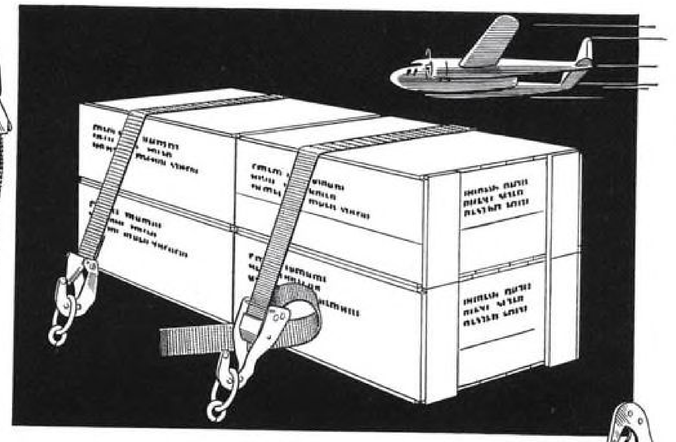
Flight Refueling, Inc. also makes the famous FR lightweight, flexible pipe connector for joining aluminum pipe 1" to 4" in diameter. Maintains fuel-tight connection under pressure even when flexed 10°. Widely used on many jet aircraft. Write for data sheet.

FLIGHT REFUELING INC.

Specialists in Aircraft Fueling Systems and Equipment

Danbury, Conn.

OVER 16 YEARS EXPERIENCE IN DEVELOPING PRESSURE FUELING SYSTEMS AND EQUIPMENT



Secure in Flight!

Held in place—no matter how severe the flight or landing condition!

Eastern's "TYZEM"* line of cargo tie-downs does exactly that. They are widely used in Air Force heavy cargo aircraft, ranging from 1,250 pounds (shown) to 35,000 pounds rated capacity. Write for brochure.

*Trademark

EASTERN ROTORCRAFT
CORPORATION
P. O. Box 110, Doylestown, Pa.

Need PRECISION Potentiometers?
Need SPECIAL Designs?
Need Potentiometer "KNOW-HOW"?

call **Helipot**

World's largest manufacturer of precision potentiometers!

HELIPOT offers a unique combination of unequalled "know-how", advanced manufacturing facilities and experienced personnel for solving *your particular* problems in the application of precision potentiometers to modern electronic circuits.

Suppliers to both Government and industry, HELIPOT has developed high speed winding, assembling and testing equipment that combine custom-built precision with mass-production economies. Multiple and single-turn designs ... single and double shaft extensions ... ganged assemblies ... custom-spaced taps ... multi-turn dials ... *these and many other special features are part of the daily output at* HELIPOT!

If you have a problem requiring precision potentiometers, bring it to HELIPOT Corporation—*world leader in its field.* A call or letter outlining your problem will receive immediate attention! *Write for Data File 822*

A Typical Example ...
This 10-Turn, Model "A" HELIPOT provides a 46" slide wire in only 1¾" dia. panel space. Resistance ranges—10 to 300,000 ohms, power rating, 5 watts. Can be ganged with multiple units per shaft ... supplied with custom-spaced taps ... and other special features.
Adaptable to a wide range of applications in experimental, military, industrial and educational fields.

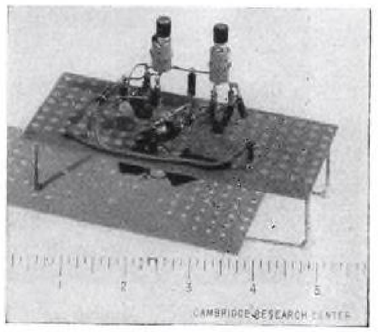
Helipot *division* BECKMAN INSTRUMENTS, INC.
SOUTH PASADENA, CALIFORNIA
PLANTS IN SO. PASADENA, CALIF. AND MOUNTAINSIDE, N. J. • REPRESENTATIVES IN PRINCIPAL CITIES

■ AVIONICS

in their own laboratories.

With a basic understanding of solid-state physics, AFCRC is also able to develop transistor circuit techniques which overcome certain shortcomings of the devices.

For example, the Circuitry section of the Communications lab has developed techniques for overcoming the transistor "hole" storage time, making it possible to design a computer shift register which can operate at frequencies as high as 9 mc.



TRANSISTOR flip-flop circuit can operate at frequencies of 9 mc.

Another product of AFCRC work in the field is an experimental negative-resistance germanium diode which can replace two vacuum tubes normally required in simple flip-flop circuits.

▶ **Facilities**—AFCRC has facilities for refining experimental quantities of germanium and producing point contact transistors. To measure the structure, chemical composition, and cell size and orientation of transistor materials, the Microtronics section has an electron microscope, optical grating spectograph, and Geiger-counter X-Ray spectograph.

Investigations planned for the future include silicon (high temperature) transistors, non-linear dielectrics such as barium titanate, and ferrites.

Application of commercially available transistors and experimental ones developed in the Microtronics section is made in the Circuitry section. The 9-mc. shift register is their project.

Another is a classified airborne digital device slated for flight tests next year.

Propagation Lab

The Propagation laboratory, formed about a year ago, is principally concerned with tropospheric propagation (line of sight), although it has some interest in ionospheric propagation. Small in size, this laboratory's mission is to "try to understand rather than to design things," according to Dr. Philip Newman, lab chief.

One current lab investigation is in the field of beyond-line-of-sight transmission of microwaves. It was previously thought that the field strength of microwaves fell off exponentially beyond the horizons, requiring tremendous boosts in power to achieve tiny increases in range.

Recent data obtained here indicates that after an initial 40-db. attenuation beyond the horizon, field strength attenuates much more slowly with increased distances. This phenomenon may be due to scattering or refraction due to moisture or to temperature differences, Dr. Newman says.

▶ **MW Communications**—This new knowledge should prove extremely useful in microwave communication networks. When these are constructed over water or wild terrain, it is not always convenient to locate repeater stations within line-of-sight distance of one another. If greater range can be obtained without huge increases in power, this problem is greatly eased.

The technique is not applicable to radar where the echo signal is too small to make the return trip beyond line-of-sight distances.

▶ **Other Activities**—Approximately 30-40% of the Propagation lab's 10-man professional scientific staff is currently exploiting what T. F. Rogers, assistant lab chief, calls a "technological breakthrough" for a classified program. (A "technological breakthrough" is a term used to describe a fortuitous technological discovery which holds great promise for solving a pressing military problem.)

This lab is also experimenting with COZI—the Communications Zone Indicator—developed initially by RADC, as a long-range radar but which is more useful in determining the amount of power reaching a remote location and the optimum transmitting frequency to use.

▶ **Propagation Characteristics**—Other activities include investigation of the propagation characteristics of ultra-microwaves—whose wavelength approaches the infra-red region.

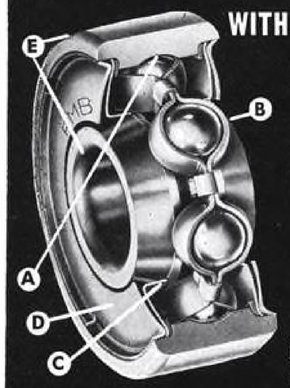
In its research, the Propagation lab works closely with scientists in AFCRC's Geophysics labs, because of the interrelation of atmospheric conditions and disturbances on the propagation of electromagnetic radiation.

In the past there was a tendency for communications and radar equipment designers to overlook propagation and atmsopheric effects, Dr. Newman says. As an example, he cites the choice of the 1.25-cm. (K-band) wavelength for radar during the last war.

This wavelength was almost the worst possible choice, because attenuation of radar signals by moisture and rain is a maximum at that particular wavelength, Dr. Newman points out.

The Propagation laboratory has been

MINIATURE BALL BEARINGS
WITH 'BIG BEARING' CONSTRUCTION

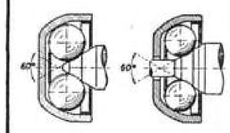
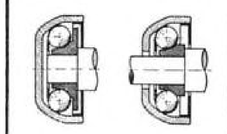
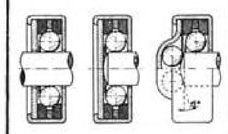
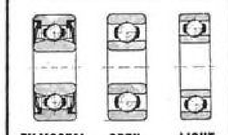
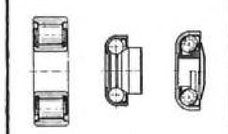


When you use RMB miniatures in instruments and small mechanisms, you get engineering features which you expect to find only in anti-friction bearings of much larger size. For example, RMB Type RF FILMOSEAL bearing (illustrated) has these important design details:

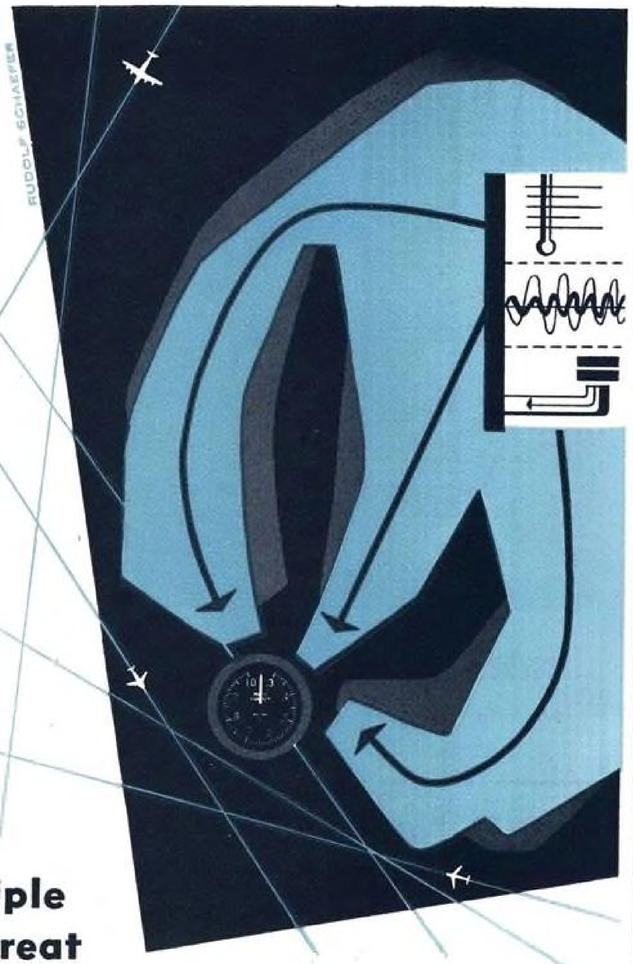
A—Deep groove races, uninterrupted by filling slot.
B—Balanced, two-piece ball retainer.
C—Non-rubbing capillary oil seal.
D—Dust shield.
E—Precision tolerances.

In the manufacture of all RMB bearings, no matter how small, there is never any compromise with the principles of good bearing design.

Over 250 RMB *Types and Sizes*

PIVOT Self-aligning		The simplest and most compact of the miniature types. Use them where size, weight and cost must be kept low, yet where you want the low friction and greater endurance of a ball bearing. *Typical applications:* Meter movements, small gear trains, lever pivots. *Sizes:* From .043" to .423" O.D.
ANGULAR CONTACT Self-aligning with inner race		Similar in capacity and application to the pivot types, but somewhat easier to install because they take cylindrical shafts. These types, as well as the pivot types, are self-aligning, will carry thrust and radial loads. *Sizes:* From .157" to .787" O.D.
RADIAL Without inner race		Particularly useful where loads are relatively light, low starting torque and high shock and wear resistance are important. *Typical applications:* Pivots for balance arms; shaft supports in control and recording mechanisms. *Sizes:* From .1181" to .4724" O.D.
RADIAL Deep Groove with inner race	 FILMOSEAL OPEN LIGHT	These Conrad type precision ball bearings, with deep groove design and balanced ball retainer, provide maximum load capacity, high running speeds, long life. *Typical applications:* Small motors, sound recorders, computers, potentiometers. *Sizes:* From .1181" to .8661" O.D.
OTHER TYPES		MANY SPECIAL TYPES AND DESIGNS NOT SHOWN HERE ARE ALSO AVAILABLE IN A WIDE RANGE OF SIZES. WRITE FOR COMPLETE CATALOG, WHICH INCLUDES A DISCUSSION OF DESIGN PROCEDURE FOR BALL BEARING SELECTION.

RMB **LANDIS & GYR, INC.**
45 WEST 45th STREET, NEW YORK 36



triple threat

Changing temperatures, vibrations, and accelerations affect the operation of all instruments. In spite of these variables, our products produce the right answers because they are properly designed.

- AIRCRAFT INSTRUMENTS AND CONTROLS
- OPTICAL PARTS AND DEVICES
- MINIATURE AC MOTORS
- RADIO COMMUNICATIONS AND NAVIGATION EQUIPMENT

Current production is largely destined for our defense forces; but our research facilities, our skills and talents, are available to scientists seeking solutions to instrumentation and control problems.

kollsman INSTRUMENT CORP.

ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF Standard COIL PRODUCTS CO., INC.

delegated prime responsibility in this area by the Air Force, and it serves as a consultant to other ARDC centers, operating commands, and industry.

RF Components Lab

The ideas for new experimental ground-based radars and many of the components needed to build them are developed in the RF Components laboratory, headed by Dr. L. M. Hollingsworth.

For example, the idea behind Project Volir, a single radar using multiple stacked beams to provide information on target azimuth, range and height (normally requiring two separate radars) came out of this lab, Dr. Hollingsworth says. So did many of the techniques and components which made Volir possible, such as the use and phasing of 10 magnetrons to provide extremely high output power.

▶ **Lab Sections**—The RF Components lab is staffed by approximately 50 people, of whom roughly three-quarters are either engineers or what Dr. Hollingsworth calls "super technicians." The lab is divided into four sections:

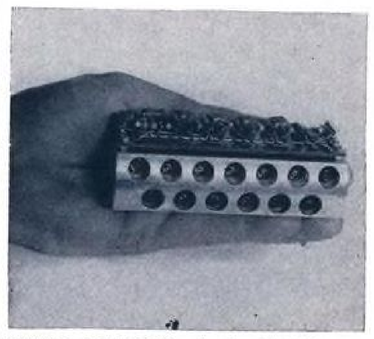
- **Receiver Circuits.**
- **Modulator and MTI (moving target indicator).**
- **Transmission Lines.**
- **Electron Tubes.**

▶ **Receiver Circuits**—In recent months there has been more emphasis in the Receiver Circuits section on improved MTI circuit techniques to improve radar's ability to pick out targets from surrounding clutter.

In the same section there are studies on the effects of frequency and pulse repetition rate on an airborne radar's ability to discriminate between different types of ground targets.

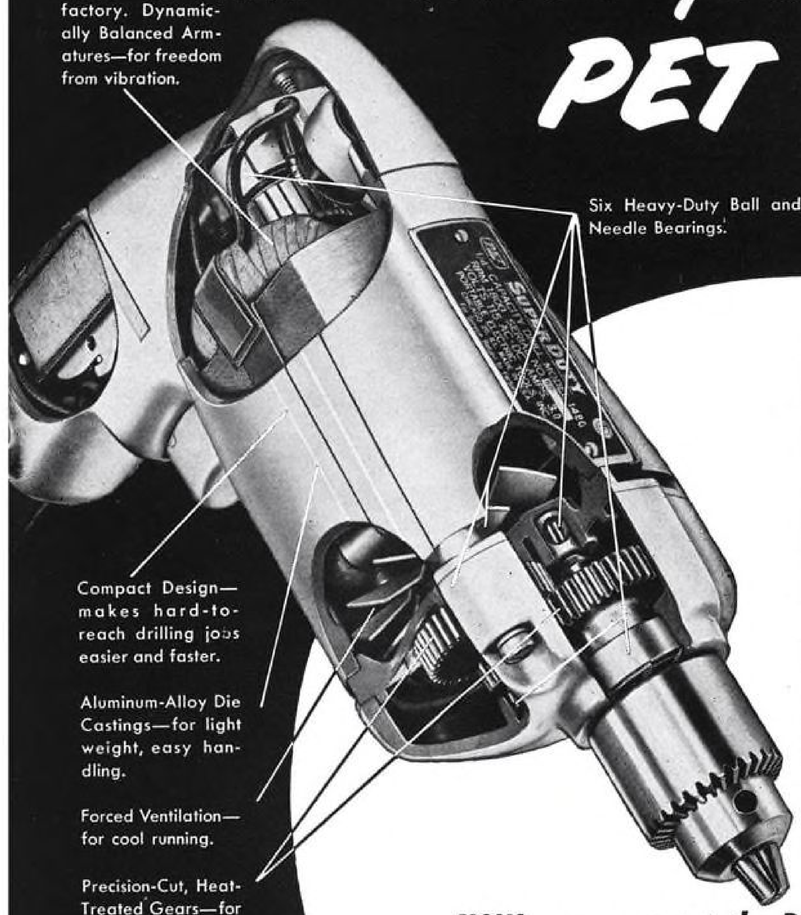
Another area of activity is the design of tiny experimental subminiature radar beacons.

▶ **The "Talking Monster"**—The Receiver Circuits section has devised an ingenious gadget, sometimes referred to as "the Talking Monster," or "Project



SMALL BEACON coder has 13 tubes.

You get ALL these Features when you buy PET Drills!



If you want the *best* for your maintenance or production work, take an extra look at the PET Superduty Drill shown here. Check its features! Here's a drill that's made for heavy, continuous duty...with *plus* power per pound . . . built to *work* right and *handle* right on the job.

Normally you might expect to pay extra for such features—in the form of "optionals" that jack up your cost. But that's not true of PET Drills! All these features are standard in the PET Superduty line . . . *and they're available to you at a standard drill price!* That's why the coupon below can save money for you. For free catalog and name of your nearest PET distributor, *mail it today!*

NOW...you can get the RIGHT DRILL for YOUR job!

PET Superduty Drills are available in 54 distinct models and 3 capacities: ¼", ⅜" and ½". Your choice of pistol or saw-type grip. With such a broad line, you don't have to compromise on a drill that's "almost" right! You can choose *exactly* the drill you need for your job. The PET Superduty line includes drills meeting U. S. Government and military specifications.

PET® POWER TOOLS *Plus Power per Pound*

PORTABLE ELECTRIC TOOLS, INC.

320 West 83rd Street, Chicago 20, Illinois

In Canada: Portable Electric Tools, Ltd., 452 Birchmount Road, Toronto 13, Ontario, Canada

MAIL COUPON FOR FULL INFORMATION

PORTABLE ELECTRIC TOOLS, INC. AW-83
320 W. 83rd St., Chicago 20, Ill.

Gentlemen: Please send us free copy of your PET Superduty catalog, and name of nearest distributor.

*Name*_____ *Title*_____

*Company*_____

*Address*_____

*City*_____ *State*_____

How many spoonfuls per passenger mile?*

It's a fact, too—

Shell Aviation fuel carries the most passengers . . . the most air freight . . . the most air mail in the United States today.

***SHELL AIR FACTS**

Air transportation is efficient:

Only 12 tablespoons of aviation fuel are needed to propel you a distance of one mile in a modern 4-engine airliner.

SHELL OIL COMPANY

50 WEST 50TH STREET, NEW YORK 20, NEW YORK
100 BUSH STREET, SAN FRANCISCO 6, CALIFORNIA

SHELL

■ AVIONICS

Talk-back." It permits a pilot or radio mechanic to check the transmission and reception of an airplane's communications equipment, without bothering control tower personnel. It could find application to civil air operations.

Gen. E. E. Partridge, returning from a visit to Korea, reported that pilots there would often call the control tower to ask whether their signal was getting through, diverting tower personnel from other duties.

► **Automatic Tape Recorder**—The Receiver Section's solution is a small tape recorder which is wired into the control tower radio receiver squelch circuit. When a pilot wants to check his radio gear, he tunes to the regular tower frequency and clicks his microphone button three times, which starts the tape recorder. The pilot identifies his aircraft, and says: "Test, one, two, three." The recorder then plays back this test transmission over the tower's transmitter.

The entire check procedure takes only 10 seconds, and is completely automatic insofar as tower personnel are concerned. Maintenance crews checking radio equipment on the ground can also use the "talking monster."

The device uses a continuous magnetic tape rotating on a thin drum. It can be connected into the control tower receiver with a minimum of receiver modification, and without any change in the transmitter.

► **Static Signal Converter**—A static (nonvibrator) type of converter for changing d.c. signals to a.c. has been developed in the Modulator and MTI section.

The d.c. signal is applied to an argon glow tube whose light output excites photo cells to produce a proportional a.c. signal whose phase depends upon the polarity of the d.c. input.

Advantage of this photo converter over conventional vibrator choppers, according to Dr. Hollingsworth, is its high impedance input, lack of moving parts,

PHOTOCONVERTER uses argon glow tube to change d.c. signals to a.c.

Over 455

PRECISION PUSH-BUTTON SWITCH TYPES

Looking for precision-built push-button or snap-action switches in the 15 to 50 ampere range with operating pressures of approximately 4 pounds?

Chances are, Hetherington has just what you want—in standard types—backed by a record of proved performance in critical aviation or military applications. Just about any circuit, activating arrangement or mounting style is available and each standard type is readily adaptable to numerous and inexpensive variations.

Write for catalog—or send details of your requirement for recommendation by Hetherington switch specialists.

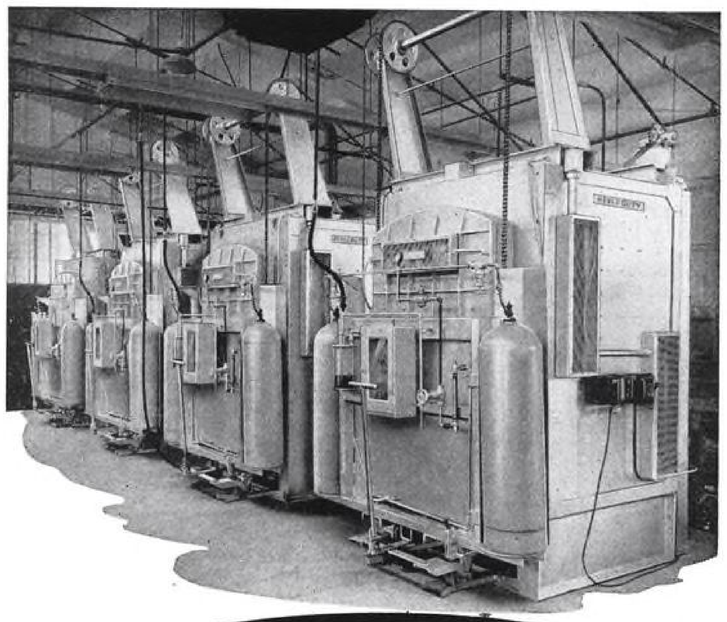
HETHERINGTON, INC., SHARON HILL, PA.

West Coast Division: 8568 W. Washington Blvd., Culver City, Calif.

PROMPT DELIVERIES . . . LARGE QUANTITIES OR SMALL

HETHERINGTON

SWITCHES WITH BUILT-IN INDICATOR LAMPS
MINIATURE SWITCHES
TOGGLE SWITCHES • ROTARY SWITCHES
SWITCHES TO MILITARY SPECIFICATIONS

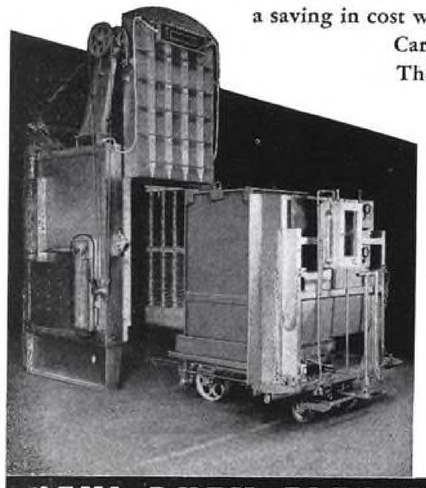


FOR INCREASED PRODUCTION OF NITRIDED PARTS USE A

HEVI DUTY CAR BOTTOM NITRIDING FURNACE

Manufacturers producing nitrided parts for aircraft, engines, and heavy machinery items have found that more production is possible at a saving in cost when they use the Hevi Duty Car Bottom Nitriding Furnace. The furnace car, complete with sealed retort and ammonia dissociation equipment can be removed from the furnace for cooling and a second car with a cold load can be inserted immediately for a minimum loss of time between heats.

Write for Bulletin HD-664



HEVI DUTY ELECTRIC COMPANY

HEAT TREATING FURNACES HEVI DUTY ELECTRIC EXCLUSIVELY

DRY TYPE TRANSFORMERS — CONSTANT CURRENT REGULATORS

MILWAUKEE 1, WISCONSIN

and its ability to operate on carrier frequencies up to 5 kc. He also says the device is more stable than conventional vibratory signal converters.

▶**Other Projects**—Major activities of this section, as the name suggests, are in the field of magnetrons, pulse transformers, and MTI devices. The performance of each of these devices is heavily dependent on the characteristics of the other two.

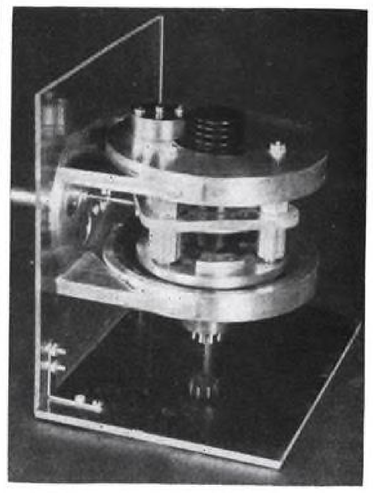
In addition to development work on magnetic modulators, this section often runs tests on new magnetic materials to obtain response characteristics that are needed by pulse transformers designers.

This data is sometimes converted to easy-to-use charts to simplify pulse transformers design. This section has analog computer capabilities.

▶**Dielectric Waveguides**—As radar wavelength goes down, the waveguides used to transmit RF energy get smaller and more difficult to manufacture. The conventional metal waveguides also tend to become "loss-ier," Dr. Hollingsworth states.

This explains why the Transmission Line section is casting an eye at waveguides made of dielectric materials, particularly for the extremely high-frequency radars. The problem is that the present low-loss dielectrics (polystyrenes) are structurally weak when subjected to the very high temperatures that are encountered in highspeed jet aircraft.

One product of this section is a parallel plane tuner to vary the frequency of klystron tubes. It has enabled AFCRC to get 30 watts output power from a klystron rated at only 10 watts. The device achieves the increase by maintaining ideal alignment



PARALLEL plane tuner for klystron tubes increases available power output.

This wall has more substance to it!

The Sonic Barrier was tough enough!

But penetrating the wall of high temperatures that lies ahead requires development of many new components.

We specialize in development and manufacture of aircraft and engine components made of high temperature alloys.

Perhaps we can aid you in your progress toward high mach number performance.

SMITH-MORRIS COMPANY

PRECISION AIRCRAFT COMPONENTS

FERNDALE 20, MICHIGAN

CHICAGO 6633 WEST 65TH ST., CHICAGO 38 • DETROIT 7450 MELVILLE, DETROIT 17

AM ACCURATELY MADE gears, INC.

A SUBSIDIARY OF HUPP CORPORATION

CLEVELAND • DETROIT

CHICAGO

WHEN GEARS GET COMPLICATED

"AIR-SPEC" QUALITY

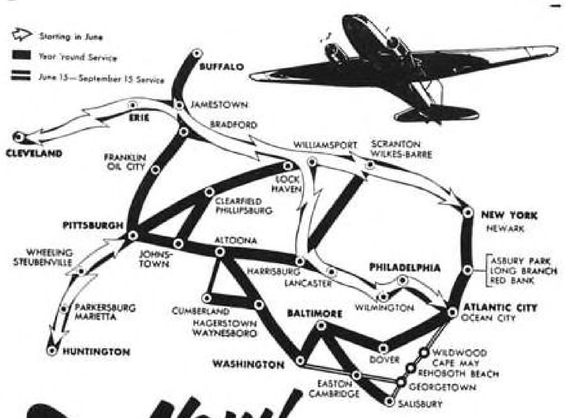
IS THE ANSWER

Call an Amgears sales engineer for gears, machining, and gear assemblies.

Spur, Helical, Worm, Straight and Spiral Bevel, Spline Shafts, and Gear Grinding.

Amgears' customer list reads like Who's Who in American Industry.

MORE AIR ROUTES!



NOW! additional same day round trips between many points!

FLY ALLEGHENY AIRLINES

■ AVIONICS

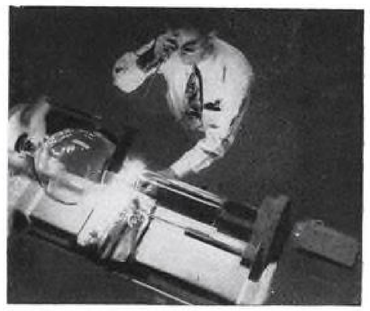
of klystron elements during tuning. Another development is a non-mechanical, instantaneous attenuator for radar transmission lines.

▶**Mathematical Vacuum Tubes**—Nonlinear vacuum tubes which can perform computing functions are one area of activity in the Electron Tubes section. Current developments include a "square law" and "logarithmic" tube.

The square-law tube can, for example, be used to obtain the product of two quantities, each represented by a voltage ("X" and "Y") in the following way:

The sum of the two voltages is squared in one tube, a voltage proportional to $(X^2 + 2XY + Y^2)$. The difference between the two voltages is squared in another tube giving a voltage proportional to $(X^2 - 2XY + Y^2)$. These two voltages are subtracted from each other, leaving a voltage equal to 4XY. Then, by a voltage divider, one-quarter of this voltage is obtained to give XY, the desired product of the two quantities.

▶**Glass Blowers**—The Electron Tubes section has glass-blowing facilities which enable it to fabricate most of its experimental tubes within the lab.

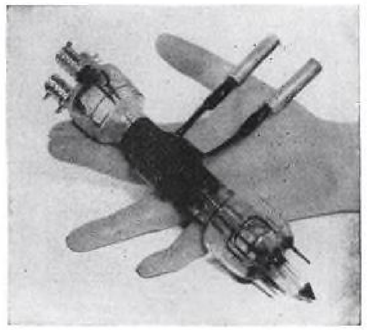


LAB BLOWS its own experimental tubes.

The only exception is hydrogen-filled thyratrons. Present AFCRC facilities (in former old warehouse) are not considered suitable or safe for handling hydrogen.

When pilot quantities of an AFCRC tube are needed, they are usually produced by outside tube manufacturers to AFCRC specs. For example, the non-linear vacuum tubes are built by Raytheon Mfg. Co.

▶**L-Cathode**—One current program is to improve the L-cathode developed by Philips-Eindhoven of Holland. Potentially this type cathode is more rugged and can be operated at higher current levels. However, Dr. Hollingsworth says, U. S. tube manufacturers have generally had trouble keeping the emitter material on the cathode. The tube section is trying to solve this problem. This section also develops neon-tube



L-TYPE CATHODE and external anode are employed in this experimental tube.

noise generators, used to check receiver signals to noise ratio, for the ultra-microwave region where they are not commercially available, Dr. Hollingsworth says.

Antenna Lab

Research into the characteristics of electromagnetic radiation in the microwave region and development of devices to control radiation patterns has frequently caused the Antenna laboratory to turn to optical discoveries made 50-100 years ago, Dr. Roy C. Spencer, lab chief, told AVIATION WEEK.

In fact, the lab's professional scientists (approximately 20 in number) are mostly physicists and mathematicians rather than electronics engineers. That is because at the very short wavelengths used in radar, electromagnetic radiation shows many of the characteristics of light.

It is because microwave energy is scattered and reflected from solid objects, much like light, that radar is able to "see" these targets. The strength of the radar echo, like the amount of light reflected from an object, depends upon the object's size, shape, and projected area.

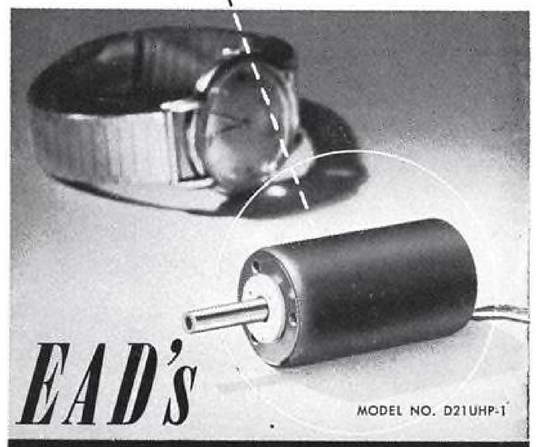
Because of this similarity the antenna lab has been able to study some of the properties of radar scattering, and compare the effective radar reflecting area of different shapes of aircraft by studying the amount of light reflected from small models.

A small model aircraft is illuminated by a point source of light and a photograph taken from the same direction to record the amount of reflected light. Balls of varying diameters are placed along side the model to serve as standards, i.e. to compare the amount of light reflected by a ball of known size with that reflected by the model airplane.

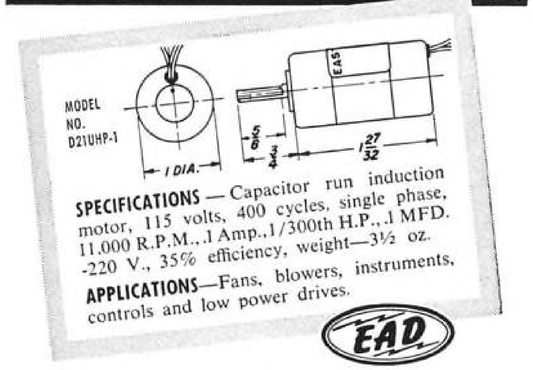
▶**Microwave Optics**—From the very early days designers have patterned radar antennas after the parabolic searchlight reflector. In order to focus radar energy into a narrow pencil beam,

"miniaturized"

FOR MAXIMUM EFFICIENCY



new versatile 1" motor



SPECIFICATIONS — Capacitor run induction motor, 115 volts, 400 cycles, single phase, 11,000 R.P.M.,.1 Amp.,1/300th H.P.,.1 MFD. -220 V., 35% efficiency, weight—3½ oz.

APPLICATIONS—Fans, blowers, instruments, controls and low power drives.

Another outstanding EAD contribution to the miniaturization program is this extremely small, precision motor. Engineered for *long life and high efficiency*, it is especially designed for operation in confined areas where minimum size and weight is essential.

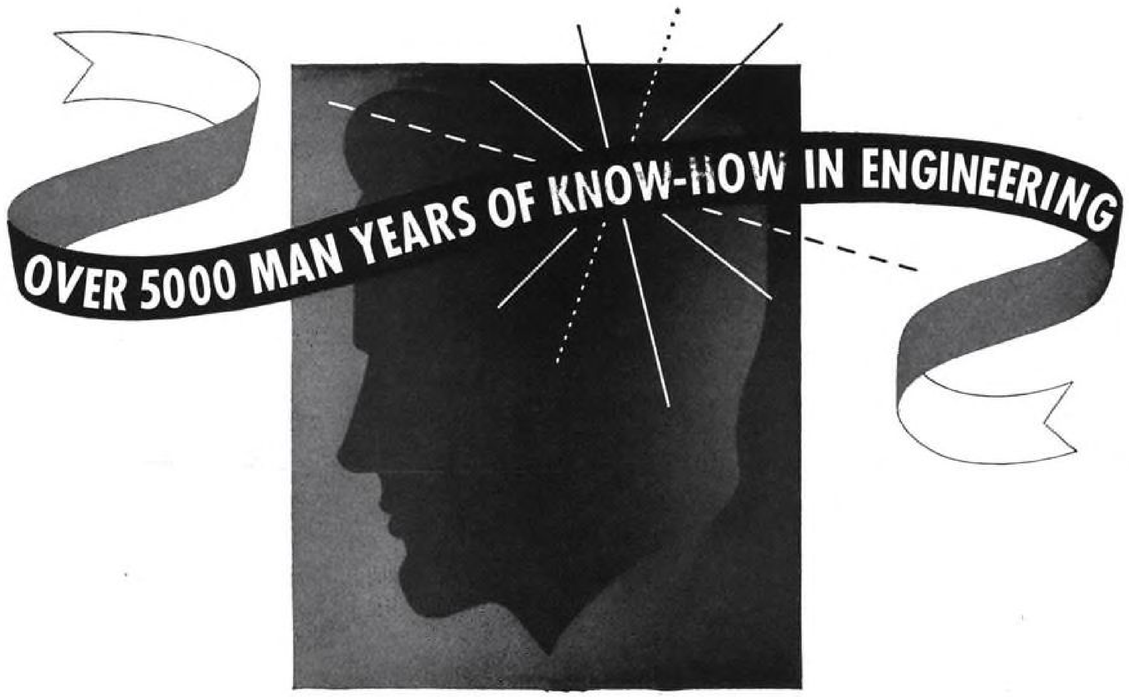
Units are available in this small frame size for 400 cycle or variable frequency operation, with 400 cycle power ratings ranging up to approximately 1/100 H.P. Modifications include high ambient and high altitude versions as well as servo, synchronous and gear motors.

400 CYCLE OPERATING CHARACTERISTICS

APPROXIMATE R.P.M.	7,000	10,500	21,000
PHASES	1, 2	1, 2, 3	1, 2, 3
INPUT VOLTAGE (MAXIMUM)	115	115	115

EASTERN AIR DEVICES, INC.

585 DEAN ST., BROOKLYN 17, NEW YORK



Solving complex development problems is a Magnavox SPECIALTY

What we are doing...

- Search Radar
- Radio Compasses
- Bombing Systems
- Solenoids
- Synchros
- Radio Receivers
- Fuse Development
- Radio Amplifiers
- Special Computers
- Test Equipment
- Radio Transmitters
- Miniaturized Components
- Commercial Radio and Television
- Loudspeakers
- Recorders
- Mercury Battery Development
- Capacitors
- And many varied specialized components.

and what we can do for YOU...

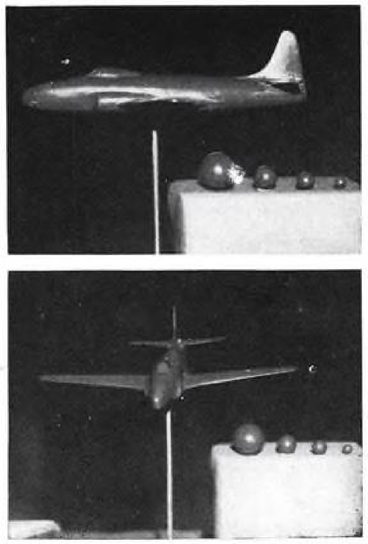
- Telemetering
- Missile Intelligence Units
- Missile Computers
- Airborne and Ground Radar
- Rocket and Mortar Fusing
- Special Computers
- Radio Compasses
- Test Equipment
- Toss Bombing Units
- Remote Positioning Services
- Servos
- Actuators
- Synchros
- Miniaturization
- Radio Transmitters
- Radio Receivers
- Solenoids
- Bomb Arming Controls
- High-Speed Indicating Equipment
- Navigational Devices
- Auto-Pilot Units
- Specialized Components
- Precision Instruments
- Servo Mechanisms
- Fire Control Devices
- Electric Rotating Devices

To Put Magnavox's Vast Research, Technical and Experimental Resources to work for you, Write, Wire or Phone—

INDUSTRIAL AND DEFENSE PRODUCTS DIVISION, *Dept. 99,*

THE MAGNAVOX COMPANY

Fort Wayne 4, Indiana



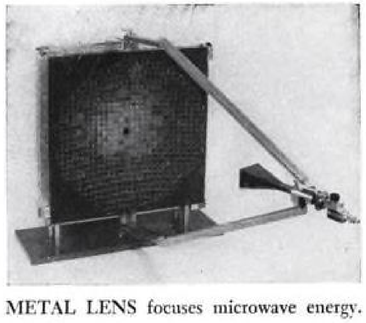
REFLECTED highlights on model and reference balls gives measure of radar energy that actual plane would reflect.

the source of radar energy is located at antenna's focal point.

Although this practice is still widely used, other more sophisticated optical principles are being adapted to the shaping of microwave beams. One technique which has been explored in the Antenna lab is to place the microwave source behind a metal lens, consisting of many square waveguide tubes of varying depth. This metal lens focuses microwaves much like a common reading glass focuses light.

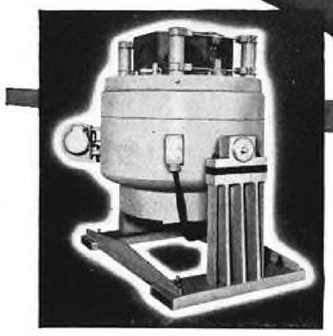
▶**Antenna Designs**—An unusual antenna design, invented by Dr. Spencer, consists of two metal sheets, each bent in the form of a parabolic cylinder, but joined so that their principal axes are at right angles to each other. Energy radiated from a small horn inserted through a hole in one sheet bounces back and forth between the metal sheets and emerges as a parallel (collimated) beam.

For ground or airborne surveillance radars, it is desirable to use a fan-shaped beam instead of a thin pencil beam.



METAL LENS focuses microwave energy.

it can give even an air giant the "shakes"



MB produces the largest vibration exciter ever built

• There's nothing like a good shaking to test out structural designs for faults and flaws. A form of applied vibration, the shakers to do such jobs are logically part of MB's business. And, to be expected from "headquarters" for vibration engineering, the largest electromagnetic exciter, shown above, has been developed and actually built right here at MB.

This monster delivers 5 tons continuous force for all heavy duty vibration tests under MIL-E-5272 and other specifications. It incorporates a number of unusual design features for easy, quick, convenient operation. This equipment can test the fatigue strength and response to vibration of even the largest air giants.

But that's not all. Still larger capacity units are on MB's boards right now!

Remember—when you're dealing with vibration, deal most effectively with it by drawing on MB's 15 years of cooperation with the aviation industry.

the MB *manufacturing company, inc.*

1067 State Street, New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS . . . TO ISOLATE VIBRATION

. . . TO EXCITE IT . . . TO MEASURE IT

On this Lockheed All-Weather Interceptor, Lockfoam is used to provide structural strength, lightweight construction, and improved performance. Lockfoam is used in both their commercial and military planes by Lockheed Aircraft Corporation.

NOPCO LOCKFOAM

Versatile *NEW* Structural Tool

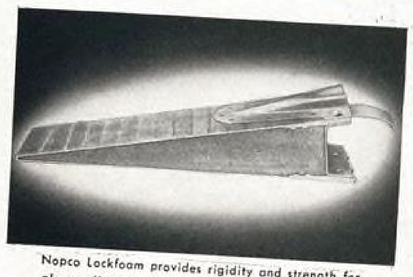
NOPCO® Lockfoam offers many new concepts in aircraft design, engineering, and manufacture.

As a strong, lightweight reinforcing material it has won immediate acclaim in the aircraft industry.

In addition to its unique ability to be foamed in place with exceptional ease and speed without the need for complicated equipment, Nopco Lockfoam possesses so many other interesting properties that it has proved ideal for countless applications.

Nopco Lockfoam can be foamed in place to fill any cavity regardless of configuration. Density of the material can be adjusted to meet design requirements. Bonding is automatic. Radar transmission characteristics are excellent. It can be used for electrical and thermal insulation. In its flexible forms, it is capable of absorbing heavy impact loads with low shock transmission. Physical and chemical properties may be varied but are predictable and reproducible. Lockfoam can also be cast in molds, fabricated in both rigid and flexible forms.

The assistance of a technical service staff in the selection, formulation, and application of Lockfoam is available from Nopco's Lockfoam Division. Send for complete technical data.



Nopco Lockfoam provides rigidity and strength for plane ailerons. Note cellular structure of rigid Lockfoam thermosetting foamed-in-place plastic.

Nopco Lockfoam is now used by the aircraft industry for a wide variety of applications to:

INCREASE RIGIDITY OF CONTROL SURFACES by filling cavities in ailerons, rudders, elevators, wing tabs

PROVIDE A STRONG CORE sandwiched between Fiberglas skins for nose radomes

STRENGTHEN SHOCK-ABSORBING STRUCTURES

INSULATE cabin ventilating systems

STIFFEN rocket doors to prevent buckling

FABRICATE SHOCK PANELING

DAMPEN VIBRATIONS

POT ELECTRONIC EQUIPMENT

FABRICATE COWLINGS

Nopco Lockfoam has many other potential industrial uses. Call or write Nopco for details and technical service.

Lockfoam is a registered trademark of Lockheed Aircraft Corporation

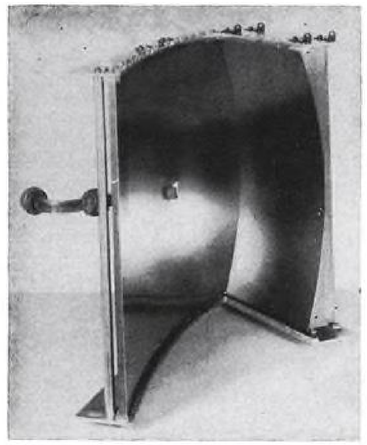
NOPCO

Chemical Company, Harrison, N. J.

Branches: Boston • Chicago • Cedartown, Ga. • Richmond, Calif.

NOPCO — EVOLVED THRU RESEARCH

■ AVIONICS

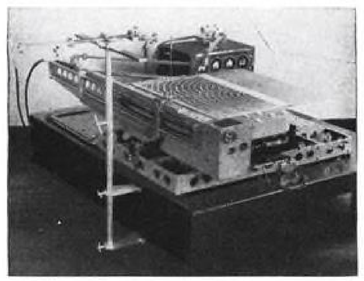


DOUBLE parabolic cylinder antenna forms MW energy into parallel beams.

This can be accomplished by "distorting" the normal paraboloid shape of the antenna, or by using an extended microwave energy feed to the antenna.

A new technique, recently developed by Dr. F. S. Holt and C. J. Sletter of the Antenna lab, uses a waveguide with slots milled in its side through which the energy "leaks." This technique has resulted in certain improvements, Dr. Spencer says.

The shape of a radar beam generated by a microwave lens or aperture is determined by the relative phase and amplitudes of the electromagnetic fields in front of the lens or aperture. The Antenna lab has developed an extremely



PHASE and amplitude of microwave fields can be plotted on this device.

useful device for checking antenna performance. It is a machine which measures and plots phase and amplitude contours for various types of radiators.

▶ **Microwaves on a String**—Unlike low-frequency power, which can be transmitted over conventional wires, microwaves have required expensive and difficult-to-manufacture waveguides or coaxial cables.

But a phenomenon discovered since the end of the war—that microwave energy will cling to the outside surface of a conductor—may permit the use of single-wire transmission lines. The Signal Corps, for example, has developed a "G-string" type of microwave conductor consisting of enamel-covered wire in which microwave energy clings to the enamel and the wire acts merely as a mechanical support.

Other types of similar transmission lines are corrugated rods and ferrite-coated wires. They were first studied by Walter Rotman and F. J. Zucker of the Antenna lab here, according to Dr. Spencer. He adds that single-wire lines show promise of usefulness in the microwave region.

▶ **Flush-Mounted Antennas**—Radar antennas have long been a thorn in the side of aircraft designers. No matter where you hang them, radar antennas usually compromise clean aerodynamic design.

The Airborne Antenna section of the lab is experimenting with new types of radar antennas which can be flush-mounted with scarcely a bulge showing. These antennas could also eliminate the need for the considerable space within the airframe to permit the radar antenna to rotate or scan.

▶ **Twinkle, Little Star**—The growing interest in automatic star trackers for automatic celestial navigation has prompted more than romantic interest

Integrated

AERONAUTICAL • ELECTRONIC • MECHANICAL

staffs...

. . . are designing and producing a wide variety of items for military and commercial aircraft applications. Listed below are recent developments indicative of the coordinated services rendered when projects involve more than one field of Brenco specialization. Inquiries are invited as to how these combined efforts can profitably help you supplement your engineering staff.

AIRBORNE STORES AND TANKS • AIRPLANE THRUST STANDS • BOMB HOISTS • ARMAMENT INSTALLATIONS • TRAINING DEVICES • GROUND HANDLING EQUIPMENT • RADAR ANTENNAE AND DRIVES • FIRE CONTROL SYSTEMS • SERVOMECHANISMS • ELECTRONIC PACKAGING

★★★

Complete information on any of the developments is available to responsible firms or individuals

★★★

Bulletin PS-200

MULTIPLE POWER SUPPLIES

"600" SERIES: Multiple output regulated power supplies designed around the needs of the broadest laboratory requirements. Voltage and current combinations are available to fit all specifications. Six wide range standard models available for early delivery.

VIDEO TEST INSTRUMENTS

MODEL 531: A highly stable and accurate range marker generator with features of versatility not usually found in one piece of equipment of this size. Circuit includes accurate range markers plus a precision sliding pulse with provisions for external triggering. Coincidence circuit may be used exetrnally or as an internal calibrator.

Bulletin VT-100

BRISTOL ENGINEERING CORPORATION

BRISTOL • PENNSYLVANIA

Phone — Bristol 8-7894

WATCH FOR ANNOUNCEMENT OF NEW BRENCO AIRPLANE THRUST STAND

in the twinkling of stars—the source of the reference signals that guide the star trackers.

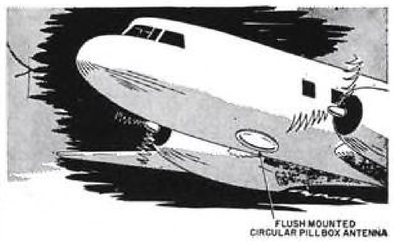
To Dr. Heinz Fischer of the Spectroscopy section of the Antenna lab, this "twinkle" is plain "noise." And the ratio of signal to noise is most important for star trackers. This is one of the research programs under way in this section.

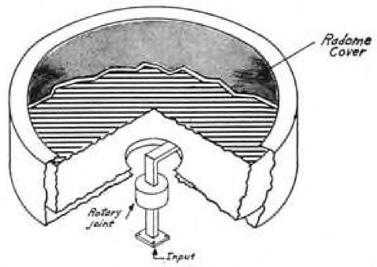
▶**Hydrogen Reversal**—Among other problems under investigation is high-density gaseous spark discharge. A spokesman says Dr. Fisher has photographed the reversal of hydrogen lines, which indicates higher temperatures than had been previously reported in technical journals.

Dr. Spencer considers this an important milestone in the history of spectroscopy.

▶**Some Research Outside**—The Antenna lab farms out some of its research programs to universities. For example, basic research in electromagnetic theory is done at New York University, slot radiation work at Brooklyn Polytech, and microwave optics at McGill University in Montreal.

A recent four-day symposium on microwave optics at McGill brought together some of the world's top experts in radar, antennas, optics, and information theory.





FLUSH RADAR ANTENNAS are a "must" for jets.

The nature of Antenna lab research involves considerable mathematics and computational work. In addition to familiar desk calculators, the lab uses a recently obtained Monorobot digital computer, the first which Monroe Calculating Machine Co. has delivered, according to Dr. Spencer.

Computer Lab

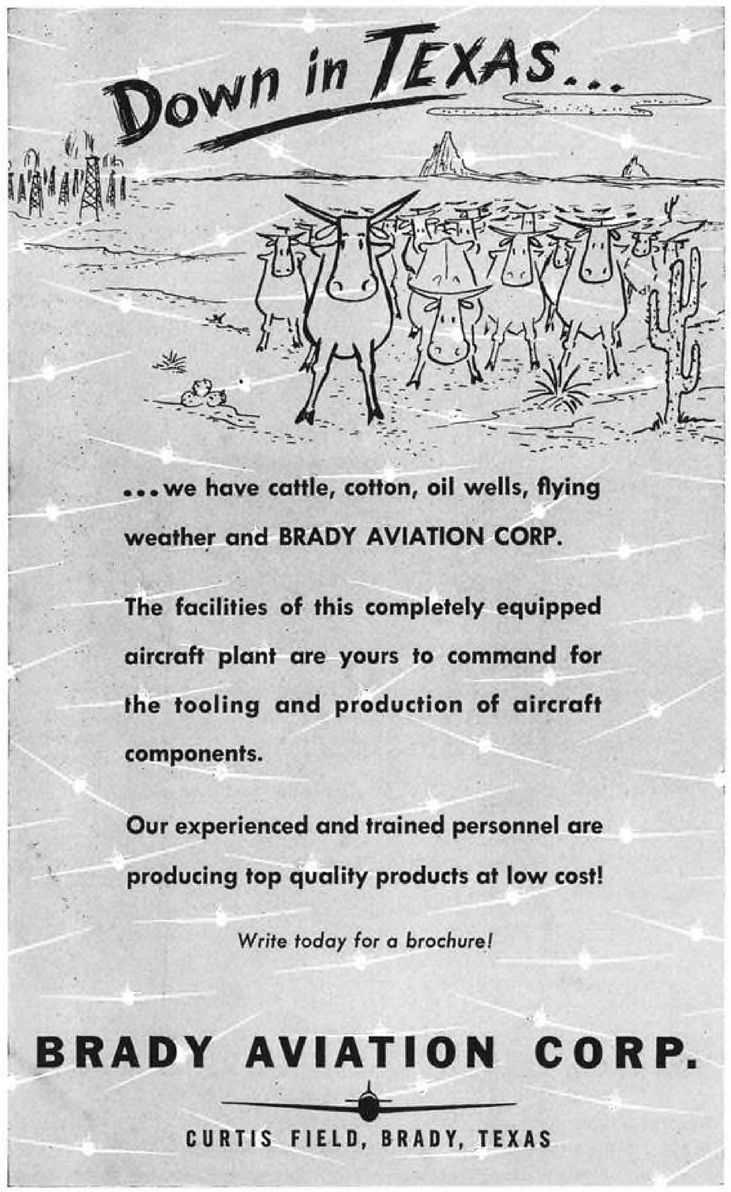
For several years, AFCRC engineers have been applying digital techniques to the processing of radar and other types of information. Recognizing that these techniques will play an increasingly important role in future Air Force systems, AFCRC formed the Computer Lab to bring together some of the groups which have been working on digital techniques.

The major efforts of this lab are devoted to digital data-processing requirements, both current and anticipated, for systems under development by the Center. In addition, the Lab maintains a Computional Section which provides mathematical assistance to AFCRC scientists by programming problems for solution on the Monorobot and the AFCRC-developed ABC (Automatic Binary Computer).

AFCRC expects these electronic computers to be useful in advance evaluation of the relative effectiveness of alternate system designs.

Systems Project Office

Within the past several months, responsibility for all ground environment equipment used in the continental air defense system now under design has been delegated to AFCRC, and in turn



Combat mission . . . or freight flight . . . now we are working to help the pilot locate his position without a radio beacon — merely by equipment right in the cockpit of his plane! Thanks to a Ford Instrument Company design, development and manufacture . . . another step is being taken toward greater flying safety.

This is typical of the problems that Ford has been given by the Armed Forces since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic, electro-mechanical, magnetic and electronic instruments that bring us our "tomorrows" today. Control problems of both Industry and the Military are Ford specialties.

You can see why a job with Ford Instrument offers young engineers a challenge. If you can qualify, there may be a spot for you in automatic control development at Ford. Write for brochure about products or job opportunities. State your preference.

FORD

9

FORD INSTRUMENT COMPANY
DIVISION OF THE SPERRY CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

Send for important data on

AIRCRAFT CLEANING

Wyandotte Chemicals — the world's largest manufacturer of specialized cleaning products for business and industry —offers outstanding products and skilled technical service for these typical aircraft-cleaning and processing problems.

1 Aluminum cleaning
2 Deoxidizing aluminum prior to spot welding
3 Magnesium cleaning
4 Removing heat-treat scale from stainless steel
5 Brightening heat-treated aluminum
6 Paint-booth coating
7 Water-wash paint-booth compounds
8 Electrocleaning
9 Barrel finishing
10 Paint removing
11 Steam cleaning
12 Emulsion cleaning
13 Carbon removing
14 Integral fuel-tank desealing
15 Removing exhaust stains
16 Washing aircraft exteriors
17 Floor absorbents (anti-slip)
18 Engine test-cell cleaning
19 Washing-machine cleaning
20 Aluminum brightening

For information circle the number on the coupon for each problem you're interested in. We'll send FREE DATA. *Wyandotte Chemicals Corp., Wyandotte, Mich.; also Los Angeles 12, Calif.*

Wyandotte CHEMICALS

Wyandotte Chemicals Corporation
AIRCRAFT DEPARTMENT
Wyandotte, Michigan

Please send information on the problems whose numbers I have circled.

1 2 3 4 5 6 7 8 9 10
11 12 13 14 15 16 17 18 19 20

Name_____ Title_____
Firm_____
Street_____ City_____
Zone_____ State_____

■ AVIONICS

to the Systems Project Office here.

The SPO was set up several years ago when AFCRC found that research and component development suffered when the same group tried to carry on systems engineering, according to Dr. Edwin G. Schneider.

SPO also carries out sub-system engineering to support the air defense program, the RADC tactical air weapons system program, or for miscellaneous projects. This group does some "hardware" work, to the extent of assembling new components into a breadboard system to prove new system concepts developed within the SPO.

However, SPO tackles component development only when the Component & Techniques group can't handle it.

▶ **Guiding Air Defense**—The SPO group to guide all air defense ground equipment development activities is now being formed. Headed by M. A. Chaffee, its job is to survey the entire air defense program to determine the compatability of individual portions of the system.

For example, AFCRC must see to it that the Hughes Aircraft fire control system, to be used in our newest interceptors, will cooperate properly with the ground-based equipment. Anti-craft missiles and their ground avionic equipment, must also be integrated into the system.

Air defense project will also look for possible duplication of efforts, as well as areas where more work is needed.

The group itself will probably be small, made up of individual specialists in such fields as radar, data handlers, data link, missiles and interceptor fire control, to mention a few.

AFCRC is not new to air defense work. For several years an AFCRC group has been working in the Lincoln laboratories on one phase of the overall system. In addition, Lincoln labs have brought specific research and component development problems to AFCRC for work in its labs.

▶ **Specs for Hardware**—One important SPO task will be to prepare specifications for the procurement of prototype equipment for the air defense system. Actual procurement will be handled by the Air Materiel Command, and a small AMC unit may be located at AFCRC for closer liaison.

Larger contractors may have an edge in the early phases of the program, because most of the contracts will be for large complex sub-systems.

Later, when the system is proven, and performance tolerances can be established for individual components, it should be possible to bring in more small contractors, a spokesman indicated.

▶ **Traffic Control Computer**—A system designed to schedule automatically the orderly flow of air traffic in the area around an airfield to permit the landing of two aircraft per minute (per instrument runway), is another SPO program.

Called Project Volscan, the system consists of a track-while-scan radar which supplies azimuth as well as range data on all aircraft in the area to an analog computer which schedules their approach to a GCA or ILS "gate."

▶ **Picking a Slot**—When a new aircraft enters the controlled area, it is picked up by the radar and the computer calculates its earliest time of arrival at the final approach gate, based on its present position, altitude, and speed.

If this earliest time of arrival does not conflict with other aircraft, the new aircraft continues straight in. If there is a conflict, the computer looks for the next vacant "slot," and then calculates a detour course which will bring the new airplane in at the later time.

In the event the newly arriving airplane has lost an engine or is suffering battle damage, the computer can be instructed to "bump" one of the previously scheduled aircraft to make way for the emergency approach.

▶ **Automatic Flight Control**—Although the scheduling calculated by the computer is presently transmitted orally by radio, the same information could be transmitted by data link to give each pilot visual steering instructions and/or provide signals to the plane's autopilot to control its flight path automatically.

The 1953 Thurman H. Bane award for outstanding achievement in aeronautical development was recently made to Benjamin F. Green, Jr. of AFCRC for his work on Project Volscan.

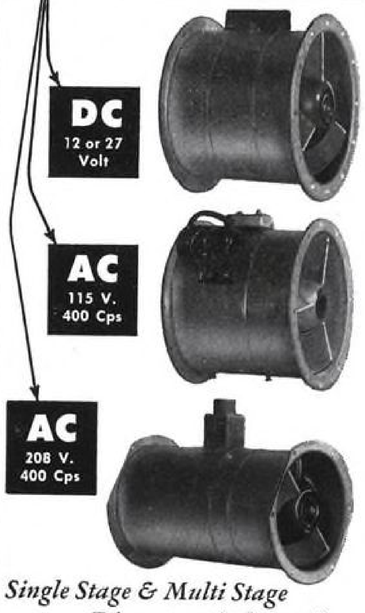
▶ **Project Volir**—During World War II, two separate surveillance radars were used jointly, one to determine target azimuth and range; the other to measure target height.

Shortly after the war, Cambridge launched Project Volir—the development of a single radar and single antenna capable of simultaneously providing azimuth, height, and range data.

But it recognized that a three-dimensional radar, such as Volir, raised display and "bookkeeping" problems. How do you display and keep track of hundreds of targets in three dimensions on a cathode ray tube which has only a two-dimensional display capability?

AFCRC's solution was an automatic digital tracking analyzer computer (ADTAC) which accepted data from the Volir radar and kept a running record of the range, azimuth, and height of up to 400 different aircraft. ADTAC would produce this data (plus target velocity) for any specific target upon "request" of its human operators. ADTAC was tested last Summer and the results are currently being evaluated.

Your BLOWER PROBLEM is our BUSINESS



Single Stage & Multi Stage Diameters 2" thru 20"

- HIGH PRESSURES
- HIGH EFFICIENCY
- LIGHT WEIGHT
- COMPACT PACKAGE
- SPECIAL SHAPES
- DEPENDABILITY

Since 1942 we have specialized in Aircraft and Electronic Blower Applications. This 11 years of of "Know-How" is yours when you call us in on your Blower Requirements.

We have 100 Active Models which can be adapted to your specific requirements.

We manufacture the entire unit, including the motor, so responsibility for warranty rests squarely with us and schedules are met.

"THE BLOWER YOU NEED *IS* GUARANTEED!"

DYNAMIC AIR ENGINEERING *Inc.*
7412 Maie Avenue, Los Angeles 1, California

Maryland Electronic
MANUFACTURING CORPORATION
College Park, Maryland

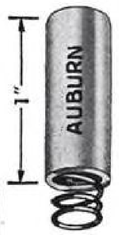
Auburn SPARK PLUG CONNECTORS

for aircraft

NEW! Teflon connectors with Inconel Volute Springs

1041-TV (9/16")
1099-TV (1")

1041-C Steatite
1041-M Mycalex
1041-D Alumina
(AN 4164-2)



1099-C Steatite
1099-M Mycalex
1099-F Phenolic
1099-D Alumina
(AN 4164-1)

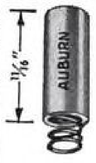
9/16" and 1" sleeves only, without springs, are also available

SPRING AND EYELET ASSEMBLIES

No. 1066-9A
(AN 4164-22)
(Used with 3-48 Stud)

for military trucks and tanks (for 5 mm cable)

CC4020 Mycalex
CC4013 Alumina

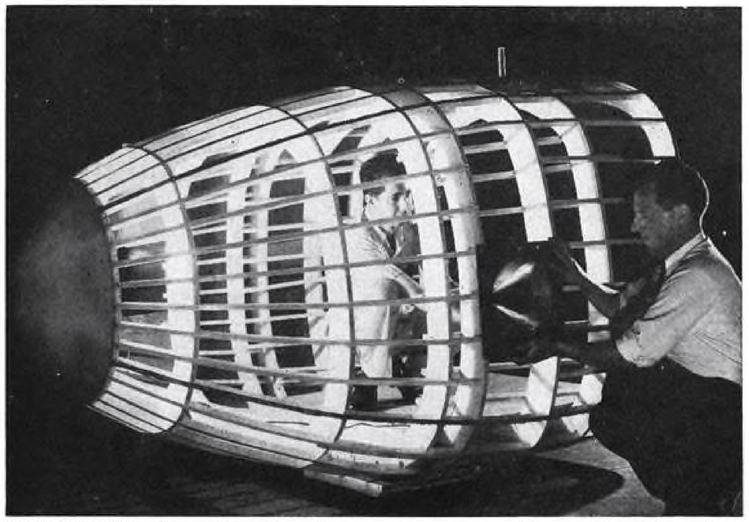


11/16" sleeves only, without springs, are also available

Silicone Grommets
AD51-960
Used with all 11/16" connectors on 5 mm cable

AA50-313
Spring Assembly
Used with all 9/16" and 11/16" connectors for 5 mm cable

AUBURN SPARK PLUG
Co. Inc., Auburn, N.Y.



SIGHT AT NIGHT requires a plane to carry many antennas, like one shown in mock-up.

WADC's Aircraft Radiation Lab:

Where AF Perfects Radar 'Eyes'

Dayton, Ohio—How can you spot two dozen enemy tanks moving up under cover of darkness when you're zooming overhead in a 600-mph jet?

How do you pick out an important strategic target on a bombing radar scope when you don't know the target's exact location relative to known landmarks?

And when there are no distinctive landmarks, how do you train radar bombardiers to familiarize them with how an enemy landscape will appear on a radar scope?

These are some of the knotty problems under investigation in WADC's Aircraft Radiation Laboratory, which might more aptly be named, "The Sixth Sense Lab."

▶ **Mission: Vision**—ARL's mission is to develop techniques and equipment which will enable our airmen to extend range of their vision and enable them to penetrate darkness and overcast to see and identify enemy aircraft, and strategic or tactical targets.

Another important ARL mission is to develop airborne countermeasures equipment capable of neutralizing enemy airborne and ground-based radar and communications.

▶ **ARL Branches**—Headed by Col. C. H. Lewis, the Aircraft Radiation Laboratory is divided into six branches:

- **Advanced Development,** under P. J. Snider.
- **Countermeasures,** under George Rappaport.
- **Search Radar,** under C. J. Marshall.
- **Guidance Development,** under R. E. Houser.
- **Design Engineering,** under C. N. Kelier.
- **Installation Engineering,** under R. M. Worley.

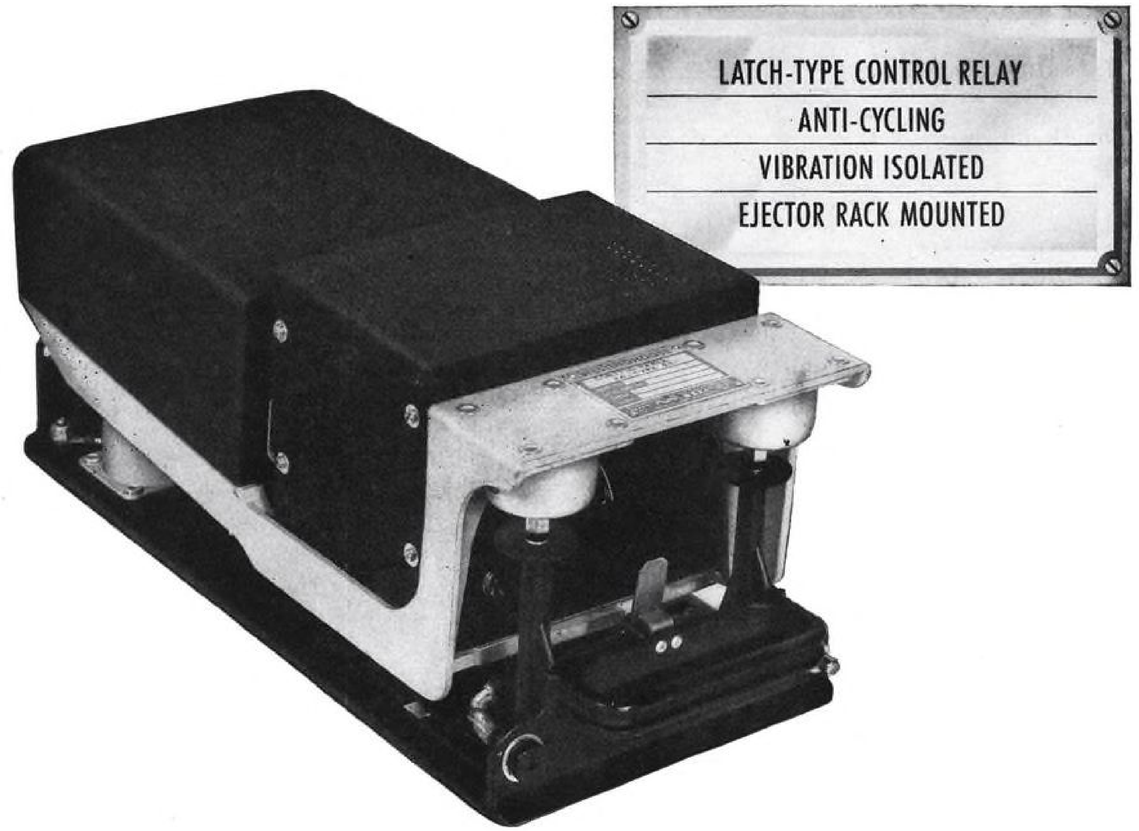
Advanced Development

"We get lots of 'stuff' on our radar scopes that we don't understand which may have important significance and which could be sorted out," according to F. L. Holloway, Technical Director of ARL. "We need to get more basic information on the significance of radar return," he adds. This is the kind of assignment delegated to ARL's Advanced Development branch which does much of the applied research within the Lab and most of its in-house development. This branch is divided into three sections:

- **Wave Propagation.**
- **Antenna Design.**
- **Applied Physics.**

▶ **Wave Propagation Section**—Overly enthusiastic claims sometimes made for radar tend to obscure the fact (to those outside the radar field) that looking at a bombing radar scope is a far cry from looking out a visual bombsight on a clear day. Reading a radar scope involves considerable interpretation, much of it of an empirical nature. That is what Holloway means by his statement about "lots of stuff on our radar scopes that we don't understand."

One program underway in the Wave Propagation section is intended to find out more about how specific types of terrain and materials look on radar.



New Westinghouse Control Panel provides protection for 3-phase aircraft electrical power system

This new Westinghouse a-c generator control panel —total weight only 12 pounds—provides *positive* protection and continuity of service for any 115/200-volt, 3-phase aircraft electrical power system.

The panel's unfailing efficiency is due to the dependable operation of the following electrical components:

Generator control relay . . . differential protection relay . . . overvoltage relay . . . transformer-rectifier . . . field flashing circuit . . . power indicator relay . . . power selector rectifier . . . lockout relay.

All are built into a one-piece mounting base, which in turn is mounted on an ejector rack designed in strict accordance with USAF Drawing 52D 21558.

The main contacts of the latch-type (electrically or mechanically operated) trip-free generator control relay—a Westinghouse innovation—are enclosed in permanent magnet blowout arc chutes to assure positive arc interruption. Auxiliary contacts are available for closing or tripping the circuit breaker.

For further information on this new Westinghouse control panel or other aviation products, call your nearest Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-03013

YOU CAN BE SURE... IF IT'S

Westinghouse

That is, what kind of signal returns (echoes) are received from different types of terrain and what are their distinguishing features.

▶ **Studying the Pulse**—Airborne targets return only a small amount of radar energy, often making them difficult to detect in the presence of energy reflected from moisture in the air. The WP section is analyzing the echo signals from airborne targets in an attempt to extract all possible information from them. As a part of this study, the WP section needs to analyze each individual pulse of echo energy, rather than the average signal which appears on a radar scope.

Another propagation study in this section is aimed at determining the cause of sporadic fading in radio air-to-air communications.

▶ **Antenna Design Section**—Applied research into the design of airborne radar and countermeasures antennas for operation at frequencies "from d.c. to infrared—whatever the enemy chooses to use," is the way Fanning describes the problem of the Antenna Design section. The solution becomes more difficult for highspeed aircraft, Fanning points out, where antennas must be flush-mounted or nearly so.

As possible solutions, the AD section is investigating recessed and slot antennas as well as exciting portions of the airplane fuselage or empennage to serve as a radiator.

Asked about progress, Fanning says it has been "considerable." "We have been able to design flush antennas to give the desired radiation—but not at all the frequencies, yet," he says.

Fanning notes that ARL has a very complete antenna testing facility, possibly the best in the country.

▶ **Applied Physics Section**—The Applied Physics section is devoting most of its efforts to developing ultra-sensitive infrared detectors and studying the propagation characteristics in this region.

Generally speaking, infrared has the same distance limitations as visible light. Hence it appears attractive for night operations, but not too good for operations in rain or mist. ARL views infrared as a supplemental aid to radar and not as a potential replacement for it, Holloway says.

Countermeasures

Airborne Electronic Countermeasures (ECM) is the science of denying the enemy any advantage that he might gain in his use of electronic systems designed to defeat our aircraft or missiles. Most of the Air Force's airborne ECM work is carried out in the Countermeasures branch here.

▶ **Easier and Harder**—In one respect airborne ECM engineers have an easier job than their ground-based counterparts at Rome Air Development Center; in another sense their job is much more difficult. The job is easier for WADC because electro-magnetic radiation doesn't respect or stop at national boundaries.

Thus by the very nature of the problem, the airborne ECM engineers get some advanced information on the characteristics of the ground equipment which they may be called upon to jam in event of war, while the ground-based equipment engineer never knows what airborne ECM will be thrown at him until war breaks out.

▶ **Other Side of the Coin**—The airborne ECM engineer has his problems, though. ECM has to compete for space and choice location on a bomber with such things as fuel tanks, bombing systems, and armament. The weight, size, and complexity of airborne jamming equipment is necessarily limited because it must be carried in an airplane.

The ground radar designer, effectively without any of these limitations, can go to great pains to build in sophisticated anti-jamming circuits. What is more, he has a great deal of power to "play with," while the airborne jammer must operate with much more modest powers.

In neither case does the ECM engineer, have a bed of roses in his work.

Col. Lewis told AVIATION WEEK that he believes that "ECM requires as much technical skill and ingenuity as any other equipment under development in ARL." He adds that the ECM art is so "sophisticated and complex" that the majority of these developments must be given to contractors with considerable technical capability.

▶ **ECM Activities**—The Countermeasures branch is divided into five sections:

- **Reconnaissance.**
- **Jamming Systems.**
- **Chaff Systems.**
- **Deception.**
- **Research.**

For security reasons, Holloway declined to discuss details of the work in each of the sections, except to outline their general areas of activity. For example, the Reconnaissance section develops airborne equipment designed to search the RF spectrum, analyze, and record enemy radiation.

The Jamming section develops equipment which creates RF "noise" to block out enemy ground or airborne radars. The Chaff systems section develops new types of chaff and airborne dispensers.

As used in World War II, chaff consisted of finely shredded pieces of aluminum foil which were dumped out by our bombers. The chaff drifted slowly earthward, reflecting energy from enemy ground-based radars, creating the illusion of false targets and cluttering the enemy radar scopes.

The Deception section devises new electronic methods for creating confusion among enemy radars. The Research section presumably serves all of the other sections in the branch. Roughly 25% of the Research section's work is in-house development, Col. Lewis says. Practically all developments in the other five sections are contracted out.

Asked how the Countermeasures Branch tests the effectiveness of its ECM, Col. Lewis replied that new components are tested against RADC equipment at Air Force Armament Center. He points out, though, that ECM is a never-ending race. The enemy can be expected to develop techniques for countering our ECM.

Search Radar

The application of airborne radar and television equipment to get more aerial reconnaissance information faster, is being studied in the Search Radar branch.

▶ **Search sections**—The Search Radar branch is divided into five sections:

- **Radar Reconnaissance.**
- **Surveillance.**
- **AMTI (air moving target indicator).**
- **Display.**
- **Television.**

▶ Radar Reconnaissance—In recent

NOW - ONE-PIECE NYLOK

Self-locking Bolts and Screws

Eliminate costly safety wiring, lock washers, jam nuts!

Now you can do a real fastening job, put your product together faster, and drastically reduce manufacturing and maintenance costs. Here's how:

No other method equals the Nylok principle of locking threads securely in any position—*seated* or *unseated*. The smooth wedging action of the nylon insert does it! The lock is vibration-proof, and the ONE-PIECE construction ends laborious fussing with separate auxiliary parts, such as safety wiring, lock washers or jam nuts. The lock is always there—the operator can't forget to apply it. Extra security and ease of service give your product enhanced sales value—and you save plenty on assembly operations.

Nylok bolts and screws also provide a leakproof seal where liquids are present. They will not mar mating surfaces and can be used over and over again.

SIZES #6 UP: LENGTHS 3/8 INCH UP

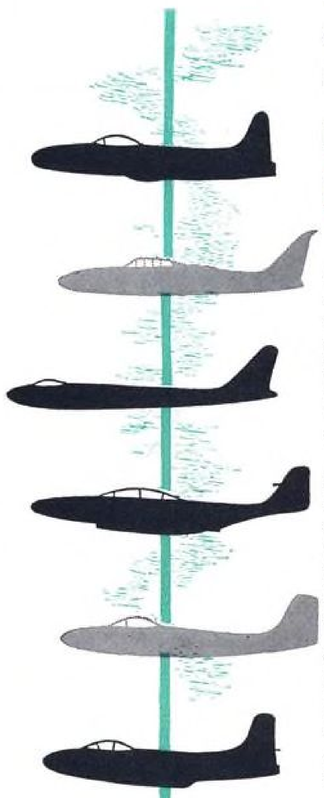
IMMEDIATELY AVAILABLE

The NYLOK CORPORATION, 475 Fifth Ave., New York 17, N.Y.
FACTORY: Elmira Heights, N.Y.

Manufacturers of Nylon-Locked Fasteners,. Covered by U.S. patents and patents pending.
Please send Bulletin 8 on Self-Locking Bolts and Screws.

Name _____ Title _____
Company _____
Address _____
City _____ Zone ____ State _____

USE THE COUPON FOR QUICK INFORMATION



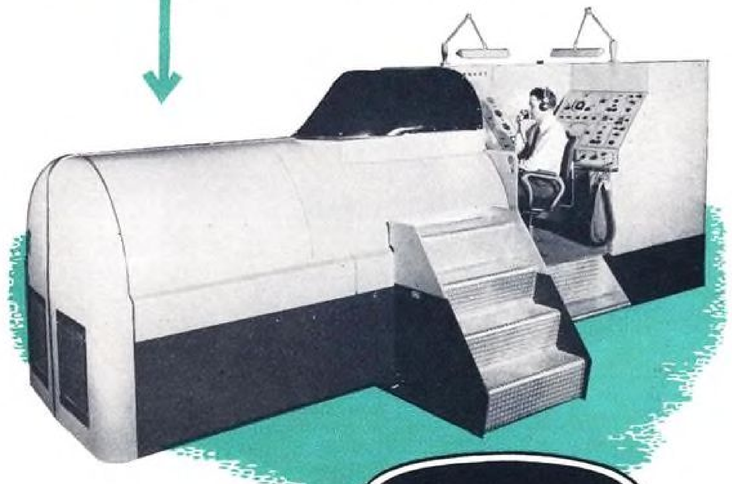
Common Denominator of all LINK Electronic Equipment...

INFINITE PRECISION

As aircraft behavior at sub-sonic and super-sonic speeds becomes more and more complex, the need for thorough on-the-ground flight training becomes ever more vital to the success of the Air Training Program. At the same time the simulation of these complex flight conditions demands infinite precision.

Link Electronic Equipment simulates *with infinite precision* every power and aerodynamic factor that influences take-off, flight and landing . . . speed, direction, rate of climb, effect of fuel consumption on trim, flight position, deviation and a host of others.

This infinite precision is built into all Link Electronic Equipment. Link Jet Trainers operate with the dependable certainty of the simplest mechanism. Yet they duplicate *exactly* the "in air" conditions of today's most advanced aircraft.



—the connecting link between ground and sky

LINK AVIATION, INC. BINGHAMTON, N.Y.

LINK invites employment applications from engineers and draftsmen.

Oster

AVIATION PRODUCTS
for air-borne quality and dependability

SAFER FLIGHT EXTRA FIGHT

Here is an engineering and production skill you can use to help you achieve safer flight, extra fight. For 25 years, OSTER has specialized in electro-mechanical products. A staff of trained field engineers is at your service. Call on us to help you select the product best suited to your job.

INSTRUMENT CONTROL MOTORS

1. Synchro Generator
2. Synchro Control Transformer
3. Synchro Transmitters
4. Synchro Differentials
5. Synchro Receivers
6. Synchro Resolvers
7. Two Speed Synchros
8. Reference Generators
9. Low Inertia Servo Motors
10. Servo Torque Units
11. Tachometer Generators

DRIVE MOTORS & BLOWER MOTORS

1. Permanent Magnet
2. DC
3. 60 Cycle AC
4. 400 Cycle, 1 Phase
5. 400 Cycle, 2 Phase
6. 400 Cycle, 3 Phase
7. 50 — 1600 Cycle, Variable Frequency

AIRCRAFT ACTUATORS

1. Rotary 2. Linear

JOHN OSTER MANUFACTURING COMPANY
AVIATION DIVISION
RACINE, WISCONSIN

©1953

HANSEN COUPLINGS
...give you 2 big advantages

Locking pins in Hansen Push-Tite Coupling Socket afford large area contact with plug, thereby preventing wear and subsequent leakage.

To connect a Hansen coupling, you merely push the plug into the socket with one hand. Flow is instantaneous. To disconnect, push back sleeve on socket . . . coupling disconnects. Flow is shut off instantly and automatically. *One-way shut-off, two-way shut-off, and straight-through types. Write for Catalog.*

REPRESENTATIVES

BALTIMORE, BIRMINGHAM, CHICAGO, CLEVELAND, DALLAS, DAYTON, DENVER, DETROIT, FT. WAYNE, HARTFORD, KANSAS CITY, LOS ANGELES, LOUISVILLE, MILWAUKEE, MINNEAPOLIS, NEW ORLEANS, PITTSBURGH, ROCHESTER, SAN FRANCISCO, SAVANNAH, SEATTLE, ST. LOUIS, MONTREAL, TORONTO, VANCOUVER

Export Department: Cleveland

THE HANSEN MANUFACTURING COMPANY
4031 WEST 150th STREET • CLEVELAND 11, OHIO

■ AVIONICS

years there has been a great improvement in the overall quality of reconnaissance radar (used for ground mapping), according to C. J. Marshall, branch chief. This improvement is partly due to improved receiver and display circuitry and better cathode ray tubes, Marshall says, and partly to improved techniques for photographing radar scope displays.

Previously, provisions for attaching cameras to radar scopes were fairly crude and fixed-focus cameras were used, Marshall says. The result was that the picture was frequently out of focus and fuzzy.

New techniques developed in the Radar Reconnaissance section enable an operator to check the focus of the camera on the scope, and make adjustments if necessary. This section has also devised new controlled techniques for developing and printing radar scope photos to show greater detail.

However, the primary task of this section is to develop new search radars. Frequently these developments are later adapted to other uses, such as for bombing systems.

The distinction between search and navigation radars is this, according to Holloway: Search radars, used for ground reconnaissance mapping usually require greater precision than navigation radars.

▶ **Surveillance Section**—The term surveillance radar is applied to airborne radar used to detect other aircraft (or missiles). The Surveillance section is developing airborne equipment for both the Air Defense Command and the Tactical Air Command for use as early-warning radars.

By "hoisting" radars up to considerable altitudes, their range, which is limited by the earth's curvature or horizon, is extended considerably.

▶ **AMTI**—The use of airborne radar in ground support action has not, in the past, been practical because it is too difficult to pick out slow moving targets from the "ground clutter" (echoes returned from stationary ground objects).

Moving target indicators (MTIs) have been used for some years in ground-based radars to sort out aircraft from spurious echos, but the problem is much easier there. For one thing the unwanted clutter comes from fixed ground objects while the wanted airplane echo is moving, making it possible to discriminate (electronically) between the two.

The airborne MTI problem resolves itself into this: The airplane and its radar are moving at, say, 500 mph.; the target (a tank or truck) is moving at 20 mph. Relative to the radar, the ground is moving at 500 mph. and the

How to fly a guided missile in your laboratory

Practically any electrical, mechanical or physical phenomenon — even the full flight of a guided missile — can be precisely re-created in the laboratory from Ampex magnetic tape recordings.

Ampex retains and plays back data in the same electrical form in which it is received, making its playback in effect equivalent to a rerun of the original test. But it has these added advantages: Data can be repeated at any time or place, can either be scanned or studied in whole or part, can be speeded up or slowed down, can be fed to automatic reduction systems. Furthermore, desired portions of the data can be reduced to oscillograph traces, pen recordings or any other form that could have been made at the time of the original test.

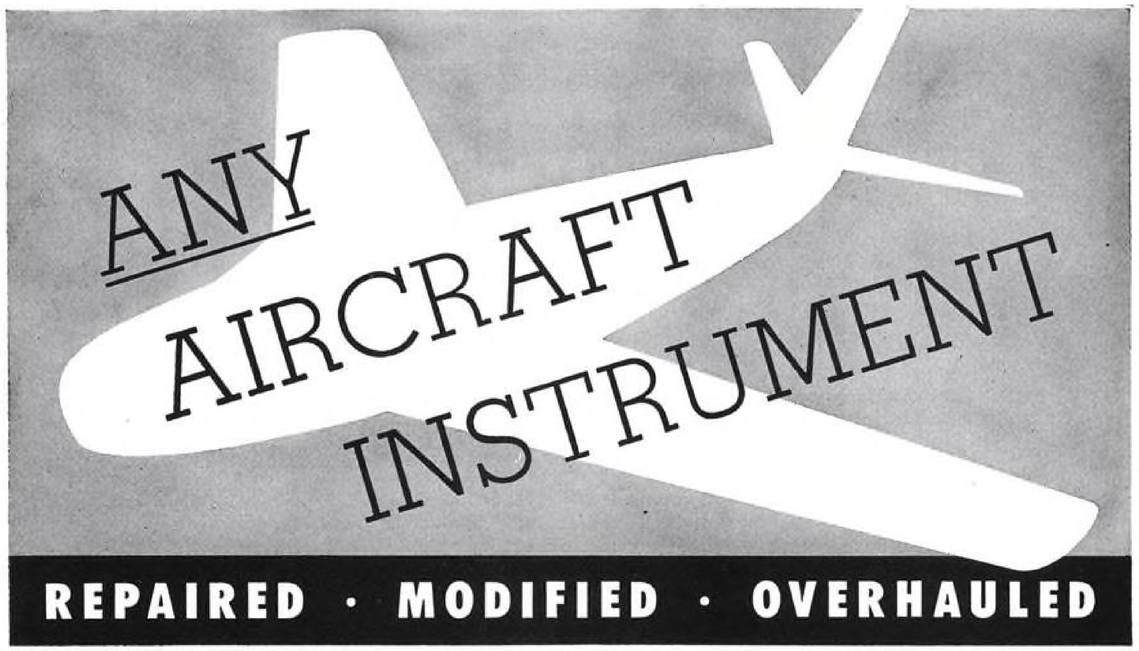
Besides the convenience and versatility of the data itself, Ampex Magnetic Recorders and the tape they use have these desirable physical qualities:

- *Ampex Tape Recorders, being rugged, compact and portable, are usable where other equipment would not be feasible;*
- *Tape requires no processing, hence is immediately available for playback;*
- *Tape stores an enormous quantity of information at low cost and in minimum bulk.*
- *Ampex Tape Recorders cover extremely wide frequency range:*
  Model 306 — 0 to 5000 cycles/sec.
  Model 307 — 100 to 100,000 cycles/sec.
  Model 303 — Pulse width modulation
  Many other models are also available.

AMPEX
MAGNETIC RECORDERS

For further information write to Dept. Q-1037A

AMPEX ELECTRIC CORPORATION
934 CHARTER STREET • REDWOOD CITY, CALIF.



Decker Aviation Corp. is a pioneer in the complete modification, overhaul, and conversion of aircraft instruments of all types. One of the first organizations to be CAA licensed for all four instrument classifications, Decker has maintained a reputation for the finest of workmanship and prompt delivery.

Whether your problem is a J-8 Attitude Horizon Indicator, B-1 Gun Chargers, C-5B Gyro Directional Indicators, Demand Type Oxygen Regulators, or any other of the latest manufactured instruments or test equipment, Decker can meet your requirements with complete laboratory facilities and trained technicians. A full stock of replacement parts permits unusually quick service on all types of instruments. Our Research and Development laboratories can solve your special instrument problems.

USAF–USN–RCAF–Quality Control Approval • CAA License, Classes 1-2-3-4 •
Authorized Service Station for Eclipse Pioneer • Kollsman • U.S. Gauge

Decker
AVIATION CORPORATION
1361 Frankford Ave., Phila. 25, Penna.

truck at 480 (or 520) mph. The object is to "throw out" signals received from the object moving at 500 mph., while retaining the echo signal from the truck or tank moving at 480 mph. The criterion for discrimination between wanted and unwanted signals is obviously a very narrow one.

Despite the difficulty of the problem, Marshall reports that the AMTI Section has "made considerable progress and some specific hardware is in sight." During the lean years of 1946-48, the work was carried on in-the-house, Marshall says. Now it is contracted out.

AMTI must be engineered into airborne radars and cannot be added to existing ones, as a general rule, Marshall says. The reason, he explains, is the need for greater stability in some of the radar circuitry. Part of this section's job is to pass along its AMTI know-how to industry engineers under contract to the Radar Reconnaissance section, Marshall says.

► **Display Section**—"Predicting, or synthesizing, the radar picture which would be obtained over unexplored, unfriendly territory is a tough problem," is the way that Marshall describes one of the current investigations in the Display Section. "You can't go to the literature, like the MIT Radiation lab series, for the answer either," he adds. Marshall points out that you can't always rely on natural landmarks. The Mississippi River, for example, with flat land on either side of its banks, would appear quite differently on a radar scope than the Hudson River which has high rocky cliffs along its banks (in some areas).

The direct opposite of this "synthesis" work is a systematic study of how to interpret radar scope presentations to distinguish different types of terrain and buildings. This program, the results of which are so important to the use of radar for reconnaissance, is being carried out jointly by the Display and Propagation sections of ARL.

► **Color Displays**—The Display section is currently experimenting with color cathode ray tubes for possible radar application in the hope of making it easier to discriminate between different types of terrain and targets. The idea is to use different colors to indicate the relative signal strength of the returning radar echo—in effect adding a third dimension to radar displays. This section also develops new types of radar displays with an eye cocked at the human engineering aspect of their design. The section works closely with the WADC Aero-Med Lab, Marshall says.

From the air, landmarks look considerably different on a radar scope than to the human eye, which makes conventional aerial maps of little value in radar navigation. The answer is to give navigators "radar maps" showing the area as it appears on a radar scope. The display section is developing techniques and computers to speed up the process of preparing radar maps.

► **Television Section**—"Television offers attractive possibilities for aerial reconnaissance," Marshall says, "because the intelligence can be instantly transmitted back to headquarters."

Techniques developed in the Television section of the Search Radar branch can be applied to aerial mapping under visual conditions, to radar mapping under overcast conditions, and to the remote control of drone aircraft, Marshall notes. In the latter application, TV is used to show the cockpit instruments in the drone airplane.

Advantage of TV over radio telemetering, Marshall points out, is that TV is fail-safe: If a picture is being received—the operator on the ground knows that he has an accurate indication of drone cockpit instrument readings.

► **Photos Used**—When TV is used for direct photo reconnaissance in a high-speed aircraft, little information can be obtained by directly viewing the TV screen. For that reason the picture is recorded on film on the ground so that it can be replayed at slower speeds. Another type of reconnaissance technique is to make a mosaic photograph of a large area.

Present efforts of the TV section are devoted to devising new techniques to reduce the bandwidth required to transmit the TV picture. One technique involves the use of very low frame rates. To eliminate the flicker that normally accompanies low frame rates, the section is trying a "dot interlace" scanning technique instead of using the conventional sequential interlace.

Guidance Development

How do you quickly rendezvous thirsty jet bombers with their tanker aircraft for air-to-air refueling? How can jet bombers keep their station (position) when flying formation in instrument weather. These are a couple of the problems under investigation in the Guidance Development branch.

► **Guidance Groups**—The Guidance Development branch is divided into five sections:

- **Altimeter.**
- **Anti-Air Techniques.**
- **Anti-Surface Techniques.**
- **Radar Techniques.**
- **Radio Control & Telemetering.**

► **Altimeter Section**—Radio and radar altimeters, developed in the Altimeter section, are not normally thought of as

* **Important Reasons why Electrical Products AIRCRAFT RELAYS...**

are standard equipment for military and commercial aircraft

* *Simplicity* of design, *efficiency* of "circuitry" for *highest resistance to shock vibration and acceleration* and *statistical quality control* in all phases of production. These all-important factors assure . . . less chance of relay malfunction . . . less maintenance . . . less weight . . . less space . . . uniform high quality and performance of each relay for a longer, trouble-free service life.

RELAY BASIC UNIT A-1105
Has rotary armature with unique, close-coupled contact linkage for speedy, low-inertia operation specially designed for exceptional resistance to vibration, shock and acceleration. This unit is basic part of relays below.

Hermetically-Sealed
A-N APPROVED TYPES

RELAY A-1104 (AN-3306-1)
Has RS-06-20-7P Cannon connector mounting. 24-28 VDC. Dimensions: 1-3/4" x 1-3/4" x 3-7/16". 10 Amp. DPDT.

RELAY A-51-108 (AN-3311-1)
Suitable for base or panel mounting. 24-28V DC. 2-1/2" x 2-1/2" x 2-1/16". 10 Amp. DPDT.

RELAY A-1106 (AN-3307-1)
Is arranged for panel mounting. 24-28V DC. 1-3/4" x 1-3/4" x 2-7/8". 10 Amp. DPDT.

RELAY A-52-111 (MIL-R-6106)
Has individual terminal lugs. 24-28V DC. 2-1/16" x 1-13/16" x 1-9/16". 10 Amp. DPDT. Weight 4.8 ozs.

Send us your requirements, or request our illustrated 10-page Relay Brochure.

RELAY DIVISION
Electrical Products CORP.
1100 N. Main Street, Los Angeles 12, California

Three reasons

why Lockheed in California

offers

better careers for engineers

1 *Diversified Production*

Huge luxury airliners, cargo transports, fighters, bombers, trainers and radar search planes are rolling off Lockheed assembly lines. Twelve models are in production.

2 *Diversified Development Projects*

The most diversified development program in Lockheed's history is under way—and it is still growing. The many types of aircraft now in development indicate Lockheed's production in the future will be as versatile as it is today—and has been in the past.

3 *Diversified Living*

You work better in Lockheed's atmosphere of vigorous, progressive thinking—and you live better in Southern California. You enjoy life to the full in a climate beyond compare, in an area abounding in recreational opportunities for you and your family.

This capacity to develop and produce such a wide range of aircraft is important to career-conscious engineers. It means Lockheed offers you broader scope for your ability. It means there is more opportunity for promotion with so many development and production projects constantly in motion. It means your future is not chained to any particular type of aircraft—because Lockheed is known for leadership in virtually all types of aircraft.

Lockheed's versatility in development and production is also one of the reasons it has an unequaled record of production stability year after year.

Lockheed AIRCRAFT CORPORATION
Burbank, California

guidance devices, although they do have important uses as such, R. E. Houser, branch chief, points out.

For example, in photo reconnaissance work, it is important that the airplane remain at a fixed altitude above the terrain. This can be achieved by tying in a radio or radar altimeter to the airplane's automatic pilot. Height above the terrain is also important to troop carriers transporting paratroopers.

A new radar altimeter has been developed by the Altimeter section which eliminates the old cathode ray tube type of cockpit indicator and substitutes a Veeder-counter and pointer type indicator, Houser says.

Although the device weighs slightly more than its predecessor, the new altimeter has a greater operating range and is less complex, Houser notes. The new radar altimeter will shortly be in production. It can be used for automatic altitude (terrain clearance) control of both piloted aircraft and missiles.

▶ **Obstacle and Tail Warning**—One program which has just gotten under way is to develop an obstacle warning device, capable of detecting not only mountain tops, but smaller objects like buildings, towers, and even high-tension wires.

Another program is pointed toward a device which will warn a fighter or tactical bomber pilot when an enemy plane is on his tail. Functionally similar devices were used during World War II, but when used on low flying aircraft, reflections from the ground created false warnings.

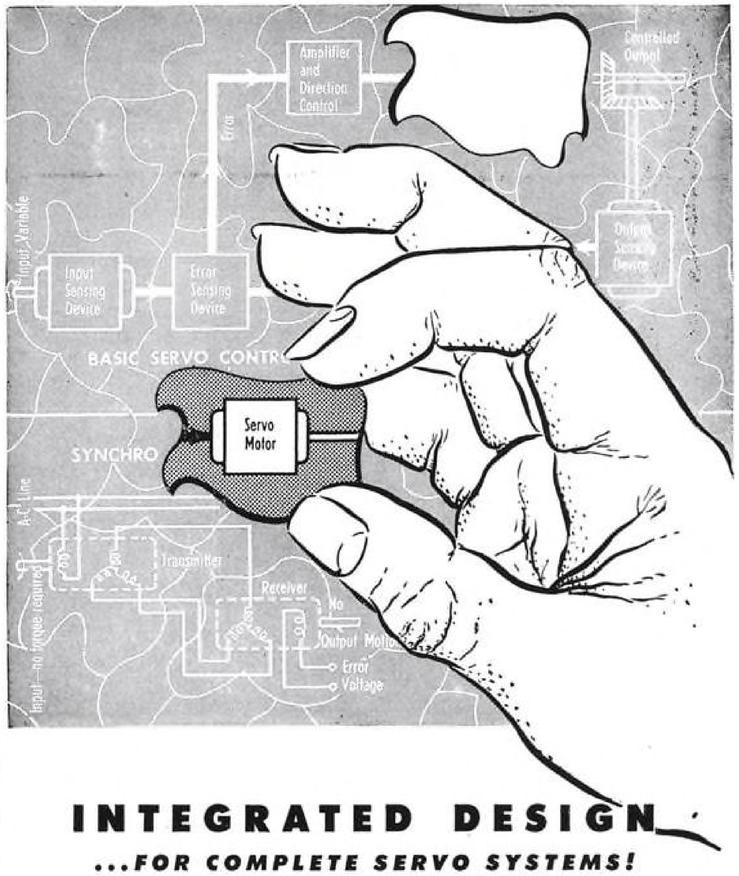
Object of the new development is to eliminate false warnings from ground return, to extend the operating range of the tail warning radar, and to make it possible to detect smaller targets, such as air-to-air missiles. Houser indicates.

▶ **Anti-Air & Surface Sections**—The Anti-Air and Anti-Surface Techniques sections have responsibility for technical guidance of radar techniques used in air-to-air, ground-to-ground, and air-to-ground missiles, operating through the armament laboratory and/or the Weapons Systems Joint Project Office. This includes such pilotless aircraft as the B-61 (Matador) and the Hughes Aircraft F-98 (Falcon) air-to-air missile.

The Anti-Air section also has the projects for developing rendezvousing and station-keeping techniques and equipment.

▶ **Radar Techniques Section**—New techniques designed to improve the range, accuracy and resolution of bombing and fire-control radar are initially developed in the Radar Techniques section. Its work includes the investigation of new operating frequencies for radar.

Most of this section's developments are performed by outside contractors.



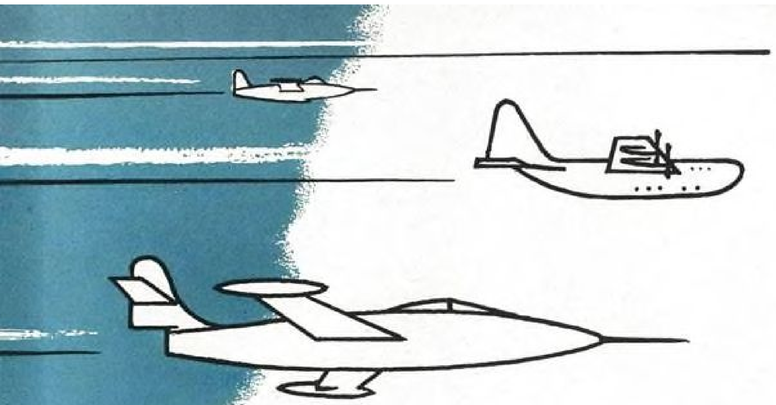
INTEGRATED DESIGN
...FOR COMPLETE SERVO SYSTEMS!

Like pieces in a jig-saw puzzle, all components in a Transicoil servo system are designed to fit each other . . . coordinating to form the complete picture. Systems made by piecing together unmatched components usually spoil the picture by limiting the final efficiency of the entire system.

But if building your own system seems desirable, you'll find that individual Transicoil components offer the best performance in the job each is required to do. Built to your exact specifications, ready for immediate application, their ability to fit into the picture of your system is limited only by the restrictions you place upon them.

Details covering Transicoil Servo Systems, or components are available upon request to . . .

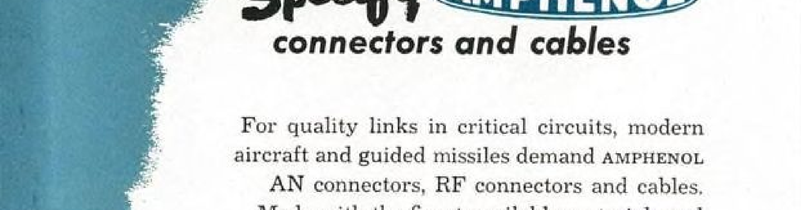
TRANSICOIL CORPORATION 107 GRAND STREET NEW YORK 13, N.Y.



where there can be no compromise with quality

Specify AMPHENOL connectors and cables

For quality links in critical circuits, modern aircraft and guided missiles demand AMPHENOL AN connectors, RF connectors and cables. Made with the finest available materials and manufactured with the strictest quality and inspection controls, these components fully meet government and industry specifications. And not only in performance but in design, can AMPHENOL components be recommended. For constant cooperation with the military and with leading manufacturers has resulted in hundreds of new designs for new applications from AMPHENOL. Connectors and cables which operate efficiently at extreme temperatures, ranges thought impossible just a few years ago, are included now in the versatile AMPHENOL components line. Write AMPHENOL for a copy of catalog B-2, which gives a condensed listing of all AMPHENOL products. For more specific listings of AMPHENOL literature, consult the inside back cover of the B-2.



AMPHENOL

AMERICAN PHENOLIC CORPORATION

chicago 50, illinois

AVIONICS

A recent exception is a new range radar for computing fighter gunsights. The section here built up the breadboard model, and then "sold" it to the Armament Lab, which is putting it into production, Houser says.

▶ **Radio Control & Telemetering Section**—Receivers and transmitters, which can be used either in the air or on the ground for the remote control of aircraft and target drones, are products of the Radio Control & Telemetering section.

In addition to these familiar uses, remote control set-ups are handy for running aerodynamic tests on new missile airframes before the missile's own guidance system is ready for use, Houser points out.

Remote control equipment developed by this section is used at other ARDC bases, Houser says.

Telemetering equipment for transmitting data from experimental airplanes or missiles under flight test to ground stations for recording and analysis is also a responsibility of this section. Houser says that pulse-coded modulation is generally used in preference to FM/FM because it can be relayed more easily without deterioration of its accuracy. Another advantage is that it can be recorded directly on IBM cards without intermediate conversion equipment, Houser adds.

Design Engineering

Most of the activities of the Design Engineering branch cut across the lines of other branches in ARL to achieve uniform design engineering practices throughout the lab.

▶ **Design Sections**—The branch is divided into four sections:

- **Anti-Jamming Research.**
- **Requirement & Analysis.**
- **Standards.**
- **Instrumentation.**

▶ **Anti-Jamming Research**—"Although the methods and progress achieved are highly classified, it can be revealed that research in anti-jamming techniques has resulted in considerable optimism in an area that only a few years ago was considered nearly devoid of solution," an ARL spokesman says.

Research and development of techniques to make our radars and guidance systems resistant to enemy ECM are the responsibility of the Anti-Jamming Research section. This section also acts as a consultant to other ARL Branches and other WADC labs to see that new anti-jam techniques are passed on to industrial contractors.

Another AJR section task is to evaluate airborne equipment to determine its susceptibility to ECM. and then to rate it with a "jamming susceptibility factor."

▶ **Standards Section**—The Standards section engineers work through project engineers in other ARL groups to see to it that newly developed equipment meets AF needs in terms of producibility, reliability, tactical suitability, ease of maintenance, and configuration.

This section tries to avoid the use of critical materials and to spot mis-application of components. All development specs are reviewed here before being issued, and the group works with AMC on ARL equipment.

Another task is to study and consider the application of new components to ARL equipment.

▶ **Requirements & Analysis**—When a contractor delivers a new piece of equipment, it goes to the Requirements and Analysis section for test and evaluation.

This group checks to see whether it meets the contract specs and other requirements established by the Standards section.

▶ **Instrumentation Section**—Should test devices be built into a new piece of equipment or should separate external testers be used?

The Instrumentation section studies each new development to determine how to minimize the amount of external test equipment required. If a specialized piece of external test equipment seems desirable, this section monitors its design.

Other activities include devising special testing techniques and inter-service standardization of common test gear.

Installations Engineering

Developing a new radar or ECM, and putting it into production, is only part of the job that must be done. The best designed radar set will give just so-so results if not properly installed in the airplane, or if the radar operator can't conveniently reach its controls.

The Installations Engineering branch sees to it that ARL equipment is properly installed from both an engineering and a human-engineering viewpoint; that it is compatible with other equipment on board, and that it can operate from the existing power supply.

Branch personnel plan and direct the installation of ARL equipment in both piloted and pilotless aircraft. The branch provides installation data equipment specs, drawings and instructions for bench test and flight test. It also provides liaison engineers to work with contractors, Weapons Systems project officers, testing facilities, or installation and maintenance facilities.

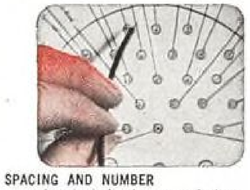
The branch also functions to provide "feedback" to ARL project engineers on what type of installation problems may be encountered with new equipment in new aircraft and missiles.

IF YOU WORK WITH ELECTRICAL OR ELECTRONIC CIRCUITS...

A color film with schematic animation and supporting narration... to help you select connectors engineered to your requirements and operating conditions. Disconnect system? Number of contacts? Voltage? Amperage? These and other factors are covered in this helpful film. In addition you'll learn how the printed Cannon Plug Guide (below) leads you to the *right* connector for any job. Request your free showing today.

CANNON PLUG GUIDE
... An easy-to-follow graphic aid.

CURRENT CAPACITY
and its relation to contact spacing.



SPACING AND NUMBER
of contacts involves many factors.

CANNON ELECTRIC

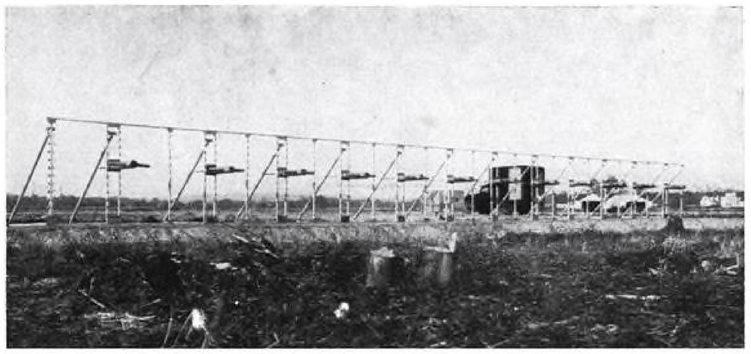
since 1915

Main office and plant, Cannon Electric Company, Los Angeles 31, California. Factories in Los Angeles, New Haven, Toronto. Representatives in principal cities.

"Contact", a 30-minute, 16mm Kodachrome sound picture, costs you nothing except 2-way transportation charges. You furnish sound projector. 24-page printed Plug Guide will be furnished for each person viewing film. To avoid delay request your booking for the film on coupon today. Dept. C-110

MODERN TALKING PICTURE SERVICE, INC. 234
45 Rockefeller Plaza, New York 20, N. Y.

NAME_____
FIRM_____
DATE TO BE SHOWN_____
ALTERNATE DATES_____
ADDRESS_____
CITY_____ ZONE___ STATE_____



NEW ILS LOCALIZER gives straighter low approach beam, allows easier alignment.

Communications & Navigation Lab Reports . . .

Automatic Navigation Is Nearer

Dayton—"We have made nearly unbelievable progress in the field of self-contained airborne navigation systems," a spokesman for WADC's Communications and Navigation Lab says. This C&N Lab statement is encouraging because aircraft and missiles which can navigate without depending on signals from ground stations are practically impervious to enemy jamming and thus less vulnerable to enemy countermeasures.

This lab is responsible for development of airborne navigation systems, airborne communications equipment, certain terminal area aids (both airborne and ground-based) and avionic rescue aids.

▶**The Lab's Work**—There are other interesting developments in the C&N lab, including:

- **Dead-reckoning computers.**
- **Tiny "handie-talkie" radios for rescue of downed pilots.**
- **Automatic rescue beacon for locating downed aircraft.**
- **Flarcout adapter for near-automatic landings.**
- **Automatic tuning HF transceiver.**
- **Airborne teletypewriter.**

▶**Six Branches**—The C&N Lab, headed by Col. C. U. Brombach, is divided into six branches:

- **Self-Contained Navigation,** under H. S. Rosenberg.
- **Ground Reference Navigation** under C. S. Franklin
- **Communications,** under G. H. Scheer, Jr.
- **Techniques,** under R. E. Kester
- **Test,** under J. E. Chamberlain
- **Installations,** under C. A. Ahalt

▶**SCN Branch**—Self-contained navigation systems are comparatively new. Until late in World War II, dead reckoning involved essentially the same laborious manual techniques which had been inherited from the sea. Aerial celestial navigation used manual sextants which were fundamentally the same as those that are used on shipboard.

Navigational radar was one of the first self-contained navigation systems to come into use, late in the war. Another was an electro-mechanical computer used in the B-29 to perform most of the navigator's dead reckoning computations for him.

A much-improved dead-reckoning computer, the A-1, has been developed by the Ford Instrument Co., under the sponsorship of the Self-Contained Navigation branch. Another development, the AN/APA-58, combines a dead-reckoning computer and an airborne radar to provide further improved navigational accuracy.

▶**A-1 Computer**—The navigator or pilot sets into the A-1 computer the plane's initial latitude and longitude, wind velocity and heading, and magnetic variation (difference between magnetic and true north). Information on airplane speed and magnetic heading are fed into the A-1 automatically during flight. The device continuously calculates and indicates airplane position in terms of latitude and longitude.

Instrument accuracy is reported to be 1% of the total distance traveled. In actual use, errors may run somewhat higher if accurate data on wind direction and velocity is not available throughout the flight.

▶**AN/APA-58**—The new AN/APA-58, developed by Eclipse-Pioneer, gets added information to compensate for changes in wind velocity and direction by virtue of being tied into a radar, such as the AN/APS-42.

Radar beacons on the ground, or other known landmarks appearing on the radar scope can be used to re-establish true airplane position at frequent intervals and/or to determine wind velocity and direction.

▶**Inertial & Celestial Systems**—"Things which would have been considered completely impossible and fantastic in 1946, nobody questions today," so says L. B. Hallman, C&N Lab technical director in describing progress in automatic inertial and celestial navigation systems.

There is no secret about some of the principles involved in either type of system; reducing these principles to working hardware is the real problem.

A patent granted last year for an inertial navigation system stated the fundamentals for one such type of system. It involved the use of accelerometers mounted in an airplane in such a way as to measure its acceleration relative to the earth. A double integration of the accelerometer signal gives distance traveled—much easier to say than to do to the required accuracy.

▶**Star Tracker**—An automatic celestial navigator might consist of two star trackers—telescopes with photoelectric cells suitably gimbaled and positioned by a servo system so as to keep each pointed at its assigned star. This is equivalent to the two sightings normally taken by a human navigator with a manual sextant.

Telescope positions, relative to a vertical and azimuth reference (as required in manual sightings) would be fed into a computer which could determine the craft's latitude and longitude.

Both automatic inertial and celestial navigation systems are useful in missiles where there are no navigators or human operator to set in the inputs required for dead-reckoning devices.

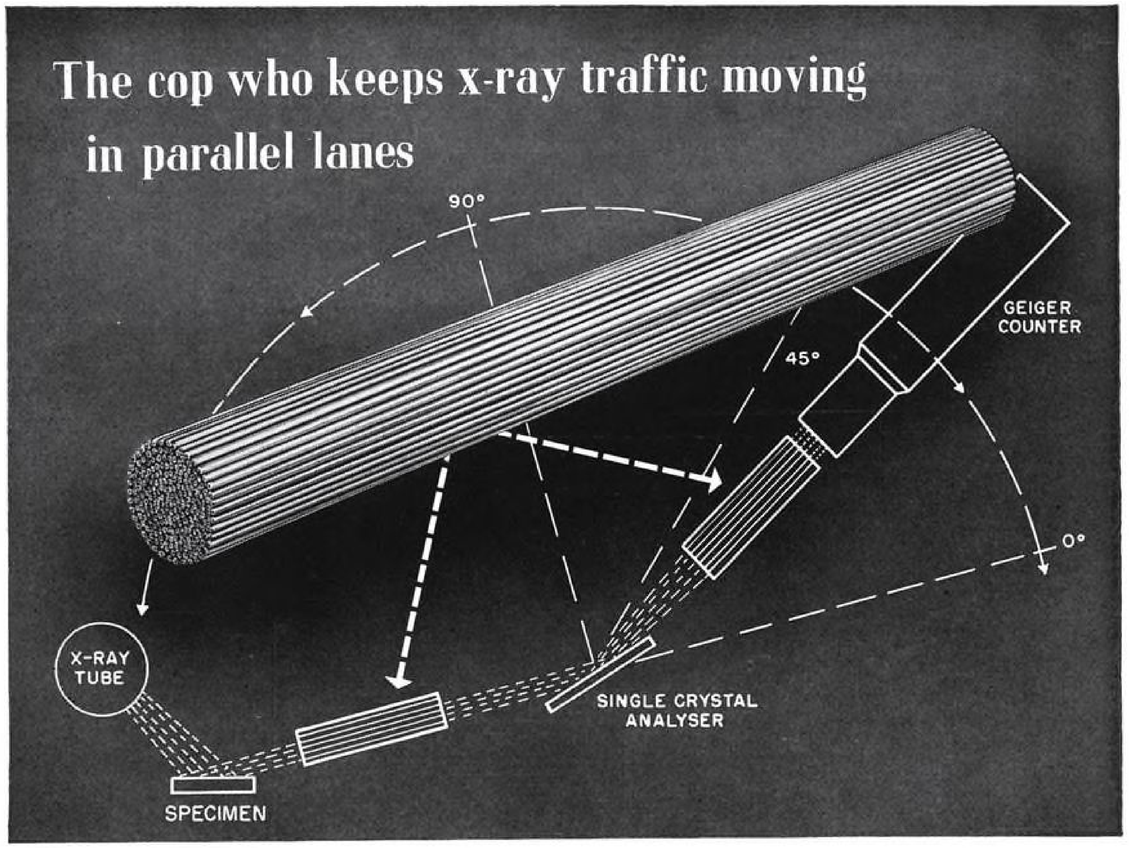
A spokesman says the trend is toward using digital (rather than analog) computers in the new navigation systems, but there are still reliability problems involved in this type.

The SCN branch also develops special types of navigation radars, compass-slaved gyros, manual sextants, and associated dead-reckoning and celestial navigation accessories.

▶**GRN Branch**—Two recent developments in the Ground Reference Navigation branch show promise of lower visibility and ceiling requirements for landing military aircraft. One is the APN-71 flareout adapter, developed by Hazeltine; the other is improved ground-based ILS equipment. Both are under the cognizance of the GRN Branch's Terminal Aids To Approach & Landing section.

▶**Low Approach System**—The ILS (instrument landing system) is really a misnomer; it currently is only a low approach system down to 100-200 feet for military aircraft.

To permit instrument weather approaches to even lower altitudes, the AN/APN-71 was designed to furnish guidance signals for the flareout after leaving the ILS glide-slope. The device's guidance signals can be displayed



Fluorescence analysis is the new, fast way to find out which elements and how much of each are in alloys—without destroying the sample of the alloy.

This trick is accomplished by bombarding the alloy specimen with X-rays using a Fluorescence Analysis Unit produced by North American Philips, Inc. The x-radiations of each element bounce off the specimen only to be separated according to wavelength and measured.

As the x-radiations leave the specimen they shoot through bundles of fine tubes known as "collimators". The collimator acts as a kind of traffic cop, keeps the rays moving in parallel lanes, reduces divergence. This is an interesting job, and we're pleased that North American Philips chose Superior fine nickel tubing for it on the basis of its uniformity in diameter, wall thickness and finish.

Undoubtedly you have opportunities where tubing could be helpful—as a carrier, a weight-saving structural member, or as a shape that saves machining time. Look into the variety of forms, sizes, and analyses Superior produces to tight specifications. Take advantage of the experience and testing facilities that Superior brings to focus on your problem. Tell us the nature of your application and we'll send you information and a Data Memo by return mail. Superior Tube Company, 2040 Germantown Ave., Norristown, Pa.

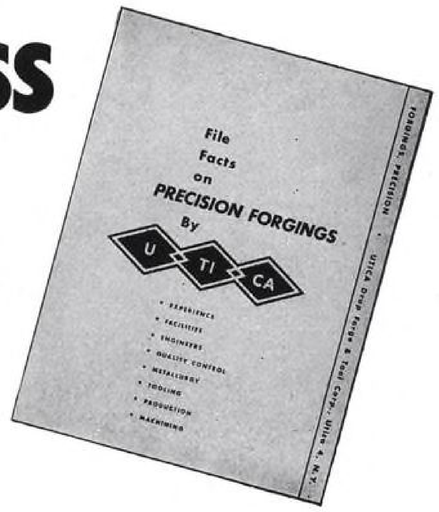
Round and Shaped Tubing available in Carbon, Alloy, and Stainless Steels, Nickel Alloys, Beryllium Copper, Titanium and Zirconium.

Superior
THE BIG NAME IN SMALL TUBING

West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. UNderhill 0-1331

All analyses .010" to ⅝" O.D.
Certain analyses (.035" Max. wall) up to 1⅜" O.D.

NEW ACCURACY
NEW TOUGHNESS
in small metal parts



Our new data folder, available upon request, brings the details to you.

Utica is now forging small parts accurate to within a very few thousandths.

The extra toughness of the forging process is being worked into new metals, more rugged than ever. The result is accurate, tough metal parts.

400,000 square feet of UTICA plant—die shops, forge shops, finishing operations—are tooled to produce any conceivable forged shape. Millers, grinders, all types of forges, presses, upsetting machines, furnaces, heaters, sandblasters, broaches, polishers unite in efficient production of complicated parts.

New methods, and new machines as well, spring from UTICA's policy of "going heavy" on engineering skill. They are natural results of a cost-minded, progressive approach to the handling of each job on an individual basis.

Hard-to-handle metals are a specialty of the Metallurgical Department. Backed by a 10,000 sq. ft. laboratory with the latest physical testing and metallographic equipment, metallurgists are the "watchdogs" of all UTICA products.

Quality Control on irregular shaped parts is a familiar problem. Dimensional readings plus visual inspection plus statistical control are all in full use.

Jet blade production, an exacting new field requiring true pioneering, has absorbed the major part of UTICA facilities. But the problems are similar, if less complicated, in other cases where special accuracy and toughness in parts are needed.

We'd like to help you on your post-emergency plans. Insofar as our defense duties permit, let us consult with you on your projects for the future.

Jobs available for technically trained personnel.

The more complete story is in "File Facts on Precision Forgings." Write for it today. We'll keep it up-to-date by sending you further data sheets automatically as new developments occur.

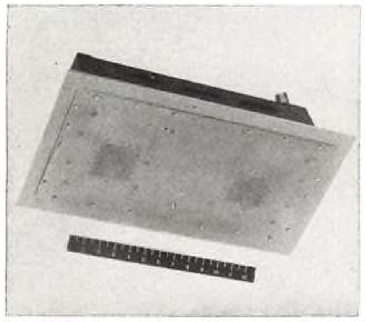
PRECISION····
U TI CA
TRADE MARK ····FORGINGS

UTICA DROP FORGE & TOOL CORPORATION
Utica 4, New York

MAKERS OF THE FAMOUS UTICA LINE OF DROP FORGED PLIERS AND ADJUSTABLE WRENCHES

on the ILS cockpit indicator, and can be connected into the plane's autopilot for an automatic flareout, if desired.

► **Flareout Adapter**—The APN-71 consists of an FM altimeter, which measures airplane height from the ground, and a computer which calculates an ideal exponential flareout path for the airplane. The device can be set to cut in at a preselected altitude so that there is no discontinuity between the glide-slope and the flareout signals.



FLAREOUT adapter used for low ILS approaches and as terrain clearance indicator.

If, during the flareout, a gust causes the plane to deviate from the previously computed flareout path, the computer instantly computes a new flight path (based on the new altitude) rather than trying to keep the plane on the original path.

Flight tests of the APN-71 indicate that it can be used for completely automatic touchdown in slower aircraft. However, C. S. Franklin, branch chief, views the device as a means of extending the low-approach capabilities of ILS. By virtue of its radio altimeter, the APN-71 can also serve as a terrain clearance indicator.

At present the device's maximum effective altitude is 200 ft., but Hazeltine is working to increase this value.

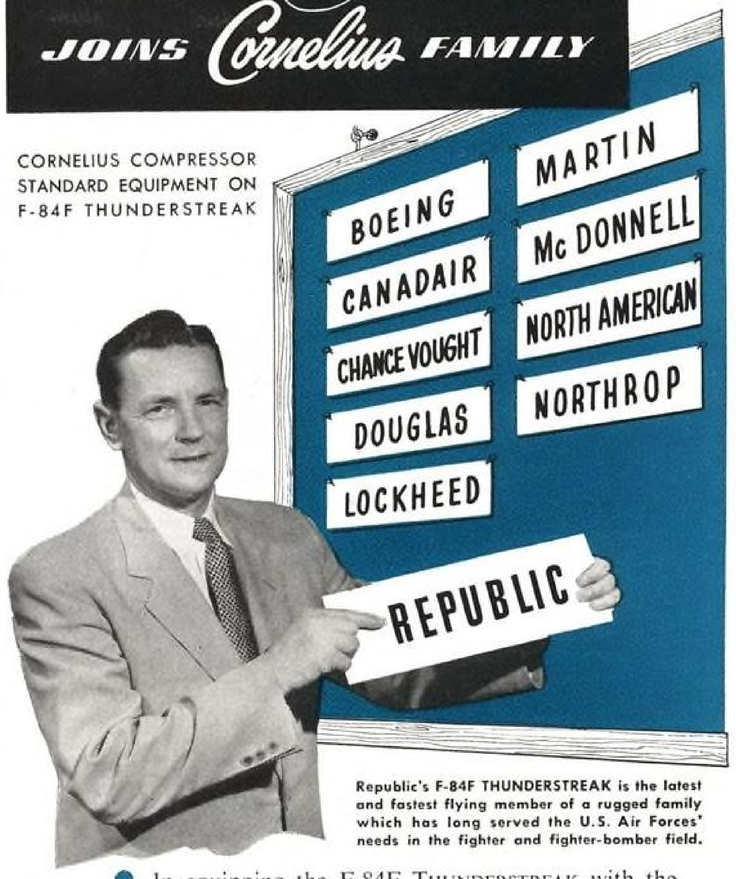
► **Improved ILS**—New antenna arrays which have been developed for Air Force ILS installations not only give much improved beam linearity, according to Franklin, but they are much easier to site and align, an important consideration for military operations.

The new MRN-7, -8 localizer and glide slope transmitters are much more reliable, Franklin adds, and they are being installed in duplicate with automatic switchover in the event one transmitter fails.

The Terminal Aids section is also responsible for the development of ILS airborne receivers. One current program at Crosley Div. of Avco Mfg. Corp. is the AN/ARN-31, a subminiaturized combination localizer and glide slope receiver for use in aircraft which

REPUBLIC AVIATION JOINS Cornelius FAMILY

CORNELIUS COMPRESSOR STANDARD EQUIPMENT ON F-84F THUNDERSTREAK



Republic's F-84F THUNDERSTREAK is the latest and fastest flying member of a rugged family which has long served the U.S. Air Forces' needs in the fighter and fighter-bomber field.

● In equipping the F-84F THUNDERSTREAK with the CORNELIUS AIR COMPRESSOR Republic Aviation joins the CORNELIUS family of famous names in aviation ... Boeing, Canadair, Chance Vought, Douglas, Lockheed, Martin, McDonnell, North American, Northrop.

CORNELIUS is proud of this recognition ... developed from long experience building dependable pneumatic equipment for the Air Force, Navy and leading aircraft manufacturers. Profit from our experience ... write to us about your pneumatic equipment requirements.

CORNELIUS COMPRESSOR
4CFM ... 3000 PSI
Powered by integral hydraulic motor. Other models available with various pumping capacities. All compressors can be furnished with either hydraulic motors, DC electric motors or AC 400 cycle motors.

THE Cornelius COMPANY
MINNEAPOLIS 21, MINNESOTA

Pioneers in the Development of
AIRCRAFT PNEUMATIC SYSTEMS

For the

finest in filtration... specify PurOlator

IN MODERN MILITARY and commercial aircraft—where there can be no compromise with quality and performance—you will find Purolator* filters specified as standard equipment in oil, hydraulic, fuel and air systems.

No matter what your aircraft filtering problem, you will find a well-engineered, "AN"-approved Purolator available for your needs. And remember—only in Purolator filters can you find the famous Purolator Micronic* element . . . capable of filtration down to *submicrons* (.000039 in.), at higher flow rates than ever before obtained for such fineness of filtration.

For example—the Purolator Micronic Filter PR-255, for aviation fuel, removes all particles down to 10 microns, yet provides a 300 gallon-per-hour flow rate in a unit only 5⅜ in. by 10¼ in.!

For further information, write for the Purolator Aviation Catalog, which contains specifications of more than 30 different use-tested and approved Purolators designed especially for aircraft applications.

*Reg. U. S. Pat. Off.

PUROLATOR PRODUCTS, INC., Rahway, New Jersey and Toronto, Ontario, Canada
Factory Branch Offices: Chicago, Detroit, Los Angeles

PUROLATOR
WORLD'S FINEST OIL FILTER

do not have (or need) omnirange receivers that cover ILS localizer frequencies.

▶ **Navaglobe Future in Doubt**—The Medium & Long Distance Navigation section of the GRN branch is developing a production prototype of an airborne receiver to operate with the Navaglobe long-distance "omnirange" system under investigation at RADC.

Although lab people speak well of Navaglobe's capabilities, they think it is better suited to civil airline operations than to military needs. Federal Telecommunications Labs, which developed Navaglobe, is building the prototype receiver. It will be housed in a ½ ATR, making it comparable in size to present VOR receivers, Hallman says.

▶ **Loran and ADF**—Airborne Loran receivers capable of operating with RADC-developed systems are assigned to this section, which is also responsible for airborne automatic direction finders.

The Short-Distance Navigation section is responsible for VOR receivers, course-line (offset track) computers, and similar types of navigation equipment.

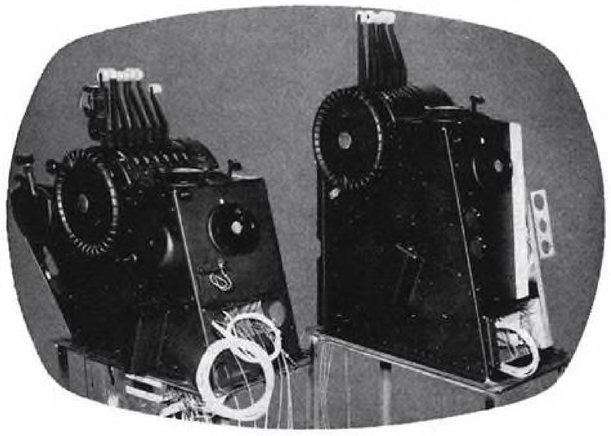
▶ **Life Savers**—In Korea, a tiny "handy talkie" VHF/UHF radio transmitter/-receiver, developed by the Air Rescue section of the GRN branch is credited with helping to save the lives of 150 airmen downed behind enemy lines in a three-month period. Thirty of the men gave complete credit for their rescue to the handy talkie.

The device, called the AN/URC-4, weighs only 6 lb. and is tiny enough to be carried by flight personnel in their pockets. When downed behind enemy lines, an airman can call for help, giving his location and warning of nearby enemy troops. The device can also be used to guide recue helicopters in over hazardous terrain. The battery supply is good for 24 hours of operation.

▶ **Crash Locater Beacon**—Another life saver development in the Air Rescue section is an aircraft crash locater beacon for use in conjunction with a

"HANDY TALKIE," shown with cover removed.

Nerve Centers of the mighty B-47



Nerve centers of the USAF's B-47 Boeing Stratojet are these two control stands, the pilot's on the left and the co-pilot's on the right.

To Associated Company, Inc., of Wichita, Kansas, Boeing gave the job of quantity production of these vital assemblies for the world's fastest known medium bomber.

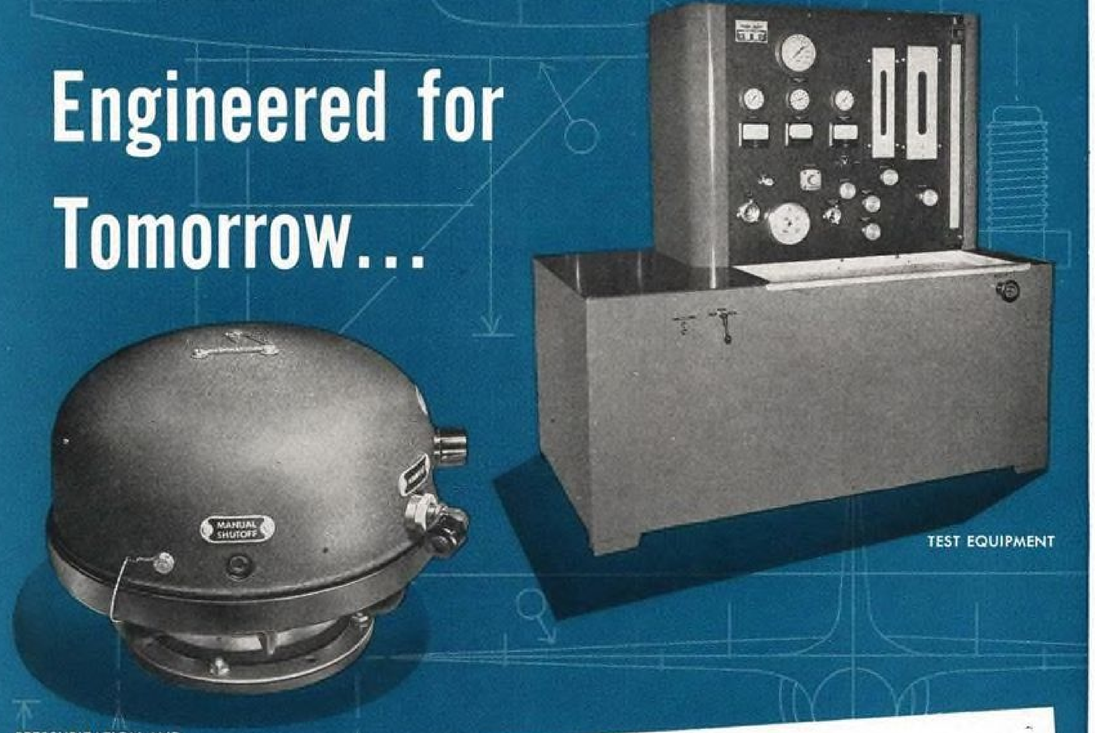
On-schedule deliveries and cost reductions consistent with the compaign for "more air force per dollar" have made Associated Company, Inc., an integral part of the Boeing-USAF jet bomber program.

Associated's engineering, tooling and manufacturing experience and facilities stand ready to serve YOUR needs, whether military or commercial – to design, tool and produce to fit YOUR requirements.

Associated Company, Inc.
ASSOCIATED AIRCRAFT SALES, INC.
ASSOCIATED FABRICATORS, INC.

1211 EAST DOUGLAS • WICHITA 7, KANSAS

Engineered for Tomorrow...



PRESSURIZATION AND TEMPERATURE CONTROL SYSTEMS

AC AND DC ROTARY ACTUATORS

Engineered by PAC

Tomorrow's jet-propelled aircraft and guided missiles are *today's* problems at Pacific Airmotive Corporation.

In the fields of aircraft air-conditioning, heating, ventilating and pressurization, the Manufacturing Division of PAC has the engineering "know how" to solve the toughest problems. It provides the engineering design, research and development for a vigorous follow through to any assignment.

Above all, PAC's Manufacturing Division has the growing production capacity to assure contract fulfillment right on schedule.

MANUFACTURING DIVISION

PACIFIC AIRMOTIVE PAC CORPORATION

2940 NORTH HOLLYWOOD WAY, BURBANK, CALIFORNIA

OTHER DIVISIONS: OAKLAND AND CHINO, CALIF. • SEATTLE, WASH. • KANSAS CITY, KAN. • LINDEN, NEW JERSEY

AVIONICS

world-wide rescue network involving ground-based detectors and direction-finders under development at RADC.

The beacon under development here will be carried inside of an airplane and will be catapulted out in the event of a crash. Upon landing on the ground (or in water—in which it will float), legs automatically extend to erect the beacon, an antenna mast is automatically extended, and the beacon then begins to transmit a specially coded SOS which identifies the aircraft and the interval since the crash.

AIRMEN carry small VHY/UHF Handy Talkie to call for help when downed.

RADC developed ground-based stations will instantly take bearings on this crash beacon and feed the data to a centralized control point where a computer will calculate the most probable location of the crash.

▶ **For the Busy Pilot**—When a pilot finds himself in an emergency, he's usually too busy to radio an SOS, give his position, and operate his transmitter long enough for a ground-based direction finder to take a bearing. AF bombers and transports are currently being equipped with a small device, called an automatic keyer, that does all this automatically for the pilot. When he throws an emergency switch, the automatic keyer turns on his HF transmitter, tunes it to the emergency frequency, starts keying an SOS and another code which identifies the plane, and provides a signal which can be used by ground direction finders.

The device was an in-house development of the C&N lab.

▶ **Communications Branch**—One of the major problems facing the C&N lab is to increase the reliability of long distance air-to-ground and air-to-air HF communications.

Reliable transmission from aircraft is much more difficult than from ground-based equipment. For one thing, ground stations can use large directional antenna arrays, an impossibility in aircraft. The use of flush-mounted antennas further limits aircraft radiation compared to ground stations.

▶ **Simplified Tuning**—On the favorable side of the ledger, complex tuning procedures previously required in operating HF airborne radio equipment have been greatly simplified by a recent development sponsored by the Communications branch.

It is a new HF transceiver (AN/ARC-21) which is very nearly automatic, Hallman says. The set was developed by Radio Corp. of America and is now in production. With the new ARC-21, the pilot pre-selects more than a dozen operating frequencies before leaving on his mission. During the flight the pilot need only position the selector switch to any one of these positions, and the HF receiver, transmitter, and antenna are automatically turned to that preselected frequency.

▶ **Airborne Teletypewriter**—The Long Distance section also has under development a lightweight airborne teletypewriter that will enable an aircraft to receive or send teletype messages. The device, which is expected to weigh about 50 lb., will include a tape cutter and transcriber so that incoming or outgoing messages can be "taped" for delayed transmission or transcribing. The new airborne teletypewriter will

NEW PSP HOT SOLENOID

(North American Aviation, Inc. Photo)

reliable at +500° F ambient temperature!

Now, PSP Engineering Company announces a new hot solenoid which supplies positive, reliable actuating force at ambient temperatures from −65°F to +500°F.

This new solenoid is shown in the photo, at right. Here, it is used on an Anti-Icing shut off valve made by Hydro-Aire, Inc. The valve, used in the F-86, is solenoid controlled, pilot operated, to keep ice off the Sabre engine at high altitude. Mounted on the engine, it must safely operate through all conditions encountered by the F-86.

PSP design engineers, recognized as foremost in the solenoid field, have worked months to perfect this solenoid for high temperature. The solenoid features a special new design, a high temperature switch, special heat resistant wiring and insulation. Continuing research, design and performance tests promise soon to push the solenoid's effective operating range to +600°F and beyond.

You can have complete information and cost data on the new PSP hot solenoid by writing on your company letterhead. PSP also furnishes data on 220 other PSP solenoid models, now used in every major U. S. and Canadian aircraft. If necessary, our engineers will design a solenoid to fit your specifications.

Send us your requirements today.

(Hydro-Aire, Inc. Photo)

NOTICE: If you have not written for your copy of our informative solenoid catalog, do it today.

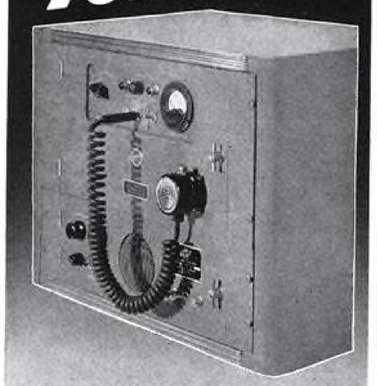
PSP SOLENOIDS

ENGINEERING COMPANY

8420 Otis Street • South Gate, California

Largest manufacturer on the Pacific Coast producing aircraft quality solenoids exclusively.

Tel-Air



A COMPLETE TWO-WAY RADIO GROUND STATION

especially designed to fill the VHF radio needs of airlines and private airports.

OUTSTANDING because it's . . .

RELIABLE— *Tel-Air* 's conservative design and quality construction reduce maintenance.

SIMPLE—No highly skilled personnel required for installation and operation.

VERSATILE— *Tel-Air* can be used in more situations. Designed for local and remote operation, with additional receivers or other accessory equipment.

PERFORMANCE—Better performance is not available from any equipment. 10 watt transmitter is ample for most locations. Receiver sensitivity (1 microvolt at 10 db S/N ratio), sharp selectivity bring in clearly the weakest, noisiest signals.

Write today for descriptive literature.

SCHUTTIG and CO.
INCORPORATED
NINTH AND KEARNY ST., N. E.
WASHINGTON 17, D. C.

be designed to operate from the ARC-21 which has provision for frequency shift keying (FSK) circuits.

Teletypewriter communication has several advantages over voice communications in certain applications. For one thing, an incoming message can be received without diverting the flight crew from other duties. Also, there is less chance of misunderstanding long complex messages if they are printed rather than spoken. A further advantage is that the system operates on a narrower bandwidth than normal voice communications.

▶**Emphasis on UHF**—The Short-Distance section of the Communications branch is primarily concerned with UHF, which is replacing VHF throughout the military services.

A spokesman says that a new miniaturized UHF transceiver has been developed by RCA and is going into production. This new AN/ARC-34, which will replace the present ARC-27, is about half the size and weight of its predecessor.

▶**New Hi-Fi Intercom**—The first completely integrated airborne intercommunications system (including public address system where needed) was sponsored by the Accessories section of the Communications branch. It is the AIC-10, developed by RCA and currently in production.

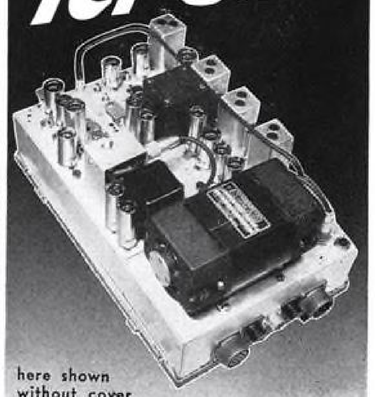
The new system provides improved fidelity and understandability despite high cabin background noise, Hallman says. In addition, the system is smaller and lighter, and the mike and earphones have been specifically designed to fit under the plastic crash helmets worn by jet pilots.

The AIC-10 eliminates carbon microphones—sometimes called the world's most expensive 'loose connection.'

In addition to its responsibility for

HEADSET of AN/AIC-10 curves under helmet; mike is built into oxygen mask.

Tel-Car



here shown without cover, speaker, or control console

MOBILE AIRPORT TWO-WAY RADIO

Tel-Car is for the airport operator who must RELY on his VHF radio, who cannot chance signal failure.

Tel-Car 's greater output and higher sensitivity means RELIABILITY of contact; *Tel-Car* 's conservative design and careful construction mean RELIABILITY of service.

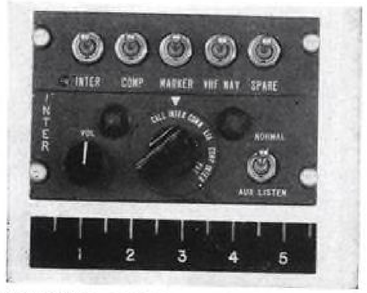
Tel-Car will get the signal through, day or night, month after month, regardless of airport size or "dead" spots.

There are sound technical reasons why *Tel-Car* is best, why it is more RELIABLE.

Write today for descriptive literature.

SCHUTTIG and CO.
INCORPORATED
NINTH AND KEARNY ST., N. E.
WASHINGTON 17, D. C.

RCA'S AN/AIC-10 is first interphone system designed to fit in crash helmet.



CONTROL PANEL permits pilot to select any desired radio or intercom circuit.

intercoms, mikes, headsets, and loudspeakers, the Accessories section also develops airborne wire and tape recorders.

▶**Data Link**—Airborne receivers for radio data link systems (used to transmit instructions to individual aircraft and to permit ground control of individual aircraft flight path) are under development by the Specialties section of the Communications branch.

The work includes the development of suitable cockpit instruments to display ground instructions sent over the data link.

This group helped to develop the airborne adapter, which permits automatic GCA guidance signals to be transmitted to the aircraft cockpit using the plane's regular communications receiver without disrupting normal voice communications.

This section also follows various types of frequency-control components such as crystals and magnetostriction devices.

▶**Techniques Branch**—Research and development of special techniques which can be applied to several or all fields of activity in the C&N lab are the responsibility of the Techniques branch.

For example, the Antenna section acts as a consulting group and reservoir of antenna design knowledge for all C&N projects, and has consulting contracts with the country's top antenna experts.

Right after the war this section had the task of developing techniques to design flush-mounted antennas in order to eliminate protuberances from high-speed aircraft.

Another part of the job was to convince aircraft manufacturers that antennas could be built into the fuselage, empennage, and wings.

▶**Flush Antennas**—To convince the industry, and arouse interest, the Antenna section designed and installed flush-mounted antennas in a C-54 for a variety of different types of avionic equipment, including UHF, VHF, HF, ADF, ILS, marker beacons, loran, radio altimeter, and radar. The plane is believed to have been the first to completely eliminate external antennas.

Originally much of the flush-antenna design work was done here in the C&N lab, but now the aircraft manufacturers have assembled staffs to take over this responsibility. The Antenna section gets back into the act when a fundamentally different type of flush antenna is needed by the aircraft industry.

▶**Scale Models**—The advent of flush-mounted antennas, whose shape and location affect the structural design of the aircraft has meant that antennas may no longer be "hung" on the airframe after it has been designed.

Today, antenna performance must be evaluated by means of tiny scale models before the airframe design is frozen, an Antenna section spokesman points out.

▶**Chasing Shadows**—UHF flush antennas have given some trouble because high-frequency energy is reflected from or shadowed by the fuselage and wings resulting in blind spots (points of weak signals) in certain directions.

The most promising solution to this problem, an Antenna section spokesman says, is the use of several antennas (diversity antennas) located in different portions of the airplane. The transmitter, or receiver) is then continuously switched from one antenna to another. Current efforts are being devoted to finding the best place to locate the several antennas and how to switch from one to the other.

▶**Other Sections**—Other sections in the Techniques branch, and their general areas of responsibility include:

• **Interference reduction:** Develop techniques and circuitry to minimize the effect of precipitation static, lightning and similar natural interference, as well as protecting against interference generated by man-made equipments.

• **Anti-jamming & security techniques:** Research in new techniques to make C&N lab-developed equipment resistant to enemy jamming.

• **IFF & military traffic control:** Avionic identification systems, including air-to-air IFF, airborne equipment to identify aircraft to ground-based traffic

Confidence !

YOU GET THIS IMPORTANT "HUMAN ELEMENT" AS AN EXTRA WHEN YOU SPECIFY

TUBE METHODS

STAINLESS STEEL TUBING

There's no guesswork, no taking quality for granted, no "Good enough" attitude when TUBE METHODS cold draws tubing for you. We're tougher than our toughest customer . . . and earned the right to "The Mark of Quality" by insisting on precision engineering every step of the way on EVERY order. More than half a century of experience backs up that confidence . . . that ability.

The Mark of Quality TMI

STAINLESS STEEL AND ALLOY TUBING IN SMALL DIAMETERS—.050 to .625 O.D.

TUBE METHODS INC.
METALLURGISTS • ENGINEERS • MANUFACTURERS
BRIDGEPORT (Montgomery County), PA.

AN Fittings
Special Fittings
Flexible Metal Hose Assemblies
Silicone Rubber Hose Assemblies

We will be pleased to quote on all AN fittings and special aircraft components. Write or phone for further information.

AIRCRAFT COMPONENTS DIVISION

DUNBAR KAPPLE Inc.
406 N. River St. Batavia, Ill. Phone Batavia 5400

2140 Westwood Blvd.
Los Angeles 25, Calif.
Arizona 9-2202

10 S. Union St.
Bay Shore, N. Y.
Bay Shore 6161

1016 Fisher Building
Detroit 2, Michigan
Trinity 4-3580

127 Crosby Avenue
Kenmore, New York
Riverside 5186

1619 Seevers Avenue
Dallas, Texas
Woodlawn 1676

426 Transportation Bldg.
Cincinnati 15, Ohio
Garfield 0612

217 Ninth Ave., North
Seattle 9, Washington
SEneca 4948

10 High St., Room 506
Boston 10, Massachusetts
Liberty 2-6935

267 E. Paces Ferry Road, N.E. Atlanta, Georgia
Exchange 1494

control radars, and air-to-ground beacon navigation systems for use by troop carriers.

Two important supporting service groups within the C&N lab are the Test branch and the Installations branch.

▶ **Test Branch**—The Test branch is divided into three sections with the following responsibilities:

- **Engineering facilities:** Handles ground radio and similar ground facilities needed in flight testing.
- **Equipment evaluation:** Handles test data reduction and analysis.
- **Flight operations:** Handles flight test arrangements with WADC Flight Test division and schedules operations.

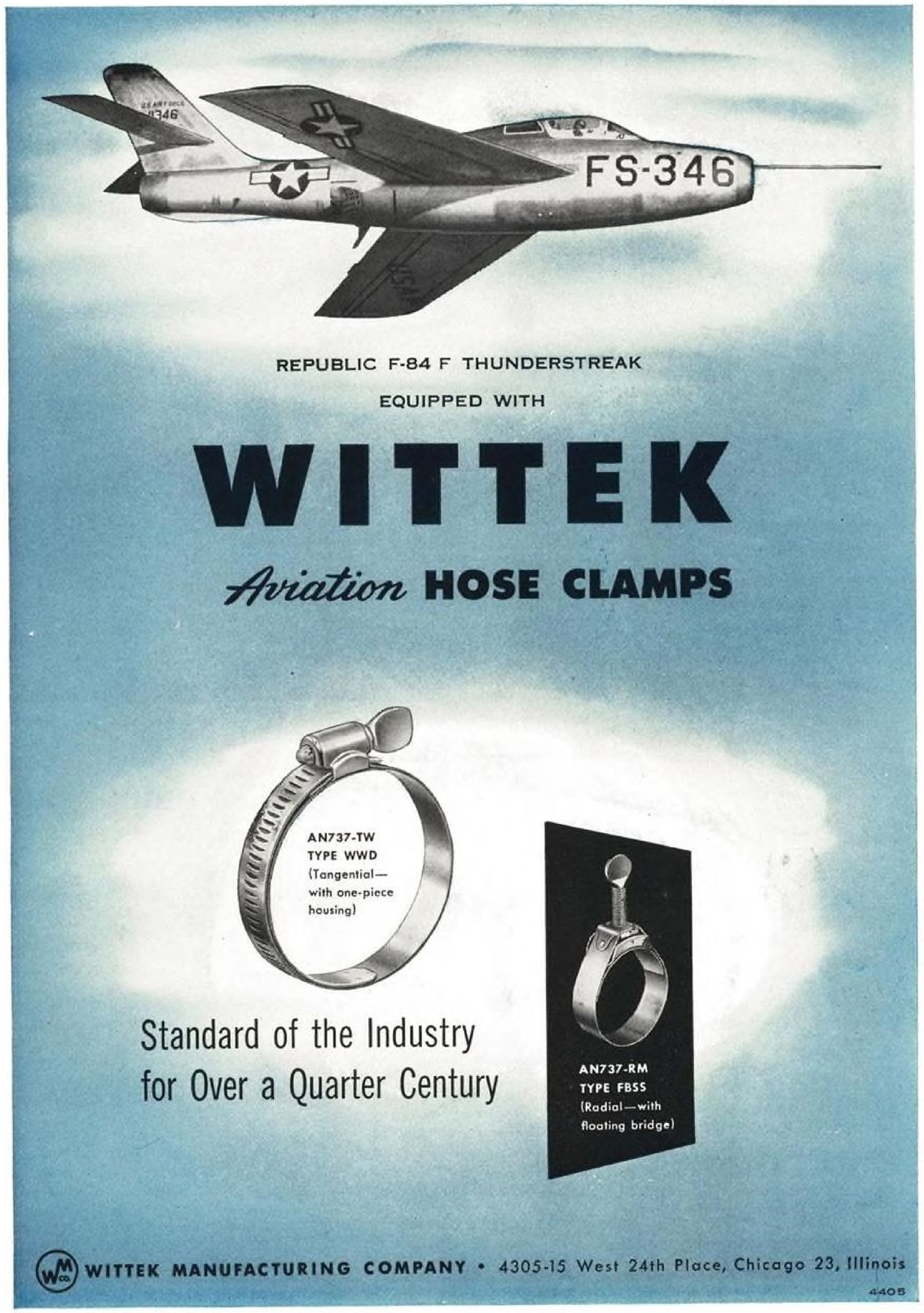
▶ **Installations Branch**—The Installations branch provides aircraft manufacturers with installation data and instructions for C&N-developed equipment used in their aircraft. This branch is the lab's principal liaison with mockup boards and joint project officers.

One of three sections in the branch, Liaison & Design, is staffed by engineers who are essentially equipment specialists.

The other two sections, Bomber & Missiles, and Fighter & Transport, have men who are specialists in their particular type of airframe, knowing its installation problems and limitations.

▶ **Special Lab Facilities**—Recognizing the expense and difficulties of flight testing, the C&N lab tries to do as much as possible of its testing on the ground. This requires many specialized test facilities, such as:

- **Noise room,** for testing understandability of aircraft mikes, headsets, and interphone systems; electronically simulates engine, propeller, and aerodynamic noises.
- **Personal altitude chamber,** which can also produce simulated cockpit noise, is used to test understandability of communications equipment under altitude conditions.
- **Anechoic chamber,** constructed so as to eliminate reflection of sound waves from chamber walls, is used in acoustical measurements.
- **Million-volt generator** is used for corona discharge tests to evaluate interference rejection of communications equipment. At lower voltages, the generator is used to determine the radio noise and discharge current characteristics of static dischargers or corona onset voltages for corona-resistant antenna assemblies.
- **Flight simulator,** which can be used to evaluate new types of navigational cockpit displays.
- **Ultrasonic trainer,** which simulates motion of an aircraft over land, is used in evaluating human engineering aspects of navigational radar design.



Aircraft ANTENNAS by d-m

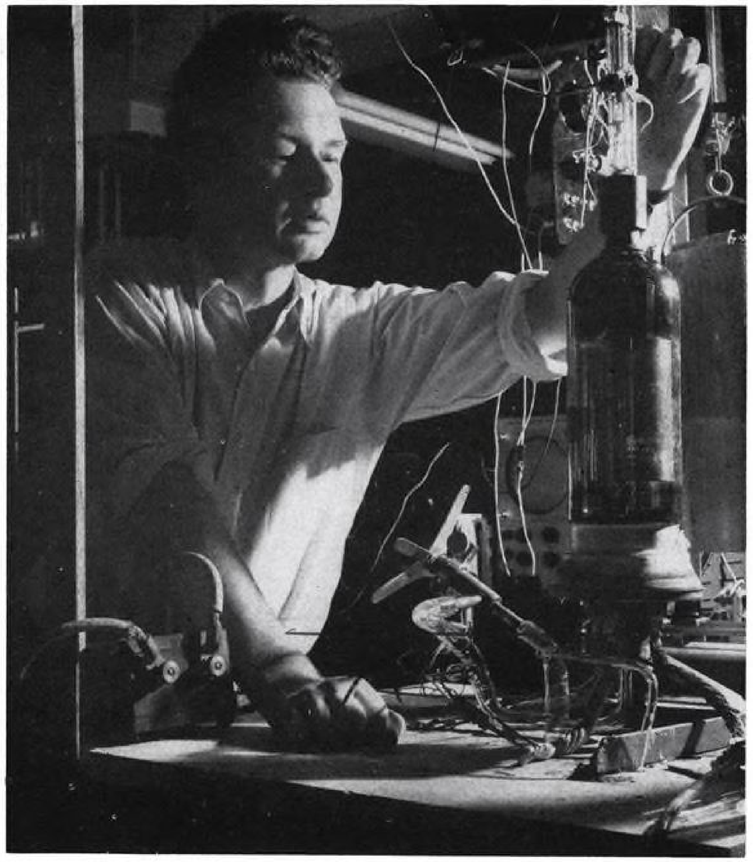
DORNE and MARGOLIN offers the aviation and electronics industry a superior antenna service complete from problem analysis to final design and quantity production. From v-h-f through microwaves D&M antennas provide unexcelled quality and performance. Inquiries on your specific problems will receive prompt attention.

NEW BROCHURE AVAILABLE

Call or write for your copy, now. When writing, please address Dept. E-1.

DORNE and MARGOLIN

30 SYLVESTER STREET
WESTBURY, LONG ISLAND, N. Y.



SEARCH for better componments requires research into fundamentals of their operation.

ECL's Field: Avionic Components

Dayton—The Electronic Components lab is testing a new line of ceramic vacuum tubes capable of operating at ambient temperatures of 250C despite the fact that most avionic equipments today need only operate at 100-125C. This is ECL's job—to anticipate the component needs of the avionic equipment designer and to sponsor or stimulate research programs that will make these components available when needed, according to Col. R. S. Carter, chief of ECL.

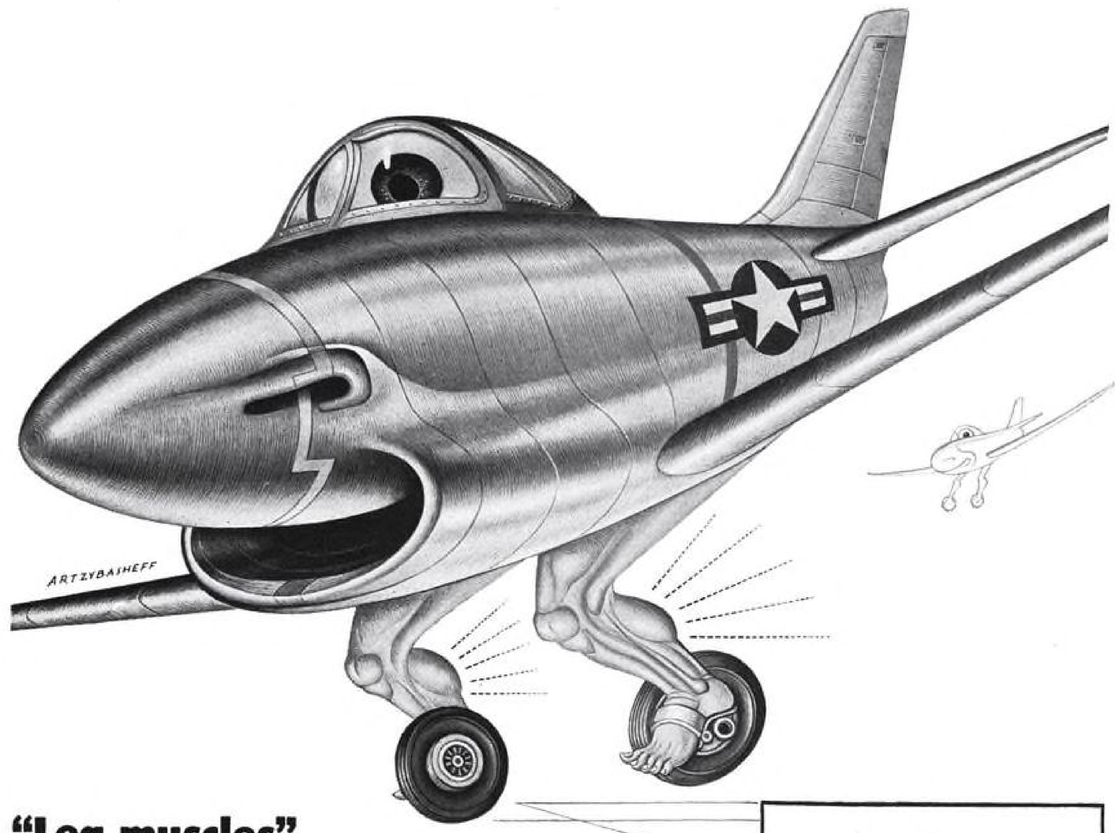
▶**The Catalyst**—Airplane and missile speeds and operating altitudes are continually increasing, forcing equipment designers to seek higher temperature, more rugged components. But the components won't be available unless the component manufacturer has started his research 2-3 years previously. The Electronic Components lab serves as a catalyst to get component manufacturers started before the need would otherwise be apparent.

This is particularly true of avionic components whose requirements are so stiff that they find little application in commercial or industrial electronic fields.

ECL works closely with other Air Research and Development Command labs to find out what their needs will be during the coming years. What sort of radar peak powers and new operating frequencies are envisioned, for example. ECL then sponsors development or research in the component industry or in universities to meet these needs.

Sometimes the goal is improved performance or higher operating temperature. Sometimes the object is smaller size or lower weight. Or the program can be pointed toward new manufacturing techniques to permit automatic production of components now fabricated largely by hand operations, as is the case with vacuum tubes.

▶**The End Product**—The result or end



"Leg muscles" that cushion a jet's landing

When the landing gear of an F-86 Sabrejet hits the runway at lightning speed, the shock is absorbed by hydraulic action within the tough, precision-made cylinder on each "leg." To machine these 37-lb. cylinders to exact tolerances from solid 158-lb. steel forgings . . . to give them mirror-smooth inside finishes . . . Cleveland Pneumatic depends on Lycoming.

If *your* metal-working needs—like Cleveland Pneumatic's—can be solved by precision production, or if your problem is volume fabrication, or "just an idea" in the rough or blueprint stage—*look to Lycoming*. Long famous for metal-working skills, Lycoming meets the toughest specifications of exacting customers, both industrial and military.

Lycoming's 2½ million square feet of floor space, its more than 6,000 machine tools, and its wealth of creative engineering talent all stand ready to serve your needs.

AIR-COOLED ENGINES FOR AIRCRAFT AND INDUSTRIAL USES • PRECISION-AND-VOLUME MACHINE PARTS • STEEL-PLATE FABRICATION

FOR RESEARCH · FOR PRECISION PRODUCTION

LOOK TO LYCOMING

LYCOMING-SPENCER DIVISION, WILLIAMSPORT, PA.
BRIDGEPORT-LYCOMING DIVISION, STRATFORD, CONN.

For main leg cylinders that enable a Sabrejet to absorb the jolt of high-speed landings—Cleveland Pneumatic looks to Lycoming's precision production

Lycoming-Spencer Division
AVCO Manufacturing Corp.
652 Oliver Street
Williamsport, Pa.

Please send me further information on Lycoming's varied abilities and facilities.

Name_____

Firm_____ Title_____

Address_____

City_____ Zone____ State____

product of ECL research and development programs is technical know-how, according to H. V. Noble, ECL's technical director.

This knowledge is converted into a component specification and made available to the various component manufacturers.

In many cases, manufacturers carry the ball from here, tooling up and getting into production on their own, Noble says. If the potential market for the device is extremely limited, the Air Materiel Command, through its industrial mobilization group, awards a contract to one or more manufacturers to cover initial tooling and pilot production.

► **Lab Organization**—To handle its assigned mission, ECL has approximately 200 people on its staff, of whom about 60% are engineers or scientists, Noble says. Annual R&D expenditure runs about $3-5 million.

The lab itself is divided into four Branches:

- **Components Development,** under F. E. Wenger.
- **Components Test,** under D. L. Lane.
- **Electron Tube,** under A. H. Dicke.
- **General Purpose Test Equipment,** under N. D. Flinn.

Components Development

Development of all avionic components, from radomes to tube sockets, to pilot lights to shock mounts (but not vacuum tubes and transistors) is assigned to the Components Development branch. Its activities include research into automation techniques for completely automatic fabrication of avionic assemblies and new ways to disseminate information on available components.

The Branch is divided into five sections:

- **Dielectrics,** under Fred Behrens.
- **Resistance, Inductance, & Capacitance,** under C. E. Doyle.
- **Mechanical,** under C. A. Golueke.
- **Electromechanical,** under I. S. Mayer.
- **General Engineering,** under Yale Jacobs.

► **Dielectrics Section**—Radomes (radar antenna covers) of the future will probably be made out of ceramic or other inorganic material capable of withstanding the extremely high temperatures encountered in ultra-high speed flight, according to Fred Behrens, chief of the Dielectrics section.

Increasing airplane speeds have created a progression of radome design problems for this section in the past and will continue to in the future.

When jet interceptors first started using radar, airplane designers complained that a hemispheric-shaped radome ruined the aerodynamics of the airplane, but streamlining the radome spoiled its "optical" characteristics. (Ideally a radome should in no way affect the radar energy passing through it.)

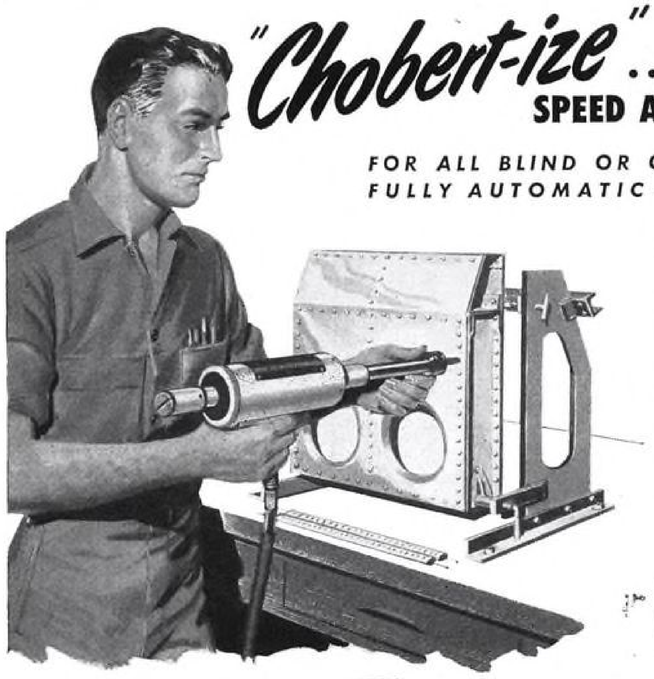
Streamlined radomes caused refraction of the radar beam creating distortion not unlike that experienced in the curved portions of automobile windshields. Also, some radar energy was reflected internally, bouncing around inside the radome to cancel outgoing radar energy and creating spurious targets on the radar scope.

ECL-sponsored programs have developed new techniques for designing and fabricating radomes which have partially solved these problems, Behrens says. The use of several different dielectric materials in radome construction, and the close control of radome thickness has greatly reduced internal reflections.

Whereas transmission efficiencies used to vary as much as 20% from one portion of a radome to another, this figure has been cut to only a few percent, according to Behrens. Refraction

"Chobert-ize" ... FOR INCREASED RIVETING SPEED AND PRODUCTION ECONOMIES!

FOR ALL BLIND OR OPEN RIVETING APPLICATIONS — FULLY AUTOMATIC — NO SKILLED HELP REQUIRED!



Chobert rivets and pneumatic, fully-automatic riveters are the answer to a demand for increased speed in fabrication where consistently uniform riveted results are desired. The Chobert High-Speed riveting team of rivets and "gun" eliminates hand placing and bucking of rivets. The Chobert System assures top results with unskilled operators and solves all blind or open riveting problems even in situations usually considered inaccessible with other riveting methods!

Rivets are quantity-loaded into the Chobert pneumatic riveter and the joining of separate surfaces is accomplished as fast as the operator can insert the Chobert rivet, automatically held ready by the gun, into the hole and press the trigger. Release trigger and next rivet is ready to go to work!

APPROVED under Air Force Blind Rivet Specification 40911. Complete information on the Chobert High-Speed Riveting System and illustrated literature are available on request. Write today!

Manufacturer and Distributor of pip Self-locking, Quick-release Pins and avdel Positive-action Sheet Grippers.

AVIATION DEVELOPMENTS, INC. 210 NORTH FRONT STREET • BURBANK, CALIFORNIA

AVIATION DEVELOPMENTS (CANADA), LTD., TORONTO • AVIATION DEVELOPMENTS, LTD., LONDON, ENGLAND

PHOTO COURTESY NORTH AMERICAN AVIATION INC. COLUMBUS DIVISION.

World's Largest Stretch-Wrap Forming Machine

Goes to work for North American Aviation Inc., Columbus, Ohio

The Model 60 is Hufford's largest stretch-wrap forming machine to date, exceeding the capacity of all existing stretch-wrap forming machines in the world today.

With its 703,720 pounds of "pull" it is now forming stabilizer fairings, panels and fuselage skin parts for the new FJ-2 FURY. New dies will utilize its huge capacity on sheets measuring 6 feet wide by 31½ feet long. Its tremendous strength enables formation of sheet thicknesses as great as ½ inch!

The Model 60 opens another chapter in stretch-wrap forming history, *almost doubling the capacity of the largest Hufford press heretofore built.* It is Hufford's answer to unusual requirements of the present in preparation for the commonplace of the future!

Hufford

HUFFORD Machine Works Inc. EL SEGUNDO, CALIFORNIA

Manufacturers of
PRECISION HYDRAULIC STRAIGHTENING PRESSES
PORTABLE HYDRAULIC ELEVATORS • HYDRAULIC STRETCH-LEVELING TABLES
HYDRAULIC STRETCH-WRAP FORMING MACHINES
HYDRAULIC METAL FORMING BULLDOZERS • HYDRAULIC COMPACTION PRESSES
CUSTOM-MADE HYDRAULIC MACHINE TOOLS AND ACCESSORIES

Every B-36 lands on U·S·S Carilloy Steel

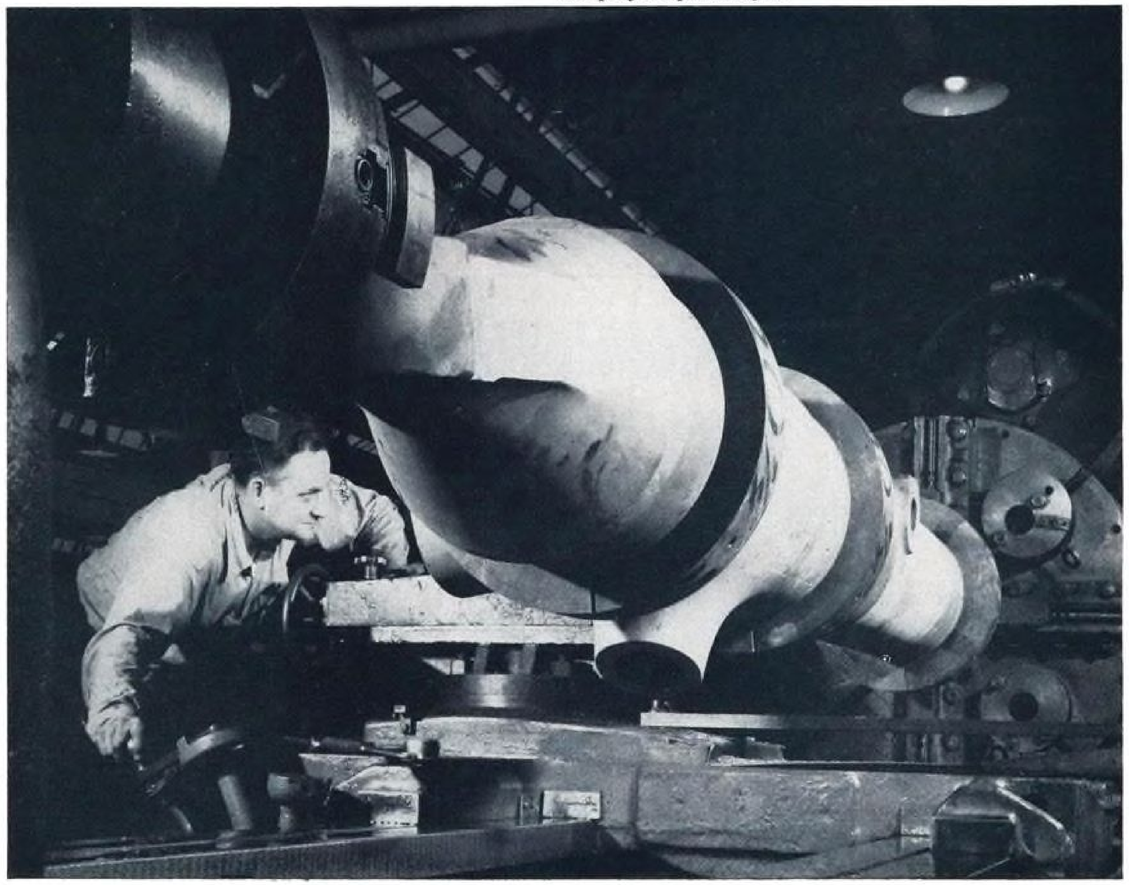
● When 179 tons of B-36 thump down on a landing strip, tremendous stresses are built up in the structural parts of the landing gear. Only the highest quality in steel can handle this tough job, which is one of the most exacting in the aircraft industry.

All of the rugged main columns for these landing gears are made from U·S·S CARILLOY electric-furnace aircraft quality ingots. This high quality alloy steel provides the great strength and shock resistance demanded in the performance of the finished part. The main columns for these landing gears are forged. The original ingot, as shipped to the forger, weighs approximately 37,500 lbs. From it are produced two columns each weighing about 1200 lbs. In other words, approximately 93% of the steel has been removed—with a mere 7% of the original ingot left to do this tremendous job. Obviously, this steel must be of the very best quality.

The same care and skill go into every ton of U·S·S CARILLOY steel that *you* buy, whether it's a giant alloy ingot or a few tons of special steel. Our experienced metallurgists keep a close check on *every* heat of steel to make sure it has the strength, hardness, toughness and machinability that's needed.

If you have a special steel problem, let us know. We'll be glad to help you with it.

U·S·S CARILLOY electric-furnace aircraft quality steel meets every requirement for these vital parts. The precision machining and expert heat treatment they get at Cleveland Pneumatic Tool Company complete the job.



NO ORDINARY STEEL could withstand the huge shock loads imposed on the main landing gears of Convair's giant Air Force B-36 Bomber. The plane has a maximum gross weight of 358,000 lbs., with still higher landing shock loads. U·S·S CARILLOY steel has more than enough impact strength to hold up under this severe punishment.

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

Carilloy Steels

ELECTRIC FURNACE OR OPEN HEARTH

COMPLETE PRODUCTION FACILITIES IN CHICAGO OR PITTSBURGH

3-1215

UNITED STATES STEEL

Hermetic Seal Connector

Withstands rugged operating and assembly conditions

M-7500 Series Blue-Glass Seal Connector gives complete protection to circuits of hermetically sealed electronic or electrical devices under roughest handling, assembly, and operating conditions.

For example, Blue-Glass hermetic seal withstands:

- Mechanical shock of 100 G's.
- Thermal shock from —300°F. to +500°F.
- Bonding temperatures as high as 1500°F.
- Operating pressures up to 7000 p.s.i.
- High potentials of over 1000 volts.

In addition, connector is impervious to moisture, corrosion (salt, acid, oil, etc.), rare atmosphere, fungus and vibration.

One end of connector mates with standard AN (MIL) types. Other end has tapered and serrated surface so connector is mechanically anchored against turning when pressed into device housing.

Strength of mechanical anchor plus high melting temperature of connector's Blue-Glass insulation permit use of any common method of bonding connector to housing — soft solder to welding. No need for special assembly jigs and staking tools . . . . no danger of breaking or melting seal.

M-7500 Connectors are also available with special alloy shells and mounting arrangements.

For shell sizes, insert arrangements, and other information, send this coupon.

GENERAL ELECTRIC COMPANY
Wiring Device Department G-9
95 Hathaway Street, Providence 7, R. I.

Please send catalog information on Monowatt M-7500 Series Connectors.

Name.....
Title.....
Company.....
Address.....
City.....*Zone*.....*State*.....

■ AVIONICS

(boresight) errors have been reduced, but there is still room for further improvement, Behrens notes.

▶ **Protection From Rain**—In the past, raindrops beating against a radome on a speedy airplane frequently caused the radome to disintegrate. The Dielectrics section has developed a protective coating for radomes which enables them to stand up under moderate rainfall for several hundred hours in high speed jet planes.

Although aircraft manufactures now design their own radomes, the Dielectrics section does the pioneering work on fundamentally new designs. For example, it has several development contracts under way to devise new inorganic radome materials for ultra-high-speed flight. This section also prepares performance spects which aircraft manufacturers can follow in designing their radomes.

▶ **New Sub-Min Connectors**—The Dielectrics section expects to establish a new standard sub-miniature connector, for use in low-voltage, low-current circuits, during the coming year, Behrens says. This is based on a study of WADC electronic equipment which showed that 90% of their connector pins carry "only a few milliamps of current at a couple hundred volts." This makes it possible to use smaller pins, more closely spaced, to cut size and weight, Behrens reports.

As presently envisioned, the new line of sub-min connectors will be used for the majority of the incoming circuits; the high-voltage and high-current circuits will feed through the larger, conventional connectors.

The Dielectrics section is sponsoring the development of several sub-min connectors and expects to evaluate these and others, developed with private funds, within the year to establish the new AF standard.

▶ **Waveguides Too**—New techniques for fabricating waveguides to use less critical materials and reduce weight have also come out of the Dielectrics section. One technique uses a steel-cladded material which is formed in a rolling process, and thus adapted to mass production techniques. The result is a waveguide which weighs only one-fifth as much as a brass waveguide and is considerably less expensive to produce.

When the Aircraft Radiation lab is contemplating a new operating frequency for radar, it turns to the Dielectrics section here to develop suitable waveguide and transmission line components for the new frequency.

▶ **Ohms, Henries, & Farads**—Variable inductors using ferrite cores appear likely to replace variable condensers for tuning purposes in future transisorized equipments, according to C. E. Doyle, chief of the Resistance, Inductance & Capacitance section, unless someone devises a new way to sub-miniaturize tuning condensers. Development of tiny components for use in transistor circuits is a major program in this section. Unless sub-miniature components are available, "transistorizing" won't reduce equipment size greatly.

Because transistors operate at lower voltages than vacuum tubes, fixed capacitors are being redesigned for use at lower voltages (1-50 v.). The lower voltage would ordinarily permit the use of thinner dielectric materials, except that they are already so thin that physical strength rather than dielectric strength is the limiting factor. To get notable reductions in the size of fixed and variable capacitors, "we need some radically new techniques," Doyle remarks.

He reports that one manufacturer now is at work on a "markedly different technique" of making capacitors. The program is privately financed, and reportedly shows a promise of cutting paper capacitors to one-tenth their present size, and electrolytics to perhaps half their present size. End products of this program are several years away, Doyle believes.

▶ **Film Resistors & Pots**—Film-type precision potentiometers with the same accuracy as present-day wire-wound pots should be available in several years and at a considerably lower price, it is estimated. The film technique is particularly well suited to making non-linear potentiometers, and it avoids the use of critical materials.

Another promising resistance film, which shows practically zero temperature coefficient characteristics, is under investigation at the Battelle Memorial Institute. This film can be used in making both fixed resistors and pots, Doyle says.

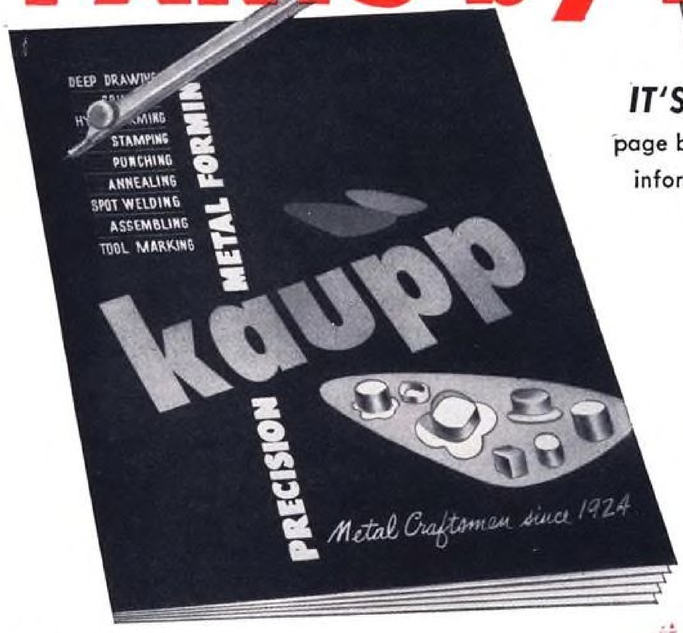
A few of the other investigations that are being sponsored by this section include:

- **Transformers and coils,** for use in transistor circuits (Radio Corp. of America.)
- **Non-metallic magnetics,** including such materials as ferrites, are under study at General Electric to find possible new applications and uses.
- **Magnetic amplifiers** and new magnetic materials to improve the response of mag-amplifiers.

▶ **Mechanical Section**—A modular type case for housing avionic equipment, and a rack in which these cases are compactly stacked to fit the curvature of an airplane fuselage, have recently been developed by the Mechanical section, headed by C. A. Golueke. Several new AF equipments are going to use

Here's your COMPLETE GUIDE to—

PRECISION METAL PARTS by KAUPP



IT'S FREE! The new sixteen page brochure containing helpful information covering all phases of precision metal forming and sub-assembly work.

Designers, production engineers and purchasing staffs are invited to request their copies, now!

SPINNING
STAMPING
PUNCHING
DEEP DRAWING
HYDROFORMING
ANNEALING
SPOT WELDING
ASSEMBLING
TOOL MAKING

New! For Experimental and development engineers—
HYDROFORMING
reduces costs, saves time on short runs and development components

New process sharply reduces tooling time and tool costs. Punch and nest ring are the only tool requirements as hydraulic oil functions as the die member. Send drawings for quotations and information.

COMPLETE FACILITIES and over a quarter century of metal forming to close tolerances assure precision components for the most critical applications. Kaupp experience includes forming and drawing of intricate shapes in stainless, inconel, aluminum, cold rolled steel, brass and other alloys. Gauges from 1/32 sheets to 3/8 plates. For full details ask for your copy of the new brochure.

PRODUCTION AND DEVELOPMENT FACILITIES FOR THE ELECTRONICS, AVIATION, MARINE INDUSTRIES

C. B. KAUPP & SONS
NEWARK WAY • MAPLEWOOD • NEW JERSEY

THE HISTORY OF AIRCRAFT HEATING PROGRESS

has been written by

South Wind
REG U S PAT OFF

From the beginning, South Wind has been the pioneer and leader in the development of aircraft heating equipment combining unfailingly dependable performance with simplified design and installation, utmost safety, minimum maintenance requirements.

The research, engineering, testing and production facilities thus developed are unique in the industry. They are at your disposal to help solve your most challenging heating problems for military, commercial or civilian aircraft.

Write today for information. South Wind Division, Stewart-Warner Corporation, Indianapolis 7, Indiana. In Canada, Stewart-Warner of Canada, Ltd., Belleville, Ontario.

South Wind
REG U S PAT OFF

A PRODUCT OF SW STEWART WARNER

AIRCRAFT HEATING AND THERMAL ANTI-ICING EQUIPMENT INERT GAS GENERATORS

Milestones in the March of Progress

1936 First Production Combustion Type Vehicle Heater
South Wind Model 781, 6,000 BTU/hr.

1941 First Production Combustion Type Aircraft Heater
South Wind Model 789, 8,500 BTU/hr.; Model 790, 80,000 BTU/hr.; Model 791, 40,000 BTU/hr.

1943 South Wind Model 900, 200,000 BTU/hr.

1943 South Wind Model 911, 160,000 BTU/hr.

1944 South Wind Model 906, 50,000 BTU/hr.

1944 South Wind Model 912, 175,000 BTU/hr.

1944 South Wind Model 917, 25,000 BTU/hr.

1945 South Wind Model 920, 100,000 BTU/hr.

1945 South Wind Model 921, 200,000 BTU/hr.

1945 South Wind Model 979, 18,000 BTU/hr.

1945 South Wind Model 68077, 800,000 BTU/hr.

1945 South Wind Model 919, 290,000 BTU/hr.

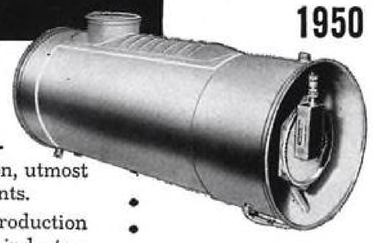
1946 South Wind Model 918, 400,000 BTU/hr.

1948 South Wind Model 930, 100,000 BTU/hr.

1949 South Wind Model 910, 235,000 BTU/hr.

1949 South Wind Model 929A, 700,000 BTU/hr.

1950 South Wind Models 995, 996, 999, Inert Gas Generators



1951 South Wind Model 960, 25,000 BTU/hr.

1952 South Wind Model 997, Inert Gas Generators

1952-1953 South Wind Model 929C, 600,000 BTU/hr.

Participating in this March of Progress . . .

South Wind products have been used in aircraft or equipment manufactured by:

Beech Aircraft Corporation
Bell Aircraft Corporation
Boeing Airplane Company
Cessna Aircraft Company
Chrysler Airtemp Construction Co.
Consolidated-Vultee Aircraft Corp.
Curtiss-Wright Corporation
Douglas Aircraft Company, Inc.
Fairchild Engine & Airplane Corp.
Grumman Aircraft Engineering Corp.
Hughes Aircraft Company
Lockheed Aircraft Corporation
Glenn L. Martin Company
North American Aviation, Inc.
Northrop Aircraft, Inc.
Piper Corporation

■ AVIONICS

the new case and rack configuration and, if it proves successful there, it could become mandatory for all AF avionic equipments.

The new system gives the equipment manufacturer a wider selection of case sizes. He has a choice of three controlled widths (5, 11⅜ or 17¾ in.), uncontrolled case length to 9 in. and fixed beyond that at 12, 16, and 20 in., and a choice of heights varying in ⅜-in. increments. Pressurized cylindrical cases are accommodated by mounting them on a rectangular front panel and supporting cradle.

Shock and vibration mounts for individual cases are eliminated in favor of isolation mounts for the entire equipment rack. This permits cases to be mounted flush to one another, eliminating "sway space" normally allocated when each has its own isolation mounts. Equipment cases of varying lengths can be positioned in the rack in a "stair-step" arrangement to conform to the contour of the airplane fuselage.

Specifications for the new standard cases, MIL-C-7452 (USAF), were issued this spring; the rack spec, MIL-R-7453 (USAF) was released only during the past month.

► **Shock and Vibration**—The Mechanical section concerns itself with other mechanical aspects of avionic equipment design.

For example, the mounting bases of avionic equipment chassis are usually beefed up to be sure they won't tear loose in a crash and become a flying hazard to the crew. This section is developing shock links which will be used to anchor equipment to the rack, yet designed to yield sufficiently to dissipate crash momentum. This will permit the use of lighter chassis for all equipment, Golueke says. Working models of the new shock link are expected in nine months.

This section also has studies underway to measure the general level of vibration and shock that exists in different portions of present day aircraft and missiles.

Concurrently another program is determining the general level of shock and vibration which different types of components (tubes, relays, transformers, etc.) can withstand without failure. The end product is expected to be a designers handbook aimed at guiding engineers in the mechanical design and layout of avionic equipment.

► **Electromechanical Section**—A new tube socket which will permit all the internal wiring of an avionic assembly to be hermetically sealed, while its tubes protrude into the outside area where they can better dissipate their heat, is a recent product of the Electromechani-

GREAT AIRLINES

From Little Airlines Grow

and become GREAT
assets to the commercial and military
might of our Nation!

NORTH AMERICAN AIRLINES too is a splendid example of free enterprise in action, beginning only a few years ago, at the end of World War II, when Jim Fischgrund and Stan Weiss started Standard Airlines with two DC-3's and Red Hart and Jack Lewin started Viking Airlines with three additional DC-3's. Backed only by private capital and stern determination to render a vital new service to the Nation and its citizens, these carriers pioneered low fare air coach service.

In those days, CAB flight frequency requirements were considerably less stringent than today, and the companies prospered without mail pay or subsidy. For the most part their passengers were those who had previously been unable to afford the higher cost, luxury service then in existence and generally believed to be the only economically feasible air transport service. In 1949 these companies joined forces to provide improved passenger service and formed North American Aircoach System, Inc.

During the summer of 1951, the Senate Small Business Committee recommended that the CAB encourage consolidations among the independent carriers, and soon thereafter North American Aircoach System, Inc., asked CAB to approve a merger of North American Airlines, Trans National Airlines, Trans American Airways, Republic Air Coach System, California Aircraft Company and Twentieth Century Aircraft Company, the surviving company to be North American Airlines, Inc.

Aircraft owned by these companies comprises Douglas DC-4's equipped with rearward facing "safety seats" and soon will include factory-new DC-6B's, the first to be produced in an all coach configuration. Ticket offices are located in 23 major cities.

Today, only seven years after the first air coach flight, revenue passenger miles approach Western Airlines', exceed Continental or Chicago and Southern, exceed the combined total of Colonial and Northeast, and the group ranks fifth among all domestic carriers in total air coach traffic.

Thus, this year, the golden anniversary of powered flight, NORTH AMERICAN AIRLINES, pioneering air coach in today's tempo, is proud to be following the trail of the pioneers who have contributed so much in the development and growth of the Nation's air transport industry under the American free enterprise system.

North American Airlines
First in Air Coach

***METAL Caps and Plugs Assure Maximum Protection** because they won't chip . . . no particles to clog lines.

METAL Caps and Plugs Assure Maximum Protection because they resist hard knocks, seal out dust and moisture, or seal in fluid when required.

METAL Caps and Plugs Assure Minimum Cost because they can be reused many times . . . they "spin" on by hand, and keep Hydraulic Systems clean . . . clean, *clean.*

CATALOG
free when requested
on your firm letterhead.

For Protection During Manufacture, Shipment and Storage of Hydraulic Lines and Fittings, Demand . . .

THE ORIGINAL METAL CLOSURES by TUBING SEAL CAP INC.

Home Office and Factory: 808 W. Santa Anita Ave., San Gabriel, California.
Eastern Office: 428 New Center Bldg., Detroit 2, Michigan.

■ AVIONICS

cal section. These hermetically sealed sockets are expected to be available in seven- and nine-pin miniature and in octal bases within three to six months, according to I. S. Mayer, section chief.

This section is responsible for a variety of components, from tube bases to circuit breakers, from metallic-plate rectifiers to rotating shaft seals, from small panel meters to pilot lights.

▶ **High-Temp Rectifier**—Rectifiers made from titanium dioxide appear to be capable of operation at temperatures as high as 200C, considerably beyond the limit on present selenium rectifiers, Mayer reports. The new titanium dioxide rectifiers also appear to have high back impedance, low forward impedance, and to maintain their characteristics with temperature and age. This makes them extremely attractive for use with magnetic amplifiers, Mayer notes.

The trend toward building test circuits and devices into avionic subassemblies to permit operators or maintenance men quickly to spot a bad unit, should get a boost from a tiny microammeter developed for this section. Only one inch in diameter, the meter has a 270-degree scale which gives excellent readability despite its small size. The device was built by International Instruments, Inc., of New Haven, Conn.

▶ **General Engineering Section**—The vastly increased use of avionics in aircraft and missiles has prompted many to wonder whether this country could produce enough avionics to sustain a full-scale shooting war. The problem is particularly acute because of the large amount of hand labor involved in present fabrication methods.

This explains why the General Engineering section has launched a program at Stanford Research Institute to develop techniques and machines for producing avionics devices automatically and with practically no hand operations.

The Army Signal Corps and Navy have somewhat similar programs under way, according to Yale Jacobs, section chief, but he says that the project is so important that "many heads are needed to investigate all possible approaches."

▶ **Two Tasks**—One of the General Engineering section's major tasks is to foster and develop new avionic fabrication techniques, including miniaturization, cooling and automatic production. The other task is to devise ways for quickly supplying equipment manufacturers with information on the availability of components they need.

In fostering new fabrication techniques, the section operates in several ways. On the problem of designing adequate cooling provisions into avionic equipment, the section has established

EXPERIENCE
EQUIPMENT
FACILITIES

Twin Coach has what it takes *to meet schedules—...*

Experienced aircraft specialists . . . latest equipment . . . modern plant facilities . . . and a reputation for meeting or improving on production schedules—that's Twin Coach Aircraft Division.

This combination means that prime contractors can turn over tool design and construction to Twin . . . can rely on Twin's producing assemblies to specification, in quantity, *on schedule.* Modern facilities, modern equipment, and experienced manpower make Twin Coach a *dependable* source for every type of major airframe assembly.

A-7506

TWIN COACH AIRCRAFT DIVISION
is currently delivering major airframe assemblies for helicopters, bombers, search and attack planes, fighters and triphibians.

TWIN COACH COMPANY *Aircraft Division* **BUFFALO, N.Y.**

TWIN COACH PRODUCTS:
AIRCRAFT ASSEMBLIES • MOTOR COACHES • TROLLEY COACHES • SUPER FREIGHTER CARGO TRUCKS • FAGEOL GASOLINE AND PROPANE ENGINES • FAGEOL-LEYLAND DIESEL ENGINES

■ AVIONICS

Ohio State University as a research center in this field. Each year, ECL and Ohio State sponsor a 2-day conference on avionic cooling problems which is well attended by engineers from aircraft and equipment manufacturers.

Another approach was used when a contract was given to Lear, Inc., to miniaturize the old World War II BC-348R radio receiver (200 kc to 18 mc.). Lear made no attempt to improve the set performance, tried only to cut size and weight. The result was a set weighing only one-third as much and only one-fifth as big.

Reports on projects like these, with emphasis on the techniques employed, are then circulated to industry and WADC project engineers for application to new equipments, Jacobs says.

▶ **Component Information Center**—A centralized source of information capable of providing the names of manufacturers who can supply any desired component is envisioned as the result of a study by the Battelle Memorial Institute.

If an engineer wants to find out who manufactures the smallest two-phase, 400-cycle, 1/100-hp. induction motor, the request would be submitted to the Electronic Components Information Center (ECIC) where machines would sort through thousands of punch-cards to get the answer.

Another similar program at Battelle is the preparation of an Electronic Components Development Register, which lists new experimental components under government-sponsored development and the date when they are likely to be available. If funds permit, Jacobs says that ECL plans to publish this register every six months.

Another project is to publish planning charts for component manufacturers to show areas where new component developments are needed.

Components Test

New devices produced in the Components Development branch undergo test and evaluation in the Components Test branch.

Test facilities include the normal complement of environmental test chambers (altitude, temperature, humidity), plus microwave test devices for measuring the transmission characteristics of radomes and radome materials.

Other facilities permit the measurement of dielectric constant and loss tangent of dielectric materials up to 8,600 mc., over a temperature range of −65C to 300C.

The branch is divided into six sections, four of which are directly assigned to test the products of their counter-

MAXSON ENGINEERING

develops and manufactures

gyros

for military applications.

Eighteen years' experience, and 3000 employees can augment your facilities.

What are your requirements?

THE W. L. MAXSON CORPORATION
460 West 34th Street, New York 1, New York
Plants at Long Island City, N. Y. and Old Forge, Pennsylvania

MAXSON

FUEL and OIL SYSTEM VALVES

Kenyon PN 11088

FUEL TANK PRESSURE CONTROL VALVE

1. Delivers air from ram to tank.
2. Closes off air supply at designated pressure.
3. Bleeds any excess pressure in tank to vent.
4. Automatically dumps pressure during or after taxi-ing to permit safe, immediate refueling.

KENYON

Kenyon PN 11180

OIL TANK FILLER-SEPARATOR VALVE
Isolates cold weather starting oil in diluted oil tank from regular engine oil in main tank, yet when required permits filling of diluted oil tank with regular oil during normal filling operation.

SWING CHECK VALVE
Connections per AND 10060 shown. Available in 1¼", 1½", and 2" tube sizes. Also made with flanged ends or combination flanged and tube ends for individual needs. High flow, low cracking pressure.

Kenyon PN 11019

KENYON INSTRUMENT CO., INC.
1345 NEW YORK AVENUE
HUNTINGTON STATION
L. I., N. Y.

FINE ORGANICS INC.
F.O.
AVIATION CHEMICALS DIV.

FINE ORGANICS OFFERS

qualified facilities for research and development work

on corrosion inhibitors, propellants and explosives.

At the present time we are serving the BUREAU OF AERONAUTICS and the BUREAU OF ORDNANCE.

In 1953 more users are turning to

FINE ORGANICS RESEARCH FACILITIES and AVIATION CHEMICALS

for their superior effectiveness, economy and safety.

PRODUCERS AND DEVELOPERS OF:

- CLEANERS
- ALUMINUM BRIGHTENERS AND POLISHERS
- CARBON REMOVERS
- ENGINE CLEANING COMPOUNDS
- DE-ICING COMPOUNDS
- DEODORANTS AND DISINFECTANTS
- PAINT STRIPPERS
- INSTRUMENT PARTS CLEANERS

FINE ORGANICS qualify under U. S. Government specifications on the above products.

Write for complete information

Aviation-Industrial Division

FINE ORGANICS inc.

211J East 19th St. • New York 3

■ AVIONICS

parts in the Components Development branch:

- **Dielectric Test,** under M. W. Miller.
- **Resistance, Inductance & Capacitance Test,** under J. F. Rippin.
- **Mechanical Test,** under C. W. McDowell.
- **Electromechanical Test,** under W. E. Deis.
- **Atmospheric,** under J. C. Wightman, carries out environmental tests for the other sections.
- **Calibration & Standards,** under R. W. Stolzenbach, is the "little National Bureau of Standards" for the Air Force. It provides calibration facilities for instruments used in all other WADC labs, and coordinates such work for all other ARDC centers.

Electron Tubes

In the fall of 1950, the Strategic Air Command reported that roughly half of its aborted missions were caused by failures of electron tubes. This illustrates the importance of developing tubes specifically designed to withstand the rigors of the airborne environment—the assignment of the Electron Tube branch.

The branch is divided into six sections:

- **Transistor,** under R. D. Larson.
- **Receiving Tube,** under L. L. Gibbs.
- **Special Tube,** under W. H. Nelson.
- **Transmitting Tube,** under J. R. Hayes.
- **Tube Techniques,** under Dr. O. M. Stuetzer.
- **Tube Test,** under S. Badger.

▶ **Transistor Section**—Development of transistors capable of operating at the high temperatures encountered in airborne use is one of the programs under way in the Transistor section.

Silicon looks promising as a high-temperature transistor material, Larson reports, but it is difficult to produce in the required degree of purity.

Another project is aimed at improving transistor reliability and the contractor is reported to be making good progress. Hermetic sealing appears to solve the reliability problem for grown-junction transistors, Larson says, and he adds that all manufacturers are going to hermetic sealing.

Asked about power transistors, Larson reports that an undisclosed manufacturer has demonstrated a transistor capable of handling 40 watts, and he adds that transistors capable of power outputs of one to five watts should be in pilot production by the end of the year.

Larson also reports that a manufacturer expects to have germanium diodes capable of handling up to 50 amperes, a 500-fold increase over the present top rating of about 100 ma. Larson also noted a trend to four-element (tetrode) transistors to achieve improved operation at higher frequencies.

▶ **Receiving Tube Section**—There is a two-pronged program under way in the Receiving Tube section to get better and more reliable tubes.

One, an interim program, employs more rigid specifications, inspection, and test, to maintain improved quality control on existing tube designs. This program, known as the 6000/CT series tubes, or Military Control Electron tubes, has resulted in much more reliable tubes, based on limited experience to date, according to L. L. Gibbs, section chief. When sufficient quantities of the MCET units are available, they will be recommended for use in all AF equipment, Gibbs indicates.

The second phase of the program is a long-range effort involving fundamental changes in tube design and construction—for example, the use of ceramic envelopes instead of glass.

Another objective is to design the tube so it can be constructed largely from pieces that can be punched or drawn on automatic machines, eliminating most or all manual operations. This is expected to produce more reliable tubes.

▶ **New Ceramic Tubes**—Raytheon Mfg. Co. has developed a ceramic tube equivalent of the 6L6 beam power tube which can be operated at a temperature of 250C without derating. The new tube is only $\frac{1}{10}$th the size of a conventional metal 6L6 which is only rated for operation at 70C.

Gibbs says Raytheon is developing three other ceramic tube types using similar construction: one is a video amplifier, another is a half wave rectifier, and the third is a low-mu triode.

The tubes' compact construction and the use of ceramics should make them extremely rugged, Gibbs believes. He says they are still in the developmental stage and not ready for production.

▶ **Transmitting Tube Section**—There has been a sizable improvement in the frequency stability of some magnetrons (used in airborne radars) as the result of development programs sponsored by the Transmitting Tube section, according to E. L. Breen. The careful selection of materials used in constructing magnetrons prevents changes in physical size of the cavity due to temperature changes, giving improved stability.

Breen also notes similar improvements in the stability of reflex klystrons, making them relatively unaffected by temperature and altitude changes.

▶ **Special Tube Section**—Cathode ray (electron beam) tubes and thyratrons are the major concern of the Special Tube section.

■ AVIONICS

A recent development is a very-high-intensity direct-view storage tube which can be used to display visual instructions transmitted from the ground, or could be used in a radar scope. The tube, developed by RCA, produces a "blinding" illumination of 5,000 foot-lamberts, according to W. H. Nelson, section chief. This section has recently launched a program to develop a long-persistence color CRT.

Two recent developments may find widespread use as built-in fault-indicators for avionic sub-assemblies. One is a tiny cathode ray tube (1 in. dia. x 3 in. long) which can display significant waveshapes. The other is a tiny "magic eye" tube ($\frac{3}{4}$ in. dia. x 1 in. long) which has two voltage indicators capable of giving an approximate indication of voltage magnitude without disturbing high impedance circuits.

▶ **Tube Techniques Section**—Applied research into the physics and chemistry behind transistor and vacuum tube operation is done in the Tube Techniques section under Dr. O. M. Stuetzer.

In the course of this work, Dr. Stuetzer invented the "fieldistor," a type of transistor in which the input signal controls output by means of an electrostatic field.

Advantage of the fieldistor is its desirable high input impedance; disadvantage is the difficult fabrication technique involved in its construction.

▶ **Tube Test Section**—Newly developed transistors and tubes are put through their paces in the Tube Test section, which serves the other sections in this branch much like the Components Test branch serves the Components Development branch.

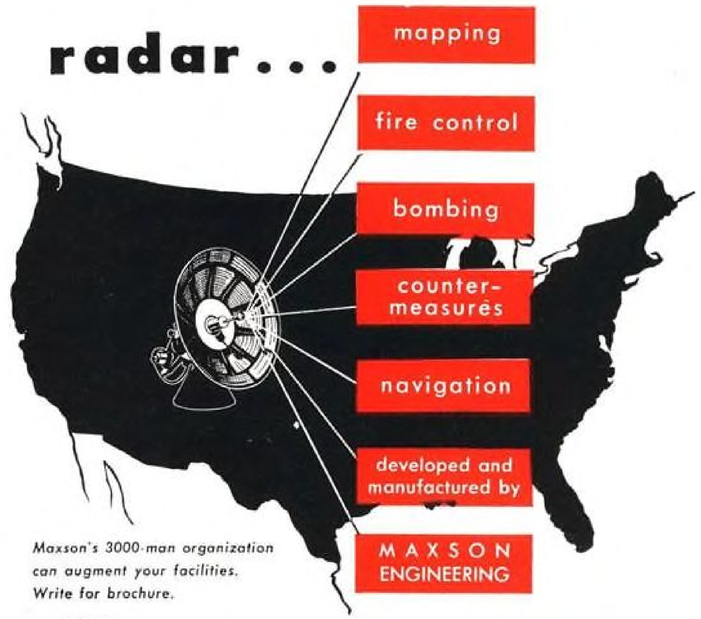
This section is equipped with latest test equipment for evaluating transistor performance, including noise, impedance, four-pole parameter, rise, fall and delay time.

General Purpose Test Equipment

The General Purpose Test Equipment branch is divided into three sections, with these responsibilities:

- **Development.** General purpose test equipment such as ammeters, ohmmeters, multimeters, vacuum-tube, voltmeters.
- **Measurements & Techniques.** Develops new measurement techniques to permit the use of simpler, less expensive test equipment.
- **Interference Reduction.** Develops new techniques for inter-equipment interference reduction and establishes tolerable limits of radiation from individual equipments developed by all other WADC laboratories.

radar...



Maxson's 3000-man organization can augment your facilities. Write for brochure.

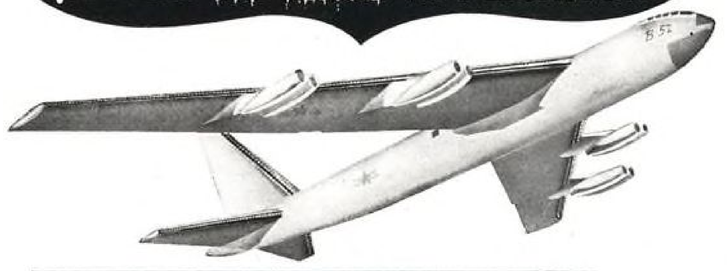
MAXSON

THE W. L. MAXSON CORPORATION

460 West 34th Street, New York 1, New York

Plants at Long Island City, N. Y. and Old Forge, Pennsylvania

SSP WEIGHT SAVING Tapered Tubes for HEAT DE-ICING APPLICATION



Leaders of Aircraft Industry Select S.S.P. Tapered Tube Ducts

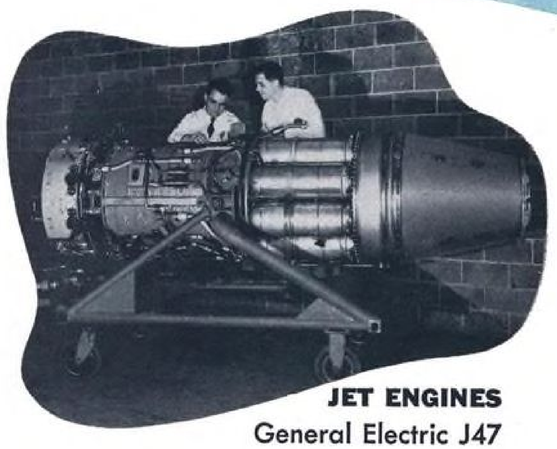
Boeing B-52 engineers demanded tapered tube ducts for DE-ICING application on AMERICA'S biggest, fastest and hardest-hitting bomber. The plane facts are they selected STAINLESS STEEL PRODUCTS tapered tubing—the leading product for the leading edge ducts. S.S.P. tapered tubing saves weight; fits structure better, which means it is possible to put DE-ICING closer to the leading edge; reduces heat losses due to radiation and gives better flow characteristics.

STAINLESS STEEL PRODUCTS INC.
2390 N. SAN FERNANDO BLVD.
BURBANK, CALIFORNIA

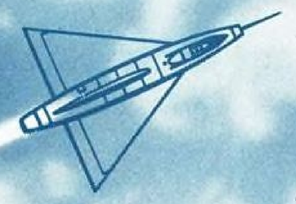
Tapered tubes are but one of STAINLESS STEEL PRODUCTS' family of many dependable engineered products now serving America's Aviation Industry.

Ready for flight FASTER ...because CAMLOC LOCKS FASTER!

GUIDED MISSILES
Chance Vought "Regulus"



JET ENGINES
General Electric J47



Camloc fasteners save valuable time in original assembly—and still more time at each inspection, repair or overhaul. A quarter turn of the stud locks the fastener so firmly it cannot vibrate open.

For securing exterior coverings or interior panels, where frequent opening is the rule, Industry has relied on Camloc for quick, positive performance.

In the future, as in the past, Camloc will continue to keep pace with the latest engineering developments of the aircraft, electronic and allied industries.

Write for information on the new Camloc line of heavy duty, quick opening latches.

GUN TURRETS
Courtesy
General Electric

AIRCRAFT
Douglas RB66A
Photo Reconnaissance

Camloc versatility is recognized by the nations leading manufacturers.

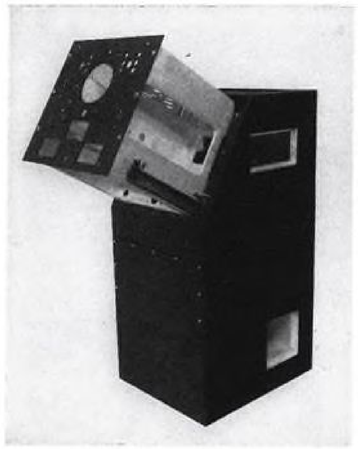
CAMLOC® FASTENER CORPORATION

MAIN OFFICE AND FACTORY
22 SPRING VALLEY ROAD, PARAMUS, NEW JERSEY
WEST COAST OFFICE
5410 WILSHIRE BOULEVARD, LOS ANGELES 36, CALIFORNIA

On the GROUND . . .
or at the
Speed of SOUND . . .

REF Means *Controlled* Quality!

Quality control follows all REF products from tooling through fabrication, heat treat, precipitation hardening, welding, alodizing, assembly and finish. You're sure of "aircraft quality," whether your product flies at the speed of sound or never leaves the ground.



Console and Chassis manufactured to exacting tolerances by REF for Bendix and DuMont Laboratories. Detail parts were made with special care . . . to provide interchangeability between console and chassis.

Air Portable Test Bench, designed and manufactured for Sperry Gyroscope.

Nose Wheel Doors for Grumman's "Albatross" Rescue Ship.

Manufacturers of

REF SKYGALLEYS MINEOLA, N.Y.

SEND FOR OUR FACILITIES REPORT

REF Manufacturing CORPORATION

397 Jericho Turnpike
Mineola, N. Y. • GArden City 7-0790

West Coast Office
15117 Ventura Blvd. Sherman Oaks, Calif.
STate 4-1662

WADC's Armament Laboratory:

Where Avionics Joins Firepower

Dayton, Ohio—It was little more than 10 years ago that a group of high-ranking Air Force officers visited the General Electric plant in Schenectady to see a demonstration of the then radically new remote-control turret system to be used on the B-29. The officers were quite impressed to see two large twin-gun turrets being remotely positioned from a small gunsight 40 feet away.

Then one of the generals walked over to look inside one of the system's black boxes. His jaw dropped as he counted 12 vacuum tubes. What he said as he walked away left little doubt that he thought that vacuum tubes had no place in aircraft armament.

Today, WADC's Armament Laboratory might well be called the Electronic Warfare Lab, if that name had not earlier been applied to electronic countermeasures groups elsewhere.

In 10 short years, the vacuum tube has become the backbone of aircraft armament. But there is a growing awareness here that avionics can not do it single-handed; that these complex avionic armament systems must be designed to accommodate better the human operator who must use them and the men who maintain them.

▶ **Bombing Accuracy Up**—Despite the fact that bombing accuracy tends to deteriorate as bomber speeds and altitudes increase, we are now achieving better radar bombing accuracy in any weather than we got at World War II speeds and altitudes by optical means, according to Lt. Col. S. C. Phillips, chief of the Plans Office in the Armament lab. Major credit goes to the new K-series (radar and optical) bombing and navigation system. One version of this system reportedly weighs 1,700 lb. and uses 365 vacuum tubes.

Not all of this complexity can be charged solely to increased bombing accuracy. In our new B-47 jet bombers, a three-man crew performs the tasks that kept 11 men busy in World War II B-29s. For example, a single B-47 crewman serves as bombardier, navigator, and radar operator.

This requires the K-system to perform automatically many of the functions performed manually on previous bombing systems, and this means more complexity, according to Lt. Col. W. M. Hilt, chief of the Strategic Bombing branch.

▶ **No End in Sight**—As bomber speeds go even higher, bombing and navigation systems will become even more complex, Hilt predicts. More automaticity will be needed because human reaction time can't be speeded up to match higher bomber speeds.

With increased bomber speed, the bomb must be released farther away from the target so the bombing system must be able to "acquire" the target farther out, Phillips says.

New-type bombing systems, which will permit bombing without using any target-derived data, are under development, Phillips says.

▶ **Lessons From the Past**—The evolution from simple optical bombsights to complex avionic bombing systems has been a difficult one and the Armament lab is trying to apply the painfully learned lessons of the past to its new bombing systems. For example:

• **System Engineering.** When radar was first applied to airborne armament late in World War II, it proved expedient to "marry" the radar to existing armament by means of adaptors ("marriage boxes").

Experience showed that these complex sub-systems were not easily mated. The Armament lab found that it didn't have sufficient manpower or facilities to handle systems-engineering on large complex systems.

Present practice is to give complete system responsibility to a single prime contractor. This assures optimum system integration and minimum system weight and volume, according to P. E. Koenig, technical director of the Armament lab.

• **The Human Factor.** As the requirements for weapons systems performance increase, it becomes necessary to pay more attention to the relationship between the man and his equipment.

The Air Force has learned that operations which are easy to perform during a training flight may prove unnatural and difficult under the strain of combat conditions.

For example, radar scope data should be presented to the bombardier in a natural or familiar fashion. These principles are being applied to new bombing system designs, according to both Phillips and Hilt.

• **Reliability.** In 1950, the Air Force was experiencing a large number of aborted training missions and many of these were charged to vacuum tube or avionic equipment failures. Unreliability is one consequence of increased complexity, at least in the early stages of equipment design.

Project Reliable was formed in 1951 to find the basic causes of armament system unreliability, to clean them up, and to project that knowledge into future designs. (One phase of this program was to produce more reliable vacuum tubes which the Electronic Components Lab has achieved through

INFORMATIVE!
NEW!
PRECISION SAND CASTING BY THE OSBRINK PROCESS

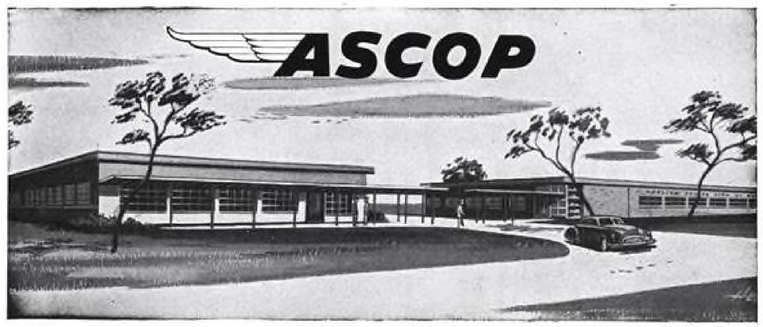
The story of the World Famed **OSBRINK PRECISION SAND CASTINGS** told on film—in technicolor with detailed narration!

Acclaimed by Engineers, Designers, Executives as a **"NEW DESIGN TOOL"**—Should be seen by everyone in the Aircraft Industry."

TEXAS INSTRUMENT COMPANY'S "SONAR REEL ASSEMBLY" DEVELOPED FOR CASTING WITH OSBRINK MFG. CO.

Available for group showing by request to your Organization! See how great aircraft companies reduce parts cost by having them "Cast to Size"—How Castings can replace fantastic fabrications—How advance prototypes solve production design problems in Magnesium and Aluminum. Write

R. H. Osbrink Mfg. Company
6917 McKinley Ave.
Los Angeles 1, Calif.



Radio Telemetering
Data Handling
Vehicle Instrumentation
High Speed Sampling

Research, Development, Design, and Production Services
Involving Specialized Application of the
Principles of Electronics, Mechanics, and Optics

ASCOP
WE PROVIDE THE LEVER • YOU MOVE THE WORLD

Your Inquiries Are Invited — Wire, Write or Phone

APPLIED SCIENCE CORPORATION OF PRINCETON
P. O. Box 44, Princeton, New Jersey • PLainsboro 3-4141

***New* ALTITUDE SIMULATION CHAMBER**

- Altitude Range to 120,000 feet.
- Temperature Range from 300°F. to −140°F.
- Micrometer Temperature Adjustments hold ±2°F.
- Compact Design. .Requires less Floor Space
- Humidity Cycle available

Providing extreme flexibility in temperature and vacuum ranges, M & M Altitude Simulation Chambers give you precise control and easier, simpler operation that will reduce test costs considerably. Custom-quality built in every detail, M & M Chambers are designed to meet Government altitude simulation test standards. Available with many optional features to speed testing, such as Program Heating, Cooling, and Humidity Cycles, Automatic Recorder for controlling and integrating temperature, humidity and altitude. Write for details on Altitude SIMULATION Chambers as well as M & M Cold Temperature Test equipment.

MURPHY & MILLER, Inc.
1346 South Michigan Avenue • Chicago 5, Illinois

■ AVIONICS

its Military Control Electron Tube program.

Project Reliable lessons are being applied to new bombing systems, Hilt says. These will have "go, no-go" type testers built in to enable the bombardier to check out his system in flight. If he finds a malfunction, he can isolate it by switching to another mode of operation, in many instances.

The system is being designed using highly "unitized" construction, to permit quick replacement of faulty units. Improved ground maintenance testers have been developed to expedite system test and trouble-shooting, Hilt adds.

▶**Avionic Impact On Fighters**—For many years, fighter armament consisted of guns and a simple ring-and-bead sight, but avionics has changed all that, with impressive results. Sizable credit for the overwhelming Sabre-to-MiG kill ratio in Korea (which from May to the end of June was 74 MiGs, zero Sabres) is given to the computing gunsight, and its companion range radar, by Lt. Col. G. C. Clementson, chief of the Fixed Gunnery branch.

Although much has been written in praise of the computing gunsight, Col. Clementson emphasizes the important role of the range radar set which measures the distance to the target and feeds this information into the computing gunsight.

The gunsight computes the angle by which the Sabre guns must be aimed ahead of the target's present position. This "lead angle" is the product of target velocity and (essentially) target range. Thus a 10% error in range information means roughly a 10% error in lead angle computation—enough to completely miss the target.

▶**Importance of Range Radar**—Before the advent of range radar, the pilot had to turn a small knob to adjust the diameter of a circle of dots in his gunsight so that they continuously spanned the target. He had to do this in the heat of combat while he was simultaneously trying to maneuver his plane into position, adjust engine power, and anything else that might come up. The result was very inaccurate range data for the gunsight computer, and poor tracking, giving incorrect lead angle computations.

With range radar, the pilot can concentrate on tracking his target while the radar continuously pumps accurate range data into the gunsight computer.

▶**Aware of Complexity Dangers**—Clementson shows a keen awareness of the dangers of going overboard in fighter armament complexity. For example, he told AVIATION WEEK that his branch is currently analyzing two new fighter gunsights to determine which should go into production as a replacement for the sight now in use. One of the new sights is considerably more complex but will give improved accuracy, providing that the fighter pilot is able to track his target very smoothly. But in the newer highspeed fighters, airplane stability is not as good as in slower aircraft, making it difficult to track smoothly, Clementson says.

The other new gunsight under consideration has accuracy "comparable" to the gunsight now in use, but it is fundamentally much more simple in construction and should therefore be easier to maintain and keep in operation, Clementson says.

In weighing these two new gunsights, Clementson says that the more complex sight could be as reliable as the simpler one, after a suitable period of equipment "debugging" and personnel familiarization.

The trouble is this: if the "debugging" and familiarization period is too prolonged, the equipment will be blacklisted, or obsolete before an acceptable degree of reliability is achieved, Clementson says.

▶**Interceptor Fire Control**—Interceptor fire-control systems, developed by Hughes Aircraft and currently in use on the F-86D, F-94C, and F-89D, have increased the probability of locating and destroying an enemy bomber by a factor of 10:1, Clementson estimates.

This ratio is based on comparison with airplane capability if it had no airborne fire-control system and had to be directed by ground controlled intercept (GCI) radar.

Present interceptor radar fire-control systems enable the pilot to spot a target in any weather. A computer automatically calculates the required interceptor course, and in some versions, the autopilot automatically maneuvers the airplane into the correct position and holds it on the calculated course.

More advanced systems under way at Hughes will fire the Hughes-developed Falcon air-to-air missile. This is expected to increase the probability of successful interception considerably, Clementson says. For one thing, it will enable the interceptor to open fire at greater distances from the target, making it less vulnerable to enemy bomber counterfire.

▶**Bomber Defense**—Bomber defense, for which the vacuum tube was first introduced into the armament field, has been hard hit by recent avionic advances. The new automatic interceptor fire-control systems and guided missiles pose a serious threat to bomber defense, according to Major E. O. Godfrey, chief of the Bomber Defense branch.

It would be possible to provide extremely good bomber-defense capabilities, Godfrey says, if space and weight were no limitation. However, he points out that fuel tanks usurp most of the space in new jet bombers, leaving little room for turrets or gunners.

"Bomber defense tends to take a back seat to greater bombload, longer range, and better bombing systems, until the crew finds itself under attack," Godfrey notes.

▶**ECM Will Help**—A few years ago, many people held a defeatist attitude on bomber defense, Godfrey says, but there have been recent developments which show considerable potential. Electronic countermeasures, for one, appears to offer "tremendous possibilities," Godfrey says.

The use of long-range radar to spot and track enemy fighters much farther out is another answer to the problem of higher closing speeds in jet combat, he notes.

▶**Tactical Bombing Branch**—Shoran equipment, used in tactical bombing for target location, is an exception to the general rule that Rome Air Development Center handles ground-based avionics. The Tactical Bombing branch here is responsible for both the airborne receivers and the ground-based beacons.

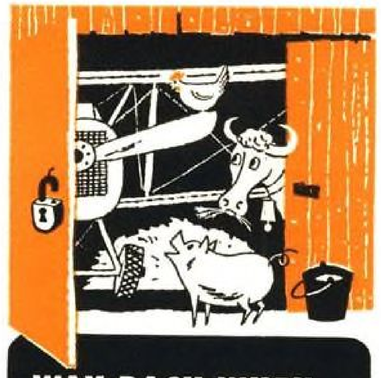
This branch is charged with developing bombing systems for both fighter-bombers and tactical (medium) bombers, to enable them to knock-out anything from a railroad-marshalling yard to a truck, from a radar site to a railroad

COATED FABRICS by *Sawyer*

VINYL COATED
NYLONS
FIBERGLAS
COTTONS AND
SYNTHETICS.

To meet government and aircraft specifications.

THE H. M. SAWYER & SON CO.
ESTABLISHED 1840
Coated Fabrics Division
(The Brunsene Co.)
Watertown, Mass. WA 4-0520



WAY BACK WHEN...
They locked the barn
to protect the aeroplane

NOW...
They lock the cabin (with Adams-Rite Locks) to hold in the pressure

NO. 1607 LOCK ASSEMBLY
This flush-type exterior lock has been designed for use in a turbo-prop transport. Withstands pressure of 18.5 PSI and provides positive security with rugged convenience. Button releases handle which rotates in either direction to open. Inside handle supplied. Length 9⅛" overall Weight approximately 2 pounds.

NO. 1563 LOCK ASSEMBLY
Developed by Adams-Rite for newest twin-engine trainers. Flush-type with 5 pin tumbler cylinder. Button ejects handle which rotates clockwise to open. Assembly is pressure sealed to customer specification. Length 8⅞" overall Weight approximately 1.3 pounds.

NO 876 AUXILIARY DEADLOCK
This is one of the first pressured locks developed by Adams-Rite for a famous four-engine super transport Still in use in the latest production airplanes. Unlocks from outside by key only; handle always operates lock from inside. Overall diameter 2⅛/16" Weight .6 pounds.

NO. 1586 CYLINDER
Four pin-tumbler construction for use on one of latest flying boats. Although not pressurized, this cylinder is made throughout of solid stainless steel for salt water exposure and is used on a pressurized door.

The Adams-Rite locks shown above are only a few samples of many custom-designed locks now being made. For door bolting systems—emergency exit locks—exterior door locks—bulkhead door locks and other closing devices—**ask Adams-Rite**—headquarters for locks.

ADAMS-RITE MANUFACTURING CO.
340 WEST CHEVY CHASE DRIVE, GLENDALE 4, CALIFORNIA, U. S. A.

Midwest Representative George E Harris & Co.
Municipal Airport, Wichita, Kansas
Offices: St. Louis, Kansas City Ft Worth
Canadian Representative
Railway and Power Engineering Co. Montreal
Offices throughout Canada

NEW AIRCRAFT SERVO COMPONENT

The Type 71-5 Baroresistor is a pressure actuated potentiometer designed for operational use in aircraft. It features:

HERMETICALLY SEALED MECHANISM

The potentiometer winding and operating parts are hermetically sealed in a vacuum. Pressure is applied inside the bellows only. Therefore, the Type 71-5 Baroresistor is not affected by dust, fungi, or moisture.

RUGGEDIZED CONSTRUCTION

A special high force mechanism was developed for the Trans-Sonics Baroresistor to avoid the necessity for employing micro force potentiometer elements. Shock of 30g in any direction will not cause electrical discontinuity.

MACHINE CALIBRATION

Each instrument is calibrated by machine and its performance is automatically recorded as a graph of resistance versus pressure. Every turn of the winding is inspected. All electrical characteristics are automatically checked in an eleven stage inspection cycle.

Condensed Data

Range: 0-15 psi, absolute
Resistance: 7500 ohms
Maximum voltage: 75 volts
Resolution: ⅓%
Accuracy: 2% of full scale

Typical Applications

Servos—Vary servo loop gain as a function of altitude.
Computers—Voltage divider, P total/P static.
Fire Control—Air density measurements.
Telemetering—Pressure transducer.
Recording—Pressure transducer.

TECHNICAL REPRESENTATIVES

Los Angeles, Calif. Telephone: Cumberland 3-4183
Dayton, O. Telephone: Hemlock 1254
San Francisco, Calif. Telephone: Lytell 3-2189
Seattle, Wash. Telephone: Main 7005
St. Louis, Mo. Telephone: Sweetbriar 2175
Houston, Tex. Telephone: Monroe 5-5624
Detroit, Mich Telephone: Broadway 3-2900
Cleveland, O. Telephone: Yellowstone 2-7849

Write for Bulletin No. 71-5 for further details

TRANS-SONICS, INC.
7 Forest Street, Bedford, Mass.

Price: $225.00 Short delivery

We'll Guarantee
PERFECT UNIFORM TWIST
INCREASED PRODUCTION
LOWER COST by at least
50%
savings with . . .

ZipTwist
FOR SAFETY WIRE

Produces either RIGHT or LEFT Symmetrical Twist
SIMPLE TO OPERATE
NO MARRING, FRACTURING OR DENTING OF WIRES
COMPACT . . . will get into those impossible areas
HARD-CHROME FINISH
A GUARANTEED PRODUCT

Ziptwist used in assembly of numerous aircraft parts mfg. by Hydro-Aire, Inc., Burbank, Calif.

$24.00 each (F.O.B. Burbank)
Manufactured by SAN-FER AERO TOOLS, San Fernando, California
For further information, write to:
EXCLUSIVE SALES AND SERVICE
HERCO PRODUCTS 1311 W. MAGNOLIA BLVD. BURBANK, CALIFORNIA

bridge, or from supply dumps to troop concentrations.

The Tactical Bombing branch works very closely with RADC on the TAC weapons system program. Despite occasional differences of opinion on the best approach, A. Zmeskal, assistant branch chief, says that good progress is being made toward improving the interdiction capabilities of tactical aircraft.

▶ **Disappearing Autopilots**—"Automatic pilots, as such, may cease to exist." This startling statement comes from Col. A. I. Lingard, head of the Automatic Flight Control branch which is responsible for autopilots, stability dampers, and similar devices. At first blush this might indicate that autopilots no longer serve a useful military purpose, but the situation is actually just the reverse.

Automatic pilots have become so important to bombing systems and interceptor fire-control systems that the autopilot is being merged with the bombing or fire control-system and thus losing its individual identity, Lingard explains.

In other cases the autopilot is being merged into the airframe because most highspeed aircraft need stability augmenters (damper systems) to make the plane stable enough for the human pilot to fly.

These stability augmenter systems are essentially autopilots minus heading gyros and attitude gyros, A. J. Longiaru, member of the branch points out.

▶ **Hydraulic Actuator**—Whereas the autopilot and the airplane's boost system formerly used separate actuators to operate the plane's control surfaces, a new hydraulic actuator has been designed which can be operated from either the pilot's stick movement or from electric "autopilot" signals, Longiaru says.

The small console-mounted control station which the human pilot used to introduce airplane maneuvers through the autopilot is giving way to a new type of control (pioneered by Minneapolis-Honeywell) where maneuvers are introduced by moving the airplane's regular control stick or column, Lingard says.

▶ **Techniques Branch** — A recently formed group in the Armament Laboratory is the Techniques branch which seeks out and explores new techniques which could find application in one of the other lab sections. This branch sponsors the development of new devices or sub-systems in the field of radar, infrared, computers, and optics, and evaluates their effectiveness for airborne armament.

This is intended to prove out new techniques before committing them to specific armament systems in the other branches.

DC from AC

the NEW TREND in AIRCRAFT POWER SUPPLY!

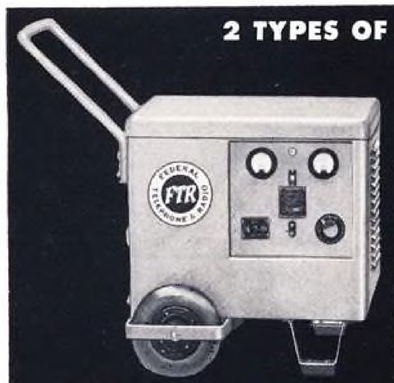
AVIATION'S growing trend from *generated* DC to 400 cycle AC has created a broad need for rugged and reliable power supplies to furnish DC voltages where required.

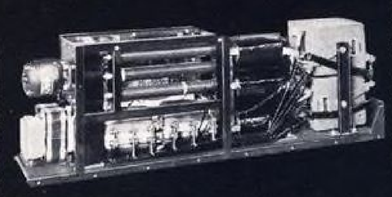
To serve both ground and airborne applications Federal has developed an extensive line of high-quality equipments . . . without expendable parts that require frequent replacement. All are powered by Federal *selenium rectifiers* . . . outstanding for long life and trouble-free service!

The equipments shown here are but a few of the types now available from Federal for a wide range of aircraft applications.

Federal
is ready to meet your requirements with compact, efficient, dependable
SELENIUM RECTIFIER EQUIPMENTS

2 TYPES OF FEDERAL GROUND POWER SUPPLIES





FTR-3438 *Meets MIL-P6905 and applicable portion of BuAer-38A1B9-C.* Output voltage fixed at 30 volts, 200 amps. Adjustable to 26.5 to 31 volts, 200 amps. Input—nominal 200 volt; 400 cycle. No moving parts. Tests show this equipment far surpasses performance of comparable units now in service.

FTR-3181-AS *Used in starting aircraft engines and in servicing.* Converts 208-230 volts, 60 cycles, 3 phase AC power to 28 volts DC with rated current of 130 amps. Requires little attention. In case of overload or short circuit, the circuit breaker will trip. Should the fan fail, the selenium rectifier will start to heat and thermostat contacts will open and trip input breaker. With skids or wheels. Approx. weight is 250 lbs. Also in sizes rated to 400 amps.

EXAMPLES OF FEDERAL AIRBORNE POWER SUPPLIES

FTR-3125-AS
AC Input: 190 to 210 volts; 380 to 420 cycles; 3 phase.
DC Output: 21 amperes; 21 to 32 volts; resistive-inductive load.

FTR-3146-BS
AC Input: 195 to 210 volts; 380 to 420 cycles; 3 phase.
DC Output: 50 amperes; 24 to 31 volts; resistive-inductive load.

FTR-3431-AS
AC Input: 195 to 210 volts; 380 to 420 cycles; 3 phase.
DC Output: 100 amperes; 24 to 31 volts; resistive-inductive load.

Federal's Application Engineering Department is ready to assist you in designing aircraft power supplies to qualify any or all of the following Engineering Tests

UNDER MIL-E-5272
- Salt Spray
- Fungus
- Sand and Dust
- Humidity
- Altitude
- Vibration
- Shock
- Temperature

LET Federal HELP YOU solve your aircraft power supply problems. Get the benefit of the 4 decades of technical experience behind "America's first and largest manufacturer of selenium rectifiers."

For information on equipments or application problems, write Dept. E-1110

Federal Telephone and Radio Company
100 KINGSLAND ROAD, CLIFTON, NEW JERSEY
In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P.Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N. Y.

■ AERO-MEDICINE

Airman Survival Is Aero Med's Big Job

Dayton, Ohio—An aerosol bomb, a tight-fitting nylon suit and a can of rations have one common denominator—survival.

The bomb contains Aeroplast, a new spray-on surgical dressing for treating burns. It can be applied by anyone in minimum time and can save aircrew lives otherwise lost to fires in the air.

The suit is the T-1 partial-pressure protective garment. Already it has saved several extremely valuable test pilots and more than $18 million worth of aircraft they were flying.

The can is part of a survival kit for downed pilots and crew. The kit fits under the seat, and will shelter, feed and arm the crewman.

These are some of the items that are typical of the end product of research and development in aviation medicine, the primary job of the Aero Medical Laboratory.

▶ **Work Defined**—"We're concerned with basic and applied research in the human factors," said Col. Robert H. Blount, Chief of the laboratory at Wright Air Development Center.

"In military language, our mission is twofold:

• "To provide technical information based on scientific research.

• "To carry out the actual development of items of personal equipment.

"In less formal language, our job is to put a man in an airplane and to keep him alive."

How well is that job being done? Is the laboratory abreast of the aircraft performance required for the military tasks of the future?

"I believe we are keeping pace," said Lt. Col. C. C. Cain, who is Chief, Operations and Plans. "In one instance at least, we're ahead of the aircraft design. We try to get at the job about five years ahead of the time it will be needed."

T-1 PRESSURE SUIT is high-altitude emergency garment with automatic operation.

▶ **Way Up High**—Cain told AVIATION WEEK that it was Boeing's big B-29 Superfort that gave the first indications of human factors in aircraft design.

"It was the first plane we had that could go high enough on routine missions to introduce problems," he said.

"It was the first plane designed to provide a degree of comfort and efficiency for the aircrewman on routine missions.

"Temperature and pressurization for crew compartments, as well as improved crew workspace, indicated a realization of the human requirements on the part of the designers of that particular aircraft."

Cain pointed out that the inevitable design compromise is not new to aeromedical specialists. The requirements for high performance generally mean cutting down weight and cross-sectional area, and this makes the aeromedical job tough.

▶ **Information Lacking**—"One place where information is lacking," said Cain, "is on the number of missions during a combat tour where the pilot uses his emergency equipment. Also we don't have enough experience with combat at high altitudes to show the vulnerability of cockpit pressurization.

"Then there's one big problem: Do we make the aircraft and operator a combination to accomplish a mission, or do we want to use safety equipment to rescue the human operator? We don't have the answer to that one."

▶ **Recent Developments**—These are some of the development projects that have come out of Aeromed lab during the past months:

• **Resuscitator of extreme versatility.** This little unit can be connected anywhere that there is a low-power electrical source:

For example, at home, in aircraft, even in a car, where it can be plugged into the cigarette lighter. It produces positive and negative pressure, and will operate at altitude for use in combat or evacuation aircraft.

The unit is about as big as a man's fist and there is no supplemental equipment. Its development won for Henry Seeler the 1952 Thurman H. Bane award of the Institute of the Aeronautical Sciences.

• **Coordinated cockpit arrangement.** As one result of this continuing program, accidental raising of the landing gear on the ground has almost been eliminated. This used to be a prevalent accident because of confusion between flap selector and gear retraction lever.

• **Liquid oxygen converter.** This item rose out of the obvious space saving afforded by using liquid instead of gaseous oxygen. The Type A-3 Liquid Oxygen Converter is now a standard item scheduled for installation in the Republic F-84 series.

• **Minimum simulation for maximum effectiveness.** The high cost of flight simulators—approaching half that of the airplane itself—stems from the amount of simulation worked into the design of the trainers. But in some cases too much simulation has been found to reduce effectiveness in training.

One of the current jobs of Aeromed is to figure just how much simulation is necessary—or in other words, where is the point of diminishing return?

• **New anti-G suits.** There have been two new types of anti-G suits developed which raise the protection level about 3G above average tolerance, to an over-all level approaching 7G. One byproduct: G protection now approaches the values obtained by prone flight and poses the question of the practical value of the prone position in the plane from a physiological viewpoint.

Drag reduction requirements of supersonic flight may still necessitate flush cockpits, forcing use of the prone pilot position.

• **New inflight meals.** Aluminum foil packs are the basic idea behind a new scheme for inflight feeding of bomber and transport crews. A minimum of inflight preparation and expense can produce freshly cooked, nutritious meals.

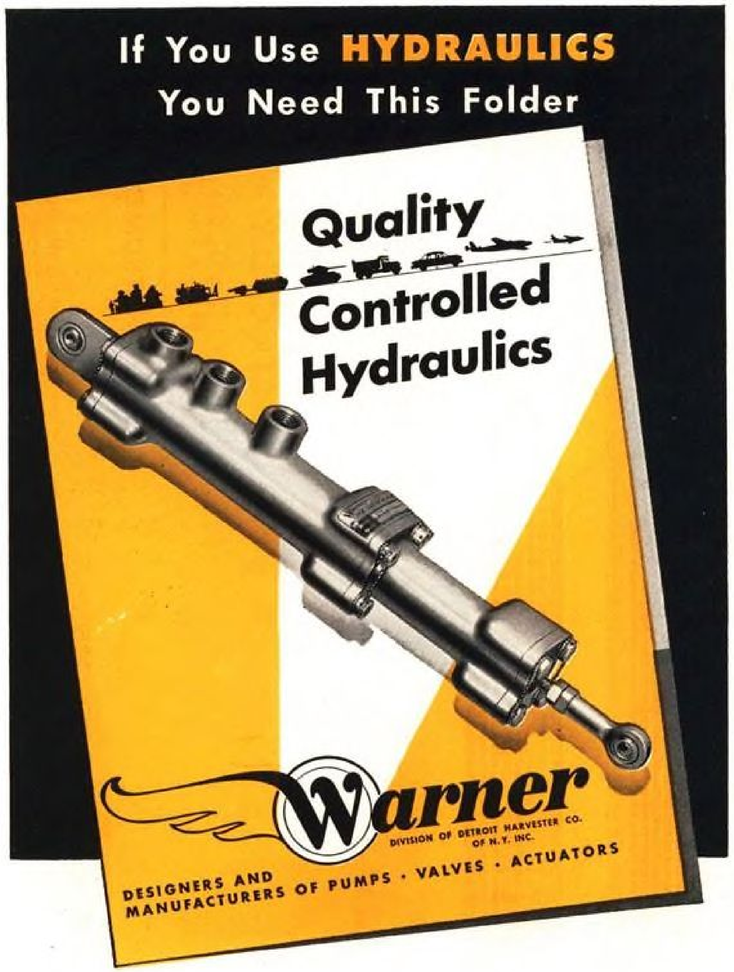
Part of the same program is a new galley developed for MATS. It can be loaded aboard the aircraft by a lift truck, and comes in modular units so that several can be stored easily in a large plane. Service from the unit is expected to consist of sandwiches, soups and beverages.

• **Human Engineering Guide.** This is a document for designers where all available human engineering data will be assembled. The first complete volume is expected to be out in 1955, with portions available before then.

• **Handbook of Acoustic Noise Control.** This report is a general approach to the problem of noise, and gives contractors the best current methods for coping with the noise levels of new powerplants.

The scope of this work extends from design handbooks and reports to tangible hardware and food. Of all the survival projects that have gone through the lab, perhaps the most exciting to laymen would be the development of Aeroplast. To pilots and engineers, the protective clothing—typified by the

If You Use **HYDRAULICS**
You Need This Folder



Warner's Extension Power Brake Valve, shown above, has an exclusive hydraulic feed-back feature to give the pilot immediate warning in event of hydraulic system failure. This compact, lightweight, space-saving valve is adaptable to a wide range of system and brake pressures.

Warner is qualified by experience and facilities for the design and production of critical hydraulic equipment for a wide range of uses. Warner engineers will welcome an opportunity to assist you in the development of special hydraulic equipment to meet your particular requirements.

Write for your copy of the illustrated folder shown above describing typical examples of Warner precision hydraulic equipment.

Warner DIVISION OF DETROIT HARVESTER CO. OF N.Y. INC.
21535 GROESBECK HIGHWAY • P.O. BOX 3886 • DETROIT 5, MICHIGAN
DESIGNERS AND MANUFACTURERS OF PUMPS • VALVES • ACTUATORS

■ AERO-MEDICINE

T-1, V-3 and G-suits—would probably be most interesting.

Here are detailed descriptions of these projects.

Aeroplast

Almost anyone can use an Aeroplast bomb. That is what sets it apart as a dressing for burns. The container has a thumb valve on top that sprays the burned area with a thin layer of plastic. That is the complete treatment.

The implications of such a dressing are enormous. In civil defense, for example, one of the chief worries is that there will not be enough bandage available to cover the hundreds of thousands of burn cases expected from atomic explosions.

▶ **Five-Minute Job**—But a 50% body burn—one in which half the skin has been seared—can be completely dressed by two medical corpsmen in five minutes, using four Aeroplast bombs. Compare that with the doctor and nurse, two and one-half pounds of ointment, 120 yards of bandages and the hour or more required to treat the same burn by the current bandage technique.

Burns aren't the only type of injury that can be treated. Clinical tests were made of Aeroplast in Bellevue Hospital, New York, on skin-graft donor sites, operative wounds and lacerations as well as first- to third-degree burns. In most cases Aeroplast proved itself equal or superior to usual forms of dressings.

▶ **Development**—Aeroplast is the brainchild of Capt. Daniel S. J. Choy. He began work in August 1951, developed the dressing, tested it, and wrote his final report by December 1952.

The material is elastic and flexible, waterproof and permeable to water vapor. It peels off easily, and does not leave the skin wrinkled or puckered.

It is inflammable; its base is chemically inert, but the solvent can be toxic in large concentrations. Only one out of a thousand control subjects showed any reaction to a patch test on the shaved forearm. In contrast, about 20% of the control group showed mild to severe reaction to the normal adhesive bandages used to cover the patch.

▶ **Bellevue Experience**—In any medical development, clinical testing is the final answer. Bellevue Hospital in New York used Aeroplast on a variety of cases, and it is worth citing a couple.

One patient was treated for first- and second-degree flash burns of the face, neck, trunk and arms. All the burns, except those on the face, were sprayed with Aeroplast. There was almost immediate relief of pain where the dressing had touched, but the facial burns remained painful. First-degree

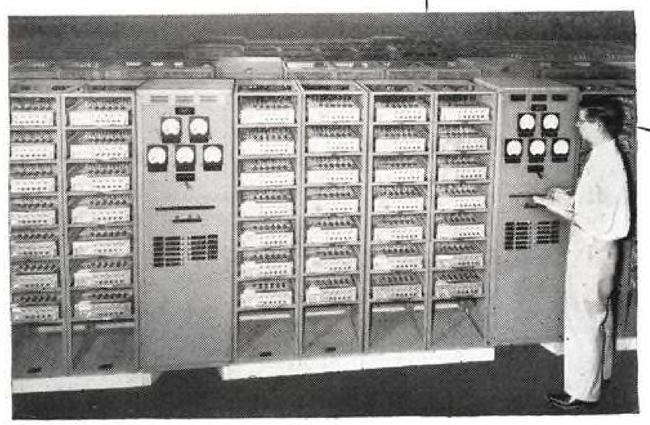
"United Press Photo"

But
...without Reliable Electronics it would have been an Abort!

. . . and Reliability in electronics can result only from excellence in design, manufacture, inspection, and testing methods.

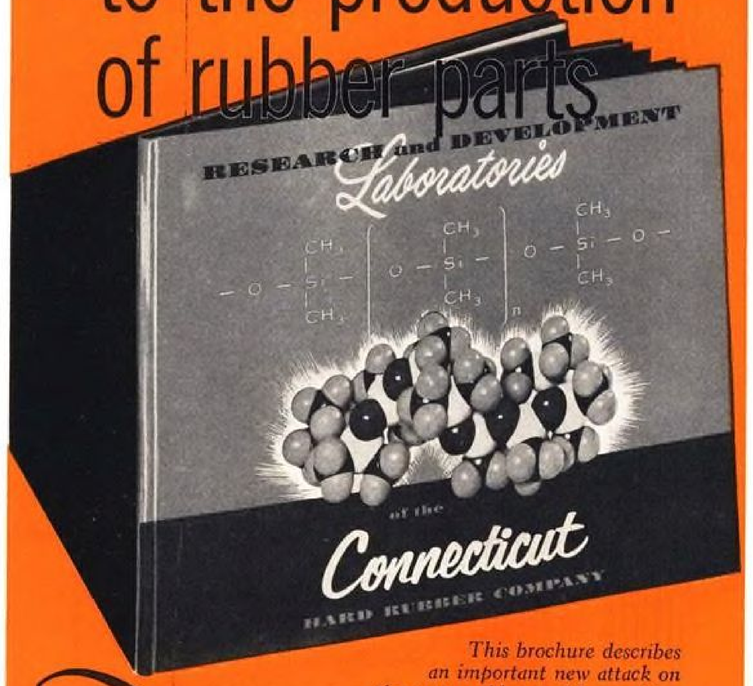
The DuKane Corporation maintains a vacuum tube "proving ground" which provides a constant flow of tubes for the assembly lines of one airborne project at their plant. This "proving ground" constantly ages 10,000 tubes by a process of simultaneous vibration and full power operation before they are subjected to a close-limits inspection. This is only one way DuKane assures greater "Reliability" in electronics.

If your service has a classified project or a prime contractor has a project where electronic "Reliability" is the number one factor, take advantage of DuKane's thirty years of experience and established manufacturing facilities. Let our technical men discuss it with you.



DUKANE
CORPORATION
ESTABLISHED AS "OPERADIO" 1922
ST. CHARLES, ILLINOIS

a new approach to the production of rubber parts



This brochure describes an important new attack on the many rubber problems arising in the aircraft industry.

THE CONNECTICUT HARD RUBBER CO. is a development organization, with more than one-quarter of its personnel engaged in technical work. This staff has solved many important problems in the rubber and elastomer fields and continues to do so daily. Some of this work is done on a research contract basis. Our achievements in this direction have earned the company an outstanding reputation.

The development skills and know-how gained through this research work are available for the solution of commercial problems and for the production of difficult rubber pieces on a quantity basis.

A copy of this brochure will be sent upon request.

COHRLASTIC
414 EAST STREET
NEW HAVEN, CONNECTICUT

PRODUCT OF THE
Connecticut
HARD RUBBER COMPANY

■ AERO-MEDICINE

burns were completely healed in six days.

Another patient had second-degree burns of fingers and hands from a gasoline fire. After spraying, he was encouraged to use his hands. He did, so vigorously that the plastic glove had to be retouched at the finger pads and web spaces. In 10 days, both hands were healed.

Current status of Aeroplast is one of waiting; it must qualify under the Pure Food and Drug Law, but this step is regarded as merely a matter of course by Aero Medical people. Following that, the plan is to make the dressing available to pharmaceutical houses for production to meet the needs of hospitals, the services and civil defense.

Pressure Suits

Valuable aircraft and more valuable pilots have been saved because of the pressure suit, developed after almost a decade of continuous work by the Aero Medical lab and universities.

"It's an emergency garment with automatic operation when cabin pressure fails," said Dr. Wayland Hull, physiologist with the lab. "It gives the pilot a strong second skin and—by mechanical pressure—supports his musculature and maintains normal circulation."

▶**X-1 Started It**—The first high-altitude flights of the Bell X-1 touched off the need for the suit. Experimental units were borrowed from the lab for the flights, and the pilots, with some misgivings and some griping, wore them.

One day Lt. Col. Frank K. Everest was blasting along in the X-1 when his suit suddenly inflated. The cabin had been losing pressure steadily through a slow leak. When the cabin altitude reached something more than 40,000 ft., the suit inflated automatically. Everest was suddenly uncomfortable and somewhat inconvenienced, but he was alive. That convinced him, and similar incidents have made other pilots staunch believers in the suit.

▶**Air Force Users**—Today more than 250 AF personnel are wearing one of two models of the suit.

• **Tactical and test pilots** get the T-1 suit, a combination of the emergency partial-pressure garment and a G-suit.

• **Strategic crews** get an S-2 suit, which doesn't have the G protection—you don't pull many in maneuvering a big bomber.

The suits, originally custom tailored, are now available in a variety of sizes that will handle any Air Force pilot or crewman of normal build. A sergeant issues the suit, and makes initial

TOO LATE TO HIDE . . . from a RELIABLE missile

ACCURATE CONTROL IS A MUST IN GUIDING THE MISSILE, *BUT . . .*
WILL CONTROL FAIL IN THESE LAST TWO SECONDS?

Hundreds of test hours become worthless should a component fail at this critical moment. A major source of last-minute failure is the unpredictable jamming of a hydraulic control valve by just a single particle of dirt.

Now, Sanders Associates, Inc. offers a hydraulic valve that is accurate . . . *and reliable*. Utilizing a unique form of mechanical feedback, this new valve creates forces as high as 500 pounds to break free any jamming particles. Interfering metal chips are literally chopped up. Here is a self-clearing valve that operates without oil filters, even with dirt, sludge and metal particles in the hydraulic fluid supply . . . *this is reliability* . . . "built-in" reliability.

Sanders Associates, Inc. is active in complex research and development programs where new concepts of accuracy and reliability are essential. Typical of the product development under such programs is this two-stage hydraulic servo valve . . . a key component in guided missiles, fire control, auto-pilots, automatic machine control and other applications where the transfer from electrical to hydraulic energy *must* be both accurate and reliable.

Address inquiries to Dept. 40-AW.

SANDERS ASSOCIATES
INCORPORATED

137 CANAL STREET
NASHUA, NEW HAMPSHIRE
TELEPHONE: NASHUA 5570

RELIABILITY IN ELECTRONICS

■ AERO-MEDICINE

adjustment of the many tapes which gives the final contours. Under pressure, an airman can't stand up straight, because the suit is adjusted to seated posture.

Leg and arm contours are distorted by external capstan tubes which run the length of the limbs. Tapes around these tubes tie in to the material of the suit. These tapes tighten the suit and apply pressure to the skin.

▶ **For Emergencies**—Normally nothing happens in the suit, said Dr. Hull; you don't need it unless there is an emergency at altitudes beginning somewhere above the 40,000-ft. level. The suit regulator is set to fire at 43,000 ft; when it goes off, it sends oxygen—from a bottle worn on the right side of the back next to the chute—through the capstan tubes and also into the helmet.

Under pressure, the capstan tubes expand and draw the tapes tight; that pressurizes your skin, and you're safe. There is a manual operator, just in case the automatic regulator doesn't work.

Next step is to fly the plane down to a safe altitude, disconnect the bottle and come home. If the plane is shot up or otherwise not worth taking back, you bail out in the prescribed way.

The suit holds pressure, the bottle contains about 10 minutes worth of oxygen for breathing and operation, and you can get all the way to the ground in that amount of time from any current altitude.

▶ **Development**—Many years of development work have been summed up in the T-1 and S-2 suits. Most of the early suit proposals were built around the full-pressure scheme of the diver's suit. Wiley Post had such a garment and an RAF officer wore one to set a world's altitude record in the 1930s.

Work on what was to be the T-1 suit started in 1943 and was greatly accelerated by the Air Materiel Command in 1946 as the flights of the X-airplanes began.

Dr. Harold Lamport of Yale University was working with a scheme for exerting pressures in a G-suit, using inflatable tubes with tension tapes to pull fabric tight. Dr. James Henry of Aero Medical had the idea of applying that system to pressurization of the whole body, and in 1946 delivered the first partial-pressure suit to the Air Force.

Since then the suit has changed very little, although work continues on the development of an adequate helmet. In 1949 Air Force decided to standardize the suit, and in May this year, the last stages of that program were completed.

▶ **Two Pressures**—Although pressure is applied mechanically to the arms, legs and torso, the head and chest are pressurized pneumatically by pressure breathing, Hull explained. This is the reverse of normal breathing where exertion is used to inhale and the diaphragm relaxed to exhale. In pressure breathing, the oxygen is forced into the lungs as the airman relaxes, and exhaling is done forcibly.

Under pressure, the suit is uncomfortable; but at an outside altitude of 40,000 ft., a pilot under pressure can squat, climb or touch the back of his head. At 50,000 ft. outside altitude, there is little inconvenience; the body reacts about as it does in free air at 10,000 ft.

The hands and feet, not covered by the suit, will swell if not protected. Special shoes and gloves are available to handle this situation.

V-3 Exposure Suit

Arctic exposure or the torrid cockpits of supersonic planes will not make any difference to a pilot wearing a V-3 suit. It is an air conditioned anti-ex-

SERVING . . . Industry, Commerce, Transportation

Our satisfied list of customers include . . . RCA · Ford · Chrysler · General Motors · Sikorsky Aircraft · Hamilton Standard · Pratt & Whitney · Republic Aviation · Kaman Aircraft · Fuller Brush · General Electric · Dodge and many others.

kc

1 ELECTRONICS
2 COMMUNICATIONS
3 INSTRUMENTATION
4 HYDRAULICS
5 PNEUMATICS
6 TEST EQUIPMENT

Kahn and Company, Inc.
541 WINDSOR STREET • HARTFORD 1, CONN.

Send for folder KC-100 for complete list of products, engineering and development facilities.

NOW IN STANDARD PRODUCTION . . .

Test equipment for: turboprops, propellers, propeller synchronizers, anti-icing equipment, feathering devices, electronic jet fuel control, fuel pumps, generators, and high pressure air and pneumatic systems—as well as engine R. P. M. control switches, resistance bridges, precision frequency oscillators, solenoid coils, filter boxes, and D. C. power supplies.

*The Helostama Temmincki

Proper Connections Are Important

- PORTABLE EQUIPMENT
- INSTRUMENTATION
- COMMUNICATION
- TEST APPARATUS
- AIRCRAFT

*The Helostama Temmincki, or Kissing Gourami has definitely made some sort of connection. This type of connection can only be determined by experts in the field of Ichthyology.

However, when dealing with connectors or connections for Electronic application, only an expert in that field can design and produce the proper connection for your specific need.

USC's complete engineering, tooling and production facilities are geared to produce quality connectors, allied components and assemblies.

Over 25 years experience is at your service

Assemblies custom engineered and produced to your exacting requirements.

USC

U. S. COMPONENTS, Inc.
Associated with U. S. Tool and Mfg. Co., Inc.
454-462 East 148th Street, New York 55, N. Y. CYpress 2-6525-6

FOR LIGHT GAUGE WELDING

miller

SELENIUM RECTIFIER TYPE D. C ARC WELDERS

3 MODELS

The new MILLER SR Welders offer wide current ranges for all types of welding, from the thinnest gauge aircraft welding to the maximum capacity of each welder. Select one of the following with standard current ranges as shown:

SR-200	3 AMPERES TO 300 AMPERES
SR-300	3 AMPERES TO 400 AMPERES
SR-400	3 AMPERES TO 525 AMPERES

Hand or foot remote control units permit crater elimination and micrometer amperage selection. New, conveniently located range selector switch and dual "unitized" current controls simplify your welding problems. Newly designed polarity reversal switch gives the operator instantaneous polarity selection.

Why not get the complete story on the new SR Welders—today!

See your MILLER distributor.

ARC SPOT miller GENERATORS WELDERS

miller ELECTRIC MANUFACTURING CO.

SINCE 1929

APPLETON • WISCONSIN

Speaking of Tube Bendings . . .

KELLETT

The oldest name in Rotary Wing Aircraft

has established an unbeatable performance record on troublesome machined, bent, brazed and welded tube assemblies . . . Entrust your problems to our *Engineering Abilities* and *Sub-Assembly Precision Part Production Know-how.*

since 1929

KELLETT Aircraft CORP

Central Airport, Camden 1, N. J.

Phone: Merchantville 8-4800

Three engines can be safety wired with

ROBINSON WIRE TWISTERS

in less time than it takes to do one by any other method

Saves up to $140 per engine*

with split-second twisting action. 3 tools in 1 – pliers, cutters, twisters. Two sizes – 12" and 9". Now used by Army, Navy, Air Force, Pratt & Whitney, GE, TWA and hundreds of others. *Satisfaction guaranteed.* $19.50 each. $18.50 ea. in dozens. FOB, Sacramento, Calif.

**Sure, we have proof! Write for detailed report.*

RALPH C. ROBINSON CO.
Dept. AW6
BOX 494, NORTH SACRAMENTO 15, CALIF.

■ AERO-MEDICINE

posure suit that protects him during immersion in anything from icy water to hot cabin air. It is completely ventilated inside and uses high-efficiency insulation.

Full Protection—With the V-3 suit, the pilot is fully protected against:

- **Low temperatures to −70F.**
- **Cold water immersion.**
- **Arctic exposure to −50F.**
- **High cabin air temperature to 160F.**
- **Cabin wall heat radiation to 350F.**

Explanations—How the suit is made and how it works were explained by John Hall, Jr., of the lab's physiology branch.

There are two pieces to put on—a spacer garment and an outer shell. The spacer is made of Saran plastic woven into a loose netting. It mounts ventilating tubes which run out along legs and arms, and distribute air on the basis of half the mass flow to the legs, and the other half divided between the arms and trunk, Hall pointed out.

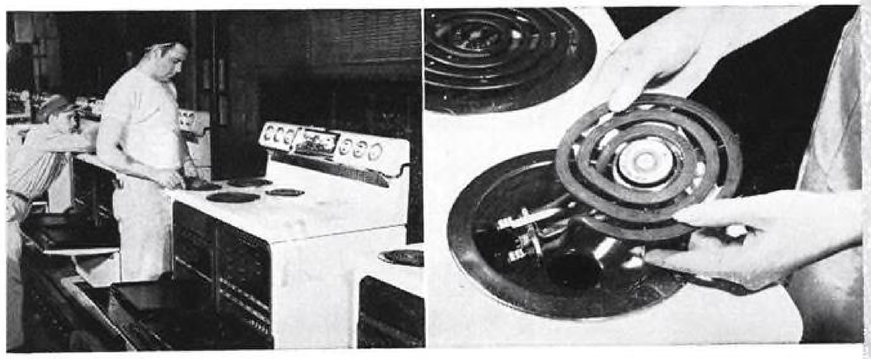
Over the spacer suit the pilot wears an impermeable outer shell which is basically the Navy's Mk. 4 exposure suit. This shell is lined with one-quarter-inch-thick wool pile insulation between waterproof layers of material. You get into it through a cloth trunk which sprouts out of the neck; then you tuck in the trunk and zip up.

▶ **Valve Arrangement**—The suit is bespangled with circular valves that are

V-3 Suit Spacer Garment

SILASTIC helps Westinghouse score another FIRST . . .*

"COOKING without LOOKING"



Engineers have been working for years to make a heat control system for electric range surface units that would forever banish pot watching. But it took Westinghouse, using a bit of Silastic, a thermistor, and a few relays and vacuum tubes, to perfect the "Electronic Eye." This heat control system regulates the temperature so accurately that food can be warmed, boiled or fried without danger of burning or scorching—even if all the water is boiled away.

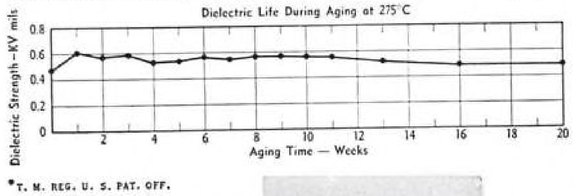
The heart of the temperature measuring device, the thermistor, is embedded in Silastic paste for protection and heat transfer. Flexible Silastic insulated cable is used to connect the thermistor to the exterior wiring, and the Electronic Eye itself is isolated in the center of a flexible Silastic diaphragm. The Silastic components have stood up under exposure to boiling water, oil, grease, coffee and syrup, as well as accelerated life testing equivalent to 15 years of actual service.

Performance proves...

SILASTIC works

where other materials fail!

Many of the most able designers, like those Westinghouse men who made automatic cooking a practical reality, save time and money by trying Silastic first when they need rubbery properties at temperatures far above or below the limits of any ordinary rubber. And exceptional stability at both high and low temperatures is combined in Silastic with excellent resistance to outdoor weathering and good resistance to a variety of hot oils and chemicals. Further proof of the inherent stability of Silastic is given in this small graph showing the effect of aging at 275°C (527°F) on the dielectric strength of Silastic.



Dielectric strength measured with ¼ inch electrodes in air on two layers of Silastic R Tape, for example, average 0.475 KV per mil. After 20 weeks of continuous aging at 275°C with both surfaces exposed in an air circulating oven, dielectric strength gradually decreased from a high of 0.601 to 0.485 KV per mil.

That's the kind of performance that makes Silastic, the Dow Corning silicone rubber, unique among all rubbery materials. When you need rubbery properties at temperatures above 150°F or below −40°F, or excellent dielectric properties in a resilient and flexible material ***specify Silastic.***

*T. M. REG. U. S. PAT. OFF.

ATLANTA
CHICAGO
CLEVELAND
DALLAS
LOS ANGELES
NEW YORK
WASHINGTON, D. C.
(Silver Spring, Md.)

first in silicones

DOW CORNING CORPORATION
Midland, Michigan

Canada: Fiberglas Canada Ltd., Toronto • England: Midland Silicones Ltd., London

MAIL COUPON TODAY FOR DATA ON THE PROPERTIES, PERFORMANCE AND APPLICATIONS OF SILASTIC.

DOW CORNING CORPORATION, Dept. D-8A, Midland, Michigan

Please send me:

- ☐ Silastic Facts 10a, properties and applications of Silastic stocks and pastes.
- ☐ List of Silastic Fabricators.
- ☐ "What's A Silicone?", your new 32-page booklet on silicone products and applications.

Name _____ Title _____

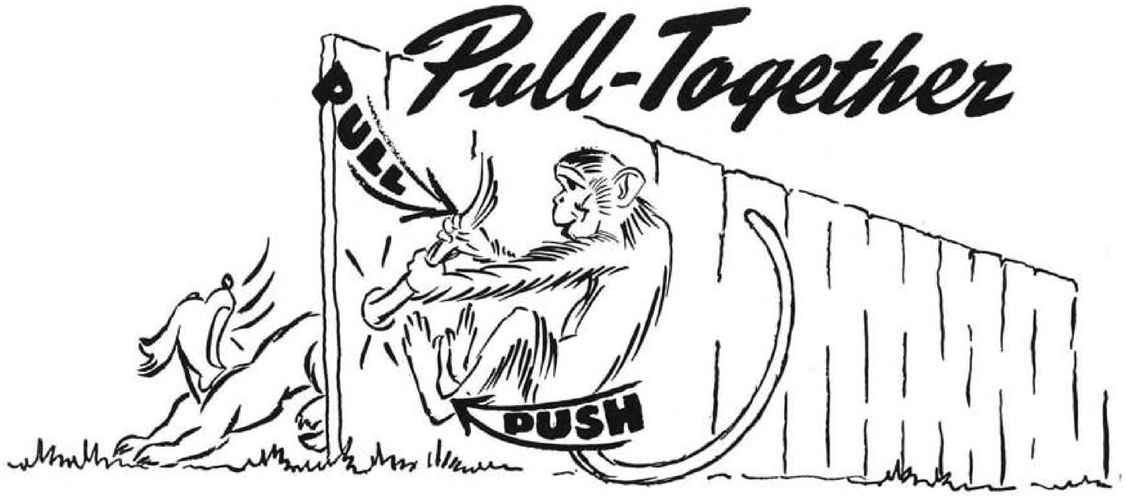
Company _____

Address _____

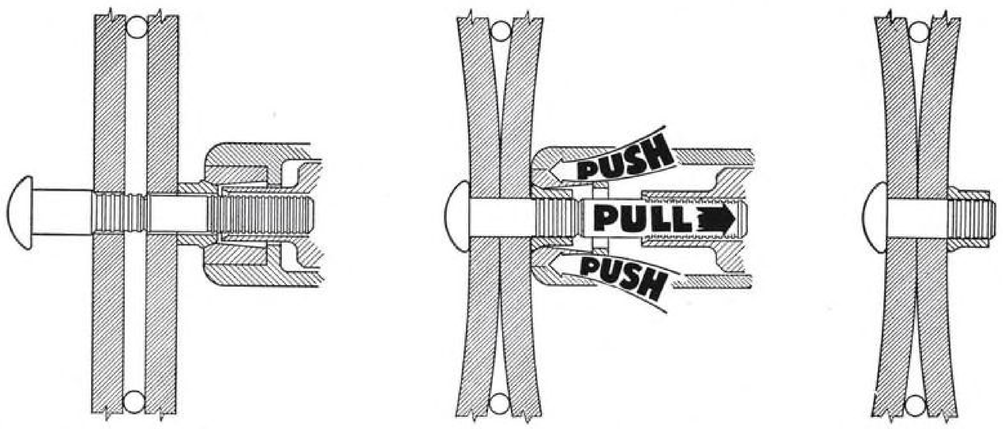
City _____ Zone _____ State _____

Huck Lockbolt* Principle

INSURES POSITIVE *Pull-Together*



HERE IS HOW *Huck* LOCKBOLTS* PULL TWO PIECES OF WORK TOGETHER



Insert Lockbolt* pin from one side of work. Slide locking collar over pin tail from opposite side of work. Attach driving tool to pin tail.

Pull trigger and tool automatically pulls on pin, pushes on collar, causes Lockbolt pin to fill hole, pulls work together, swages collar, breaks off pin tail and ejects tool.

Result: A positive locked fastener with high tensile preload; a non-deflecting joint that is uniformly tight; also a faster, easier and simpler installation.

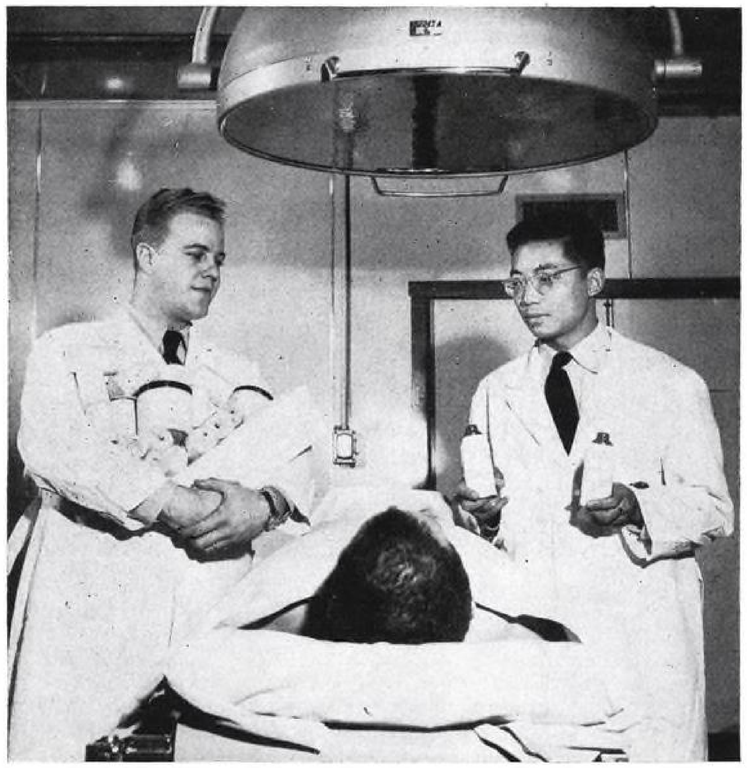
Form 8-152

**Manufactured under U. S. patents, other patents pending*

Complete literature on Huck fasteners is available on request to:

Huck MANUFACTURING COMPANY
DETROIT, MICH.

CALIFORNIA REPRESENTATIVE: M. A. MINER & ASSOCIATES, 3808 W. 54th St., Los Angeles, California. Phone AXminster 3-8208



TWO AEROPLAST BOMBS contrast with armload of dressings to cover same burned area.

normally open. But if the pilot sees himself headed for the water he pulls a wire which closes all the breather valves and seals them against water pressure. This arrangement is to be replaced by a refined valve that will be balanced to close and open under air loads and stay closed in water.

The suit can be worn on the ground if you're willing to go through a calisthenic routine to make the suit act like a bellows and keep you ventilated. For normal operation in an airplane, the suit can be hooked up to cabin air; this will work with high cabin air temperature because evaporative cooling can be comfortable.

Ventilation can also be provided by a small (28-cfm.) blower. If excessive temperatures plague pilots during the next decade, an expansion turbine should provide the answer.

Anti-G Suit

An anti-G suit is a way to fool the heart. The mechanism of this trickery has not been fully understood. Dr. O. H. Gauer, Dr. J. P. Henry and their group of Aero Medical's biophysics branch, recently have evolved some new ideas on the operation of the anti-G suit.

▶ **Different Aim**—This new approach was not the original aim of Dr. Gauer. He was interested in a program of basic research on blood distribution in animals, part of his studies on the circulatory system in general.

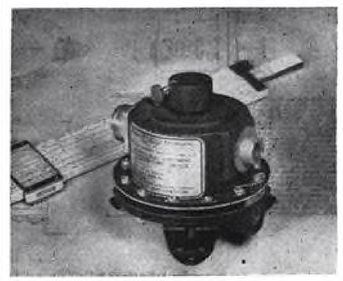
Key to the knowledge of suit operation was a tiny instrument with which Gauer and his associates were able to measure—for the first time—the extremely low pressures in the veins. The instrument is a tiny manometer and transducer complete in a capsule not much larger than the top of a retractible ball-point pen.

Earlier instruments used a pressure-sensing element inside the veins, then ran manometer tubes out through the skin to a remote indicator. The trouble was that the pressures which had to be measured by this system were of the same magnitude as the errors in measurement.

But the instrumentation developed for Gauer measures pressure and converts it to an electrical signal in the capsule itself, and there are no pressure losses to cope with as there would be in long lines.

▶ **G-Suit Action**—In order to maintain the supply of blood to the brain under conditions of increased gravity load, the output pressure of the heart has to be increased. With a G-suit, you mechanically compress the legs and the lower abdomen.

The general explanation of the suit action has been that this compression



A new pressure switch with dual control for low pressure operation has been designed and developed to meet Specifications MIL-E-5272. The internal controls of the switch can be set to any predetermined valve from 5″ H_2O to 10 p.s.i. for control to either a linear or non-linear characteristics. The minimum spread between operate and return of either control is 1.5 inches H_2O.

The dual switch is capable of operation at an extremely low temperature of −80°F and at a high temperature of +180°F with a minimum degree of temperature drift.

The switch has a light weight of 22 oz. with an over all height of 4 inches. The mounting is achieved by three bolts on a 4-⅝ inch dia. bolt circle.

For additional information write

"AIRCON ENGINEERING"

DIVISION OF
Aeronautical Machinists,
386 Mountain Grove Street,
Bridgeport 5, Connecticut.

BIG NEWS!

Both *Inch-Pound* and *Foot-Pound* Models of Amazing PROTO Torquer Now Available!

Announced in January! Over 30,000 bought by March 31!! That's the whirlwind success story of the sensational PROTO torque-*limiting* wrench. In addition to foot-pound models, you can now buy *inch-pound* styles with all of the features that made the Torquer famous overnight. Thousands of jobs can now be handled with the various inch-pound and foot-pound capacities, different drive sizes and plain or ratchet head styles available. Whether used for repair, assembly, inspection or installation work, the super-fast Torquer pays for itself in time saved. Buy the model you prefer from your PROTO dealer today! Send 10¢ for 68-page catalog of entire line to

PLOMB TOOL COMPANY

2221Z Santa Fe Avenue, Los Angeles 54, Calif.

Fastest Torquer in the World!

* Automatic Torque-Limiting Release
* NO Dials, Scales or Pointers to Watch or Break
* Ratchet Head Models Save Time
* Use in Dark, Noisy or "Blind" Locations
* Enclosed Precision Spring and Accurate Micrometer-Type Adjustment
* All-Steel Trouble-Free Construction

5383

PROTO TOOLS

PROTO means PROfessional TOols

Eastern Factory—Jamestown, N.Y.
Canadian Factory—London, Ont.

tends to throttle portions of the arterial system and force the pressure to rise in other portions to feed the brain. This view is based on the tacit assumption that the heart is a constant-volume pump.

► **Effect of Throttling**—Test have shown that the heart is a constant-pressure device; so if you throttle the system, Gauer says, the heart cuts down the output and there is no gain. What actually appears to happen is that by compression of legs and guts, pressure is raised on the input side of the pump—behind the left ventricle—and the heart adds its normal pressure rise to the inlet pressure provided by compression.

The result is an outlet pressure sufficient to raise the blood to the head under high G.

The extra blood from the compressed portions is pushed up through the veins and adds to the venous pressure. Extra volume of blood is stored in the lungs—a series of chest X-rays show this fact clearly.

The volume distribution of blood in the body is such that you cannot raise G protection indefinitely—there is a limit currently at 3G above the normal tolerance of 4G. There is also a limit to the amount of blood that can be squeezed into the lungs, and that amount is not enough to cause any damage.

"This idea and work is one place where basic research has paid off," said one of the group's superiors. "It was based on curiosity on how animals distribute the blood through their systems. Now we know how to design better G-suits."

Organization

Six branches perform the mission of the lab and support Wright Air Development Center in its over-all job. Here is the task breakdown for the branches:

• **Biophysics.** Study of flight acceleration affects, body-to-cockpit dimensional relationships, escape techniques and effects of noise and vibration.

• **Clothing.** Design, development and standardization of all flights, functional and uniform clothing, some types of personal equipment and all restraining devices, establishment of material requirements for clothing.

• **Engineering and development.** Design and development of oxygen masks and regulators, resuscitation equipment, survival kits, life rafts, medical and sanitation equipment, safety harnesses and the like.

• **Physiology.** Response of humans to heat, cold, humidity, radiation, explosive decompression, study of vision, inflight and survival rations, and toxicology.

V-3 SHELL is modified exposure suit.

• **Psychology.** Human engineering directed to improving the design of AF equipment for better operation, location, design and arrangement of instruments and controls, response tests and color for interiors.

• **Service.** Design; drafting spec preparation; release, editing and distribution of reports; photographic work; maintenance and operation of the laboratory animal pens, and of air conditioning, refrigeration and altitude chamber facilities.

The end product of these six branches is generally a technical report, sent out to the contractors who require the particular information.

Facilities

As it stands today, the Aero-medical lab calls seven buildings its permanent home, and lives in seven other barracks-type buildings and some space on loan from equipment lab. Current floor space totals 77,328 sq. ft.

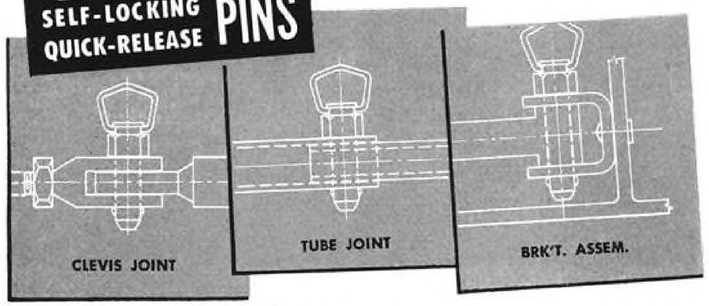
► **New Housing**—New buildings are either under construction or have been budgeted or proposed. Building 33, the newest lab building, is now being topped with a third floor to add 6,700 sq. ft. A high-altitude building is also under construction. In final design stage are a new engineering building and an addition to the main building. A bio-acoustics facility is in the 1954 fiscal year budget request, and a clothing building will be sought later.

If all these buildings are approved, the lab's total space will be more than doubled to a total of 177,983 sq. ft.

► **Man vs. Machine**—Testing of humans is somewhat different from testing a

pip SELF-LOCKING QUICK-RELEASE PINS

the *One Unit* answer for every IMPORTANT LOCK-PIN PROBLEM!



FAST • ECONOMICAL • DEPENDABLE IN BLIND OR OPEN APPLICATIONS!

The patented push-to-insert, pull-to-remove principle of PIP double acting pins provides quick release and positive self-locking safety in a single unit. No cotter pins, nuts, bolts or other separate retaining items or assembly tools are required or need enter into your design specifications! PIP pins offer faster assembly speed, versatility and economy and are available in most diameters and lengths to usual bolt standards or can be manufactured to your specifications. Write for PIP details today!

an accepted part in industrial, military and aircraft designs

AVIATION DEVELOPMENTS, INC. PIP 210 NORTH FRONT STREET • BURBANK, CALIFORNIA

AVIATION DEVELOPMENTS (CANADA), LTD., TORONTO • AVIATION DEVELOPMENTS, LTD., LONDON, ENGLAND

INSERTS DESIGNED BY SPECIALISTS

Series SR Studs

—CAST-IN—
Series NP "Nico-Lok" Self-Locking Replaceable

—CAST-IN—
Series NN Self-Locking

—INSTALLED—
Series NAR Regular & Self-Locking

—CAST-IN—
Series RNB Replaceable

DO A BETTER JOB...

When the job calls for threaded inserts, there is one *right* answer... Newton* Threaded Steel Inserts and Studs. Designed by men who are specialists in the field, produced in a factory devoted to the manufacture of the world's finest fasteners, Newton Regular and Self-Locking Inserts and Studs are built to give longer, stronger service, lower cost and with a minimum of installation time. No matter what your application problem may be, a Newton Engineer is ready to assist you. Write today for information on the full line of Newton cast-in and installed type Inserts and Studs.

*Patents Pending

Newton Inserts and Studs are specified for practically all modern aircraft and in missiles, rockets, gyros, radar and jettisonable tanks.

1321 EAST 17TH STREET
LOS ANGELES 21
CALIFORNIA

Newton Insert Company

Save Draftsmen's Time

YOUR TYPIST CAN DO THE JOB BETTER

The Vari-Typer lettering machine is the fastest and most economical method of lettering specifications on tracings and drawings. It is four to five times faster than hand lettering and is operated by an office typist. Every letter and figure is uniformly clear and distinct. Instantly changeable type, with hundreds of different styles to choose from in sizes ranging from 6 point to 18 point. Write today for information.

Vari-Typer

Lettering Machine

Body copy produced on DSJ Model. Headlines photo-composed on the Headliner.

RALPH C. COXHEAD CORP.
720 Frelinghuysen Avenue,
Newark 5, N.J.

Please send Vari-Typer Book 197

NAME.....
COMPANY.....
ADDRESS.....
CITY.....ZONE...STATE...

RADAR CABLE ASSEMBLY

Now Available—

Approved Electronic Products

• Z & W Machine Products, Inc. offers you a government approved, reliable source for the components shown, as well as many other items of electronic nature.

•

We also have available complete engineering and manufacturing facilities for research and development of antennas and control devices.

•

Z & W has the manufacturing—production—and testing facilities for all types of precision assemblies.

← ALTIMETER ANTENNA

COMMUNICATION ANTENNA

Z&W MACHINE PRODUCTS, INC.

strip of stainless steel. The testing machine has to be big enough to contain the subject and the equipment he is trying to operate or wear. Consequently, Aeromed-lab facilities are big.

The centrifuge, for example, is housed in a circular room more than 60 ft. across. It is made up of a pair of 48-ft.-long steel booms that carry a free-swinging cab between them 20 ft. from the spin axis. Electric motors drive this carousel up to about 52 rpm. maximum —this would produce about 21G at the cab.

Temperature in the cab can be controlled between 70F and 120F, and about 400 lb. net is the load limit.

Another man-whirler is the spin table, an 8-ft.-dia. horizontal centrifuge. It is being used to study the effects of tumbling, the violent and unpredictable motion that occurs when a pilot ejects into the highspeed slipstream. Volunteers have been whipped around up to 100 rpm. while lying on their right sides with the body in a seated attitude.

► **Ejection Tests**—Upward and downward ejection seat towers are another type of special test facilities used. For upward ejection the test track rises 100 ft. into the air, and the seat is stopped by gravity. There are seven safety devices which work on three different principles to retain the seat. Top speed—determined by the charge used to hurl the subject aloft—won't exceed 60 fps. Acceleration peak is about 15G, with a rate of change of acceleration (now called "jolt") of about 150G per second.

Riding the seat downward is somewhat different. The seat is mounted 35 ft. off the floor, and after ejection, roars into a curved section of track that guides the seat to a horizontal stop on a track section on the floor.

► **For New Heights**—An altitude chamber was the first test facility at the lab, and since the early days, chambers have been added and modified to keep pace with the drive to higher and higher reaches.

Col. R. L. Blount
Chief, Aero-Medical Lab

Latest of these arrangements uses a group of three interconnecting small rooms tied to a large 20-man unit. The three chambers comprise a four-man, 225-cu. ft. chamber, an air lock, and a capsule with 60 cu. ft. capacity.

• **The four-man chamber** has an altitude capacity of 65,000 ft., and climb to altitude can be simulated at conventional rates, or by explosive decompression.

• **The air lock** provides space for observers, and lets subjects be taken up or down without changing the simulated altitude of the test chamber.

• **The capsule chamber** has one job: higher altitude simulation than the group chamber. Its small volume more nearly gives the decompression rate of a fighter cockpit suddenly depressurized by gunfire or failure. Altitude capacity is 80,000 ft., still beyond the record for manned altitude flights.

► **Crew Training**—One important job of the altitude chambers in this group is the indoctrination of test crews in the use of the partial-pressure emergency suit. Other work which has stemmed from the use of these chambers includes the development of oxygen regulators and other protective equipment.

The various units:

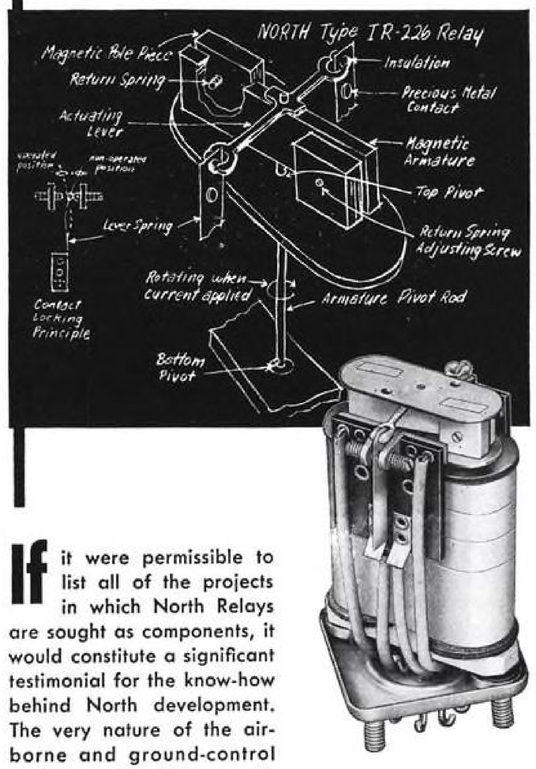
• **Altitude chamber** for testing equipment has a completely removable back through which heavy units can be brought for test. The room is about 14 ft. long by six feet wide and high. Simulated rate of climb is 8,000 fpm. to a peak altitude of 40,000 ft.; temperature can be dropped to —67F.

• **Guardite stratosphere** altitude cham-

Lt. Col. C. C. Cain
Chief, Operations & Plans

■ AERO-MEDICINE

for airborne services



If it were permissible to list all of the projects in which North Relays are sought as components, it would constitute a significant testimonial for the know-how behind North development. The very nature of the airborne and ground-control equipment in which our clients, including government, are using North relays, makes superior development engineering a basic specification.

Typical of North-developed relays specially suited to airborne electronic service is the IR 226, one set of specs for which reads like this:

Hermetically sealed.
2 C contacts. Load rating 2.0 amps at 30 v DC resistive or 0.5 amps at 110 v DC inductive.
Operating power nominal 36 ± 4 milliwatts.
Temperature range −65° C to +125° C.
Dimensions 1" x 1" x 1¾" (from shoulder).
Withstands 50Gs shock and 500 cycle vibration tests.

Ask for full details of
NORTH'S Relay Development Service

NORTH
THE NORTH ELECTRIC MANUFACTURING COMPANY
691 South Market Street
Galion Ohio

something to think about

Peace in our time depends upon plenty of *this* sort of thing:

"We were given a map," said the man from Martin, "and a target to be destroyed. Problem was to produce the hardware—the optimum weapons system to destroy that target."

That's as far as he would go. Except to say this:

It looks like nothing ever flown by man. Pilotless. Can be launched from a pad of scorched earth. A team of Martin scientists and engineers in five branches of aeronautical engineering produced this thing in a matter of months from problem to proving ground.

Today at Martin an entirely new concept, known as Martin Systems Engineering, is resulting in the production of new aircraft, guided missiles and electronics weapons designed not as yesterday's flying vehicles but as the coordinated and controlled spaceborne systems of tomorrow.

The principle of Martin Systems Engineering now makes possible developments in airpower that may change the shape of things to come—our way!

You'll hear more about Martin.

Martin AIRCRAFT THE GLENN L. MARTIN COMPANY BALTIMORE • MARYLAND

■ AERO-MEDICINE

ber is somewhat different and features precise control of altitude and temperature. The space, about 10 ft. long, four feet wide and eight feet high, can be cooled from room temperature to −60F in four minutes after a precooling cycle.

Pressure altitude and temperature control can be planned and coordinated through a time-schedule controller.

• **All-weather unit** is 13 ft. wide, 18 ft. long and 10 ft. high. Temperature can be set at any point between −40F and 160F, and held within about three degrees variation.

• **Anechoic room** is the quietest spot in the lab. It is used to study the effects of intense sound on animals and humans. Inside walls are lined with a foot and a half of Fiberglas faced with Fiberglas wedges one foot high and eight inches square on the base.

• **Vibration table** rounds out the list. This is a four by three-foot steel plate that can be vibrated in three directions up to a frequency of 60 cps.

How It All Began

Credit for the foundation of a separate medical service for aviation goes to the Germans. In 1910 they drew up the first set of minimum physical requirements for pilots, and shortly after established the first aviation medical service.

Another German idea was the program of pilot maintenance, based on medical reexamination at fixed intervals. This monitoring kept the physical standards of the Imperial German Air Service higher than any of its contemporaries.

► **U. S. Recognition**—The U. S. was well into World War I before any formal recognition was given to the fact that flying demanded a new yardstick for physical examinations and requirements. In September 1917, aviation medicine came into its proper niche when Gen. T. C. Lyster was appointed Chief Sur-

Dr. J. W. Heim
Chief, Physiology Branch

to the one-in-a thousand

Yes, there *is* a critical shortage of engineers. And the present bonanza of job offers, with special attractions, may sound like a midsummer engineer's dream.

But is it?

The fact is, hundreds of companies (we among them) are in need of engineering "help." But only a relatively few top managements (we among them) have *futures* to offer.

So we're addressing this to the one-in-a-thousand whose interest and qualifications go beyond fringe benefits and free transportation.

If you want a *job*, we have that, too. But if you are that one-in-a-thousand, there are a few outstanding opportunities here for administrators, scientists and designers in the aeronautical, electrical, electronics, structural and physics fields.

You will hear more about Martin.
(See opposite page)
Let's hear more about you!

Martin AIRCRAFT THE GLENN L. MARTIN COMPANY BALTIMORE • MARYLAND

Electronics Division

Designers and

Manufacturers of

ELECTRONIC EQUIPMENT

COMPUTERS

RADAR COMPONENTS

SPECIAL WEAPONS

AND

PRECISION GEARS

AMERICAN MACHINE & FOUNDRY COMPANY

1085 COMMONWEALTH AVENUE
BOSTON 15, MASSACHUSETTS

Quality

SCREW MACHINE Products

Since 1893

FINE INSTRUMENT SCREWS

Complete Facilities

WALTHAM SCREW COMPANY

87 Rumford Avenue
Waltham, Massachusetts

■ AERO-MEDICINE

geon, Aviation Section, Signal Corps, United States Army.

► **Lab Established**—Between wars, the awareness of medical problems related to the airplane and the new environment it imposed on humans came in for closer scrutiny by doctors in uniform. One of these, Brig. Gen. Malcolm C. Grow, is credited with the idea of founding a laboratory which would explore the physical effects of flight.

Through Gen. Grow's efforts, that laboratory was officially established in 1935 as the Physiological Research Unit, Experimental Engineering Section, Equipment Laboratory.

First director of the lab was Capt. Harry G. Armstrong, MC—now Surgeon General of the Air Force—who was picked for the spot by Gen. Grow.

► **First Home**—There was some available space in the basement of the Equipment lab which became office and lab for the fledgling unit. Free balloons were going out of fashion then, and so a portion of the balloon hangar was turned over to the unit for installation of a centrifuge. These unpretentious facilities were to be home—except for a few minor additions—until late in 1942.

The job list grew and so did the personnel roster. In 1939 there were so many different projects that the unit name was changed to Aero-Medical Research Unit. The next year, a detachment of Medical Department enlisted men was activated.

► **New Status**—Next change was one of status. From a unit, the aero-medical people were advanced to laboratory status, still under the Experimental Engineering Section, and Col. Otis O. Benson, Jr., was named chief.

All this time the lab had been running out of space at an ever-increasing rate. Brig. Gen. David N. W. Grant, then the Air Surgeon, appropriated money for construction of a new building about 100 by 50 ft., with three stories and a penthouse. This new housing for the lab was completed in November 1942, and all activities, except for a small group working with altitude chambers, moved in.

More money was forthcoming and was plugged into the construction of a human centrifuge and a building to house it. In March 1943 the first spins were made and, one month later, the first human subject whirled through his gut-straining merry-go-round ride.

That spring, the Aero-Medical lab was presented with another responsibility—the development of oxygen equipment, a job formerly assigned to the Equipment lab. Lt. Col. W. Randolph Lovelace, II, headed the new Oxygen Branch, and later that year was appointed chief of the entire lab.

Dr. H. E. Savely
Chief, Bio-Physics Branch

Currently, the lab is set up under the Directorate of Research at Wright Air Development Center, with Col. Robert H. Blount as its chief.

► **Other Groups**—There are medical activities in the Air Force apart from those carried on here at WADC. The USAF School of Aviation Medicine is one of these. It was organized to train medical personnel in the peculiar requirements of aviation medicine, and has a secondary job of long-term and clinical research.

There are medical organizations also at the AF Flight Test Center and at Holloman Air Development Center. Both sections originated as part of the Aero-Medical lab, and were stationed in the field because of certain facilities available there. They grew to size, and were made part of the Center's activities.

The Future

There is still a lot of work to be done. Col. Cain pointed out one of the areas—highspeed buffeting of aircraft—where little is known. There is some feeling that this may present problems of fatigue and flying ability to pilots, and it must be studied.

Good as the current suits are, work still continues on developments. One goal: a high-altitude suit for altitude protection of several hours' duration above 40,000 ft. Another goal: an all-zone flying suit to be worn anywhere pilots have to fly under global warfare.

Oxygen systems still need perfecting—one project is aimed at the development of a simplified, lightweight and reliable system for the entire group of medium and high-altitude aircraft of the future.

"We have to keep ahead of the field," says Cain. "A man's environment and well-being is as important a part of the weapons systems as the guns he has to fire. Our job is to anticipate future needs and keep man on a par with the functional reliability of the machines he flies."

■ PARACHUTE FACILITY

Chute Facility Tests Unification

Testing parachutes is El Centro's big job; but joint AF-Navy operation also tests how services work together.

El Centro, Calif.—One of Air Research and Development Command's most unusual units, the Joint Parachute Test Facility, is operated jointly with the Navy and does 75% of its work for the Army.

Located just north of the Mexican border on a Naval air station 41 ft. below sea level, the parachute group operates in the sweltering Imperial Valley area of California, more than 200 mi. from its parent organization at Edwards AFB.

Its mission is the development, testing and evaluation of parachutes and related devices. But it is obvious that the facility is testing not only parachutes—it is testing unification.

► **Cargo and Men**—"We drop cargo and men," is the way Col. Leo C. Moon, one of the two commanding officers of the facility, describes activities at the test center. He shares responsibility for the unit with Navy Cmdr. William H. Shockey.

Both Air Force and Navy men tumble from high- and medium-altitude aircraft to test equipment which later may save the lives of fliers in both services. One Navy man has made 404 test jumps and several of the unit's personnel have jumped as much as eight times in one day.

Majority of the projects, however, involve less dangerous cargo drops for Army testing, in which giant 200-ft. chutes sometimes float to earth loads as heavy as an 18,000-lb. bulldozer.

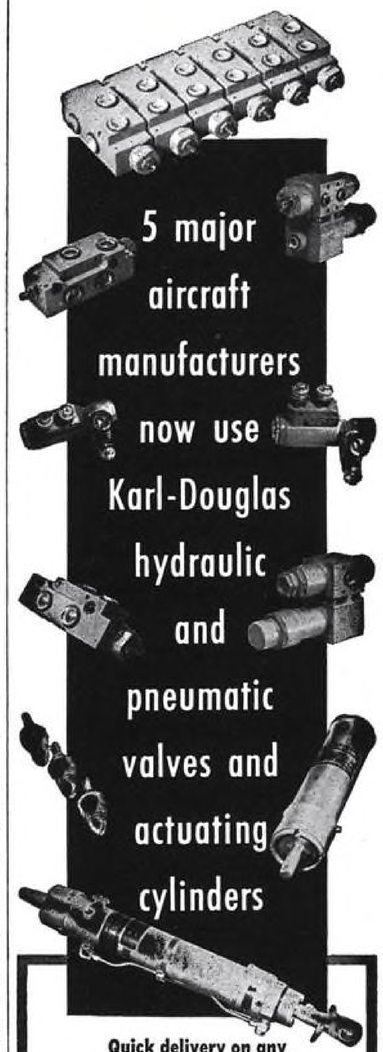
"Give us an airplane big enough," says Col. Moon, "and we can drop anything we can extract from the plane."

► **Chute Recovery**—In addition to testing personnel parachutes and aerial delivery systems for cargo, the unit also is concerned with parachute recovery systems for guided missiles, deceleration parachutes for jet aircraft, ejection-seat parachute systems, and any vertical retardation devices which perform the function of a parachute. These latter, so-called "roto-fins," have proved largely unsuccessful due to bearing problems, according to Col. Moon.

Live jumps are made in the level desert on the U. S. side of the Mexican border, 10-12 mi. from the base, while small cargo and dummy drops take place on a 40-acre field just outside the air station. Heavy cargo is tested in a more remote area and water drops are made into the nearby Salton Sea, largest inland body of water in California.

Both Navy and Air Force aircraft, such as R4Ds and C-119s, are assigned to the unit.

► **Unit Chiefs**—Col. Moon commands the Air Force's 6511th Parachute Development Test Group while Cmdr.



Quick delivery on any type, size or quantity!

K-D hydraulic and pneumatic valves and actuating cylinders are built to manufacturer's specifications or to original designs developed by K-D's experienced hydraulic engineers.

All parts are precision machined and carefully inspected before shipment. Facilities are available for large scale production.

For further information please write to:

Karl-Douglas Associates

3160 WEST EL SEGUNDO BLVD.
HAWTHORNE, CALIFORNIA

GAS TURBINE ANALYSIS and PRACTICE

Just Published!

A broad, overall survey of the design, operation, and scope of the modern gas turbine, and its application in various fields of transportation and power. Discusses various types, gives specifications, sketches, and photos, shows how to calculate thermodynamic performance, and outlines fundamental concepts necessary in design work. **By Burgess H. Jennings and Willard L. Rogers, both of the Technological Inst., Northwestern U. 487 pp., 200 illus., $8.50**

POWER PLANTS for AIRCRAFT

Gives a concise technical understanding of all types of aircraft power plants: their basic principles and their comparative merits. Unique graphic presentation, explaining major concepts through pictures and diagrams that show principles and operation in detail. Covers all types of power plants applicable to aircraft, including reciprocating engines, turbojets, turboprops, ramjets, rockets, and potential nuclear types. **By Joseph Liston, Prof. of Aeronautical Engineering, Purdue University. 577 pp., 454 illus., $8.50**

AIRCRAFT DESIGNERS' DATA BOOK

A pictorial presentation of design details that will enable you to grasp the design features of many typical domestic and foreign aircraft and power plants quickly and easily. Shows the reader starting new design what has been done in a particular area such as wings, landing gear, control systems, etc. **By Leslie E. Neville, Curtiss Wright Corp. 534 pp., 788 illus., $12.50**

AERODYNAMICS of PROPULSION

A survey of this new branch of aerodynamics. Gives an understanding of the basic processes and flow phenomena which will enable the aerodynamicist to work out problems for himself. Reviews the main types of propulsion systems, especially the aerodynamic aspects of the ducted propeller, ram-jet, and turbo-jet. Collects much material on engine fairings, air intakes, jet engine installation, and cooling. **By Dietrich Küchemann and Johanna Weber. 340 pp., 167 illus., $9.00**

See These Books 10 Days FREE

McGraw-Hill Book Co.,330W. 42nd St.NYC(36)

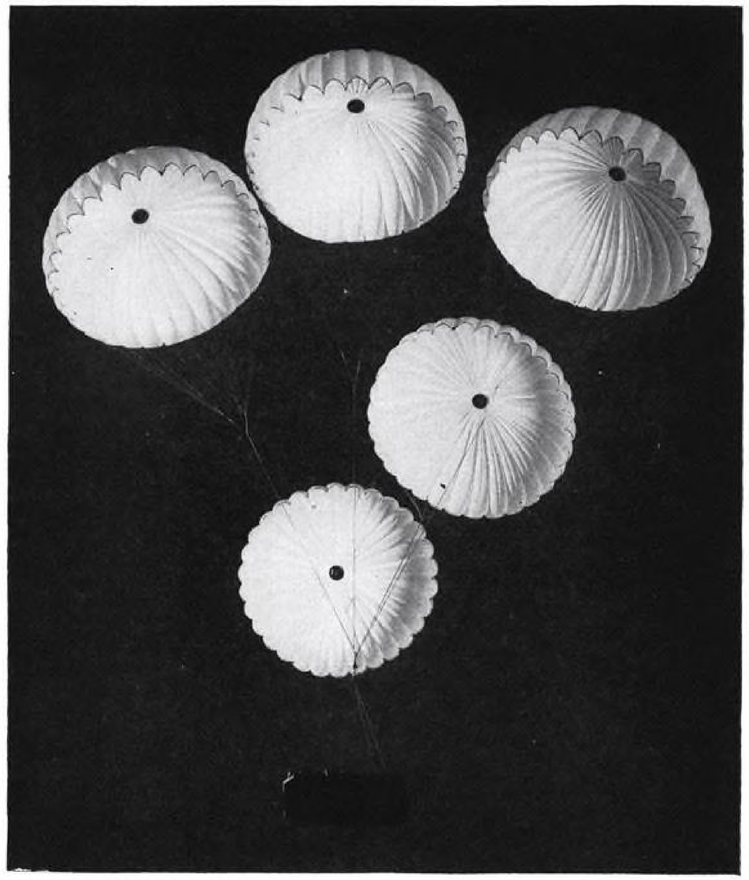
Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep, plus few cents delivery, and return unwanted book(s) postpaid. (We pay delivery if you remit with this coupon—same return privilege.)

☐ Jennings & Rogers—**Gas Turbine**—$8.50
☐ Liston—**Power Plants**—$8.50
☐ Neville—**Air, Designers' Data Book**—$12.50
☐ Küchemann & Weber—**Aero of Propulsion**—$9.00

(Print)
Name .....
Address .....
City .....Zone....State.....
Company .....
Position AW-8-17

This offer applies to U. S. only.

■ PARACHUTE FACILITY



CARGO CLUSTER chutes ease the drop of heavily loaded pallet in tests at El Centro.

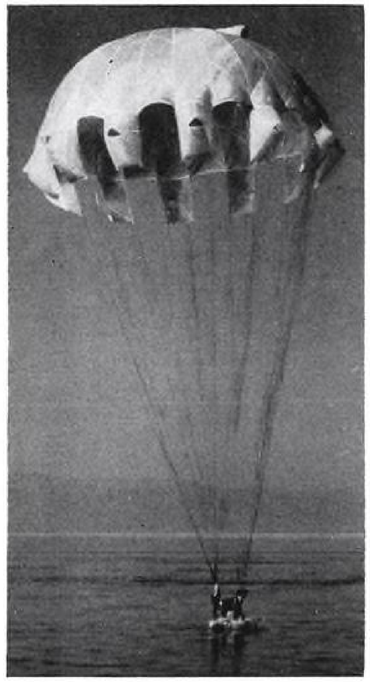
Shockey's group is known as the Navy Parachute Unit (NPU).

The directive setting up the facility emanated from the Joint Chiefs of Staff. Technically, the unit reports to the Defense Department on its work but ARDC is charged with Air Force responsibility. Top-level reports are signed by both commanding officers, with one copy going to the Defense Department through ARDC channels while the other reaches the same destination through Navy BuAer channels. ARDC projects are assigned by the Wright Air Development Center.

The Navy unit works closely with the Bureau of Ordnance on such programs as mine-laying by parachute and missile parachute work. Projects to test pod escape from high-altitude aircraft also are undertaken here. Navy has responsibility for Marine testing while Air Force takes charge of Army projects.

Certain of the unit's facilities, such as the instrumentation lab, whirl tower, drying tower, packing loft and fabric shop, are under Air Force operating control while the Navy takes charge of the windtunnel, textile lab, machine shop, metal shop and photo lab.

THREE PHASES in opening of new guide surface chute demonstrated by Navy and Air Force test jumpers.



WET LANDING completes parachute test.

► **Unification in Action**—Unification appears to work well on what Col. Moon calls "coordination on a personality basis." He and Cmdr. Shockey work closely to administer the facility.

Minor irritations can flare quickly into major disputes in a hot and remote location where temperatures as high as 120 deg. force the base to close down for the day at 2:30 each afternoon (work begins at 6 a. m. to take advantage of cooler morning hours). Individuals in either service who do not fit into the pattern are transferred quietly.

The Joint Parachute Test Facility is only one of several units on the El Centro Naval Auxiliary Air Station. Fleet Air Gunnery Unit (FAGU), for example, operates from the base on a mission similar to that of the Air Force gunnery school at Nellis AFB, Las Vegas.

The Naval base, under the command of Capt. Walter E. Premo, Jr., furnishes services for the facility, including food, housing and utilities. Air Force personnel are paid by the NAAS disbursing officer, who draws on a special fund.

Cooperation extends even beyond the operation of the parachute facility, with aircraft from Edwards AFB occasionally flying to El Centro to aid the Navy on missions unconected with the parachute test work while Navy men sometimes assist on unrelated Air Force projects.

Perhaps the most revealing sign of this inter-service coperation is over the entrance to the coffee bar at El Centro. It reads: "Unification Room."

ARDC Field Liasion Offices

A national system of field liaison offices is operated by the Air Research and Development Command to coordinate USAF technical projects and program and serve as a point of contact between USAF and persons who require technical information from the military.

The 22 field liaison offices in the development field organization are administered from ARDC headquarters in Baltimore. Following is the list of ARDC liaison offices:

- Hq., Air Research & Development Command
  Directorate of Field Liaison
  Lt. Col. W. R. Beckett
  Baltimore 3, Md.
  Telephone: Lexington 2616
  Ext. 44 or 344

- Washington Air Force Development Field Office
  Room 4945, Main Navy Building
  Lt. Colonel H. A. Orban
  Washington 25, D. C.
  Telephone: Liberty 56700
  Ext. 63594–62471

- Air Force Development Field Representative
  NACA Langley Aeronautical Laboratory
  Langley Air Force Base, Va.
  Telephone: Hampton 7911
  Ext. 21144

- Air Force Development Field Representative
  Naval Research Laboratory
  Maj. Edgar Van Rosen
  Washington 25, D. C.
  Telephone: Johnson 36600
  Ext. 266

- Air Force Development Field Representative
  Applied Physics Laboratory
  The Johns Hopkins University
  Mr. H. C. Beaman
  Silver Spring, Md.
  Telephone: Washington—Juniper 97700
  Ext. 10
  Baltimore—Plaza 2-1317
  Ext. 10

- Air Force Development Field Representative
  Engineer Research & Development Laboratories
  Capt. Joe Sherman
  Fort Belvoir, Va.
  Telephone: Temple 67400
  Ext. 34251

- Air Force Development Field Representative
  Army Field Forces Board No. 1
  Maj. J. L. Hight

CAL-FLEX

conduit and hose pressure tested 3/16" to 1" diameter

wire braiding

immediate delivery

FLEXIBLE METAL HOSE MFG. CO.

Plant and General Offices
640 West 17th Street, Costa Mesa, Calif.

Sales Offices
Washington, D.C., 13th and E Streets
Detroit, Mich., Book Tower Bldg.
New York, N.Y., Grand Central Bldg.
Chicago, Ill., 600 South Michigan Blvd.

A Basic Manufacturer of Flexible Metal Pressure Tested Conduit and Hose

COMCO

MODEL **278** "CONTROLLER"

VHF-AM TWO-WAY RADIO

For airport vehicles and base stations

Mobile...Portable...AC...DC

MOBILE PACKAGE WITH ALL ACCESSORIES

- COMPACT—case 13" x 11" x 5"
- AMPLE POWER—mobile transmitter 3.5 watts
- LOW BATTERY DRAIN—7.5 amps. standby
- EASY MAINTENANCE—color code tuning
- CRYSTAL CONTROLLED—highly selective
- HAND CARRIED CASE or DESK CONSOLE
- ROOF TOP or COWL MOUNTED MOBILE ANTENNA

Write or wire for details today

COMCO

Manufacturers of Radio and Electronic Equipment

COMMUNICATIONS COMPANY, INC.

CORAL GABLES 34, FLORIDA

NOW Convert mechanical motion to electrical energy

with Electro Magnetic Pick-up

Model 3010-A

generates up to 28 v. without contact

Small, compact and rugged, this Electro Magnetic Pick-up generates electrical voltages proportional to the rate of speed of any object with magnetic properties. It produces useful output voltages at frequencies up to 75,000 cps. Self-energized by built-in magnet. Low cost permits use in production machinery.

A Few of Many Applications

- Indicates rate of motion
- Acceleration and velocity studies
- For precision ignition timing
- For ballistic research

Write for Bulletin MT-592

Electro ELECTRONIC EQUIPMENT

ELECTRO PRODUCTS LABORATORIES

4501-AWu Ravenswood, Chicago 40

Fort Bragg, N. C.
Telephone: Fayetteville 72311
Ext. 38232

- Air Force Development Field Representative
  Naval Air Test Center
  Maj. J. E. Foley
  Patuxent River, Md.
  Telephone: Great Mills 3111
  Ext. 9179

- Air Force Development Field Representative
  Naval Ordnance Laboratory
  Maj. Archie L. McKay
  Silver Spring 19, Md.
  Telephone: Hemlock 47100
  Ext. 210

- New York Air Force Development Field Office
  346 Broadway
  Lt. Col. Trygve Sandberg
  New York, N. Y.
  Telephone: Rector 28000
  Ext. 486–488–489

- Air Force Development Field Representative
  Armed Services Electro Standards Agency
  Col. T. J. Ice, Jr.
  Fort Monmouth, N. J.
  Telephone: Eatontown 31060
  Ext. 1419–1519

- Air Force Development Field Representative
  Signal Corps Engineering Laboratory
  Maj. R. L. Elmendorf
  Fort Monmouth, N. J.
  Telephone: Eatontown 31060
  Ext. 1761–3167

- Air Force Development Field Representative
  Naval Air Development Center
  Maj. T. J. Rall, Jr.
  Johnsville, Pa.
  Telephone: Hatboro 0700
  Ext. 431

- Air Force Development Field Representative
  Massachusetts Institute of Technology
  Division of Industrial Cooperation
  Maj. Carlo N. DeGennaro
  Cambridge, Mass.

- Los Angeles Air Force Development Field Office
  5504 Hollywood Blvd.
  Lt. Col. R. A. Trennert
  Los Angeles 28, Calif.
  Telephone: Hollywood 7-5171
  Hollywood 7-5375

- Air Force Development Field Representative
  Naval Air Missile Test Center
  Maj. M. E. Baker
  Point Mugu, Calif.
  Telephone: Oxnard 62401
  Ext. 756

- Air Force Development Field Representative
  Naval Ordnance Test Station
  Maj. J. B. Goudy
  Inyokern
  China Lake, Calif.
  Telephone: Inyokern 82211
  Ext. 71403

- Air Force Development Field Representative
  Directorate of Flight Safety Research
  Norton AFB
  Maj. J. D. Kelly
  San Bernardino, Calif.
  Telephone: S. Bernardino 7211
  Ext 5123

- Air Force Development Field Representative
  NACA Ames Aeronautical Laboratory
  Maj. D. R. Latham
  Moffett Field, Calif.
  Telephone: Yorkshire 73056

INDEPENDENT OFFICES

- Air Force Development Field Representative
  NACA Lewis Flight Propulsion Laboratory
  21000 Brookpark Road
  Maj. H. W. Robbins
  Cleveland 11, Ohio
  Telephone: Orchard 11211

- Air Force Development Field Representative
  % Deputy for Operations
  Air Proving Ground Command
  Lt. Col. I. K. Mays
  Eglin AFB, Fla.
  Telephone: Eglin 5171
  Eglin 25174

- Air Force Development Field Representative
  Aberdeen Proving Ground, Md.
  Maj. J. S. Restifo
  Telephone: Aberdeen 1000
  Ext. 2287

- Air Force Development Field Representative
  Research & Engineering Command
  Army Chemical Center
  Lt. Col. J. C. Bones
  Edgewood, Md.
  Telephone: Edgewood 1000
  Ext. 4227

- Air Force Development Field Representative
  Chemical Corps
  Biological Laboratories
  Camp Detrick
  Lt. Col. W. W. Eakins
  Frederick, Md.
  Telephone: Monument 3411
  Ext. 4224

Designs That Never Fly Play Important AF Role

A group of designers at Wright Air Development Center spends its time developing interesting new and radical aircraft designs that are never built—yet their work is reflected in production USAF airplanes of yesterday and today, and will be seen in aircraft and missiles of tomorrow.

It is their assignment to crystallize new potentials in power, and aerodynamics into designs which will give Air Force planners a definite fix on which route should be chosen to accomplish the missions planned. Often they develop several alternate designs for a single mission, and the actual production airplane may combine best features of each, or be a compromise.

Some of the design concepts pictured in model form are very recent, others go back several years. Included are: a turboprop light bomber, which looks like a relative of the Douglas XB-66 twin-jet light bomber; an early six-jet guppy bomber with common air intakes for engines buried in the plane's belly, and with common tailpipes; an early all-weather turboprop fighter fitted with three-blade counter-rotating propellers of swept blade design, later obsoleted by very thin straight blades; an early pantabase fighter design with tandem retractible hydro-skis; a recent four-jet bomber design, with interesting notched sweepback in wing and a recent tailed delta fighter concept exploring the advantages of a conventional tail configuration with a delta wing.

NEWS OF THE WEEK

NEWS DIGEST

Domestic

Air Force Secretary Harold E. Talbott said last week the U. S. will meet its commitments to NATO air power strength through this year and 1954 despite the $5-billion slash made by Congress in USAF's budget.

North American RB-45 made the first nonstop jet flight across the Pacific, flying the great circle route July 29, 1952, from Elmendorf AFB, Alaska, to Yokota, Japan, in 9 hr. 50 min., USAF disclosed. Maj. Louis H. Carrington, pilot of the jet bomber, will be awarded the 1952 Mackay trophy for the "most meritorious flight" of the year.

New flight director, designed to simplify ILS approaches, has been developed by Westinghouse Electric Corp. and is being installed on an American Airlines Convair for evaluation. New system adds a third pointer to the conventional ILS cockpit indicator to show rate of approach to the localizer beam center.

Small business firms in the Los Angeles area have pooled their efforts by incorporating as United Western Manufacturers, Inc., Inglewood, Calif., to seek defense contracts in the metal trades industry. The companies: Aircraft Div., Calnevar, Inc.; Certified Welders & Engineering Co.; Hartford Manufacturing, Inc.; Modern Plating Co.; Telair Engineering, and Tubing Appliance Co.

Pan American World Airways has replaced DC-4s and Constellations with DC-6Bs on Latin American tourist flights, cutting an estimated 2¼ hr. from the time on the New York-Buenos Aires route.

Lightplane shipments totaled 311 aircraft at a dollar value of $2,596,000 during June, dropping from the previous month's 388 units at $3,435,000, according to figures released by Aircraft Industries Assn.

Automatic ejection seats with telescoping rails that guide the seat out of a cockpit are being installed by Lockheed Aircraft Corp. in F-94Cs. The new device was developed by Lockheed, tested in flight at USAF's Wright Air Development Center.

Civil Aeronautics Administration has approved a change in Hamilton Standard's automatic propeller feathering circuit that gives a two-second delay between cockpit indication and start of blade action, allowing the pilot an opportunity to reject reversal.

John Floberg, former Assistant Secretary of the Navy for Air, has returned to the law firm of Kirkland, Fleming, Green, Martin, and Ellis as a resident Washington member. Before entering Naval service in World War II, Floberg served with the firm at its Chicago headquarters.

Financial

Lockheed Aircraft Corp., Burbank, Calif., last week reported Super Constellation sales averaged one every 10 days during the first half of 1953, pushing the mid-year commercial backlog to a record $150 million.

United Air Lines made net earnings of $4,068,416 for the first six months of this year, compared with $3,782,565 for the same period of 1952. Operating revenues totaled $83,075,523, a 14% increase.

Northwest Orient Airlines made a net profit of $302,500 from operating revenues totaling $29,095,000 during the first half of 1953, compared with a net loss of $525 and revenues of $24,657,600 for the similar period of the previous year.

North American Aviation reports a June 30 backlog of $1,130,573,807 and net income after taxes for nine months ending that date of $7,990,000. Total sales and other income for the period: $460,712,180.

Temco Aircraft Corp., Dallas, reports net income of $906,342 for the first six months of this year, compared with $860,223 in the first half of 1952. Sales were $27,505,040, a 9.7% increase.

Continental Air Lines net income climbed to $1,040,204 during the first half of 1953 from $88,940 for the same period of last year. Operating revenues were $5,222,117, compared with $4,900,252.

Western Air Lines reports a net income of $356,567 for the first half of this year, dropping from $445,839 for the same period of 1952. Operating revenues were a record $10,876,332, cut into by purchase of a new DC-6B fleet, inauguration of a new route and training program.

International

Three Comet 1As last week began flight on Air France routes to the Near and Far East. Carrier has ordered three Comet 3s, expects to begin operating 10 Super Constellations, 15 Vickers Viscounts and 12 Breguet Deux Ponts this year.

Royal Air Force has taken delivery of the first of several Prestwick Pioneer liaison planes on order.

Piper's First Production Apache

First flight photo of the initial production-model Piper Apache twin-engine four-place light transport. It embodies numerous refinements over the prototype which has been undergoing a year-and-a-half of flight tests. Plane pictured is of all-metal construction, compared with metal and partially fabric-covered previous version. Its external lines have been smoothed out, particularly the nose, engine nacelles and around the cabin. In production at Lock Haven, Pa., the Piper Apache is scheduled to sell below $25,000. Powerplants are two 150-hp. Lycomings. Cruise speed is reported at more than 150 mph.; one-engine service ceiling, fully loaded, in excess of 5,000 ft.

Nonsked Battle Brews in Senate

Commerce committee chairman is expected to favor skeds; subcommittee member fights five-point plan.

A clash over Senate Commerce Subcommittee's approach to its review of the 1938 Civil Aeronautics Act and its administration points to a major battle on the nonsked issue on Capitol Hill before long.

In his outline of topics to be covered, the subcommittee's chairman, Sen. John Cooper, put down charges of Civil Aeronautics Board discrimination against nonscheduled airlines for airing before the group.

▶ **Skeds' Position**—This brought a staunch defense of the scheduled airlines' position from Sen. Edwin Johnson, subcommittee member.

Johnson expressed the hope that the group "will not be used unwittingly as a vehicle to promote selfish interests (of nonskeds) rather than the public interest."

He took issue with Senate Small Business Committee's report (AVIATION WEEK Aug. 1, p. 56) laying down a five-point program to keep alive a lusty nonsked industry and calling on the Cooper subcommittee to implement the program. He called it "more propaganda than a calm appraisal of actual conditions. . .," adding that "such a course by us could jeopardize our great national air transportation system which is so vital to our national defense."

▶ **Decisive Factors**—As a special committee, the Senate small business group lacks the authority to act on legislation, a power the Cooper subcommittee does have.

The third Cooper subcommittee member, Sen. Dwight Griswold, has given no indication of his position, which could be decisive in the three-man group.

Another factor that may influence the outcome is the switch in chairmanship of the full committee: Sen. John Bricker has taken over the reins from recently deceased Sen. Charles Tobey, who appointed the Cooper subcommittee and indicated sympathy for the nonskeds' case. Although Bricker has not actively participated in aviation matters so far, he is expected to lean in favor of the scheduled airline industry's position.

Meanwhile, Air Transport Assn.'s president, Vice Adm. Emory Land, protested that if the Small Business Committee's program were ever adopted "we would have two scheduled airline systems in the U. S., each operating under different sets of rules."

▶ **Subcommittee Approach**—Here are highlights of Cooper's outline of the approach of his subcommittee:

- **Define the public's interest** in air transportation as it looks in 1953, obtaining the views of leading economists, political scientists and industry representatives.
- **Determine how monopolistic** and competitive practices manifest themselves in the airline industry and how the public is affected.
- **Consider the extent** to which the spirit and intent of the 1938 CAA act has been and is being "energetically and creatively fostered" by CAB.
- **Propose measures** for the future that will strengthen the air transportation system in the passenger and cargo fields of domestic and international operations.
- **Consider the fundamental issue** of the right of entry of new companies into the field.
- **Consider airline profits** and subsidies and the level of passenger fares and freight rates.

▶ **Critical Reply**—Johnson's reply, skeptical of the Cooper agenda, criticized nonskeds for their "relatively poor safety record," Civil Aeronautics Administration for its "shameful failure" to enforce nonsked safety standards, and prodded CAB to enforce regulations against regular operations by nonskeds.

"The recent slaughter of troops in nonsked accidents has shocked the nation," Johnson declared. "So far this year the nonskeds have had, altogether, four fatal accidents and killed 122 passengers." Over the five years from 1948 to 1952, he said, "the nonskeds killed over seven times as many passengers per passenger mile as did our certificated domestic and international carriers, combined."

He urged that the subcommittee take action along these lines:

- **CAB should either** put an end to all nonsked route-type operations or define new legal limitations for a type of operation that is economically feasible.

"Havoc reigns because a small vocal part of the air transport industry is unregulated and submits to no economic restraint."

- **"The nonskeds' record** of continuous overloading of planes, inadequate maintenance, untrained and over-worked pilots and disregard of prudent dispatching procedures is well known to the CAA," whose present method of "spot" inspection is "entirely inadequate."

The imposition of civil penalties for serious violations are "a mere slap on the wrist."

- **Too many nonskeds** operate on "a shoestring" with "insecure financing."

"I cannot see how anyone can find these carriers 'fit, willing and able' to receive a governmental operating authority to transport military personnel. The responsibility of the nonskeds to carry the public with the highest practical degree of care should not be overlooked by the subcommittee either."

EISENHOWER INSPECTS XB-52

President Dwight D. Eisenhower recently got a firsthand impression of the new Boeing XB-52 eight-jet Stratofortress during a visit to Seattle with other top government officials. Chief test pilot A. M. (Tex) Johnston flew the big bomber on two highspeed low-altitude runs past the President's reviewing stand and made a sharp, climbing turn from 500 ft. to 10,000 ft. Johnston climaxed the air display by landing and opening the plane's drag chute. The President and his party are seen walking beneath one of the plane's big external fuel tanks, shown for the first time in this photo. From left to right: Edward C. Wells, Boeing vice president-engineering; William M. Allen, Boeing president; President Eisenhower; U. S. Secretary of the Treasury William M. Humphrey; and Secretary of the Air Force Harold E. Talbott. (See "More B-52s?", p. 426.)

Stockholders Approve Tiger-Slick Merger

Merger of Flying Tiger Line and Slick Airways came a step nearer last week after a nearly unanimous vote of approval by stockholders of the two air cargo carriers.

Only hurdle still to be cleared is Civil Aeronautics Board approval.

CAB staff considers advisability of the merger a "close question" from a public policy standpoint, plans to state its position for or against the merger in a brief to the Board's trial examiner this month.

The examiner will make an independent recommendation shortly thereafter, and the full Board is expected to rule after hearing oral arguments this autumn.

Riddle Quits ATA's Military Traffic Group

Reorganized Riddle Airlines has switched its military traffic agency representation from Air Transport Assn. to Independent Military Air Transport Assn.

Riddle retained membership with ATA on normal association matters, however.

New management took over the scheduled airfreight line last month (Aviation Week Aug. 3, p. 18), and Paul Weesner bought 20% interest in the company. Weesner is maintaining a silent-investor position, however. He has no office in the company and is not a member of Riddle's new board of directors.

President William Boyd plans to boost scheduled airfreight service and generally operate military contract flights with equipment that otherwise would be idle.

The company has raised an estimated $300,000 in new funds to restore a normal working capital position, according to reports.

Ted Wells Leaves Beech Aircraft

Ted A. Wells, vice president and chief engineer of Beech Aircraft Corp. since its organization in 1932 and for several years a director of the company, resigned last week. Ralph Harmon, Beech's assistant chief engineer, who had been with the company since early in World War II, also resigned.

T. D. Neelands, Jr., another Beech director, resigned late last month.

Wells and Neelands were among the oldest top brass in point of service at Beech. Both assisted the late Walter H. Beech in organizing the corporation.

Beech told Aviation Week no other changes are expected in the company management, that successors to Wells and Harmon will be announced later.

Officials reported employment at the Beech plant had dropped from a high of 13,500 last December to 7,500 early this month, following cancelation of the USAF T-36 program, in which Beech had a $100-million production contract.

ANDB Orders Civil Radar Beacon System

Air Navigation Development Board has launched a program to develop a new radar transponder beacon system for civil aircraft, a plan designed as a step toward a common navigation network for military and civilian flight.

The proposed 1,000-mc. system, predicted by Aviation Week (Mar. 30, p. 11), will be developed to work with the military system used to identify aircraft on terminal area radar scopes.

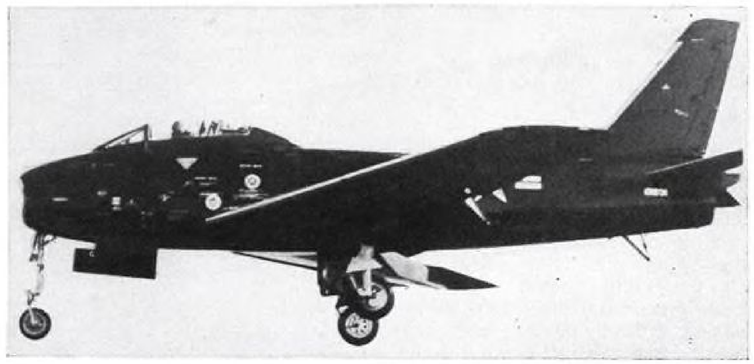
▶**Tests in 1954**—First experimental units of the new system are expected to be tested early next year.

The beacons are small receiver/transmitters that reply to ground radars by transmitting a coded signal identifying the aircraft and providing a strong "echo."

▶**Frequency Shift**—Previous ANDB radar beacons, which never got beyond the experimental stage, involved only an airborne unit triggered by radar energy from the ground-based air surveillance radars (operating at 3,000 mc.).

The new system involves not only a shift in frequency to 1,000 mc. but will require a special 1,000-mc. ground interrogator and receiver.

Navy's Bureaus of Ships and Aeronautics have been designated by ANDB to develop the ground-based and airborne portions of the new beacon system.



NAA TESTS SAPPHIRE-POWERED FURY

A prototype of the new North American FJ-3 Fury—an FJ-2 modified to take the Wright J65 Sapphire turbojet—recently completed its initial flight tests at Port Columbus, Ohio. First views of plane are shown. Described as heavier, slightly larger and faster than the earlier GE J47-powered FJ-2, the newer FJ-3 model is expected to have a top speed of approximately 700 mph. Most noticeable external difference over the FJ-2 is the revised nose intake for the larger Sapphire engine. Internal changes include an improved gunsight for its four 20-mm. cannon and new-type navigation equipment. The FJ-3 is in preliminary production stages at North American's Columbus, Ohio, plant. It is one of several Navy aircraft, including a new Grumman job, taking the J65.

EDDIE RICKENBACKER (seated left) discusses Eastern Air Lines affairs with the carrier's new president, Thomas F. Armstrong (seated right). Standing are Sidney L. Shannon, vice president-operations (left) and Paul H. Brattain, first vice president.

Eastern Names New President

Capt. Eddie Rickenbacker, president of Eastern Air Lines for the past 15 years, has turned that post over to Thomas F. Armstrong, EAL's former treasurer and secretary, in a surprise shift of the carrier's management.

Rickenbacker was elected chairman of the board and keeps his position as chief executive and general manager.

▶**Jet Planning**—He said at a press conference he hoped the top-level switch and other changes would give him more time for policy matters and long-range planning.

Jet transports are coming inevitably, he said, and the "hard, realistic" thinking about them has to be done now. And "economic readjustments" are on the horizon—"We have to learn to sell and merchandise again."

▶**Top Team**—Armstrong, who joined the company in 1928 as an apprentice bookkeeper, has been secretary and treasurer since 1938 and a director since 1940. Thomas E. Creighton, formerly assistant secretary, succeeds him as treasurer and becomes a member of the board. Floyd Farley, who was assistant treasurer, was elected secretary.

They will be part of a "top management" team of a dozen men, Rickenbacker said.

▶**Guided Judgment**—Rickenbacker explained that one purpose of the changes was "to get young men on the job where they can carry the load and responsibility," but Eastern's "oldtimers" are staying on the job and the younger men will have "opportunity to exercise judgment but with guidance."

Armstrong is 51 years old, Creighton 40 and Farley 47. Rickenbacker said he would be 63 in October.

Towers Heads FSF

Adm. John H. Towers (USN Ret.), often described as the "principal architect of Naval aviation," has been elected president of Flight Safety Foundation, Inc., FSF managing director Jerome Lederer announced last week.

The admiral will take over organizational planning, finance and public relations, freeing Lederer to devote full time to the "promotion of ever greater safety in aviation."

The first Naval aviator to reach the rank of admiral, Towers was chief of the Bureau of Aeronautics in 1939, became commander of Naval and Marine forces in the Far East during the final part of World War II, and was chairman of Navy's now-defunct General Board shortly before his retirement in 1947. He is a former vice president of Pan American World Airways and presently is a PAA consultant.

Comet Ban

- **U. S. ambassador steps into RCAF-NATCC fight.**
- **Says New York should allow occasional landing.**

International diplomacy has entered the National Air Transport Coordinating Committee's current fight (Aviation Week July 20, p. 14) to prohibit Royal Canadian Air Force Comets from landing at New York's Idlewild International Airport and other commercial fields in the area.

R. Douglas Stuart, U. S. ambassador at Ottawa, has written C. R. Smith, chairman of NATCC's executive committee and American Airlines president, that he hopes the group "will find it possible to permit the Comet to land at commercial airports on an occasional and infrequent basis."

Stuart said the U. S. embassy at Ottawa will face difficulties "if it should become necessary for the RCAF to request a clearance into New York for the Comet on behalf of the Minister of National Defense or an official of equivalent rank."

"It would be embarrassing," he said, "if such a clearance were refused when the aircraft in question is flying on commercial routes in many areas of the world."

Miss E. Claire Wilson, U. S. embassy civil air attache, has discussed the Comet problem with the RCAF "on several occasions," the ambassador wrote, "and they have to date refrained from operations into La Guardia and Idlewild."

However, he added, "the RCAF Air Transport Command is naturally anxious to proceed as soon as possible with the program they have established for this aircraft."

The Comet dispute began early in June when Air Commodore R. C. Ripley, chief of RCAF's Air Transport Command, asked the Port of New York Authority for permission to operate the Comet into Idlewild Airport on an intermittent basis. At the same time, he asked and received Civil Aeronautics Administration approval to land a Comet at Washington National Airport.

Port of New York Authority, however, turned for guidance to NATCC, later informed Ripley it would prefer that he not operate into Idlewild but land at a military field.

Smith said the different noise characteristics of a multi-jet transport would provide "fresh ammunition" to groups trying to close the airports.

In view of PNYA's refusal, the

Canadian Comet was flown to Mitchel AFB on Long Island after a stop at Washington July 8 and returned to Ottawa the following day.

Purpose of the Canadian Comet flights to this country, according to Air Commodore Ripley, is in the interest of joint security of the North American continent and as a means of transporting Canadian chiefs of state and other personages to and from the U.S.

Chase Reorganization Deadline Is Aug. 31.

Deadline for acceptance of one of two alternate plans for reorganization of Chase Aircraft Corp. has been set for Aug. 31, informed sources reported last week.

The alternatives:

• **Kaiser Motor Corp.** will put $1,750,000 on deposit at Chase National Bank in New York to form a new corporation with Michael Stroukoff holding all the stock. In exchange, he will surrender his 51% control of Chase.

The new corporation will have all the rights to Chase designs, Chase research and development contracts, its leases at Mercer County, N. J., Airport, and the right to purchase at book value all equipment of the present Chase company. Kaiser, for its deposit, will receive all rights to the C-123 assault transport and the Chase name.

• **If the Kaiser deposit** is not made on or before Aug. 31, the second plan will be followed. This provides for a reorganization of the Chase board of directors, with Stroukoff getting five of the nine-member board so he has effective control of the operating policies.

Kaiser now holds 49% of the Chase stock. It is understood that a preliminary agreement, providing that one of the two reorganization plans will be followed, already has been signed by Stroukoff and Kaiser representatives. (Other details of the proposed transaction appeared in AVIATION WEEK Aug. 10, p. 19).

Army Orders First Production Firebee

Los Angeles—U.S. Army has placed the first production order for Ryan Aeronautical Co.'s jet-powered target plane, the Firebee.

Official designation will be XM-21, the Los Angeles Ordnance District revealed last week in announcing the contract.

▶ **Fighter Performance**—The Army announcement said the highspeed Firebee will be used in training units in the anti-aircraft operation of the Skysweeper gun, the Nike and "other guided missiles."

The XM-21 will maneuver at varying speeds and altitudes over anti-aircraft installations to simulate invading enemy aircraft. Ryan claims performance of the target aircraft, powered by a Fairchild J44 jet engine, approaches that of the F-86 jet fighter.

Army will ground launch the XM-21 with the aid of Rato (rocket assist takeoff) unit and a launching track. Rato is jettisoned after takeoff of the pilotless target plane.

▶ **First Contract**—Although development contract for the Firebee was under the joint auspices of the Army, Navy and Air Force, the Army contract is the first to be announced for the target aircraft.

The Firebee, with sweptback wings and tail surfaces, is approximately 18 ft. long with a 12-ft. span. Weight is estimated at 1,800 lb. A two-stage parachute recovery system is designed to lower the aircraft without damage after each flight.

MIT Engineer Wins Aviation Week Award

Massachusetts Institute of Technology has announced award of the 1953-54 Aviation Week Fellowship in aeronautical engineering to Robert Roy Piper of Princeton, N. J.

The award, made annually since September 1950, carries a stipend of $1,800 and goes to a student enrolled for an advanced degree in MIT's department of aeronautical engineering. Funds are provided through Robert W. Martin, publisher of AVIATION WEEK.

Piper, who entered MIT in the fall of 1949, is a member of the honors group of aeronautical engineering students and the student chapter of the Institute of the Aeronautical Sciences.

CAB Crash Report Blames Controller

A double misunderstanding of radio messages—between a pilot and a Civil Aeronautics Administration traffic controller—contributed to the crash of a C-46 Apr. 3 near Selleck, Wash., the revised opinion of Civil Aeronautics Board investigators reveals.

Preliminary field reports to CAB officials in Washington previously placed the blame solely on the pilot (AVIATION WEEK Aug. 3, p. 52).

Two survived and two were killed when the American Air Transport plane hit a mountain range while approaching Seattle from Cheyenne.

Traffic control cleared the transport to cross the Hobart fan maker at 8,000 ft., then cross over to Seattle at or above 4,000 ft.

Tape recording of the subsequent radio transmissions:

• **Pilot:** "Roger, this, uh, nine three metro is cleared to, uh, Hobart—to—cross there four thousand or above—the range station, ah, four thousand we're to report to you at, uh, Hobart, over."

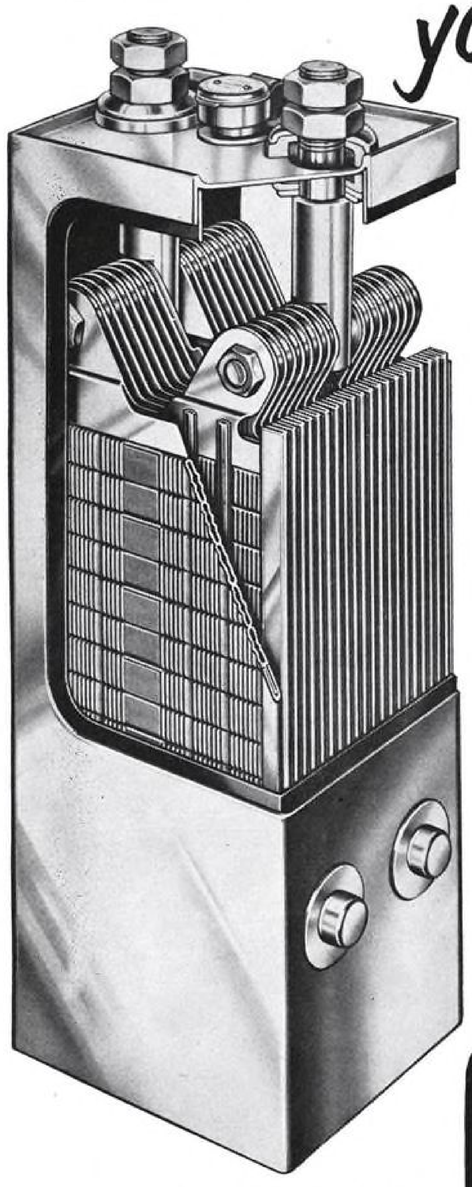
• **Controller:** "Negative, report Hobart to Seattle approach control."

(Continued on page 425)

AUTOGIRO MODIFIED FOR CONVERTIPLANE TESTS

Artist's conception of how tri-motor modification of prewar Kellett KD-1B will look. Craft is being rebuilt by the original maker under a Navy contract to gather convertiplane data (Aviation Week Aug. 10, p. 20). Two 140-hp. Lycomings and wings are to be added to the craft, also a new rotor power drive. Nose engine, a 225-hp. Jacobs, is being retained. Flight tests will check theories about unloading helicopter rotors and transferring loads to the wings. When completed the modified KD-1B will weigh approximately 3,400 lb. This Autogiro was used by Eastern Air Lines in 1939 on the first regularly scheduled rooftop rotary-wing airmail route between Camden (N. J.) Airport and the rooftop of Philadelphia post office.

Stand-by Power you can depend on!



CUTAWAY VIEW of a Nicad cell, showing all-steel construction

NICAD

Nickel Cadmium Batteries are built for many years of low-cost service

You can leave a Nicad battery in any state of charge, for long periods without attention — or fear of deterioration.

Ruggedly built of nickel-plated steel, Nicad batteries combine great mechanical strength with low internal resistance. They will stand up under severe service conditions, eliminating such common battery troubles as noxious fumes, corrosive spray, damage due to overcharge, plate breakage and deterioration of separators. Using very little water, their simple, inexpensive maintenance pays for their first cost many times over.

Specify Nicad Batteries For:

Airport emergency lighting . . . Control tower consoles . . . Continuous power units . . . Engine starting . . . Micro-wave and telephone systems . . . Radar equipment . . . Switchgear and substation operation.

NICKEL CADMIUM BATTERY CORPORATION
100 Park Avenue, New York 17, N. Y.
Plant, Easthampton, Massachusetts

NICAD

MADE IN U.S.A.

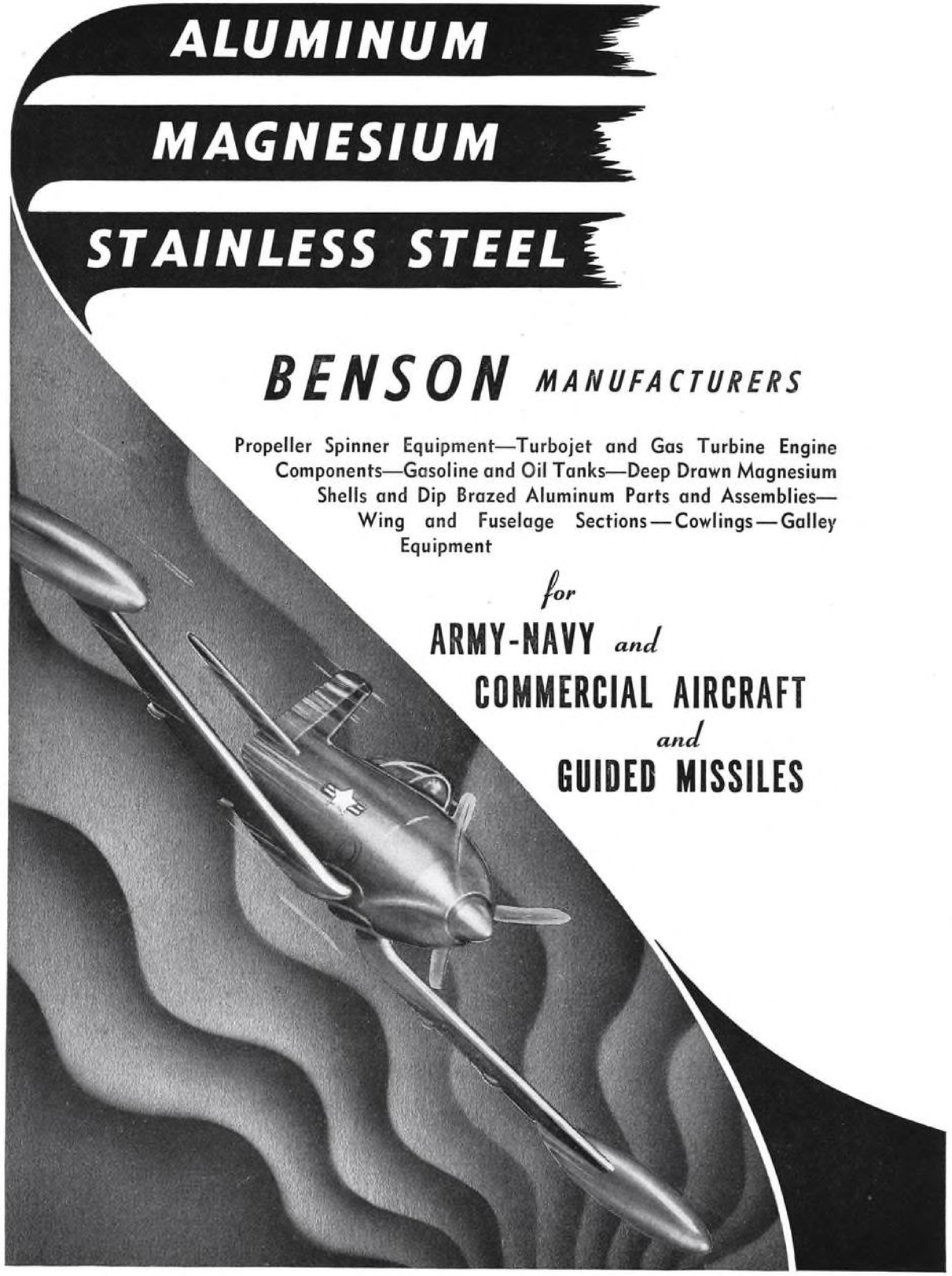
ALUMINUM
MAGNESIUM
STAINLESS STEEL

BENSON MANUFACTURERS

Propeller Spinner Equipment—Turbojet and Gas Turbine Engine Components—Gasoline and Oil Tanks—Deep Drawn Magnesium Shells and Dip Brazed Aluminum Parts and Assemblies—Wing and Fuselage Sections—Cowlings—Galley Equipment

for

ARMY-NAVY *and*
COMMERCIAL AIRCRAFT
and
GUIDED MISSILES



FACILITIES

ENGINEERING DEPT. equipped with complete library, reproduction drawing equipment, and staffed with mechanical and technical engineers with extensive knowledge and thoroughly experienced with basic procedure in development and perfecting the complete product for its particular purpose.

LABORATORY complete with chemical and physical apparatus for Miscroscopic and Metallurgical examination, X-Ray equipment for examination of welds up to two inches in aluminum, equipment to determine electrical resistance of metal surfaces, magnaflux equipment, Rockwell hardness testing equipment, P. H. meters for chemical tests. Pyrometers and all necessary equipment for examination of metal materials in process of manufacture and staffed with Chemists and Metallurgists with extensive experience.

MACHINE TOOL DIVISION equipped with engine and machine lathes, turret lathes, milling machines, boring mills, shapers, grinders, tapping machines, power saws, hardening furnaces, and radials drills.

HYDRAULIC PRESS DEPT. equipped with presses with 200-ton to 1000-ton capacity to produce formed parts measuring up to 6 feet wide and 12 feet long.

MECHANICAL PRESS DEPT. equipped with 15 punch presses ranging up to 100-ton capacity.

SPINNING DEPT. equipped with electric annealing furnaces and 23 spinning machines with capacity up to 60 inches in diameter.

SHEET METAL DEPT. equipped with 12-foot power rolls, 12-foot power brakes, 12-foot power shears, routing machines, nibbling machines, power saws, and drill presses.

WELDING DIVISION equipped with Inert Shielded Argon Welding Equipment, electric spot welders, electric seam welders, electric flash butt welder, heliarch welders, electric arc welders, atomic hydrogen welders, and acetylene gas welders.

DIP BRAZING complete with furnace and quenching facilities, can dip braze aluminum assemblies up to 54" x 54" x 36". Facility is rapid and eliminates machining of any part after brazing for additional hardness if required furnaces are available for aging; dip-brazing is used for conversion of cast housings, elimination of porosity, by the use of formed or drawn sheet aluminum housings.

HEAT TREATING FURNACE—Lindbergh electric heat treating furnaces each with 600 Cubic Foot Capacity, equipped complete with automatic controls and quenching baths.

AGING FURNACES—Lindbergh electric aging furnaces equipped with modern automatic controls; each furnace has 600 cubic foot capacity.

FOUNDRY—Associate, equipped with oil fired furnaces, tram rail, crane, automatic molding machines, sandblasting machines, producing castings from one ounce to five hundred pounds.

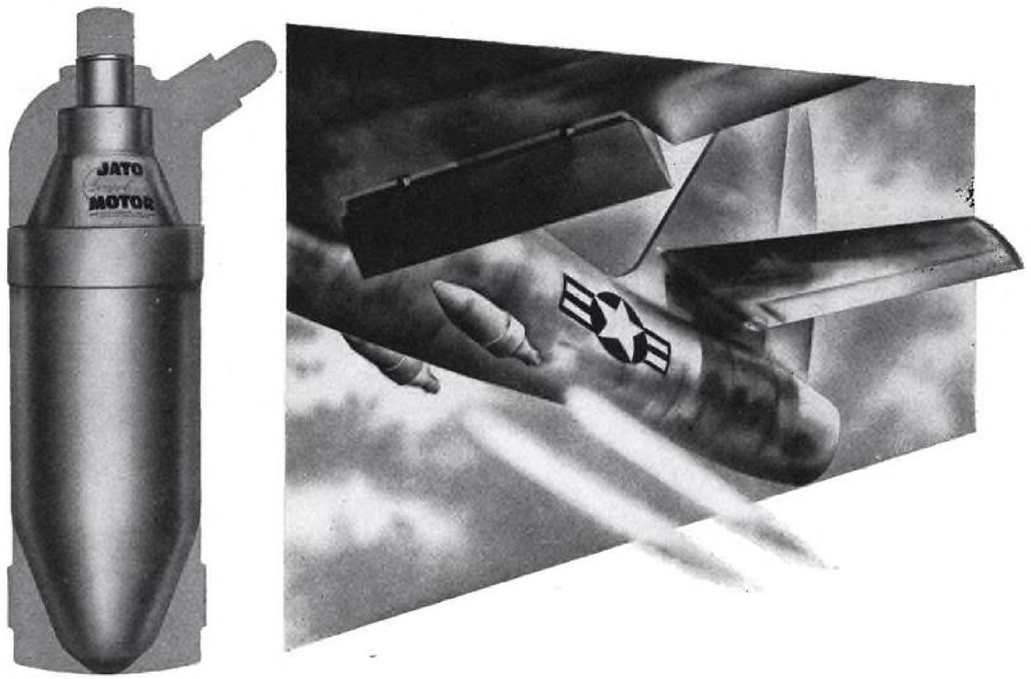
PLATING DEPT.—complete with equipment for cadmium plating steel and iron castings and machined parts.

FINISHING DIVISION—Anodizing, chromatizing, alumilite, enameling and plating plant equipped with tram rail system—4000-gallon tanks, heat exchangers for automatic control laboratory maintained by expert electrochemists, testing tanks, water wash enamel department, chemical dip tanks, drying furnace and ample electric power.

SHIPPING—Crate and box making department equipped with complete wood working equipment and large dock facilities for convenient loading and transportation.

Benson MANUFACTURING CO.

NEW YORK KANSAS CITY LOS ANGELES



REMEMBER THE SMOKE ?
IT'S BEEN TAKEN AWAY ! !

The new, smokeless 15KS-1000 JATO — now in mass production — is proof of Aerojet-General's ability to conduct basic and applied research for the improvement of rocket power plants.

The background and accumulated knowledge of the Aerojet-General research, development, and production staffs have established their leadership for the further development and determination of future applications of ROCKET POWER.

- Solid Propellant Rockets
- Liquid Propellant Rockets
- Missiles, Boosters, and Components
- Specialized Avionics
- Auxiliary Power Units and Gas Generators
- Architect-Engineer Services

Aerojet-General CORPORATION

THE GENERAL TIRE

A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY

AZUSA, CALIFORNIA • SACRAMENTO, CALIFORNIA • CINCINNATI, OHIO • MARION, INDIANA

(*Continued from page 420*)

Thus, although the transcription reveals that the pilot said, "cleared to, uh, Hobart . . . four thousand . . .," the controller said he heard only a three to four second pause in place of "Hobart" and therefore thought the query referred only to whom to report next.

Static and outside noise, including four other radio receivers near the controller's ear, may have caused obliteration of words, according to testimony on this case by Carl F. Kusrow, district supervisor of the facilities operation branch of the CAA in Seattle.

Colonial Profit Cuts Need for Subsidy

Colonial Airlines last week revealed it has reduced its subsidy need to less than one-tenth of last year's requirement to break even after compensatory mail pay. Colonial earned a $375,000 net profit the first half of this year, compared with a $200,000 loss a year ago.

Meanwhile, rivals Eastern and National Airlines await decision of the President on whether either or neither should be approved for purchase of Colonial (AVIATION WEEK Aug. 10, p. 55). Colonial's rapidly improving financial independence is taking some of the urgency out of the merger question.

▶ **Subsidy Halved**—Colonial reported its subsidy need to break even dropped from $816,000 the first half of last year to $77,000 this year—after compensation for cost of hauling the mail. Overall subsidy, including profit element, was cut in half.

Colonial's net working capital, after purchase of a Douglas DC-4 for $640,000 and other capital expenditures, was $554,000 June 30, compared with $918,000 a year ago.

June 30 capitalization was $1,570,000 equity and no long-term debt. Net worth thus increased about $380,000 from last year's equity of $1,191,000.

▶ **Break Even**—Before receiving non-subsidy compensation for carrying mail, Colonial reports break-even need of $170,000 the first half of this year. Compensatory mail rate would yield about $93,000. This leaves non-subsidy deficit of $77,000. First half year usually is Colonial's poorer season. Second half business generally is better.

▶ **Sales Gain**—Commercial revenues increased 51% the first half of this year—from $2,658,000 a year ago to $4,037,000. Bermuda traffic gained 63% and domestic passengers 45%.

▶ **Management**—New management policies include:

• **Sales techniques,** including confirming reservations over scheduled capacity, then running extra sections to take the balance. This includes the unorthodox procedure of sometimes running all planes at once, with no spares. Traffic vice president Robert Hernstein says the airline serves thousands more persons this way than by operating set schedules with spare planes standing by. Plan seldom causes a flight cancelation, he says.

• **Night aircoach,** designated "Owl" service, is patterned after Capital's original "Night Hawk" that blazed the coach trail for other scheduled airlines.

• **Leasing Constellations** for the Bermuda run has improved Colonial's revenues and competitive position with Pan American and BOAC.

Aviation's Women

Every week almost 135,000 women pocket an $11-million slice of the U. S. aircraft manufacturing industries' payroll, says the Aircraft Industries Assn. Yet this is only a part of the economic role aviation plays in the lives of American women today. An additional 20,000 women are working for America's scheduled airlines; another 18,000 are serving in aviation with USAF, Navy and Marines, 3,000 as flight nurses. Uncounted thousands more are employed by airport operators, federal aviation agencies, aircraft contractors and suppliers and air travel agencies.

U. S. Forces ICAO Budget Cutback

(McGraw-Hill World News)

Brighton, England—The seventh session of the International Civil Aviation Organization closed last month and the U. S. delegates could count at least two major objectives achieved:

• **Budget cut** of almost $300,000 was pushed through under strong U. S. pressure. Most of the money was saved by permitting ICAO to draw on its financial reserves. The 60 member states will still contribute $2.5 million this year, a little more than 25% coming from the U. S.

• **Limiting ICAO's activities** where they allegedly encroach upon the province of industry or operators (AVIATION WEEK June 29, p. 67).

The conference also accepted Japan's application for membership, making ICAO the first United Nations agency on which this country is represented.

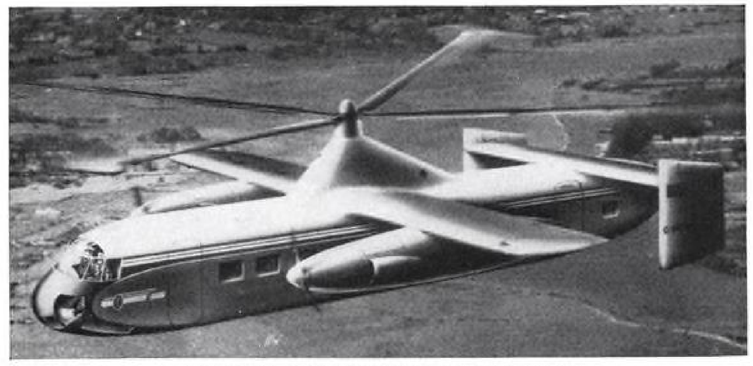
▶ **Other News**—Other developments at the seventh session:

• **Multilateral agreement** on commercial rights, a perennial target in the assembly, was stalled again this year by the U. S. on the grounds that codification of regional commercial rights of operators might work to the disadvantage of trunklines. The assembly approved a request from the Council of Europe that a conference be convened by ICAO "to coordinate and improve European air transport."

• **Definition of nonsked rights,** also opposed by the U. S., was defeated. ICAO's Council was directed to study the problem, especially to see how charter operations could be distinguished from regular services. U. S. held the view that it is too early to expect universal freedom for nonskeds.

• **Factual report on charges** levied on operators for use of airports and radio facilities was ordered. This report is to be forwarded to member governments to enable them reasonably to judge claims made by airport and aircraft operators.

• **More emphasis on implementing** already accepted ICAO standards was called for in an assembly resolution. An exception is the ICAO Airworthiness Standard, which is not binding on anyone.



FAIREY ROTODYNE TRANSPORT

Artist's conception of the new Fairey Rotodyne convertiplane ordered by the Ministry of Supply to meet requirements of British European Airways for a large intercity coach-type rotorcraft. Designed to carry 40-50 passengers, the Rotodyne will be powered by Napier Eland turboprops and have jet-driven four-blade rotors.

Spray Dusters Build Agriculture Plane

A new specialized agricultural airplane—capable of carrying more than 40 cu. ft. of spray, dust, seed or fertilizer—is under construction at Yakima (Wash.) Municipal Airport. The prototype is scheduled to make its first flight in October.

Specifications for the new craft, named the Air Tractor, were laid down by Central Aircraft, Inc., of Yakima, one of the country's largest spray-dust contractors. Engineering was done by Lamson Aircraft Co., Seattle.

In configuration, the Air Tractor is an equal-span twin-bay staggered biplane. Upper surfaces, of gull-wing design, taper sharply at the center section. Upper and lower surfaces are fitted with end-plates. Landing gear is conventional type with tail wheel. Noteworthy features of the plane include:

- **All wing panels** and all control surfaces are interchangeable.
- **Rear of fuselage,** from behind the cockpit to the tail tip is uncovered to permit easy cleaning of the agricultural chemicals.
- **Automotive parts** are used where possible.
- **No instrumentation** is inside the cockpit.

The first Air Tractor is to be powered by a single 450-hp. Pratt & Whitney Wasp Jr. Lighter models, with 220-hp. and 300-hp. engines, are to be flown later.

Central plans to sell the aircraft minus engines. Customers will be able to send their own powerplants to the company for installation in a standard Air Tractor airframe.

Ace Boosts F-86F

(McGraw-Hill World News)

Tokyo—The North American F-86F Sabre is a far better fighting plane than the preceding A and E models and more than a match for Russia's MiG-15, USAF jet ace Maj. James W. Jabara told AVIATION WEEK prior to returning to the U. S.

Jabara said the F-86F has a higher ceiling than earlier Sabres, more speed and better pressurization, defrosting equipment and improved oxygen supply.

Up to 40,000 ft., the new Sabre outperforms the MiG in every category but climb, where the MiG retains a slight edge. The enemy jet also has a slightly higher operational ceiling, but this advantage has been cut by approximately 5,000 ft. The more powerful General Electric J47 engine in the later Sabre permits it to overtake and outstrip the MiG, Jabara said.

The triple jet ace also made these points:

- **Radar gunsight** is indispensable for highspeed combat. Improvements, especially those developed by Project Jaybird (AVIATION WEEK Mar. 2, p. 140), eliminated objections Jabara had towards the device at the end of his first tour of duty in 1951.
- **Emergency systems** pay off and should not be eliminated.

More B-52s?

Air Force officials are still musing over President Eisenhower's reported comment when he inspected Boeing's eight-jet B-52 while in Seattle for the Governors' Conference recently.

The President turned to Boeing president William M. Allen and said:

"Well, I always see something new when I come here."

"New—and expensive," interjected Treasury Secretary George Humphrey.

"That's just like a Secretary of the Treasury," the President replied with a smile. "George, order several hundred of them."

Hexcel

HONEYCOMB

Basic core material used by America's leading aircraft manufacturers—wherever light-weight high strength sandwich structures are demanded.

The radome on the F-86D Sabre Jet is but one of countless production parts fabricated of Hexcel Honeycomb.

Photo courtesy of North American Aviation Company

Write for catalogue: "Structural Honeycomb for Sandwich Construction"

HEXCEL PRODUCTS CO.

Distributors of Honeycomb • Manufactured by
California Reinforced Plastics Company
955 Sixty First Street • Oakland 8, California

structural honeycomb in aluminum · glass fabric · cotton fabric

A new advance in automatic data reduction...

THE TELEDUCER

Automatically converts voltage into decimal digits...*with 0.1% accuracy*

It offers these important advantages:

Provides 0.1% accuracy (±999 counts full scale).
Provides for minimum full-scale input of 10 millivolts (10 microvolts per count) and maximum full scale input of 1.0 volt without external attenuation.
Reads these low voltages **without** D.C. amplification and digitizes higher voltage by means of attenuators.
Requires only 0.8 second or less for balancing.
Uses a simple bridge-balancing circuit.
Does not hunt or oscillate.
Relays digital output to neon lamp bank, punched cards, an electric typewriter, magnetic tape or punched tape.
Recognizes sign of input voltage.
Provides for zero reference shift.

Thermocouples
Strain Gauges
Telemeter Receivers
Record-Reading Devices
Analog Computer Output
Pressure Measuring Elements
→ Teleducer → Program Unit →
Punched Cards
Electric Typewriter
Magnetic Tape
Punched Tape

The Teleducer also serves as a general purpose precision recording laboratory voltmeter.

TELEDUCER Technical Bulletin 104 and Technical Bulletins 106 and 107, giving specifications on the Program Unit and Electric Typewriter, will be mailed you upon request. Coupon below is for your convenience.

Turn hours into minutes with automatic data reduction

TELECOMPUTING CORPORATION
BURBANK, CALIFORNIA

Mr. Preston W. Simms, Dept. AW-8
Telecomputing Corporation, Burbank, California

☐ Please send me Teleducer Bulletin 104.
☐ Please send me Bulletins 106 and 107 on the Program Unit and Electric Typewriter.

Name

Company

Street Address City and State

NEW PILOT PROTECTION WITH THE STURGESS MULTI-DIRECTIONAL Harness Reel

HERE IS THE NEW STURGESS HARNESS REEL THAT PERMITS NORMAL PILOT MOVEMENT AND INSTANTLY SECURES HIM AGAINST INJURY IN EMERGENCY

MULTI-DIRECTIONAL in its protective function. Instantly activated by slight shock load protecting the pilot against injury on instrument panel or other projections.

AUTOMATIC—Locks automatically and is equipped with manual control lever for pilot's use. Entirely mechanical in operation, requiring no auxiliary power such as electricity or hydraulics.

LIGHT WEIGHT—Entire unit, including manual control, weighs only 2 pounds—substantially less than MIL-R-8236 specifications.

TESTED—The Sturgess Harness Reel has successfully passed the most rigid qualification tests, and is in production.

IN PRODUCTION...Write Today
for complete information Dept. AW-8

Pacific SCIENTIFIC CO.

1430 Grande Vista Ave., Los Angeles 23, Calif.
25 Stillman Street, San Francisco 7, California
1915 1st Avenue South, Seattle 4, Washington
806 East Abram Street, Arlington, Texas
EASTERN REPRESENTATIVE: AERO ENGINEERING INC.
Mineola, L.I., N.Y. • Indianapolis • Baltimore • Montreal

■ EDITORIAL INDEX

A

Advanced Development Branch, Aircraft Radiation Lab, Wright Air Development Center, p. 344.

Aerodynamics Branch, Aircraft Lab, Wright Air Development Center, p. 108.

Aero Medical Laboratory, Wright Air Development Center, p. 392.

Aeronautical Research Lab, Wright Air Development Center, p. 113.

Ahalt, C. A., Chief, Installations Branch, Communication and Navigation Lab, Wright Air Development Center, p. 356.

Airborne Electronic Countermeasures, Countermeasures Branch, Aircraft Radiation Lab, Wright Air Development Center, p. 346.

Aircraft Lab, Wright Air Development Center, p. 102.

Aircraft Radiation Lab, Wright Air Development Center, p. 344.

Air Defense Lab, Systems Div., Rome Air Development Center, p. 279.

Air Force Armament Center, Eglin AFB, p. 210; organization chart, p. 212.

Air Force Cambridge Research Center, p. 228; organization chart, p. 230.

Air Force Flight Test Center, Edwards AFB, p. 118; organization chart, p. 120, map, p. 126.

Air Force Missile Test Center, Patrick AFB, p. 170; organization chart, p. 172.

Air Research and Development Command, p. 73; centers and bases, map, p. 74; organization chart, p. 89; field liaison offices, p. 413.

Akers, Col. Marion, Chief of Staff, Air Force Flight Test Center, Edwards AFB, picture, p. 132.

Amann, Col. John R., Commandant, Experimental Flight Test Pilot School, Air Force Flight Test Center, Edwards AFB, p. 146.

Anti-Air Techniques, Guidance Development Branch, Aircraft Radiation Lab, Wright Air Development Center, p. 353.

Armament Branch, Flight Test Engineering Lab, Air Force Flight Test Center, Edwards AFB, p. 132.

Armament Lab, Wright Air Development Center, p. 386.

Armament Test Facilities Lab, Air Force Armament Center, Eglin AFB, p. 216.

Arnold Engineering Development Center, p. 150; facilities chart, p. 154; map, p. 166; organization chart, p. 162.

Atmospheric Analysis Activity, Geophysics Research Directorate, AF Cambridge Research Center, p. 242.

Atmospheric Analysis Lab, Geophysics Research Directorate, AF Cambridge Research Center, p. 244.

Atmospheric Devices Activity Geophysics Research Directorate, AF Cambridge Research Center, p. 242.

Atmospheric Physics Lab, AF Cambridge Research Center, p. 232.

Atomic Warfare Div., Cambridge Research Center, p. 229.

Automatic Flight Control Branch, Armament Lab, Wright Air Development Center, p. 390.

B

Badger, S., Chief, Tube Tester Sect., Electron Tube Branch, Electronic Components Lab, Wright Air Development Center, p. 382.

Bechtel, Col. Paul S., Deputy Chief of Staff, Test Operations, Air Force Armament Center, Eglin AFB, p. 213.

Behrens, Fred, Chief, Dielectrics Sect., Components Development Branch, Electronic Components Lab, Wright Air Development Center, p. 370.

Biophysics Branch, Aero Medical Lab, Wright Air Development Center, p. 404.

Blount, Col. Robert L., chief, Aero Medical Lab, Wright Air Development Center, p. 392; picture, p. 406.

Bomber Defense Branch, Armament Lab, Wright Air Development Center, p. 389.

Boone, Lt. Col. Harry F., Deputy Commander, Guided Missile Test Group, Holloman Air Development Center, p. 187.

Boushey, Col. H. A., Director, Weapons Systems Div., Wright Air Development Center, p. 83.

Boyd., Maj. Gen. Albert, Commander, Wright Air Development Center, picture, biography, p. 101.

Brombach, Col. C. U., Chief, Communications and Navigation Lab, Wright Air Development Center, p. 356.

C

Cain, Lt. Col. C. C., Chief, Operations and Plans, Aero Medical Lab, Wright Air Development Center, p. 392; picture, p. 407.

Carter, Col. R. S., Chief, Electronic Components Lab, Wright Air Development Center, p. 368.

Chaffee, M. H., Chief, System Projects Office, AF Cambridge Research Center, p. 320.

Chamberlain, J. E., Chief, Test Branch, Communications and Navigation Lab, Wright Air Development Command, p. 356.

Choy, Capt. Daniel, S. J., development of Aeroplast bomb, Aero Medical Lab, Wright Air Development Center, p. 394.

Clementson, Lt. Col. G. C., Chief, Fixed Gunnery Branch, Armament Lab, Wright Air Development Center, p. 388.

Clothing Branch, Aero Medical Lab, Wright Air Development Center, p. 404.

Cobb, Andrew C., Chief of Photo-Optics Branch, Armament Test Facilities Lab, Air Force Armament Center, Eglin AFB, p. 219.

Communications and Navigation Lab, Wright Air Development Center, p. 356.

Communications Branch, Communications and Navigation Lab, Wright Air Development Center, p. 363.

Communications Lab, Components and Techniques Group, Electronics Research Directorate, AF Cambridge Research Center, p. 320.

Components and Techniques Group, Electronics Research Directorate, AF Cambridge Research Center, p. 320.

Components Development Branch, Electronic Components Lab, Wright Air Development Center, p. 370.

Components Test Branch, Electronic Components Lab, Wright Air Development Center, p. 381.

Countermeasures Branch, Aircraft Radiation Lab, Wright Air Development Center, p. 346.

Craigie, Lt. Gen. L. C., USAF Deputy Chief of Staff Development, picture, p. 78.

Cruickshank, Col. A. W., Jr., Chief of Staff, Air Force Armament Center, Eglin AFB, picture, p. 219.

Cruickshank, John, Chief, Radar Search and Height Finding Sect., Equipment Development Div., Rome Air Development Center, p. 288.

D

Data Reduction Branch, Flight Test Engineering Lab, Air Force Flight Test Center, Edwards AFB, p. 132.

Davis, Harry, Technical Director, Rome Air Development Center, picture, p. 260.

Deis, W. E., Chief, Electromechanical Test Sect., Components Development Branch, Electronic Components Lab, Wright Air Development Center, p. 382.

Demler, Col. M. C., Vice Commander, Wright Air Development Center, picture, p. 102.

Deputy for Research & Development, Rome Air Development Center, organization chart, p. 252.

Design Branch, Aircraft Lab, Wright Air Development Center, p. 108.

Design Engineering Branch, Aircraft Radiation Lab, Wright Air Development Center, p. 354.

Dicke, A. H., Chief, Electronic Tube Branch, Electronic Components Lab, Wright Air Development Center, p. 370.

Directorate of Flight and All-Weather Testing, Wright Air Development Center, p. 110.

Directorate of Flight Tests and Development, Air Force Flight Test Center, Edwards AFB, p. 125.

Directorate of Laboratories, Wright Air Development Center, p. 102.

Directorate of Research, Wright Air Development Center, p. 102.

Dodge, Lt. Col. J. A., Project Officer, Gas Dynamics Facility, Arnold Engineering Development Center, p. 152.

Donicht, Col. Harry, Commander, 4925th Test Group (Atomic), AF Special Weapons Center, p. 94; picture, p. 97.

Doubleday, Brig. Gen. Daniel Campbell, Commander, Rome Air Development Center, picture, biography, p. 251.

Doyle, C. E., Chief, Resistance, Inductance and Capacitance Sect., Electronic Components Lab, Wright Air Development Center, p. 370.

Dunn, W. S., Chief, Systems Div., Rome Air Development Center, picture, p. 279.

Dynamics Branch, Aircraft Lab, Wright Air Development Center, p. 108.

E

Electron Tube Branch, Electronic Components Lab, Wright Air Development Center, p. 382.

Electronic Components Lab, Wright Air Development Center, p. 368.

Electronic Warfare and Techniques Div., Rome Air Development Center, p. 300.

Electronic Warfare Lab, Electronics Warfare and Techniques Div., Rome Air Development Center, p. 302.

Electronics Research Directorate, AF Cambridge Research Center, p. 316.

Elvin, Lt. Col. Malcolm P., Chief, Base Development Div., Air Force Flight Test Center, Edwards AFB, p. 144.

Engine Test Facility, Arnold Engineering Development Center, p. 150.

Engineering and Development Branch, Aero Medical Lab, Wright Air Development Center, p. 404.

Engineering Lab. Directorate of Flight Tests and Development, Air Force Flight Test Center, p. 132.

Engineering Support Div., Rome Air Development Center, p. 278; p. 308.

Equipment Development Div., Rome Air Development Center, p. 286.

Equipment Lab, Wright Air Development Center, p. 113.

Everest, Lt. Col. Frank K., Director of Flight Test, Air Force Flight Test Center, Edwards AFB, picture, p. 136.

Experimental Flight Test Pilot School, Air Force Flight Test Center, Edwards AFB, p. 145.

SCHULZ

means PRECISION and SKILL
in the fabrication of

Components and Assemblies for Jet Aircraft

Automatic fuel level control valves
Fuel shut-off valves
Fuel transfer valves
Micronic fuel filters
Fuel strainers
Fuel vent valves
and other essential components

SCHULZ Tool and MFG. Co.

425 S. Pine St. San Gabriel, Calif.

Aetco

TESTING SERVICE

AETCO is equipped and staffed to perform almost any conceivable test on all types of aircraft components.

AETCO tests are recognized as accurate and dependable. AETCO reports are prompt and complete.

In-Flight Testing, too!

Aetco AIRCRAFT EQUIPMENT TESTING COMPANY
1806-12 FLEET ST. BALTIMORE 31, MD.

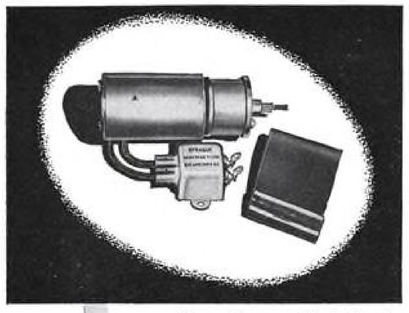


Photo Courtesy Globe Industries

Miniaturized Antenna Motor Filter

Reduces Control Motor Noise . . . Occupies Only 1/5 of Original Volume

PROBLEM—Engineers of a large Western aircraft manufacturer required components with greater reliability, yet smaller in size, for the suppression of noise from control motors in airborne radar. Any new design would have to meet Military Specifications MIL-I-6181.

SOLUTION—Sprague's Radio Noise Suppression Laboratories at Culver City, Calif., tackled the problem and came up with the filter shown above . . . tailored specifically for the permanent magnet motor involved. Dimensions: $1\frac{1}{8}$" x 1" x $\frac{15}{16}$", 80% size reduction from the filter previously used by the aircraft manufacturer. And the reliability requirements were more than met!

RESULT—Let Robert Stein, Vice President in Charge of Engineering, Globe Industries, Inc., 125 Sunrise Ave., Dayton, O., tell you in his own words: "As the manufacturer of this permanent magnet control motor, we now furnish it complete with the Sprague tailor-made filter installed and have adopted this filter as standard on other applications, because of its small size, light weight, and excellent performance."

PRODUCTION SCHEDULES for such filters designed by Sprague's California labs are regularly met by Sprague's extensive pilot plant and mass-manufacturing facilities, the former for those sizzling rush orders, the latter for volume needs. For help with your radio noise filter applications, write, wire, or phone Sprague Electric Co., 11325 Washington Blvd., Culver City, Calif. (TExas 0-7491) or North Adams, Mass. (North Adams 423).

Sprague on request will provide you with complete application engineering service for optimum results in the use of radio noise filters.

YOU CAN DEPEND ON

SPRAGUE

EDITORIAL INDEX

F

Fischer, Heinz, Spectroscopy Sect., Antenna Lab, Directorate Services Branch, Electronics Research Directorate, AF Cambridge Research Center, p. 340.

Fixed Gunnery Branch, Armament Lab, Wright Air Development Center, p. 388.

Flight Development Test Branch, Flight Test Engineering Lab, Air Force Flight Test Center, Edwards AFB, p. 129.

Flight Research Branch, Flight Test Engineering Lab, Air Force Flight Test Center, Edwards AFB, p. 129.

Flight Test Engineering Lab, Directorate of Flight Tests and Development, Air Force Flight Test Center, p. 126.

Flight Test Operations Lab, Directorate of Flight Tests and Development, Air Force Flight Test Center, p. 126.

Flinn, N. D., Chief, General Purpose Test Equipment Branch, Electronic Components Lab, Wright Air Development Center, p. 370.

Foster, Lt. Col. Gilbert, Chief of Armament Test Facilities Lab, Air Force Armament Center, Eglin AFB, p. 216.

Franklin, C. S., Chief, Ground Reference Navigation Branch, Communications and Navigation Lab, Wright Air Development Center, p. 356.

Fuels and Ore Branch, Powerplants Lab, Wright Air Development Center, p. 108.

G

Gabelman, I. J., Chief, Strategic Air Command and Military Air Transport Command Lab, Systems Div., Rome Air Development Center, p. 283.

Gardner, Trevor, Special Assistant for R&D on USAF Secretary's staff, picture, p. 80.

Gas Dynamics Facility, Arnold Engineering Development Center, p. 152.

Gauer, Dr. O. H., Biophysics Branch, Aero Medical Lab, Wright Air Development Center, p. 403.

General Purpose Test Equipment Branch, Electronic Components Lab, Wright Air Development Center, p. 379.

General Purpose Test Equipment Branch, Electronic Components Lab, Wright Air Development Center, p. 383.

Geophysics Research Directorate, Cambridge Research Center, p. 231.

Gerson, N. C., Head, Ionospheric Physics Activity, Geophysics Research Directorate, Cambridge Research Center, p. 239.

Gibbs, L. L., Chief, Receiving Tube Section, Electron Tube Branch, Electronic Components Lab, Wright Air Development Center, p. 382.

Godfrey, Maj. E. O., Chief, Bomber Defense Branch, Armament Lab, Wright Air Development Center, p. 389.

Golueke, C. A., Chief, Mechanical Section, Components Development Branch, Electronics Lab, Wright Air Development Center, p. 370.

Great Plains Turbulence Field Project, Atmospheric Analysis Lab, Geophysics Research Directorate, AF Cambridge Research Center, p. 245.

Greene, Benjamin F., Jr., AF Cambridge Research Center, p. 343.

Ground Reference Navigation Branch, Communications and Navigation Lab, Wright Air Development Center, p. 356.

Guidance Development Branch, Aircraft Radiation Lab, Wright Air Development Center, p. 351.

H

Hale, Maj. L. J., Head, Project Plans Div., Air Force Armament Center, Eglin AFB, p. 214.

Handelsman, Morris, Chief. Research and Applied Techniques Lab, Electronic Warfare and Techniques Div., Rome Air Development Center, p. 302.

Harris, Jr., Brig. Gen. Samuel, Commander, Arnold Engineering Development Center, picture, biography, p. 152.

Hayes, J. R., Chief, Transmitting Tube Sect., Electron Tube Branch, Electronic Components Lab, Wright Air Development Center, p. 382.

Haywood, Col. Oliver G., Jr., Chief, Office of Scientific Research, Headquarters, Air Research and Development Command, p. 87.

Heavner, Col., Williams, Deputy for Research and Development, Rome Air Development Center, p. 258.

Heim, J. W., Chief, Physiology Branch, Aero Medical Lab, Wright Air Development Center, picture, p. 409.

Hilt, Lt. Col. W. M., Chief, Strategic Bombing Branch, Armament Lab, Wright Air Development Center, p. 385.

Hoffman, Robert C., Head, office of Plans and Controls, Armament Test Facilities Lab, Air Force Armament Center, Eglin AFB, p. 216.

Hollingsworth, L. M., Chief, RF Components Lab, Components and Techniques Group, Electronics Research Directorate, AF Cambridge Research Center, p. 328.

Holloman Air Development Center, p. 186; Organizational Chart, p. 188.

Holloway, F. L., Technical Director, Aircraft Radiation Lab, Wright Air Development Center, p. 344.

Holt, F. S., Antenna Lab, Directorate Services Branch, Electronics Research Directorate, Cambridge Research Center, p. 339.

Holtoner, Brig. Gen. J. Stanley, Commander Air Force Flight Test Center, Edwards AFB, picture, biography, p. 121.

Holzman, Col. Benjamin, Director of Research and Development, AF Special Weapons Center, picture, p. 97.

Hooks, Col. Daniel, Vice-Commander, AF Special Weapons Center, picture, p. 97.

Houser, R. E., Chief, Guidance Development Branch, Aircraft Radiation Lab, Wright Air Development Center, p. 344.

Hull, Dr. Wayland, physiologist, Aero Medical Lab, Wright Air Development Center, p. 397.

Human Factors Branch, Flight Test Engineering Lab, Air Force Flight Test Center, Edwards AFB, p. 129.

Installation Branch, Powerplants Lab, Wright Air Development Center, p. 108.

I

Installation Engineering Branch, Aircraft Radiation Lab, Wright Air Development Center, p. 344.

Installations Branch, Communications and Navigation Lab, Wright Air Development Center, p. 366.

Installations Engineering Branch, Aircraft Radiation Lab, Wright Air Development Center, p. 355.

Instrumentation Branch, Flight Test Engineering Lab, Air Force Flight Test Center, Edwards AFB, p. 129.

Ionospheric Physics Lab, Geophysics Research Directorate, Cambridge Research Center, p. 239.

J

Jack, Col. J. C., Head, Atomic Warfare Div., AF Cambridge Research Center, p. 229.

Jacobs, Yale, Chief, General Engineering Sect., Components Development Branch, Electronic Components Lab, Wright Air Development Center, p. 370.

RREP has been the prime developer, designer, and producer of precision electronic telemeter equipment since the industry's infancy back in 1942 . . .

RREP TELEMETRY systems are presently used by U.S. military agencies, many foreign governments, most major aircraft companies, and numerous research and industrial organizations . . . This invaluable experience puts no premium on the cost of RREP equipment. Naturally, we will discuss your plans in complete confidence.

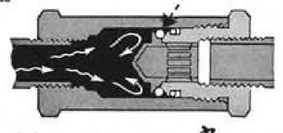
RREP

RAYMOND ROSEN ENGINEERING PRODUCTS, Inc.
32nd & Walnut Streets • Philadelphia 4, Pa.

when only the BEST is right!

. . . Be sure by specifying "CIRCLE-SEAL" Valves - - -

The "Circle-Seal" principle affords perfect leakproof performance with inches of water or thousands of pounds differential . . . non-chattering action . . . cushioned closing . . . which prevents wear or damage to seats



The ultimate answer to check valve requirements from very low pressure to 3,000 psi.

CIRCLE SEAL
PRECISION CHECK VALVES
LOW PRESSURE RELIEF VALVES
SHUTTLE VALVES
FLOW LIMITER VALVES

Send for free engineering data

JAMES-POND-CLARK
2181 E. Foothill Blvd. • Pasadena 8, Calif.

Over 85% of the torque wrenches used in industry are

STURTEVANT TORQUE WRENCHES
Read by Sight, Sound or Feel.

- Permanently Accurate
- Practically Indestructible
- Faster—Easier to use
- Automatic Release
- All Capacities

in inch ounces . . . inch pounds . . . foot pounds (All Sizes from 0-6000 ft. lbs.)

Every manufacturer, design and production man should have this valuable data. Sent upon request.

P.A. STURTEVANT CO.
ADDISON QUALITY ILLINOIS

HERE IS THE SOLUTION

to many metering and positioning problems requiring extreme sensitivity *and* extreme durability.

Texas Instruments originally developed this sensitive, smooth, linear and long-lived **magnetic fluid clutch meter/positioner** to solve a 30° bi-directional recording problem in some airborne military gear. Simply and durably built, it far outlasts anything similar we've ever seen (over 3000 hours continuous duty at rated load).

In essence, it consists of two TI-developed magnetic fluid clutches (weighing .46 lb each) working in opposition. Input current of 100 microamps causes a 6° output shaft deflection with from 10 to 500 microamps being measurable. General data is appended.

If *you* are being perplexed by a metering/positioning problem demanding a rugged — yet sensitive and accurate — movement, just drop us a line and we'll be glad to answer your questions in detail.

TI magnetic fluid clutch meter/positioner

SPECIFICATIONS

Meter/Positioner Movement

Sensitivity.....6° per 100 microamps
Accuracy.....±5%
Life.....3000 hr @ rated load
Frequency Response
.....Flat to 5 cps, as applied
Deflection.....30° either side of zero
Min. Input Signal.....10 microamps
Max. Input Signal.....500 microamps
Ambient Temp. Range...—40 to +75° C
Coil Impedance....15,000Ω, 450 henries

following data taken w/o springs

Output Torque
.....0.125 oz-in./100 microamps
Maximum Output Torque
.....5.25 oz-in. at 4 milliamps

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVE. DALLAS 9, TEXAS

■ EDITORIAL INDEX

Joint Parachute Test Facility, Air Research and Development Command, p. 411.

K

Kelier, C. N., Chief, Design Engineering Branch, Aircraft Radiation Lab, Wright Air Development Center, p. 344.

Kester, R. E., Chief, Techniques Branch, Communications and Navigation Lab, Wright Air Development Center, p. 356.

Keto, John E., Technical Director, Wright Air Development Center, picture, p. 107.

Koenig, P. E., Technical Director, Armament Lab., Wright Air Development Center, p. 386.

Kronauer, Lt. Col. C. J., Director, Test Operations, Air Force Armament Center, Eglin AFB, picture, p. 222.

Kunze, Alan A., Chief, Equipment Development Div., Rome Air Development Center, picture, p. 286.

L

Lane, D. L., Chief, Components Test Branch, Electronic Components Lab, Wright Air Development Center, p. 370.

Larson, R. D., Chief, Transistor Sect., Electron Tube Branch, Electronic Components Lab, Wright Air Development Center, p. 382.

Lewis, Col. C. H., Chief, Aircraft Radiation Lab, Wright Air Development Center, p. 344.

Libby, Richard, Chief, Detection and Evaluation Sect., Electronic Warfare Lab, Electronic Warfare and Techniques Div., Rome Air Development Center, p. 302.

Lingard, Col. A. I., Chief, Automatic Flight Control Branch, Armament Lab, Wright Air Development Center, p. 390.

Ljunggren, Col. Ernest, Asst. for Development Weapons Systems Div., ARDC Hq., p. 83.

Longiaru, A. J., Automatic Flight Control Branch, Armament Lab, Wright Air Development Center, p. 390.

Long Range Missile Test Range, Patrick AFB, map, p. 183.

Luke, Maj. Ernest P., Research Test Branch, Holloman Air Development Center, p. 194.

M

Maintenance Lab, Directorate of Flight Tests and Development, Air Force Flight Test Center, Edwards AFB, p. 132.

Marks, Ralph, Chief, Radio Equipment Communications Sect., Equipment Development Div., Rome Air Development Center, p. 296.

Marshall, C. J., Chief, Search Radar Branch, Aircraft Radiation Lab, Wright Air Development Center, p. 344.

Materials Lab, Wright Air Development Center, p. 116.

Maude, Maj. Gen. Raymond Coleman, Commander, AF Cambridge Research Center, picture, biography, p. 229.

Mayer, I. S., Chief, Electromechanical Sect., Components Development Branch, Electronic Components Lab, Wright Air Development Center, p. 370.

McDowell, C. W., Chief, Mechanical Test Sect., Components Development Branch, Electronic Components Lab, Wright Air Development Center, p. 382.

Mechanical Branch, Aircraft Lab, Wright Air Development Center, p. 108.

Mechling, Brig. Gen. Edward Pont, Commander, Air Force Armament Center, picture, biography, p. 211.

Miller, M. W., Chief, Dielectric Test Sect., Components Development Branch, Electronic Components Lab, Wright Air Development Center, p. 382.

Mills, Maj. Gen. John S., Commander, Special Weapons Center, ARDC, Kirtland AFB, picture, biography, p. 91.

Moore, Col. Walter, Director of Flight Test and Development, Air Force Flight Test Center, Edwards AFB, picture, p. 133.

Moskowitz, Fred, Chief, Lab 1, Equipment Development Div., Rome Air Development Center, p. 294.

Mountain Wave Project, Atmospheric Analysis Lab, Geophysics Research Directorate, Cambridge Research Center, p. 244.

N

Nelson, W. H., Chief, Special Tube Sect., Electron Tube Branch, Electronic Components Lab, Wright Air Development Center, p. 382.

Newman, Philip, Chief, Propagation Lab, Components and Techniques Group, Electronics Research Directorate, AF Cambridge Research Center, p. 327.

Noble, H. V., Technical Director, Electronic Components Lab., Wright Air Development Center, p. 370.

Non-Rotating Engine Branch, Powerplants Lab, Wright Air Development Center, p. 108.

Norton, Col. H. W., Commander, Range Group, Missile Test Center, Patrick AFB, picture, p. 184.

Nuclear Propulsion Branch, Powerplants Lab, Wright Air Development Center, p. 108.

O

Office of Scientific Research, Air Research and Development Command, p. 87.

Ostrander, Col. Don, Commander, Holloman Air Development Center, picture, biography, p. 187.

P

Packard, Lt. Col. P. L. M., Chief, Research and Development Procurement, Rome Air Development Center, picture, p. 265.

Parachute Branch, Holloman Air Development Center, p. 204.

Partridge, Lt. Gen. Earle, picture, p. 79.

Paul, Col. Franklin, Vice-Commander, Rome Air Development Center, picture, p. 256.

Peoples, Dr. James, Head, Terrestrial Sciences Lab, Geophysics Research Directorate, AF Cambridge Research Center, p. 240.

Performance Test Branch, Flight Test Engineering Lab, Air Force Flight Test Center, Edwards AFB, p. 129.

Phillips, Col. S. C., Chief, Plans Office, Armament Lab, Wright Air Development Center, p. 386.

Photo Branch, Flight Test Engineering Lab, Air Force Flight Test Center, Edwards AFB, p. 132.

Photo-Optics Branch, Armament Test Facilities Lab, Air Force Armament Center, Eglin AFB, p. 219.

Photo Reconnaissance Lab, Wright Air Development Center, p. 115.

Physiology Branch, Aero Medical Lab, Wright Air Development Center, p. 404.

Polve, Maj. James H., Chief, performance Section, Experimental Flight Test Pilot School, Air Force Flight Test Center, Edwards AFB, p. 146.

Powerplants Lab, Wright Air Development Center, p. 108.

Preliminary Design Group, Aircraft Lab, Wright Air Development Center, p. 108.

Project Lincoln, AF Cambridge Research Center, p. 229; Lincoln Lab, p. 231.

Project Reliable, Armament Lab, Wright Air Development Center, p. 386.

Project Volir, AF Cambridge Research Center, p. 343.

Propagation Lab, Components and Techniques Group, Electronics Research Directorate, AF Cambridge Research Center, p. 326.

Propeller Lab, Wright Air Development Center, p. 113.

Propulsion Windtunnel, Arnold Engineering Development Center, p. 154.

Psychology Branch, Aero Medical Lab, Wright Air Development Center, p. 404.

R

RF Components Lab, Components and Techniques Group, Electronics Research Directorate, AF Cambridge Research Center, p. 328.

Ramjet Addition, Engine Test Facility, Arnold Engineering Development Center, p. 151.

Rappaport, George, Chief, Countermeasures Branch, Aircraft Radiation Lab, Wright Air Development Center, p. 344.

Republic F-84F Project, Air Force Flight Test Center, Edwards AFB, p. 133.

Research and Applied Techniques Lab, Electronic Warfare and Techniques Div., Rome Air Development Center, p. 302.

Research Directorate, Special Weapons Center, ARDC, Kirtland AFB, p. 94.

Research Test Branch, Holloman Air Development Center, p. 194.

RF Components Lab, Components and Techniques Group, Electronics Research Directorate, AF Cambridge Research Center, p. 328.

Richardson, Col. F. H., Chief of Staff, Arnold Engineering Development Center, p. 150.

Richardson, Maj. Gen. William Lloyd, Commander, Air Force Missile Test Center, Patrick AFB, picture, biography, p. 175.

Ridley, Lt. Col. Jackie L., Chief, Flight Test Engineering Lab, Air Force Flight Test Center, Edwards AFB, p. 125.

Rippin, J. F., Chief, Resistance, Inductance and Capacitance Test Sect., Components Development Branch, Electronic Components Lab, Wright Air Development Center, p. 382.

Rocket Branch, Engineering Lab, Directorate of Flight Tests and Development, Air Force Flight Test Center, Edwards AFB, p. 132.

Rocket-Sounding Activity, Geophysics Research Directorate, Cambridge Research Center, p. 239.

Rogers, T. F., Asst. Lab Chief, Propagation Lab, Components and Techniques Group, Electronics Research Directorate, AF Cambridge Research Center, p. 327.

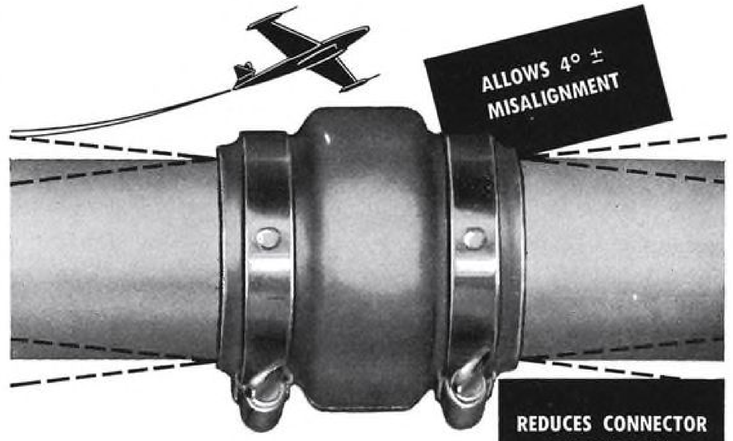
Rome Air Development Center, p. 251; organization chart, p. 250; procurement, p. 262.

Rosenberg, H. S., Chief, Self-Contained Navigation Branch, Communications and Navigation Lab, Wright Air Development Center, p. 356.

Rotman, Walter, Antenna Lab, Directorate Services Branch, Electronics Research Directorate, AF Cambridge Research Center, p. 339.

S

Samson, E. W., Chief, Communications Lab, Components and Techniques Group, Electronics Research Directorate, AF Cambridge Research Center, p. 320.

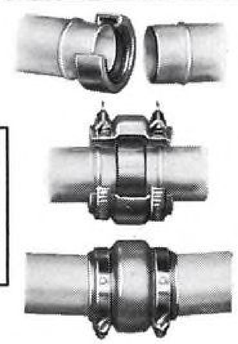


Manufactured and sold under license from Northrop Aircraft, Incorporated. In use on current fighters, bombers and missiles.

Here's the answer to the need for efficiency, simplicity and flexibility in fluid line connections. Rubber Teck's flexible fluid line connectors are effective with misalignment up to 4°, materially absorb vibration and torque motions as well as axial expansion and contraction, while maintaining a positive, fluid-tight seal. Available for tube sizes from 1" to 4½" O.D. Test data shows this unit meets or surpasses requirements of NAS 512 specification, with satisfactory performance under temperature range from 160° F to −65° F; pressures from 160 PSIG to 28½ inches Hg vacuum. Special requirements at greater extremes of temperature and pressure can be accommodated.

Write today for technical bulletin showing how Rubber Teck research, development and manufacture can help you.

No Leak-No Strain with RUBBER TECK'S FLEXIBLE FLUID LINE CONNECTORS



Easy on—Easy off

Installation of the Rubber Teck Connector is accomplished in three simple steps, without using special tools. View 1—insert beaded ends of tubing into seal assembly. View 2—place clamp assembly into position over the seal. View 3—close the clamp and tighten thumb screws.

Other **RUBBER TECK PRODUCTS**

- Flexible Breakaway Connectors
- Flexible Hot Air Duct Connectors
- Rigid-type Lightweight Duct Connectors

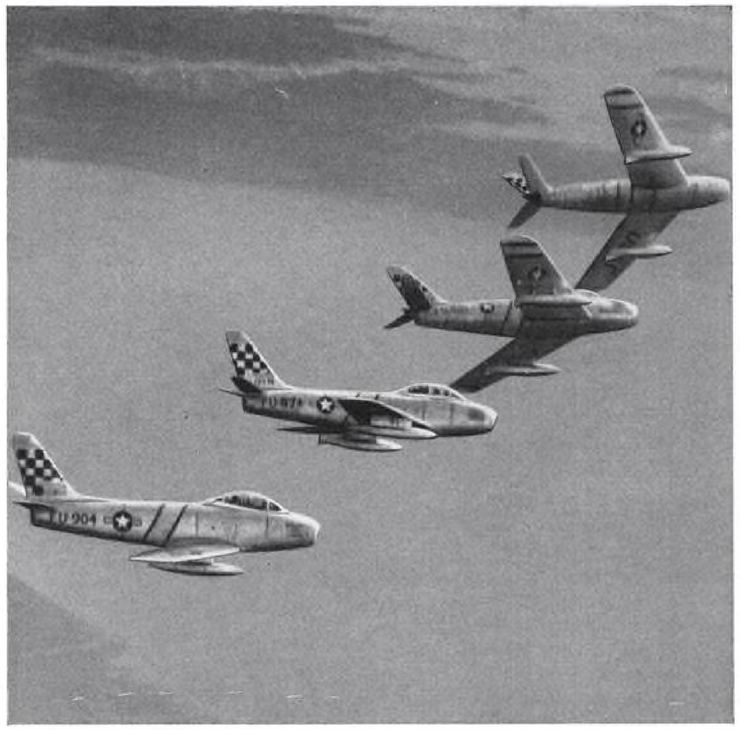
RUBBER TECK

RUBBER TECK, Inc.

19115 S. HAMILTON STREET, GARDENA, CALIFORNIA

Engineering Service Representatives

RUBBER TECK SALES & SERVICE CO.
8479 Higuera Street, Culver City, Calif., TExas 0-6836
5439 Harford Rd., Baltimore, Maryland, CLifton 4-967



SABRE JET'S EDGE CUTS DEEPER

. . . *with* PASTUSHIN TANKS

Pastushin-made jettisonable fuel tanks give North American Aviation's F-86 greater fuel capacity . . . give it that fighting edge in Korean combat.

AIRCRAFT FUEL TANKS • SEATS • LANDING FLAPS
AILERONS • TAIL SURFACES • BOMB BAY DOORS

PASTUSHIN AVIATION CORPORATION

5651 West Century Boulevard • Los Angeles 45, California
LOS ANGELES INTERNATIONAL AIRPORT, LOS ANGELES, CALIFORNIA

The Stephen-Douglas Co. INC.

LICENSED ENGINEERS • R & D SPECIALISTS

2950 NEBRASKA AVENUE
SANTA MONICA, CALIFORNIA
TELEPHONE EXbrook 3-4785

NEW WESTERN SWING...

ELECTROLIZING

—for longer wearing production parts and freedom from corrosion. Write for information.

ELECTROLIZING SALES and TOOLS, Inc.
1406 E. 15th St., Los Angeles 21

EDITORIAL INDEX

Savely, H. E., Chief, Bio-Physics Branch, Aero Medical Lab, Wright Air Development Center, picture, p. 410.

Schaffer, Maj. Louis, head, Technical Support Directorate, Air Force Armament Center, Eglin AFB, p. 226.

Scheer, G. H., Jr., Chief, Communications Branch, Communications and Navigation Lab, Wright Air Development Command, p. 356.

Schlegelmilch, R. O., Chief, Electronic Warfare and Techniques Div., Rome Air Development Center, p. 302; picture, p. 304.

Schneider, E. G., Director, Electronic Research Directorate, AF Cambridge Research Center, p. 318; picture, p. 319.

Schulte, Lt. Col. O. J., Assistant Deputy for Research and Development, Rome Air Development Center, p. 260.

Search Radar Branch, Aircraft Radiation Lab, Wright Air Development Center, p. 347.

Self-Contained Navigation Branch, Communications and Navigation Lab, Wright Air Development Center, p. 356.

Service Branch, Aero Medical Lab, Wright Air Development Center, p. 404.

Simons, Maj. David, Space Biology Lab, Holloman Air Development Center, p. 199.

Sletter, C. J., Antenna Lab, Directorate Services Branch, Electronic Research Directorate, Cambridge Research Center, p. 339.

Smith, Capt. J. V., Head, Parachute Branch, Holloman Air Development Center, p. 204.

Snider, P. J., Chief, Advanced Development Branch, Aircraft Radiation Lab, Wright Air Development Center, p. 344.

Space Biology Lab, Holloman Air Development Center, p. 196.

Special Projects Branch, Aircraft Lab, Wright Air Development Center, p. 108.

Special Test Facilities, AF Flight Test Center, Edwards AFB, p. 121.

Special Weapons Center, ARDC, Kirtland AFB, p. 90; organization chart, p. 96.

Stewart, Col. S. R., Chief of Staff, Wright Air Development Center, picture, p. 110.

Stolzenbach, R. W., Chief, Calibration and Standards Sect., Components Development Lab, Wright Air Development Center, p. 382.

Storrs, Ernest, Chief, Lab 1, Equipment Development Div., Rome Air Development Center, p. 286.

Strategic Air Command and Military Air Transport Command Lab, Systems Div., Rome Air Development Center, p. 280.

Strategic Bombing Branch, Armament Lab, Wright Air Development Center, p. 386.

Stuetzer, O. M., Chief, Tube Techniques Sect., Electron Tube Branch, Electronic Components Lab, Wright Air Development Center, p. 382.

Summerfelt, Col. Milton F., Commander, Rome Air Development Center Depot, picture, p. 265.

Sverdrup and Parcel Operating Div., Arnold Engineering Development Center, p. 162.

Systems Div., Rome Air Development Center, p. 278.

Systems Projects Office, AF Cambridge Research Center, p. 320.

T

Tactical Air Command Lab, Systems Div., Rome Air Development Center, p. 280.

Tactical Bombing Branch, Armament Lab, Wright Air Development Center, p. 389.

Tallman, O. G., Chief, Engineering Support Div., Rome Air Development Center, p. 308.

Technical Advisory Group, Air Force Armament Center, Eglin AFB, p. 211.

Technical Information Sect., Services Branch, Engineering Support Div., Rome Air Development Center, p. 315.

Technical Support Directorate, Air Force Armament Center, Eglin AFB, p. 226.

Techniques Branch, Armament Lab, Wright Air Development Center, p. 390.

Techniques Branch, Communications and Navigation Lab, Wright Air Development Center, p. 365.

Terrestrial Sciences Lab, Geophysics Research Directorate, Cambridge Research Center, p. 240.

Test and Evaluation Lab, Engineering Support Div., Rome Air Development Center, p. 315.

Test Branch, Communications and Navigation Lab, Wright Air Divelopment Center, p. 366.

Test Operation Directorate, Air Force Armament Center, p. 226.

Tonart, C. N., Head, Atmospheric Analysis Activity, Geophysics Research Directorate, AF Cambridge Research Center, p. 242.

Track Branch, Engineering Lab, Directorate of Flight Tests and Development, Air Force Flight Test Center, Edwards AFB, p. 132.

V

Vogelman, Joseph, Chief, Electronic Warfare Lab, Electronic Warfare and Techniques Div., Rome Air Development Center, p. 302.

W

Walsh, J, Chief, Air Defense Lab, Rome Air Development Center, p. 285.

Wave Propagation Sect., Advanced Development Branch, Aircraft Radiation Lab, Wright Air Development Center, p. 344.

Waxler, D. E., Chief, Terminal Aids Sect., Equipment Development Div., Rome Air Development Center, p. 290.

Weapons systems plan, ARDC, p. 82.

Wenger, F. E., Chief, Components Development Branch, Electronic Components Lab, Wright Air Development Center, p. 370.

Wightman, J. C., Atmospheric Sect., Components Test Branch, Electronic Components Lab, Wright Air Development Center, p. 382.

Wild, J. M., Director of Engineering, Sverdrup and Parcel Operating Div., Arnold Engineering Development Center, p. 164.

Williams, Lt. Col. F. W., AF Project Officer, Engine Test Facility, Arnold Engineering Development Center, p. 151.

Winebrenner, Col. L. E., Deputy Chief of Staff, Air Force Armament Center, Eglin AFB, p. 214.

Woodward, Col. Lester, Chief, Research Directorate, Special Weapons Center, Kirtland AFB, p. 94.

Worley, R. M., Chief, Installation Engineering Branch, Aircraft Radiation Lab, Wright Air Development Center, p. 344.

Worthman, Lt. Col. Paul, Head, Atmospheric Devices Activity, Geophysics Research Directorate, AF Cambridge Research Center, p. 242.

Wright Air Development Center, p. 98; organization chart, p. 100.

Wyckoff, Peter H., Head, Atmospheric Physics Lab., AF Cambridge Research Center, p. 232.

Z

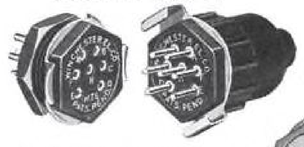
Zmeskal, A., Assistant Branch Chief, Tactical Bombing Branch, Air Armament Lab, Wright Air Development Center, p. 390.

Zucker, F. J., Antenna Lab, Directorate Services Branch, Electronic Research Directorate, Cambridge Research Center, p. 339.

Winchester Electronics

MINIATURE CONNECTORS*

MINIATURE Type "M"



ACTUAL SIZE

MINIATURE HERMETIC PLUG
Type "HM"
(USED WITH TYPE M RECEPTACLE)

EMPLOYED IN MANY ADVANCED QUALITY DESIGNS OF **AIRBORNE ELECTRONICS EQUIPMENT** TO MEET MINIATURIZATION REQUIREMENTS

MINIATURE HIGH-VOLTAGE
Type "PM"

HALF SIZE

These Miniature Connectors are available with various numbers of contacts. Please send your inquiries for variations of these types . . . or for entirely new designs . . . to our Engineering Department.

MINIATURE RECTANGULAR
Type "MRE"

ACTUAL SIZE

SUB-MINIATURE RECTANGULAR
Type "SMRE"

ACTUAL SIZE

WINCHESTER PRODUCTS AND WINCHESTER DESIGNS ARE AVAILABLE ONLY FROM WINCHESTER ELECTRONICS INCORPORATED

HERMETIC MINIATURE RECTANGULAR PLUG
Type "HMRE"
(USED WITH TYPE MRE RECEPTACLE)

MINIATURE INSERT in SPECIAL SHELL
Type "B"

TWO THIRDS SIZE

* "MONOBLOC" CONSTRUCTION
* PATENTED AND PATENTS PENDING

Wire or write for catalog on other types or advise your special requirements.

West Coast Branch:
1729 WILSHIRE BOULEVARD,
SANTA MONICA, CALIFORNIA

WINCHESTER ELECTRONICS INCORPORATED

GLENBROOK, CONN., U.S.A.

AC QUALITY PRODUCTS

ENGINEERS
ELECTRONIC SERVO

DESIGNERS
ELECTRO-MECHANICAL

"AC" OFFERS
A Challenge to Men of Resourcefulness

FIELD ENGINEERS

• For recent college graduates, here are positions with a challenge —

ASSIGNMENT — you will assist in the installation, operation, and maintenance of our equipment at aircraft plants and Air Force bases. The work will include liaison between AC and the customer, training of customer personnel, analysis of problems, and recommendations for improvements. Many of these outstanding openings are one-year overseas assignments.

YOUR BACKGROUND — your educational background can be in any of the fields of AE, EE, ME, Physics, or equivalent. To be successful in these positions you should have a definite interest in people as individuals and be willing to relocate to field assignments. Single men given preference.

TRAINING — our theoretical and applied in-plant training (here in Milwaukee) will prepare you for these assignments. In addition to your salary, you will receive a field allowance—and a substantial bonus if selected for overseas assignment . . . if you're looking for an opportunity with a "present" and a *future* write us for further facts.

We need men of high caliber, experienced in the field of airborne automatic electro-mechanical control equipment. You will be engaged in the manufacture and development of highly complex equipment of the most advanced type in a steadily expanding division of our company—a division with 20 years of successful operation in the precision instrument field.
We offer many advantages to those who join our organization—
SALARY increases are based on merit and initiative . . . two weeks VACATION with pay . . . HOSPITALIZATION BENEFITS . . . LIVING and RECREATIONAL FACILITIES are among the best anywhere along Lake Michigan . . . POSITIONS ARE PERMANENT due to long-range manufacturing and development programs . . . in short—here at our "AC" Milwaukee plant you get small company advancement opportunities with large company employe benefits . . . EXPENSES incident to interviews are all absorbed by us.
For less experienced engineering graduates, we have a Junior Engineer Training Program which makes it possible for you to become acquainted with all phases of our company . . . you can also take advantage of educational opportunities for advanced degrees at Marquette University and the University of Wisconsin.
We answer ALL inquiries . . . write or apply

AC SPARK PLUG DIVISION
GENERAL MOTORS CORPORATION
1925 E. KENILWORTH PLACE • MILWAUKEE 2, WISCONSIN

EMCO AIRCRAFT CORPORATION

Dallas, Texas *OFFERS*

ENGINEERS
and OTHER TECHNICAL PERSONNEL

GOOD POSITIONS IN

AERODYNAMICS
ARMAMENT
LOFTING
CONTROLS
STRUCTURES
FLIGHT TEST
ELECTRICAL INSTALLATION
POWER PLANT INSTALLATION
FLUTTER & VIBRATION
ANALOGUE & DIGITAL COMPUTERS
ENGINEERING PROCEDURES & PLANNING

EXCELLENT OPPORTUNITIES
HOUSING READILY AVAILABLE

ATTENTION ENGINEERING PERSONNEL
BOX 6191, DALLAS, TEXAS

Cessna

ENGINEERING OPPORTUNITIES

with world's leading producer of light commercial airplanes

for

- **Design Engineers**
- **Design Draftsmen**
- **Research Engineers**

Send Resume to

CESSNA AIRCRAFT CO.
ENGINEERING PERSONNEL
WICHITA, KANSAS

FUTURE HELICOPTER PASSENGER PROGRAM HAS OPENINGS FOR
Helicopter Pilots, Mechanics, Electrical, Communications, and Accounting Personnel
Address reply direct to:
LOS ANGELES AIRWAYS, INC.
Box 10155 Airport Station, Los Angeles 45, Calif.

DESIGN RESEARCH DEVELOPMENT

key words to your employment opportunities at GOODYEAR AIRCRAFT . . . pioneer and leader in lighter-than-air craft . . . an established and growing company building an outstanding technical reputation

DESIGN ENGINEERING opportunities exist in the fields of airships, airplanes, and components, airframes, power-plant installations, controls, hydraulics, electronics systems, fuel cells, canopies, and wheels and brakes

DEVELOPMENT of missiles, jet aircraft, and helicopters, electric and electronics system, servomechanisms, fiber resin laminates, and many other projects present an urgent need for capable engineers

WELDING ENGINEERS, civil engineers, mechanical engineers with ability in metals fabrication, and industrial engineers experienced in time study are needed. Job opportunities also exist for technical editors and illustrators

POSITIONS are open at several levels, and inquiries are also invited from recent graduates. Salaries are based on education, ability, and experience

PAID VACATIONS, free group life insurance, a good hospitalization plan, paid sick leave, company-sponsored pension plan, planned recreation, and free parking are among the facilities at the plant

A FRIENDLY CITY, Akron, Ohio, is located in the center of the midwestern industrial region

IF YOU ARE INTERESTED in a secure future, write, giving details, or request an application from

C. G. Jones, Salary Personnel Department

GOODYEAR AIRCRAFT CORPORATION, 1210 Massillon Road, Akron 15, Ohio

OUTSTANDING ENGINEERING OPPORTUNITY

Are you a specialist or a recent graduate proficient or interested in one or more of the following fields?

- Aero-thermodynamics
- Internal Aerodynamics
- External Aerodynamics
- Ballistics
- Ram Jet and Turbo Jet Test and Performance
- Transonic and Supersonic Test Operations
- Turbine and Compressor Design

Sverdrup & Parcel, Inc. is engaged in the design of advanced and unusual aeronautical test facilities which require the theory and application of these special fields. The wide variety of our work, embracing the design of general industrial facilities of all types, offers challenging problems and provides excellent opportunity for individual development and advancement. Starting salary and extent of responsibility are dependent upon individual ability and experience. Fringe benefits include: an unusually attractive Employee Benefit Plan which furnishes insurance features and provides for retirement; paid vacations, holidays and sick leave; overtime rates; and an employees' club which offers interesting social and practical values. Two accredited universities offer opportunity for advanced education.

Your letter of inquiry will receive prompt attention and reply. Please write to—

SVERDRUP & PARCEL, Inc.
Consulting Engineers
915 Olive — St. Louis 1, Mo.

A GOOD CONNECTION

That's what the jet pilot says when he "plugs into" the FR refueling system and that's what forward-thinking engineering personnel say when they study the opportunity for growth with Flight Refueling, Inc., a company expanding on a sound, long-range basis in the whole new field of in-flight refueling.

We have immediate openings with a future for:

DESIGNERS
CHECKERS
PROJECT ENGINEERS
TEST ENGINEERS

We need engineers with experience in design, development or testing of mechanical and electrical equipment, preferably in the aeronautical field. We also need engineers with background in aircraft fuel system component and materials development.

Your resume giving details of education, experience, and salary requirements will be held in strict confidence.

Write today to Personnel Director
FLIGHT REFUELING, Inc.
Danbury, Conn.

Aviation Sales Executive

An established aircraft instrument and accessory manufacturer seeks a merchandising expert to market a new flight instrument of wide application in the airline executive transport and military markets. The man we are thinking of should be of high caliber with a thorough knowledge of aviation national distribution and military procurement. He should be able to point to a successful record in a similar line. Answer fully including salary requirements. Replies held strictly confidential.

SW-8403, Aviation Week
330 W. 42 St., New York 36, N. Y.

REPLIES (Box No.): Address office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITIONS VACANT

WANTED: PURCHASING Agent for fast-growing local Service Airline. Location: Ithaca, New York. Previous Airline experience necessary. Write Mohawk Airlines, Attn: Personnel Dept.

POSITIONS WANTED

A and E Mechanic—Desires position with Corporation—Recent experience on Executive Aircraft—13 years in aviation including Airline, all Phases conversion and maintenance. Age 33—Married—Three children—Willing to relocate—Available now. PW-8575, Aviation Week.

PURCHASING AGENT, Experience with jobbers on Airframe and Power Plant, extensive Sources of Supply. Age 30, Married. PW-8603, Aviation Week.

EXPERIENCED EXECUTIVE Co-pilot, commercial and Instrument, land and sea, single, and multi-eng. A&E, 14 yrs. experience. Over 3,600 hrs, also DC-3 rating. PW-8705, Aviation Week.

EXECUTIVE PILOT, domestic and international experience. Sales and Administrative background. 8000 hours. ATR DC3 and 4. Presently employed as Airline Captain. Resume on request. PW-8813, Aviation Week.

EXECUTIVE AIRCRAFT pilot. Former Navy-Airline pilot. ATR, over 10,000 hours. Qualified twin-beech, DC-3, DC-4, DC-6. Straight flying or business combination. PW-8815, Aviation Week.

HELICOPTER PILOT 500 hours Helicopter time 1700 total time. Want test, executive, or air line. Age 34, married. Presently USMCR. PW-8868, Aviation Week.

CO-PILOT AND mechanic A&E, commercial with instrument and DC-3 rating. 13 years experience. Married. PW-8448, Aviation Week.

SELLING OPPORTUNITY WANTED

MFR'S REPR (Graduate Engineer) Will render sales & engineering. Liaison with Acft & Missile Manufacturers in Southern California vicinity, R&D experience. RA-8592, Aviation Week.

BUSINESS OPPORTUNITY

We are a small company having limited use for our new Cessna 195B Aircraft. We desire another company or responsible individual as co-owner. Equipment receives best maintenance and is hangared in New York Metropolitan area. BO-8464, Aviation Week.

WANTED

Will Pay Cash for one or two F4U Corsair type Aircraft for Airshow work. Reply price and condition to W-8790, Aviation Week.

ENGINEER
Aircraft

Expanding National organization located Idlewild Airport, N. Y. has an excellent opportunity for qualified Service Engineer with experience on Constellation, DC-6, DC-4 and other Multi-engine aircraft maintenance, overhaul and repair methods. College Grad preferred.

Send full resume of age, education, experience and salary requirements.

LOCKHEED
Aircraft Service International
Hangar #1 N. Y. Internat'l Airport

AIRCRAFT INSTRUMENTS ENGINEER

Excellent position for engineering graduate with several years' experience in aircraft instrument design, production, or repair. This is a new position in a progressive, independent, research organization. Please address reply directly to

BATTELLE MEMORIAL INSTITUTE
505 King Avenue
Columbus 1, Ohio

SALES REPRESENTATIVE

Expanding aircraft instrument manufacturer has opening for an energetic salesman with a good working knowledge of aircraft distribution. Permanent position. Salary commensurate with ability and experience.

SW-8407, Aviation Week
330 W. 42 St., New York 36, N. Y.

SKILLED
PILOTS
AVAILABLE
No Fee to Employers
PILOTS EMPLOYMENT AGENCY
Teterboro (N. J.) Airport
Hasbrouck Heights - 8-1091

4,000 MILLING, TOOL-DIE HOURS A WEEK AVAILABLE
DUTCH MANUFACTURING CO.
310 Depot St. Scranton 9, Pa.
Phones: 4-7782 or 73810

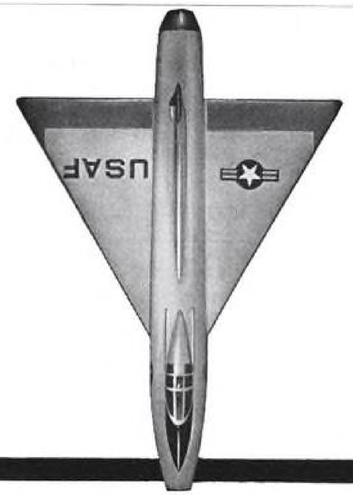
AIRCRAFT UPHOLSTERING
A Complete Service
BAUCO
Single Seats to Complete Interiors
Over 50 years of experience
26 GLEN ROAD, RUTHERFORD, N. J.
Adjacent to Teterboro Airport
RUTHERFORD 2-8928

WANTED TO BUY:
LOCKHEED LODESTAR
For conversion
Submit full specification to:
Jack Hale
OHIO AVIATION COMPANY
Dayton Municipal Airport
Vandalia, Ohio
Tel: 4-4646

NAVCO, Inc., HAS IN STOCK
for Executive Aircraft
New, Factory Fresh
Goodrich (Hayes) Brakes for DC-3, C-47
Deicer Boots for DC-3, C-47, D18, Lodestar, PV1
AN3025-1 Relays, reverse current
1589 Bendix latest Voltage Regulators
A.R.C., Bendix, Collins Executive Radio
AIREX SERVICE—phone Terryhill 5-1511
Lambert Field St. Louis, Missouri

For Sale
DC-4's—C-47's—Lodestars
Convair 240—Constellation
WESTAIR, Inc.
White Plains, N. Y.

INSTRUMENTS
Authorized Factory Sales for and Service
*** Eclipse–Pioneer**
*** Kollsman**
*** U. S. Gauge**
C.A.A. Approved Repair Station #3564
Contractors to U. S. Air Force
Our stock of instruments is one of the largest in the East.
IMMEDIATE DELIVERY
CALL • WIRE • WRITE
INSTRUMENT ASSOCIATES
Telephone: Great Neck 4-1147
351 Great Neck Road, Great Neck, N. Y.
Telegraph: WUX Great Neck, N. Y.



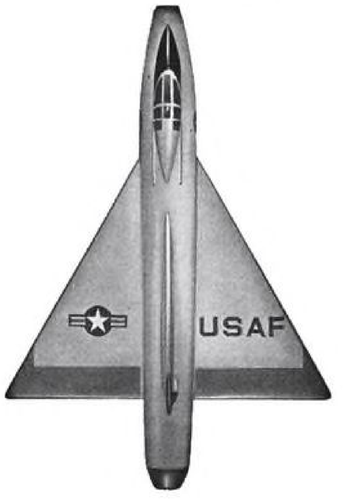
SPECIAL OPPORTUNITIES FOR
SENIOR ENGINEERS

Convair in cool, clean, beautiful San Diego invites you to join an "engineers" engineering department. Interesting, challenging, essential long-range projects in commercial aircraft, military aircraft, missiles, engineering research and electronics development. Positions open in these specialized fields:

Electrical Design	**Servo-mechanisms**
Mechanical Design	**Aerodynamics**
Structural Design	**Thermodynamics**
Structures	**Operation Analysis**
Weights	**System Analysis**

Generous travel allowances to those accepted. For free brochure, write Mr. H. T. Brooks, Engineering Dept. 200

CONVAIR
IN BEAUTIFUL
SAN DIEGO
3302 PACIFIC HIWAY
SAN DIEGO 12, CALIFORNIA



Model 049
CONSTELLATION

For sale by Owner

Formerly in BOAC Service

Overseas Interior and Radio

1655 Hrs. Since Major Overhaul and Tank Reseal
By Lockheed Air Craft Service

R-3350 BA3 Fuel Injected Engines
#1 899:51 hrs. #3 700:45 hrs. #2 825:41 hrs.
#4 Zero

This is a Straight Model 049, Not a Converted C-69

Call - Write or Wire BEST OFFER

KIRK KERKORIAN
LOS ANGELES AIR SERVICE
Municipal Airport *Osborne 6-0411* Hawthorne, California

FOR SALE
DOUGLAS C-47
P&W 1830-92 ENGINES
ZERO TIME SINCE MAJOR O.H.
Licensed for scheduled airline use. Large cargo doors, cargo floor. Janitrol heater. Full radio equipment.
CALL OR WIRE
LEEWARD AERONAUTICAL
P. O. Box 210 Baer Field
Fort Wayne, Indiana Phone H-2145

AIRPLANE ENGINE HOISTS
Model A-2A,
Capacity 3000 Lbs.
Portable.
Suitable for other uses.
Send for Booklet.
The Vimalert Company, Ltd.
807 Garfield Avenue
Jersey City 5, N. J.

TWIN BEECHCRAFTS
C18S and D18S Transports—Excellent Condition fully equipped from $25,000
LODESTAR EXECUTIVES
Why take less for your money?
Ready to go complete from $55,000
We Invite Inquiries For Any Types
WINGS, INC., AMBLER, PA.

D-18-S TWIN BEECH
N-5869C, Serial # A-570

Total Airframe Time: 1295:00

Engines: Left 780:30 TSO—Right 277:25 TSO

Propellers: Hamilton Standard Full Feathering Hydromatic—Left 277:25—Right 277:25

Special Equipment: Anti-icing and de-icing equipment—Auxiliary Tank (80 gallon)—Windshield Wipers—Flares—"No Smoking"—Fasten Seat Belt" signs—Special factory paint—Pearl Grey and yellow with white stripe.—Heavy duty tail wheel tire & tubes—Two spare zero time engines

Aircraft Interior: 3 chairs and lounge—1 card table—Grey ladder-weave with solid green headliner—2 Thermoses

Radio Equipment: Lear Auto Pilot—Bendix ADF—Bendix MN-85 Omni Receiver and 280 Channels Crystal control—ARC-1 20 Channels Transceiver—Glide Path Receiver—Western Electric 2-light visual and audio marker receiver—ARC 5 Channel Transmitter—Isolation Amplifier—Custom RAS Overhead Control Panel—ARC Command Receiver—Dual Gyro Panel

Aircraft Exceptionally Well-Maintained.—One Corporation Owner.—Reason for Selling: Replacing with De Haviland "Dove"

AVAILABLE AFTER SEPTEMBER 1, 1953.
ASKING PRICE: $75,000

D-18-S TWIN BEECH
N-48Y, Serial # A-173

Total Airframe Time: 2900:00

Engines: P & W R-985—Left 600:00 TSOH—Right 235:00 TSOH—One spare zero time engine

Propellers: Hamilton Standard Full Feathering

Interior: 5 chairs (all reversible)—1 card table—Completely sound insulated—Green interior fabric including crew compartment—Curtains

Special Equipment: Windshield wipers—Control locks—Liquid dispenser—"No Smoking" sign—80 gallon Nose Tank

Radio Equipment: ARC-15 Omni—Low Freq. Transmitter & Receiver—3105 Command Transmitter—VHF Transmitter (ARC)

Airplane Exterior: Painted light green with dark green trim, white piping, white cabin top.

AIRCRAFT EXCEPTIONALLY WELL-MAINTAINED. ONE CORPORATION OWNER.

..ASKING PRICE:.$47,000..

Reading Aviation Service, Inc., P. O. Box 1201, Phone: 3-5255, Reading, Penn.

CURTISS PROPELLERS
C632S-B52
COMPLETE SELECTION BRAND NEW
Spare Parts Available
FOR SALE
ALSO
BRAND NEW
CURTISS TYPE 744-C2-0
BLADES AVAILABLE
SCANDINAVIAN AIRLINES SYSTEM
Hangar No. 2 N. Y. International Airport
JAMAICA 20, N. Y. *Olympia 6-5900*

Gadgets, inc.
HYDRO-WYPE SCRAPER RINGS
AN-6231-A
Write for complete catalog to: ATSCO
Dept. W 4217 North Main St., Dayton 5, Ohio

ENGINE WORKS
Lambert Field Inc. St. Louis, Mo.
will OVERHAUL and CONVERT
1830-92 into SUPER-92
only **$5500** with new cylinders, pistons, pins, rings, etc.
20°-40° Cooler Running
700 HP Easy Cruise
Safer Single Engine
Less Fuel per Mile
Lower Maintenance Costs

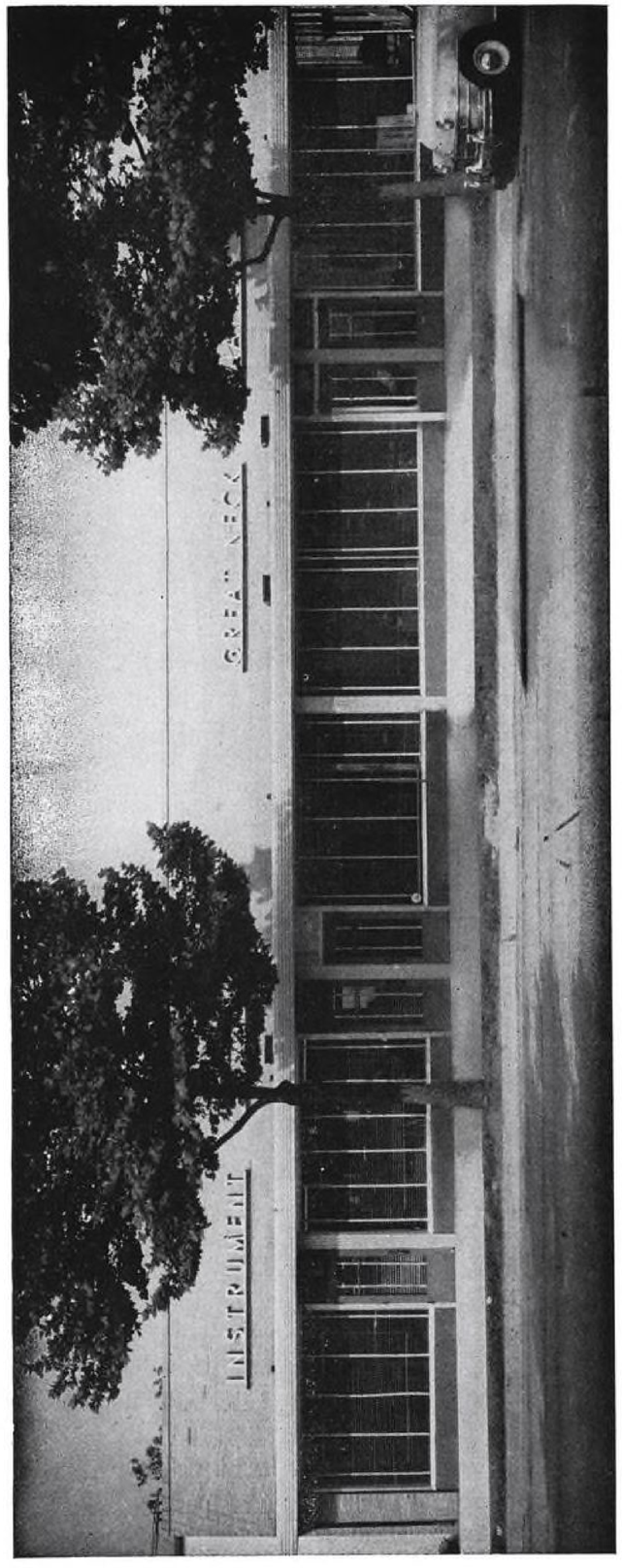
FOR SALE (by owner)
LOCKHEED LODESTAR
Check these features ! !
- √ Flush Riveted
- √ Large Door
- √ 24 Volt System
- √ Dual Fuel System
- √ Down Locks
- √ New De-Icer Boots Installed
- √ Tanks Excellent Condition
- √ Plushed Interior
- √ No Corrosion

ENGINES R-1820-65
PRICE: *MAKE OFFER* (It must be sold)
DEAL DIRECT WITH THE OWNER
Phone Wire Write
WESTAIR, INC.
WHITE PLAINS, NEW YORK

FOR SALE
LOCKHEED 12-A
Excellent condition; low time engines; hydromatic propellers; A-3 Auto Pilot; good radio equipment and interior. Reasonable price, includes spare engine and parts. For full information write:
BAKER OIL TOOLS, INC.
P. O. Box 3048, Houston 1, Texas

- Center Section for C-47B Repairable
- Right Horizontal Stabilizer for C-47
- 1—C-47 Fuselage—Repairable

METEOR AIR TRANSPORT INC.
Teterboro Air Terminal, Teterboro, N. J.
Hasbrooks Hgts. 8-1755



INSTRUMENT OVERHAUL and EMERGENCY EXCHANGE

Our new plant in Great Neck, Long Island, New York with new facilities and expert technical help serves our armed forces, aircraft companies and airline transports with precision instrument overhaul. *Our stock of instruments is one of the largest in the East.*

A complete line of flight and navigation instruments and engine instruments on our shelves will keep your aircraft flying. We invite inquiries from air frame builders, maintenance shops, and private aircraft owners on our efficient overhaul service or emergency exchange.

ASSOCIATED ELECTRONIC EQUIPMENT

351 GREAT NECK ROAD, GREAT NECK, N. Y.
Telephone GReat Neck 4-1147

U. S. Export License-2140
Western Union address: WUX Great Neck, N. Y.

INSTRUMENT ASSOCIATES
Write for Catalog NE100

Authorized factory sales and service for Eclipse Pioneer, U. S. Gauge, Kollsman and Exide Battery. C.A.A. approved repair station #3564. Contractors to U. S. Air Force and Navy.

ADVERTISERS INDEX

AVIATION WEEK—AUGUST 17, 1953

A. C. SPARK PLUG DIV., G.M.C. 177
Agency—D. P. Brother & Co., Inc.

ACCESSORY PRODUCTS CO. ..... Insert 240A
Agency—Anderson-McConnell Adv. Agency

ADAMS RITE MFG. CO. 389
Agency—The Shaw Company

ADEL DIV., GENERAL METALS CORP. 175
Agency—The McCarty Company

ADVANCE GEAR & MACHINE CORP. 303
Agency—Mack-Wharton Adv.

AERIAL PRODUCTS, INC. 180
Agency—James J. McMann

AERO INSTRUMENT CO. 393

AEROJET GENERAL CORP. 424

AEROLAB DEVELOPMENT CO. 429

AERONAUTICAL COMMUNICATIONS 414
Agency—Grant Advertising, Inc.

AERONAUTICAL MACHINIST 403

AEROPRODUCTS DIV., G.M.C. 37
Agency—Campbell-Ewald Co.

AEROQUIP CORPORATION 21
Agency—Hopcraft-Keller, Inc.

AEROTEC CORPORATION, THE 158
Agency—Hening & Co., Inc.

AIR ASSOCIATES, INC. 5
Agency—G. M. Basford Co.

AIRBORNE ACCESSORIES CORP. 194
Agency—Gray & Rogers Adv.

AIRCOOLED MOTORS, INC. 236
Agency—Richards & Webb, Inc.

AIRCRAFT EQUIPMENT TESTING CO. 429
Agency—Mahool Advertising, Inc.

AIRCRAFT RADIO CORP. 20
Agency—Burke Dowling Adams, Inc.

AIR PARTS, INC. 55
Agency—Beaumont & Hohman, Inc.

AIRWORK CORP. 279
Agency—Geare-Marston, Inc.

ALLEGHENY AIRLINES 334
Agency—Ketchum, MacLeod & Grove, Inc.

ALLEN AIRCRAFT PRODUCTS, INC. 262
Agency—The Fred Bock Adv. Co.

ALLIED INDUSTRIES, INC. 447

ALLMETAL SCREW PRODUCTS CO. 199
Agency—Fred Lange Assoc., Inc.

ALUMINUM CO., OF AMERICA 254
Agency—Fuller & Smith & Ross, Inc.

AMERICAN CYSTOSCOPE MAKERS, INC. 284
Agency—Noyes & Sproul, Inc.

AMERICAN ELECTRIC MOTORS CO. 280
Agency—Clyde D. Graham Adv.

AMERICAN GYRO CO. 220
Agency—Mann Advertising Co., Inc.

AMERICAN MACHINE & FOUNDRY CO. 261
Agency—Fletcher D. Richards, Inc.

AMERICAN MACHINE & FOUNDRY CO. 410

AMERICAN NON-GRAN BRONZE CO. 447
Agency—Norman P. Hewitt Adv.

AMERICAN PHENOLIC CORP. 354
Agency—Burton Browne Adv.

AMERICAN TIME PRODUCTS 263
Agency—H. M. Alexander & Assoc.

AMGEARS, INC. 334
Agency—C. Franklin Brown, Inc.

AMPEX ELECTRIC CORP. 349
Agency—Walther-Boland Assoc.

ANTI-CORROSIVE METAL PRODUCTS 379
Agency—Woodard & Voss, Inc.

APPLIED SCIENCE CORP. OF PRINCETON 388
Agency—Paul M. Healy Adv. Service

ARO EQUIPMENT CORP. 218
Agency—Beeson-Reichert, Inc.

ASSOCIATED CO., INC. 561
Agency—The McCormick-Armstrong Co.

AUBURN SPARK PLUG CO. 344
Agency—Richards & Webb, Inc.

AUSTENAL LABORATORIES, INC. 241
Agency—Frank C. Nahser, Inc.

AVIATION DEVELOPMENTS, INC. 370, 405
Agency—Jaycraft Co.

AVIATION ENGINEERING DIV., AVIEW-KNICKERBOCKER, INC. 41
Agency—Robert W. Orr & Associates, Inc.

AVICA CORPORATION 242
Agency—Knight & Gilbert, Inc.

AXELSON MFG. CO. 10, 11
Agency—C. B. Juneau, Inc.

B. H. AIRCRAFT CO., INC. 216
Agency—Harold Marshall Adv. Co.

BARBER COLMAN CO. 14, 15
Agency—Howard H. Monk & Assoc.

BARRY CORP. 116
Agency—Engineered Advertising

BELL AIRCRAFT CORP. 114
Agency—Comstock & Co.

BENDIX COMPUTER DIV. BENDIX AVIATION CORP. 214
Agency—The Shaw Company

BENDIX PACIFIC DIV. BENDIX AVIATION CORP. 36, 239
Agency—The Shaw Company

BENDIX PRODUCTS DIV. BENDIX AVIATION CORP. ..... Third Cover
Agency—MacManus, John & Adams, Inc.

BENDIX RADIO COMM. BENDIX AVIATION CORP. ..... Insert 67, 68, 69, 70
Agency—MacManus, John & Adams, Inc.

BILL JACK SCIENTIFIC INSTRUMENT CO. 129

BENSON MFG. CO., THE 422, 423

BOWER ROLLER BEARING CO. 24
Agency—MacManus, John & Adams, Inc.

BRADY AVIATION CO. 340
Agency—Interamerican Advertising Agency

BRAND & CO., INC., WM. 196
Agency—Cory Snow, Inc.

BREEZE CORPORATIONS, INC. 163
Agency—Burke Dowling Adams, Inc.

BRISTOL COMPANY, THE 181
Agency—James Thomas Chirurg Co.

BRISTOL ENGINEERING CORP. 339

BRUNSENE CO., THE 389
Agency—McMillan & Marsden, Inc.

CAMLOC FASTENER CORP. 384, 385
Agency—Lewis Advertising Agency

CANNON ELECTRIC COMPANY 355
Agency—Hixson & Jorgensen, Inc.

CARTER MOTOR CO. 448
Agency—Robert Peterson Adv.

CESSNA AIRCRAFT CO. 208
Agency—Gardner Advertising Co.

CGS LABORATORIES, INC. 415
Agency—Roming Advertising Service

CHASE AIRCRAFT CO., INC. 132
Agency—Geare-Marston, Inc.

CIBA COMPANY, INC. 29
Agency—Briggs & Varley, Inc.

CITIES SERVICE OIL CO. 12
Agency—Ellington & Co., Inc.

CLARE & CO., C. P. 45
Agency—Reincke, Meyer & Finn, Inc.

CLEVELAND PNEUMATIC TOOL CO. 264
Agency—Meldrum & Fewsmith, Inc.

COLLINS RADIO CO. 61
Agency—W. D. Lyon Co., Inc.

COMPUTER RESEARCH 238
Agency—Clyde D. Graham Adv.

CONNECTICUT HARD RUBBER CO. 396
Agency—Peck Brothers Adv.

CONSOLIDATED INDUSTRIES, INC. 282
Agency—Hugh H. Graham Agency

CONSOLIDATED VULTEE AIRCRAFT CORP. ..... Insert 103
Agency—Buchanan & Co., Inc.

CONSTANTIN & CO., L. L. 215
Agency—David Cummins & Assoc.

CONTINENTAL MOTOPS CORP. 219
Agency—Cummings & Hopkins Adv.

CONTROL PRODUCTS, INC. 146
Agency—George Homer Martin Assoc.

COOPER PRECISION PRODUCTS, INC. 162
Agency—Sudler Company

CORNELIUS CO. 359
Agency—Dwyer & Devoy Adv.

COXHEAD CORP., RALPH C. 406
Agency—United Advertising Agency

CROUSE-HINDS CO. 176
Agency—Barlow Advertising Agency

DARNELL CORP., LTD. 148
Agency—Henry L. Rhea Adv.

DECKER AVIATION CORP. 350
Agency—The Harry P. Bridge Co.

DE HAVILLAND AIRCRAFT CO., LTD., THE ..... Insert 173
Agency—Samson Clark & Co., Ltd.

DeJUR-AMSCO CORP. 217
Agency—Friend, Reiss, McGlone Adv.

DESPATCH OVEN COMPANY 60
Agency—Harold C. Walker Adv.

DILL MFG. CO., THE 258
Agency—McDaniel, Fisher & Spelman Co.

DORNE AND MARGOLIN 368
Agency—George Homer Martin Associates

DOUGLAS AIRCRAFT CO. ..... Insert 139
Agency—J. Walter Thompson Co.

DOW CHEMICAL CO. 34B
Agency—MacManus, John & Adams, Inc.

DOW CORNING CORP. 401
Agency—Don Wagnitz Adv.

DuKANE CORPORATION 395
Agency—Kennedy & Co. Adv.

DUMONT AVIATION ASSOC. 143
Agency—Len Woolf Co.

DUNBAR KAPPLE, INC. 366
Agency—Ideas Unlimited

DYNAMIC AIR ENGINEERING, INC. 342
Agency—The McCarty Company

EATON MFG. CO. 32
Agency—Clark & Bobertz, Inc.

EASTERN AIR DEVICES 335
Agency—Lewis Adv. Agency

EASTERN ROTOCRAFT CORP. 326
Agency—Geare-Marston, Inc.

EASTMAN KODAK CO. 13-43
Agency—J. Walter Thompson Co.

ECLIPSE-PIONEER DIV. BENDIX AVIATION CORP. 261
Agency—MacManus, John & Adams, Inc.

EDISON, INC., THOMAS A. 265
Agency—Gotham Adv., Co., Inc.

EDO CORPORATION 165
Agency—Davis-Parsons, Inc.

ELASTIC STOP NUT CORP. 312
Agency—G. M. Basford Co.

ELECTRICAL PRODUCTS CORP. 351
Agency—The McCarty Co.

ELECTRIC STORAGE BATTERY CO., THE 168, 169
Agency—Geare-Marston, Inc.

ELECTROL, INC. 115
Agency—G. B. Woodin Co.

ELECTROLIZING SALES & TOOL INC. 434, 444, 448
Agency—Francis D. Gunda Co.

ELECTRO PRODUCTS LABORATORIES 414
Agency—Robertson, Buckley & Gotsch, Inc.

ELECTRO-TEC CORP. 44
Agency—George Homer Martin Assoc.

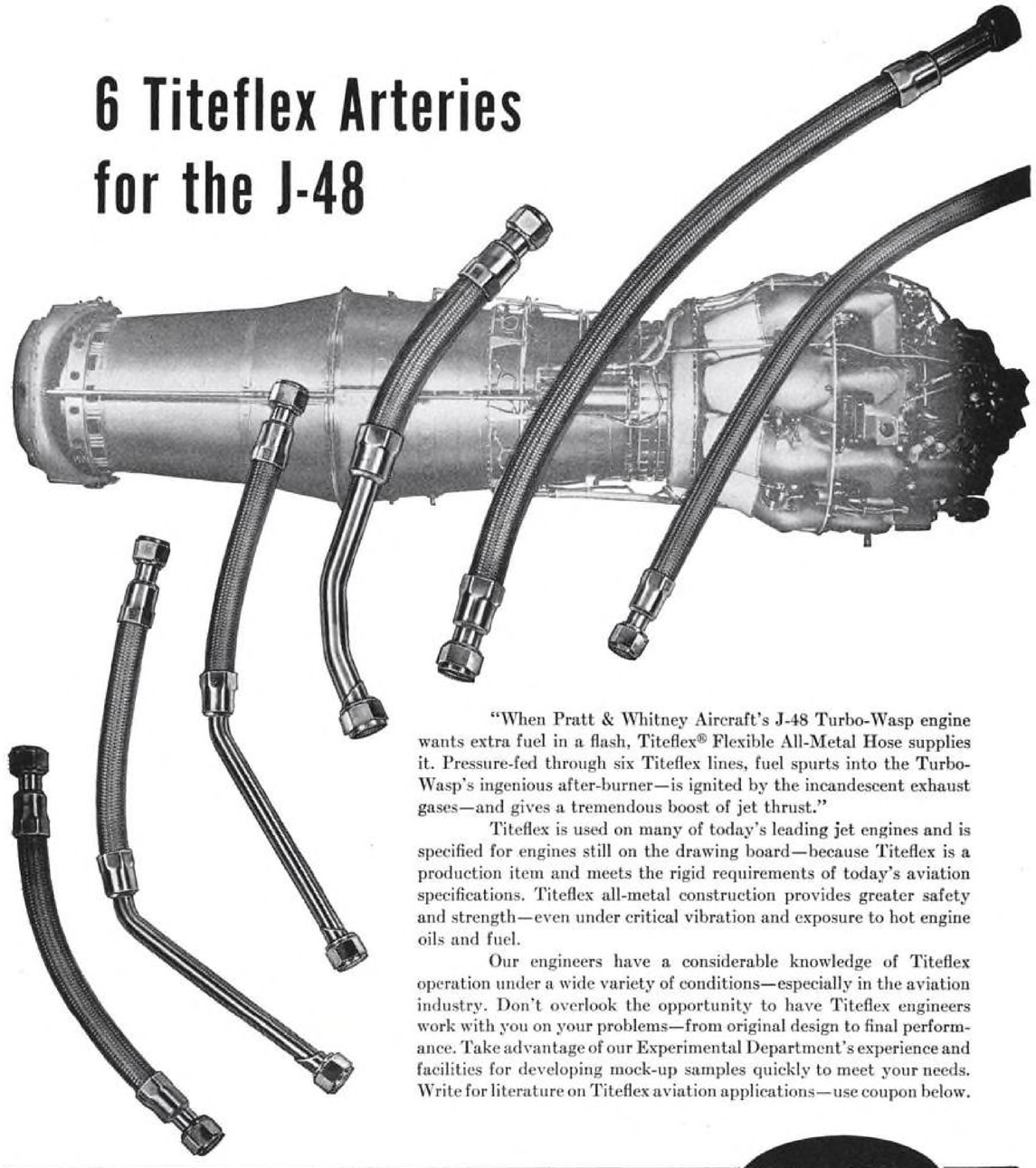
ELECTRONIC ASSOC., INC. 209
Agency—Hasted & Van Vechten

ENGINEERING & RESEARCH CORP. 136
Agency—Mallor & Wallace Adv.

ESSO EXPORT CORP. 54
Agency—McCann-Erickson, Inc.

EX-CELL-O CORPORATION 319
Agency—Holden-Clifford-Flint, Inc.

6 Titeflex Arteries for the J-48



"When Pratt & Whitney Aircraft's J-48 Turbo-Wasp engine wants extra fuel in a flash, Titeflex® Flexible All-Metal Hose supplies it. Pressure-fed through six Titeflex lines, fuel spurts into the Turbo-Wasp's ingenious after-burner—is ignited by the incandescent exhaust gases—and gives a tremendous boost of jet thrust."

Titeflex is used on many of today's leading jet engines and is specified for engines still on the drawing board—because Titeflex is a production item and meets the rigid requirements of today's aviation specifications. Titeflex all-metal construction provides greater safety and strength—even under critical vibration and exposure to hot engine oils and fuel.

Our engineers have a considerable knowledge of Titeflex operation under a wide variety of conditions—especially in the aviation industry. Don't overlook the opportunity to have Titeflex engineers work with you on your problems—from original design to final performance. Take advantage of our Experimental Department's experience and facilities for developing mock-up samples quickly to meet your needs. Write for literature on Titeflex aviation applications—use coupon below.

Let Our Family of Products Help Yours

Titeflex

√ Check products you are interested in.

☐ SEAMED AND SEAMLESS METAL HOSE
☐ PRECISION BELLOWS
☐ IGNITION HARNESS
☐ IGNITION SHIELDING
☐ ELECTRICAL CONNECTORS
☐ RIGID AND FLEXIBLE WAVE GUIDES
☐ FILTERS
☐ FUSES

TITEFLEX, INC.
517 Frelinghuysen Ave.
Newark 5, N.J.
Please send me without cost information about the products checked at the left.

MAIL COUPON TODAY

NAME _____
TITLE _____
FIRM _____
ADDRESS _____
CITY _____ ZONE ____ STATE _____

Are Materials Your Problem?

THE NEW

Refractory Hard Metals

by Paul Schwarzkopf and Richard Kieffer

may solve those problems

The only up-to-date book on materials of particular advantage for high temperature uses, it gives full information on the structure, preparation, and properties of the carbides, borides, nitrides and silicides, with a comparison of the performance of cemented products in high temperature applications with that of recently developed alloys and products in the ceramic field.

Are these titles on your reference shelf?

Aerodynamics of the Helicopter

By Gessow & Myers. A valuable guide for designers, containing much practical engineering data.

Technical Sketching

By Katz. How to put your engineering ideas or instructions into quick, clear drawings.

Chambers's Technical Dictionary

Defines 50,000 technical and scientific terms —an invaluable reference for your secretary or new assistant.

Introduction to the Study of Aircraft Vibration & Flutter

By Scanlan & Rosenbaum. The outstanding reference on problems of aeroelasticity and flutter analysis.

CHECK THE ONES THAT CAN HELP YOU MOST AND SEE THEM ON APPROVAL

The Macmillan Company, 60 Fifth Ave., N. Y. 11

Please send me the books checked below. I will either remit the full price plus small delivery charge, or return the book(s) in 10 days. (Save: Enclose check or money order and we pay delivery charge.)

- ☐ Refr. Hard Metals $10.
- ☐ Aerodyn. of the Helicopter $6.
- ☐ Tech. Sketching $5.
- ☐ Chambers' Tech. Dictionary $6.50
- ☐ Air. Vibration & Flutter $10.

Signed .....

Address .....

(This offer good only within continental limits of U.S.A.)

FAIRCHILD ENGINE & AIRPLANE CORP., AIRCRAFT DIV. 179
Agency—Buchanan & Co., Inc.

FEDERAL TELEPHONE & RADIO 391
Agency—J. M. Mathes, Inc.

FINE ORGANICS, INC. 382
Agency—Kermin-Thall

FLETCHER AVIATION CORP. 268
Agency—The Shaw Company

FLEXIBLE METAL HOSE MFG. CO. 413
Agency—Heintz & Co., Inc.

FLEXONICS CORPORATION 174
Agency—Russell T. Gray, Inc.

FLEX-O-TUBE DIV. OF MERIDAN CORP. 235
Agency—Charles M. Gray & Assoc.

FLIGHT REFUELING, INC. 325
Agency—Davis-Parsons, Inc.

FLIGHTEX FABRICS, INC. 318
Agency—The Powers Co., Adv.

FLITE TRONICS, INC. 240
Agency—Jaycraft Co.

FLYING TIGER LINE, INC. 323
Agency—Hixson & Jorgenson Adv., Inc.

FOOTE BROS. GEAR & MACHINE CORP. ..Fourth Cover
Agency—The Buchen Company

FORD INSTRUMENT CO. 341
Agency—G. M. Basford Co.
Agency—MacManus, John & Adams, Inc.

FRIEZ DIV., BENDIX AVIATION CORP. 296

GARRETT CORP. AIRESEARCH MFG. CO. 156
Agency—J. Walter Thompson Co.

GENERAL CABLE CORP. 22, 23
Agency—Hicks & Greist, Inc.

GENERAL ELECTRIC CO. 160, 161, 205, 271
Agency—G. M. Basford Co.

GENERAL ELECTRIC CO., CHEMICAL DEPT. ..38, 39
Agency—Benton & Bowles, Inc.

GENERAL MILLS, INC. 321
Agency—Batten, Barton, Durstine & Osborn, Inc.

GIANNINI & CO., INC., G. M. 288
Agency—Western Adv. Agency, Inc.

GLADDEN PRODUCTS CORP. 256
Agency—Walter C. Davison Co.

GOODYEAR TIRE & RUBBER CO. ..... Insert 34A
Agency—Kudner Agency, Inc.

GORN ELECTRIC CO. 308
Agency—Renner Advertisers

GRAND CENTRAL AIRCRAFT CORP. 309
Agency—Oscar Nordin Co.

GREER HYDRAULICS, INC. 255
Agency—Dunwoodie Adv.

GYROMECHANISMS 313
Agency—Croydon M. Johnson Co.

HANSEN MFG. CO. 348
Agency—Richard T. Brandt, Inc.

HARPER CO., H. M. 31
Agency—The Buchen Co.

HARTMAN ELECTRICAL MFG. CO. 305
Agency—Palm & Patterson, Inc.

HARTWELL AVIATION SUPPLY CO. 166
Agency—The McCarty Company

HARVEY MACHINE CO. 287
Agency—Hixson & Jorgensen, Inc.

HAYDON CO., A. W. 141
Agency—Cory Snow, Inc.

HELIPOT CORP. 326
Agency—Dozier-Eastman & Co.

HERCO PRODUCTS 390
Agency—Kay Christopher Adv.

HERMAN NELSON DIV., AMERICAN AIR FILTER CO. 213
Agency—The Griswold-Eshleman Co.

HETHERINGTON, Inc. 331
Agency—The Harry P. Bridge Co.

HEVI DUTY ELECTRIC CO. 332
Agency—Camm, Costigan & Seitz, Inc.

HEXCEL PRODUCTS CO. 426
Agency—Raymond I. Lang Adv.

HUCK MFG. C. 402
Agency—Charles M. Gray & Assoc.

HUDSON TOOL & DIE CO. 56
Agency—George Homer Martin & Assoc.

HUFFORD MACHINE WORKS, INC. 371
Agency—Clyde D. Graham Adv.

HUGHES AIRCRAFT CO. 202, 203
Agency—Foote, Cone & Belding

HYDRAULIC PRESS MFG. CO., THE 490, 491
Agency—The Jay H. Maish Co.

HYDRO AIRE, INC. 227
Agency—Roy S. Durstine

INDIANA GEAR WORKS 64
Agency—A. L. Perkins & Co.

INET, INC. 142
Agency—The McCarty Co.

INFRA ELECTRONIC CORP. 71
Agency—Mitchell Adv. Agency

INSTRUMENT CORP. OF AMERICA 8
Agency—George Homer Martin Assoc.

INTERNATIONAL ELECTRONIC RESEARCH CORP. 298
Agency—Jaycraft Co.

JACK & HEINTZ, INC. 42
Agency—Fuller & Smith & Ross, Inc.

JAMES-POND-CLARK 431
Agency—Anderson-McConnell Adv. Agency

JOHNS MANVILLE CORP. 62, 63
Agency—J. Walter Thompson Co.

JOY MFG. CO. 66
Agency—Walker & Downing, General Agency

KARL-DOUGLAS ASSOCIATES 411
Agency—Clyde D. Graham

KAHN & COMPANY 398
Agency—Sellavision Corp.

KAUPP & SON, C. B. 375
Agency—George Homer Martin Assoc.

KEARFOTT COMPANY, INC. 133
Agency—E. M. Freystadt Associates

KELLETT AIRCRAFT CORP. 400

KENYON INSTRUMENT CO. 381
Agency—Corydon M. Johnson Co., Inc.

KETAY MFG. CORP. 124
Agency—Hicks & Greist, Inc.

KIDDE & CO., INC., Walter 30
Agency—Cunningham & Walsh, Inc.

KITTELL-LACY, INC. 182
Agency—Clyde D. Graham Adv.

KLINCHER LOCKNUT CORP. 260
Agency—Chamberlin-Junk Adv., Inc.

KOHLER CO., THE 266
Agency—Roche, Williams & Cleary, Inc.

KOLLSMAN INSTRUMENT CORP. 328
Agency—Erwin, Wasey & Co., Inc.

LAMSON & SESSIONS, CO. 122, 123
Agency—Belden & Hickox

LAND-AIR, INC. 138
Agency—Symonds, MacKenzie & Co., Inc.

LANDIS & GYR, INC. 327

NEW WESTERN SWING...

ELECTROLIZING

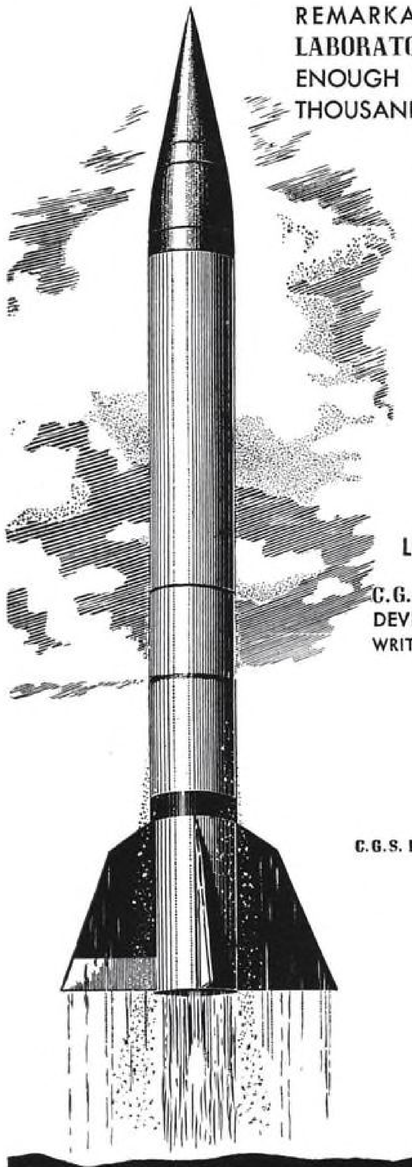
—for longer wearing production parts and freedom from corrosion. Write for information.

ELECTROLIZING SALES and TOOLS, Inc.

1406 E. 15th St., Los Angeles 21

ONE THOUSAND G's SHOCK!

REMARKABLE STRENGTH HAS BEEN BUILT INTO THE C.G.S. LABORATORIES MINIATURIZED S-BAND CAVITY OSCILLATORS. RUGGED ENOUGH TO WITHSTAND THE SMASHING IMPACT OF OVER ONE THOUSAND G'S AND YET RELIABLY PRECISE IN OPERATION.



Originated by C.G.S., our S-Band Cavities have been perfected in cooperation with Signal Corps Engineering Laboratories. They utilize the pencil tube series and meet all applicable Jan specifications. These cavities feature peak powers up to 1 Kw on pulse, or average powers of at least 25 mw on CW. Upper frequency limit is 3350 Mc on pulse types, 3000 Mc on CW models. The frequency stability at 3000 Mc is better than ±2 Mc over the range —50° to +70° C. End tuned and side tuned models are available.

LENGTH 4½" DIAMETER 1" WEIGHT 8 OZ.

C.G.S. LABORATORIES FACILITIES ARE AVAILABLE FOR RESEARCH AND DEVELOPMENT OF SIMILAR EQUIPMENTS ON OTHER FREQUENCIES. WRITE FOR CAVITY DATA AND MICROWAVE CAVITY INQUIRY FORM TO DETAIL YOUR SPECIFIC REQUIREMENTS.

ELECTRONICS

C.G.S. LABORATORIES LINE OF INCREDUCTOR* CONTROLLABLE INDUCTORS

INVESTIGATE THE USE OF THESE HIGH FREQUENCY, WIDE RANGE, HIGH Q, SATURABLE REACTORS. THEY PERMIT REMOTE CONTROL AND OTHER IMPORTANT ADVANTAGES IN RECEIVERS, ANTENNA TUNING NETWORKS, FREQUENCY MODULATORS AND SIMILAR APPLICATIONS. THEY HAVE NO MOVING PARTS AND ARE RUGGED, LIGHT WEIGHT AND SHOCK RESISTANT. WRITE FOR ADDITIONAL TECHNICAL DATA ON THESE UNITS.

ELECTRONICS

*TRADE MARK

C.G.S. LABORATORIES INCORPORATED

INSTRUMENTATION — SYSTEMS ENGINEERING

391 Ludlow St. Stamford, Conn.

LAPOINTE MACHINE TOOL CO., THE.....277
Agency—Wells Advertising Agency

LAVELLE AIRCRAFT CORP.....52
Agency—Geare-Marston, Inc.

LAVOIE LABORATORIES.....316
Agency—Picard Adv. Co.

LEACH RELAY CO.....206
Agency—The McCarty Co.

LEAR, INC.....46, 47
Agency—Buchanan & Co., Inc.

LEBANON STEEL FOUNDRY.....302
Agency—Foltz-Wessinger, Inc.

LEWIS ENGINEERING CO.....137

LINE MATERIAL CO.....147
Agency—Erwin, Wasey & Co., Ltd.

LINK AVIATION, INC.....347
Agency—Buchanan & Co., Inc.

LIQUIDOMETER CORP.....197

LOCKHEED AIRCRAFT CORP.....276, 277
Agency—Foote, Cone & Belding Adv.

LOCKHEED AIRCRAFT CORP.....352
Agency—Donahue & Coe, Inc.

LORD MFG. CO.....59
Agency—Davies & McKinney Adv.

LUNDY MFG. CO.....195
Agency—Mitchell Adv. Agency

LYCOMING DIVISIONS—AVCO MANUFACTURING CORP.....369
Agency—Benton & Bowles, Inc.

MACMILLAN CO., THE.....444
Agency—Atherton & Currier, Inc.

MAGNAVOX COMPANY, THE.....336
Agency—Maxon Inc.

MAGNETIC AMPLIFIERS, INC.....292
Agency—George Homer Martin Assoc.

MANNING, MAXWELL & MOORE, INC.....28
Agency—Fuller & Smith & Ross, Inc.

MARMAN PRODUCTS, CO.....50
Agency—West Marquis, Inc.

MARTIN CO., THE GLENN L.....408, 409
Agency—Vansant, Dugdale & Co., Inc.

MARYLAND ELECTRONIC MFG. CO.....343
Agency—Geare-Marston, Inc.

MAXSON CORP, THE W. L.....379, 381, 383
Agency—Engineered Advertising

M B MFG. CO., INC., THE.....337
Agency—Richard & Co., Inc.

McGRAW-HILL BOOK CO.....412

MICRO-BALANICING CO.....269
Agency—Mitchell Adv. Agency

MILLER ELECTRIC MFG. CO.....400
Agency—R. C. Breth, Inc.

MINIATURE PRECISION BEARINGS, INC.....127
Agency—Ad-Service, Inc.

MINNEAPOLIS HONEYWELL REGULATOR CO.....178
Agency—Foote, Cone & Belding

MINNESOTA MINING & MFG. CO.....140
Agency—MacManus, John & Adams, Inc.

MISCO PRECISION CASTING CO.....204
Agency—L. Charles Lussier, Inc.

MONADNOCK MILLS, UNITED CARR FASTENER CORP.....25
Agency—H. B. Humphrey, Alley & Richards, Inc.

MONOWATT DEPT. OF GENERAL ELECTRIC CO..374
Agency—Horton-Noyes Co.

MONROE CALCULATING MACHINE CO.....281
Agency—L. H. Hartman Co., Inc.

MONSANTO CHEMICAL CO.....9
Agency—Gardner Advertising Co.

MOREY MACHINERY CO.....243
Agency—Walter J. Zimmerman Assoc.

MURPHY & MILLER, INC.....388
Agency—Ross Llewellyn, Inc.

MYSTIK ADHESIVE PRODUCTS.....144
Agency—George H. Hartman Company

NATIONAL PNEUMATIC CO.....322
Agency—James Thomas Chirurg Co.

NATIONAL UNION RADIO CORP.....167
Agency—Brooks and London Adv.

NEW DEPARTURE DIV., G.M.C.....149
Agency—D. P. Brother & Co., Inc.

NEWTON INSERT CO.....405
Agency—Mack & Wharton Adv.

NEW YORK AIR BRAKE CO., THE.....155
Agency—Humbert & Jones Adv.

NICKEL CADMIUM BATTERY CORP.....421
Agency—James Thomas Chirurg Co.

NOPCO CHEMICAL COMPANY.....338
Agency—Lewin, Williams & Saylor, Inc.

NORTHROP AIRCRAFT, INC.....306, 307
Agency—West Marquis, Inc.

NORTH AMERICAN AIRLINES.....377
Agency—Killingsworth Co., Inc.

NORTH AMERICAN AVIATION.....446
Agency—Batten, Barton, Durstine & Osborn, Inc.

NORTH ELECTRIC MFG. CO.....407
Agency—Carpenter Adv. Co.

NUTT SHEL COMPANY.....185
Agency—Welsh-Hollander Adv.

NYLOK CORPORATION, INC.....346
Agency—Burke Dowling Adams, Inc.

OHIO SEAMLESS TUBE CO.....248
Agency—Howard Swink Adv. Agency

OMOHUNDRO CO., PAUL.....275
Agency—Francis D. Gonda Co.

ONSRUD CUTTER MFG. CO.....447
Agency—Robert Peterson Adv. Agency

OSBRINK MFG. CO., R. H.....387

OSTER MFG. CO., JOHN.....348
Agency—Klau-Van Pietersom-Dunlap Assoc., Inc.

PACIFIC AIRMOTIVE CORP.....362
Agency—Buchanan & Co., Inc.

PACIFIC SCIENTIFIC CO.....428
Agency—Darwin H. Clark Co.

PARKER APPLIANCE CO.....35
Agency—Fuller & Smith & Ross, Inc.

PASTUSHIN AVIATION CORP.....434
Agency—Lynn-Western, Inc.

PERMACEL TAPE CORP.....283
Agency—The Aitkin-Kynett Co.

PESCO PRODUCTS CO.....198
Agency—Fuller & Smith & Ross, Inc.

PHEOLL MFG. CO.....244, 245
Agency—The Cramer-Krasselt Co.

PIONEER PARACHUTE CO.....234
Agency—Julian Gross Advertising Agency

PITTSBURGH PLATE GLASS CO. (SAFETY GLASS).....289
Agency—Batten, Barton, Durstine & Osborn, Inc.

POLYTECHNIC RESEARCH & DEVELOPMENT..26, 27
Agency—George Homer Martin Assoc.

PORTABLE ELECTRIC TOOLS, INC.....329
Agency—Erwin, Wasey & Co., Ltd.

PROTO TOOL CO.....404
Agency—Willard G. Gregory & Co.

PSP ENGINEERING CO.....363
Agency—L. J. Swain Advertising

PUROLATOR PRODUCTS, INC.....360
Agency—J. Walter Thompson Co.

RADIO CORP. OF AMERICA.....237
Agency—J. Walter Thompson Co.

RAYMOND ROSEN ENGINEERING PRODUCTS.....431
Agency—Al Paul Lefton Co., Inc.

RED BANK DIV., BENDIX AVIATION CORP.....221
Agency—MacManus, John & Adams, Inc.

REF MANUFACTURING CORP.....386
Agency—H. L. Mihle & Co., Inc.

REM-CRU TITANIUM, INC.....293
Agency—G. M. Basford Co.

REMINGTON RAND, INC.....128
Agency—Leeford Adv. Agency, Inc.

REPUBLIC AVIATION CORP.....3
Agency—DeGarmo, Inc.

REPUBLIC STEEL CORP.....314
Agency—Meldrum & Fewsmith, Inc.

RESISTOFLEX CORP.....300
Agency—Richard & Co., Inc.

REVERE CORP. OF AMERICA.....33
Agency—Troland, Inc.

REZOLIN, INC.....17
Agency—Dozier-Eastman & Company

RIVERSIDE METAL CO.....315
Agency—Robert S. Kampmann, Jr.

ROBERTSHAW-FULTON CONTROLS CO.....16
Agency—The Griswold-Eshleman Co.

ROBINSON AVIATION, INC.....200
Agency—Platt, Zachary & Sutton, Inc.

ROBINSON CO., RALPH C.....400
Agency—Chapin-Damm Advertising

ROHM & HAAS CO.....18, 19
Agency—John Falkner Arndt & Co., Inc.

ROHR AIRCRAFT CORP.....Insert 106
Agency—Barnes Chase Co.

RUBBER TECK, INC.....433
Agency—The McCarty Company

RYAN AERONAUTICAL CORP.....301
Agency—Batten, Barton, Durstine & Osborn, Inc.

SAGINAW STEERING GEAR DIV., G.M.C.....49
Agency—Price, Hedrick & Tanner, Inc.

SANDERS ASSOCIATES.....397
Agency—Robert Hartwell Gabine

SCHULZ TOOL & MFG. CO.....429

SCHUTTIG & CO., INC.....364

SCINTILLA MAGNETO DIV., BENDIX AVIATION CORP.....48
Agency—MacManus, John & Adams, Inc.

SCOTT AVIATION CORP.....65
Agency—Melvin F. Hall Adv. Agency

SEARCHLIGHT SECTION..436, 437, 438, 439, 440, 441

SERVICE STEEL CO.....184
Agency—Claude E. Whipple Adv.

SERVOMECHANISMS, INC.....233
Agency—Sanger-Funnell, Inc.

SHAFER BEARING CORP.....231
Agency—Marsteller, Gebhardt & Reed, Inc.

SHELL OIL CO.....330
Agency—J. Walter Thompson Co.

SIMMONDS AEROCESSORIES, INC.....257
Agency—Burke Dowling Adams, Inc.

SINCLAIR REFINING CO.....6, 7
Agency—Morey, Humm & Johnstone, Inc.

SMITH MORRIS CO.....333

SNAP-ON-TOOLS CORP.....232
Agency—The Cramer-Krasselt Co.

SORENG PRODUCTS CORP.....253
Agency—Rogers & Smith Adv., Inc.

SOUTH GATE ALUMINUM & MAGNESIUM CO.....294
Agency—Byron H. Brown & Staff

SOUTHWEST AIRMOTIVE CO.....286
Agency—Laughlin-Wilson-Baxter & Persons Adv.

SPECIAL MACHINE TOOL ENGINEERING WORKS.....112
Agency—Fred Wittner Advertising

SPENCER THERMOSTAT DIV., METALS & CONTROLS CORP.....157
Agency—Sutherland-Abbott Adv.

SPERRY GYROSCOPE CO.....130, 131
Agency—Charles Dallas Reach Co., Inc.

SPRAGUE ELECTRIC CO.....430
Agency—The Harry P. Bridge Co.

STAINLESS STEEL PRODUCTS CO., INC.....383

STANDARD PRESSED STEEL CO.....58
Agency—Gray & Rogers Adv.

STANDARD-THOMSON CORP.....226
Agency—Caldwell, Larkin & Co., Inc.

STEPHEN-DOUGLAS CO., INC., THE.....434

STEWART WARNER CORP.....376
Agency—MacFarland, Aveyard & Co.

STRATOS DIV., FAIRCHILD ENGINE & AIRPLANE CORP.....240B
Agency—Buchanan & Co., Inc.

STURTEVANT CO., P. A.....431
Agency—Ross Llewellyn, Inc.

SUMMERS GYROSCOPE CO.....272
Agency—Byron H. Brown & Staff

SUPERIOR TUBE CO.....357
Agency—John Falkner Arndt & Co., Inc.

SUPREME PRODUCTS, INC.....291
Agency—Harris & Bond, Inc.

SURFACE COMBUSTION CORP.....134, 135
Agency—Odiorne Industrial Adv.

SURPRENANT MFG. CO.....192
Agency—Ad-Service, Inc.

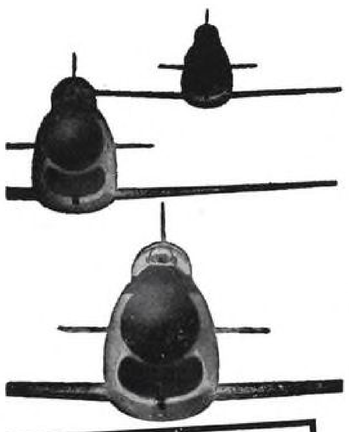
TALLER & COOPER, INC.....259
Agency—Harold Marshall Adv., Co.

TELECOMPUTING CORPORATION.....427
Agency—Hal Stebbins, Inc.

TENNEY ENGINEERING INC.....189
Agency—O. S. Tyson & Co., Inc.

TENSOLITE INSULATED WIRE CO., INC.....318
Agency—George Homer Martin Assoc.

TEXAS INSTRUMENTS, INC.....432
Agency—Laughlin-Wilson-Baxter & Persons Adv.



Engineers—

PICK A WINNER

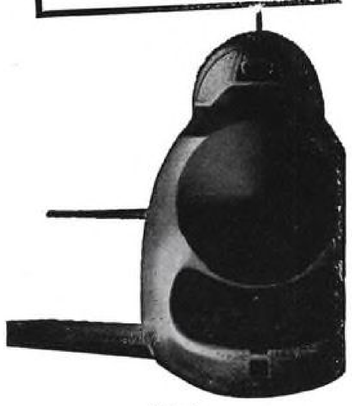
The Engineering Department which designed the Sabre and other headline-making military airplanes has openings for engineers—experienced in aircraft, recent engineering grads, or men from other fields with adaptable experience. Long-term military projects and twenty-five years of continuous expansion underwrite your future at North American. Current openings in:

All Design Fields

Thermodynamics | Aerodynamics
System Analysis | Structures
Servo-mechanisms | Electronics

Specialists in all major aircraft fields

Liberal travel and moving allowances



Write to

North American Aviation, Inc.

DEPT. 10, ENGINEERING PERSONNEL OFFICE
LOS ANGELES INTERNATIONAL AIRPORT
LOS ANGELES 45, CALIFORNIA
or
COLUMBUS 16, OHIO

NORTH AMERICAN HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD

U. G. CONNECTORS

Our Coaxial Cable Connectors Meet All Government Specifications

ALL ORDERS DELIVERED PROMPTLY

Manufacturers of Highest Quality Connectors

AI-11039, type BNC resistive termination plug, Weatherproof, Styrene Copolymer insert. Neoprene rubber gasket. Can be furnished with any desired impedance.

AI-11072, Army-Navy type UG-21D/U, improved type N plug for use with RG-8, 9, 9A, 10/U cables. Weatherproof. Teflon insert, neoprene mating seal gasket, silicon rubber cable clamp gasket.

AI-11070, Army-Navy type UG-154/U, type LC plug for use with RG-17, 18/U cables, Weatherproof. Silicon rubber gaskets.

AI-11032, Army-Navy type UG-37A/U, high voltage pulse receptacle pressurized. Ceramic insert, neoprene rubber gaskets.

AI-11022, special type BNC high voltage plug. Mates only with high voltage receptacles and jacks, for use with RG-59/U cable, Weatherproof. Teflon insert, Neoprene rubber gaskets.

AI-11006, Army-Navy type UG-355/U Klystron Coupler. Weatherproof. Styrene Copolymer and linen base bakelite inserts. For use with klystron tube 726C.

AI-11030, Army-Navy type UG-306/U, type BNC right angle adapter. One male, one female end. Weatherproof, Teflon inserts. Neoprene rubber gasket.

ALLIED INDUSTRIES, INC.

1023 S. 21st Street
Louisville 10, Ky.
Phone Arlington 4640

WHERE TO BUY

NEW EQUIPMENT — ACCESSORIES
MATERIALS
SERVICES AND SUPPLIES

are porous castings causing you losses?

end them—
specify
Spun
NON-GRAN
CENTRIFUGAL CASTINGS

• Get details—request booklet. American Non-Gran Bronze Co., Berwyn, Pa.

FIND OUT HOW THIS NEW CUTTER HEAD CUTS SPAR MILLING COSTS

CUTS COSTS . . SAVE TIME
Onsrud SERT - A - BLADE wedge type spar milling cutters with serrated, inserted carbide tipped blades are engineered to proper rake and shear angles for milling aluminum spar sections. Knife faces are spiral ground to maintain positive rake throughout entire length of blade, for better, smoother cutting. Serrated, insertable blades are secured by bolted wedges, . . . safe, secure, easier to remove. Designed to allow adjustment to compensate for wear and repeated sharpening. Permits full use of practically the entire carbide tip. MAIL COUPON NOW for full details.

ONSRUD CUTTER MANUFACTURING CO.
800-820 E. Broadway Libertyville, Ill.

Onsrud Cutter Mfg. Co.
800-820 E. Broadway, Libertyville, Ill.
Please rush Full Details on your SERT-A-BLADE Milling Heads for the Aircraft Industry.
NAME_____
FIRM_____
ADDRESS_____
CITY_____ STATE_____

COMPACT
DEPENDABLE
EFFICIENT *Rotary Power* by Carter

THE NEW *Custom*

DC-AC CONVERTER

These latest of all Carter DC to AC Converters are specially engineered for professional and commercial applications requiring a high capacity source of 60 cycle AC from a DC power supply. Operates from storage batteries, or from DC line voltage. Three "Custom" models, delivering 300, 400, or 500 watts 115 or 220 V. AC. Wide range of input voltage, 12, 24, 32, 64, 110 or 230 V. DC. Unequalled capacity for operating professional recording, sound movie equipment and large screen TV receivers. Available with or without manual frequency control feature.

MAIL COUPON FOR CATALOG

Carter Rotary Power Supplies are made in a wide variety of types and capacities for communications, laboratory and industrial applications. Used in aircraft, marine, and mobile radio, geophysical instruments, ignition, timing, etc. MAIL COUPON NOW for complete Dynamotor and Converter Catalogs, with specifications and performance charts on the complete line.

Carter MOTOR CO.
2653 N. Maplewood Ave.
Chicago 47

Carter Motor Co.
2653 N. Maplewood Ave., Chicago 47
Please send new catalogs containing complete information on Carter "Custom" Converters and other Rotary Power Supplies.
Name_____
Address_____
City_____ State_____

THERMO ELECTRIC CO. 145
Agency—Fred Lange Assoc., Inc.

THOMPSON AIRCRAFT TIRE CORP. 317
Agency—Norton M. Jacobs Adv. Agency

THOMPSON CO., H. I. 57
Agency—Abbott Kimball Co. of Calif.

THOMPSON PRODUCTS, INC. 40
Agency—Meldrum & Fewsmith, Inc.

TIMKEN ROLLER BEARING CO. 51
Agency—Batten, Barton, Durstine & Osborn, Inc.

TITEFLEX, INC. 443
Agency—John Falkner Arndt & Co.

TOMKINS-JOHNSON CO. 304
Agency—Beeson-Faller-Reichert, Inc.

TORRINGTON CO., THE 267
Agency—Hazard Advertising Co.

TOWNSEND COMPANY 295
Agency—Bond & Starr, Inc.

TRANSICOIL CORP. 353
Agency—The Harry P. Bridge Co.

TRANSPORT EQUIPMENT CO. 4
Agency—Jaycraft Co.

TRANS-SONIC, INC. 390
Agency—Hare Advertising

TRANS-WORLD AIRLINES, INC. 117
Agency—Batten, Barton, Durstine & Osborn, Inc.

TUBE METHODS, INC. 365
Agency—John Miller Adv. Agency

TUBING SEAL CAP, INC. 378
Agency—L. J. C. Spruance Adv.

TWIGG, INDUSTRIES, INC. 299
Agency—Gregory & House, Inc.

TWIN COACH CO. 380
Agency—Palm & Patterson, Inc.

TWIX MANUFACTURING CO., INC. 311
Agency—Harold Marshall Adv. Co.

U. S. COMPONENTS, INC. 399
Agency—Mitchell Advertising Agency

U. S. STEEL CORP. 372, 373
Agency—Batten, Barton, Durstine & Osborn, Inc.

U. S. TIME CORP., THE 246, 247
Agency—Hirshen-Garfield, Inc.

UNIVERSAL METAL PRODUCTS 290
Agency—Byron H. Brown & Staff

UTICA DROP FORGE & TOOL CORP. 353
Agency—Wilson, Haight & Welch, Inc.

VARD, INC. 164
Agency—The Essig Company

VICKERS, INC. 34
Agency—Witte & Burden Adv.

VOI SHAN MFG. CO., INC. ..... Insert 207
Agency—Anderson-McConnell Adv. Agency

WALTHAM SCREW CO. 410
Agency—Edmund S. Whitten, Inc.

WARNER DIV., DETROIT HARVESTER CO. 394
Agency—Clark & Bobertz, Inc.

WEBER AIRCRAFT CORP. 159
Agency—Ruthruaff & Ryan, Inc.

WELLMAN BRONZE & ALUMINUM CO. 222
Agency—R. C. Wellman & Assoc., Inc.

WESTERN GEAR WORKS 53
Agency—Ruthruaff & Ryan, Inc.

WESTINGHOUSE AIR BRAKE CO. 320
Agency—Batten, Barton, Durstine & Osborn, Inc.

WESTINGHOUSE ELECTRIC CORP. 223, 224, 225, 345
Agency—Fuller & Smith & Ross, Inc.

WESTINGHOUSE ELECTRIC CORP. 310
Agency—H. W. Buddemeir Co.

WHITE INDUSTRIES, INC. 297

WHITTAKER CO., LTD., WM. R. 270
Agency—Mogge-Privett, Inc.

WILCOX ELECTRIC CO. 111
Agency—Carter Adv. Agency, Inc.

WILDING PICTURE PRODUCTIONS 324

WINCHESTER ELECTRONICS, INC. 435
Agency—The Kotula Co.

WITTEK MFG. CO. 367
Agency—Merrill & McEnroe & Assoc., Inc.

WOLFE CO., FRANKLIN C. 278

WOLLENSAK OPTICAL CO. 109
Agency—Ed Wolff & Assoc.

WYANDOTTE CHEMICALS CORP. 342
Agency—Brooke, Smith, French & Dorrance, Inc.

Z & W MACHINE PRODUCTS, INC. 406

ZENITH PLASTICS CO. ..... Second Cover
Agency—Francis D. Gonda Co.

SEARCHLIGHT SECTION
(Classified Advertising)
H. E. HILTY, Mgr.

EMPLOYMENT
Positions Vacant 436, 438
Selling Opportunities Offered 438
Positions Wanted 438
Selling Opportunity Wanted 438
Employment Agencies 438

SPECIAL SERVICES
Contract Work 439

PLANES—EQUIPMENT
(Used or Surplus New)
For Sale 439-441

WANTED
Planes—Equipment 438, 439

NEW WESTERN SWING...
ELECTROLIZING
—for longer wearing production parts and freedom from corrosion.
Write for information.
ELECTROLIZING SALES and TOOLS, Inc.
1406 E. 15th St., Los Angeles 21

DOUBLE BARREL
ADVERTISING

Advertising men agree—to do a complete advertising job you need the double effect of both Display Advertising and Direct Mail.

Display Advertising keeps your name before the public and builds prestige.

Direct Mail supplements your Display Advertising. It pin-points your message right to the executive you want to reach —the person who buys or influences the purchases.

In view of present day difficulties in maintaining your own mailing lists, our efficient personalized service is particularly important in securing the comprehensive market coverage you need and want.

Ask for more detailed information today. You'll be surprised at the low overall cost and the tested effectiveness of these hand-picked selections.

Mc GRAW-HILL
DIRECT MAIL LIST SERVICE

McGraw-Hill Publishing Co., Inc.
330 West 42nd St., New York 36, N. Y.

A great new airliner
sets new performance standards!

BENDIX DIRECT INJECTION FUEL SYSTEM

Lowers maintenance costs • Gives longer engine life • More engine power • Better altitude performance and engine acceleration • Easier starting • Shorter warm-up periods • More payload or more ton-miles per gallon.

With the introduction of the Super Constellation, Lockheed Aircraft Corporation adds a new chapter to its long history of aviation accomplishments. Greatest of a long line of Lockheed giants of the air the Super Constellation has even faster speed, added safety and more passenger comfort than its illustrious predecessors.

And when the Bendix* Direct Injection Fuel Metering System is combined with the engineering achievement of the plane and engine builder, this new airplane accomplishes its outstanding performance record with almost unbelievable operating economies.

Over the years the challenge of better and faster service at lower cost for the traveling public has been met by Bendix through the development of more efficient fuel metering. Problems of landing heavier loads at higher speeds have likewise been solved with efficient, high strength and low weight Bendix* brakes, struts and landing gear.

*REG. U. S. PAT. OFF.

BENDIX • PRODUCTS DIVISION • SOUTH BEND Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

FIRST IN FUEL METERING — LEADER IN LANDING GEAR

swift compact fighters
giant aerial fortresses

FOOTE BROS. SERVES THEM BOTH WITH PRECISION GEARING AND MECHANICAL DRIVES

From the swift McDonnell Banshee*, with its amazing record of fighter performance—from the revolutionary Boeing B-47 that recently flew the Atlantic in 5 hours, 22 minutes, breaking the transatlantic speed record—to the giant Boeing B-52, the newest and mightiest Air Force defense bomber—Foote Bros. serves them all. Gears and mechanical drives rugged in design and construction, jewel-like in precision, all designed to fit a confined space envelope—these are providing better performance, greater speed, simplified operation.

McDONNELL 2HF-3

BOEING B-47

BOEING B-52

FOOTE BROS. Duti-Rated LIFETIME GEARING

THIS TRADE MARK STANDS FOR THE FINEST IN INDUSTRIAL GEARING

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION • 4545 SOUTH WESTERN BOULEVARD • CHICAGO 9, ILLINOIS

* REG. TRADEMARK