Aviation Week

Including Space Technology

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A McGraw-Hill Publication

May 12, 1958

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ARMA SLED TESTS TITAN GUIDANCE

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When the Lockheed Q5 plummets earthward, it plunges its one-piece filament-wound radome-boom into the ground. The tail remains skyward with instruments unharmed. This requires a radome-boom (nose) of steel-like toughness and strength, yet one which must be precise to ± .002 inch to meet the "optical" requirements of its microwave system.

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AVIATION CALENDAR

May 19-22—17th Annual National Conference, Society of Aeronautical Weight Engineers, Inc., Belmont Plaza Hotel, New York, N. Y.

May 21-22—Flight Safety Foundation, Inc., Regional Business Aircraft Safety Seminar, Palmer House, Chicago, Ill.

May 25-31—1958 Aviation Writers Assn. Convention, the Shamrock Hilton, Houston, Tex.

June 2-4—National Telemetering Conference, Lord Baltimore Hotel, Baltimore, Md.

June 4-5—West Coast Magnesium Symposium, correlated program by the Society of Aircraft Materials and Process Engineers and the Magnesium Assn., Institute of Aeronautical Sciences Bldg., Los Angeles, Calif.

June 4-6—Second National Conference on Production Techniques, sponsored by the Institute of Radio Engineers Professional Group on Production Techniques, Hotel New Yorker, New York, N. Y.

June 5-6—13th Annual National Meeting, Armed Forces Chemical Assn., Hotel Traymore, Atlantic City, N. J.

June 9-12—American Rocket Society Semi-annual Meeting and Astronautical Exposition, Hotel Statler, Los Angeles, Calif.

June 9-13—Fourth International Automation Exposition and Congress, Coliseum, New York, N. Y.

June 16-18—Second National Convention on Military Electronics, Sheraton Park Hotel, Washington, D. C.

June 19-21—Annual Meeting, Institute of Navigation, University of California Santa Barbara College, Goleta, Calif.

June 22-27—61st Annual Meeting, American Society for Testing Materials, Hotel Statler, Boston, Mass.

June 24-26—31st Meeting, Aviation Distributors and Manufacturers Assn., Mount

(Continued on page 6)

AVIATION WEEK Including Space Technology

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AVIATION CALENDAR

(Continued from page 5)

Washington Hotel, Bretton Woods, N. H.

June 25-27—Air Transportation Conference, American Institute of Electrical Engineers, Hotel Statler, Buffalo, N. Y.

June 27—First Water-Based Helicopter Symposium, sponsored by the Bureau of Aeronautics and Stevens Institute of Technology, Stevens Institute of Technology, Hoboken, N. J.

July 8-11—The Institute of the Aeronautical Sciences, National Summer Meeting, Ambassador Hotel, Los Angeles, Calif.

July 14-15—Triennial Inspection, National Advisory Committee for Aeronautics, Ames Aeronautical Laboratory, Moffett Field, Calif.

July 24-25—Fifth Annual Symposium on Computers and Data Processing, Albany Hotel, Denver, Ohio.

July 24-25—Quarterly Regional Meeting, Assn. of Local and Territorial Airlines, Denver, Colo.

Aug. 6-8—Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers, sponsored by the American Institute of Electrical Engineers, Hotel Statler, Los Angeles, Calif.

Aug. 13-15—Conference on Electronic Standards and Measurements, National Bureau of Standards, Boulder Laboratories, Boulder Colo. Jointly sponsored by NBS, American Institute of Electrical Engineers, and Institute of Radio Engineers.

Aug. 19-22—Western Electronic Show & Convention, Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif.

Aug. 25-30—Ninth Annual Congress, International Astronautical Federation, Amsterdam, Holland.

Sept. 1-7—1958 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

Sept. 3-5—1958 Cryogenic Engineering Conference, Massachusetts Institute of Technology, Cambridge, Mass.

Sept. 6-14—International Aviation Show, Coliseum, New York, N. Y.

Sept. 8-13—First International Congress of the Aeronautical Sciences, Palace Hotel, Madrid, Spain.

Sept. 8-13—Dynamics of Flight, University of Michigan, intensive course for practicing engineers, Ann Arbor, Mich.

Sept. 15-19—Annual Instrument-Automation Conference & Exhibit (International), Instrument Society of America, Philadelphia Convention Hall, Philadelphia, Pa.

Sept. 22-24—1958 Meeting, Professional Group on Telemetry and Remote Control, Americana Hotel, Bal Harbor, Miami Beach, Fla.

Sept. 29-Oct. 3—National Aeronautic Meeting, Society of Automotive Engineers, Inc., The Ambassador, Los Angeles, Calif.

Oct. 27—14th Annual General Meeting of the International Air Transport Assn., New Delhi, India.

Oct. 27-28—East Coast Conference on Aeronautical & Navigational Electronics, sponsored by the Institute of Radio Engineers, Lord Baltimore Hotel, Baltimore, Md.

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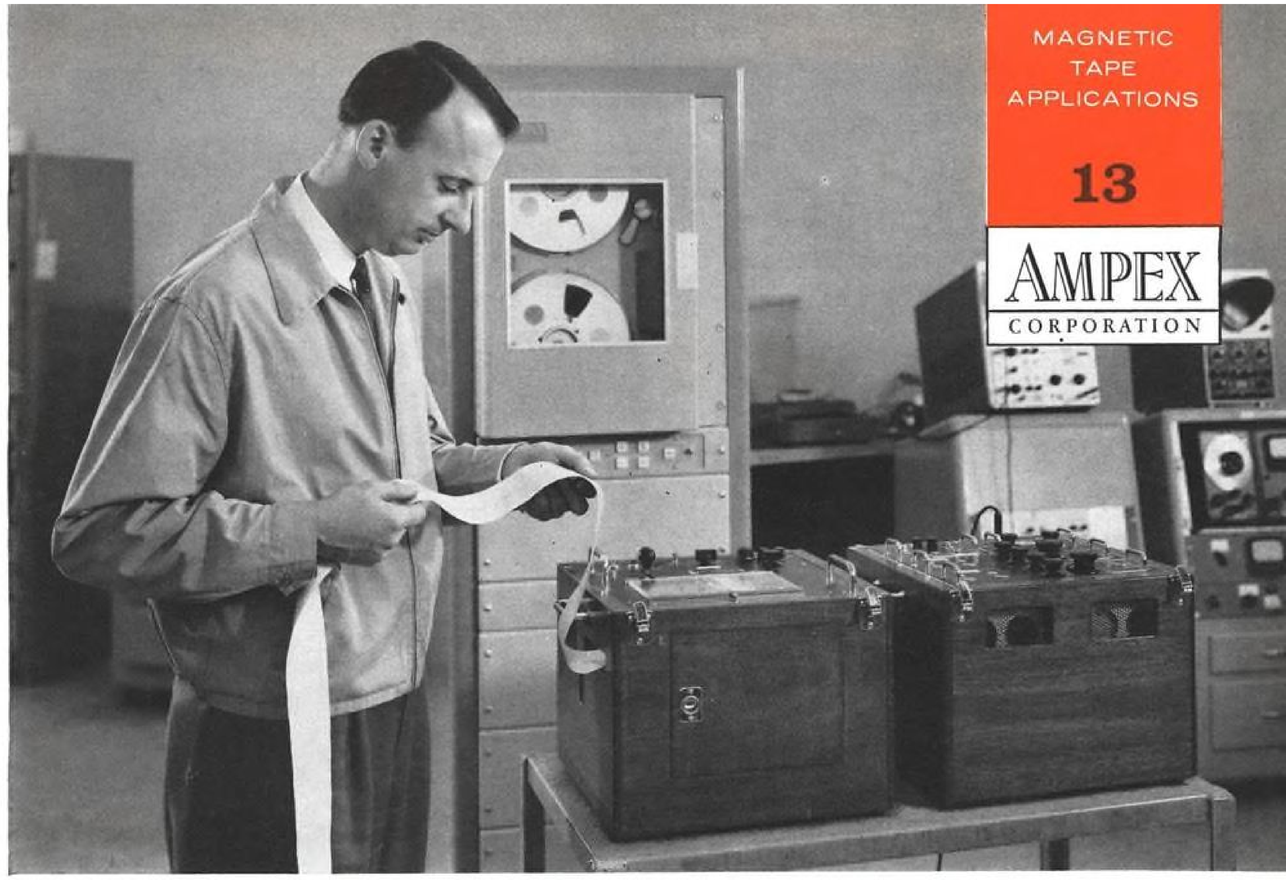

How to write 10,000-cycle data on a pen recorder

A tape tie-in banishes frequency-response limitations and saves paper

We will cancel the laws of physics, throw out inertia, and behold here is a pen recorder writing out 10,000 cycles per second ready to read. Don't scoff. There is a way. Assuming visual data is really what you want, keep your eye on the oscillograph or pen recorder, and think of the tape recorder as an ingenious "frequency-response extender" or "data stretcher."

A SLOW-MOTION LOOK AT TRANSIENTS

When an aircraft manufacturer was having shock problems from the firing of an experimental plane's armament, nothing could be seen in real-time data. For a better look, shock waves were recorded on tape, slowed down, recopied and then written out in visual traces. A thousandth of a second was stretched out to a full second. The exact extent and nature of the shock pattern and its manner of transmittal through the plane's structure became clearly evident – and with it the design solution.

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Compared to any visual-trace recorder, an Ampex instrumentation tape recorder has virtually unlimited response. Frequency components as high as 10,000 cycles per second (and much more) are easily recorded. And tape has decided advantages too at 1000 or 2000 cycles. A tape speed of 60 inches per second captures any of these higher frequencies and has tremendous room for slowdown on playback. Reproducing the tape at 0.6 in/sec. reduces 10,000 cps. to a mere 100. Connect a direct-writing recorder to the tape recorder and 100 cycles response is all that you need.

Actually Ampex has a wide range of tape speeds and tape slowdown ratios available. Tapes can be recopied once or even twice multiplying these ratios accordingly.

TYPICAL TAPE SLOWDOWN (OR SPEEDUP) RATIOS

AMPEX MODEL	Basic speed ratio	First recopy	Second recopy
FR-1100	8 to 1	64 to 1	512 to 1
FR-100	32 to 1	1024 to 1	32,768 to 1
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On 5000-cycle data, an ordinary 10½" reel of 1-mil magnetic tape will record 24 minutes. On a visual-trace recorder writing 100 cycles per inch, a 250-foot magazine of expensive paper would last just one minute! When you record data first on tape, you will seldom recopy the whole test onto paper. With an oscilloscope or other scanning device, you find the important parts of the tape and copy as little as a few seconds onto the visual medium. The tape can be stored for future reference, cut into loops for analysis or can be erased and reused. It saves hundreds of feet of paper.

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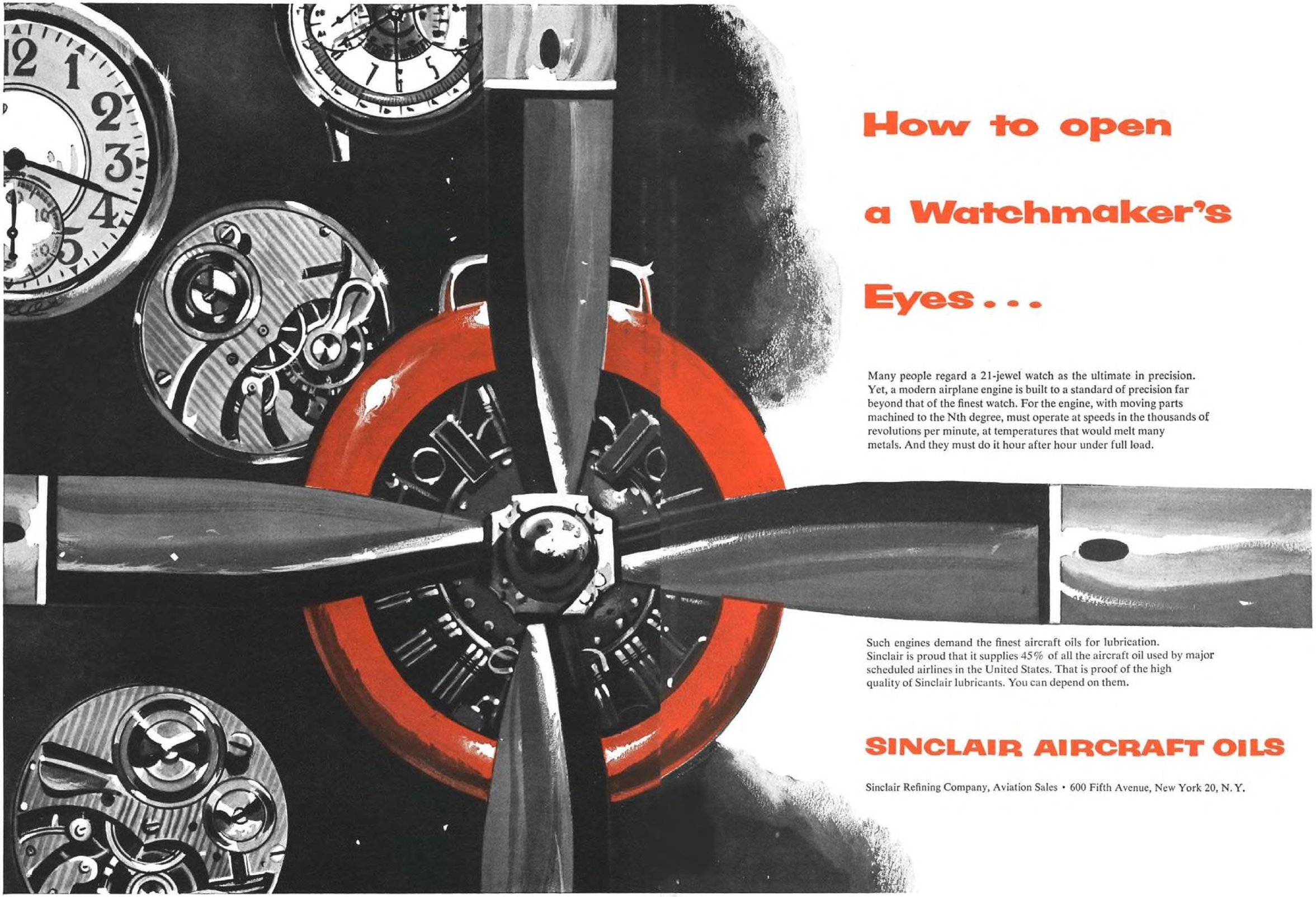

How to open a Watchmaker's Eyes . . .

Many people regard a 21-jewel watch as the ultimate in precision. Yet, a modern airplane engine is built to a standard of precision far beyond that of the finest watch. For the engine, with moving parts machined to the Nth degree, must operate at speeds in the thousands of revolutions per minute, at temperatures that would melt many metals. And they must do it hour after hour under full load.

Such engines demand the finest aircraft oils for lubrication. Sinclair is proud that it supplies 45% of all the aircraft oil used by major scheduled airlines in the United States. That is proof of the high quality of Sinclair lubricants. You can depend on them.

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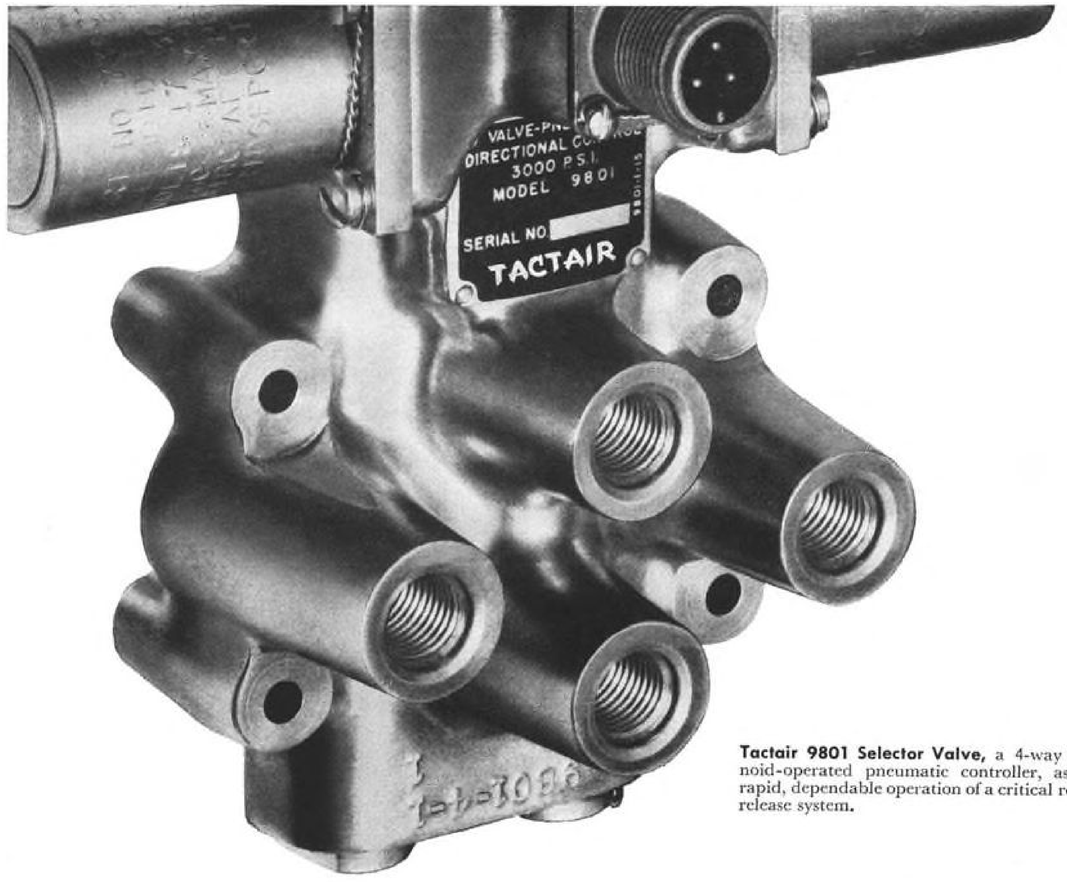


Tactair 9801 Selector Valve, a 4-way solenoid-operated pneumatic controller, assures rapid, dependable operation of a critical rocket release system.

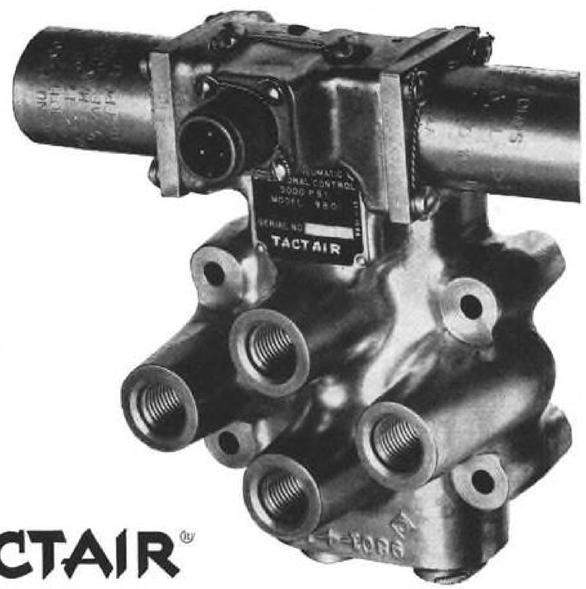
Memo: to missile men looking for dependable components

Split-second operation, high flow capacity and low leakage are important requirements for pneumatic and hydraulic valves used in rocket and missile control systems. In addition, these components must be compact and light weight and provide utmost dependability.

Case in point: this 4-way, solenoid-operated, pneumatic selector valve for a rocket release mechanism. To assure its rapid, dependable operation over a wide range of operating pressures, we combined a number of tried and proved design principles used individually in other models. And to minimize weight, we made the valve a pilot-operated unit.

Result: an uncommonly wide pressure range of 500 to 3,000 psi at altitudes from sea level to 70,000 feet. Extremely high flow capacity for a valve this size—actual flow factor of .2 Qu. Low leakage—3 cc per min. of free air. Rapid operation—.05 sec. max. (energized). And with this, a weight of only 1.9 lbs.

Reminder: on standard or special components, we welcome the opportunity to assist you with your next precision valve problem. Every job we do is done on a personalized basis. It has been that way for 16 years. Tactair Valve Division, Aircraft Products Company, Bridgeport, Pa. BRoadway 5-1000.



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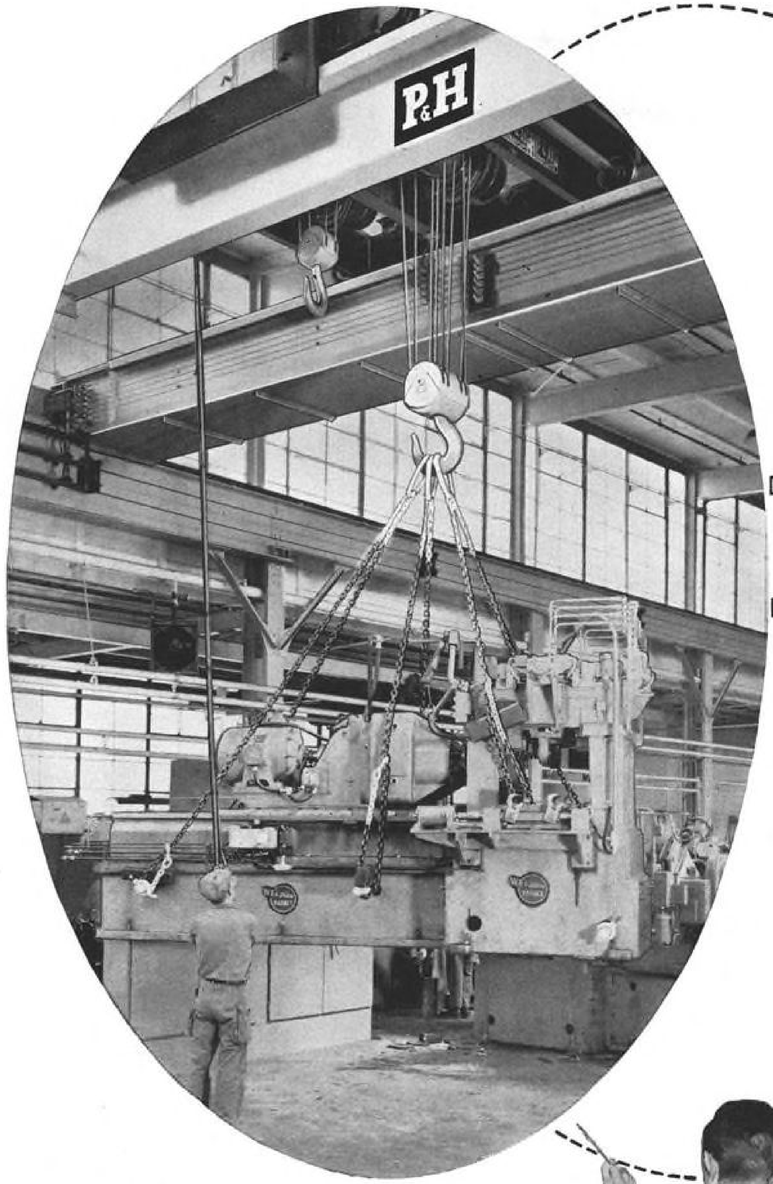

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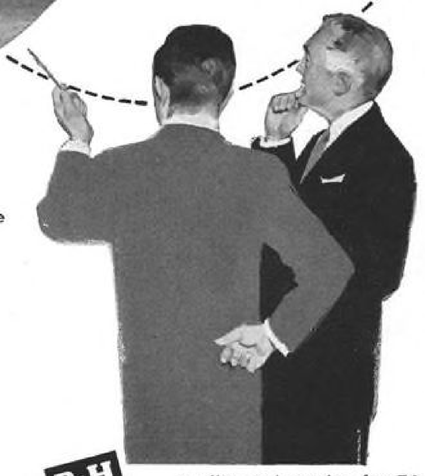

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COVER: Inertial guidance system for Titan intercontinental ballistic missile is subjected to intercontinental ballistic missile-type shock-vibration environment on supersonic test sled at Naval Ordnance Test Station, China Lake, Calif. For first detailed report on Titan guidance, produced by American Bosch Arma Corp., see p. 92.

PICTURE CREDITS

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73,981 copies of this issue printed

EDITORIAL

Scramble for Altitude

Within the past few weeks a healthy international and interservice rivalry has blossomed to push the official world altitude record to some fantastic new levels. At this writing, it looks as though the altitude laurels rest firmly on the collective brows of USAF Maj. Howard C. Johnson, Lockheed Aircraft Corp.'s F-104 Starfighter and General Electric's J79 turbojet engine. Maj. Johnson's zoom to 91,249 ft. in the J79-powered F-104 should be the first in a bid for this combination to win the triple crown of altitude, speed and time to climb. The F-104 will be shooting for a 1,400 mph. speed mark to top the 1,207 mph. set last winter by the McDonnell F-101 and plans to beat the climb to 50,000 ft. in two min., 50 sec. set by the French Sud Aviation Trident a few weeks ago.

The altitude record has changed hands three times in the last few weeks in a refreshing outburst of competition that is now getting the mark to a more realistic level. First kudos in this competition go to Navy pilot Lt. Cmdr. George Watkins, the Grumman F11F-1F Super-Tiger and the G.E. J79-3 engine for bringing the altitude record back to the U.S. after it reposed 28 years abroad.

It was the late Adm. Apollo Soucek who wrested the altitude record from Germany in 1930 with a 43,000 ft. climb over Washington in the Wright Apache powered by one of Pratt & Whitney's first Wasp engines for the last previous U.S. notch on this trophy. Cmdr. Watkins boosted his Super-Tiger to an officially recorded 76,828 ft. over Muroc Dry Lake, although he went well over 80,000 feet in practice zooms. Under Federation Aeronautique Internationale competition rules, the Navy and the Super-Tiger after setting a mark lost priority for boosting it until other competitors had their crack.

A few weeks later, the French made good their bid with an 80,000 ft. zoom by the Sud Aviation Trident powered by two wing-tip Gabizo turbojets and a SEPR rocket in the tail. The Trident record-breaking flight over Istres was ironically described by the French press as its "swan song" because government budget cuts have brought this promising line of development to a complete stop.

Then Lockheed entered the lists with a trio of USAF pilots well versed in the F-104 operations from their experience at Hamilton AFB, Calif. The F-104s flown in this triple bid are powered by a later and more powerful version of the G.E. J79, which offers a 20% boost in thrust at altitude over the -3 engine powering the Super-Tiger and enables the F-104 to reach a higher altitude and Mach number in its zoom climb before flame-out.

It is interesting to note that in both the Super-Tiger and Starfighter record climbs using only turbojet and afterburner, pilots relied on a zoom of more than 20,000 ft. after their engines flamed out from lack of oxygen at extreme altitudes. The control problems in executing such a maneuver called for a high degree of pilot skill.

This burst of international rivalry that wrested the record from the special British Canberra bomber powered by Bristol Olympus turbojets and Napier Scorpion rockets has certainly enhanced the prestige of both USAF and Navy and the two bitter contenders in the European and Asiatic export market—the Starfighter and Super-Tiger.

It also presents a genuine challenge to the Soviet Union to get into this international competition or tactily admit its inability to match these performances with the designs of Artem Mikoyan and Pavel Sukhoi. The Soviet Union has been taking an increasingly active role as a member of the Federation Aeronautique Internationale. It has filed a number of officially recorded helicopter records with this custodian of international performance and will play host next summer to the 52nd annual meeting of the FAI in Moscow. It would indeed be interesting if, as further evidence of a genuine desire for international cooperation, the Soviet Union entered the record competition in all categories.

Glider Support

We have in hand a communication from Paul Schweizer, president of the Soaring Society of America in Elmira, N. Y., with news of plans to field a team of top glider pilots to defend the U.S. title in the FAI-sanctioned world gliding championships to be held next month in Leszno, Poland. Our readers will recall that Dr. Paul MacCready of Pasadena won the world championship in the last international competition held in 1956 in France. To support the 1956 U.S. gliding team, approximately 24 American aviation firms contributed.

This year, with business conditions soft in general and the aviation industry in particular being cudgeled by austerity edicts from the Pentagon, financial support for the gliding team is lagging badly. We believe it is extremely worthwhile to have the U.S. ably represented in this exhiliarating, peaceful and non-profit aspect of aviation in international competition held within the Soviet sphere. We hope the aviation industry will make it possible.

—Robert Hotz

WHO'S WHERE

In the Front Office

William B. Bergen and **Clarence W. Miles**, directors, The Martin Co., Baltimore, Md.

Stratoflex, Inc., Fort Worth, Tex., has announced the following officers: **K. W. Davis**, president and general manager; **D. H. Thornbury**, vice president; **C. A. Thomas**, vice president-sales; **John Tullis**, vice president-manufacturing.

Marvin B. Ruffin, vice president and general manager, Chicago Aerial Industries, Inc., Melrose Park, Ill.

Stanley C. Pace, a vice president, Thompson Products, Inc., Cleveland, Ohio. Mr. Pace is assistant manager of the company's newly formed Tapco Group.

Frederick I. Ordway, vice president and director-Astronautics Division, National Research and Development Corp., Atlanta, Ga.

Howard W. Griesbach, vice president-operations and a director, Flexonics Corp., Maywood, Ill.

Peter E. George, a vice president, Emery Air Freight Corp., New York, N. Y.

Arthur Freed, vice president-marketing, Servo Corporation of America, New Hyde Park, N. Y.

H. R. Ferguson, executive vice president and treasurer, and **Dr. H. W. Ritchey**, vice president, Thiokol Chemical Corp., Trenton, N. J. Dr. Ritchey is technical director of the Rocket Division.

I. A. Gray, assistant vice president-operations, and **J. A. Gillies**, director-maintenance and engineering, Canadian Pacific Airlines, Ltd. **R. J. Burden** succeeds Mr. Gillies as chief engineer.

Group Capt. Douglas Bader, managing director, and **F. J. Stephens**, chairman, Shell Petroleum Company's newly formed Shell Aircraft Co.

Col. William S. Cowart, Jr., (USAF), Director, National Aviation Facilities Experimental Center, Airways Modernization Board, Atlantic City NAS, N. J.

Vertol Aircraft Corp., Morton, Pa., has announced the following appointments for two new corporate divisions: **Harry S. Pack**, head, International Division; **James N. Davis**, director, Government Operations Division.

Honors and Elections

Arnold I. Beck, Republic Aviation design safety specialist and Major, USAFR, has received a commendation medal and citation "for meritorious achievement when at personal risk far in excess of the normal requirements of his duty assignment he accomplished an ascent in an altitude chamber to 198,770 ft., the highest altitude ever attained by man. The ascent was made in 1956 while Mr. Beck was on active duty at Wright Air Development Center, Wright Patterson AFB, Ohio.

Maj. Samuel Tyson of the MATS 55th Air Transport Squadron will receive Aviators' Post No. 743 annual Valor Award for "safely piloting his seriously crippled C-97 aircraft . . ."

(Continued on p. 139)

INDUSTRY OBSERVER

► Watch for McDonnell UCX four-engine utility jet transport to emerge as a dark horse in the USAF competition with a Pratt & Whitney JT12 turbojet rated at about 2,900 lb. static thrust. McDonnell prototype is scheduled to fly late this year.

► **Navy plans to finance an initial increment of seven Lockheed anti-submarine warfare Electras out of Fiscal 1959 funds. Initial contract (AW May 5, p. 27) was for research and development work involved in converting the turboprop transport into an ASW configuration. Main competition for the Navy award, which may eventually mean production of up to 200 aircraft, was from a Douglas design based on the DC-7 configuration powered by Rolls-Royce Tyne turboprops.**

► Douglas is working hard to sell USAF a Mach 2 tanker-transport powered by Pratt & Whitney's J58 turbojet which is now running at 30,000 lb. static thrust without afterburner on the test stand at P&W's new Florida development facility. Douglas Mach 2 transport design is based on the DC-8 development project and would utilize some DC-8 components.

► **Rolls-Royce is offering a new turbo-ramjet design to U. S. manufacturers in the 60,000-lb. thrust class with availability in the early 1960s for both military and commercial designs.**

► Russia's coaxial single-place Kamov Ka-10 helicopter weighs only 440 lb. Ceiling for the "flying motorcycle" is listed at slightly over 8,000 ft. The collapsible helicopter is powered by a four cylinder, 55 hp. engine and reportedly gets up to 19 miles per gallon of fuel.

► **Toxicity of niobium (columbium) and other high-temperature metals will be studied by Aero Medical Laboratory, Wright Air Development Center, to determine permissible human dosage levels. Similar studies on materials, equipment and fuels for use in space vehicles now must include consideration of the effect of high temperatures, ozone, ultraviolet and cosmic radiation, etc., on normally nontoxic items.**

► Air Force estimates that between $16 million and $20 million would be required to successfully impact a payload on the moon. The total would allow, USAF says, five to seven shots with a 70% chance of success for each missile. Approximately $500,000 would be needed for research and development work, the remainder for production.

► **National Advisory Committee for Aeronautics is building a working model of the ion engine proposed by Ernest Stuhlinger (AW May 5, p. 28). Stuhlinger suggested heating a cesium plate which emits large numbers of positively charged ions at relatively low temperatures and then accelerating the particles through a nozzle with an electrostatic field. Engine is large enough to get realistic data on the idea but too small to be of practical value.**

► Advanced versions of F-105 Thunderchief planned by Republic Aviation Corp. include an interceptor model with an auxiliary rocket powerplant.

► **Aero Design & Engineering Corp. is readying a new "economy-model" Commander executive transport designated Model 500. Scheduled for delivery in June, Model 500 will be powered by twin 250-hp. direct-drive engines turning two-blade propellers. Commander 500 will be aimed to compete with Cessna 310 twin, will be priced at approximately $62,000. It will utilize basic model 560E airframe, lighter by several hundred pounds and probably will seat seven, with minimum radio and full tanks. With 200 lb. of radio equipment, it would seat six and carry full tanks.**

► North American Rocketdyne Division has designed a package of three 250,000 lb. thrust rocket engines using liquid oxygen and liquid hydrogen fuel for the second stage of the freight-carrying space vehicle proposed recently to USAF by Convair's Krafft Ehricke (AW April 28, p. 26). First stage would be a standard Atlas booster also powered by Rocketdyne rocket engines.

Washington Roundup

"Fly Early Nuclear Plane"

Congressional Atomic Energy Subcommittee on Research and Development is urging Dr. James Killian, presidential scientific adviser, to re-evaluate a decision to abandon developmnt of a "fly early" on-speed atomic-powered aircraft. The main argument given the subcommittee by the President for dropping the project was that it would divert talent from development of "a militarily important aircraft."

At a session with the Killian committee which had advised the President on his decision, the committee said it developed that the group had based this finding on general knowledge and that no review had been made of the situation in the nuclear aircraft field.

Members of the Killian group were: Dr. James Doolittle, chairman of the National Advisory Committee for Aeronautics; Dr. Hugh Dryden, director of NACA; Dr. Hans Bethe, recently-named disarmament adviser to the President, and Dr. Robert Bacher, chairman of the Division of Physics, Mathematics, and Astronomy at California Institute of Technology.

Rep. Mel Price (D.-Ill.), chairman of the subcommittee, has charged that the claim that the "fly early" project would waste scientific manpower is "a smoke screen for inaction" and "without basis in fact" (AW March 17, p. 26).

Satellite Recovery

Authorization for the armed forces to enter private property to recover any missile or satellite or portions that survived re-entry into the earth's atmosphere is also being sought by Rep. Price. Under legislation introduced by Price, persons who will not permit the government to recover the fallen missiles or satellites will be subjected to a $500 fine, a six-month jail sentence or both. If the person turns the fallen objects over to a foreign government, the fine would be $20,000, a 20-year prison sentence or both.

Defense Trims Committees

A number of joint Defense Department committees will be abolished by July 1 under an order issued last week by Secretary Neil H. McElroy. Many others are exempted and those abolished can be re-chartered if they are fact-finding, research and study groups or audit, review, inspection and survey groups and can justify a need for continued existence.

Aim is to maintain "effective coordination" but with "less formal working relationships," McElroy said, "In other words, it should not be necessary to charter a committee with responsibilities, functions and duties in order to confer jointly on matters of mutual interest."

President Eisenhower had asked earlier for a review of Defense's inter-departmental committee structure with an eye toward accelerating the process of making decisions.

McElroy's order exempts 16 specific committees and boards, including the Arlington Memorial Amphitheater Commission and the Joint Committee of the Uniformed Services Contingency Options Act of 1953, and all security hearing, screening and review boards and state reserve facilities boards. Most of those exempted are statutory or deal with armed forces pay, policy or civilian employment or security.

Airspace Dissension

Dissension over where final authority lies in the control of airspace still exists and is likely to grow as plans materialize for a single coordinating agency, the Federal Aviation Agency.

During hearings last month before a House Appropriations Subcommittee, James Durfee, chairman of the Civil Aeronautics Board, said that responsibility for the control of airspace and air traffic control for both civil and military aircraft has been placed by the Congress with the CAB subject to the power of the President to restrict certain areas for national defense purposes.

Elwood Quesada, chairman of the Airways Modernization Board, not entirely in agreement with the board chairman, interjected, "with some degree of embarrassment," that the responsibility of coordinating airspace rests with the President. He explained that the President has appointed a special assistant as advisor on such matters and added, "that special assistant in fact is me."

Trans Caribbean Rebuttal

Trans Caribbean Airlines wants Civil Aeronautics Board to investigate proposals in Eastern and Pan American airlines that their third class fares be reduced to $45 one-way between New York and San Juan, Puerto Rico. TCA, which instituted a $45 one-way fare over route on March 8, charges that Pan American and Eastern, which have been awarded first-class fare increases of 4% plus $1 in this market, filed for a decrease in third-class rates from $52.50 one week later as a means of "subsidizing their combined competition" with Trans Caribbean. The carrier pointed out that requests also oppose the CAB order granting the 4% increase with a stipulation that third-class fares would not be affected.

Industry Opposition

Industry has formally voiced its opposition to the annual accrued expenditure bill now before Congress. In a report to Defense Secretary Neil H. McElroy, the committee charged that the requirement in the bill for detailed accurate advanced estimating of contract expenditures for each year is "impractical of accomplishment." The report added that any delays by Congress in appropriating funds each year "would seriously disrupt the financial plans of the industry." It added that, even if the money were appropriated "in a timely manner, the administrative task of apportioning and allocating the new annual funds will be so time consuming as to undoubtedly delay payments for months after the beginning of each new fiscal year.

Different versions of the expenditure bill have passed the Senate and the House. The House version of the bill is now before the Senate.

McElroy Assistant

A retired U.S. Army major general, Otto L. Nelson, Jr., vice president of the New York Life Insurance Co., stepped in last week as special assistant to the Secretary of Defense for a period of several months. Gen. Nelson will make recommendations as to ways and means of accelerating the decision-making process after reviewing the interdepartmental committee structure in the Department of Defense.

—Washington staff

U.S. Explores Global Monitoring Methods

Passive techniques studied that could detect missile firings, nuclear explosions and submarine positions.

By James A. Fusca

New York—Nuclear explosions, missile firings, and submerged submarines can be detected at ranges of thousands of miles with passive techniques presently being explored by the U.S. They depend upon fundamental physical principles that are as well understood in the Soviet Union as in the U.S.

How They Work

Using U.S. bases in this country and abroad, these techniques are capable of monitoring the entire globe. This is how they work:

• **Nuclear explosions.** Part of the energy released during a nuclear explosion is radiated as electromagnetic energy.

This radio signal is attenuated rapidly except near the bottom of the very low frequency band where the surface of the earth and the ionosphere act as a "wave-guide" to conduct it over long distances with very little attenuation. Three receiving sites can locate the exact point of detonation by comparing the times of arrival of the signal.

• **Missile firings.** During the launching of any missile the size of an intercontinental or intermediate range ballistic missile, electromagnetic energy is generated. Also, a column of intensely ionized gases is left behind which acts as an excellent low frequency antenna.

In the same manner as with nuclear explosions, sufficient energy is radiated in the very low frequency range to provide a detectable signal thousands of miles away.

This detection capability is basis for recent testimony before the House Committee on Astronautics and Space Exploration (AW April 28, p. 25) when Rear Adm. John T. Hayward, assistant chief of naval operations for research and development, affirmed U.S. was studying techniques for monitoring the entire world.

• **Submerged submarines.** During World War II it was discovered that layers of dense water deep in the ocean conduct sound with little attenuation.

Tests showed that explosion of a small charge should be heard over distances as great as 10,000 mi. Since 1950, the Navy has been exploring detection of sounds originating at or near the surface that become trapped in these deepwater sound ducts and can be detected up to 2,000 mi. As with the radio techniques, three receiving stations can fix the location and, especially important in the case of submarines, continuously track a suspected submarine.

The major problem with this technique is identification of submarine signals from the large number of natural and man-made sounds simultaneously present.

VLF Propagation

Propagation at very low frequencies has been studied intensively both here and abroad. In the U.S. this research has been centered at the National Bureau of Standards and the Naval Research Laboratory. Much similar work has been done in England and the Soviet Union. Until very recently, the mathematical model considered by many researchers to best explain VLF propagation was that of the Soviet scientist Ya L. Al'Pert, but results obtained in this country during the last year have improved on this model.

In the very low frequency part of the radio spectrum, minimum attenuation is found in a band of frequencies several kilocycles wide that shifts back and forth between 10 and 20 kc. with changing propagation conditions. A similar area of low attenuation exists below 100 cycles but problems of detecting a signal in this region are difficult.

Experiments show that attenuation at the 10-20 kc. minimum can be less than 1 db. per 1,000 km. and seldom exceeds 2 db. per 1,000 km. Reason for this is that at these frequencies the earth and ionosphere act as the parallel plates of a waveguide or, more exactly, two concentric spheres so that energy is propagated in a quasi-TEM (transverse electromagnetic) mode around the surface of the earth.

Lightning Interference

A disadvantage of these excellent propagation characteristics is that radio noise generated by lightning strokes is propagated as well.

There are an estimated 100 lightning strokes per second around the world so the ambient noise level at these frequencies is high.

This problem is easily overcome by use of well-understood correlation techniques which separate a signal with known characteristics from random noise.

Soviet Maj. Gen. I. G. Pokrovsky has discussed in public lectures the use of electromagnetic energy generated by explosions for guidance and communications purposes, in addition to simple detection. Projects are underway in this country to study the radiation spectrum and how this energy is generated.

Sylvania Electric Products, Inc., recently completed a contract for study of detection phenomena and signal characteristics at these frequencies. Stavid Engineering, Inc., presently has a similar contract.

Electromagnetic radiation from a nuclear explosion is maximum at about 30 cycles and decreases rapidly with increased frequency to 0.1% of maximum at 1 kc. Despite this decrease, the signal radiated in the 10-20 kc. band is strong enough to be well above the minimum detectable signal level halfway around the world.

This signal originates in two different ways. First, the violent expulsion of electro-kinetically charged particles generates electromagnetic energy. Second, the gas cloud created by the explosion is highly ionized and acts as an excellent conductor for discharging the earth's vertical field gradient (the difference in electrical potential between the earth and the atmosphere with increasing altitude) which generates a transient signal similar to that generated by lightning.

Significance of present theories as to the origin of the electromagnetic energy radiated from a nuclear explosion is that underground nuclear tests probably could not be detected by this method. The movement of charged particles would be damped and the field gradient discharge would be eliminated. More tests are planned to explore this area.

Radio signals generated by missiles as they accelerate from the launching pad through the atmosphere come from similar origins. The column of highly ionized gases trailing the missile back to the ground is a highly efficient, very low frequency antenna for signals generated by the violent molecular vibration-oscillation resulting from the high exhaust velocity of the rocket engine gases. Ionization column also forms a path for discharging the vertical field gradient in the same manner as nuclear explosions.

Both U. S. and Soviets have conducted extensive experiments on sound ducts that exist in all of the world's oceans. These ducts vary in depth, rising nearer to the surface with increased latitude so that they are found frequently in the Arctic at the ocean surface.

Attenuation of acoustic signals in these ducts can be extremely low, 1 or 2 db. per 1,000 km. First proposed use of this phenomenon was for submarines to signal that they were under attack by dropping a small explosive charge into the duct. Shore stations would then locate the submarine by difference in times of sound arrivals.

Second proposed use was for air-sea rescue. System, called SOFAR, would place a small charge in each aircraft flying overseas routes. In case of ditching, the charge would be detonated by a pressure-depth fuse and signal location of the aircraft in distress. System never was accepted because of objections to placing the explosive charge in the aircraft.

Soviet Union has published results of experiments conducted in the Kara Sea which confirm results obtained in this country.

Navy is exploring two related techniques of submarine detection. For very long range, sound ducts conduct noises originating outside of the ducts —at or near the ocean's surface—which are trapped in the ducts by refraction of the sound waves as they penetrate the denser layers of water. Second technique involves multiple refraction of sound waves which first penetrate deep into the ocean and then curve back to the surface at distances of about 35 mi. where they are reflected by the surface.

Sounds trapped in ocean ducts can be detected to ranges of 2,000 mi. Sounds refracted in the depths and then reflected from the surface are detectable at ranges to 200 mi.

Primary problem of long range submarine detection is separation of the submarine's engine noises from those of other vessels and from the ocean's natural noises which are loud and plentiful.

An interesting theoretical possibility that probably will receive increased attention is the propagation of very low frequency radio waves through strata of the earth's crust. Sharp interfaces between rock strata would provide a ducting or "waveguide" effect for radio waves with sound waves.

Detection of electromagnetic radiation propagated underground would be by re-radiation into the air as a result of surface discontinuities or, theoretically, could be attained by providing a proper coupling (impedance match) to the underground image antenna of a conventional vertical VLF antenna.

An application of such a technique would be the detection of concealed underground nuclear tests.

Soviets Test New Missile

Washington—Russians have flight tested a new air-to-ground missile with a megaton warhead during the series of nuclear tests recently concluded in Siberia. The Soviet missile is propelled by a solid fuel rocket and launched from a Bison intercontinental bomber at altitudes around 50,000 ft. It has a range of approximately 50 mi. It is roughly equivalent in function and range to the Bell Aircraft Corp. Rascal missile which is now operational with Strategic Air Command B-47s in service test quantities (AW April 14, p. 67).

In contrast to the Bell Rascal, which employs a radar guidance system, the Soviet air-to-ground missile is unguided and relies entirely on its ballistic trajectory to hit a target. Its megaton warhead indicates it is intended as a weapon for area destruction rather than pinpointing specific targets. Warhead is exploded by an altitude-actuated fuze to get an air burst.

The Soviet air-to-ground missile is air launched from a rigid steel frame suspended under the belly of a Bison four-jet bomber. The frame extends far enough under the Bison to put the missile in its own airflow and to avoid pitch-up into the mother plane after launching that can result from interference from the airflow around the mother plane. Its solid propellant rocket gives the missile supersonic speed on its 50-mi. run to the target.

Lack of electronic or infrared guidance and emphasis on megaton-type warheads appears to be a deliberate Soviet policy at least for short range missiles. This policy appears to be based on a recognition that USAF electronic countermeasures are sufficiently sophisticated to make such guidance systems of dubious value in operational service. Soviet emphasis appears to lie in achieving maximum stability of missile to hold a true ballistic course.

Principal advantage of the Soviet air-to-ground missile would be to put the Bison or Bear mother planes out of range of the current family of Army's Nike defensive missiles, such as the 30 mi. slant range Ajax and the 50 mi. slant range Hercules.

Altitude Records Fall

Palmdale, Calif.—Lockheed F-104 set a new world altitude record last week by zooming to 91,249 ft.—more than two miles higher than the previous record of 80,190 ft. set only the week before by Sud Aviation's rocket-jet interceptor, the Trident II.

Flying from Palmdale and monitored by Federation Aeronautique Internationale officials, the F-104 was in the air for a total of 27 minutes. Pilot for the flight was Air Force Maj. Howard C. Johnson, 37, operations officer of 83rd Fighter-Interceptor Squadron of Air Defense Command's Western Air Defense Force. Powerplant of the F-104 is General Electric's J79 turbojet.

The earlier Trident flight had broken the 76,928-ft. mark set on April 16 by a Grumman F11F-1F.

Ironically, altitude record flight was final flight for Trident II. Company said budget restrictions have led to stoppage of the development project. Sud Aviation originally had order for 10 prototypes. Record was set in No. 6 prototype.

Trident performance, carried out under Federation Aeronautique Internationale control, beats previous record set by Grumman F11F-1F (AW Apr. 28, p. 31).

Martin Titan ICBM

Artist's conception of Martin Titan intercontinental ballistic missile has pointed nose cone although it reportedly is designed for blunt cone. First stage has two engines, second a single engine, and third has none (AW April 7, p. 23). Missile is under test at the Martin Co.'s Denver, Colo. plant.

Tight Fiscal Rein Crimps Industry Effort

By Cecil Brownlow

Washington—Defense Department has rejected a plea to alter present fiscal policies which, top aviation executives charge, may weaken industry to a point where it "will not be strong enough financially to do the job assigned to it."

The executives told Defense Secretary Neil H. McElroy that the policies requiring industry to spend more and more of its own funds are forcing "a permanent change in the financial structure of the industry" and threaten to "bring about drastic changes in long-range planning."

In a detailed report to McElroy, the industry leaders said the fiscal policies already have pushed the short-term borrowings of 15 aircraft companies from $208.2 million at the end of Fiscal 1956 to a total of $451.3 million as of last Dec. 31.

They added:

"The industry's ordinary sources of financing are, or will soon be, fully committed before the full impact of the new Defense Department policies . . . are felt."

Why U.S. Lags

The group also warned that scientific and technical progress in the U.S. is being retarded by:

• **"Arbitrary and unrealistic limitations** on the allowance of research development costs." Basic cause of the deterioration of the U. S. scientific position, it charged, has been inadequate research and development activity since World War II.

• **"Restrictions of earnings** to the point where adequate research and development facilities cannot be provided."

• **Policies of the armed services** on proprietary rights "which destroy incentive and divert inventiveness from the defense effort."

• **"Unnecessary restrictions** on industry's right to make decisions and its consequent ability to get results."

In addition, the committee charged that a proposal now under consideration by Defense for a new set of contract cost principles would "disallow certain normal and necessary costs of doing business . . . produce inequities to industry and . . . in the long run result in greater costs to the government.

To offset the need for industry to search for more and more private capital, the industry leaders urged that:

• **Progress payments** on fixed price contracts be returned to a 90% level from the present rate of 70%.

• **Cost reimbursement**, on cost plus fixed fee contracts be returned to the 100% rate that existed prior to last Nov. 1 when payments were reduced to 80%.

The executives also told McElroy that another crippling factor, "while not an expressed Department of Defense policy," has been the "substantial delays in definitizing contractual documents. These delays have held up invoicing of amounts due, with the result that millions of dollars of contractors' funds have been tied up for extended periods of time."

Defense Reply

The proposals to speed payments, first made in closed meeting with McElroy on Jan. 23, were recently rejected by Perkins McGuire, Assistant Secretary of Defense for Supply and Logistics, in a letter to Orval R. Cook, president of the Aircraft Industries Assn. The letter said in part:

"We have reviewed our payment policies and do not feel that we can revise upward the current rate of progress payments or payments under cost reimbursement contracts."

Actually, there is little the Defense Department can do to relieve the situation until, and if, the debt ceiling is raised by Congress upon the request of President Eisenhower. Both Air Force and Navy's Bureau of Aeronautics are being forced to stretch progress payments, order slippages in delivery schedules and request deferred bills because of a lack of cash on hand at the Treasury Department (AW April 21, p. 26).

Presenting the proposals to McElroy at the meeting, which had been arranged by AIA, was an industry "Committee of 12" composed of:

William M. Allen, chairman and president of Boeing Airplane Co.; George M. Bunker, chairman of the Martin Co.; Whitley C. Collins, president of Northrop Aircraft Inc., Donald W. Douglas, Jr., president of Douglas Aircraft Co. Inc.; Robert E. Gross, chairman of Lockheed Aircraft Corp.; C. G. Holschuh, executive vice President of Sperry Rand Corp.

H. M. Horner, chairman of United Aircraft Corp.; L. A. Hyland, vice president of Hughes Aircraft Co.; Dan A. Kimball, president of Aerojet-General Corp.; J. H. Kindelberger, chairman of North American Aviation Inc.; C. J. McCarthy, chairman of Chance Vought Aircraft Inc., and J. S. McDonnell, president of McDonnell Aircraft Corp.

The group told McElroy that industry is not adequately capitalized to carry the burden of increasingly financing larger proportions of both work-in-process under all types of contracts and facilities for government work and added:

"While the industry has 'plowed back' most of its profits into inventories, accounts receivable and facilities and has obtained extensive outside financing as well, present policies of the Department of Defense actually call for a permanent change in the financial structure of the industry and (will) bring about drastic changes in long-range planning for the industry."

It warned that, if its recommendations to speed payments were not followed, "then permanent capitalization of the industry must be increased.

"Equity and loan capital cannot be forced; it must be attracted by means of suitable returns combined with growth possibilities and reasonable security and stability. To achieve such returns, the earnings on government work must be increased substantially more than the 'bare interest' costs currently being proposed by the Air Force in connection with the 80% CPFF Directive."

Assistant Secretary McGuire rebutted in his letter to Orval Cook that industry profits "are not too low, taking into consideration all of the factors under which the industry operates." The letter added:

"Because of rapid changes in technology and in business volume and because of the high cost of research facilities required in this industry, it is probably inevitable that such facilities will have to continue to be provided largely by the government."

Committee of industry leaders told McElroy that basic cause of the U. S. technical decline as opposed to the progress of Soviet Union since World War II is the inadequacy of its various research and development programs.

It charged that "so many restrictions have been placed on self-starting in defense matters, particularly with regard to basic research and innovations in weapons," that the following steps should be taken if the U.S. is to regain its position:

• **Permit defense contractors to allocate** as overhead against defense contracts, defense related research and development "within reasonable limits."

• **Permit defense contractors sufficient** earnings to acquire fully adequate research and development facilities.

• **Reward the creative developer** by protecting his legitimate proprietary rights.

• **Remove unnecessary restrictions** on industry's right to make decisions.

Assistant Secretary McGuire said the Defense Department agreed that "efforts should be made to provide more freedom and flexibility to industry in the attainment of performance goals with less detailed review of day-by-day engineering and business decisions."

He added, however, that, "where substantial sums of money are involved in such decisions or where some basic governmental objective is affected, it is obvious that the government cannot divorce itself from responsibility. However, a proper balance should be achieved for efficient operations."

In its report to Defense Secretary McElroy, the committee formally announced its opposition to the annual accrued expenditure bill now before Congress. Different versions of the proposal, which requires the military to operate each year under a legally established budget ceiling, have passed the Senate and the House. The House version of the bill is now before the Senate.

Aircraft Industry Hits Renegotiation

Washington—Aircraft industry leaders have charged that present administration of the Renegotiation Act by the Renegotiation Board confiscates "earnings that are well within the contractual limits contemplated by both" the government and contractors.

In a report to Defense Secretary Neil H. McElroy, the executives representing 12 major aviation firms charged that the act as presently administered:

• Eliminates incentives for cost reduction and efficiency.

• Undermines the effectiveness of the Department of Defense's incentive approach to contract pricing. "Since unilateral determinations have, in many cases, eliminated all or a substantial portion of incentive earnings, the incentives established at the time of negotiation are, on an after the fact basis, negated."

• Is used as a punitive measure against cost-plus-fixed-fee contracts, "thus discouraging contractors from entering into research and development contracts on advanced projects."

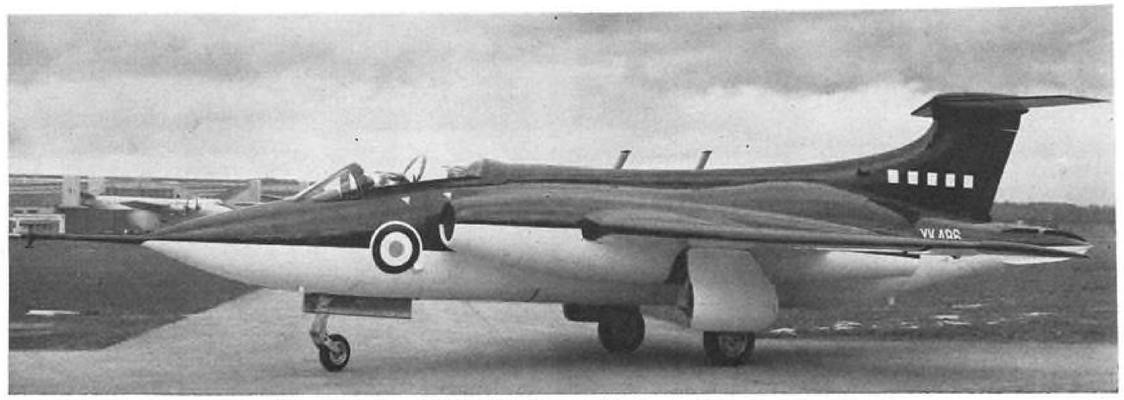
• Reduces participation of small business in the defense program through the imposition of penalties for extensive subcontracting.

• Imposes unfair penalties for effective and economical utilization of government-owned facilities.

• Imposes unfair penalties by not giving consideration in the renegotiation process to the substantial time period needed to develop and profitably produce a new weapon.

• Impedes industry's ability to implement facilities' expansion and research and development programs.

• Undermines the "effectiveness of the human resources of the industry" by sapping its financial strength and impairing its ability to "attract and retain vital human resources."



Blackburn NA.39 Completes First Flight

First flight of Blackburn & General, Ltd., NA.39 low-altitude naval strike aircraft has been completed after repairs from minor ground mishap (AW April 28, p. 37). Flight lasted 40 min. NA.39 has auxiliary ram air intakes on nacelle for tailpipe and generator cooling. Fuselage is area ruled (note pronounced aft bulge) and elongated tail cone contains speed brakes. White tail markings are for flight test purposes. Two-seater aircraft is powered by two de Havilland Gyron Junior turbojets of 7,000 lb. thrust each; has flap-blowing devices.

ARDC Stresses Space in Research

Washington—Future Air Force state-of-the-art research and development will be largely oriented toward space technology requirements, except for programs aimed at meeting specific or anticipated weapon system needs.

Space technology orientation criteria, outlined in Air Research and Development Command directive issued earlier this year to ARDC Centers, will apply to approximately one-third of the $700 million which Air Force expects to obligate for research and development during Fiscal 1959. It will not apply to programs planned to support existing or new weapon system—or electronic supporting system requirements.

The directive, signed by ARDC vice commander Maj. Gen. John W. Sessums, Jr., was intended to remove previous barriers to space technology R&D programs laid down before Sputnik I.

Headquarters statement on state-of-the-art research and development, policy directs ARDC Centers to:

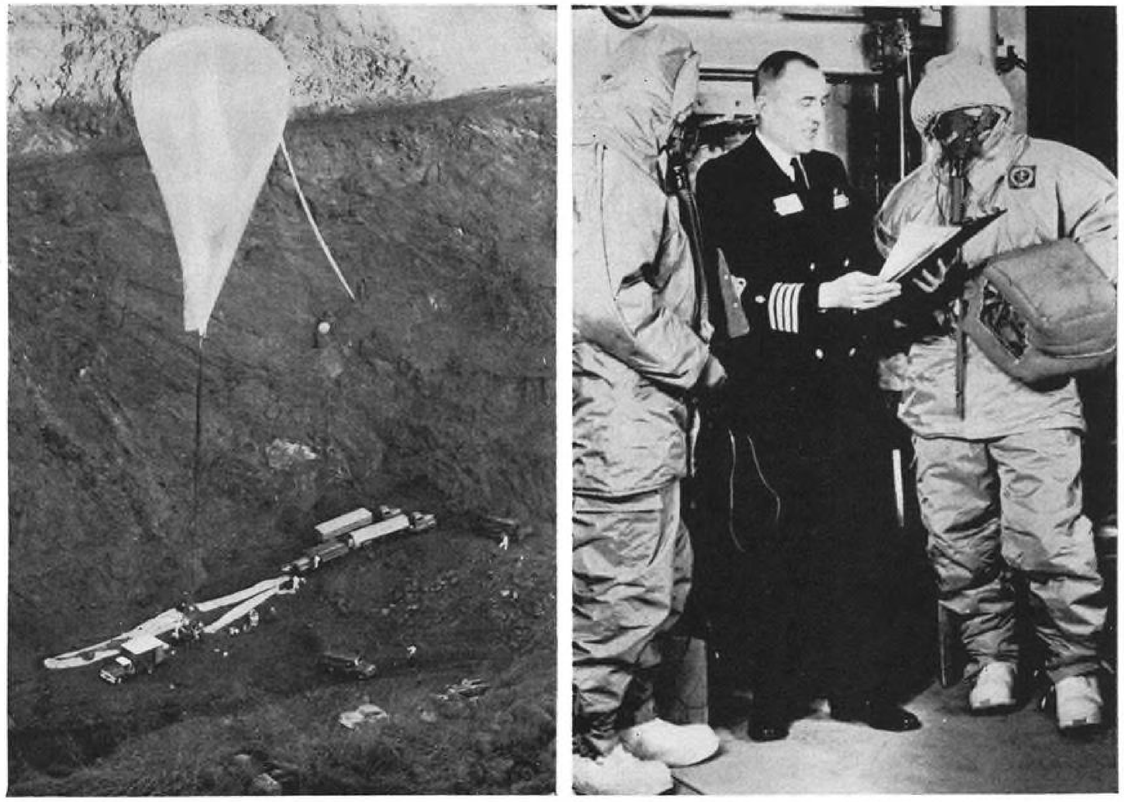
• **Review and revise technical programs** to assure that they are "essentially space technology" oriented. ARDC Centers will not launch state-of-art development in fields of ballistic missiles or aeronautics except upon specific request of ARDC deputy commander for weapon systems to meet needs of existing or upcoming programs.

• **Retain only those non-space oriented** R&D programs which offer "potentially significant increase in future operational capabilities."

• **Orient programs to seek new knowledge** and/or demonstration of technical feasibility, eliminate hardware developments from state-of-the-art programs.

• **Apply "large percentage" of funds** to developments "which may achieve revolutionary advances," although some effort must also be devoted to programs of more evolutionary nature.

There are some indications that the policy directive, prepared and issued several months after Sputnik I was launched, will be liberally interpreted by the ARDC Centers.



PLASTIC balloon is readied for launch from open pit iron ore mine at Crosby, Minn., before climb to 40,000 ft. At right, Capt. Norman L. Barr briefs astronomer A. H. Mikesell and the pilot, Cmdr. Malcolm D. Ross prior to pressure and temperature testing.

Space Technology

Navy Balloon Flight Aids Space Research

By Evert Clark

Washington—Sixth manned balloon flight in Navy's Stratolab series made significant contributions to space research last week by:

- **Lifting a U. S. astronomer** to an altitude above four-fifths of the earth's atmosphere for the first time for studies of stellar scintillation effects of the atmosphere on astronomical seeing and other observations.
- **Providing the first yield test** of a telemetry-telephone system that probably will be used to return physiological data from the first orbiting manned space vehicles.
- **Producing unexpected medical** information that might account for some previously unexplained fatal aircraft accidents and could lead to abandonment of pressure breathing technique used in high altitude flight.

The night-time flight was made from a 350-ft.-deep iron ore pit near Crosby, Minn., using a 72 ft. diam., .0025-in. thick General Mills polyethylene balloon carrying an open 5 ft. by 30 in. Fiberglas gondola.

Pilot was Cmdr. Malcolm D. Ross, atmosphere physicist in the Air Branch of the sponsoring agency, the Office of Naval Research. Cmdr. Ross, a veteran of more than 20 balloon flights, administers ONR's Strato-Lab upper atmosphere research program.

Passenger was Alfred H. Mikesell, Naval Observatory astronomer who has studied scintillation of starlight since 1950 with Dr. John S. Hall of the Observatory and Dr. A. A. Hoag of the Observatory's Flagstaff, Ariz., station. Dr. Hoag made similar measurements from the ground during the flight to correlate with the high-altitude information.

Twelve-Hour Flight

Twelve-hour flight was called Strato-Lab Mikesell No. 1 in honor of the astronomer.

Ross and Mikesell encountered 60 kt. winds and −76F temperatures at the planned peak altitude of approximately 40,000 ft., which they held for a little less than two hours. Descent was made in planned steps and observations were made at 28,000 ft., 20,000 ft., 12,000 ft and 10,000 ft. Last altitude was held until sunlight warmed the helium in the gas bag to provide lift and make a soft landing easier to accomplish.

Both men wore oxygen masks and new Navy cold weather gear, without pressure suits. They sat on their deflated life rafts and parachute packs on small seats at diagonally opposite corners, with only the lower parts of their legs inside the 18-in. deep gondola.

Mikesell's primary goal was to measure changes in brightness with time of the telescopic images of certain selected stars in the 10-1,000 cycles per second range.

For this, he used a small relatively simple Quester telescope with a quartz lens to minimize atmospheric effects, and a four-channel, electronic-photographic measuring system consisting of a photo-multiplier tube, amplifier, noise meter and its recorder, wave analyzer and its recorder, cathode ray oscillograph and 35 mm. recording camera, and a separate recorder for indicating average source brightness.

He also made subjective telescopic measurements of the effects of the upper fifth of the atmosphere on seeing (change in position, shape or size of an image) on the moon and planets, particularly Jupiter, Venus and Mercury. Flight was planned to try to coincide with a full moon if weather and other factors permitted, but it missed by several days.

Other observations included atmospheric measurements for Naval Research Laboratory and the University of Minnesota, photographic measurements for Bureau of Aeronautics, photography of the earth "glow" and measurement of the twilight period.

Later flights will include more scientific measurement of seeing. ONR's overall balloon program also calls for a two-man flight sometime this fall to measure planetary atmosphere spectroscopically from a two-man, telescope-carrying gondola at 85,000 ft. (AW Oct. 28, p. 27).

Ross and Mikesell made three simulated test flights in environmental chambers at General Mills' Minneapolis, Minn., laboratories and at the Naval Medical Research Institute at Bethesda, Md., before the actual flight. General Mills' Balloon Division was contractor for the project. A Cessna 170 and a University of Minnesota Beechcraft tracked the flight.

In addition to piloting the balloon, Cmdr. Ross studied rotation of the gondola about the balloon's vertical axis. Mikesell expected to be able to track stellar targets even with rotation as high as 15 deg. per min.

Aeromedical observations were telemetered to a converted field ambulance which followed the balloon on the ground. They also were relayed "live" at intervals by phone lines to Capt. Norman L. Barr, chief of Navy's aviation and space medicine programs, at the Research Institute in Bethesda, and recorded there.

Telemetering-telephone system developed under Dr. Barr's direction can cover entire earth. From orbiting vehicles, information would be transmitted to ships at sea. They would relay by low frequency radio to a central point or by radio to land masses where telephone lines would then be used. Special generating equipment is needed when phones are used.

This was the first field test of the system using phone lines, although Dr. Barr has used the FM/FM telemetering system to monitor balloon flights from his R5D flying laboratory in the past.

For this flight, only pulse rate, electrocardiogram, respiration rate and heart sounds for each man were relayed. System can carry 18 items, however, and existing telemeter systems carrying up to 96 items of information could be adapted to relay physiological and geophysical data from satellites.

Near the peak altitude during the balloon's ascension, either Ross or Mikesell had a change in rate of electrical conduction from the top of his heart to the bottom, and this appeared on the electrocardiogram. This is the WPW syndrome familiar to cardiologists, but Dr. Burr said this is the first time in aviation history that the phenomenon has been recorded in flight.

If this occurred between 37,000 and 39,000 ft., as Barr suspects the flight profile will show it did, it almost certainly was caused by the cut-in of the pressure oxygen system, which would increase oxygen pressure in the lungs to 10 in. of water pressure.

Number of people in whom the syndrome might appear is small. Phenomonon that occurred on this flight still is one step short of the "runway" heart that would cause collapse of a pilot. But, Barr said re-evaluation of the use of pressure breathing will be necessary if further investigation indicates that the oxygen pressure precipitated the phenomenon. Both Ross and Mikesell were examined extensively before the flight. Pressure breathing on this particular flight was used only to provide an additional 1,500 ft. altitude margin.

Some operational military aircraft still require use of pressure breathing, and it has been employed in balloon flights. On the basis of the earliest data on the flight, Barr feels the intended safety factor of pressure breathing may be not only a possible hazard on future flights but might account for some of the previous unexplained fatal accidents from high altitudes.

Strato-Lab Mikesell No. 1 flight began at 8:50 p.m. EDT on May 6 and ended at 8:26 a.m. EDT on May 7 in a field of clover in East Dubuque, Ill.

Re-entry Satellite Predicted for '60

Washington—U. S. should be able to recover earth satellites in 1959 or 1960 and launch vehicles weighing several tons into orbit in the early 1960s, according to Dr. Herbert F. York, chief scientist of Defense Department's Advanced Research Projects Agency.

Dr. York presented a tentative timetable and list of propulsion units and instrumented vehicles to be used in U. S. space exploration in a talk before the American Physical Society here.

First advance in payload launching capability beyond the present Jupiter C and Vanguard systems to become available to the space scientists will be units based on the Thor and Jupiter intermediate range ballistic missiles. Modifications to these missiles would be primarily in the guidance systems and fuel and oxidizer tankage. These, York said, would be available in late 1958 or early 1960 and would be able to send about 100 lb. to 300 lb. into orbit. Fuel used would be liquid oxygen and a special type of kerosene.

Further development of these units to include more stages would increase their payload to a maximum of approximately 700 lb. if placed into the easiest orbits.

York defined an easy orbit as a circular orbit about 200 miles high which has been entered by firing to the east from a low latitude. Payload capacity would go down as the launching azimuth was altered toward the north or south or the launching point moved farther from the equator.

Other stages to be added to the basic IRBM first stage were described as being of special design but using currently available fuels.

Recoverable satellites should also be available during this period, according to York. The percentage of the weight placed in orbit that would be available for instrumentation would be about 50%, however, to permit more rugged construction of the satellite shell so that it could accept a large quantity of heat during re-entry.

These modified IRBM launching systems also would be capable of sending payloads to the moon and beyond. The ARPA scientist said that this type of mission would lower the payload to between one-fifth and one-third of the satellite payload. The lower fraction was used when referring to a system where the upper stages were specifically for use in the escape mission. The larger fraction refers to the case where another stage was added to a vehicle intended to launch earth satellites.

Any extra equipment, such as retrorockets designed to slow the payload down for an easy landing on the moon would reduce the amount of payload allowed for instruments.

The next large increase in payload launching capacity outlined by York would come in the early 1960s, possibly as early as 1960, when ICBM boosters become available. These would again use a special type of kerosene and liquid oxygen as propellants and, initially, they would be able to place approximately one ton in a satellite orbit. Ultimately, York indicated that, with the addition of extra stages, the vehicles could send several tons into easy orbits.

Navy to Establish Moon-Relay Radio Communications System

New York—Novel point-to-point radio communications system that will bounce signals off the moon and extend the range of line-of-sight frequencies to several thousand miles is being established by Navy.

The new system, reportedly capable of providing one voice channel or several teletype channels, was revealed by Rear Adm. H. C. Bruton, director of naval communications, during a recent talk before the New York Chapter of Armed Forces Communications-Electronics Assn.

Adm. Bruton said that much thought is being given to use of man-made satellites for communication purposes, both as passive reflectors and as active relay stations. Another possibility is to store data in a satellite, then play it back on command when satellite is over another portion of the earth.

Complementary Systems

Two new complementary communications systems intended to meet future Navy needs, which are "well along in development," also were reported.

• **High Capacity Communications** System for shipboard use will employ single sideband techniques, be capable of providing one voice channel and up to 40 teletype channels for each transmitter and receiver. Single antenna will serve for transmission and reception.

• **Naval Tactical Data System**, also for shipboard use, will employ digital communication techniques for transmission of tactical situation and radar data. Three types of radio links are being developed to satisfy different data rate, transmission distance requirements.

Navy recently made fleet evaluation of single sideband equipment, using commercially available hardware. "Communication improvement was so marked and the operators were so enthusiastic, that considerable pressure was generated for immediate installation of such equipment," Adm. Bruton said. As a result, Navy is accelerating its plan to use single sideband for medium and high frequencies "to the extent that funding levels will permit," Bruton said.

The admiral also reported:

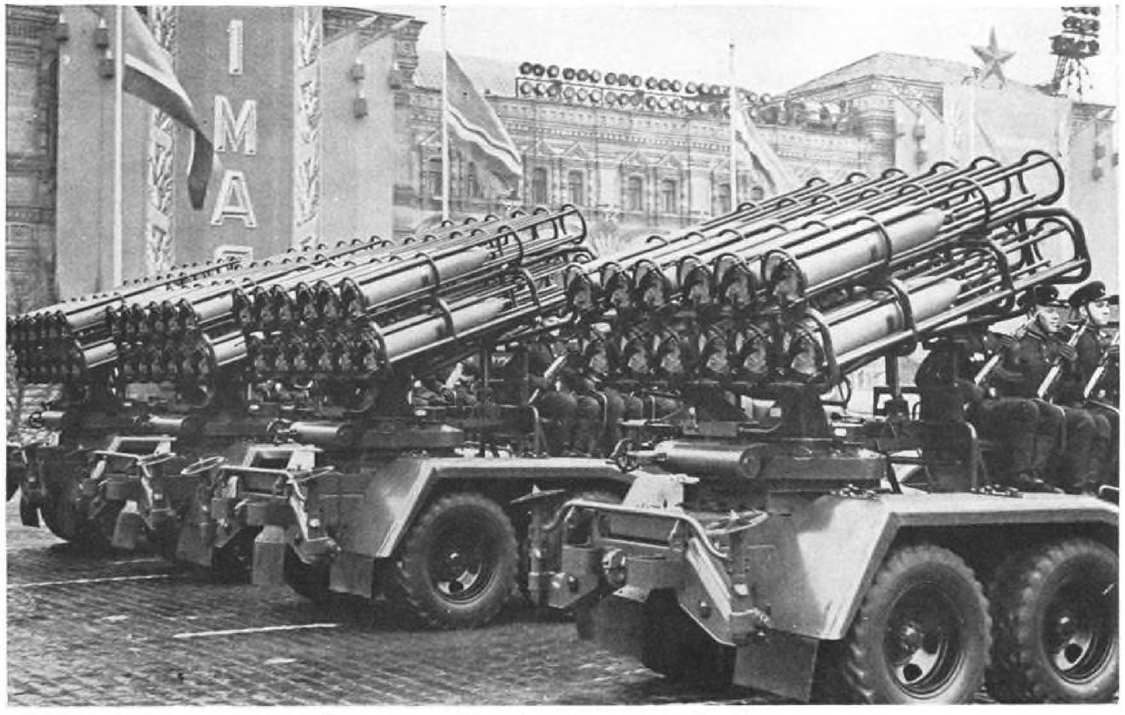
• **New high-power very-low-frequency** (VLF) station, for communications with completely submerged submarines, is under construction in Washington County, Maine. New station will be more than twice as powerful as the four VLF stations now in operation.

• **Acceleration of rate** at which data can be transmitted at VLF frequencies is coming. "In time we expect to be able to use one, possibly more, 60 word-per-minute teletype channels on all our VLF stations," Bruton said.

• **Meteor-burst and tropospheric scatter** techniques are under investigation for ship-to-ship and ship-to-shore use. Relatively small antenna size, weight, power and antenna orientation requirements for meteor burst technique make it appear feasible for shipboard installation.

• **Broadband sleeve type antennas** which utilize parts of ship's hull as antenna element have been developed by Navy laboratories.

Number of different shipboard antennas required also is being reduced through use of coupling devices which allow several transmitters and/or receivers to use single antenna.



Russians Display Barrage Rockets

Russian barrage rocket in a launcher somewhat similar to those shown in the Nov. 7 parade last year (AW Mar. 17, p. 66) was part of the May Day parade in Moscow this year. Much shorter than the previously shown rockets, these have configuration reminiscent of Nord SS.10 tactical missile but without evidence of the SS.10's fins or wire guidance. Launchers are shorter than those shown Nov. 7 and have no discernible offset to give missile spin as those did in earlier parade.

Partial Submersion Eases G Force Effect

Washington—Air Research and Development Command reports that humans partially submerged in water have managed to withstand higher G forces than previously thought possible. Neither today's flying equipment nor complete submersion was found to be as desirable under extreme accelerative loading as partial submersion.

Nine volunteers at the Wright Air Development Center, Dayton, Ohio, were subjected to a series of tests by Aero Medical scientists.

When completely submerged in water in a coffin-like container, the men were subjected to increasing G forces. It was found that movement of the limbs was easily accomplished since the subject's effective weight was lower because of his immersion in water. Physiological improvement did not develop, however. The subject suffered chest pains, had difficulty in breathing and finally blacked out under about the same force that he normally would.

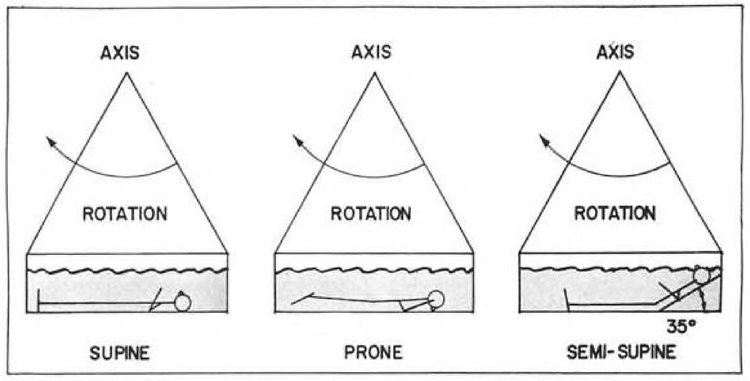
Then the subjects were placed in a supine position and the container partially filled with water so that the body position approximated the positions which recent findings have found to be best for resisting acceleration. In this partially submerged condition, the torso and head were at an angle of approximately 35 deg. to the hips.

In this attitude, the man was completely mobile at 13Gs. Time this force could be withstood was limited by a chest pain which made breathing difficult. Fifteen runs were made at 13Gs and some lasted as long as four min. This compares with 12Gs for 1.75 min. once thought to be a max. for man.

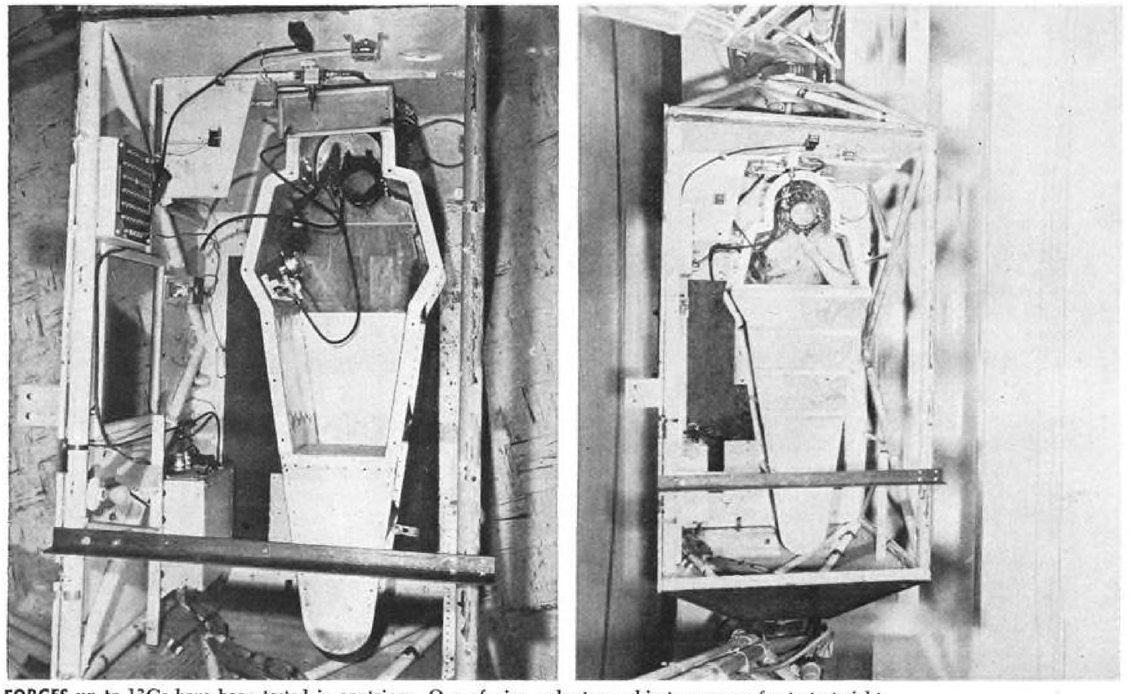
Further tests are planned. The equipment used in this series was considered unsafe above 13Gs.

As presently envisioned by the experimenters, the space flyer that would circle the earth only a few times would be submerged in water that would reach just under his eyes when he stood. This submersion would last during the entire flight, and his eyes would stay above water so that his vision would be unimpaired and he could monitor dials. The controls he would have to manipulate would be under water.

Idea of submerging a man in water to reduce G loadings was originally based upon Archimedes' principle that a body when immersed in a liquid will displace a weight of liquid equal to his own weight. This effectively reduces a man's weight and theoretically would lower the force on his body during any given number of Gs. The ARDC research showed, however, that body position was also a critical factor.



IMMERSION positions range from supine and prone to 35 deg. trunk angle (right).



FORCES up to 13Gs have been tested in container. One of nine volunteer subjects prepares for test at right.

Anderson Attacks NASA Space Program

By Ford Eastman

Washington—Considerable revision of the Administration's proposed plan to create a national space agency with the National Advisory Committee for Aeronautics as its nucleus was predicted last week by Sen. Clinton P. Anderson (D-N.M.).

Another witness, Roy W. Johnson, director of the Advanced Research Projects Agency endorsed the general concept of a civilian agency but flatly opposed legislation submitted by the Administration.

He said the plan as presented could severely restrict military space projects and harm national security. Johnson suggested that the wording of the bill be changed so that the military could continue to control space projects needed for national defense. He added that most of the projects planned for the area between the earth and moon would be mostly military in nature but that projects beyond the moon probably would be civilian.

Anderson, a member of the Senate Special Committee on Space and Astronautics, launched a bitter attack against the plan as the committee began hearings on the space agency proposals. He began his attack during questioning of James H. Doolittle, NACA chairman, and later detailed objections in a speech on the Senate floor.

Anderson, who also serves as vice chairman of the Joint Committee on Atomic Energy, said he agreed in principle with the Administration plan but objected to many provisions and the lack of others. A major part of his criticism was directed toward the fact that the bill had been drafted by the Bureau of Budget.

He said that after the President ruled that the space program should be under civilian control, the Budget Bureau was asked to prepare draft legislation and forward it to Congress. But, he said, there is substantial conflict between the President's purposes and the draft:

"Revisions are needed to cure defects," Anderson said, "or perhaps a completely new bill must be written." He listed these specific problems:

• **"Budget Bureau tried to modify** existing legislation under which NACA operates and make it into a bill for the outer space agency, but the two concepts are not compatible. NACA is essentially a research study and service group which has never worked on or directed a complete project, while the new agency would direct whole projects and use contract powers to a great extent."

• **"Membership of the present** NACA 17-member committee is changed under the proposal from 10 government and seven private representatives to nine private and eight government representatives, thereby turning over control of the new agency to private persons."

• **"The 17-man board** would have referred to it all policy, programs, budget, organization and major personnel matters. With that much power of decision, they obviously would control the agency."

• **Budget Bureau draft bill** is "silent" on the international aspects of space technology. "The omission is indeed strange when we think of this science as a force for peace and see the ample provision for military representation in the agency."

• **"The proposal contains no section** on patents. Its silence leaves patent awards in the hands of the new space agency. Since a majority of the board controlling the agency will be from private life, one would wonder what thought was given to protecting the government's interest in the patent rights arising out of contracts for research and development of outer space components.

• **"NACA is required to come before** Congress to obtain specific authorizing legislation before it can construct new facilities or expand existing ones. This provision was deleted in the proposed bill."

• **"Bill calls for the civilian agency** to be responsible for all space programs except those peculiar to or primarily associated with military weapon systems or military operation. If this is to supply the demarcation between civilian and military control, it would be a farce to call this a civilian program. So few things in modern life could not be described as peculiar to military operations that if the same test were used in the rest of our national affairs, we would have a military dictatorship."

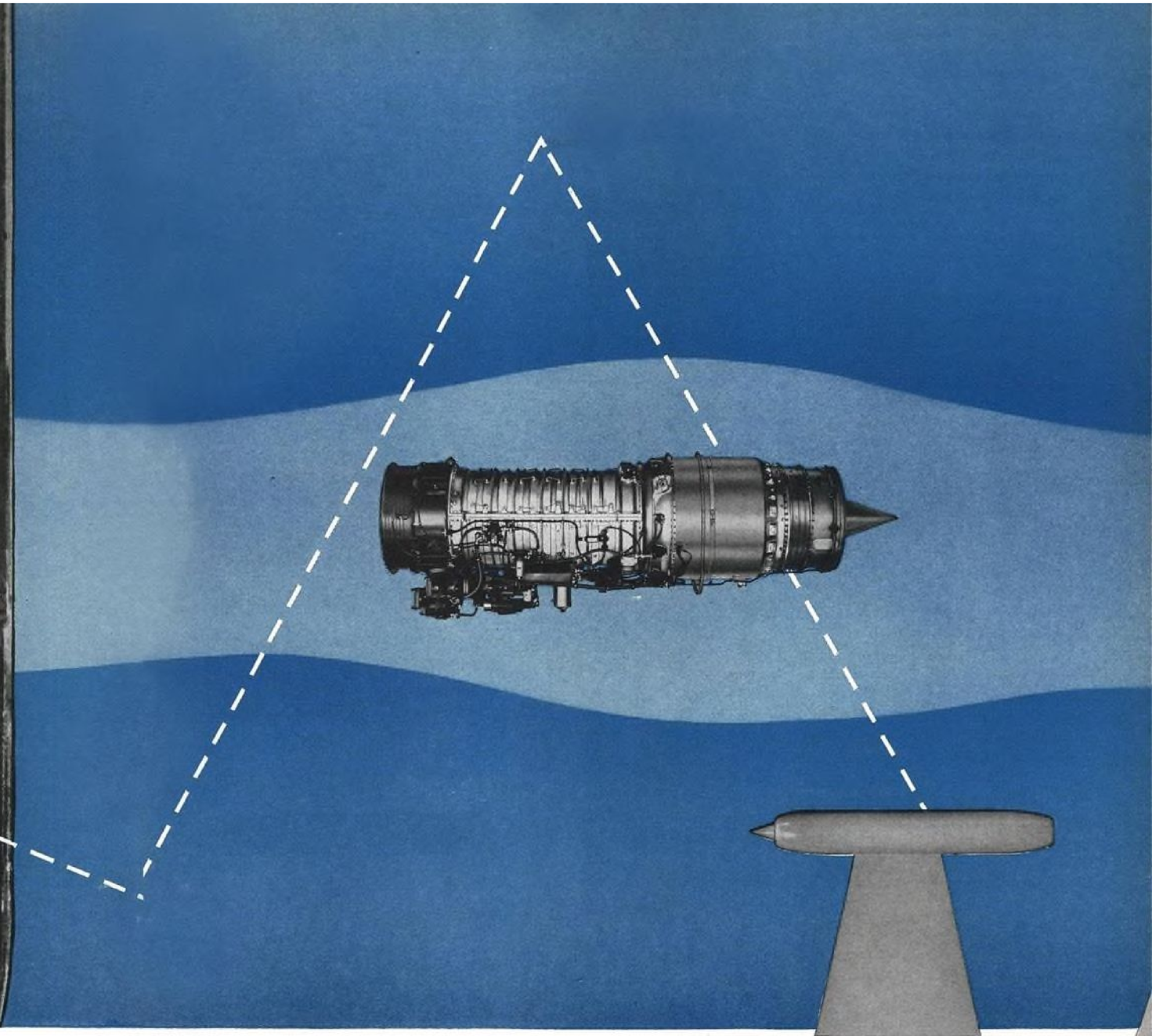
• **"Draft provides that the new agency** report to the President annually, but Congress, while it is called upon to appropriate billions of dollars of public money, must often proceed with the scantiest of information."

• **"Draft provides criminal penalties for** disclosures of information and violation of the space agency's security regulations. We have learned that penal provisions of a substantive nature in new

House Budget Requests

Washington—Budget requests totaling $520 million for Fiscal 1959 have been presented to the House Appropriations Committee by the Advanced Research Projects Agency. Of that amount, ARPA proposed that $448 million be utilized for military purposes associated with missile defense, military satellites and space technology and $72 million to continue non-military space projects authorized by the President. The breakdown is as follows:

		(in millions)
1. Missile Defense Against ICBM		$157.4
2. Military Reconnaissance Satellites		152.0
3. Military Developments for and Applications of Space Technology		138.2
3.1 Man in Space	$46.2	
3.2 Special Engines	20.0	
3.3 Special Components for Space Systems	10.0	
3.4 Project ARGUS	15.0	
3.5 Satellite Tracking and Monitoring Systems	10.0	
3.6 Satellite Communications Relay, Meteorological Reporting, Navigational Aid Systems	15.0	
3.7 Bomb-Powered Rocket	2.0	
3.8 Solid Propellants	20.0	
4. Other Advanced Research		72.0
4.1 ABMA/JPL Program	20.0	
4.2 AFBMD Program	7.0	
4.3 Naval Ordnance Test Station Program	.3	
4.4 Follow-on Program	44.7	
5. Executive Direction		.4
		$520.0



Westinghouse proves jet combustion efficiency

This plastic combustor model enables Westinghouse engineers to predetermine combustion efficiencies in turbojet designs. Observations of the flow of the colored water and air bubble mixture permit visual evaluation of air flow patterns in normally unobservable areas of engines. This test method minimizes trial and error testing with handmade metal prototypes.

Development of the latest J34 configuration for use in North American Aviation's T2J trainer proved the value of this water flow analogy test rig when design modifications to permit the use of avgas and JP-4 or JP-5 were quickly and accurately evaluated. This is just one of the many complete facilities for research, design, development, testing and production of jet engines at the Aviation Gas Turbine Division, Westinghouse Electric Corporation, Box 288, Kansas City, Missouri. J-54050

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laws weaken the basic statutes."

Anderson said he hoped the Budget Bureau draftsmen would be called before the committee to explain many provisions of the bill and why other provisions were left out. He said he also wants to know why the bill makes a provision for the acceptance of gifts by the agency from private sources and why jurisdiction over outer space matters should not be controlled by appointed government officials confirmed by the Senate than by private parties.

• **National program should be far** broader than now contemplated.

• **Congress should establish the policy** that the new agency utilize existing facilities and talent so far as possible. For example, he said an almost unlimited reservoir of scientific and engineering talent exists in the Atomic Energy Commission. While the AEC probably should not have jurisdiction over the outer space program, he said legislation should provide a mechanism whereby the space agency can use the major laboratory facilities of the AEC.

• **Space Agency should be started** on a small scale. Whether a one man or a three-to-five man commission should be in charge is a matter for further study, Anderson said.

• **Statement of policy should call for** international negotiations to seek international agreement to deny the use of outer space for military purposes and provide for mutual scientific cooperation.

• **Establishment of an entirely new** agency with power to place requirements for scientific study and work upon NACA rather than work within its structure "where industry and military personnel are so much in command" should be considered.

• **Language which protects** the government interest and yet equitably awards to inventors the exclusive right to profit from their work should be found.

Adm. Lewis Strauss, AEC chairman, differed with Anderson on the administration proposal and said the commission concurred with him in supporting the basic concepts of the plan which creates one agency to direct and control the space program.

McNeil Describes Fiscal Delays

By Katherine Johnsen

Washington—Defense Department's comptroller, Assistant Secretary W. J. McNeil told the House Armed Services Committee last week that the President's plan to reorganize the Defense Department would "neither hurt nor cure" the two major financing problems that cause entanglements and delays of programs. He listed them as:

• **Pre-programming,** dictated by technological progress, shifts in the international situation or changes in military thinking.

• **Spending ceilings,** imposed by the debt limitation or other considerations.

McNeil said, however, that the plan might pave the way for quicker decisions on priorities and program recasting by increasing the power of the Secretary of Defense and reducing controversy over his decisions.

Rep. Carl Vinson (D-Ga.), chairman of the committee, has contended, with the support of most members, that the Defense Secretary already has full authority to make such prompt decisions, and that the main reason for confusion and delay at the Pentagon has been his failure to exercise it with an attitude of "I'm boss."

McNeil protested Vinson's charge that, through purse string control, he has established himself as "supervisor" of military programs in his "zeal to make a splendid record." McNeil said the budget simply reflects the military decisions of the Secretary of Defense, the Joint Chiefs of Staff and others.

He described his role as "reviewer, coordinator and catalyst." The comptroller's office, he said, is "the only one place that some 3,000 defense programs come together," affording the opportunity for overall evaluation. He said he points to inconsistencies and makes recommendations but emphasized that the decision-making is left to others.

McNeil also challenged testimony by Lt. James Gavin, retired former chief of Army research and development, and others that military programs are being hamstrung in the comptroller's office. Commenting that Gavin "not once" inquired about the release of funds, although he conversed with him regularly, McNeil observed:

"Actually, the crux of the matter is the difficult task of reaching the proper decisions in these days of rapid change, technological progress and frequently conflicting military and technical advice. Once firm program decisions are made, the record will show that fund apportionments are made speedily." The hearing also disclosed:

• **Defense Department has a total of** 140,638 budget personnel, 173 in McNeil's office. Army has 38,454; Navy, 58,612, and Air Force, 43,399.

• **"Inspection and Audit Division"** is being established in the comptroller's office "to make special physical and financial inspections and audits of defense operations and programs."

Other developments:

• **Air Force Chief of Staff** Gen. Thomas D. White gave full support to the President's plan. Gen White was particularly enthusiastic over the proposal to build an operational staff for the Joint Chiefs of Staff and to transfer service functions to the vice chiefs of staffs. He said this would enable the Joint Chiefs to become "tantamount to a general staff" and develop "corporate views" to end interservice duplication.

• **Adm. Arthur Radford,** former chairman of the Joint Chiefs of Staff, said he was "in full accord" with the "objectives" of the President's plan.

Lockheed-IAM Contract

Tentative agreement on a new two-year contract covering 16,000 Lockheed employes in Burbank, Palmdale and Maywood was announced jointly today by the chairman of the company and union negotiating committees that have been bargaining for nearly four months. Lockheed Missile Systems Division is not included in the tentative contract.

Tentative agreement would provide wage and benefit increases averaging nearly 22 cents an hour.

Announcement came from Donald M. Wilder, Lockheed California Division industrial relations director, and John Snider, president of IAM Lodge 727.

Snider will report details of the agreement to union members attending a meeting to be scheduled as soon as possible.

News Digest

Air Force B-47s will begin a modification program in which the wings will be reinforced with steel plates. Purpose of the modification is to provide greater safety when the aircraft are used in low-level labs bombing techniques for which they were not specifically designed. The steel plates also will provide a fix for any fatigue failures that might be imminent. A recent accident investigation has indicated that fatigue failure might have been a primary cause.

Flying Tiger Line, only one of the four all-cargo domestic carrier that had not asked for subsidy, made it unanimous last week. The line said it planned to ask the Civil Aeronautics Board for exemption from its certificate provisions that prohibit government aid.

German financial backing has been assured to Snecma to allow French engine firm to continue VTOL Flying Atar project into supersonic range. Reports indicate Snecma will work with Focke-Wulfe of Bremen. Company has been seeking German aid for some time (AW April 14, p. 67) after French Air Ministry refused additional funds.

Local Service Lines Protest Rate Plan

CAB bureau recommendation to boost rate of return from 8% to 9.5% termed inadequate; 12% asked.

By Robert H. Cook

Washington—Local service airlines plan an all-out attack against a recommendation to the Civil Aeronautics Board allowing the carriers a 9.5% return on investment based on the expected cost of attracting new financing.

Objecting to both the amount and method of rate making, the carriers say the proposal fails to meet their financial needs which they estimate will require a return of at least 12% as opposed to the present allowance of 8%.

CAB Proposal

Submitted by CAB's Bureau of Air Operations in the Rate of Return-Local Service Carriers Case, the proposal urges adoption of a "cost of capital approach" of rate making. Basis of the "approach" method is an estimate of a fair rate needed to encourage and pay the costs of direct loans and stock issues needed for expansion. As a framework for its study, the bureau applied this theory to the "medium eight" trunk carriers.

Attorneys for the Assn. of Local Service and Territorial Airlines preparing rebuttal testimony in the case say they will fight for a rate based on a percentage of gross revenues in an effort to expand a dwindling profit margin. The CAB last year viewed such a method as "essentially a cost plus concept" which geared profits to the volume of business. During its hearing in the first phase of the General Passenger Fare Investigation, the Board also charged that local service carriers had failed to offer any evidence as to what operating ratio was needed or why. ALTA attorneys say their rebuttal testimony in the Rate of Return Case will center around their need for the operating ratio concept along with an estimated rate needed.

Major objections by the carriers to the bureau exhibits center about the following points:

- **9.5% rate is too low** and should be a minimum of 12%.
- **Cost approach cannot apply** to local service carriers because too little is known of the present or future status of their common stocks on which to base an analysis.
- **Difference between the** capitalization structure and operations of the "middle eight" trunklines is too great for any comparison for a rate making purpose.

Reviewing the need for at least some increase in the rate of return, the bureau said that a study covering figures for the past 10 years showed that local service carriers paid as much as 1% more for loans than the "middle eight" trunklines.

An interest rate of 5.28% was needed to obtain this capital as compared with the 4.78% paid by the trunkline carriers.

The cost of floating new stock issues was estimated at 8% of the purchase price of the shares for the smaller carriers. The local service carriers contend that this "cost-of-acquisition" phase, covering the expense of advertising, sales commissions and printing is now as high as 20%.

Testimony during the General Passenger Fare Case last year reported that it cost six times as much to acquire equity capital as debt capital.

Debt-Equity Ratios

Debt-equity ratios for the local service airlines range from a low of 19% of capitalization for Southern Airways to a high of 90% for Mohawk, the bureau said. Average for the industry was estimated at 55.3% debt and 44.7% equity. These figures probably will rise to 73% and 27% by the end of this year, according to the exhibits, which recommended a debt ratio of 55% of capitalization as "fair to the group."

Application of the rate of return formula suggested by the bureau will only complicate an already overly complicated issue, the local service carriers say. Investment base, anchor of the proposal, is virtually non-existent for these carriers, most of whom operate DC-3 equipment. The constantly decreasing value of these aircraft has left the industry "abnormally undercapitalized," presenting both a shrinking investment base for a fair rate of return and a dwindling of capital structure that fails to attract investors so that equipment expansion programs can be carried out.

Crucial Point

Former CAB Chairman Oswald Ryan, who testified for the local service carriers last year, says the investment base problem is the crucial point in determining a fair rate of return. He denounces the present CAB rate of 8% on investment for the local carriers as both unsuitable and inadequate.

"Key to security" for the carriers, Ryan says, would be a rate based on an operating ratio of expense to revenues that would provide a "margin cushion" needed in a "highly volatile" operation.

Indicative of the high risk involved in local service operations is the extreme sensitivity of the carriers to the slightest decrease in traffic revenues. Ryan says that a drop of as little as 1% in an operational forecast would wipe out 89% of a typical local service carrier's profit.

The same percentage decrease, he adds, would slice 30% from the profits of a trunkline but only 12% from a public utility.

Rate of Return

Ryan also believes that, while a rate of return based on investment suits the needs of public utilities with large capitalizations and low annual turnover, airlines are "radically different" since their annual revenues often equal or double their investment.

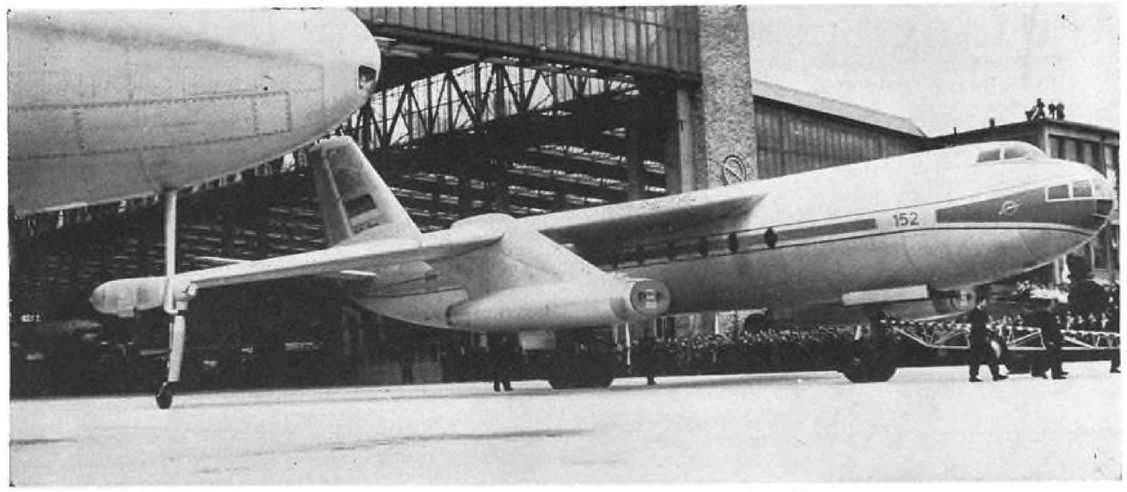
CAB's present "guarantee" of an 8% return on investment is termed a "fallacy" by the local service carriers who point to a realized rate of return of only 1.43% between 1946 and 1956, while testimony in the Suspended Passenger Fare Case set an average rate of return of 10.77% for trunkline carriers over the same period.

Load factors continue to be a financial problem for the smaller airlines which have an actual load factor average of only 45% as compared to an average need of 75%.

Approximately half of the carriers need a load factor average beyond that of the group average, according to the bureau exhibits.

Eastern Electras on Lockheed Line

Nine Lockheed Electra turboprop transports under construction for Eastern Air Lines are on Lockheed's main assembly line at Burbank, Calif. Six aircraft have been rolled out and American Airlines' first Electra is entering final assembly. First three Electras are now flying CAA certification and customer demonstration tests; fourth is used for static test and fifth has been bought by Allison Division of General Motors Corp. as turboprop engine demonstrator.



East German Jet Transport Rolls Out

East German BB-152 jet transport, shown at rollout at Dresden plant, has major structural changes from model revealed at Leipzig Trade Fair (AW Mar. 24, p. 32). Aircraft has bombardier-type nose, pronounced anhedral droop to wings. Landing gear is tandem and incorporates retractable outriggers on each wing. Designed by Prof. Brunolf Baade, transport is scheduled to fly soon. Aircraft seats 72 passengers; apparently has lower fuselage doors underneath circular windows for either cargo or bomb load. Four Type 024 engines have 6,950 lb. thrust each.

Court Upholds CAB in Specht Decision

Washington—U. S. Court of Appeals last week upheld a Civil Aeronautics Board order revoking the airline transport rating of Trans World Airlines pilot Leonard J. Specht.

In its original complaint charges, the Board found that Specht had failed to adhere to air traffic control clearances under IFR conditions on a flight from New York to St. Louis (AW March 18, 1957, p. 30). The complaint charged that Specht ". . . by his actions as heretofore alleged, demonstrated a lack of degree of responsibility, care and judgment required of the holder of an Airline Transport Pilot Certificate."

Specht allegedly left an assigned 14,000 ft. position and climbed to 18,000 ft. despite air traffic control instructions to maintain 14,000 ft. because of a Capital Airlines flight at 16,000 ft. Effect of the Board's order was to require Specht to cease flying as a pilot in command, although he has since been issued a license to act as co-pilot.

The Court upheld the Board's conclusion that no emergency existed to justify the pilot's change of position to an 18,000-ft altitude. The Court also supported the Board's findings that Specht failed to exercise the highest degree of care expected of an airline transport pilot and "was therefore 'careless' within the meaning" of Civil Air Regulations.

On Specht's contention that the Board erroneously placed the burden of proof on him to show that there was in fact an emergency situation, the court said:

". . . the facts and circumstances of the claimed emergency were peculiarly within the knowledge of the pilot. It was not error to rest the burden of going forward with the proof of the emergency on the pilot who claimed it."

Specht argued that he has satisfied all technical requirements for an airline transport pilot rating and is qualified to hold the rating and certificate.

CAB Plans Recess in Fare Investigation

Washington—Civil Aeronautics Board has called a recess of four weeks in the General Passenger Fare Investigation despite protests against delays in the proceedings by the airlines and the board's examiner.

In ordering the four weeks recess requested by the CAB Bureau Counsel, the Board emphasized the action does not represent a "departure from our basic desire for maximum expedition in this case." The recess will begin after all evidence from all parties other than the Bureau Counsel has been received.

The Board said over 400 new or revised exhibits have been submitted since Feb. 5 and pointed out that the transcript of hearings since that date totals over 4,000 pages. The Board concluded that, in view of the large volume of material requiring analysis and study, a four-week recess will be required by the Bureau Counsel to prepare its case.

Aer Lingus Contends With Route Growth

By William H. Gregory

Dublin—Aer Lingus, the national-airline of Ireland, which built a relatively small but profitable operation on a monopoly service between Ireland and Britain, now is faced with digesting a combination of expanded routes in Europe and America and competition in its own backyard.

The first taste has shown the bigger morsel to be not entirely tender. Traffic on the extensions in Europe, largely through Manchester in Britain, was lower than expected, and the airline will show an operating loss this year of about $150,000.

Not Unduly Concerned

Aer Lingus is not unduly concerned over this prospect. Six months ago it appeared that the deficit would be twice that figure, and furthermore the sale of three DC-3s for $336,000 will produce a net profit for the year.

Though part of a complex, government-backed system of corporations, Aer Lingus in operation is a compact, flexible organization built around the minimum in frills.

Ireland's Department of Industry and Commerce is at the top of the organization chain, and the minister, Sean Lemass, was the driving force in the government in the long fought establishment of Irish Air Lines. This sister corporation of Aer Lingus is the transatlantic branch of Ireland's air system (AW May 5, p. 41).

The department directly controls Shannon Airport and is striving to preserve its survival in the jet age. Shannon is a free port and generous tax provisions and land grants are offered to manufacturers who will establish a plant at the field. Also, a jet-length runway is planned there. Shannon is separate from the rest of the Irish air system organization.

This consists of:

• **Aer Rianta.** Besides holding the Irish capital in the two air lines, Aer Rianta manages Dublin Airport, which, for all practical purposes, is an overhaul base and home terminal for Aer Lingus.

• **Aer Lingus.** This was the original Irish air carrier, established in 1936. Aer Rianta owns 90% of it and British European Airways the rest.

• **Irish Air Lines** (Aerlinte Eireann). This is owned 75% by Aer Rianta and 25% by Seaboard and Western Airlines, the U.S. carrier which leased it three Lockheed 1049H Super Constellations for the transatlantic service.

Until 1956, BEA owned 40% of Aer Lingus. Under the route and ownership revision made that year, Aer Rianta purchased three-fourths of this share and in turn opened previous Aer Lingus monopoly routes between Dublin and Birmingham, Cardiff, Manchester, Liverpool and London. Aer Lingus retains some monopoly routes to Britain.

In exchange, Aer Lingus obtained rights through Manchester to Zurich, Rome, Frankfurt and Brussels and to extend its existing Dublin-Manchester-Amsterdam service to Dusseldorf. The bilateral agreement between Ireland and England did not open the routes to unrestricted competition. Through a formula of annual increases, BEA will be allowed to build eventually to a maximum of 50% of the traffic.

Aer Lingus has no domestic service, except to Shannon; the stages are too short to compete with surface transport.

Helicopter service has been considered. Initially it might begin with an emergency rescue type public service using Westland Widgeons (Sikorsky S-51s built under license), not scheduled passenger transport.

DUBLIN AIRPORT, photographed from Irish Air Lines Super Constellation on its inaugural flight. Terminal building is at left on ramp. Aer Lingus engine and electronic shops are in center building, structural overhaul at right.

System Peculiarities

Like most airlines, Aer Lingus has a peak-and-valley problem. But it believes its peaks and valleys are more extreme than those of any major airline because of these peculiarities of its system:

• **Ultra short hauls.** Duration of an average Aer Lingus flight is 1.4 to 1.85 hr., depending on the aircraft used. Its average stage length is 175-290 mi.

• **Holiday travel concentration.** Because of the lack of industrialization of the Irish economy, Aer Lingus must depend greatly on vacationing Irish and British tourists. Thus does Aer Lingus not only have a busy summer and slack winter traffic pattern, but the summer traffic tends to concentrate in July and August.

Aer Lingus traffic ratio is 4.5 at peak to 1 at slack. Last August, for example, Aer Lingus flew 19 million revenue passenger miles, got 9.5 hr. daily utilization from its Viscount 800s, 7.2 hr. from its DC-3s. In February its revenue passenger miles dropped to 4 million, its Viscount 800 utilization to 5.5 hr. and its DC-3 to 3.4 hr.

(The Viscount figure even here is not truly representative. Because of wing main spar modifications needed on its Viscount 700s, the 800 series airplanes fell heir to all the traffic both would normally have flown.)

To combat this problem, Aer Lingus has had to make operational and scheduling adjustments.

• **Major overhaul.** Virtually all is scheduled in the slack months. Airframe overhauls are done at approximately 2,300 hr. and aircraft scheduling is carefully monitored to bring these periods in the slack months. In summer, turn-around maintenance is all done at night so that aircraft are available for the holiday traveler's daytime flight preferences. Crew vacations are taken off-season.

• **Scheduling flexibility.** Principal scheduling authority is placed with the research and schedules manager, who has developed a system designed for adaptability, especially in summer.

His office keeps in close touch with the operations and engineering departments with two objectives in mind: keeping its scheduling in line with the reasonable operational demands, yet remaining familiar enough with the technical side to reject nonessential demands to hold aircraft on the ground.

Flight Scheduling

Ten days in advance, the research and schedules department lays down a schedule for the week, beginning Monday, and the other departments sit down in committee to discuss it. After the necessary horse trading, the flight schedule is issued. From that point the responsibility for carrying out the schedule is handed to the technical departments, load control, engineering, etc. These can make necessary minor adjustments on checking with the research and schedules personnel.

Aer Lingus handles its summer peak demand through extra section "shadow" flights.

These flights are not listed in the formal schedules to the public, but the reservations people are told that aircraft are available. If seats on the formally scheduled flight are filled, the reservations agent may then begin to book the shadow flight, which need not run otherwise.

Aer Lingus present fleet, in a state of flux because of the Viscount spar modifications, breaks down this way:

• **Four Viscount 707s.**

• **Two Viscount 745s.** These are from Capital Airlines' deferred 15, and were leased from Vickers.

• **Two Viscount 808s.**

• **One Viscount 808A.** This is a British European Airways Viscount in BEA configuration obtained when Aer Lingus needed an airplane quickly when the spar modification was ordered.

• **Ten DC-3s.**

Passenger Seating

Viscount 700 series aircraft are a 53-seat three-and-two configuration; Viscount 800s have 60 seats in the same configuration. DC-3s are a two-and-two 32-seat configuration, adaptable to a 50-50 cargo-passenger configuration.

Aer Lingus is phasing out its DC-3s, the bulk to be gone by 1960. It plans an all-turbine fleet of:

• **Viscount 800 series.** This probably will drop to six 808 airplanes. The 818-840 Viscount with more powerful Rolls-Royce Dart 7 or 11 does not interest Aer Lingus. The 808 with the Dart engine of the 700 series gives Aer Lingus a bigger airplane than the 700 series, which it needs, but without the added speed, which it does not need on its short hauls.

• **Seven Fokker F.27 Friendships.** First will be delivered in Oct., balance through next year. These will replace DC-3s on passenger runs, but some DC-3s may be kept for cargo flights.

Financing for the Friendships was obtained privately and partly from Northern Ireland, where the Irish Republic has not always had the friendliest relations. The Irish Assurance Company provided $2.8 million and the Bank of Ulster $4.2 million.

With the return of the BEA Viscount, Aer Lingus will have two more Viscounts this summer than it wants to operate normally; these will be needed this year for the expected additional traffic to Lourdes during the religious centenary observance there.

Friendships are in a 40-seat two-and-two configuration and use the Dart 6 powerplant, but the Mk. 511 model. This is the same basic engine as in the Viscounts, but with a different reduction gear because of the larger propeller permitted on the high-wing Friendship.

Aer Lingus has raised its Dart overhaul period from 1,050 hr. to 1,200 hr. and is trying out a pilot batch at 1,400. Structural overhaul is done at the Dublin Airport base, but the Darts are sent back to Rolls by sea.

Cargo is a small part of Aer Lingus business, with a total of 6,012 tons carried 1956-57. Irish exports, such as cattle, are poor prospects for air transports. On the other hand, some imports, as appliances, are cheaper to import by air because of the much less elaborate crating required.

No major engine overhaul is done by Aer Lingus. Its Pratt & Whitney DC-3 engines also are sent to England to Marshalls, a firm which specializes in such work. Aer Lingus had plans and facilities to do its own engine work, but the government canceled the move for economy reasons.

Collins Integrated Flight System has been ordered for the Friendships. Aer Lingus prefers U. S. avionic equipment because of its reliability.

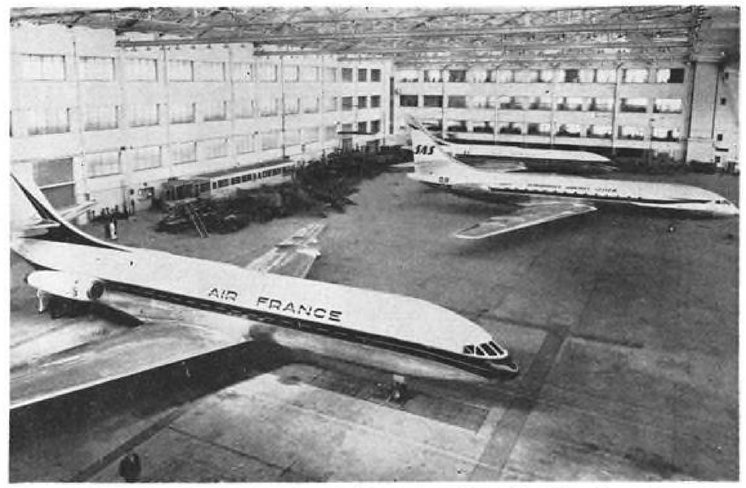
Load factors and passenger totals declined in the fiscal year that ended in March, though not drastically. Increased costs, especially fuel because of the Suez crisis, were mainly responsible for the operating deficit. The traffic figures:

	1956/57	1957/58
• Load factor	72.1	67
• Seat miles available	139,218,000	149,029,000
• Revenue passenger miles flown	100,392,000	99,839,000

Aer Lingus estimates its operating costs for the 1957-58 fiscal year at 47.5 cents per capacity ton mile.

Aer Lingus since 1950 has intensified its effort to penetrate the mass market for air travel. In a survey made of British-originated traffic to Ireland, (and coded by hostesses during the winter slack season), Aer Lingus found in 1951 it carried 28,258 upper income and 21,796 lower income group passengers. By 1956 the upper income figure rose to 38,079, but the lower income total had increased even more, to 49,686.

J. F. Dempsey, Aer Lingus general manager, expressed his concern at the competitive pressure on international flights which in some instances has brought serving of a full meal on an hour-and-a-half flight. Aer Lingus has based its operation on economical service, offering fares below European standards, Dempsey says. But he fears the price line is growing harder to hold.



First Production Caravelle Rolls Out

First production model of Sud Aviation's Caravelle jet airliner (foreground) recently was rolled out at Sud Toulouse plant. Two prototype Caravelles in background carry Scandinavian Airlines System and Air France markings. Flight tests of production model will be undertaken for Air France in next few weeks.

Airline Traffic—February, 1958

	Revenue Passengers	Revenue Passenger Miles (000)	Load Factor %	U. S. Mail	Express	Freight	Total Revenue Ton-Miles	% Revenue to Available Ton-Miles
DOMESTIC TRUNK								
American	506,949	326,262	59.1	1,497,251	622,366	6,213,253	39,748,197	52.0
Braniff	159,786	67,685	57.1	276,233	123,885	404,053	7,304,291	45.3
Capital	271,366	104,587	54.1	453,361	200,522	278,914	10,934,750	44.0
Continental	56,068	24,784	50.5	85,150	39,147	124,448	2,630,516	42.1
Delta	208,548	106,409	53.2	375,096	210,614	895,487	11,741,705	48.2
Eastern	580,427	338,702	53.43	896,899	358,034	946,058	34,896,984	48.30
National	124,228	88,021	55.7	308,503	55,299	478,225	9,426,265	47.0
Northeast	59,748	32,307	48.5	103,044	32,287	89,654	3,326,026	40.3
Northwest	95,894	59,367	46.8	363,572	190,845	695,193	6,977,359	42.8
Trans World	307,823	233,712	57.7	1,018,632	462,338	1,665,128	25,529,473	50.7
United	444,709	296,687	58.5	2,257,593	691,011	4,174,999	35,670,070	52.8
Western	77,834	39,989	56.5	195,103	60,788	181,283	4,273,159	48.6
INTERNATIONAL								
American	11,223	11,036	65.8	8,297	237	291,791	1,462,114	69.8
Braniff	4,007	7,941	55.1	8,294	.....	90,380	969,406	49.6
Caribbean-Atlantic	23,598	1,653	62.0	1,537	.....	3,770	179,426	68.1
Delta	5,752	5,984	57.2	7,228	.....	35,506	712,604	50.6
Eastern	25,668	36,068	52.50	90,048	.....	81,740	3,926,023	51.29
National	11,916	7,618	52.0	10,667	4,988	57,264	884,976	48.3
Northwest	7,494	16,425	44.6	938,009	14,737	556,573	3,328,436	37.0
Pan American								
Alaska	2,111	2,533	43.9	28,073	.....	138,085	441,131	46.8
Atlantic	58,362	73,070	48.6	1,097,236	.....	1,956,896	10,910,825	50.3
Latin America	93,762	93,456	65.5	341,195	.....	3,611,722	13,334,679	65.3
Pacific	17,976	62,414	66.2	924,037	.....	1,230,899	8,763,127	61.3
Panagra	10,474	14,159	61.4	62,501	.....	431,155	2,037,363	63.6
Trans World	14,095	38,178	50.6	711,244	.....	563,307	5,351,374	53.5
United	6,078	15,110	54.7	97,717	.....	52,599	1,701,900	52.0
Western	1,593	2,477	66.3	386	.....	3,587	272,893	69.8
LOCAL SERVICE								
Allegheny	25,274	4,238	38.3	7,947	11,924	12,001	436,479	38.6
Bonanza	15,065	3,488	48.9	4,590	2,168	5,500	245,511	46.5
Central	9,009	1,725	31.6	3,406	1,917	5,894	176,888	28.5
Frontier	20,069	6,258	55.1	23,285	8,042	45,054	679,531	62.8
Lake Central	12,784	2,004	35.7	2,918	9,562	.....	208,040	37.7
Mohawk	34,200	6,356	49.5	6,222	7,785	15,404	636,232	49.5
North Central	50,504	8,200	43.0	21,208	24,458	.....	832,275	43.7
Ozark	30,852	5,041	42.8	10,280	13,750	9,069	575,113	45.0
Pacific	26,262	5,890	51.2	10,978	3,842	12,239	589,035	50.0
Piedmont	25,379	5,063	42.8	11,668	6,497	7,397	510,397	42.3
Southern	15,203	2,774	34.7	7,522	7,822	4,148	282,700	34.7
Trans Texas	16,882	3,794	36.4	12,311	7,360	24,984	408,099	37.5
West Coast	17,881	3,249	45.15	3,832	1,633	6,238	321,881	42.89
HAWAIIAN								
Hawaiian	23,437	3,504	59.4	3,537	.....	100,188	385,596	54.5
Trans Pacific	9,802	1,370	54.4	740	.....	6,781	118,558	55.4
CARGO LINES								
Aerovias Sud Americana	.....	.....	.....	.....	.....	534,113	534,113	81.1
Flying Tiger	7,081	29,884	96.9	34,603	19,989	6,602,333	9,645,348	86.8
Riddle	.....	.....	.....	20,955	10,147	1,181,294	1,212,396	66.6
Seaboard and Western	6,362	24,550	100.0	.....	.....	1,139,818	3,598,669	70.4
Slick*	.....	.....	.....	.....	.....	.....	.....	.....
HELICOPTER LINES								
Chicago Helicopter	6,280	110.2	35.7	1,727	.....	.....	12,254	27.9
Los Angeles Airways	1,705	65	49.6	3,398	1,399	.....	11,007	54.1
New York Airways	4,119	81	35.8	1,220	701	445	10,079	38.0
ALASKA LINES								
Alaska Airlines	5,443	1,958	26.5	39,591	.....	143,817	380,450	36.5
Alaska Coastal	2,311	215	61.3	3,537	.....	3,190	28,577	64.2
Cordova	879	123	37.0	3,329	.....	3,571	19,674	34.6
Ellis	2,274	139	52.3	1,607	.....	1,499	17,362	65.2
Pacific Northern	5,520	4,581	33.6	88,596	.....	161,928	748,139	43.7

*Not available.
Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.

SHORTLINES

► **Aerlinte Eireann** (Irish Airlines) and Austrian Airlines have been admitted as active members in the International Air Transport Assn. Aerlinte operates scheduled service between Dublin and New York; Austrian Airlines operates from Vienna to the United Kingdom. There are now 84 members in the international airline organization.

► **Air Express International** has opened a new office in San Juan, Puerto Rico.

► **Air France** reports that it carried 2,505,000 passengers in 1957, an increase of 7% over 1956. The airline also reports a 4% increase in mail carried, a 3% increase in freight. North Atlantic routes showed a 22% increase over 1956 with an over-all load factor of 70%. Air France has begun nonstop service from New York to Mexico City with four Lockheed 1649A Constellation flights each way every week.

► **British Overseas Airways Corp.** will discontinue its service of four round-trips daily between Miami and Nassau on June 3. Explaining the decision, a BOAC official said that "generally speaking, it is unprofitable for a long haul airline such as BOAC to operate over short-haul routes. . . ." The Miami-Nassau decision will not affect New York-Nassau service.

► **Continental Airlines** is scheduled to begin Vickers Viscount 810 service over its Chicago-Kansas City-Denver-Los Angeles run on May 28. The airline will operate six daily schedules and will add a fourth schedule on July 1 with a stop at Colorado Springs.

► **North Central Airlines** reports that it carried 60,628 passengers during April, a 28% increase over April, 1957. The airline says it operated 99% of its 858,598 scheduled miles last month as compared with 92% last year.

► **Pan American World Airways** has begun tourist service on routes between Miami, Haiti and Venezuela and between New York, the Dominican Republic and Haiti. At the same time, it increased tourist service on its New York-Caracas route by six flights weekly, two stopping at Curacao and San Juan with the remaining four nonstop. Six combination flights operate between New York, Ciudad Trujillo and Port au Prince and six weekly between Miami, Port au Prince and Caracas.

► **Iberia Air Lines** of Spain has placed an order for two Douglas DC-8 jet transports, taken an option on a third.

AIRLINE OBSERVER

► **Watch for American and Eastern Airlines to start a new trend in the commercial engine business by leasing rather than buying their powerplants for gas turbine-powered transports. Both airlines are now discussing such arrangements with the Allison division of General Motors Corp. for the Model 501 turboprops powering the Lockheed Electra. American also has told both Pratt & Whitney Aircraft and General Electric it is interested in leasing rather than buying either the J57 or J79 powerplants for its choice of a medium-range jet transport. General Motors began equipment leasing trend with its post-war Diesel locomotive sales to railroads under direction of Harold Dice who is now No. 2 man in the Allison division.**

► Chances that austerity programs will be introduced by a number of airlines this year in moves to combat mounting expenses are growing rapidly. Degree of severity of individual programs will be determined to a large extent by the volume of seasonal aircoach traffic experienced this summer which should serve as a fair measure of how deeply the recession has hit the industry. One domestic trunkline already has tentatively scheduled a 15% across-the-board personnel cutback as a bulwark against further losses. Most observers see no immediate reversal of the current decline in load factors. They look to further fare increases to ease earnings picture and, so far, have no doubts that such increases will be absorbed without depressing traffic despite the recession.

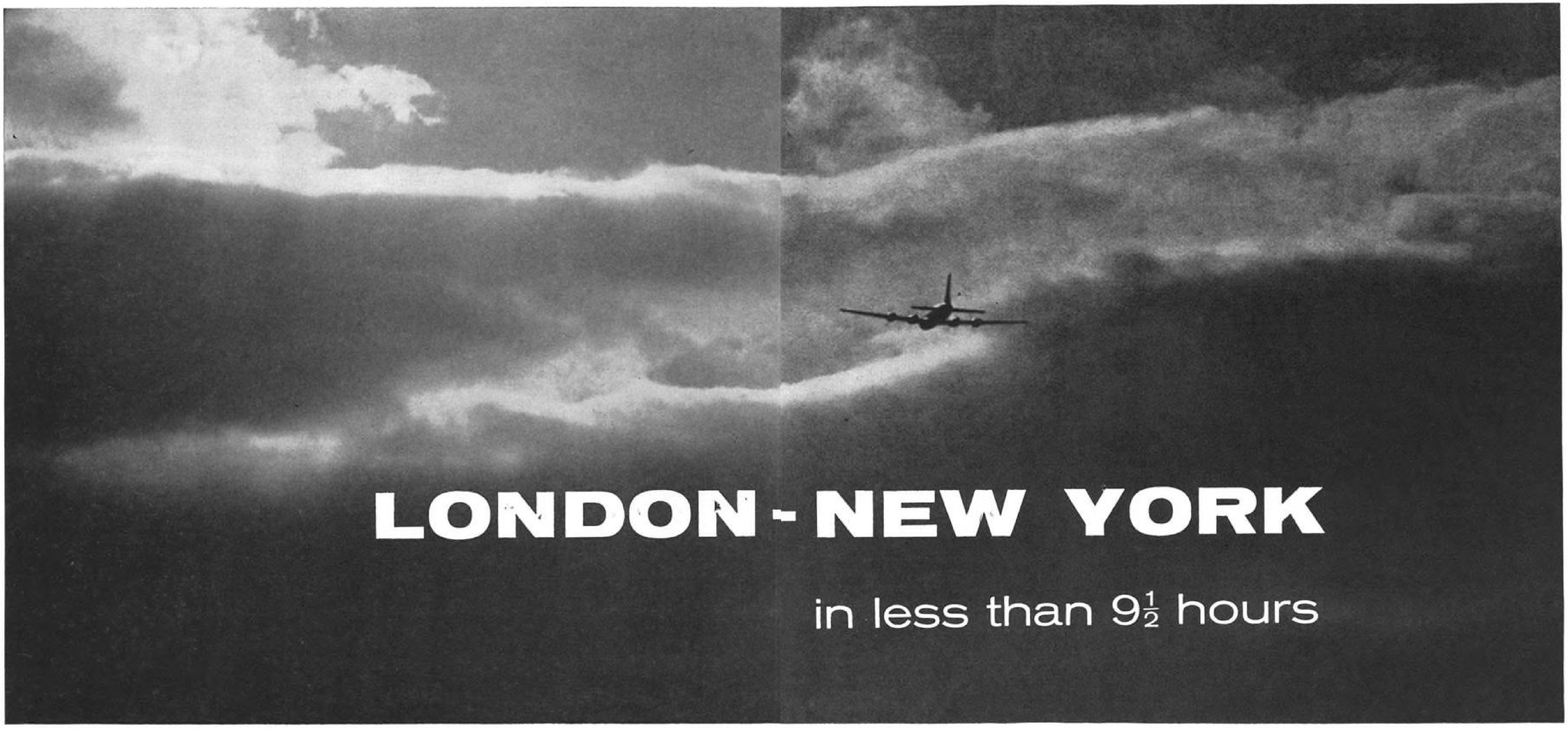
► **Merger between Capital Airlines and Continental Air Lines is again a strong possibility. Two years ago, the carriers were brought together on two occasions by Lehman Brothers for merger discussions but were unable to come to terms (AW Aug. 13, 1956, p. 45). Wall Street still hopes to see a consolidation of the two carriers as one means of strengthening their financial positions. Meanwhile, look for an interchange agreement between the two airlines within the next 60 days.**

► Airline stocks continue to react differently to a market that is not bullish but is expanding on dividend announcements and optimistic forecasts by some corporations in regard to business later this year. American, Braniff and Northwest have held close to 1958 highs, while Delta and Capital have experienced slight declines during the past two weeks. Eastern and National have remained relatively unchanged at levels below earlier highs. United has shown new strength.

► **Wall Street is not entirely pessimistic over the future of airline stocks despite a first-quarter decline in earnings and a leveling-off of passenger traffic gains (AW April 28, p. 38). One study, the Value Line Investment Survey, cautions investors against rapid fluctuation of airline stocks and the forthcoming equipment financing problems but predicts major airlines will perform above the average during the next year. Such stocks are given top rank relative to other stocks in the survey for price increase potential during the next three to five years. Survey also forecasts that dividends will become more secure later this year as the result of the recent fare increase.**

► Aircraft manufacturers will increase efforts to assist airline purchasers of turbine aircraft in disposing of piston-engine equipment as an assurance against any cutback on orders for turboprop and turbojet transports. Possibility that manufacturers may take in the older equipment as trade-ins on the new equipment is also strong. General Dynamics has promised to aid Capital Airlines in finding a market for its piston-engine aircraft as part of a sales agreement covering five Convair 880 jet transports. Boeing has agreed to accept British Overseas Airways Stratocruisers as trade-ins on 15 707s but hopes to avoid any similar deals in the future. Northwest wants Lockheed to take its Boeing 377s in on trade for 10 Electras and Douglas to absorb the airline's DC-7s as part payment on five DC-8s. No one doubts that the used-plane market will soon be glutted.

► **Russia has completed factory tests on the first production model of the Antonov An-10 Ukraina four-turboprop transport. Soviet reports say recent long-distance flights have proved the Ukraina's ability to fly 1,863 mi. while maintaining a one-hour fuel reserve.**



Another record for the Britannia

On Tuesday, 11th March, an EL AL Britannia flew from London to New York in 9 hours 22 minutes—fastest ever for a commercial aircraft.

EL AL and BOAC Britannias have broken the trans-atlantic commercial speed record eight times in three months of operation.

Aeronaves de Mexico have also made many record flights on their Mexico City/New York route.

WORLD-WIDE SERVICE, WORLD-WIDE ORDERS

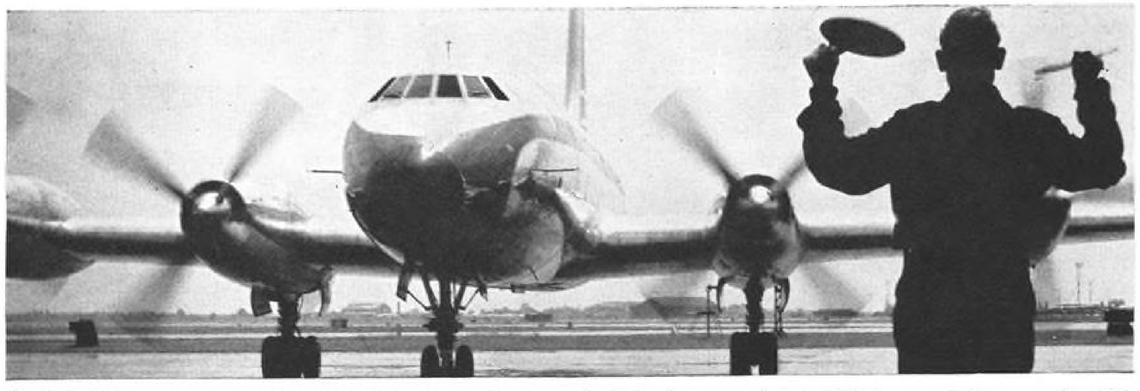
Britannia 102's are now in their second year of service with BOAC, and flying well over a million miles a month on the world's longest and most exacting scheduled air routes.

Britannia 300's and 310's are in service with EL AL Israel Airlines, BOAC and Aeronaves de Mexico. They have also been ordered by Canadian Pacific, Cubana de Aviacion, Hunting-Clan Air Transport and Northeast Airlines. Britannia 250's are on order for the British Royal Air Force and the Ministry of Supply.

BRISTOL
Britannia

BRISTOL AIRCRAFT LIMITED · ENGLAND

THE BRISTOL AEROPLANE CO (USA) INC
400 PARK AVENUE, NY 22 NY



The Bristol Proteus jet-prop engines of the Britannia are the most powerful, most advanced of their kind in airline operation. The Proteus 705 is approved to such an extent that its life between overhauls has been extended to *1,300 hours*, and this was achieved in only 13 months of airline service—a more rapid advance than that achieved by any other aero-engine in aviation history.

Magnetohydrodynamics: Hope for Space

By J. S. Butz, Jr.

Washington—Prospect of an imminent economic reward is attracting more and more U.S. firms to the relatively new and unexplored scientific field of magnetohydrodynamics

The new science forms the backbone of two devices of major importance, the controlled thermonuclear reactor and the very high specific impulse engines essential for effective space vehicles.

Economic rewards are the large research and development contracts leading to these reactors and engines which presumably will be given the companies that demonstrate a superior facility with magnetohydrodynamics.

Competition will be broad because the equipment necessary for basic studies in the new science is inexpensive by present standards. An adequate facility costs less than a low speed windtunnel with an eight-by-eight foot test section. So a company's possibility of success in this field rests more with superior personnel than with its ability to finance or acquire large research facilities.

A clear example of how small capital and the proper talent can achieve prominence was demonstrated several years ago when the Naval Research Laboratory created one of the pioneer groups in the field.

In four years NRL has spent less than $1 million on its program which has produced some important firsts in experimental techniques. This figure includes salaries, equipment purchases, power bills and all other expenses.

Another case in point is the Avco Research Laboratory's expenditure of about $50,000 during its first year of working with magnetohydrodynamics. After approximately four years its expenditure in this area is still less than half a million dollars per year. Avco's investment under the technical direction of Arthur Kantrowitz is generally considered to have resulted in one of the leading efforts in the field.

Other companies already active in the field include Lockheed Aircraft, Ramo-Wooldridge, General Electric, Republic Aviation and General Atomics.

Definition

Magnetohydrodynamics is defined as the study of the interaction between magnetic fields and electrically conducting fluids and gases. The length and composition of the term may indicate that the U.S. is tending toward the German practice of describing new sciences, processes and phenomena by combining several existing words. Synonyms for magnetohydrodynamics which do not appear to have been as well received by scientists are hydromagnetics and magnetoaerodynamics. MHD is often used as an abbreviation and will be used extensively here.

Regardless of the nomenclature, the possibilities and ideas which the rudimentary data available today are generating will be of major importance to several sciences.

Possibilities

Along with the prospect of having a virtually inexhaustable power supply from the sea through controlled thermonuclear reaction and the possibility of efficient high specific impulse engines that would provide maneuverability and a great safety factor in space, some other problems that magnetohydrodynamics has a direct influence on are:

- **Theories concerning the origin** and functioning of our solar system and the universe.
- **Postulations on the origins of weather** disturbances and cosmic ray production.
- **Communication with missiles and** space vehicles traveling at great speed and enveloped by layers of ionized gas.
- **Methods of disarming or destroying** nuclear weapons in flight by radiation.

Needless to say, few disagree with a maximum effort being directed toward the solution of some of these practical problems. However, several persons have warned against a complete departure from one of the basic tenets of basic research—that of searching with no end in mind and seeking knowledge only for the sake of knowledge.

Edward Teller reminded the second annual Lockheed Symposium on Magnetohydrodynamics in December of the alchemist who studied chemistry only to create gold. Although he said he could hardly discourage the enthusiasm of people seeking specifically to control fusion, he felt that greater things than could be imagined now will come about through men studying MHD randomly "for amusement" only.

Laboratory apparatus that can give quantitative data on the interaction between ionized gases and magnetic fields is of fairly recent origin and is the heart of today's research effort.

First MHD work was with fluids and resulted in liquid metal pumps with no moving parts.

First experiments with gases were apparently performed by the English in the late 1940s when they produced a pinched electrical discharge in a gas. Theoretical indications that this phenomena could be the basis for a controlled thermonuclear reaction had been made some years earlier in the U.S. by Enrico Fermi, Edward Teller and others at Los Alamos.

However, the Atomic Energy Commission did not authorize formal projects in this area until 1951.

Use of the shock tube for high temperature gas research was independently pioneered by groups under Arthur Kantrowitz at Cornell University and Otto Lapporte at the University of Michigan. Both groups studied the nature of gases at high temperatures, especially the radiation phenomena. Kantrowitz also investigated the effects of magnetic fields on the ionized gas pockets behind the shock.

Advanced Research

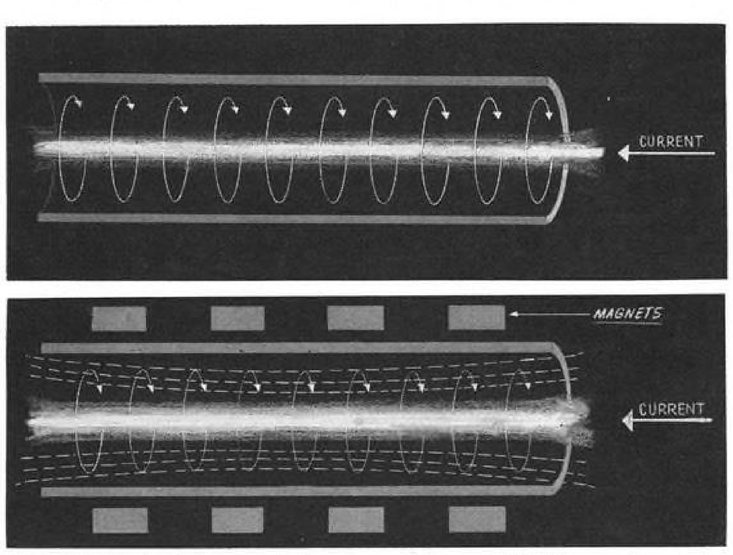
Since then, similar and more advanced work with shock tubes have been conducted by groups such as Avco, Brown University, Aberdeen Proving Ground, California Institute of Technology, Cornell Aeronautical Laboratory, Los Alamos, Maryland University, National Advisory Committee for Aeronautics and Princeton University, to name only a few. Generally, the maximum speed attainable with high pressure gas driven shock tubes is around Mach 20 with a temperature in the neighborhood of 15,000 deg. K.

Substitution of an electromagnetic driving force in place of the high pressure gas by Alan Kolb of the NRL in 1955 made Mach numbers of 200 and temperatures of about 1,000,000 deg. K. possible and greatly extended controlled conditions for the quantitative study of high temperature gases.

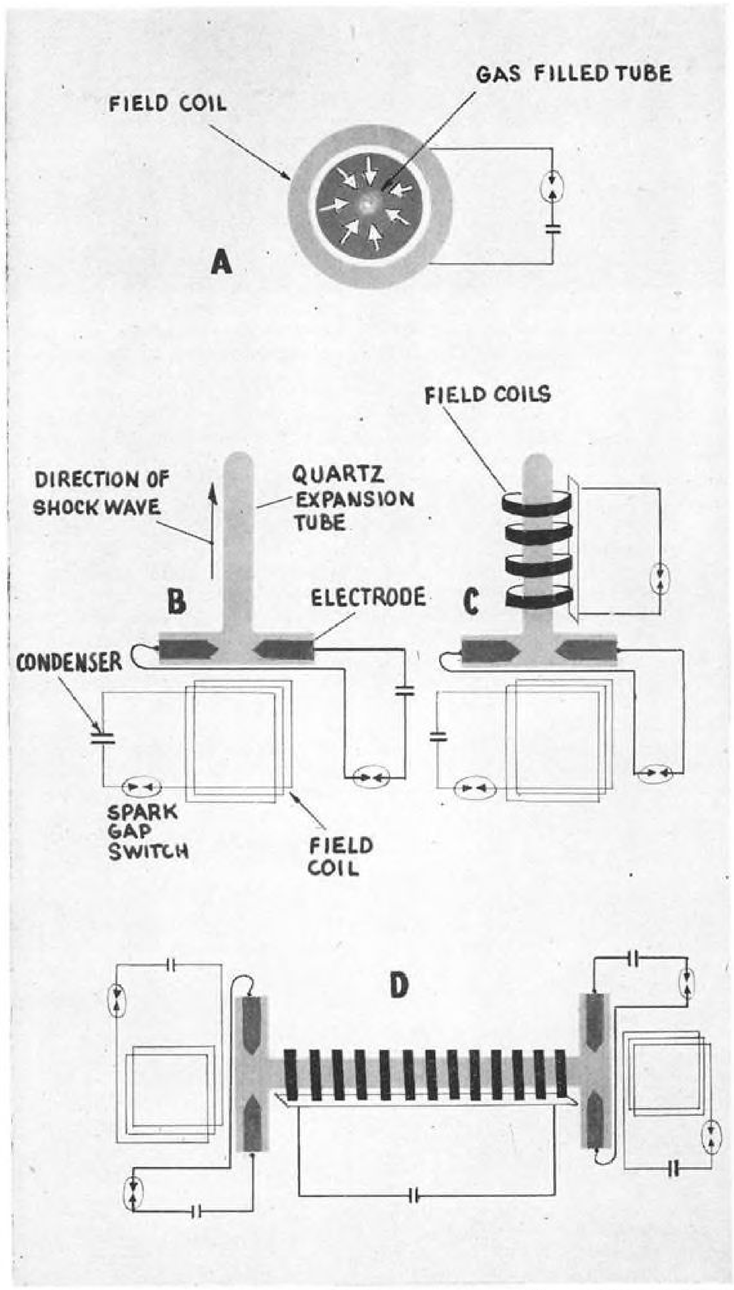
The pinched discharge was evidently the first method to be exhaustively worked with in trying to reach higher temperatures, and the Russians were the first to reveal a large portion of their work in the area. In a speech at Harwell in April, 1956, Igor Kurchatov talked in considerable detail about Soviet work with the pinch but no report was made on the actual extent of Russian progress.

Indications at the time were that the U.S. and England were ahead of what Kurchatov disclosed. In January of this year, the AEC and the English jointly released more advanced information concerning their efforts to control the pinch and create useable temperatures in deuterium and tritium gases.

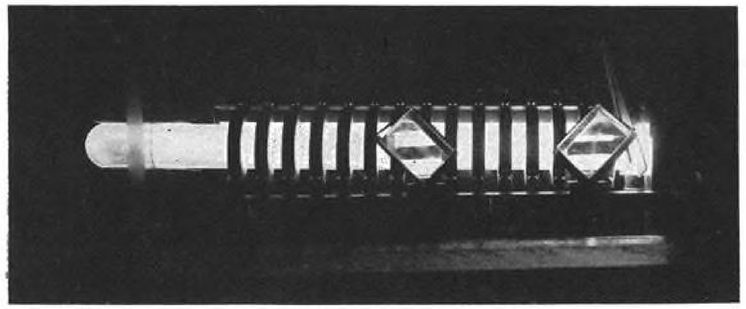
Briefly, the pinch effect results from



PINCH EFFECT, basis for many devices proposed for controlled thermonuclear reactors, is shown in the top sketch. A large current is discharged into a gas filled container ionizing the gas so it becomes a conductor with a magnetic field around it. This field squeezes the gas and raises its temperature to millions of degrees K. Pinch is inherently unstable trying to bend out and touch the container wall. This cools the gas. Surrounding the container with coils which create a longitudinal field (below) is one of the means being studied to stabilize the pinch.



FOUR DEVICES above are examples of laboratory apparatus being used to electromagnetically accelerate gas (usually deuterium or hydrogen) to high temperatures under controlled conditions. In the Avco equipment (sketch A) the gas in the container is excited by an RF signal. Then a current passed through the field coil creates a magnetic field that drives a circular shock wave toward the center of the container where it finally collapses. In the Navy device (sketch B) gas in the tube is ionized by passing a current through the cross head of the T; it is then driven up the side arm by the magnetic field of the coil underneath. This apparatus and Avco's can accelerate a gas to temperatures of about 1,000,000 deg. K. Present NRL experiments incorporate coils on the side arm which produce a squeezing field in the direction of the gas flow. Much higher temperatures are then possible. A logical extension of this work allowing still higher temperatures is shown in the bottom sketch where two squeezed shock waves would be fired at each other.



KOLB TUBE a fraction of a second after discharge is filled with luminous gas. Maximum gas temperatures of more than 1,000,000 deg. K last only a few millionths of a second. Vertical stripes across tube are the coils providing magnetic squeeze for the shock wave.

discharging a very large current into gas contained in a tube. The current is large enough to ionize the gas so that it becomes a conductor. A magnetic field is created around the gas with the conduction of the current, and the magnetic pressure of this field squeezes the gas and raises its temperature.

The gases of interest in this process are deuterium, a heavy isotope of hydrogen, and tritium, the radioactive isotope of hydrogen, because of their relatively low fusion temperatures. When ionized, the gas becomes a plasma of electrically charged nuclei or ions and electrons. The temperature of this plasma must then be raised to around 350 million deg. for a sustained, economic thermonuclear reaction in deuterium.

The temperature, which is another way of expressing the kinetic energy of the ions, is increased through collisions with the electrons that are moving many times more rapidly. Energy is released when the ions are moving fast enough to overcome their repulsive forces and fuse.

The problem with the pinched plasma is that it is inherently unstable in several ways. All of these instabilities tend to make the plasma bend so that it touches the wall of the container and cools off, destroying the pinch. Stable pinches have been achieved by surrounding container with field coils which provide a magnetic field alongside the sides of pinched plasma and tend to keep it from kinking. Passing current through the container walls is also done.

The power required to reach a given temperature increases quickly, however, because the magnetic field producing the pinch must not only squeeze the plasma but the stabliizing field also.

Doughnut-Shaped

The straight geometry pinch illustrated on page 48 has not been found to be as efficient as ones produced without electrodes as in doughnut-shaped tubes where the pinch current is induced. Instabilities around electrodes cause trouble in the straight tube.

Other possible methods of controlling the fusion reaction which have been under study by the AEC include:

- **Stellarators,** developed at Princeton by Dr. Lyman Spitzer, Jr., and his group which uses a stabilizing field that has an oscillating or pumping action.
- **"Mirror" system** developed by Dr. R. F. Post of the University of California Radiation Laboratory which has stronger fields at the end of the pinch discharge reflecting a portion of the ions back into the main stream raising its temperature.
- **"Continuous ignition" system** suggested by E. D. Shipley, L. P. Smith, A. E. Ruark, Herbert York and others which involves creating a very low density plasma with good confinement properties and slowly injecting cooler ions to form a useable plasma.

There is another method involving the use of electromagnetically accelerated shock wave to preheat and then compress deuterium gas. This is the method used by Kolb, and it essentially involves pushing an ionized gas with a magnetic field perpendicular to the current in the gas.

The gas is accelerated up a side arm of the plasma tube that is in the shape of a T. In present NRL experiments the gas is further accelerated and heated by ringing the side arm with coils which produce a field parallel to the flow. This field acts like a nozzle, increasing the velocity of the gas and keeping it away from container walls that have a cooling and contaminating effect.

Temperatures many times higher than the one million deg. or so possible with the simple Kolb tube are theoretically attainable with the coils on the side arm. A logical extension of this arrangement is to place two tubes together so that they resemble a dumbbell, and their shockwaves may be fired at each other, increasing the compression even more.

A number of experiments are using or acquiring equipment of this type. The NRL has what is believed to be the capacitor bank with the largest available current. This new equipment has a power output of 100 billion watts and a short circuit current capacity of 15 million amps. with a rise time of 3 microseconds.

It is entirely possible that some combination of the pinch and shock wave methods of heating the plasma would be used in a workable reactor. The work accomplished to date is rudimentary, and much larger equipment is believed to be necessary for an economical system although the smaller laboratory apparatus is sufficient to prove out theories.

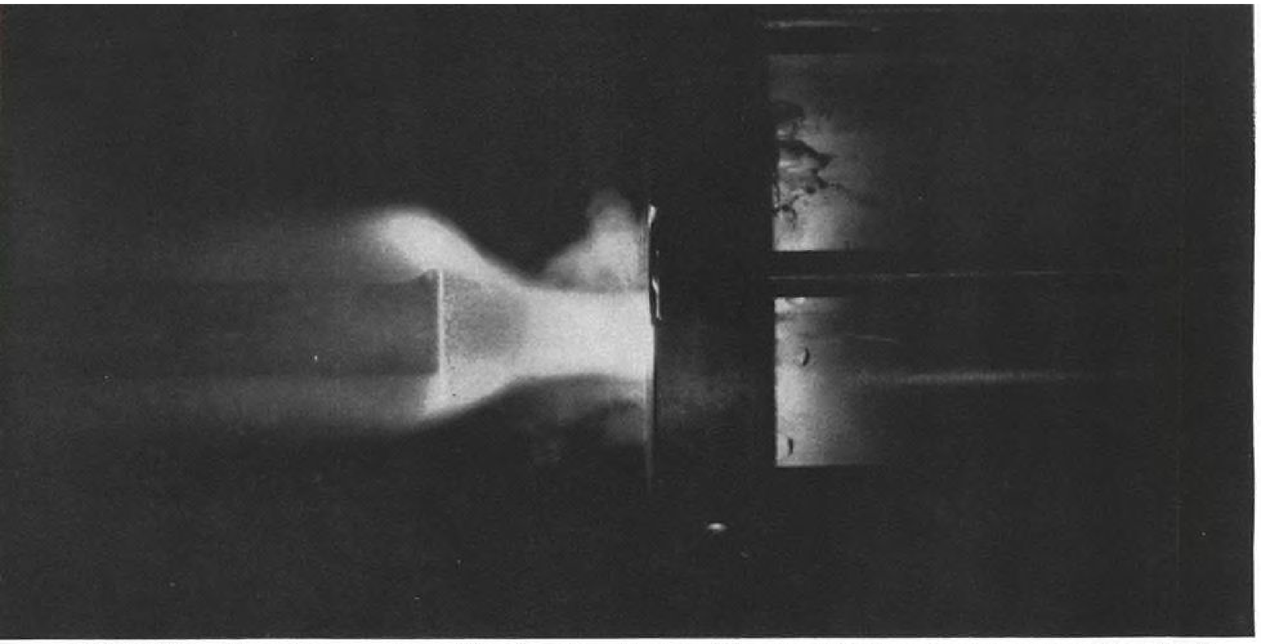
AEC Changes Stand

Probably the best gage of the rapid progress that is being made is the changing tone of AEC announcements. A year ago Adm. Lewis Strauss, AEC Chairman, reviewed progress toward the controlled thermonuclear reaction and declared that it was a hope of the somewhat distant future. Last January, in the joint announcement with Great Britain concerning the stabilization of pinched plasma, Adm. Strauss said that "it appears that years of intensive work will probably be required to develop a laboratory thermonuclear device which will yield more energy than it consumes."

Less than two weeks ago, Dr. Arthur E. Ruark, chief of controlled thermonuclear research for the AEC, issued a statement containing the following statement: "The ignition temperature is the degree of 'heat' at which the nuclear reactions in the hot gas give out as much power as the gas emits in the form of radiation. There is a general belief in the American laboratories that the ignition temperature will be achieved within a few years." Dr. Ruark went on to point out that this did not mean that the reactor would also produce enough power to operate the necessary auxiliary equipment and warrant its being called a net power producer. It does, however, show the great change in official AEC announcements over the last year.

First of Series

This is the first article in an Aviation Week series on the new science of magnetohydrodynamics which is exerting a widening influence in many fields including astrophysics, defense against high speed nuclear weapons, meteorology and propulsion and space communications. It is an integral part of the effort to produce a controlled thermonuclear reaction, which would provide virtually limitless power from the sea and eliminate the problem of atomic waste disposal.



NOSE CONE model experiences re-entry conditions in a plasma jet produced by water-stabilized arc; temperatures run on the order of 18,000K. Arcs are used extensively by Avco and GE in their materials testing programs. Both companies are developing nose cones.

Two Approaches Used in First Production

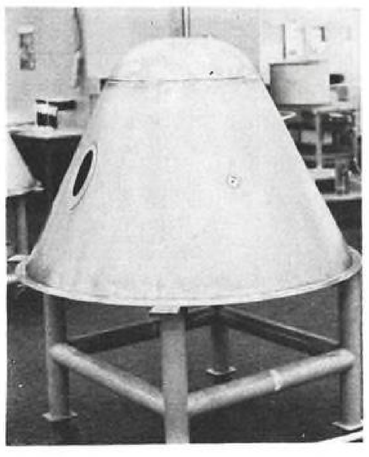
By Michael Yaffee

Design of the first ballistic missile re-entry vehicles has been frozen, and the re-entry bodies for Jupiter, Thor, Atlas and Titan have been ordered into production in their present configuration.

As the quickest, practical way to operational nose cones, the Air Force Ballistic Missile Division has chosen the thermal absorption approach to the re-entry problem. First re-entry bodies for Thor, Atlas and Titan will be blunt, heat sink structures fabricated of copper or copper-base materials. Additional cone characteristics are expected to be:

- **Integral configuration**—complete re-entry vehicle will consist of two separate sections: the forward, flattened hemisphere followed by a somewhat narrower and more elongated afterbody for aerodynamic stability. Once joined, the sections stay together.
- **Highly polished surface**—to reflect radiated heat.
- **Exhaust nozzles**—small jets exhausting compressed air or some other gas will be used for attitude control.

Inside the nose cone will be the warhead, arming and fuzing mechanism, and control equipment, all swathed in some amorphous silicone type of insulation for protection against the heat that manages to get through the cone.



NOSE CONE (above) and afterbody (left) for Thor and Atlas re-entry vehicles were displayed at Republic (AW May 5, p. 29). Nose cone is blunt, copper-based, heat-absorbing structure. Cone liner inside extends below heat shield. Afterbody is hidden from view inside missile until after separation.

Army Ballistic Missile Agency, on the other hand, has decided on thermal removal, a more sophisticated but more difficult approach. Jupiter re-entry vehicle will be a longer, more streamlined, conical structure slightly rounded at the tip and made of reinforced plastic. Other features it probably will possess are the following:

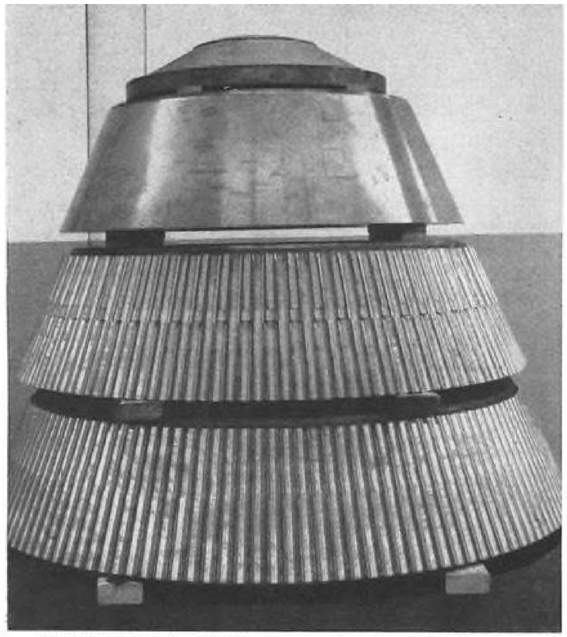
- **Sectional configuration**—nose cone will consist of two sections which will separate once the cone attains its prescribed speed.
- **Exhaust nozzle**—single, solid propellant vernier engine in the base of the nose cone will be used to make fine velocity adjustments.

Inside the nose cone front section will be the warhead and arming and safing mechanism. In the back section will be the vernier engine, its solid propellant supply, and the guidance or control equipment.

Navy Looks Around

With more time at its disposal, Navy is looking at a number of possible solutions to the re-entry problem. But barring some unforeseen, major scientific discovery, the Polaris probably will have an ablating re-entry body, made of some ceramic material.

Manufacture of the Air Force nose cones does not depend on any major technological development. Producers will use commercially available materials and a combination of standard fab-



CONCENTRIC rings (left) were cut from large beryllium ingot (right) by Avco experimental manufacturing group as part of its effort to develop fabricating techniques for making beryllium nose cones. Avco is working on research and development of the Titan nose cone.

Nose Cones

ricating techniques. Some equipment, such as polishers, is being made specially for the program because of the size of the cones, not because of any exceptionally high degree of luster required. Actually, cone fabrication is expected to lend itself quickly and easily to mass production techniques.

Ablation-Type Fabrication

Less is known about the new high-temperature polymer systems and similar materials than about copper and copper alloys. Consequently, fabrication of the first ablation type nose cones is proving a comparatively difficult but not impossible operation. Goodyear, in fact, claims it now has all the bugs out of the manufacturing set-up for the Jupiter re-entry vehicle.

Decision to freeze design and get re-entry bodies into production was not meant to stop development of a more sophisticated solutions to the re-entry problem.

Some already are in an advanced state of development; others are in the research phase. All aim at permitting the nose cone to re-enter at a higher velocity in order to minimize wind drift errors and possibilities of detection and interception.

One of the most interesting possibilities involves the use of magneto-hydrodynamics. Both Avco Mfg. Corp. and Republic Aircraft Corp. are working on this approach.

Still in the early research phase, the idea, briefly, is the following:

An electrical or bar magnet would be placed on the outside of the nose, or the nose cone itself might be made of a magnetic material. Batteries would be carried inside the cone.

Ionized Fluid

As the layer of gases ionized by the high temperatures flows over the nose cone and across the magnetic field, a current is induced in the ionized fluid. This current then becomes the source of a new magnetic field which adds vectorally to the original field.

Applied normally to the surface, the magnetic field interacts with the fluid velocity component parallel to the surface and tends to slow the fluid flow, because work has to be done to move the fluid across the magnetic field. In other words, the magnetic field exerts what is akin to a viscous drag on the conducting fluid.

This has two effects: It slows the apparent velocity of the nose cone and thereby reduces the laminar heat transfer to the warhead. Second, it reduces

DRUMS containing toxic beryllium waste are completely wrapped in plastic envelope before being removed for disposal. Air in the area is continually analyzed for safety.

the tendency to instability in boundary layer flow; i.e., the boundary layer remains laminar for a longer time before becoming turbulent, wherein the heat transfer rate is much greater.

Most engineers involved in this work believe that the application of magneto-hydrodynamics to re-entry vehicles is at least five years from operational capability. Republic's Joseph Neuringer feels it could be much sooner, perhaps two years, if the necessary funds were available.

Use of fluids to cool a nose cone during its brief re-entry period is another promising possibility. The critical factors here are (1) whether the fluid could be moved fast enough to do the job, and (2) whether the amount of fluid and associated pumping equipment that would have to be carried in the nose cone would weigh more than the material required for some other means of thermal protection.

Among the different types of cooling possible are:

• **Sweat or transpiration** cooling where the fluid is forced out the pores of the cone. This technique would be used where the surface heat transfer rate is high.

• **Regenerative cooling** where a liquid coolant might be circulated within the shell or within a jacket or pipes right beneath the cone surface and then, perhaps, exhausted through a steam jet. This would be used where the surface heat transfer rate is comparatively low.

Heat Transfer Rate

In both cases, the time rate of heat transfer is important because it will determine the required pumping rate.

A great deal has been learned about regenerative cooling from its application to rocket motors. Overall, however, the techniques of fluid cooling as applied to nose cone protection are not well known. And this approach is considered somewhere between ablation and magneto-hydrodynamics in both its state of development and promise.

For the immediate future, ablation appears to be the most promising answer to the re-entry problem. Army will use it on its first generation ballistic missile, the Jupiter, and the Air Force will almost certainly go to ablation cones for its second generation missiles. Air Force cone contractors, General Electric Co. and Avco, in fact, already have fairly well decided on materials they will use.

With an eye to the continuing development of anti-missile missiles, many weapons designers are convinced that the lob trajectories and comparatively long time-to-target of the heat sink type of re-entry vehicles will make the vehicles easy prey for even a rather primitive anti-missile system.

One way to alleviate this problem is to flatten out the trajectory; that is, launch the missile closer to the horizontal. In addition to lessening the possibility of early detection by surveillance radar, this would significantly cut flight time from launch to impact. Another way is simply to streamline the nose cone. Streamlining reduces drag, enables the vehicle to retain more of its initial velocity and thereby decreases re-entry time.

Both these approaches are relatively simple and, therefore, attractive ways of

Re-entry Problem

When a re-entry vehicle is separated from a ballistic missile at extreme altitudes, it continues to follow a ballistic trajectory that will bring it into the atmosphere and onto its target at hypersonic velocities, ranging from about 15,000 to about 25,000 ft./sec.

On its way in, the vehicle rapidly and adiabatically compresses the air in front of it, building up great pressures and heat ahead of the cone. And as the air passes over the surface of the high speed vehicle, fluid friction comes into play, setting up shearing stresses in the boundary layer and creating additional heat. Comparatively insignificant amounts of heat are also produced by the recombination of ionized air about the re-entry vehicle and by the oxidation or combustion of the nose cone material.

The drag exerted on the body is of two types:

• Wave drag which results from the pressure built up in front of the cone. This acts perpendicular to the body with a net force component that acts in a direction opposite to that of the re-entry vehicle and, thus, tends to slow it down.

• Skin friction drag which results from the viscosity of the air in the boundary layer. Air moving over the boundary layer sets up a shearing stress within the layer that exerts a net force acting along the surface in a direction opposite to the motion of the re-entry vehicle.

Total amount of heat generated by the vehicle is proportional to the total drag. The amount of this heat actually transferred to the vehicle is proportional to the friction force. Thus, heat transfer can be reduced by decreasing the ratio of friction force to total drag; i.e. by decreasing skin friction drag and increasing wave drag. To a degree, this can be accomplished by using blunt (high drag) shapes.

Except for the energy which is dissipated in wave drag, the high kinetic energy of the re-entry vehicle is translated into heat which is trapped between the shock wave and the nose cone. According to one estimate, each pound of air possesses 14,000 Btu. of heat energy. This is the amount of heat that must be coped with. Part of this heat finds its way to the atmosphere by viscous dissipation and radiation. The rest is carried to the re-entry vehicle mostly by conduction and convection and same by radiation.

Although re-entry times are brief—well under one minute—it is estimated that in this period temperatures in shock waves run to 15,000F; in the boundary layer, to 12,000F; and on the surface of the cone, 5,000F and up. The rate of heating may go as high as 450 kw. (about 427 Btu./sec.) per square foot. Pressure build-up is also severe. Plunging into ever denser atmosphere, the re-entry vehicle encounters the equivalent of pressures running from about 1 to over 1,000 psi. in a matter of seconds. The rapid deceleration of a missile cone, which has been equated to a car hitting a solid brick wall at 60 mph., imposes severe loading on the vehicle. In addition, there is a significant amount of damage during re-entry caused by vibration (buffeting) and noise.

(For comparison: a high performance jet airplane seldom encounters skin temperatures more than 650F or pressures greater than 1 psi.).

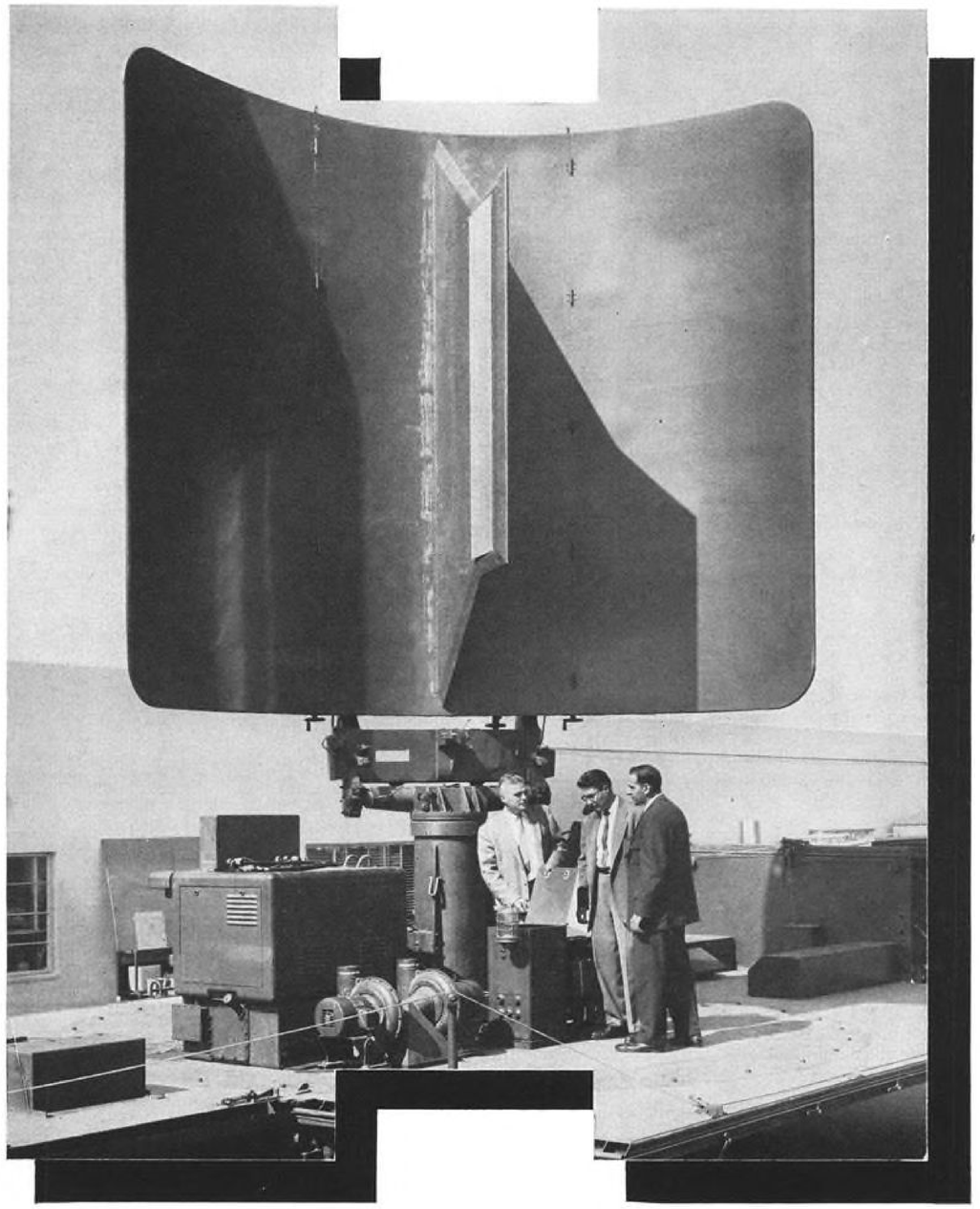
Among the effects of this combination of extreme heat, pressure, vibration and noise on the nose cone are:

- Buckling and other outcroppings of structural instability.
- Complete structural breakdown.
- Melting.
- High thermal stresses.

In effect then, this means that the re-entry vehicle, at a time when it is seriously weakened by aerodynamic heating, must be strong enough to withstand severely increased loading and remain intact. At the same time, it should also meet the following requirements:

- It must keep most of the heat from reaching its payload.
- It should not become deformed by heat or erosion to a degree where it becomes aerodynamically unstable and unable to follow its trajectory to its target.
- It should have high re-entry velocity so as to minimize possibilities of detection, interception, and wind drift errors.

HOW TO SEE IN ALL DIRECTIONS AT ONCE



They add new dimension to defense

Three dimensional radar . . . it is a positioning of radar beams in space by electronic rather than mechanical means. It provides three-dimensional target data from a single antenna, transmitter, and receiving channel. It is a radical new weapon for national defense.

Engineers at the Hughes Ground Systems Division in Fullerton are responsible for pioneering this advancement (see antenna at left). But even more importantly, these same engineers are working on an elaborate radar warning system which will not only provide this complete radar data, but also translate it into meaningful information and relay it to central communications centers.

Other Hughes activities offer similar engineering challenge. The Research and Development Laboratories in Culver City, for example, are probing into the effects of nuclear radiation on electronics equipment, studying advanced microwave theory and applications, examining communications on a global scale, and developing new methods for insuring product reliability.

The Hughes Products engineering team makes electronics useful in solving industrial problems. For example, this group has just unveiled an industrial electronics system which will automate a complete and integrated line of machine tools.

The diversity of Hughes activity offers prospective employees opportunity to build a rewarding career in a highly progressive and expanding environment.

New commercial and military contracts have created an immediate need for engineers in the following areas:

Communications	Microwaves
Reliability	Crystal Filters
Circuit Design	Computer Engineering
Systems Analysis	Field Engineering
Vacuum Tubes	Semiconductors

Write, briefly outlining your experience, to Mr. Phil N. Scheid, Hughes General Offices, Bldg. 17A-1, Culver City, California.

Advanced research on the Maser (Microwave Amplification by Simulated Emission of Radiation) performed by the R&D Laboratories is directed towards applications of a portable, airborne Maser for missiles and aircraft.

Falcon missiles have been an important factor in establishing Hughes as a leader in advanced airborne electronics. Manufactured in Tucson, Arizona, the Falcon missiles have both infrared and radar guidance systems.

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Ablation vs. Absorption

Under different heating conditions, the same material may act as either a heat remover (ablation) or as a heat absorber (sink). But rarely can one material do both jobs well, because the requisites for each job differ. Ideally, the characteristics of the perfect material for each application would include the following:

Ablation	Heat-Sink
Low density	High melting point
Low thermal conductivity	High thermal conductivity
High latent heat of fusion	High thermal capacity
High viscosity	Low surface temperature gradient
Low detection potential of vapor	High reflectivity

In common, both types of material should have the following characteristics:

High strength at elevated temperatures and pressures.	High resistance to weathering and oxidation
Fabrication facility	Low total weight
High resistance to thermal shock	Low coefficient of thermal expansion

increasing velocities of re-entry vehicles. But increased velocities mean increased aerodynamic heating. Although it is possible to absorb more heat by adding to the thickness of a heat sink cone, the additional weight soon becomes prohibitive in terms of a practical takeoff weight.

Thus, a new approach was needed and ablation appeared to be the best theoretical and practical solution. An ablation nose cone could take care of the additional heat and more important, it could be brought to the operational stage within a comparatively short time.

Heat-Absorbent

Principle of ablation is simply that a material will absorb heat as it changes from one physical state into another. In its broad meaning it would include fluid cooling and combustion. More specifically, however, it means a material that will melt, vaporize or sublime upon absorbing heat, and this is the sense in which it is being developed for nose cone work.

The problem, as far as nose cone development was concerned, was to find a material that could be easily fabricated and that would ablate aerodynamically or evenly.

Unlike heat sink material, ablation material should have low thermal diffusivities (high temperature gradients) so that the surface builds up to the melting point while the material underneath stays comparatively cool and retains its structural integrity.

In its search for a suitable ablation material for the Jupiter nose cone, the Army Ballistic Missile Agency, working on a crash basis at the time, didn't have time for any theoretical studies and so started out testing materials, making use of some data derived from earlier programs, such as the Redstone.

ABMA carried out some materials investigation in its own laboratories (where it also made the first prototype cones) and contracted for the rest with outside groups. Among these outside agencies was Battelle Memorial Institute which did considerable work on ceramics. It was the crystalline ceramics that appeared to be the most immediately promising of the possible ablation type materials.

Ceramics either can be sprayed on a substructure material such as graphite or steel or fabricated into a structural unit. For nose cone application where the surface is to be fused away, a monolithic structure seemed to be preferable to a sprayed coating. The coating, it was felt, would not have enough thickness.

In their favor, ceramics have a definite weight advantage over most metals, especially copper. They generally have poor thermal conductivity, which is considered an asset in ablation.

At the same time, however, ceramics are brittle and a ceramic nose cone might actually break if dropped. Similarly, they are much more sensitive to thermal shock than metals. In the case of re-entry, a ceramic nose cone would have to pass through the atmosphere at very high speeds to prevent spalling. The idea, according to the materials people, is to have the surface melt away before it breaks off as a result of thermal shock. Even then, there is no assurance that the cone would ablate aerodynamically.

In fabrication of ceramic nose cones it is much more difficult to make a large ceramic structure than a comparable metal or plastic one. Chances are that a large ceramic nose cone will always have to be made in parts and then assembled into a complete unit. There also is the problem of non-uniform composition within different areas of the

Cone Contractors

The following are some of the groups working on the research, development and production of the first U. S. ballistic missile re-entry vehicles:

- Avco Manufacturing Corp.—Research and development of the Titan nose cone.
- General Electric—Research, development and production of the Thor and Atlas nose cones.
- Goodyear Aircraft Corp.—Production of the Jupiter nose cone under contract from ABMA.
- Republic Aircraft Corp.—Production of the nose cone that will be used for both Atlas and Thor under subcontract from General Electric.
- Lockheed Aircraft Corp.—Research, development and production of Polaris nose cone.

same cone and from one cone to the next.

In development of Jupiter nose cone, ABMA reportedly encountered all these problems associated with ceramic materials. When it began to look as though the disadvantages would far outweigh the advantages, the Army set aside ceramics and started investigating plastics as possible ablation materials.

Comparative newcomers to the field of structural materials, plastics are generally thought of in terms of low melting point or easily inflammable household items and toys. This is no longer true as proved by the use of plastics in such hot-spot applications as nozzle liners and jet vanes. Plastics producers now are beginning to call their products by more formal names, such as polymer systems, to avoid earlier connotations.

Of most immediate interest for nose cone work is the particular group of polymer systems commonly referred to as reinforced plastics. Basically, these materials are composed of organic resins combined with organic or inorganic fibers of materials such as glass, asbestos, ceramics, nylon or metals. The fibers serve a purpose similar to that of steel in reinforced concrete.

For very short times (calculated in seconds), reinforced plastics are able to withstand temperatures above 5,000F —some compounders claim temperatures as high as 14,000F. Also, materials are light, dimensionally stable, have high strength-to-weight ratio and heat resistance, are more ductile and easier to fabricate than ceramics, and are comparatively inexpensive. Among some of the newer compounds that more-or-less are typical of this category are:

- **Astrolite,** a plastic reinforced by leached glass fibers, developed by H. I. Thompson Fiber Glass Co. At 450F, the resin melts away, leaving a mat of glass fibers. Fibers start to melt at

3,000F, turning sticky and adhering to the surface until they finally vaporize.

• **Organic polymer system** with random oriented reinforcement that is being offered by Hughes Aircraft Co. (AW, Mar. 24, p. 20). Like Astrolite, the Hughes plastic absorbs heat first by decomposing and then by subliming. Company says the material is able to withstand temperatures to 6,000F and exhaust velocities to 8,000 fps. for short periods.

• **Family of reinforced plastics** produced by Raybestos-Manhattan Inc., designated RPD. Basically, members of this group are composed of asbestos blended with other fibers, such as glass, and blended or impregnated with resins or inorganic binders, such as silicones or phenolics. Material has been tested out to temperatures of 6,000F.

• **Aerorez E601** and Aerorez E602 reinforced plastics developed by Aerojet-General Corp. First is a laminating resin reinforced with glass fibers and has been subjected to temperatures above 3,000F in a high velocity gas stream for several seconds. Second is a resin-ceramic system which is also reinforced with glass fibers.

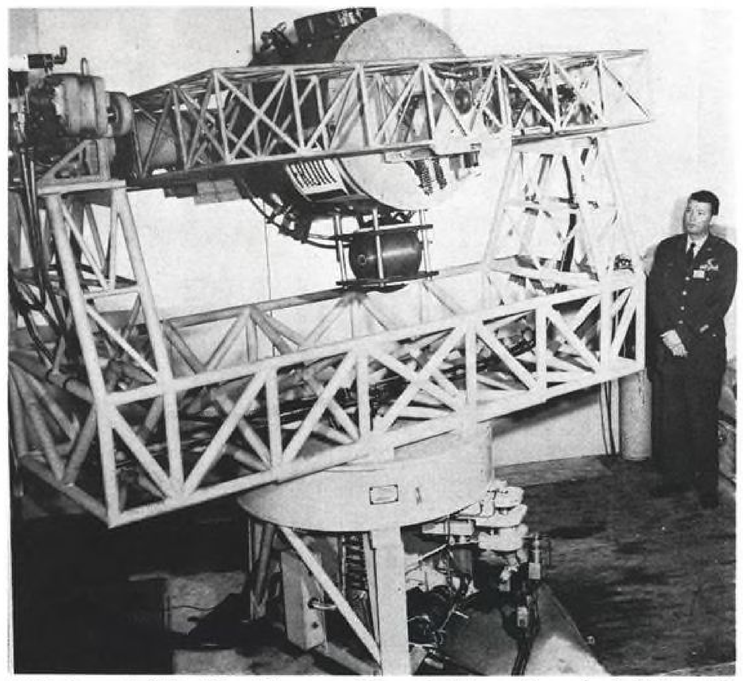
• **Plastic-bound inorganic** materials series offered by Haveg Industries, Inc. and Reinhold Engineering and Plastics Co. Materials are combinations of metals, plastics and ceramics which are said to be capable of withstanding temperatures to 12,000F for short runs.

Mass Transfer

For nose cones, the reinforced plastics are cured in a matched metal mold where they are pressed into the desired shape. Resultant cones can and have been used by themselves or fitted over substructures. For a large re-entry vehicle such as the Jupiter nose cone, it is more than likely that the shaped plastic cone is fastened to a metallic substructure.

As used on the Jupiter, the reinforced plastic re-entry vehicle will not really ablate in the accepted sense. The plastic will act more as a heat blocker than as a heat remover. As they melt and vaporize, the reinforced plastics alter the boundary layer characteristics (as a result of, among other things, the gaseous end products passing into the boundary layer) and thereby change the heat transfer coefficient; less heat is actually transferred to the missile. As yet, the scientists still don't completely understand the details of this so-called mass transfer action.

More important, the Army Ballistic Missile Agency, just now starting on a theoretical approach to the problem, says the new Jupiter nose cone works and believes its program is definitely on a par with Air Force nose cone development. All bugs in the system from fabrication to flight have been worked out,



AVCO three-axis flight table at Lawrence, Mass., simulates motions of a ballistic missile re-entry vehicle. USAF Maj. Gen. Bernard A. Schriever is inspecting the flight table, which is large enough to test navigation, guidance, control, tracking and fire control systems.

according to the Agency, and the plastic cones have been ordered into production.

Regardless of where they stand regarding the Army nose cone development, Air Force scientists apparently were sufficiently impressed by ABMA's results to start looking more closely at the possibility of reinforced plastic nose cones (AW, Apr. 7, p. 23), setting aside their ceramic work—at least temporarily.

Ablation Commitment

As far as the immediate future goes, both the Army and the Air Force are strongly committed to the ablation approach and ceramics still are definitely in the picture for both.

In fact, before this recent resurgence of interest in reinforced plastics, Air Force nose cone contractors General Electric and Avco had just about decided on the particular ceramics they were interested in for their second generation re-entry vehicles. The Army Ballistic Missile Agency also is continuing its ceramic studies.

ABMA reportedly ran into most of its trouble in trying to develop fabricating methods. Presses large enough to form ceramic structures the size and shape of the Jupiter nose cone are almost impossible to find and very costly to produce. Army decided to try to handle the ceramic like a cement mix. The idea was to pour a ceramic solution over a mold and let it dry into shape without pressure and then fire it in an oven to develop its ultimate strength.

Slip Casting

This technique, known as slip casting, is a fairly common and successful way of commercially forming refractory materials. But so far, it has failed to measure up to the demanding nose cone specifications for uniformity and reproducibility of composition. By the same token, if and when it is perfected, the Army will have a good, simple, inexpensive way of making ceramic re-entry vehicles.

Many materials engineers are convinced that as soon as slip casting or some other technique is perfected, ceramics will become the top material choice for re-entry vehicles. The reason is not simply that ceramics are better ablation compounds. The problem, scientists point out, is primarily to keep as much heat as possible from going into the re-entry vehicle.

Ceramics can do this by removing heat in changing its physical state (ablation) and by altering the conditions in the boundary layer (mass transfer) and, according to the scientists, can do the job more effectively than other materials presently available.

Early in the Air Force ballistic missile program, it was decided that the quickest way to get an operational re-entry vehicle was to take the heat-sink

approach. It was comparatively simple and more was known about the materials and techniques involved.

Once the approach was set, the first problem for General Electric and Avco was finding a suitable material. A look at the materials picture showed that there were actually only about five or six candidates that could be seriously considered.

One of the most promising was beryllium. It was light, had high specific heat and thermal conductivity, and showed good resistance to oxidation. On the other hand, beryllium metallurgy was at a comparatively early age. The material was brittle, difficult to fabricate, highly toxic and expensive.

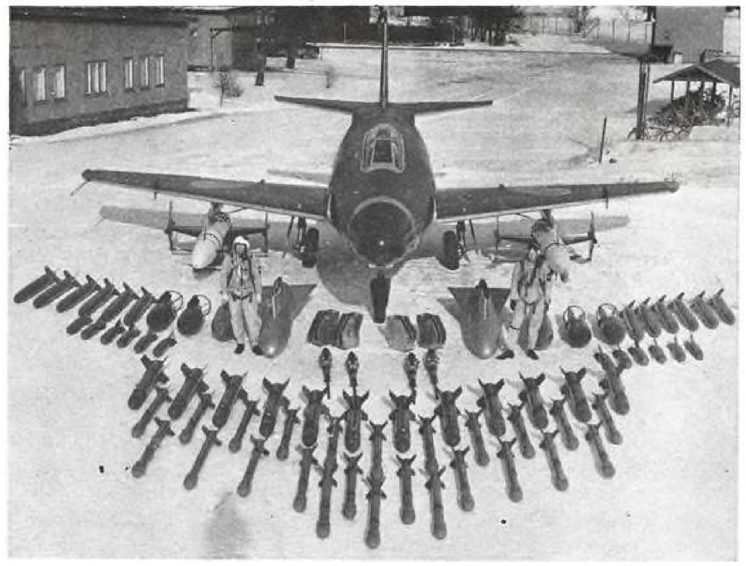
In spite of its drawbacks, both Avco and Lockheed decided that beryllium merited serious investigation as a possible nose cone material. Brush Beryllium Co. supplied the material. Both Avco and Lockheed ran into trouble trying to form the material and in coping with the highly toxic beryllium dust.

But it wasn't too long before Avco learned how to handle the material, according to a company spokesman. As evidence of its capability, the company points to what it believes is the largest beryllium ingot ever made. Avco's experimental manufacturing group took this solid ingot and turned it into a series of intricately machined concentric rings. Avco dropped the project when certain design changes in the nose cone program made it possible to go to a material much less expensive than beryllium. Company is still interested in beryllium, however, and is pushing it for use in other parts of missiles. At last reports, Lockheed was still working on beryllium as a possible nose cone material (AW Jan. 6, p. 39).

Graphite Test

Another material that showed some promise as a heat sink was graphite which is described by one major producer, Speer Carbon Co., as a machinable ceramic. From a weight standpoint, according to Jackson R. Stalder, of the National Advisory Committee for Aeronautics, the amount of graphite required would weigh only about ¼ as much as copper if each material is allowed to reach a surface temperature equal to 75% of the melting or sublimation temperature. Graphite also has good thermal shock resistance. Although graphite has low strength at room temperature, it is unusual in that it maintains, or even slightly increases, its strength at temperatures up to about 4,700F.

But graphite is subject to high surface temperature gradients. And for nose cone use, it was felt that graphite would need a coating to protect the



Swedish Saab has Armament Versatility

Armament choice that Swedish Saab-32A Lansen attack aircraft is designed to carry includes Type 304 air-to-ground guided missiles on wing pylons; twelve 18 cm and twenty-four 15 cm caliber rockets; twelve 220 lb. illumination bombs; four 550 lb. bombs and two 1,100 lb. bombs. Ammunition is for 20 mm guns.

surface against oxidation and erosion. Difficulty of developing a high temperature coating which would allow exploitation of the material's high sublimation temperatures led to a general loss of interest among nose cone designers. But a number of research groups have been working on the problem of high temperature protective coatings, and at least one, National Research Corp., has come up with what it believes is a workable solution to the graphite problem.

Material of choice proved to be copper. Despite its high density and the resultant heavy weight of a copper nose cone, General Electric and Avco scientists found that a copper re-entry vehicle had excellent resistance to thermal shock as well as high thermal conductivity and ductility. More important, the material was comparatively inexpensive and could be obtained from standard commercial supply sources.

Actually, heat sinks don't solve the re-entry problem; they mostly avoid it.

Principle of the heat sink is the absorption and storage of heat. A good heat sink material must have high heat capacity and good thermal conductivity (so that the heat can be carried away from the surface before surface temperatures build up to the melting point).

Critical environment factors are (1) the total amount of heat that is transferred to the re-entry vehicle from the environment and (2) the rate at which it is transferred. Materials, no matter how good heat sinks they are, have a limited heat capacity and rate at which they can safely conduct heat.

Once they found a good heat sink material, General Electric and Avco then faced the problem of keeping aerodynamic heating within the tolerance of the nose cone by maximizing heat capacity, minimizing heat build-up and transfer rates. The only way to increase thermal capacity—and then only by a limited amount—is by greater slab thickness in the nose cone.

Minimizing heat build-up and transfer rates was more complicated and, in accordance with the work of H. Julian Allen and A. J. Eggers, Jr., of NACA's Ames Aeronautical Laboratory (AW June 24, p. 52), meant the use of blunt shapes and flat approach angles. The flatter the approach angle, and the more blunt the shape, the longer the re-entry vehicle takes to reach the ground. This actually results in a larger total heat input but a smaller rate of heat transfer, since the heat transfer is spread over a longer time interval. In the case of a blunt body, the amount of heat input per unit area is also diminished because the heat input is spread over a greater area.

Too, the blunt body starts decelerating sooner than a streamlined unit and reaches its point of peak deceleration (which is, roughly, the same point at which maximum heating occurs) at higher altitudes where the air is less dense and so aerodynamic heating is less. Blunt bodies with their high pressure drag keep the ratio of skin friction

drag to total drag at a minimum with the result that most often heat goes to the air rather than to the cone.

By doing all these things, Avco and General Electric in effect slow their re-entry vehicles to the point where aerodynamic heating remains within acceptable limits. At the same time, however, the slowed descent and terminal speeds mean increased opportunities for detection, interception, and wind drift errors.

Once the first production contracts have been filled, heat sink nose cones are almost certain to be discarded as a solution to the re-entry problem—at least for long range missiles. There remains the possibility that this approach will be used in manned re-entry vehicles.

General Electric and Avco are reportedly among the five or six finalists in the Air Force's manned orbit program for next year (AW Apr. 7, p. 26). Both companies have claimed that with minor modifications their intercontinental ballistic missile re-entry vehicles could be used for manned satellites.

With this one possible exception, the missile nose cone picture narrows down to the ablation type re-entry vehicle made of reinforced plastics or ceramics. There are, of course, other approaches and other materials (AW Mar. 3, p. 147). New or advanced devices such as manned rocket aircraft and glide vehicles will add their own peculiar twists to the re-entry problem.

But, for ballistic missile re-entry vehicles, most scientists now involved in the nose cone program believe that ablation holds the greatest promise for the immediate future. In five years, perhaps, ablation may give way to fluid cooling or magneto-hydrodynamics. More likely, the later approaches will be used in conjunction with ablation, at least at the start.

Molybdenum Coating Technique Developed

Cambridge, Mass.—Coating technique developed by two scientists at National Research Corp. may soon give molybdenum a chance to prove its suitability as a high temperature missile material.

Long regarded as a top contender for high temperature (2,000F and above) applications, molybdenum has not yet lived up to its full potential, primarily because of poor oxidation resistance at elevated temperatures. (AW Dec. 23, p. 41.)

Now, however, Philip J. Clough and James H. Moore of National Research Corp. have developed a technique for coating molybdenum with an aluminum-silicon alloy. The coated material can withstand temperatures above 3,000F under oxidizing conditions for 7-8 hr. as well as repeated cycles of rapid heating and shock cooling. Modification of the coating with high temperature materials such as tantalum or niobium could push the temperature limit as high as 5,000F for a period of perhaps 10 sec. Applications to nose cones, rocket nozzles and jet engines are obvious and under evaluation.

Molybdenum disilicide coatings as such are not new. But heretofore application has been expensive and imperfect. Clough and Moore claim their process (for which a patent is now pending) is inexpensive, practical and, most important, deposits a uniform coating free from pinholes.

Process consists of spraying an aluminum-silicon alloy on a molybdenum surface. The coating is oxidized to form a high surface tension film and then heated in the absence of air. This results in a coating .010 to .015 in. thick that adheres strongly to the molybdenum surface.

In the finished coating, the original aluminum-silicon alloy actually resolves itself into three tightly layered but distinct parts. On top of the original molybdenum surface, a dense, adherent interface composed primarily of molybdenum disilicide is formed. The next layer is predominantly an alloy of molybdenum, silicon and aluminum. On top of this is the outermost layer, consisting principally of aluminum oxide and silicon oxide.

The layering of the protective coating is important.

In effect, it creates a double interface which slows the flow of heat into the base material.

More significant is the fact that the coating can be applied to a molybdenum surface which itself is only a thin coating on top of some other base material. An important weight saving might result, for example, if graphite could be used as the base material. Graphite can be coated in this manner, according to Clough, and graphite coated structures are being considered for nose and nozzle applications.

Early work in this area at National Research Corp. was sponsored by Curtiss-Wright which was interested in using the material in ramjet nozzles. Molybdenum-coated nozzles were produced but never proved out because of poor welding. Since then, fabricators have gained much experience in handling molybdenum and obtaining good welds is no longer a major drawback.

A coated nozzle, tested in a ramjet, lasted an hour at a gas temperature of 3,500F and a gas velocity of 5,000 fps. An uncoated nozzle would have burned out in 40 sec. under the same conditions, according to Clough.

DOUGLAS C-133 vortex generators on top wing surface ahead of ailerons raise roll rate to required level, replace hydraulic boost.

Aviation Week Pilot Report

C-133 Exhibits Stability, Controllability

CARGO loading ramp and cargo are conveyed on belts into C-133 cargo compartment. Cargo that is palleted but not tied down is held in place by cargo nets and can withstand 3G forces.

By Richard Sweeney

Long Beach—Refinements in design based on experience gained over the years have made Douglas C-133 turboprop transport an airplane capable of supporting, on a practical and economic day-in-day-out basis, military or commercial operations built around airlifts.

With an original design goal for carrying 50,000 lb. payload 2,500 naut. mi., airplane was built with ample inherent stretch in range and growth in payload potential, ready for anticipated powerplant improvements.

Airplane highlights are:

- **Cargo hold** approximating 13,000 cu. ft. squared off, which will hold plane's present maximum payload weight at slightly more than 7 lb./cu. ft. density; yet design is such that up to 10 lb./cu. ft. densities could be carried with present floor and tiedown provisions, leaving growth available here.
- **Floor height** and loading and unloading capabilities which drastically cut time of cargo handling, facilitate handling under less than optimum field conditions.
- **Systems design** and installation for maximum simplicity, ease of maintenance and service. Design is such that airplane is self-contained, reducing ground support equipment and facilities requirements.
- **Minimum structural** changes required to expand the airplane from its A model to B with attendant growth in several areas.
- **Flight characteristics** which are consistent with airplane's size, fact that it uses no flight control power boost, has simple, reliable, lightweight aerodynamic tabs.

Flight Sampling

C-133 flight characteristics, as sampled by AVIATION WEEK pilot for a short period of time, are those of a heavy airplane with good controllability, stability.

Having considerable fuselage ahead of the wing, C-133 exhibits when a sharp roll is induced to one side, then the other a lateral shaking which is definite enough to warrant either a firm stance against it or being buckled into a seat firmly.

Originally equipped with aileron boost, airplane now has vortex generators installed forward of ailerons to assure adequate roll rate, and boost has been disconnected in planes in service, is being eliminated from airplanes in production.

Aircraft, No. 13, was on re-acceptance flight by USAF after having been bailed back to Douglas for test work. Gross weight at takeoff was 182,000 lb. Plane broke ground in takeoff run after approximately 2,500 ft. at 150 kt. indicated air speed .

During climb at normal climb power, aircraft sustained a 2,000 fpm. rate until well past 10,000 ft. Climb rate at 20,000 ft. still was 1,500 fpm. These rates are approximately twice those of climb under full load conditions.

Altitude Maneuvers

Maneuvering at altitude showed a 35 deg. bank required to obtain a four minute turn. Little or no back pressure was required in turn, and control forces were normal for airplane of this size.

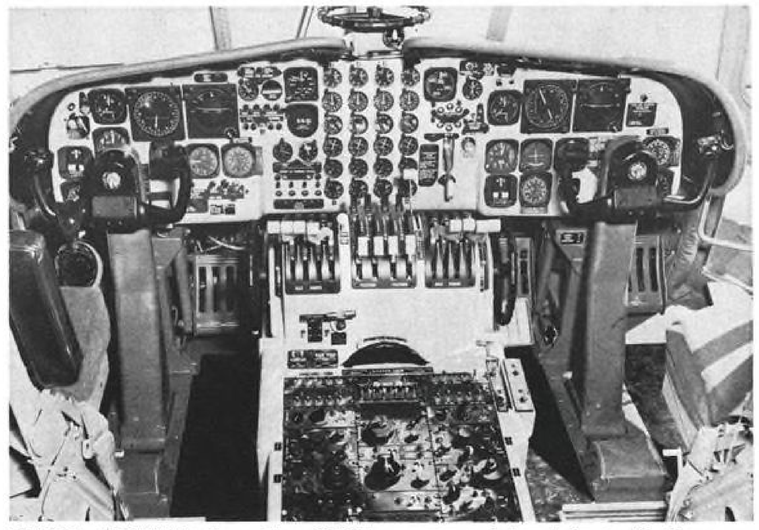
Definite changes of attitude were required to produce flight path changes. Weight and size of the airplane feedback through control system was most pronounced in pitch axis.

Aircraft registered a true air speed of 285 kt. at 80% power at 20,000 ft., with outside air temperature at −14C.

Like other aircraft of its size, C-133 requires steady and positive control movements. Overcontrol is undesirable, from a flight path standpoint and because of lateral airloads associated with the nose and tail shake noted earlier.

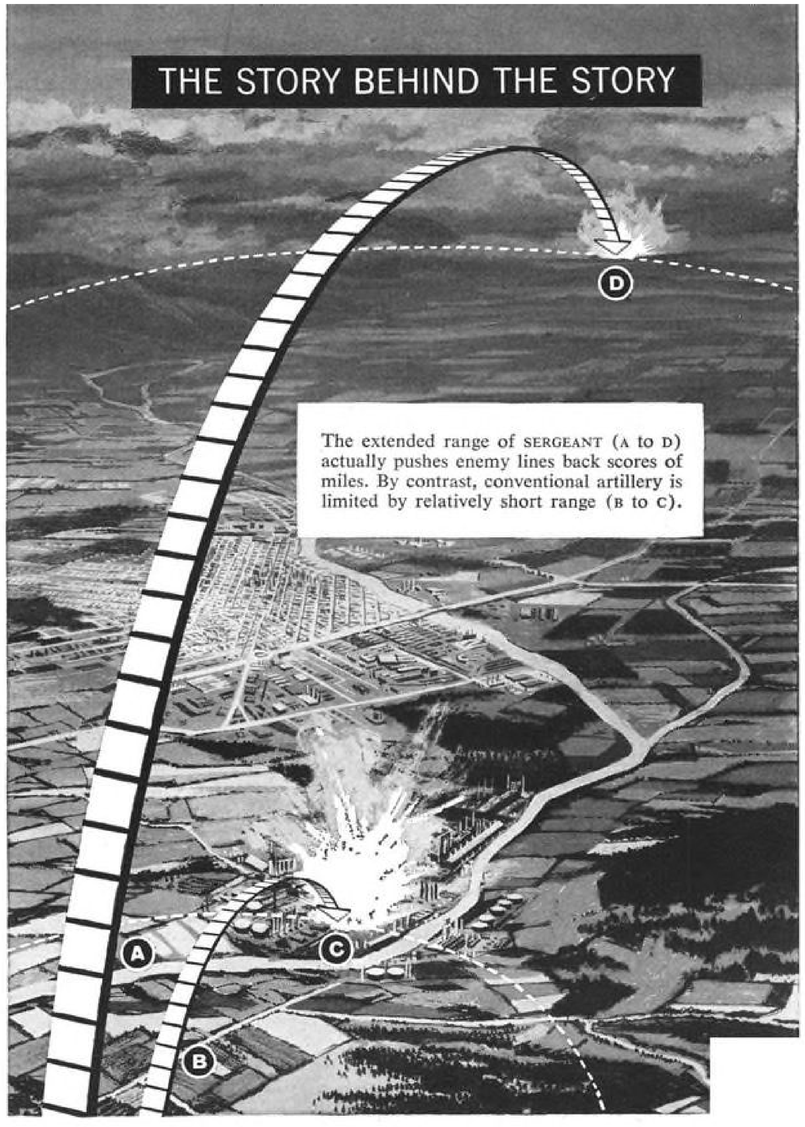
Airplane's descent characteristics are good, the clean lines producing a "fly-

CARGO, palletized for handling ease, is loaded into hold at Douglas C-133A from truck.



COCKPIT of C-133A is above. Items C-133A can carry are below, in front of loading ramp.

In recent successful test shot, SERGEANT roars into sky. A ballistic guided missile, SERGEANT is guided for precision flight to target. New guidance system cannot be detected in operation.



NEW SERGEANT MISSILE WILL GIVE U.S. ARMY GREATER STRIKING POWER

Development of the new SERGEANT ballistic guided missile is a timely reminder that our nation's security requires accurate, highly mobile tactical weapons for ground defense as well as the more spectacular intercontinental missiles so much in the news. In limited or global war, our frontline troops need the support of such a weapon to crush an aggressor's attack long before he comes within the limited range of present artillery.

The SERGEANT missile is the answer... a ready-to-go solid propellant weapon with the ability to carry a nuclear warhead, a truly important contribution to the security and retaliatory power of our ground forces. In defense, the powerful SERGEANT will furnish U. S. Army commanders with mobile firepower that will be ready in minutes to strike at any attacking force. On offense, this highly accurate weapon can join tactical air units in destroying enemy fortifications.

The SERGEANT is being developed by the Jet Propulsion Laboratory of the California Institute of Technology for the Army. In preparation for production, Sperry has been working with JPL since the beginning stages of design and development. Complete production of the weapon system will be carried out by Sperry's Surface Armament Division.

Sperry's many contributions to the U.S. missile program, ranging from complete missiles to major sub-systems such as radars, automatic inertial guidance systems, electronic countermeasures, and automatic missile checkout systems, account for its selection as system manager for the production of SERGEANT.

SPERRY SURFACE ARMAMENT DIVISION
GYROSCOPE COMPANY
Great Neck, New York
DIVISION OF SPERRY RAND CORPORATION

Boeing 707 Jet Transports in Final Assembly

Final assembly line at Boeing Airplane Co. plant is crowded with seven Boeing 707 jet transports. At top left, fourth airplane ordered by Pan American World Airways already has tail markings, is in final stage of completion. Four transports at right are under construction for American Airlines. First and second aircraft at left also are Pan American's. Total of 164 Boeing 707s have been ordered by 15 airlines.

ing down" feel in descent, rather than that of a glide or controlled fall.

Shutdown to feather of all four engines was accomplished by USAF pilot while AVIATION WEEK pilot was handling flight controls. Engines were shutdown by fuel cutoff, and yaw or roll tendencies were almost completely absent. Most noticeable flight characteristic of engine feathering cycle was a definite tendency to tuck down as engines were restarted and propellers were starting return to normal pitch. However, through all four shutdowns, airplane was easily controlled with one hand, pressures required on control column were not excessive.

Airplane decelerates slowly in flight and landing approach at light weights. Flap use is at discretion of pilot, with certain recommended settings usually followed. Aircraft at light weights comes over the fence at 100 kt. IAS and lower, while a high speed approach at high landing weights would be of the same order as that of today's DC-7 class airplanes. Aircraft has a very flat approach angle, and landing attitude is slight to moderate nose high due to configuration of the aircraft as well as its size and weight.

Taxi is accomplished in either high or low ground idle range, a function selected by pilot according to desired speed. Hydraulic nose wheel steering is accomplished by handwheel on left of pilot.

Cockpit layout is excellent, with all controls easily reached from left seat. Pilot pedestal contains fuel control levers and power levers, and communication and navigation electronics controls are on a lower level of pedestal which extends back from main section. Roll and pitch trim wheels are on pedestal, yaw trim is located above instrument panel in front of windshield. Overhead panel contains electrical, engine start, other switches.

Axial Flow Engines

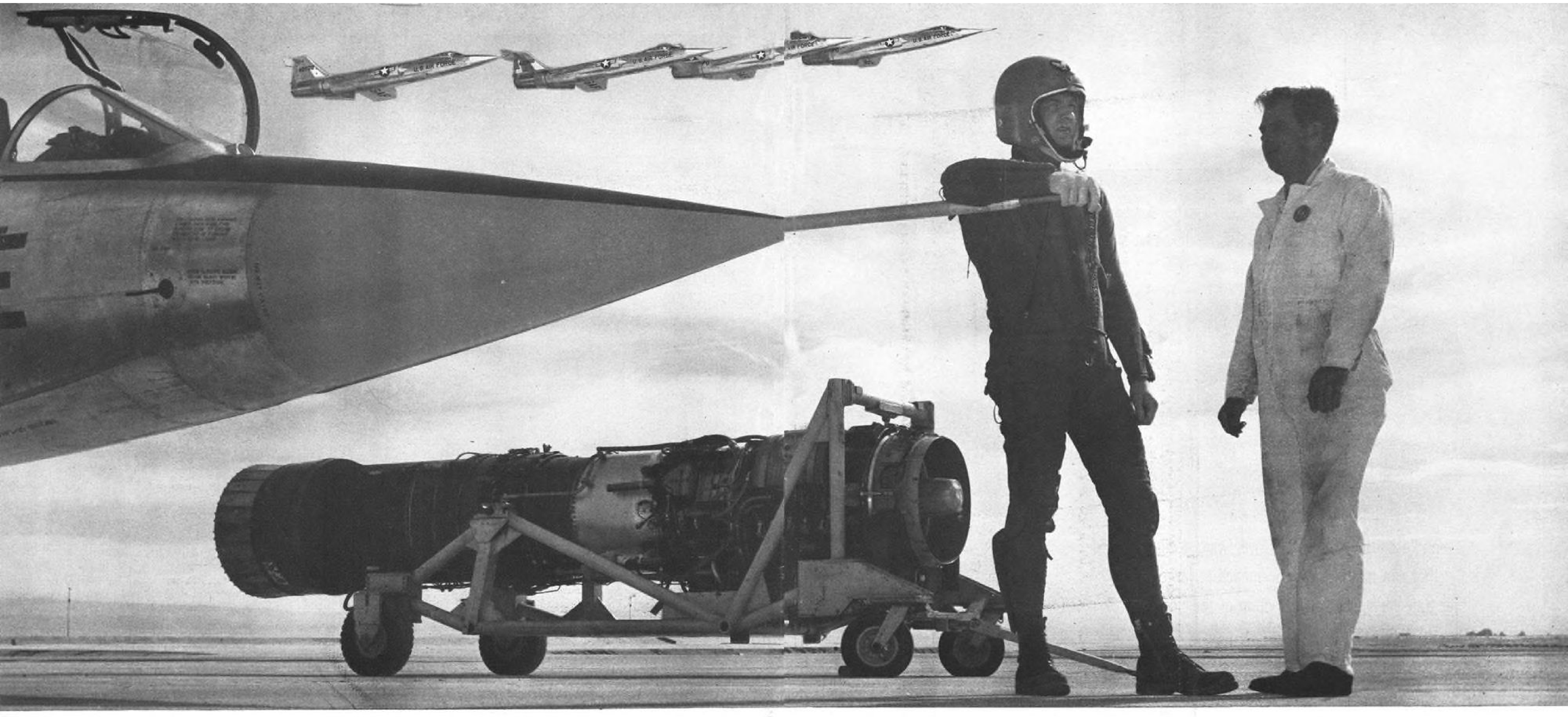
Engines are axial flow turboprops, direct drive rather than free turbine, geared down so that propeller speed stays relatively constant in flight regime, between 800 and 900 rpm. Power setting changes are absorbed through blade angle change.

Engine gages, mounted in center of instrument panel between pilot and copilot, consist of torque pressure indicators, rpm., exhaust gas temperatures, fuel flow indicators. Power is ascertained accurately by cross referencing gages, although torque pressure is a good rough index. Under these are oil temperature, pressure, other associated engine gages.

In the C-133, primary engine controls are operated from pilot and copilot stations. The systems engineer controls the auxiliary gas turbines, airplane air conditioning system, fuel management and anti-icing systems.

Since C-133 auxiliary turbines can supply bleed air for starting, airplane does not have to rely on ground start equipment. Bleed air is manifolded all directions, between auxiliary turbines and all engines and between engines. Any engine may be started first.

Procedure calls for selecting engine on bleed air manifold selector switch, and as valve opens, a light comes on from zero engine rpm. As tachometer moves to 10% rpm., fuel control valve is moved from off to normal, and as



GENERAL ELECTRIC'S LIGHTWEIGHT J79 PROVIDES . . .

Power for USAF's First Operational Mach 2 Squadrons

Following successful completion of the most comprehensive test program ever conducted on a U.S. military aircraft, the potent J79-powered Lockheed F-104A is in operational service today with USAF's Air Defense Command at Hamilton AFB, Calif., and will soon-be operational at Westover AFB, Mass.

General Electric's J79 is first U.S. Mach 2 production turbojet, makes the F-104A missile-like in speed as well as appearance.

The remarkable F-104A/J79 combination gives ADC an interceptor that is . . .

FAST...15,000 lbs/thrust powers Starfighter past Mach 2.

POWERFUL...F-104A climbs as fast as it flies level, is USAF's highest-flying interceptor.

LIGHTWEIGHT...F-104A/J79 weighs only about 20,000 lbs, J79 weighs only 3200 lbs.

VERSATILE...Starfighter does its job at high altitudes or low levels, will also serve as Tactical Air Command fighter-bomber.

EFFICIENT...clean aircraft design uses razor-thin wings; 15,000 lb-thrust-class J79 delivers more power per pound of engine than any other large U.S. production turbojet.

First of America's J79-powered "Mach 2 family," the Lockheed F-104A demonstrates that lightweight, high thrust powerplants are the key to new aircraft performance standards. *General Electric Company, Cincinnati 15, Ohio.* 235-29

Progress Is Our Most Important Product

GENERAL ELECTRIC

Navy Blue Angels Perform in F11F-1s

Two members of Navy's Blue Angel aerobatic team, flying Grumman F11F-1s, practice high over Pensacola, Fla. (AW Nov. 18, p. 71). The Wright J65-W-18-powered F11F-1 the Blue Angels use is the standard fighter with only the guns removed.

the lever moves, it activates a microswitch which turns on ignition plugs which are timed for three minutes run. Engine starter stays engaged and helps bring up engine rpm. to 48%, where starter disengages automatically.

Feathering procedure calls for moving fuel control from normal position to off position, then to feather position. A backup manual feathering switch also is provided. Position of power lever is immaterial in a feathering, except that for restart it is properly positioned in flight-idle.

Unfeathering is accomplished by moving fuel control lever from feather position to fuel-off position, which flattens blades 3 deg. and windmill occurs. At windmilling, prop decrease clutch keeps flattening blade, and at 10% rpm., ground start procedure is followed.

As a backstop, an air start position on the fuel control level will start the unfeathering cycle, but will allow engine to reach only 20% rpm. level, where engine can light off, but propeller stays in fixed pitch. Air start position must be held on fuel lever, and when released, it will return to normal run position, being spring loaded. Power lever controls engine rpm. It works on propeller blade angle and fuel scheduling by electronic connection.

Engine is provided with negative torque control since it is a direct drive system. Propeller gearing intermeshes with engine in a hookup similar to an automobile starter's Bendix spring. In a power-off condition, propeller automatically gets signal to feather itself rather than try to turn the turbine, a proposition which actually consumes some 18,000 hp. when engine is on.

A bull gear arrangement is used on front of turbine shaft which throws out whenever propeller is not incurring a positive load, sends the electronic signal to propeller to feather itself.

Like all turbine engines, T34 usable power range spans a small percentage of its rpm. However, the power levers on control pedestal have 90 deg. throw, with some 70 deg. of this devoted to the 95% rpm. to 100% rpm. range where engine output spans from 60% to full power. Full turbine power is developed at 11,000 rpm., and only 550 rpm. separates maximum power from cruise power.

Flight idle condition is at 92% rpm., while 91% rpm. is high ground idle, and 54% rpm. is low ground idle.

Power settings are achieved by establishing desired torque pressure, exhaust gas temperature, fuel flow, in combination with outside air temperature, altitude. Much of the cross referencing information is chart-derived, since pilot control activates just the two elements of engine control which are electronically interrelated. There are tolerances in readings, since sensors or gages can be inaccurate, and if two elements read correctly out of three, power is assumed to be correct, the gage wrong, since flight response coupled with two proper readings indicate proper functioning of airplane, malfunction in gage or sensor.

The 18-ft. dia. propellers are Curtiss electric, with full feathering. They function essentially in fixed pitch during ground operations, with fuel flow controlled by the high or low ground idle selection, thus slowing down propeller to 54% engine rpm. which is ground idle level.

Outstanding economic characteris-

tics of the aircraft, basis on which it achieves role of a true logistics aircraft are:

• **Direct per ton-mile** operating cost of five cents, based on C-133A type aircraft, with a further reduction from piston engine plane costs occurring when C-133B becomes operational.

• **Loading and unloading** cost yearly saving, at projected 1961 MATS cargo level, of $1,147,000, realized through a per ton cost cut from $2.80 for piston airplanes to 36 cents for C-133 type. Piston-turbine comparisons in this have total tons/aircraft, 15 and 34; load-unload times, 3 hr. and 1 hr.; crew required, 7 and 6; man hours consumed, 21 and 6.

• **Reduction** from a total fleet of 187 airplanes—143 C-124s and 43 C-133s—to approximately 80 C-133 types, both A and B models, to handle anticipated 1961 MATS requirements.

• **Operations cost cut** of $76 million yearly in 1961 for mixed fleet, to about $36 million for all-turbine fleet.

• **Fewer personnel** for flight crews and maintenance. Mixed fleet flight crews presently number 2,678 persons, could be reduced to 1,176, saving $10 million annually in salaries. Direct maintenance personnel could be cut by 1,900 to support modernized all-turbine engine fleet, saving another $8.5 million in salaries. Indirect savings also would accrue from lower training cost for air and ground crews, less support facilities required.

Economic Effects

Changeover from C-133A to C-133B aircraft would have these economic effects:

• Increase in speed—5%.

• Increase in payload at 2,500 naut. mi. range—19%.

• Increase in ton-mile productivity—25%.

• Decrease in ton-mile costs—26%.

An important economic area in which airlift already has proved itself is in transport cost of such expensive items as jet engines. Substantial procurement funds have been saved by using air transportation to reduce time a piece of equipment is out of commission for overhaul or service, requiring fewer total articles to keep operations going during the servicing cycle.

However, all this up to now has been considered premium cargo. Little or no consideration has been given to straight air haulage of lesser items necessary to sustain military operations. Commercial ventures also have given no consideration to making airlift of all merchandise an integral part of distribution system.

Cubic capacity of C-133, coupled with low direct operating costs, has made a tremendous number of items now economically transportable by air at costs lower than surface transportation, thus removing from airlift the "premium" label which has long held down its growth potential.

An example if this is the current operation of transporting Atlas intercontinental ballistic missiles from Convair's San Diego plant to Cape Canaveral, Fla. Surface contract haulage cost is $14,000 per missile (includes transporter round trip), plus cost of Air Police detailed to convoy for security. Travel time is nine days.

C-133 can haul Atlas from San Diego to Cape Canaveral in seven hours, for a round trip price of $9,200.

Savings would be much greater, in movement of IRBMs, and further economics would be realized in maintenance cycle by reduced missile "down time" while parts were in overhaul pipeline.

Additionally, since most IRBM deployment will be at relatively great distances from factory and continental U. S., need for speed is essential in support as well as delivery. Speed also is vital in redeployment, should this become necessary due to tactical considerations.

A Thor complex is completely transportable by air, including all support equipment such as liquid oxygen generating equipment, guidance vans, electrical power supply vans. Missile and its

erector-transporter, firing pad, also are easily air carried. Should storable propellants become operational, logistics requirement would be lowered both in quantity and ease of handling.

As of now, two C-133s are required to haul an operational Atlas weapon system, with perhaps one required for a Thor, or two Thors per three C-133s, disregarding in both cases the equipment which already may be on site. If entire site must be airlifted for an IRBM, some seven C-133s might be required. Two Douglas C-124s are required to haul a Snark system, where one C-133 could do it.

Commercial Possibilities

While the C-133 is strictly a military venture, and most likely will remain so, its capabilities are such that commercial use of it as a true, across-the-board freight hauler cannot be ignored.

Airplane's capabilities enable air freight lines salesmen to be able to talk to potential customers in terms of using existing planes for airlift as a vital part of their sales-distribution system all the time, rather than as an emergency measure or for perishable goods.

Changes in business thinking required to accept this premise will not come easily or in a short time. However, starting from this airplane base, missionary work to get the concept accepted to a degree can be undertaken so that if and when C-133s should become commercially available, or a better logistics airplane comes along, much of the spadework will be behind, and commercial supply by air can become a reality much sooner.

Currently, 36 C-133 type airplanes are ordered and funded. Planning calls for expansion of the Military Air Transport Service cargo fleet to about 109 airplanes total, through Fiscal 1959-61 funding. However, supplemental appropriation would fund procurement to the 109 airplane level, with production rate moving first to 1½, then 2, then 4 airplanes per month within a very short period, from today's one-a-month rate.

Above the MATS requirement, additional C-133s might be purchased for Strategic Air Command's strategic airlift (of special SAC equipment, spares and gear to support the mobility feature) which currently is accomplished with C-124 airplanes.

Another possible procurement area is airplanes for Air Materiel Command's "Operation Safety First," the transport of ballistic missiles in development, Thor, Atlas, later Titan and others, from factory to test firing sites.

Also included is shipment of nose cones, nuclear warheads and associated highly sensitive equipment, which can be more easily guarded, handled in air transportation, in addition to faster movement.

Still further procurement might occur in the area of long range troop transports to meet Tactical Air Command commitment to Army. In this area, C-133 enjoys an advantage in that its usefulness can be extended should an airplane of the now-canceled C-132 class become available. The C-133 can be used to haul very high payloads over short distances, reducing its mission to that of an intra-theater support plane.

Changing the C-133A to the B model will occur at airplane No. 35. Changeover will, in addition to improving the performance and cabilities, be accomplished with a minimum of problems in production, tooling.

Primary changes include use of Pratt & Whitney PT2G-6 engine, which has an increase in wet takeoff power to 7,500 eshp. from the 7,100 eshp. available with presently used P&W T-34-P-7W engine, and structural modifications to accommodate the increased power and associated increased takeoff gross weight. Hydraulic boost has been added to the rudder, flight crew station will be changed for greater comfort on long missions, rear loading upper doors will be changed to clamshell type for easier loading of large missiles.

More powerful engines require strengthening of nacelles and wing area surrounding nacelle, as well as heavier gage skin where propeller airloads impinge on fuselage. Ribs are added in outboard section of wing since maximum takeoff gross weight goes to 286,000 lb. from present 275,000 lb.

Vertical tail surface gets reinforcement to accommodate hydraulic rudder boost and associated increased air and static loads. Crew compartment changes are mostly relocation of stairway into cargo compartment and bunks, lounge areas.

Hydraulic system changes include use of two pumps driven by main engines to power rudder boost, and handle greater braking power which goes with increased gross weights. Main landing gear retract cylinder has been strengthened to raise speeds at which gear can be extended and retracted. Hydraulic system power formerly was supplied by auxiliary gas turbine units in wheel pods.

Airplane picks up empty weight due to structural and other changes, and suffers slightly in its maximum cargo-minimum fuel rating, compared with the C-133A. However, this is more than offset by increased cargo capacity at long ranges as a function of increased takeoff gross weight.

Fuel capacity will be 18,112 gal., carried in four wing tanks.

Some comparisons in performance between C-133A and C-133B are:

- **High speed** with military rated power is 302 kt. for the A; 312 kt. for B.
- **Service ceiling** with rated power, 19,500 ft. and 20,800 ft.
- **Cargo carried** and average speed at 3,500 naut. mi. range, optimum altitudes, are 42,000 lb. and 269 kt. for the A, 52,600 lb. and 279 kt. for B.

C-133 type airplane has taught Douglas some lessons concerning large logistics airplanes; one which would be incorporated is use of bow loading doors and a change in tail configuration to beat the drag penalty which has been picked up in C-133 design.

Cargo Handling

While the airplane capabilities are high, taking fullest advantage of them requires specialized ground equipment for standard cargo loading and unloading, equipment tailored to airplane and ground environment. Part of such a system already is in use at Dover, Del., MATS base, in form of a long pier with rollers, at airplane floor and truck bed height.

Douglas Aircraft Co. currently is negotiating for contract to design and build a prototype loading system for USAF, of which the Dover installation is a forerunner.

Configuration and characteristics of this system, according to Douglas, are a capability to load and unload 100,000 lb. of cargo within the turnaround time of the airplane.

Pier and Pallets

Parts of the system will be a roller pier, plus special pallets. Pallets would be tailored to airplane interior, where guide rails would be used. Loaded to proper dimensions and weights, pallets would run on the rollers from terminal, across pier and into airplane, where plane's own rollers would pass it along to its proper location. A set of locking pins which would engage the pallets in the airplane, would be incorporated in the guide rails.

Thus, loading and unloading would consist of winching out the airplane's palletized load into the terminal, then using airplane's winch to draw on already palletized new cargo load.

Present C-133 has 3G capacity cargo hold-down nets in addition to tiedowns. Nets hold against acceleration in yaw, pitch and roll axis.

Navy Sled Breaks Record On China Lake Mono-rail

Navy broke unmanned rocket-sled record with speed run of 2,827.5 mph. Vehicle was two-stage sled on mono-rail track at Naval Ordnance Test Station, China Lake, Calif. Previous high speed, 2,704 mph., was recorded at USAF Missile Development Center, Alamogordo, N. M., in March.

HEADING FOR MACH X

There's no such word as "normal" at Auto-Lite.

No matter what the job, every Auto-Lite engineer has his eye on the future. The engineer shown here is examining a new insulation as it is being applied to a wire by an extruding machine in the Auto-Lite Wire Laboratory at Port Huron, Michigan. This new wire insulation will bring Auto-Lite a step closer to meeting extremely high Mach number requirements that demand superthermantic equilibrium temperatures.

Hundreds of different wire insulation materials are being tested here by the finest trained personnel using the most modern research techniques and equipment. Out of these tests comes a wealth of knowledge important to all customers served by Auto-Lite.

No matter what you need—whether it be high temperature aircraft wire or cable, magnet wire or wire for electronic and electrical applications—why not tell us your insulation problem and let us help you.

AUTO-LITE®

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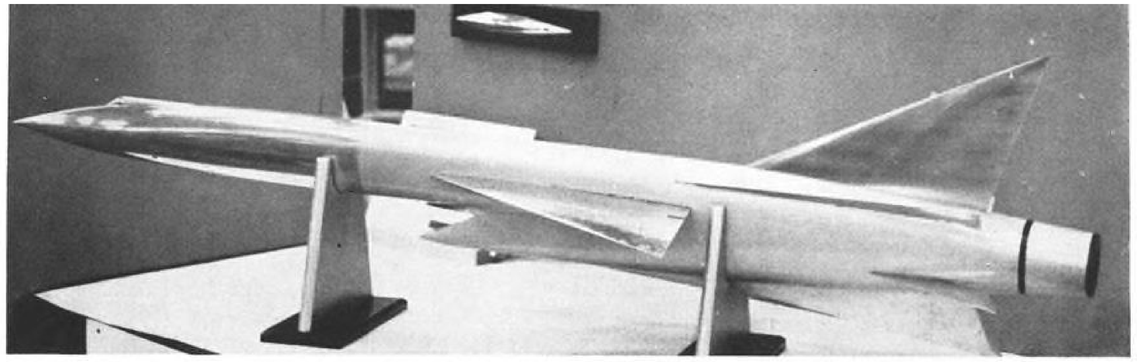
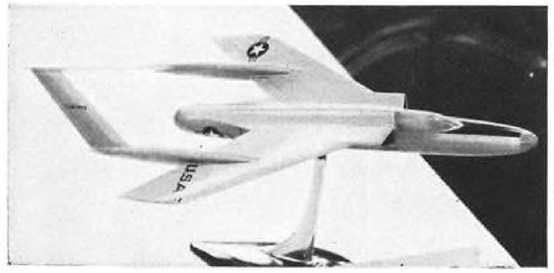
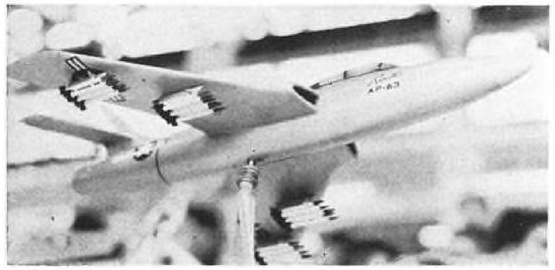
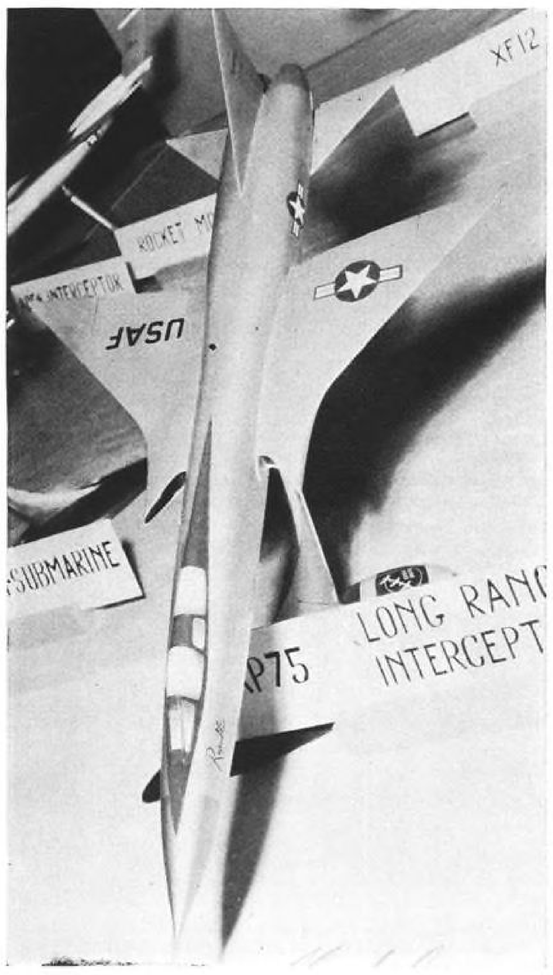


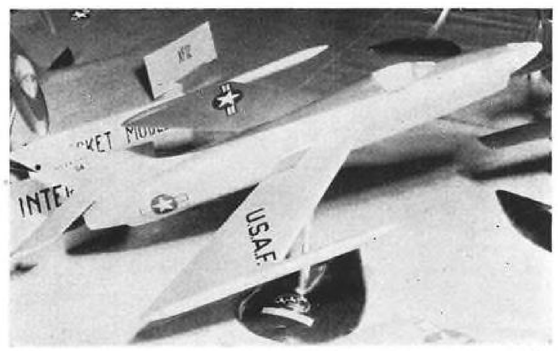
REPUBLIC XF-103 wind tunnel model shows basic delta-wing layout, turbo-ramjet underbelly intake and large tail for high-speed stability.



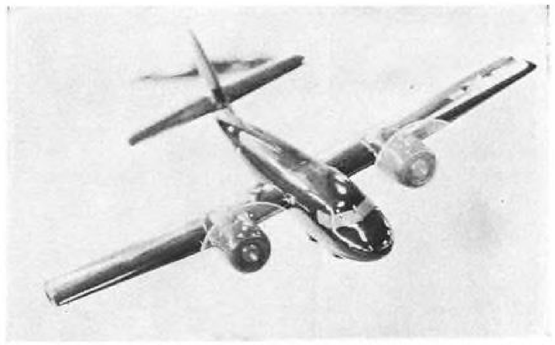


DESIGN STUDIES at Republic Aviation's recent "open house" included AP-55 interceptor (above left) featuring inverted V-tail and AP-63 fighter-bomber (above right) with rocket clusters mounted under wings.

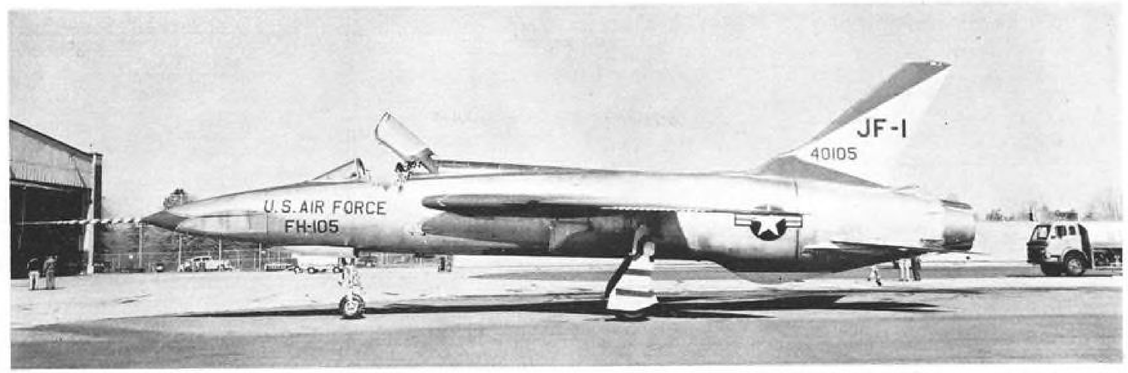




AP-63 all-weather interceptor design (above) features wings wider at tips than at roots carrying long, slender pods. Only Navy design exhibited was NP-52 twin-engine anti-submarine type (below).



AP-75 long-range interceptor design study (left) encompassed area-ruled fuselage, thin delta wings, forward-swept inlets (like F-105B) for side-by-side mounted turbojets. AP-75 was planned as two-seater.

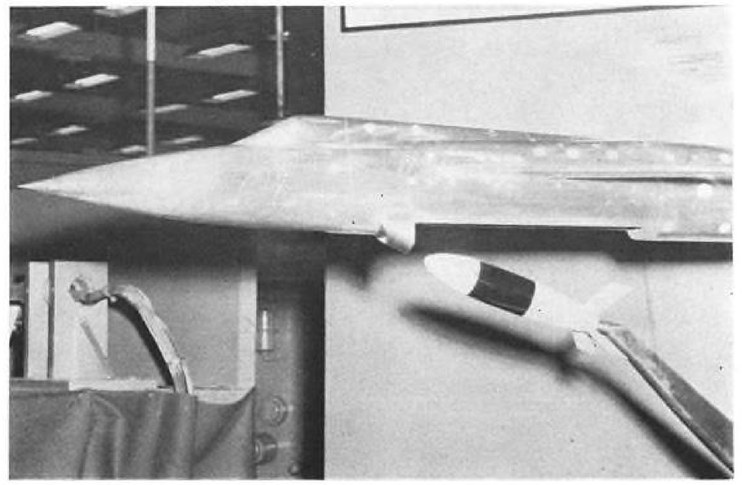


JF-105B THUNDERCHIEF, a converted RF-105B (note flat camera panels near nose), is used by Republic for F-105 test and development.

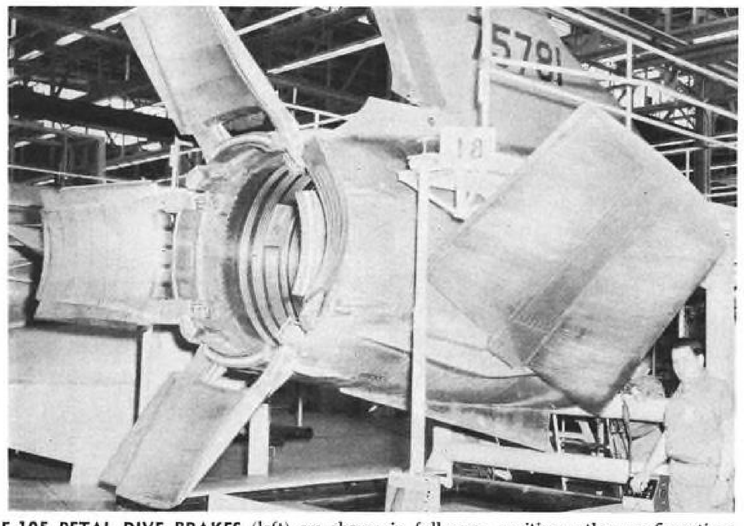
Public Views F-105s, Republic's Facilities

Some 135,000 persons thronged Republic Aviation Corp.'s Farmingdale, N. Y., plant during recent two-day "open house" which provided public with thorough view of company's research and production facilities.

More than 150 exhibits covered all phases of F-105B production, SD-3 drone and missile products and numerous design projects. A high point was dedication of Republic's $1.2 million Mach 4 wind tunnel. It was company's first open house since 1952.



F-105 WEAPON EJECTION studies utilize wind tunnel models to develop means of safely releasing nuclear and conventional stores at high speeds. Fairing, ahead of bomb bay, is designed to divert airflow and permit weapon to separate cleanly from airplane.



F-105 PETAL DIVE BRAKES (left) are shown in full open position; other configurations include top and bottom panels closed, side panels open and top panel closed, other three open. One-piece stabilator has wide range of travel, is shown in full-up position.

REFUELING PROBE on port side of Thunderchief's nose is shown fully extended. Fairing, door enclose probe when retracted.

SOVIETS plan to install light turbojet in Discoplane glider, shown in flight.

Reds Use Discoplane For VTOL Research

Moscow—Russia has authorized further research on its circular-wing Discoplane glider in an effort to develop better designs for VTOL and STOL aircraft.

New plans call for installing a light jet engine in an improved Discoplane to permit takeoff and climb to an altitude of 6,560-9,840 ft.

Built by M. V. Sukhanov, the present version of the Discoplane glider has a circular wing only 11.5 ft. in diameter. The single-seat craft is controlled by conventional ailerons and rudder, plus a specially-designed stabilizer and "side flaps" which are deflected downward to prevent pendulum-like swinging when the glider is towed.

Sukhanov says the Discoplane has proved extremely maneuverable and stable at all flight regimes and is "practically spin-proof." The Russians say they began research on circular-wing aircraft in 1910.

Induction Brazing Joins J57 Manifold

Induction heating equipment is used to braze stainless steel to copper in fabricating fuel manifolds for the Pratt & Whitney J57 engine. Automatic 90 min. process is said to give results superior to the 33 hr. hydrogen retort brazing method it is replacing. More precise control of temperature and time in the brazing process produce results described by the company as metallurgically superior.

Heat required to melt the copper and join the stainless steel sections is provided by four water-cooled induction coils.

With the unit it is possible to heat only one section of the manifold to make repairs, rather than heat the entire assembly as was necessary with the hydrogen retort furnace.

Process has been under development at Pratt & Whitney for more than two years.

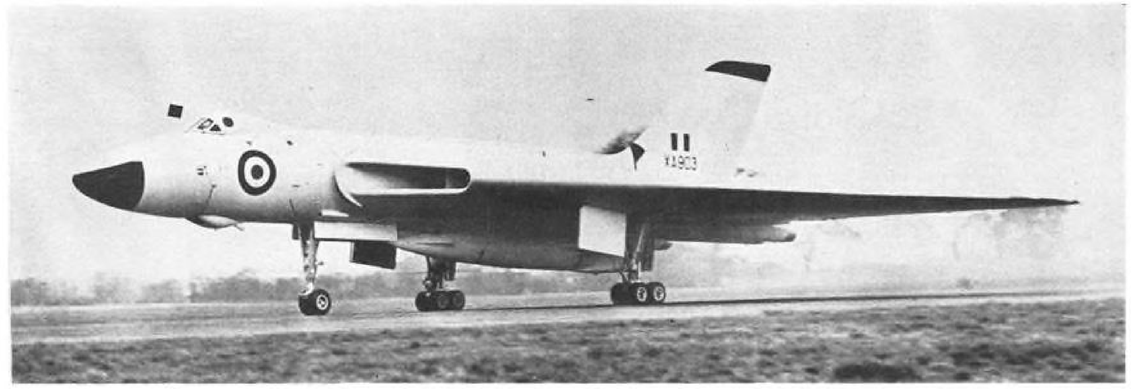
Original purpose of the project was to develop a faster brazing method with results equal to the hydrogen retort method.

Presently operating at the company's East Hartford, Conn., plant is the first of nine planned induction brazing units. Single unit cannot handle entire production for the J57 program although it is used on some J75 fuel manifolds. Feeling at Pratt & Whitney is that the potential induction brazing in engine manufacturing is only beginning to be realized.

Aluminum Container Handles Airfreight

Collaboration between American Airlines and Grumman Aircraft Engineering Corp. resulted in development of an aluminum container for handling airfreight. Known as the Paul Bunyan Box, it has a full-length hinged door which can be locked and is weatherproof. Box, measuring 84 in. long, 42 in. deep and 62 in. high, is mounted on eight caster wheels for ease of handling.

American says box will provide substantial savings to shippers by minimizing cargo handling.



Vulcan Carries Guided Bomb

Avro Vulcan bomber now carries external guided and powered bomb which also will be hauled by Victor bomber. Bomb is about 35 ft. long and apparently has delta nose plane and aft delta wing. Weapon will be rocket-powered, reportedly by de Havilland Spectre engine of 8,000 lb. thrust. Small V-shaped object at rear of bombardier's window probably is periscope to view bomb release.

USAF Contracts

Washington—Following is a list of unclassified contracts for $25,000 and over as released by Air Force Contracting Offices:

HEADQUARTERS, OGDEN AMA, USAF, Hill AFB, Utah.

Northrop Division, Northrop Aircraft, Inc., Hawthorne, Calif., design and development of modification kits applicable to F89 aircraft, (D. O. on contract AF 42(600)-18569), $106,167; spare parts for F89 series aircraft, (D. O. on contract AF 42(600)-19569), $42,257.

The Goodyear Tire and Rubber Co., Akron, Ohio, spare parts for C47, F94, F80, C54 and B26 aircraft, (D. O. on contract AF 42(600)-18607), $32,189.

ERCO Division, Nuclear Products, ACF Industries, Inc., Riverdale, Md., modification of NB-23 (F-860) flight simulators, including engineering, technical data and spares, (P. R. 00-8-6930-940, -1 and -2), $741,901.

McDonnell Aircraft Corp., St. Louis, Mo., kits for F-101 aircraft, 119 ea., (D. O. contract AF 42(600)-18610), $246,050; kits for F-101 aircraft, (D. O. on contract AF 42-(600)-18160), $141,450; design and development of modification kits applicable to F-101 aircraft, (D. O. contract AL 42(600)-18553).

All American Engineering Co., Wilmington, Del., spares to support ejection seat trainer, type NH-15, (P. R. 00-8-6910-909), $33,317.

Government Electronics Division, Emerson Radio and Phonograph Corp., Jersey City, N. J., generator, C scope assembly, mirror and shaft assembly, spare parts for AN-APG-T1A radar trainers, (IFB 42-600-58-157), $60,710.

McDonnell Aircraft Corp., St. Louis, Mo., pitch control system trainer panel to modify F-101A-1 and FR-101A-2 MTU, (D. O. on contract AF 42(600)-18610), $75,028.

Goodyear Tire and Rubber Co., Akron, Ohio, lining applicable to C-131, T-28 aircraft, 14,712 each; piston assembly applicable to F-84F aircraft, 2,291 each; piston applicable to B-57 aircraft, 635 each; (D.O. on contract AF-42(600)-18607), $62,900.

Northrop Division, Northrop Aircraft, Inc., Hawthorne, Calif., technical data for F-89 aircraft; (DO on contract AF-42(600)-18562), $176,078; design and development of modification kits for F-89 aircraft, 28 each; (DO on contract AF-42(600)-18569), $90,201.

Bendix Products Division, Bendix Aviation Corp., South Bend, Ind., piston applicable to F-86A, D, E, F, K and L aircraft, 2,000 each; pistons applicable to C-119 and B-26 aircraft, 1,000 each; adjuster applicable to B-50 and KC-97 aircraft, 6,000 each; (D.O. on contract AF-42(600)-18603), $99,994.

Goodyear Tire and Rubber Co., Akron, Ohio, disc, brake for L-20A aircraft, 1,126 each; (D.O. on contract AF-42(600)-13607), $34,568.

PURCHASING AND CONTRACTING DIVISION, White Sands Proving Ground, Las Cruces, N. Mex.

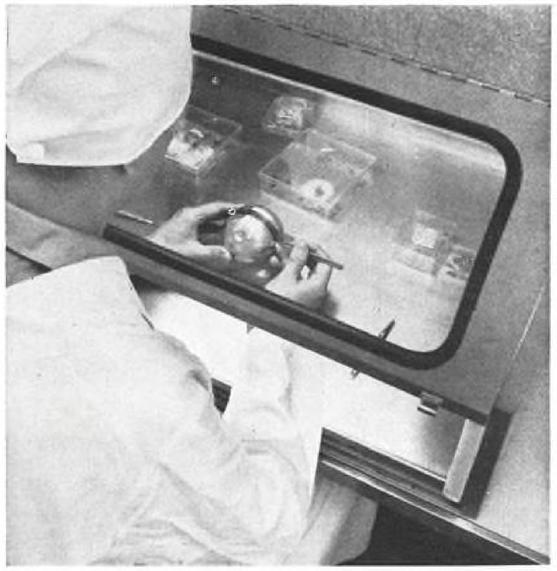
Parabam, Inc., El Segundo, Calif., 10 ft. astrodomes, contract no. DA29-040-ORD-1368 00A(M)4341-58 and 4238-58, six ea., $69,900.

Houston Fearless Corp., Los Angeles, 10 ft. astrodomes, contract no. DA29-040-ORD-1367 00A(M)4238 and 1135-58, eight ea., $54,400.

James P. Lockhart, El Paso, Tex., Dart operations building, small missile range, White Sands Proving Ground, DA-29-040-ORD-1363, $48,448.

HEADQUARTERS, San Antonio AMA, USAF, Kelly AFB, Texas.

Scintilla Division, Bendix Aviation Corp., Sidney, N. Y.; 4704-10-85800-2, ignition unit, 300 each; 4704-10-94919-1, lead assembly, 185 each; 4704-10-94920-1, lead assembly, 185 each; items are applicable to 76250 engine in support of GTP-70-9-1 power unit; (RFP-PR-SA-8-02H-1730), $40,943.



SUPER-CLEAN, pressurized hoods (left) are used for assembly of critical gyro parts. Digital computer (right) calculates ICBM velocity.

Titan Guidance Reliable, Accurate

By Philip J. Klass

Garden City, N. Y.—Reliability and accuracy demonstrated by inertial guidance system components developed for Titan intercontinental ballistic missile in supersonic rocket sled tests to date have prompted USAF to study its possible use in some Atlas ICBMs.

This was revealed by Maj. Gen. Bernard A. Schriever, commander of Air Force Ballistic Missile Division, Air Research and Development Command, during his recent visit to Arma Division of American Bosch Arma Corp. which developed Titan's inertial guidance system.

Although Arma's system has not yet flown a ballistic missile, it has not suffered a single component failure during repeated rides on a Naval Ordnance Test Station supersonic sled, according to E. A. Goetz, Arma's chief engineer. Only defective component, a transistor, was discovered during prelaunch tests and replaced, Goetz said.

This is a remarkable record for a system consisting of an estimated 40,000 individual components and parts. Its digital computer alone uses approximately 1,000 transistors, 12,000 diodes and has nearly 60,000 soldered joints, each a potential source of failure.

Accuracy of the Titan inertial guidance will exceed Arma's minimum contractual requirement and is expected to meet the optimistic target objective, based on rocket sled test results to date.

Weight of present system reportedly is under 500 lb. This makes it about one-third lighter than the inertial system used in the Thor intermediate range ballistic missile (AW Dec. 30, p. 38), despite more stringent accuracy required for an ICBM with its greater range. (Crash nature of the Thor program dictated the use of proven components and techniques with conservative safety margins, which at least partially explains its heavier weight. AC Spark Plug, Thor guidance contractor, reportedly has a lighter weight system under design.)

New digital computer and gyro stabilized platform which Arma has designed should slash present Titan system weight by close to 50%.

Technical Details

Heart of the Titan inertial system is a three-gimbal stabilized platform whose innermost gimbal carries two gyros and three accelerometers.

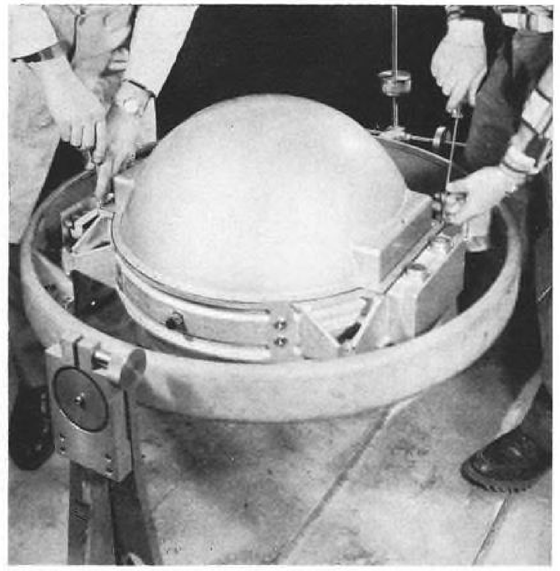
Both gyros are two-degree-of-freedom units, in contrast to the three single-axis integrating gyros employed in the Thor guidance system. Goetz concedes that each configuration has its advantages and disadvantages.

Like the integrating gyro, Arma's unit employs liquid flotation of the gyro element. Liquid density, however, is more closely controlled so that gyro element weight is fully supported by liquid buoyancy. This enables Arma to eliminate conventional gyro gimbal bearings and to suspend gyro element from thin wires.

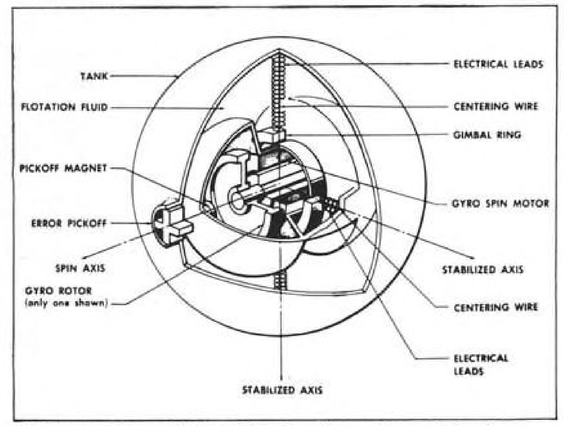
When the gyro's outer case is rotated (corresponding to a change in missile attitude), these suspension wires twist slightly to permit the gyro mass to hold fixed position in space. This displacement generates a signal in gyro pick-off which is applied to the motor of the corresponding stable platform gimbal, driving it (and gyro case) in a direction and through an equivalent angle to return the gyro case to its original position, untwisting the suspension wires.

Advantage of this type gyro element suspension is that it substitutes a known spring constant for an unknown, unpredictable friction of conventional gyro bearings, according to Arma's Dr. Bernard Litman.

ACCELEROMETER is relatively simple, low-cost device; may employ vibrating reed.



GYRO platform carrying three accelerometers forms heart of Titan.



GIMBAL bearings eliminated in Arma's two-degree-of-freedom gyro by using liquid buoyancy to support gyro element, together with thin springs which keep gyro element centered in sphere. Substitutes known torsion forces for unpredictable bearing torques but requires close coincidence between gyro's centers of gravity and buoyancy.

Company releases no figures on the accuracy of present Titan gyros. Three years ago, however, before Arma received a Titan guidance contract, it publicly quoted drift rates of 0.1 deg./hr. for wire-suspended gyros. It is not unreasonable to assume that the company has achieved a significant improvement since that time.

Relatively short time of guided flight of a ballistic missile considerably eases the required gyro accuracies, compared to inertial systems for aircraft and winged missiles with multi-hour flight times.

However, the inability to use stellar Doppler radar references in a ballistic missile, as can be done in an aircraft or winged missile to periodically correct for instrumentation errors in the accelerometers, greatly increases the accuracy requirements for ballistic missile acceleration sensors.

One of the most significant technological advances in the Arma guidance system is the "radically different" approach used to measure acceleration, according to Goetz. He declined to go into design details except to say that it is more accurate, less complex and much less costly to manufacture than the pendulous gyro type of accelerometer used in many other inertial systems. Another important advantage is that accelerometer's output can be used directly by the digital computer without analog-to-digital conversion.

Arma Unit

This suggests that the Arma unit may be using a vibrating reed type device whose resonant frequency changes directly with the applied acceleration. This is one of several possible approaches to accelerometer design described by Arma's Dr. Litman several years ago in a talk delivered before an Institute of Radio Engineers group in New York. At that time Litman pointed out that with a vibrating reed accelerometer it is only necessary to count the total number of cycles lost or gained over a fixed time interval in order to obtain the integral of acceleration. Digital computer would be suitable for making such a count.

Titan guidance system employs a completely transistorized digital computer for calculating missile position, velocity and trajectory, unlike the Thor system which uses analog computer. Arma's computer is designed more for reliability than for speed, although it is hardly a laggard since it must compute in real time. Machine can perform more than 6,000 additions of two 18-digit numbers per second.

Change of Titan target can be speedily accomplished by substituting a new

TITAN gyro, two-degree-of-freedom device, is fully-floated, uses wire suspension.

PRINTED circuit boards are handled with gloves, placed in plastic bags to keep clean.

WEIGHT-SAVING magnesium frame for Titan computer, built from extrusions.

trajectory program tray in the digital computer. Circuit redundancy is employed for critical computer functions to provide maximum reliability, according to James Maguire of Arma's Titan computer group. Those portions of the computer whose output plays a major role in determining a solution to the guidance problem are provided in duplicate, while those which merely provide solution refinements are not.

Current production model of the computer occupies a volume of about 8 cu. ft., but new miniaturized construction technique for plug-in circuitry is expected to cut this figure to less than 3 cu. ft. Arma recently received an achievement award from Miniature Precision Bearings, Inc., in its annual Miniaturization Award Competition, for the new computer plug-in package design which is about one-fourth the volume of the equivalent circuit in the earlier model.

Arma currently is beginning to investigate printed, deposited component techniques which may permit a further 10-fold size reduction. This would slash volume of the Titan computer to roughly 0.3 cu. ft. and weight to less than 20 lb.

Despite high temperatures encountered at ICBM speeds, Arma presently is using germanium transistors without in-flight cooling, relying upon thermal inertia to keep transistors and other components at safe temperatures for the duration of the guided portion of flight. In new models, however, Arma plans to switch to silicon transistors, according to Maguire.

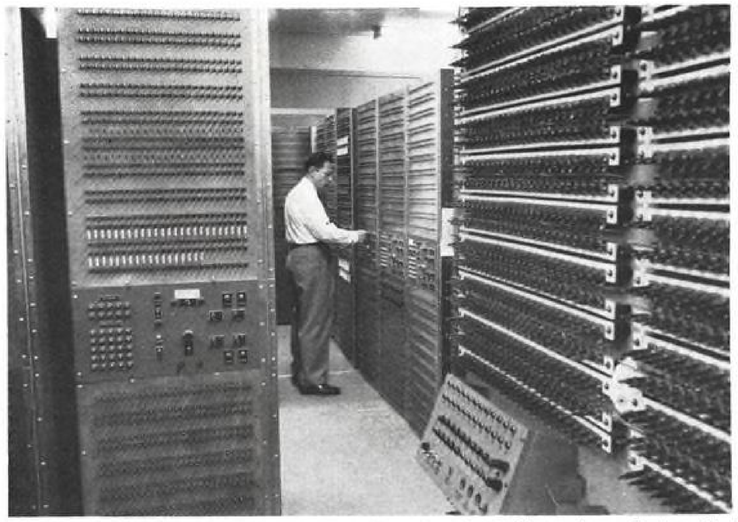
Reliability Effort

Impressive reliability record to date of Arma's inertial guidance results from a vast effort which permeates throughout engineering and manufacturing groups involved on the Titan program.

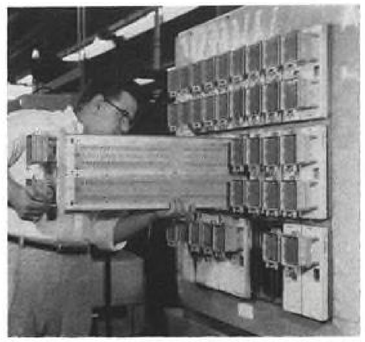
Engineering qualification and life testing to select reliable components and vendors is fairly commonplace in the avionics industry today, but Arma goes beyond normal accepted procedures. For example, in order to select a single type transistor vendor, Arma will buy 500 units from each of perhaps six manufacturers.

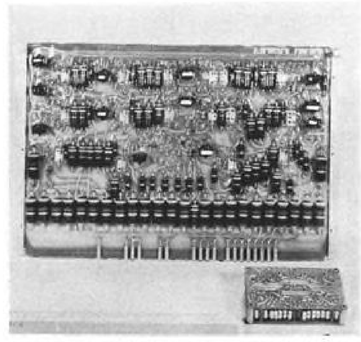
Of this number, 400 from each source will be simultaneously placed on life test. Remaining 100 units from each vendor will be subjected to what Arma calls strength tests where the severity of the environment is increased intentionally beyond the device's specified operating conditions in order to determine which units will be first to fail and the mode in which failure occurs.

When Arma has selected one of the six vendors, based on life test results, its engineers also know the component's most vulnerable mode of failure and can take this into account in circuit

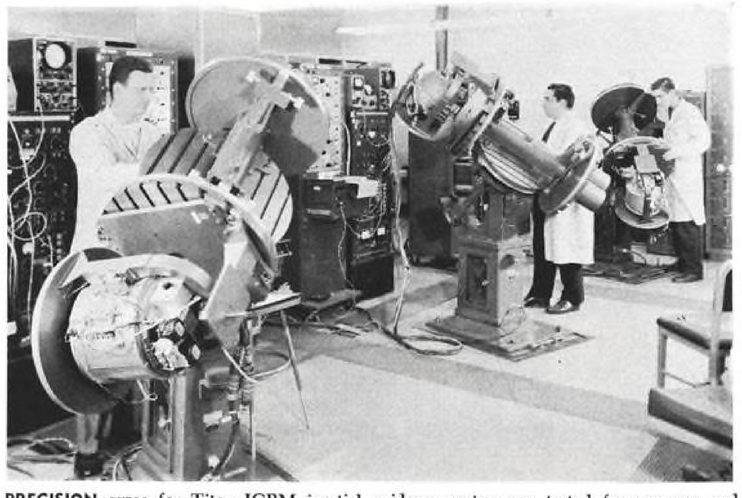


HUNDREDS of different components are subjected to both life testing and stress (test to failure) evaluation in its laboratories before Arma selects vendor.





EVERY component of the 40,000 used in Titan guidance system must pass severe environmental tests (left). Weight reduction of Titan guidance computers will result from sandwich construction (lower right) which is one-quarter size of equivalent unit.



PRECISION gyros for Titan ICBM inertial guidance system are tested for accuracy and drift rate at American Bosch Arma Corp. on these sidereal mounts.

design. For example, if a transistor is most likely to fail as result of loss of gain, feedback will be employed in the circuit to minimize the effect of such loss on over-all circuit performance.

Every circuit in Titan's digital computer is subjected to an extensive marginal-performance analysis to be sure it will perform satisfactorily despite significant changes in the value of one or more of its components.

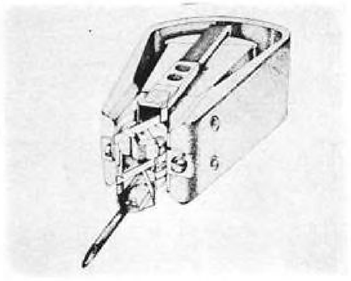
By test and analysis Arma engineers measure the effect on circuit performance of a change of 20% in supply voltage, a 20% change in value of each capacitor, a 15% change in value of each resistor and a 60% loss of current gain (beta) in each transistor. As many as 600 marginal performance plots may be prepared for a single circuit, according to Maguire.

Arma engineers then seek to modify circuit design so as to equalize, as much as possible, the effect of such variations in value for every component in the circuit.

That is, they seek a circuit design in which a 20% variation in the value of any capacitor will cause the same change in over-all circuit performance as a 1% change in the value of any resistor or a 20% change in the value of any supply voltage.

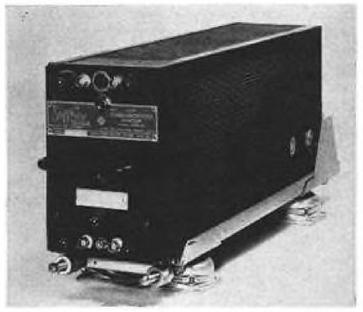
Production Testing

In addition to 100% inspection of every incoming vendor part and component intended for use in production systems, Arma subjects every component to what it calls "processing tests." These consist of as many as several hundred hours of operation while being exposed to air environment which equals or exceeds in rigor the environmental conditions in which the com-



Gravity-Compensated Frictionless Bearing

Gravity-compensated flexure pivot bearing system, for use in high performance aircraft instruments, reportedly provides frictionless bearing that permits infinite resolution without axial or radial play. Pivot members are arranged in pairs to counteract reaction to external accelerations. It was developed by Marion Electrical Instrument Co., Manchester, N. H. under Wright Air Development Center sponsorship.



22 Lb. VHF Unit

New VHF transmitter-receiver, Sapphire Model 1016A, has transistorized power supply which reduces weight by four pounds and length by 3½ inches compared to previous Model 1016. Transistorized power supply reduces starting and running power required by previous dynamotor, also is expected to improve reliability. Another improvement offers operator choice of two transmitter power levels: 7 watts or 10-12 watts. Set provides 90 to 360 transmitter channels, 90 to 560 receiver channels. Manufacturer: National Aeronautical Corp. (Narco), Ft. Washington, Pa.

ponent must operate in the Titan.

Only those components which get by this double hurdle are used in production. If any type component subsequently experiences a significantly heavy failure rate in factory tests of sub-assemblies or in system tests, it is returned to a physical design laboratory. Here it is dissected and examined under a microscope to determine the cause of failure. Sometimes the laboratory will duplicate the manufacturing operations in order to discover the cause of the trouble.

Gold Plated

The lengths to which Arma goes in its search for reliability is typified by its manufacture of printed conductor sub-assemblies. All conductors and terminals are gold plated to assure good electrical conductivity and to minimize adverse environmental effects like corrosion.

Every component that goes into a printed-conductor board sub-assembly is first cleaned by ultrasonics, then placed in position by an operator wearing nylon gloves. Sub-assemblies are placed in individual transparent plastic cases for transportation from one manufacturing operation to the next to prevent damage or contamination.

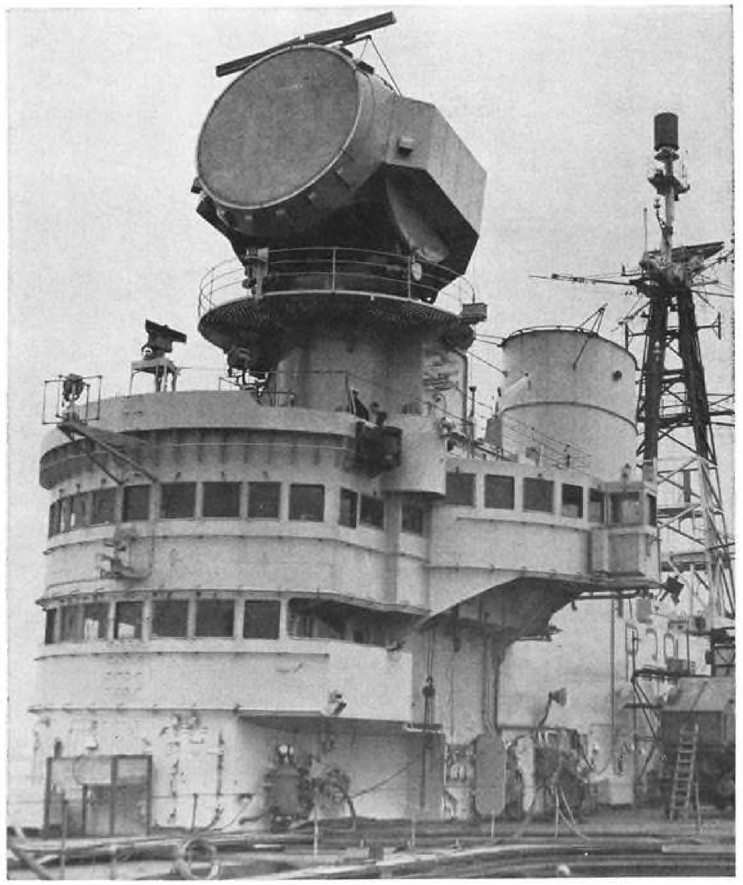
Except for certain critical gyro and accelerometer parts, the Titan inertial components are manufactured by conventional precision machine tools, according to Goetz. Their assembly, however, is the critical operation and this requires considerable skill, great care, extensive training and close supervision, he adds.

Dust-free air-conditioned rooms are used for gyro and accelerometer assembly. Temperature is held to within one degree and electronic test equipment is mounted flush with the wall to prevent its heat from disturbing room temperature and to simplify room cleaning.

Incoming air is so completely filtered that no more than one-micron size dust particle will settle per square inch over a 24-hr period, according to Stanley Seitz, Titan manufacturing project coordinator. Despite this, critical gyro parts are assembled under hoods that are pressurized at higher than room pressure.

Gyros are tested on sidereal tables which rotate precisely at earth rotation rate to neutralize this source of motion. Sidereal tables are mounted on huge slabs of concrete buried deep in the ground and are isolated from the rest of the building. Port in the roof, which can be opened as required, permits periodic sightings on Polaris (North Star) to check alignment of tables.

Balancing a two-degree-of-freedom floated gyro is a critical operation. Unless gyro element's center of gravity corresponds to the position of its center of buoyancy within a few millionths of an inch for accelerations applied in any direction, the gyro will drift under flight conditions. Early models of the



Carrier Radar Modernized

Lens antenna for "3-D" long range air search and tracking radar tops superstructure of British carrier HMS Victorious which recently completed seven year modernization job. Providing accurate target range, bearing and altitude data, radar was described by Admiral of the Fleet Earl Mountbatten, First Sea Lord, as having "almost fabulous performance."

Arma gyro required partial disassembly after initial balance test to make adjustments, but later models will permit external adjustments without disassembly.

Arma currently uses a small centrifuge to subject units up to 12 in. cube in size to 100G accelerations. Larger centrifuge capable of handling 30 in. cube sizes soon will be operational. Although centrifuges are convenient for subjecting components to high steady state accelerations, they can give only a crude approximation of the actual ICBM environment and do not permit tests of over-all inertial guidance system performance and accuracy.

More realistic approximation of ICBM operating conditions is obtainable on the Naval Ordnance Test Station supersonic rocket sled which also permits a check on open-loop operation of the complete guidance system. The sled run along the 4.1 mi. track lasts about 40 sec., counting start and stop time. Telemetry is used to obtain data on such things as deformation of stable platform gimbals, gyro drift, accelerometer output, as well as over-all system performance for the known trajectory over the earth.

Major Arma Program

Titan inertial guidance system is one of two major Air Force programs at Arma, the other being the radar-directed tail defense system for the Boeing B-52. Of the approximately 800 engineers and scientists employed by Arma, over half are assigned to the Titan project which represents more than half of the company's current $165 million backlog. Company recently received a $140 million Air Force contract for its Titan work, about $51 million of which covered work already accomplished.

Arma expects to be one of the bidders on a forthcoming Air Force competition to select an inertial guidance supplier

for new solid-propellant ballistic missile program, the Minuteman. Although Arma's work and accomplishments on the Titan guidance would appear to make it one of the top contenders for the Minuteman, company officials say they expect plenty of tough competition.

Electronic Testing Group to be Formed

Washington—Formation of a 16 man Defense Department-industry group to improve reliability of electronic components by developing improved procedures for specifying component reliability and testing will be announced shortly.

New ad hoc Group on Electronic Parts & Tubes is being established to work out details for implementing recommendations made last summer by Task Group No. 5 to Advisory Group on Reliability of Electronic Equipment (AGREE). It is being sponsored by the offices of Assistant Secretary of Defense for Research & Engineering and Supply & Logistics.

The 16-man group, to be chairmanned by an industry representative, will include three representatives from component manufacturers, three from equipment manufacturers, two representatives from each of the three military departments plus one each from the two sponsoring offices and one from Armed Services Electronic Standards Assn.

Here are some of the objectives the new ad hoc group will seek to accomplish during the next six months:

- **Establish criteria and methods** for specifying component reliability in terms of failure rate as function of time, environment and circuit application severity.
- **Determine changes necessary** in current component specification practices to introduce these reliability criteria.
- **Develop reliability assurance test** procedures that will verify that components meet specified standards.
- **Develop methods for preparing** and distributing component reliability data in a form that will be useful to equipment design engineers.
- **Seek ways to minimize duplication** of component qualification testing by military electronic equipment producers.

FILTER CENTER

▶ **Shotgun Bedding**—New transistor construction technique which mounts semiconductor crystal on ceramic wafer "bed" instead of suspending it between two upright posts is expected to greatly improve transistor ruggedness. Fixed-

bed mounting technique, developed by General Electric under Air Force sponsorship, protects against direct impact, vibration, and expansion-contraction due to temperature extremes. Sample units have worked satisfactorily after having been fired from 12-gage shotgun, GE says. Company uses new construction in its current injunction transistors and plans to extend the fixed-bed mounting to other military-industrial types in near future.

Expansions, Changes In Avionics Industry

Hoffman Electronics Corp., Los Angeles, has acquired 30% interest in Humphrey, Inc., San Diego, which develops and produces gyroscopes, accelerometers and precision instruments. Under agreement, Hoffman gains rights to manufacture Humphrey products.

Other recently announced changes and expansions in avionics field include:

• **Temco Aircraft Corp.** has acquired controlling interest in **Fenske, Fedrick & Miller, Inc.**, Los Angeles, through stock exchange which gives Temco 80% of the outstanding stock. New acquisition, which develops and produces military plotting systems and test equipment and missile guidance components, will remain in present location and retain present officers.

• **Lenkurt Electric Co.**, San Carlos, Calif., has formed separate division to handle its increased military business. Ralph R. Robertson is named general manager.

• **General Electric Co. Computer Department** will begin construction in May of new 104,000 sq. ft. facility in Deer Valley Park, near Phoenix, Ariz. Occupancy is slated for early 1959.

• **Sylvania Electric** has formed new laboratory, fourth member of its Waltham Laboratories, for research and development in field of electronic data processing. New laboratory's projects include data processing for Air Force's new ballistic missile early warning system (BMEWS), as a subcontractor to RCA.

• **Kearfott Co.**, Little Falls, N. J., has established newly formed Microwave Division in Van Nuys, Calif., at 14844 Oxnard St. George H. Singer is general manager. Company also announced that Canadian Applied Research Ltd., Toronto, Canada, will act as its exclusive Canadian distributor.

• **Epsco, Inc.**, Boston manufacturer of instrumentation and data processing equipment, will merge with the **Edin Co.**, Worcester, Mass., with latter operating as a division of Epsco.

• **Burndy Corp.**, Norwalk, Conn., has opened warehousing and sales offices in Antwerp, Belgium, headed by Augustin Bouckaert.

MICRO SWITCH Precision Switches have uses unlimited

Six Precision Switches for Aircraft and Missiles

NEW V-3-1301

High Temperature Switch

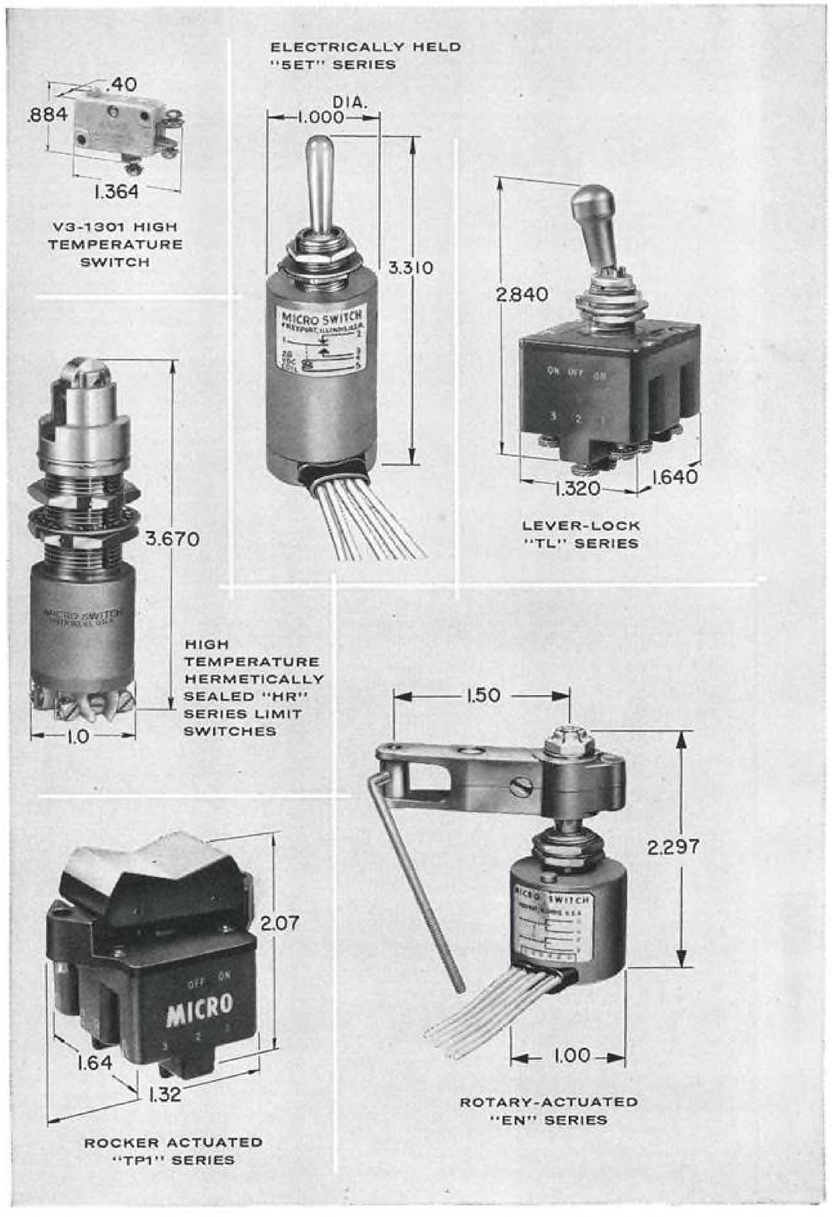
For use in jet engine and missile controls, this compact precision type "V3" switch performs reliably in temperatures up to +600° F. for a minimum of 25,000 operations. Rated at 10 amperes inductive load at 30 volts d.c. up to 600° F. Data Sheet No. 140 contains electrical and mechanical characteristics and other details. Send for it.

NEW High-Temperature Hermetically Sealed "HR" Series Limit Switches

These are hermetically sealed high temperature switches. Their two SPDT basic switching units are housed in metal-to-metal and glass-to-metal enclosures which meet the specifications in par. 5.2.2 of MIL-E5272A. Special materials and design insure dependable operation in temperatures from —65° to +600 F. Extremely compact and simple bushing mounting are other features. The "22HR" series has a heavy duty roller plunger actuator which can be adjusted to eight different positions. The "12HR" series has a straight plunger actuator. Electrical and mechanical characteristics and other details are covered fully in Data Sheet No. 122. Send for it.

Rocker Actuated "TP1" Series

The "TP" series is a new concept in panel switching and in styling. They combine rocker type actuation, flush mounting, and edge lighted indication. The "TP1" series features the same advantages of case design and construction as does the "TL" series. 78 variations are available in the "TP1" series. For complete information on electrical and mechanical characteristics and other details, ask for Data Sheet No. 141.



Electrically Held "5ET" Series

Shown is one of the family of sealed, momentary action toggle switches which may be electrically maintained by means of a built-in solenoid. With the toggle manually operated and the solenoid energized, the switch will remain actuated until electrically released. The toggle may be manually overriden even though being held electrically. The switch is of extremely small size and is sealed (MIL-E-5272A, procedure 1). SPDT basic switching unit and 28 vdc solenoid are contained in a one-inch metal enclosure. Supplied with leads, screw terminals or solder terminals. This series is fully described as to details, electrical and mechanical characteristics in Data Sheet No. 121. Request it.

Lever-Lock "TL" Series

The "TL" Series Pull-to-unlock Toggle Switches are available in over 400 variations. Illustrated is a four-pole switch with three position lever lock. Other switches in this series are obtainable with one and two locking positions on the toggle lever. This locking device is an integral part of the switch assembly. It cannot become separated from the balance of the switch. It cannot loosen or fall off. Switches of one, two or four-pole construction and in a variety of circuitry arrangements are available in this series. All are sealed preventing entrance of moisture and dirt. Data Sheet No. 142 contains all details as to electrical and mechanical characteristics.

Rotary-Actuated "EN" Series

The "EN" series of switches has been proven in over 3 years of use in missiles, military and commercial aircraft. A completely sealed enclosure permits use in any environment. One member of the "41EN" series (illustrated) has a linkage type rotary actuator, adjustable thru 360°. It is available in a variety of circuits. Send for Catalog 77.

These switches, designed and built for aircraft and missile application, possess a high degree of reliability, even under the adverse conditions of altitude, humidity, radiation, fungi and extremes of temperature that take their toll of inferior switches —whether in enclosed or exposed locations.

MICRO SWITCH precision switches are as reliable in performance —regardless of locale or service —as human ingenuity, together with unexcelled engineering and production, quality control and testing equipment and techniques can make them.

It is this care and diligence which has made MICRO SWITCH "First in Precision Switching" for twenty years.

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WHAT'S NEW

Reports Available:

The following reports were sponsored by the Office of Technical Services, United States Department of Commerce, Washington 25, D. C.:

Cargo Handling in Helicopters—by C. Henderson, W. G. Ireson, R. K. Mitchell and P. P. Tilton, Stanford Research Institute, for Wright Air Development Center, U.S. Air Force. March, 1957. $4.50; 179pp.; (PB 131195).

Investigation of Materials Fatigue Problems—by H. N. Cummings, F. B. Stulen and W. C. Schulte, Curtiss-Wright Corp., for Wright Air Development Center, U.S. Air Force. March, 1957. $5.50; 221pp.; (PB 131288).

Fatigue Investigation on High Strength Steel—by J. K. Childs and M. M. Lemco, Southwest Research Institute, for Wright Air Development Center, U.S. Air Force. July, 1957. $1.25; 44pp.; (PB 131371)

Thermal Stresses and Thermal Buckling—by J. Singer, M. Anliker and S. Lederman, Polytechnic Institute of Brooklyn, for Wright Air Development Center, U.S. Air Force. April, 1957. $3.00; 120pp.; (PB 131072).

Analytical and Experimental Investigation of Stress Distributions in Long Flat Plates Subjected to Longitudinal Loads and Transverse Temperature Gradients—by G. H. Sprague and P. C. Huang, The Martin Co., for Wright Air Development Center, U.S. Air Force. September, 1956. $4.00; 156pp.; (PB 121680).

Techniques for Application of Electron Tubes in Military Equipment—by R. S. Whitlock, Wright Air Development Center, U. S. Air Force. $7.00; 558 pp.; (PB 111644R-2).

The Effect of Nitrogen and Vacuum Degassing on the Properties of a Cast Aluminum-Silicon-Magnesium Alloy (Type 356).—by R. K. Owens, H. W. Antes and R. E. Edelman, Frankfort Arsenal, U. S. Army Ordnance Corps. $.75; 24 pp.; (PB 131351).

Hydrostatic Pressing of Alumina Radomes—by W. D. Anderson, Gladding, McBean & Co. for Wright Air Development Center, U. S. Air Force. $.75; 21 pp.; (PB 131565).

The Hypersonic Facility of the Polytechnic Institute of Brooklyn and Its Application to Problems of Hypersonic

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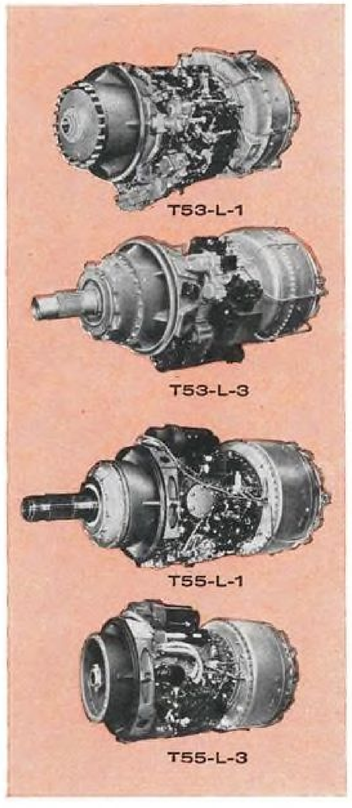
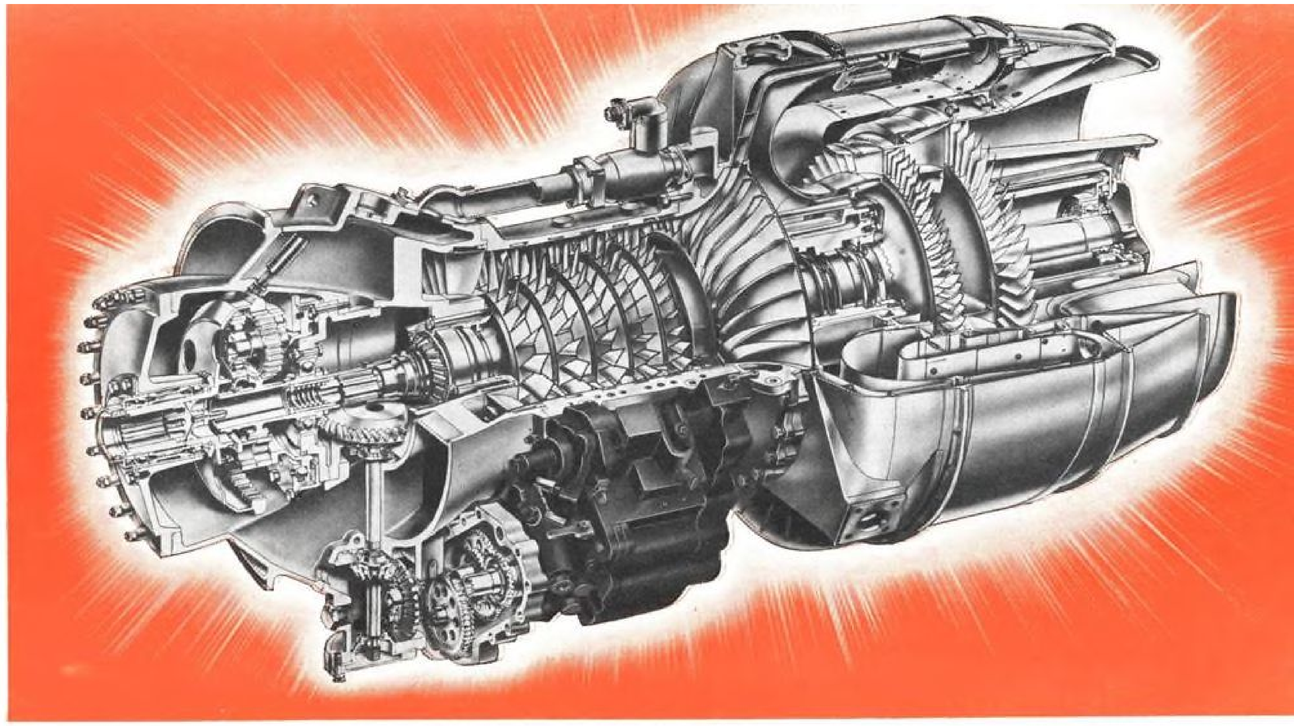


FOR FURTHER INFORMATION about Lycoming's turbine capabilities, write to:
Gas Turbine Department, Lycoming Division, Avco Manufacturing Corporation, Stratford, Conn.



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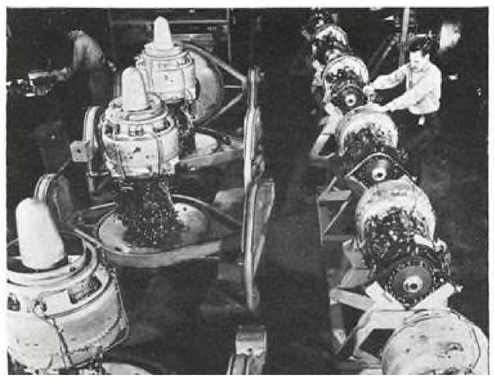
Doak Model 16 Research VTOL



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Flight—by A. Ferri and A. A. Libby, Polytechnic Institute of Brooklyn for Wright Air Development Center, U. S. Air Force. $1.50; 56 pp.; (PB 131566).

Use of a Free Molecule Probe in High Speed Rarefied Gas Flow Studies—by J. A. Laurmann and D. C. Ipsen, University of California at Berkeley for Wright Air Development Center, U. S. Air Force. $1.25; 47 pp.; (PB 131571).

Telling the Market

End uses of **small diameter stainless steel, nickel and nickel alloy tubing,** brochure, J. Bishop & Co., Platinum Works, Malvern, Pa. . . . Description of high-temperature, high-performance **Equa-Therm oven,** Bulletin No. 2299, American Instrument Co., Inc., 8030 Georgia Ave., Silver Spring, Md. . . . Brochure introducing the **products and facilities of the Boston Insulated Wire & Cable Co.,** 65 Bay St., Boston 25, Mass.

Advantages, methods of application, and selection chart of **protective and prepaint coating chemicals for aluminum,** Bulletin 1424-A, American Chemical Paint Co., Ambler 1, Pa. . . . Illustrated engineering data sheet, No. 21, describes **Nicrobraz** 150 high-temperature brazing alloy, Stainless Processing Division, Wall Colmonoy Corp., 19345 John R St., Detroit 3, Mich. . . . Descriptive information and operating specifications for **Turbo wire and cable,** brochure, William Brand & Co., Inc., Willimantic, Conn.

Illustrated description of **arc welding cable connections and accessories,** No. 11 Twecolog catalog, Tweco Products, Inc., P. O. Box 666, Wichita ,Kan. . . . Two technical bulletins contain complete engineering specifications and qualification test data for **QAF quick-action stressed panel fastener** designed for use on structural load-carrying panels in aircraft, guided missiles, etc., Special Products Division, Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N. Y.

The Use of Silicon Junction Diodes to Protect Sensitive Current Devices, semiconductor application bulletin Vol. 1—No. 1, Hoffman Electronics Corp., Semiconductor Division, 930 Pitner Ave., Evanston, Ill. . . . Bulletin on **tooling plastics,** describing the use of epoxy resins, Furane Plastics, Inc., 4516 Brazil St., Los Angeles 39, Calif. . . . Description of the complete line of **Model H. Series** high pressure transducers, Technical Bulletin SI-581, Servonic Instruments, Inc., 640 Terminal Way, Costa Mesa, Calif.

Aviation Week Pilot Report

Ag-Cat Designed as Maneuverable Duster

By Robert I. Stanfield

Calverton, N. Y.—Grumman's rugged Ag-Cat is a highly maneuverable single-place agricultural biplane geared to slow flight and quick turn-arounds at low altitudes.

Crop duster and sprayer is designed to take powerplants in the 200-300 hp. class, buyer's choice. Prototypes are powered by Continental W-670 radial engine of 220 hp. (AW Nov. 25, p. 32).

Performance factors evidenced during flight evaluation by AVIATION WEEK include:

• **Slow-flight characteristics.** At low speeds airplane reacts quickly to light control forces. Lateral control is excellent. Total wing area is 326 sq. ft. Wings are staggered, with upper acting to keep air over lower.

• **Forward visibility.** Biplane's nose slopes down 7 deg. from cockpit. In level position pilot can see ground about 50 ft. in front of propeller.

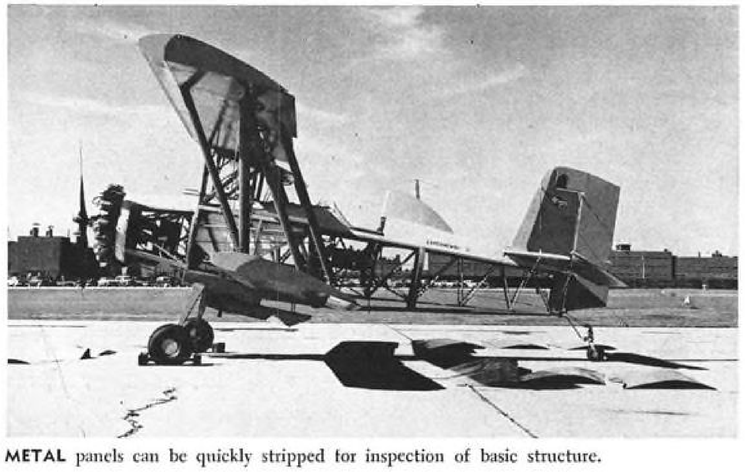
• **Short-field capabilities.** Small fields should be no problem for the Ag-Cat. Airplane went off paved runway in about 300 ft., into 40 deg. crosswind of 10 kt. About 250 ft. were used for landing. Biplane, at gross of 2,800 lb., has been brought to dead stop in 210 ft.

• **Turn-around safety.** About 45% of dusting-spraying accidents occur from spin-outs in turn-arounds. Ag-Cat, designed for gross weight of 3,600 lb., has low stall speed and anti-stall tendencies in tight turns.

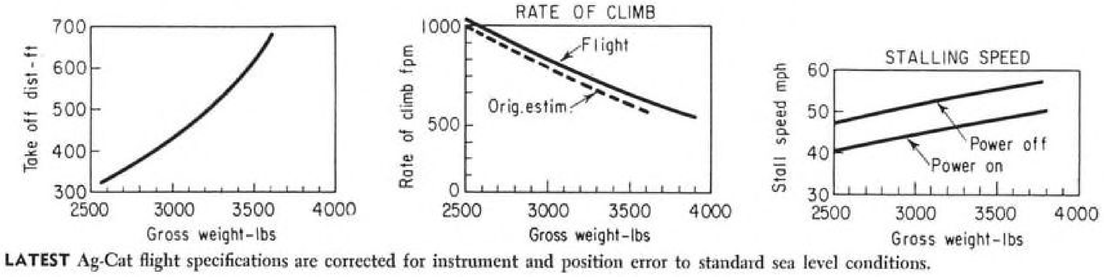
Grumman has built two prototypes which have been testing since early 1957. Airplane flown was number one prototype, N74054, which has been flown about 165 hr. and is currently undergoing certification tests under Part 8 of Civil Aeronautical Regulations. Built-in safety features are evident.

Pilot sits high in the open cockpit

TOTAL wing area of 326 sq. ft., four ailerons, add to Ag-Cat control.



METAL panels can be quickly stripped for inspection of basic structure.



LATEST Ag-Cat flight specifications are corrected for instrument and position error to standard sea level conditions.

and visibility is good to all sides. Coaming is heavily padded. Seat, shoulder harness and headrest-overturn structure are stressed for 40Gs. Latter is steel tripod extension of basic structure. Standard instrumentation includes engine oil pressure-temperature gage, airspeed indicator and tachometer.

Latter two are set in a separate panel atop fuselage just forward of hopper in pilot's line of vision. Outside fuel gage is mounted below the 34-gal. fuel tank located in center section of upper wing. Pilot can watch these instruments without looking down in cockpit while flying.

Prototype was also equipped with starter, clock, stall warning indicator, compass and gages for manifold pressure, cylinder head temperature, carburetor heat and outside air temperature.

Engine started immediately and the plane was taxied out for runup and takeoff. Rudder pedals took care of taxiturns, but brake pressure had to be applied during runup; there is no parking brake.

Biplane's no-hopper load weight—dry weight of 2,179 lb. plus pilot, parachute, gasoline and oil—is 2,600 lb. With 250 lb. of instrumentation, including starter, generator and battery, aircraft gross weight was about 2,850 lb.

Field elevation at Grumman-Peconic is 75 ft. Takeoff was to the southeast, with wind from the south at 10 kt. Outside air temperature was 48F. Sea level pressure was 30.18 in.

Takeoff and Climb

At full throttle and 2,075 rpm., we were off the ground in slightly over 300 ft. Power was reduced to 2,000 rpm. and biplane held 65 mph. in climb, at rate of 800 fpm. Slight rudder pressure compensated for torque. Sole trim control is small wheel for elevator. Large Ag-Cat tail provides good control at low speeds.

Control and visibility were excellent during climb. At 3,000 ft., biplane was leveled off and reduced power to 1,750 rpm., pulling 20 in. mp. With this setting airplane indicated 78 mph. This approximates speed used in dusting.

McCauley fixed-pitch steel propeller is ground-adjustable. Pitch on prototype, 9.25 deg., was set for climb and dusting speeds and could be increased for long-range cruise. In calibration tests, flying between fixed points, Ag-Cat indicated 119 mph. Design dive speed is 145 mph.

Biplane was light on the controls during varying degrees of turn and bank. Maneuverability, good roll rate and stall control are attributed to two-wing configuration with four ailerons.

Airplane was stalled straight ahead and in climbing turns, power-off and power-on. With propeller turning 1,800 rpm., airplane stalled at about 40 mph. indicated. With power off, break came at about 45 mph.

In every instance Safe Flight stall warning sounded 7 to 10 mph. ahead of stall. In every instance there was no definite break-away; rather a reluctant mushing out with negligible loss of altitude.

Airplane was also pulled into some tight simulated low-level, nose-high turn-arounds. Ag-Cat is stressed for limit load of plus 4.2Gs and minus 1.5Gs. Torsionally stiff wings have fixed struts, along with strut between ailerons. There was no tendency to spin out, and here advantages of the biplane configuration and four ailerons were obvious.

Short-Field Capability

Small biplane—wing span is only 35 ft. 8 in.—easily can be dropped into tight areas. For our first landing Ag-Cat was brought in slightly "hot"—at 65 mph. After one bounce it settled and, with gentle braking, was dead-stopped in about 350 ft.

Holding brakes while applying full power, we started fast and were airborne in slightly less than 300 ft. Airplane was leveled a few feet off runway until speed picked up, then sharply pulled up at about 45 deg. Getting over a 50 ft. obstacle in a hurry would be no problem.

Remaining landings were shot at 60 mph. on approach. We could get a fairly steep rate of descent and less float. Spring steel gear held tight to the ground and there was no tendency to ground loop. On each successive try we managed to further reduce landing run, minimum being about 250 ft. without excessive braking.

Simplicity is a characteristic of Ag-Cat design. Biplane is all metal, except for underside of wings and control surfaces, which are fabric covered. Short sections of metal along wing leading edges, plus removable panels on fuselage, can be quickly stripped for inspection of basic internal structures, corrosion detection and cleaning and repairs if necessary. All metal surfaces are coated with corrosion-resistant Furan base resin paint.

Basic frame is steel tubing, which carries all load. Tubing can be easily repaired in event of damage to fuselage. Upper and lower wings on the same side are interchangeable, as are any of the four ailerons.

Present estimates indicate that Ag-Cat will sell for around $17,500, AVIATION WEEK was told. If buyer supplies own engine and propeller, price will be reduced $1,500.

Surplus radial engines are available at reasonable prices. Radials are favored over in-lines because of cooling factor (no cowling). Airplanes run hot during low, slow flight, coupled with time on ground idling while hopper is being loaded.

Ag-Cat Production

Ag-Cat will be produced for Grumman by Schweizer Aircraft Corp., Elmira, N. Y., under an agreement signed by both companies (AW Apr. 21, p. 23). Schweizer is tooling for output of some 100 aircraft. First to roll out, in July, will be used by Grumman for further testing.

Between July and January of next year some 10 to 15 Ag-Cats will be produced. From January on, rate will be eight a month. Peak domestic market is in the spring.

Grumman believes there will be no problem in selling eight airplanes a month because "the future is critical for modified aircraft and replacement parts available today."

Company is keying its agricultural organization to service, and has appointed four distributors to sell its new airplane: Magnolia Aviation Co., Laurel, Miss.; Sun Valley Dusting Co., San Benito, Tex.; United Heckathorn Co., Richmond, Calif.; and Mid-Continent Aerial Sprayers & Dusters, Inc., Hayti, Mo.

Ag-Cat hopper, located just forward of cockpit, has capacity of 29 cu. ft. (217 gal.). Payload is 1,000 lb. Full throat dump valve empties hopper, which is removable without disturbing wing rigging. Small propeller drives power hopper equipment and acts as a pump for spraying gear or as an agitator for dusting spreader. Buried

Grumman Ag-Cat
SPECIFICATIONS

Wing span	35 ft. 8 in.
Total wing area	326 sq. ft.
Overall length	24 ft. 4 in.
Max. height	10 ft. 9 in.
Max. gross weight	3,600 lb.
No hopper load weight	2,600 lb.
Weight empty	2,179 lb.
Fuel	34 gal.
Oil	5 gal.
Hopper volume	29 cu. ft. (217 gal.)
Hopper load restriction	1,000 lb.
PERFORMANCE	
Max. speed (level)	110 mph.
Stall speed	
@ 2,600 lb., power on	41 mph.
@ 2,600 lb., power off	47 mph.
@ 3,600 lb., power on	48 mph.
@ 3,600 lb., power off	55 mph.
Takeoff distance	
@ 2,600 lb.	330 ft.
@ 3,600 lb.	675 ft.
Rate of climb	
@ 2,600 lb.	940 fpm.
@ 3,600 lb.	530 fpm.
Endurance (220 hp. Continental)	
@ 1,750 rpm)	3 hr.

leading edge spray booms or exposed trailing edge booms are optional.

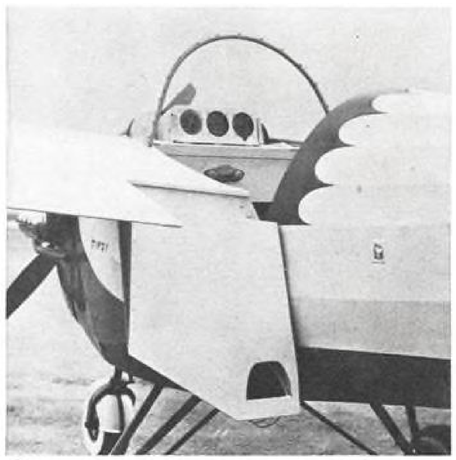
Biplane can be quickly converted from duster to sprayer. Capabilities of quick interchange units will be tested at Texas A&M. Work is expected to begin this month with number one prototype airplane. Grumman has also launched a corrosion study.

Testing will also involve several units being developed by Grumman, plus simple-to-operate Swathmaster instant-change unit designed by Joseph Sellers of Bakersfield, Calif.

Swathmaster incorporates a perforated, lightweight stainless-steel wing about 13 ft. in span, weighing about 70 lb. Wing would hang 9 in. below Ag-Cat's bottom wing. Venturi action would be created between two wings.

Liquid, dust or granules would run down hopper throat to unit. Spanwise direction is via guide vanes. With air coming through front, center, payload emerges from upper surface of wing through perforated holes.

Pump is not necessary, and use of Swathmaster, AVIATION WEEK was told, could mean an increase in hopper load.



TIPSY NIPPER shoulder-wing layout yields minimum fuselage cross section (left). Portion of wing is hinged to form step (right).

Belgians Sell Single-Seater in Kit Form

Worldwide market for a single-place private plane especially designed so that it can be built in an amateur's workshop is being sought by Avions Fairey, S.A., Belgian subsidiary of Fairey Aviation Co., England.

Priced at approximately $2,000 in kit form, the Tipsy Nipper is designed to use a 30-hp. Volkswagen engine giving it a 65-mph. cruise speed (AW Mar. 17, p. 91), but it can also utilize more powerful Porsche or other engines if higher performance is desired.

Layout is planned to provide easy mobility from owner's home to airport; wings can be taken off and stowed atop a car and the fuselage hitched behind the vehicle.

Wings are of wood construction with all loads taken by a single spar of simple rectangular cross section having constant width and with top and bottom faces parallel throughout its span. Ribs are of Warren girder construction built from spruce strips reinforced with ply gussets. Leading edge is covered with one millimeter plywood.

A metal portion of the trailing edge of the wing, aft of the spar, folds downward to provide a footstep for entering and leaving the airplane.

Fuselage is a steel tube welded structure of conventional layout, with secondary members and attachments bronze welded. Fuel tank is a light alloy, sealed with compound and is designed to form part of the fuselage fairing and also support the instrument panel and windshield. Engine cowl and propeller spinner are of reinforced plastic. Lower fuselage fairing is also a Fiberglas molding.

Fixed tricycle landing gear uses autolubricating plastic brushes on the wheels. Nosewheel is steered by the rudder pedals. Landing gear shock ab-

Avions Fairey Tipsy Nipper

Wing span	19 ft. 8 in.
Length	14 ft. 9 in.
Height	5 ft. 3 in.
Weight empty (including engine)	360 lb.
Volkswagen engine and accessories	125 lb.
Maximum designed weight	660 lb.
Load factor	7.5
Wing area	80.5 sq. ft.
Aspect ratio	4.8
Mean aerodynamic chord	4 ft. 1½ in.
Wing dihedral (spar bottom face)	5 deg. 30 min.
Angular range of nosewheel	20 deg. left-right
Undercarriage travel (nosewheel)	8⅛ in.
Undercarriage travel (main gear)	11 in.
Provisional performance data (30-hp. Volkswagen engine):	
Maximum speed	75 mph.
Cruise speed	65 mph.
Takeoff speed	38 mph.
Landing speed	38 mph.
Takeoff run	450 ft.
Landing run	300 ft.
Maximum range	187 mi.

sorbing system comprises Nieman rubber rings of the type used on some motorcycles. Simple disk-type brakes are fitted on the main wheels and are operated by a lever on the control stick.

Avions Fairey says that the complete airplane, powered by a Volkswagen engine, will be available for less than $3,000 at the factory, Gosselies, Belgium. As a kit, minus engine, the Nipper would cost approximately $1,000; a 30-hp. Volkswagen engine with dual ignition would run about $770 (with single ignition, about $500) and propeller, cowling, instruments, fabric and paint would cost another $150.

Complete kit will be packed in a box 11 ft. 6 in. x 2 ft. 8 in. x 2 ft. 4 in. weighing under 400 lb. Kit comprises:

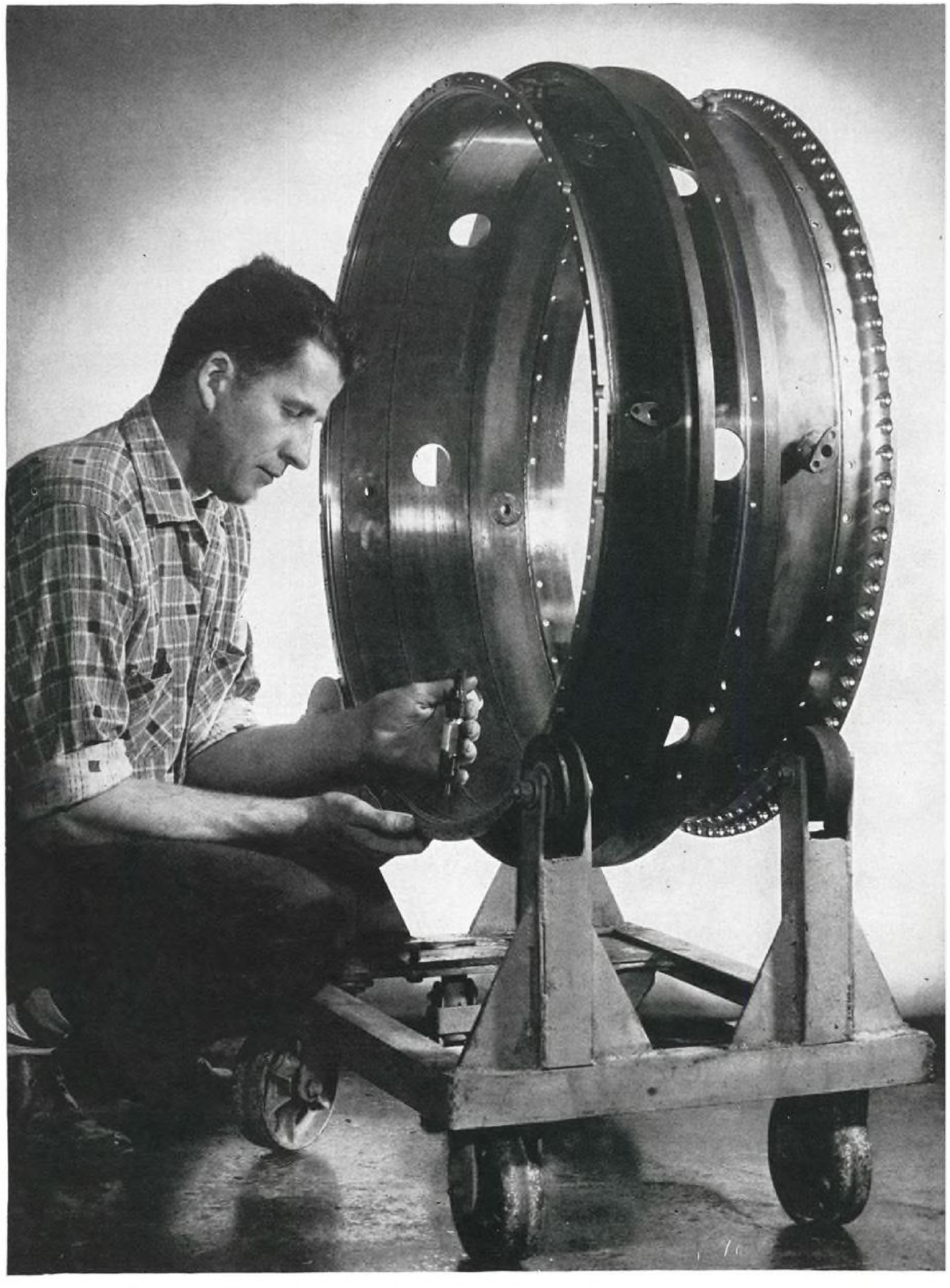
Fuselage structure, completely finished with all brackets and details welded in place; complete landing gear assembly with hubs, tires and brakes; finished metal rudder structure ready for covering; completely finished flight control system, ready for assembly; fuel tank, ready for fittings; Fiberglas molded fairings, ready for cutting to final shape; windshield with fixtures; light-alloy flap step; silver spruce laths of all wooden parts ready for cutting to size, finishing and gluing; three-ply sheets; all hardware; dimensional drawings for all assemblies and also for the wooden components to be built; and a brochure illustrating step-by-step building and assembly stages.

On inside faces of the packing case are full-size outlines, of ribs, spars, ailerons, fin, tailplane, elevator and other assemblies, permitting use of these panels as construction jigs.

Kit does not include engine, propeller, engine cowling, instruments, fabric, dope and paint.

UC-78 Tip Tanks

Reinforced plastic wingtip tanks of 36-U. S.-gal. capacity each have been installed on war surplus Cessna UC-78 by German firm, Sudflug, Stuttgart, to increase plane's endurance from normal 4 hr. to 7.5 hr. Design was planned in cooperation with Deutsche Vorschungsanstalt fur Luftfahrt (DVL). Airplane is going to Africa for use in aerial survey missions.



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for Jets and Missiles

PART: Turbine Exhaust Case Weldment J57

CUSTOMER: Pratt and Whitney Aircraft

MATERIALS: Front Flange—AMS 5648
Rear Engine Mount Ring—AMS 5613
Rear Flange—AMS 5613
Duct—Forward—AMS 5524
Rear—AMS 5504

TOLERANCE: 2" Diameter holes—± .0005".
Engine Mount Ring—Mounting Surfaces, Opening, ± .002, and Parallel within .005 in free state.

QUALITY CONTROL: MIL-5923 including Radiographic, Magnetic Particle, and Fluorescent Penetrant inspection.

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Budd's designing, development and production facilities—a complete family of engineering skills—used by jet engine and aircraft manufacturers since 1942, now stand ready to assist the minds and the men who are making today's missiles.

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Kaman K-17 Makes First Flight

Kaman Aircraft Corp. K-17 cold cycle pressure jet helicopter, shown on first flight, is one of several types of tip-driven rotors being investigated by U. S. Army (AW April 28, p. 23). Cockpit covering was not installed for initial flight. Tail rotor is for steering only.

Reading Air Display Expects 750 Planes

Some 750 private and business aircraft and at least 2,500 guests are expected to be present at Reading Aviation Service's Ninth Annual Maintenance and Operations Meeting at the Municipal Airport June 6-7.

Approximately sixty airframe and equipment manufacturers interested in the business flying market are scheduled to have displays, including Bell, Aero Design (who will show the new pressurized AltiCruiser), Cessna, Trecker, Lockheed and Republic. Bendix, Collins, Wilcox and RCA will also attend, Reading reports.

Topics of discussion planned are: Aircraft maintenance standards; greater utilization for business aircraft; United Air Lines radar school; modification of aircraft; helicopter maintenance; operating procedures of light twin-engine aircraft and new de-icing techniques.

High point will be the award of prizes to outstanding business aircraft.

Texas Firm to Lease Helicopter Air Time

Houston—Leasing plan for executive helicopter transport will be started here this week by Helicopter Air Lift, Inc. in an expansion of similar operations conducted since 1955 in the Chicago area.

Under the plan, companies will sign annual contracts for minimum blocks of 25, 50 or 100 hr. on Helicopter Air Lift's machines. Firms leasing the service will use the time as they need it. Generally the service is used for executive transport and light cargo.

The leasing plan is designed to give companies the advantages of helicopter service in metropolitan areas without the expense of buying and operating their own aircraft.

Helicopter Air Lift will operate the service here with two new Bell 47H machines. These two-passenger helicopters are the last two 47Hs made by Bell. The operator currently uses four 47Hs in its Chicago program.

Helicopter Air Lift was formed in 1955 as a division of Skymotive, Inc., a Chicago fixed-base operator. The division has been acquired by M and K Investment, Inc., a Houston firm, and the new owner has plans to expand the leasing plan to several cities in addition to the Chicago and Houston operations.

12th Powder Puff Derby Opens in San Diego July 4

Application for entry in 12th Annual All-Woman Transcontinental Air Race (Powder Puff Derby) are being accepted May 1- June 20. Takeoff positions are determined by order of receipt of applications. This year's 2,177-mi. event for stock model single or multi-engine private planes not exceeding 350 hp. will start from Montgomery Field, San Diego, Calif., at 0800 PST July 4 and terminate at Charleston, S. C., July 8. More than $3,000 in prize money and trophies will be distributed among first five places. For details write: All Woman Transcontinental Air Race, Inc., 2611 E. Spring St., Long Beach 6, Calif.

ANTI-SUBMARINE DUTIES—New weapons systems have immeasurably strengthened the U.S. Navy's capabilities in anti-submarine warfare. A key role is assigned to HSS helicopters (Sikorsky S-58s) equipped with sonar. These are the Navy's only anti-submarine helicopters. Three are shown here operating from a carrier during anti-submarine warfare exercises at sea. S-58-type helicopters are widely flown in both military and commercial service.

AROUND THE WORLD WITH SIKORSKY HELICOPTERS

HIGH ALTITUDE TRAINING—Seventy Marine Corps pilots and crew members tested performance of HUS helicopters (Sikorsky S-58s) at high altitudes and in extreme cold in the mountains of California. Aircraft were flown at 12,500-foot altitude, operating despite snow and ice.

AIRBORNE RATIONS—A twin-engined Army H-37 (Sikorsky S-56) lifts a sling load of C-rations during tests at Laguna Airstrip, Yuma, Arizona. The largest known operational helicopters in the world, versatile H-37s have transported heavy Army missiles, vehicles, and artillery pieces.

Photo: *San Diego Union-Tribune*

SPEEDING PLANT CONSTRUCTION—Lifting more than 100 tons of heating and ventilating equipment to the rooftop of a huge factory, a Sikorsky S-58 accomplished in two days a job which would have taken four weeks with ordinary crane equipment. The S-58 made 70 quarter-mile flights from a loading yard to the roof of Convair's new Atlas missile plant in San Diego, spotting loads on the 13-acre roof to a tolerance of less than one inch. Construction officials said this was the largest helicopter job ever performed on a plant construction project, an airlift that saved thousands of dollars as well as the four weeks' time.

Temco Proposes Navy Jet Trainer

Dallas—Temco Aircraft Corp. is modifying its TT-1 trainer into a more versatile competitor for a role in the primary and basic phases of Navy's pilot training program.

With more power and greater endurance, Temco feels the new TT-X can provide all the performance needed to bring a pilot through the primary-basic cycle. With its new equipment, the TT-X is designed to handle all training work through carrier qualification, with the exception of gunnery.

Temco is proposing the TT-X to the Navy as a single aircraft for all-jet primary and basic training, and a key point will be economy. Temco trainer costs about a third of a trainer the size of the T2J which North American Aviation, Inc., is developing for the Navy.

Since the TT-1 was originally classed as a primary trainer, expansion of its capabilities to cover the area of basic training will make it a stronger competitor when the Navy is making a decision. Temco figures the TT-X can cover at least half of the Navy's overall training syllabus.

TT-X is the TT-1 trainer with a more powerful engine, plus some relatively minor modifications designed to increase its versatility. Temco will build a mockup of the new version, although there are no firm plans right now to produce flyable TT-X hardware.

TT-1 was designed to handle more power as the engines became available, and improvement of the trainer coincides with development of newer versions of its J69 engine. Ultimate engine for the TT-X is the J69-T23, although the J69-T25 will serve as an interim powerplant.

Temco is currently testing the J69-T-25 in the original TT-1 prototype (AW Feb. 10, p. 85). This engine produces 1,025 lb. thrust, a 10% improvement over the J69-T2 which powers the production model TT-1. The added thrust improves performance.

When it is available, the more powerful J69-T-23 is expected to provide enough added thrust to handle the extra weight of additional fuel and equipment and still improve considerably on performance with the J69-T25.

No changes in the primary structure or the aerodynamic features of the TT-1 airframe are involved in converting the trainer to the TT-X version. The engine is housed in a secondary structure area, and changes in brackets and fairing are basically all that is necessary for the newer engines.

Current version of the Temco trainer has a 1.5 hr. training mission endurance, plus reserves. Increased fuel capacity in the TT-X will add a half-hour to this training mission capability.

All fuel in the TT-1 is carried in three bladder cells in each wing. In the TT-X, small bladder cells are added in the outboard leading edge and at the wingtip, bringing the total to five in each wing.

To accommodate more navigation gear, the trainer's canopy fairing is extended to the rear, giving the TT-X a more streamlined look. The extra space is for Tacan equipment.

Carrier training capability is provided with the addition of restraining gear and catapult lugs. Some beefing-up is required in the tail boom to handle the tail hook, and a larger nose gear is provided to compensate for the heavier stresses of carrier-type landings.

TT-X will have ground level ejection seats, and some minor instrument changes will be made to give the trainer full day and night capability for basic flight training.

Temco is currently in the midst of a production contract for 14 TT-1 aircraft ordered by the Navy for evaluation. Last of the 14 is to be delivered this summer. This production model is powered by the J69-T2 engine, but it can be retrofitted with later versions.

USS Strux... the light way to keep the belly off the ground

To almost everybody but the pilot, the least popular part of a modern airplane is its landing gear. Says one airframe engineer, "All it does is keep the belly of the plane off the runway—the rest of the time it's nothing but a deadweight drag on performance."

Actually, if you can design away 50 lbs. from the 500-odd lbs. of landing gear weight on a modern supersonic fighter, you add scores of miles to its cruising radius, reduce its turning circle by hundreds of yards, add significantly to its speed and altitude capabilities.

For it has been shown that a single extra pound of landing gear weight adds from 7 to 10 lbs. of total aircraft weight—because of extra wing area, fuel and other equipment required. No wonder aero engineers are as skittish about weight as aging movie stars!

To solve this problem, United States Steel has successfully completed the development of a new and stronger steel for lighter landing gear. Today, with an ever increasing emphasis on weight-saving in aircraft components, this steel, called USS STRUX, has been thoroughly tested and evaluated in commercial heat lots by a major landing gear builder.

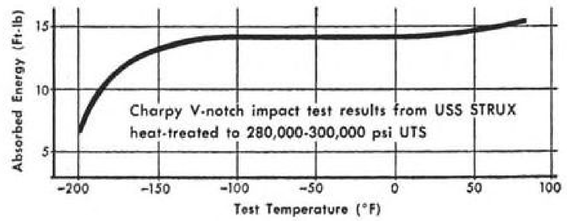
USS STRUX is an *ultra*-high-strength steel, with good toughness, that can be forged, machined and heat-treated to develop tensile strengths in the 280,000 to 300,000 psi range. Compared with SAE 4340, frequently used in crucial landing gear components, USS STRUX has about 7% more strength and, as proved by landing gear makers, can reduce weight by a comparable amount. At this time when plane builders find it worthwhile to pay $20 more per pound for components if airplane weight can be reduced by a single pound, USS STRUX certainly deserves your serious consideration.

Here's what USS STRUX offers you

HIGH TENSILE PROPERTIES. Longitudinal samples of forged 1″ rounds from a regular production run of USS STRUX provided the strength and ductility information listed in the table below. The rounds were first normalized from 1600°F. Oversize tensile specimens were machined and heat-treated by austenitizing at 1550°F, quenching in oil and tempering at the indicated temperatures for 4 hours. After final machining, the test specimens were stress-relieved for 3 hours at 400°F.

Tempering Temperature °F	Yield Strength (.2% Offset) psi	Tensile Strength psi	Elongation in 2″, %	Reduction of Area, %
450	242,860	291,300	10.25	37.5
550	243,390	281,100	10.75	38.2
650	233,260	265,220	10.25	39.6
750	216,420	239,070	10.75	30.7

EXCELLENT TOUGHNESS. At temperatures from minus 100°F to plus 100°F, Charpy V-notch impact values approximate 14 ft.-lb. For its very high strength level, USS STRUX shows excellent toughness as measured by energy absorbed. Specimens giving curve at right were tempered at 450°F.



USS STRUX is sold in the hot-rolled or annealed condition in the full range of bar sizes and as billets or blooms for forging up to 15¾″ square. It is intended for use in the heat-treated condition after forging and machining. To develop a minimum of 280,000 psi tensile strength, the recommended treatment is to normalize (air-cool) from 1600-1650°F followed by oil quenching from about 1550°F and tempering in the range 450°F to 550°F. Annealing for machining or other intermediate processing may be done by furnace cooling from about 1500°F.

For more information on USS STRUX, please write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa. or contact the nearest USS District Sales Office. Comprehensive technical data is available at no obligation, of course.

United States Steel Corporation – Pittsburgh
Columbia-Geneva Steel – San Francisco
Tennessee Coal & Iron – Fairfield, Alabama
United States Steel Supply – Warehouse Distributors
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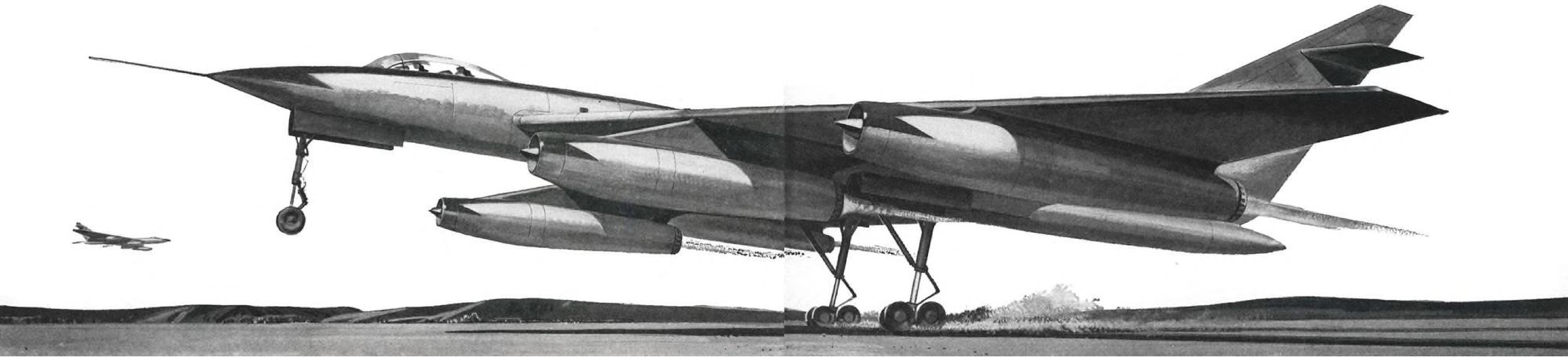
USS TRADEMARK United States Steel



Stock Transactions

Washington—Acquisition of 50,900 class A common shares of Northeast Airlines by the Atlas Corp. has been reported by the Securities and Exchange Commission. This brings Atlas' holding to 994,126 shares. Hamilton Heard, officer and director, disposed of 2,000 class A common shares, leaving a holding of 3,000. Other transactions for the period December 11, 1957, to January 10, 1958, include:

Aero Supply Manufacturing Co., Inc. Acquisition of 100 common shares by Clyde T. Keith, officer, his entire holding; acquisition of 1,200 common shares by Henry M. Margolis, director, for a holding of 52,161 with the Henmar Investing Corp. beneficially holding 20,335; acquisition of 3,000 common shares by James L. Spenser, officer and director, for a holding of 3,100; acquisition of 1,000 common shares by Estate A, under Leo Strauss, officer, for a beneficial holding of 3,500.

Aeroquip Corp. Disposal of 100 common shares by Frederic W. Corwin, officer, leaving a holding of 10,442; disposal of 300 common shares by Elbert Cheyno, officer, leaving a holding of 2.

Alaska Airlines, Inc. Acquisition of 500 common shares by Elbert Sheyno, officer, for a holding of 1,750; acquisition of 500 common shares by Robert H. Herrnstein, officer, his entire holding; acquisition of 1,200 common shares by Charles F. Willis, Jr., officer and director, for a holding of 2,600.

Allegheny Airlines, Inc. Acquisition of 11,700 common shares by Robert F. George, director, for a holding of 53,200; disposal of 10,000 common shares by W. F. Rockwell, Jr., director, for a holding of 7,000.

American Airlines, Inc. Acquisition of 200 common shares by Edwin H. Herzog, director, for a holding of 900.

Avco Manufacturing Corp. Acquisition of 1,500 common shares by Herman H. Kahn, director, for a holding of 2,500; acquisition of 9,000 common shares by John A. McDougald, director, for a holding of 10,000; acquisition of 400 common shares by Matthew A. McLaughlin, officer and director, for a holding of 1,075; acquisition of 500 common shares by William I. Myers, director, for a holding of 1,000.

Beech Aircraft Corp. Acquisition of 100 common shares by Michael G. Neuburger, officer, for a holding of 206.

Bell Aircraft Corp. Acquisition of 400 common shares by Norton C. Wilcox, officer, for a holding of 400; disposal of 1,000 common shares by Otto A. Pfaff, director, leaving a holding of 6,101.

Bendix Aviation Corp. Disposal of 100 common shares by Henry A. Gossner, officer, leaving a holding of 1,150; disposal of 200 common shares by Palmer Nichols, officer, leaving a holding of 547.

Braniff Airways, Inc. Disposal of 1,500 common shares by Milton McGreevy, director, leaving a holding of 2,500.

California Eastern Aviation, Inc. Acquisition of 1,000 common shares by Samuel J. Solomon, officer for a holding of $26,848.

Capital Airlines, Inc. Acquisition of $21,000 worth of 4¼% convertible sub-debentures by J. B. Franklin, officer, for a holding of $34,000; acquisition of $30,000 worth of 4¼% convertible sub-debentures by Thomas B. Neelands, director, for a holding of $160,000.

Continental Air Lines, Inc. Acquisition of 1,300 common shares by Frederick L. Ehrman, director, for a holding of 4,136; acquisition of 1,000 common shares by Joseph A. Uhl, officer and director, for a holding of 3,957; acquisition of $5,000 worth of 4¾% convertible debentures (1970) by Lawrence C. Ames, director, for a holding of $50,000.

Curtiss-Wright Corp. Disposal of 500 common shares by Frank H. Hankins, Jr., officer, leaving a holding of 3,600; disposal of 4,200 common shares by Sam D. Irwin,

officer, leaving a holding of 4,000.

Douglas Aircraft Co., Inc. Disposal of 5,000 capital shares by F. W. Conant, officer and director, leaving a holding of 10,000, with Mrs. Conant beneficially holding 60 shares; disposal of 5,000 capital shares by Donald W. Douglas, officer and director, leaving a holding of 15,000; disposal of 200 capital shares by John A. Dundas, officer and director, leaving a holding of 800.

Allen B. DuMont Laboratories. Acquisition of 100 common shares by Frederick H. Guterman, officer, for a holding of 400; acquisition of 900 common shares by Percy M. Stewart, director, for a holding of 1,000.

Eastern Air Lines, Inc. Disposal of 100 common shares by Everett R. Cook, director, leaving a holding of 1,356; acquisition of 145 common shares by William Van Dusen, officer, for a holding of 2,650.

Flying Tiger Lines, Inc. Acquisition of 600 common shares by Ruth H. Axe, director, for a holding of 600; acquisition of 600 common shares by Leonard S. Kimball, officer, his entire holding; disposal of 500 series "A" preferred shares by Fred Benninger, officer, his entire holding.

General Dynamics Corp. Disposal of 10,500 common shares by Lambert J. Gross, officer, leaving a holding of 12,157 and disposal of 630 common shares by a trust under Gross, owning beneficially, its entire holding; disposal of 600 common shares by Kenneth Stiles, officer, leaving a holding of 1,000; disposal of 14,910 common shares by Robert C. Tait, officer, leaving a holding of 9,060; disposal of 1,000 common shares by Robert B. Watts, officer, leaving a holding of 2,640.

General Electric Co. Acquisition of 683 common shares, through exercise of option, by Walter R. G. Baker, officer, for a holding of 12,974; disposal of 1,100 common shares by John W. Belanger, officer, leaving a holding of 11,163; acquisition of 1,930 common shares through exercise of option, by William R. Herod, officer, for a holding of 10,006; acquisition of 200 common shares through exercise of option, by H. A. MacKinnon, officer, for a holding of 6,427; acquisition of 1,125 common shares by Francis K. McCune, officer, for a holding of 7,276; acquisition of 297 common shares by Harold A. Olsen, officer, for a holding of 2,307; acquisition of 3,200 common shares by Philip D. Reed, director, for a holding of 10,000.

Grumman Aircraft Engineering Corp. Acquisition of 300 common shares by George F. Titterton, officer, for a holding of 2,500.

Lear, Inc. Acquisition of 262 common shares as a bonus, and disposal of 257 common shares by Robert H. Bloomberg, officer, making a holding of 262; acquisition of common stock in the following order under Philip E. Golde, Trustee: u/a W. P. Lear, 10/7/57, 1,350 shares for a holding of 1,350, u/a W. P. Lear, 12/15/49, 1,250 shares for a holding of 6,830 and u/a W. P. Lear, 11/1/44, 2,500 shares for a holding of 34,542.

McDonnell Aircraft Corp. Disposal of 146 common shares by Kendall Perkins, officer and director, leaving a holding of 1,802.

National Aviation Corp. Acquisition of 400 common shares by Frederick F. Robinson, officer, for a holding of 500.

North American Aviation, Inc. Acquisition of 250 common shares by Asa V. Call, director, for a holding of 750.

Nuclear Corporation of America. Acquisition of 4,900 class "A" common shares by Engelhard Industries, Inc., a beneficial owner, for a holding of 1,101,800.

Pan American World Airways, Inc. Acquisition of 500 capital shares through exercise of option by John S. Woodbridge, officer, for a holding of 3,000; disposal of 459 capital shares by Alvin P. Adams, officer, leaving a holding of 2,000.

Piper Aircraft Corp. Acquisition of 100 common shares by W. T. Piper, officer and director, for a holding of 3,053.

Radio Corporation of America. Acquisition of 100 common shares by George Y. Wheeler II, officer, for a holding of 10,733; disposal of $10,000 worth of 3½% convertible sub-debentures by Frank M. Folsom, officer, for a holding of $70,000.

Raytheon Manufacturing Co. Acquisition and disposal of 5,000 common shares by Ernest F. Leaman, officer, for a holding of 5,838.

Reynolds Metals Co. Acquisition of 3,000 common shares by United States Foil Co., a beneficial owner, for a holding of 5,236,944, with Reynolds Corp., holding beneficially 327,699 common shares.

Ryan Aeronautical Co. Acquisition of 200 common shares by Emtor, Inc., a beneficial owner, for a holding of 109,000.

Seaboard & Western Airlines, Inc. Acquisition of 200 common shares by John H. Mahoney, officer, for a holding of 608; acquisition of 2,500 common shares by Arthur V. Norden, officer and director, for a holding of 62,115; disposal of 1,000 common shares by Raymond A. Norden, officer and director, leaving a holding of 56,363.

Slick Airways, Inc. Acquisition of 1,000 common shares by John R. Alison, director, for a holding of 2,000.

Sperry Rand Corp. Disposal of 200 common shares by a joint ownership under Harry Landsiedel, owned beneficially, leaving a holding of 10,260 with Landsiedel directly holding 13,904; disposal of 100 common shares by Charles Ondrick, director, leaving a holding of 400; disposal of 13,500 common shares by H. F. Vickers, officer and director, leaving a holding of 158,491.

Thiokol Chemical Corp. Acquisition and disposal of 100 common shares by S. M. Martin, Jr., officer and director, for a holding of 2,343.

Trans World Airlines, Inc. Acquisition of 35,100 common shares by Hughes Tool Co., a beneficial owner, for a holding of 5,216,501.

United Aircraft Products. Acquisition of 3,700 common shares by a trust under Harry Harris, director, for a beneficial holding of 3,700 with Harris directly holding 5,181 common shares; acquisition of 200 common shares by Robert K. Hart, director, for a holding of 958 with Metal Production Corp. beneficially holding 18,268 and National Highway Hotels, Inc. beneficially holding 8,651, both under Hart.

Western Air Lines, Inc. Acquisition of 300 common shares by Goodrich Lowry, director, for a holding of 516.

Westinghouse Electric Corp. Disposal of 400 common shares by Fergus M. Sloan, officer, for a holding of 751; disposal of 1,300 common shares by Leonard B. McCully, officer, leaving a holding of 1,300.

AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command:

The Gertenslager Co., Wooster, Ohio, semitrailer, air-conditioned, air-transportable, expandable van body, with retractable running gears for housing and transporting photographic equipment. (PR-13569), $57,458.

Lockheed Aircraft Corp., Burbank, Calif., instrumentation and flight test program for F-104B aircraft: (PR-PH-8-1510-7025), $2,519,240; T-33 aircraft; (PR-PH-8-1510-7176), $400,000.

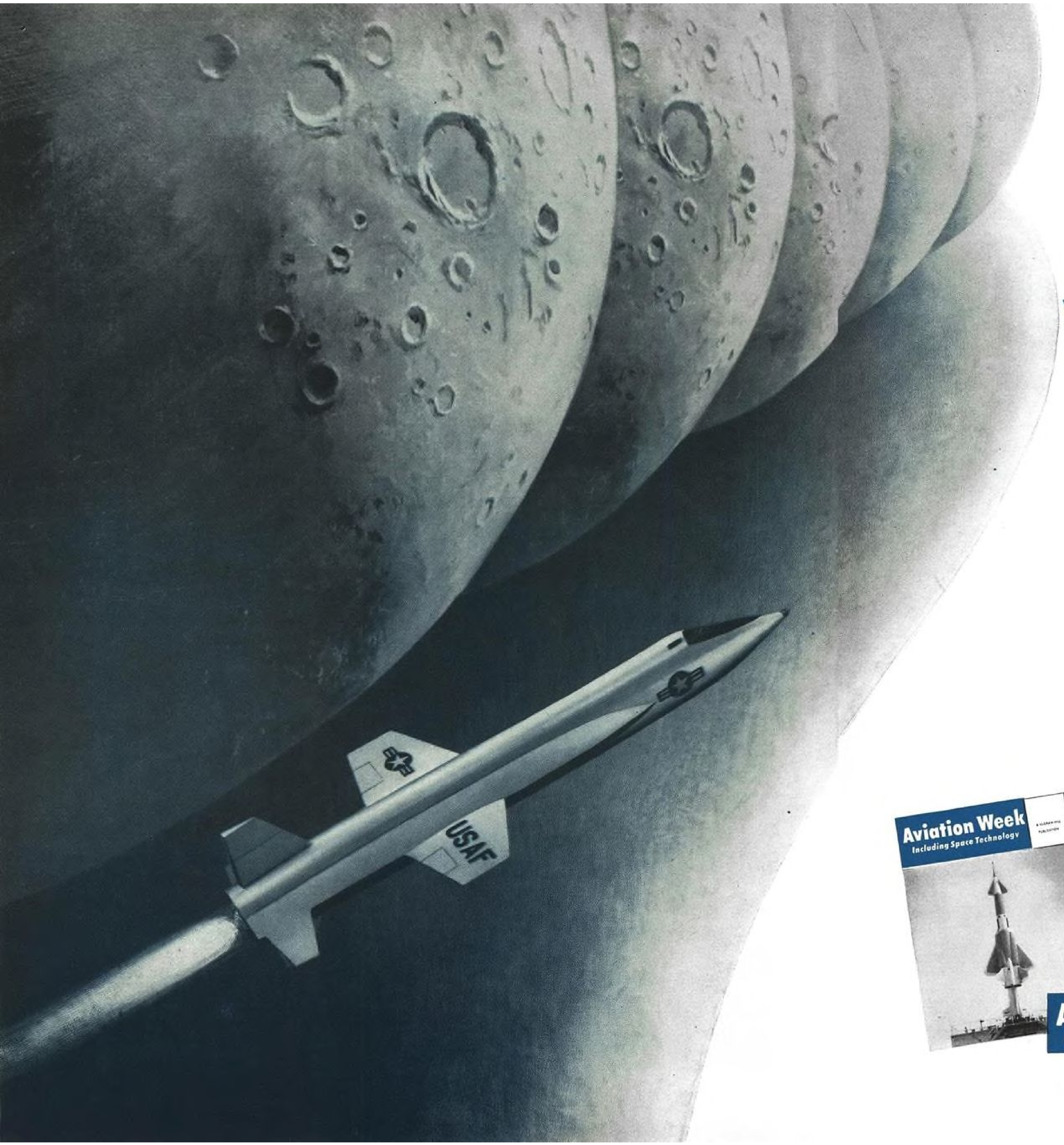
Sikorsky Aircraft Division, United Aircraft Corp., Stratford, Conn., H-37A helicopters, spare parts, special tools, data and engineering changes; MIPR-R-58-805-TC), $16,800,000.

Philco Corp., Philadelphia, Pa., AC&W on-site maintenance for Eastern and Western Air Defense Forces, Air Defense Command, (PR-ME-8-TS-2990), $1,751,187.

Boeing Airplane Co., Seattle, Wash., materials and equipment to design, pilot, produce, test and evaluate titanium castings suitable for use in aircraft construction; (PR-PB-7-MMP-6287), $675,327.

Bausch & Lomb Optical Co., Rochester, N. Y., photogrammetric rectifiers, data and ground support equipment; (PR-119631 and 73692 (old PRs) new PR: MO-58-10B-726), $255,743.

Radio Corporation of America, Camden, N. J., replenishment spare components for E-series fire control system control, (radar



"Research for Space"

1958's big AVIATION WEEK editorial theme

June 16th marks the publication date of AVIATION WEEK's "Research for Space", 1958's most ambitious and dramatic editorial effort. Major areas of editorial attention: missiles, satellites, spacecraft, space probes, Dyna-Soar, avionics, exotic fuels and hypersonic aircraft, are presently engaging the attention of the world and exciting the imagination of scientific and military minds everywhere. The soaring national defense expenditures earmarked for national defense effort in these fields and general aviation procurement, amounting to some $10 billion scheduled to be expended in the second half of 1958, i. e. (January-June 1958) spotlight the timeliness of this issue.

Last year's "Research and Development" issue generated over 18,000 top-quality inquiries. This year's "Research for Space" edition will exceed this number substantially. *Regular AVIATION WEEK* contract rates will apply. Positions will be accorded on the basis of the date insertion orders are received. Now is the time to schedule your advertising message in 1958's most dramatic and useful edition, "Research for Space".

World-wide distribution of over 70,000* net paid subscribers plus several thousand extra copies for copy sales to scientific, military, industry and government personnel, provides industry advertisers with an unmatched audience for the sale of their services, materials and products.

***Net Paid ABC December 1957: 67,008.**

Aviation Week
Including Space Technology

A McGRAW-HILL PUBLICATION,
330 WEST 42nd STREET, NEW YORK 36, N. Y.
ABC ABP

set for F-86 and F-94 aircraft), (PR-WR-7-1270-1005), $27,593.

Breeze Corporation, Inc., Union, N. J., starter-generator, type MC-1, cover assemblies, starter-generator, model VG-622 and data for T-37 aircraft; (PR-PE-8-03C-3065), $198,202.

Hughes Aircraft Co., Culver City, Calif., joint USAF/CVAC/HAC F-86 A/B AWCS and armament evaluation program; (PR-PE-8-11B-3360), $1,118,965.

Morse Instrument Co., Hudson, Ohio, various replacement spare parts for A-10A, A-13 dryer, A-14, A-14A printers, A-8 and B-5A processors and ground support equipment; (PR's, MO-8-10B-718 and amendment #1, MO-8-10D-812 and amendment #1 and MO-8-6470-1324 and amendment #1), $51,546.

Leland Electric Co., American Machine and Foundry, Dayton, Ohio, inverters, 1,500 VA, applicable to the C-130B aircraft; (PR-PE-8-03C-3341), $52,017.

General Tire and Rubber Co., Akron, Ohio, main wheels and brake assemblies for T-37A aircraft; (PR-PE-7-03B-4623 and amendments 1 and 2), $196,859.

Propeller Division, Curtiss-Wright Corp., Caldwell, N. J., material and services for cover propeller product improvement program for C-133, ZPG-3W and other in-service military aircraft utilizing Curtiss-Wright propellers; (PR-PE-8-03A-3449), $1,485,252.

General Electric Co., West Lynn, Mass., transmitter, rate of flow, fuel, type THU-7/A, used on B-52F and G aircraft; (PR-PE-8-05D-3255, and amendment #1), $1,-130,162.

CAA Contracts

Washington—Following is a list of contracts as released by the Civil Aeronautics Administration:

Nems-Clarke Co., Silver Spring, Md., $741,157.50, teletypewriter line switching units and instruction books.

Lenkert Electric Co., Inc., San Carlos, Calif., $258,547.30, for carrier panels and associated equipment.

Gabriel Electronics, Needham Hgts., Mass., $153,890, for 22 air traffic control beacon interrogator antenna units.

Topp Manufacturing Co., Inglewood, Calif., $102,944, for 60 transmitters and spare parts.

Northern Radio Co., New York, N. Y., $81,969.50 for diversity converters and spare parts.

Topp Manufacturing Co., Inglewood, Calif., $77,140 for 280 test sets.

Teletype Corp., Chicago, Ill., $67,715.56, teletypewriter units and spare parts.

Topp Manufacturing Co., Inglewood, Calif., $54,584.76 for 77 polariscopes and spare parts .

Hickok Electrical Instrument Co., Cleveland, Ohio, $53,219.76 for 161 oscilloscopes and 25 transformers.

Topp Manufacturing Co., Inglewood, Calif., $45,731.96 for 56 automatic transfer units for instrument landing system and associated equipment.

Lambda-Pacific Engineering, Inc., Van Nuys, Calif., $38,025 for 25 sets of testing equipment.

D. S. Kennedy & Co., Cohasset, Mass., $37,098.03 for 11 antenna units.

Hewlett-Packard Co., Palo Alto, Calif., $32,680.48 for 56 oscillators.

Components Engineering & Manufacturing Co., Inc., Miami, Fla., $28,407.12 for 296 relay racks.

Industrial Nucleonics Corp., Columbus, Ohio, $27,496.61 for receiver selectors and spare parts.

Federal Telecommunications Laboratory, Nutley, New Jersey, $26,500 for 10 TACAN ramp test sets.

Radio Corporation of America, Camden, N. J., $23,429.50 for video switches, changeover switches, synchronizing generators and related equipment.

Collins Radio Co., Cedar Rapids, Iowa, $20,345 for receivers and spare parts.

Hickok Electrical Instrument Co., Cleveland, Ohio, $19,244.24 for 132 tube testers.

WHO'S WHERE

(Continued from page 23)

Changes

Dr. Chuk Ching Ma, Dr. Gadlicherla Rao, and **Dr. Wilton P. Chase** have joined Rocketdyne division of North American Aviation, Inc., Canoga Park, Calif., as specialists-advanced design section.

Fred O. Draper, supervisor-production and supply, Republic Aviation Corp.'s Helicopter Division, Farmingdale, N. Y.

Oscar Ahlers, general manager, The Sheffield Corp., Dayton, Ohio.

Robert J. Bibbero, chief engineer, Applied Science Department, Bulova Research and Development Lab. Inc., Woodside, N. Y.

W. W. Roodhouse, general sales manager, and **R. C. Frost,** director-International Division, Collins Radio Co., Cedar Rapids, Iowa.

Glenn S. Gipson, general manager, and **Verne R. Anthony,** plant manager-manufacturing, Prototype Engineering Co., Inglewood, Calif.

Dr. G. S. Hislop, chief engineer (aircraft), and **L. R. E. Appleton,** chief engineer (Heston), The Fairey Aviation Company Ltd., London, England.

Philip G. Cawrey, aircraft sales manager, Western Division, Aeroquip Corp., Burbank, Calif.

Charles W. Snider, director-government relations, Defense Operations Division, Chrysler Corp., Detroit, Mich.

Charles F. Pitts, assistant division general manager, Astronics Division, Lear, Inc., Santa Monica, Calif. Also: **F. Dunstan Graham,** Eastern Operations Manager (Grand Rapids, Mich.)—engineering activities, and **Donald W. Dressel,** manager-Astronics Manufacturing Division. Astronics Contracts Division appointments include: **John A. Harper,** manager-guidance and control marketing; **Jess Uslan,** head-contracts administration; **R. Lynn Eslinger,** assistant manager-electronic marketing. Astronics Engineering Division appointments include: **Frank A. Glassow,** manager-electronics; **Ralph Braverman,** manager-guidance and flight control; **Kenneth Kramer,** assistant manager-guidance and flight control.

Col. Ray M. Sinnen (USAF, ret.), manager, Southeastern Branch, Lytle Engineering & Manufacturing Co., Fort Walton Beach, Fla.

Frank L. Spencer, assistant manager-engineering program development, Technical Products Division, Waste King Corp., Los Angeles, Calif.

Winston O. Faith, director of advanced engineering, Varo Manufacturing Co., Garland, Tex.

Harold M. Harrison, assistant chief engineer, California Division, Lockheed Aircraft Corp., Burbank, Calif.

Wilbur R. Hankes, director of military relations (Washington, D. C.), Avco Research Laboratory, Everett, Mass.

Robert O. Borst, manager-engineering and sales, Schroeder Manufacturing Division, Idaho Maryland Mines Corp., Long Beach, Calif.

Allison E. Gossett, assistant director-aviation sales, AC Spark Plug Division, General Motors Corp., Flint, Mich.

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES — EQUIPMENT - USED or RESALE

DISPLAYED RATE:

The advertising rate is $31.00 per inch for all advertising appearing on other than a contract basis. Contract rates on request.

AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page.

EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE:

$2.70 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

PROPOSALS, $1.80 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

Send NEW Ads or Inquiries to Classified Adv. Div. of Aviation Week, P. O. Box 12, N. Y. 36, N. Y.

PRICED FOR QUICK SALE
$12,500

B-25J
FLYING LABORATORY

ORIGINALLY CONVERTED FOR EXECUTIVE SERVICE BY REMMERT-WERNER

- ENGINES R2600-29 65-399 HOURS
- TOTAL AIRFRAME-1688 HOURS
- DUAL AIR-ELECTRIC PANEL
- FULL RYAN COLLECTOR RING
- S-200 JANITROL HEATER
- EDISON FIRE DETECTOR SYSTEM
- RADAR RADOME INCLUDED
- 300 AMP GENERATORS

- RADIO EQUIPMENT
  - 1-COLLINS 51R-3 RECEIVER
  - 1-BENDIX TA-1888 TRANSMITTER
  - 1-24 CHANNEL ARC-3 TRANSCEIVER
  - 1-COLLINS 51R-3-FULL INSTRUMENTATION OMNI RECEIVER
  - 1-ARC-158 OMNI INSTALLATION (INCOMPLETE)
  - 2-COLLINS 51V GLIDE SLOPE RECEIVERS
  - 1-BENDIX MN-53A MARKER BEACON
  - 2-BC-433G COMPASS RECEIVERS

GENERAL ELECTRIC COMPANY - FLIGHT TEST OPERATION
130 SARATOGA ROAD - SCHENECTADY, NEW YORK
R.L. CAINE - FRANKLIN 4-2211 EXT. 2023 OR 2435

FOR SALE

LOCKHEED 12 A

SERIAL 1294 . . . EXECUTIVE

Interior—3 seats and couch—and 2 extra seats go with. Aircraft holds 8 passengers. 5 gas tanks, 249 gallons capacity total. Hamilton Hydromatic Full Feathering props—R985-14B Engines. 430 hours on props and engines since Spartan overhaul. 1-ILS—1 ADF. 3 VFF Trans. 2-ARC 15D Omni Receivers—Dual Panel. Flares. Color is dove grey with red strip and white top. A real beauty. $24,000.

BEECH C 45G

Complete major overhaul "0" time P & W R985-14B 14B engines. 2 new "0" time Hamilton standard hydromatic Full Feathering Props. Ready to go. Less radio and interior. Any reasonable offer accepted.

Both aircraft may be inspected at:

CARMA MFG, CO.
Hangar, Municipal Airport,
Tucson, Ariz.
PO Box 11213 • MA. 3-4511

OPPORTUNITY
AT
CONVAIR FIELD
Allentown, Pa.

This field, ideally located within the city, has 2 concrete runways —3950' and 3400', approx 350 acres and is available to a qualified base operator. Excellent potential for business aircraft sales and service in this growing area with the city population over 115,000.

WRITE TODAY FOR COMPLETE DETAILS

CITY CLERK
CITY HALL, ALLENTOWN, PA.

FINEST AIRCRAFT MAINTENANCE
Twin Beech - DC-3 - Lodestar
CAA Approved Repair Station #3964
Class 1 & 3 No Limitations

SINCE 1937 Page AIRWAYS INC.
ROCHESTER AIRPORT
PHONE: FAirview 8-2720
ROCHESTER 11, N.Y.

RADAR
AUTOMATIC PILOTS, NAVIGATION & COMMUNICATION SYSTEMS
Collins, Bendix, Sperry, Lear, ARC, Wilcox

C-47'S FOR SALE DC-3'S
ALSO
REPAIR OVERHAUL MODIFICATION
VOLITAN AVIATION INC.
12820 Pierce St. Pacoima, Calif.
Phone EM-9-1283

AN FITTINGS & HARDWARE
Stainless, Aluminum, Brass, Steel

All sizes—immediate delivery from world's largest shelf stock. Buy direct from manufacturer. Lower prices—quicker service. Send for free wall charts showing complete line of AN & MS fittings and hardware. We also machine parts to your own special print, and stock AN & MS forgings.

COLLINS ENGINEERING CORPORATION
9050 Washington Blvd. Culver City, California

CERTIFIED INSTRUMENTS
C. A. A. Repair Station No. 4004

SALES AND GUARANTEED SERVICE OF PRESSURE • ELECTRICAL GYRO INSTRUMENTS • NAVIGATION AND OXYGEN EQUIPMENT

— *SPECIAL* —

Kollsman Periscopic Sextants #1471..$1150.00
Pioneer Elect. Gyro Horizon #12402...$450.00
Pioneer Elect. Horizon (PB-10) #14608..$425.00

- *Large Inventory • All Types*
- *Brochure Sent on Request*
- *Inquiries Promptly Acknowledged*

A.I.R. Corporation
OAKLAND MUNICIPAL AIRPORT
OAKLAND, CALIFORNIA

Immediate Delivery

We stock, overhaul, and install

PRATT & WHITNEY **R1830** —75, —92, —94
WRIGHT **R1820** —202, —5, —72

R985 R1340 R2000

and our most popular DC3 engine
R1830 - SUPER - 92

ENGINE WORKS
INC.
Lambert Field Inc. St. Louis, Mo.

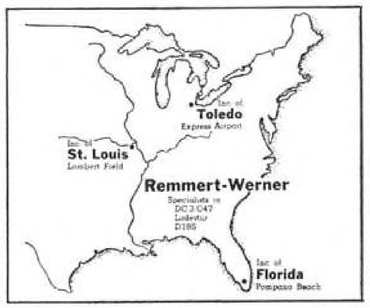
SUMMER COURSE IN AIRCRAFT ACCIDENT INVESTIGATION offered by The University of Southern California, Los Angeles—July 14—July 25, 1958.

For representatives of aircraft manufacturers; CAB and CAA personnel; flight managers, engineers and supervisors; pilots; and others concerned with accident investigation and prevention.

Course deals with investigation of civilian and military aircraft accidents. Includes instruction in collecting and interpreting evidence, preparation of reports, and phases of aero engineering, physiology and psychology pertaining to investigation.

Tuition: $225.00. To register, send check and letter to: University of Southern California Aviation Safety Division, Los Angeles 7, California. Enrollment limited. Advance registration accepted up to July 1, 1958.

Brochure available.



DC-3 AIRCRAFT

Airline operated, progressively maintained fully equipped, excellent condition. Heavy gear, Pratt & Whitney -92, full radio, galley 21 seats, standard entrance, baggage-master door, full anti-ice and de-icer, Janitrol heat.

PRICED TO SELL!

LUND AVIATION (CANADA) LTD.
MONTREAL AIRPORT, P. Q.
MElrose 1-3519

Searchlight Section
(Continued)

DEAL DIRECTLY WITH OWNER

EXECUTIVE
LODESTAR
VENTURA
BEECHCRAFT
C18S—D18S
E18S
GRUMMAN
GOOSE and
SUPER WIDGEON
PBY-5A
T-6G—PV-2—B-26
SIKORSKY S-51

AIRLINE DC-3
CARGO C-47
CARGO C-46A

We are owners of all these and interested in the purchase, sale, lease, and trading of all types of aircraft. Advise us of your requirements to receive our custom proposal to meet your exact acquisition or disposal needs.

TRADE—AYER CO.
Linden Airport Linden, N. J.
Wabash 5-3000

FOR SALE

$50,000 YEARLY PROFIT

Aircraft Parts Co. USAF Prime Contractor. 25% profit on annual gross $200,000. Repair, Foreign Sales, Movie & TV rentals. Top USAF Contract Representative. $245,000 in fixed assets, etc. Sale Price $250,000.

BO-7907—Aviation Week
68 Post St., San Francisco 4, Calif.

BEST OFFER
LOCKHEED LODESTAR-18
Wright 1820-56 WA Engines 48 hrs.
New periodic & tank resealing Mar 58
Dual radio & instruments
HAZELL • WOLFF ASSOC.
311 W. Baltimore Ave. Media, Pa. LO 6-8585

FOR LEASE
C-46F FREIGHTER
New conversion, 48,000 lbs. low time aircraft and engines. Will lease for either short or long term very reasonable.
FARRAR AVIATION
325 W. Main St., Ontario, California
Phone YUkon 6-6746

Deal Directly with Owner

HANGARS

U.S. Navy type.
120' clear span
by 200' depth
Doors 120'x28'

All Steel Constructed. Excellent monetary saving and good delivery if you are considering the construction of a hangar of this size.

TRADE-AYER COMPANY
Linden Airport Linden, N. J.
Wabash 5-3000

EMPLOYMENT OPPORTUNITIES

NATIONAL COVERAGE

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Positions Vacant
Positions Wanted
Part Time Work
Civil Service Opportunities
Selling Opportunities Wanted
Selling Opportunities Offered
Employment Agencies
Employment Services
Labor Bureaus

DISPLAYED ——RATES—— UNDISPLAYED

The advertising rate is $45.00 per inch for all advertising appearing on other than a contract basis. Frequency rates quoted on request.

An Advertising inch is measured ⅞" vertically on a column—2 columns—30 inches to a page.

Subject to Agency Commission.

$2.70 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.
Position Wanted Ads are ½ of above rate.
Box Numbers—counts as 1 line.
Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

Send NEW ADS to Classified Advertising Div. of AVIATION WEEK, P. O. Box 12, N. Y. 36, N. Y.

ENGINEERS & SCIENTISTS INTERESTED IN

FLIGHT PROPULSION LABORATORY of GENERAL ELECTRIC

CINCINNATI 15, OHIO

At the level of investigation in progress at the Flight Propulsion Laboratory, so many technical disciplines merge and overlap, that engineering management here *can* and *will*

RE-DESIGN JOB SPECIFICATIONS TO UTILIZE YOUR TECHNICAL BACKGROUND TO THE FULL
...where your experience is substantial.

Opportunities now exist for highly qualified people to work with the Laboratory on advanced concepts and engineering principles applicable to jet and rocket propulsion systems that are planned to operate up to Mach 5 and beyond. FPL is interested in you if you have had 3 to 5 years or more in the following areas:

ADVANCED APPLIED MECHANICS • COMBUSTION • MECHANICAL DESIGN & ANALYSIS • NUMERICAL ANALYSIS • DEVELOPMENT TESTS • METALLURGICAL THEORY & PROCESSING • AERO-THERMO ANALYSIS

(Also a number of positions for engineers and scientists with 1 to 3 years' experience.)

Write Mr. Mark Peters,
Building 100
Department 58WS
Flight Propulsion Lab.

"Thrust And Progress"—showing creative development at FPL—will be sent you on request.

Are you interested?

A successful European manufacturer of small, two place, low wing monoplanes is interested in having the plane produced in the U.S.A. for the American market, under a licensing arrangement or other methods of cooperation.

The plane sells for $4,000.00 in Europe. Requires only 225 feet take-off run. 265 feet landing roll. Gas consumption 4 gallons per hour. Powered with U.S.A. Continental Motor.

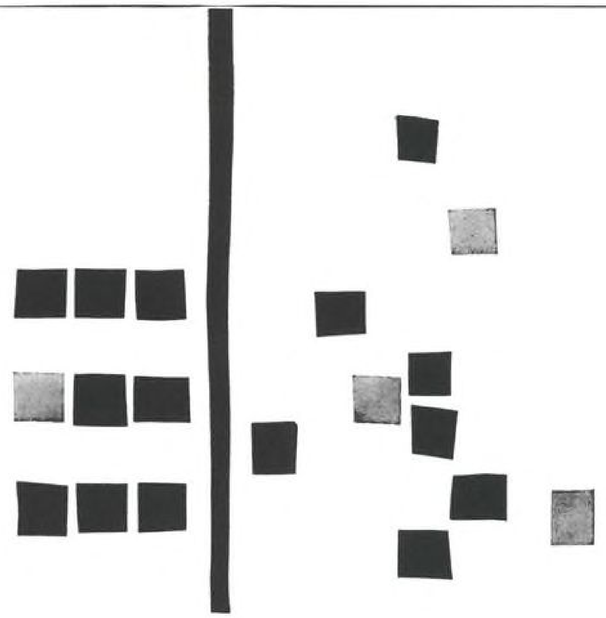
For further information and illustrated literature, write:

CLAUDE R. MYERS
39 Broadway N. Y. City

SUPER WIDGEONS
6-Place . . . Completely equipped.
GRUMMAN GOOSE
Executive . . . Zero SOH.
GRUMMAN MALLARD
630 Hours TT . . . 130 Hours SOH Airframe and engines.
TWIN BEECH SUPER 18
Zero SOH Airframe and engines.
AERO COMMANDER 560E
1957 7-Place . . . 125 Hours TT.
WELSCH AVIATION CO.
60 E. 42nd St. NEW YORK 17, N. Y.
MUrrayhill 7-5884

***When Answering* BOX NUMBERS . . .**

to expedite the handling of your correspondence and avoid confusion, please do not address a single reply to more than one individual box number. Be sure to address separate replies for each advertisement.



THE ELEMENT OF FREEDOM

and the System-Oriented Engineer

Freedom is doing what you like. Some system-oriented engineers like best to match their wits and skills against difficult problems. This characteristic or (idiosyncrasy) of liking complicated technical problems is one of the chief qualifications of the engineer we need. He will be required to study the multitude of interactions possible among advanced aircraft, missiles, and electronic devices with each other and with human elements in the nation's most extensive man-machine-computer system.

To qualify, substantial experience with air-to-air or ground-to-air missiles systems is required together with demonstrated aptitude in the field of system planning. Write for more information or call collect. Address: R. W. Frost, System Development Corporation, 2404 Colorado Ave., Santa Monica, California, EXbrook 3-9411.

SYSTEM DEVELOPMENT CORPORATION

An independent nonprofit organization, formerly a division of the Rand Corporation

CRYOGENIC ENGINEERING

This industrial research organization has openings at Cambridge for mechanical and chemical engineers to work in research and development in gas liquefaction and processing. Work will include basic thermodynamic cycle analysis, fluid mechanics, experimentation and pilot operation, insulating systems, design of complete systems, process instrumentation, thermal stress analysis, and mechanical design.

ADL is currently engaged in missile work and in research and development of gas liquefaction, storage, and handling systems for industry and Government.

Applicants must have B.S. degree plus at least five years in industry or equivalent. Experience in design and fabrication of process equipment helpful.

Send resume to CHARLES T. SCHOCK.

Arthur D. Little, Inc.

ENGINEERING DIVISION
CAMBRIDGE 40, MASSACHUSETTS

HELICOPTER

Pilots and mechanics needed
Pilots must have 500 hours
call or write
RICK HELICOPTERS, Inc.
San Francisco Airport, S. F. 28
Ph. *Juno 8-3871*

ADDRESS BOX NO. REPLIES TO: Box No. Classified Adv. Div. of this publication. Send to office nearest you.
NEW YORK 36: P. O. BOX 12
CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

POSITIONS VACANT

Air Commerce Consultant wanted by New York State Department of Commerce. Salary Range $8750 to $10,520. Civil Service examination to be held June 21, 1958. Write to NYS Department of Civil Service, Albany 1, New York before May 23 for detailed announcement and application forms.

Needed Constellation Flight Engineers and Navigators for overseas operation. P-7942, Aviation Week.

Helicopter Mechanics—With experience on Bell helicopters. Both domestic and foreign assignments. Helicopter Surveys, Inc., P. O. Box 186, Sta. B., Bakersfield, Calif.

SELLING OPPORTUNITIES OFFERED

Sales Representative Aircraft Eng. O/H Services. Your engine O/H knowledge and abilities as self-starter more important than experience. You will become Regional Mgr in Chicago or N. Y. area with good draw against commissions. Salary while training. Considerable travel. RW-7912, Aviation Week.

SELLING OPPORTUNITY OFFERED

Manufacture of Honeycomb Structure Sub-Assemblies seeks accredited selling agents with top level contacts with Prime and Sub-Contractors of Airborne and Ground-Surface Equipment. Product widely accepted among design engineers which has high application potential. Open Territories Southwest, Mid-West, West Coast, and Parts of East Coast. Submit full details resales coverage, personnel, and lines handled. RW-7962, Aviation Week.

EMPLOYMENT SERVICE

Technical Ground Service Personnel Available Free Information on Technicians with backgrounds in A&E-Electrical—Sheet Metal—Hydraulics Light Aircraft—Helicopters—Jet Powerplants—Airline Maintenance—Contact Pittsburgh Institute of Aeronautics, Allegheny County Airport, P. O. Box 10897, Pittsburgh 36, Pennsylvania. Phone Collect —Homestead 1-7500 or 1-0463.

POSITIONS WANTED

Experienced Sales Engineer available with established contacts in the East Coast Aircraft Industry will represent your company, lend technical assistance and increase sales. College Graduate. PW-7740, Aviation Week.

Seek permanent position to represent mfg'r in Electronics or Power—San Francisco area or Western States—Elect. Eng'r 5½ yrs. Sales experience—West Coast. Age 39. PW-7948, Aviation Week.

Sales Engineer, 12 yrs aircraft and 8 yrs valve sales exp. desires position with aircraft access mfgr. Prefer to work out of Maryland for representation in this as well as Pa., D. C., and southern areas. PW-7917, Aviation Week.

ATR Pilot—Lodestar, DC-3, Twin-Beech. 6000 hrs. executive, scheduled aircarrier, military. College education, excellent references. Age 37, family. Resume on request. PW-7951, Aviation Week.

Graduate Chemist. Thirteen years experience conducting, planning, and directing development and applied research on aircraft and automotive petroleum and synthetic oils, hydraulic fluids, gasoline, jet fuel, and on physical and chemical evaluation techniques. Age 34. Married. Two children. Prefer West Coast location. PW-7916, Aviation Week.

SELLING OPPORTUNITY WANTED

75% of multi million dollar exports of U. S. aviation equipment go to Latin America . . . To those firms seeking to find new outlets to bolster production, and those not equipped to handle exports, we can supply the high caliber sales staff and export know-how to assure profitable exploitation of this lucrative market. Three principals offer combined sixty years of aviation experience, fifteen years spent in developing profitable Latin markets for two U. S. plane builders and one aviation electronics firm. We are uniquely well equipped to assume your complete export sales and marketing functions from strategic Florida location at the gateway to the Americas. Exclusive export agency Umbaugh Aircraft Corp. Please Contact. RA-7950, Aviation Week.

FOR SALE

For sale by public bid. (1) Vultee L-13A Airplane, S/N 47-336A. Interested parties contact Business Manager, Reedley Joint Union High School, Box 552, Reedley, California, for information and bid forms.

BOOKS AND PERIODICALS

$2.00 Can Save You Hundreds. Now you can receive monthly information on hundreds of large and small aircraft for sale throughout the United States. At a glance you will know what is available, hours, date licensed, price, etc. We tell who owns the aircraft; you deal direct. Send $2.00 today for a full year's subscription to Flyers' Market, 5305 Congress Pkwy., Chicago 44, Ill.

All aviation books on 30 day approval. 263 aerodynamics titles are listed in free catalog A.1. Aviation Publications Service, P. O. Box 566, Ypsilanti, Michigan, USA.

DON'T FORGET
the box number when answering advertisements. It is the only way we can identify the advertiser to whom you are writing.

Ta ... and You

Ta (tantalum) is a rare element. Some engineers are rare elements, too. They stand a creative notch above their colleagues. Not because of qualifications . . . because of qualities. Insatiable curiosity . . . iron-backed determination . . tenacious thoroughness – these make rare element engineers. Men with qualities like these are needed to fill positions now open.

MECHANICAL DESIGN

Create and analyze aircraft gas turbine component designs. Provide techniques for solving critical problems related to static and rotating parts. — B.S. or M.S. degree, gas turbine experience.

THERMODYNAMICS

Create aero-thermodynamic designs for engine components. Specify engine testing; conduct engine growth and product improvement studies. — M.E. or A.E. degree, gas turbine experience; performance analysis.

These positions demand your rare element. Write us in confidence.

MR. WILLIAM MERRILL, Technical Recruiting
SMALL AIRCRAFT ENGINE DEPARTMENT

GENERAL ELECTRIC

1107 Western Avenue, West Lynn, Massachusetts.

ENGINEERS

RESPONSIBLE POSITIONS at SIKORSKY HELICOPTER

- **STRUCTURAL DESIGN ENGINEERS** — Candidates must have B. S. or M. S. degree in Aeronautical Engineering. Five years' experience in major aerodynamic studies and influence on design configuration involving EXTERNAL AERODYNAMICS, STRUCTURES, STABILITY AND CONTROL.
- **AVIONICS ENGINEERS** — SONAR SYSTEMS, AUTOMATIC CONTROL AND DRONE SYSTEMS, NAVIGATION AND COMMUNICATION SYSTEMS. Three to five years' experience. B. S. or M. S. degree in Electrical or Mechanical Engineering.
- **DYNAMIC ENGINEERS** — ACOUSTICS, VIBRATIONS, AND FLUTTER ANALYSIS. Three to five years' experience. B. S. or M. S. degree in Aeronautical, Mechanical or Electrical Engineering.
- **MECHANICAL DEVELOPMENT ENGINEERS** — B. S. or M. S. degree in Mechanical, Civil or Aeronautical Engineering. Must have minimum two years' experience in stress analysis, fatigue phenomena or design analysis of gears, bearings, shafts, linkages, etc. For advanced studies on rotor heads, blades and power transmission.

Please send a complete resume to Mr. R. L. Auten, Bridgeport Personnel Department.

SIKORSKY AIRCRAFT

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BRIDGEPORT and STRATFORD, CONNECTICUT

ADVERTISERS IN THIS ISSUE

AVIATION WEEK, MAY 12, 1958

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

LETTERS

Captain Answered

Have just finished reading the letter from the unidentified Western Captain in the April 14 issue (p. 118), and feel that this hypocrisy must not go unanswered.

I cannot help but wonder why this gentleman pays his ALPA dues. Can it be just for that little matter of $650 a month in strike benefits he gets from the rest of us? This captain's 15 years seniority undoubtedly enables him to fly very desirable trips with commensurate attendant working conditions—in short, best trips, best available pay, best time off. I doubt if my compatriots, who are back East flying up and down the coast 22 days a month in all kinds of the worst weather for less money than this man's strike benefit per month, are very happy to shell out for this kind of two-facedness. I know I'm not.

This captain also states that he doesn't want a third pilot "featherbedding" in the cockpit of his turbine transport. Possibly what he really means is that he doesn't want anyone to cut into his pay potential for flying jets and turboprops. He probably also would like to fly 85 hours a month in jets for the same reason. If it ever happens that he does, I hope his loyalty to Western remains unshaken when he finds himself on duty all day for about 22 days a month.

This man seems to bear out an expression that I overheard a short time ago. Two junior captains on my airline were talking, and one was heard to say: "One of the best things about checking out as captain is not having to fly with some of the captains you know!"

BERT A. SMITH
Los Angeles, Calif.

Taxed to Subsidize

Re: the article on cargo carriers in the April 7 issue, p. 38-39, the spokesman for American Airlines' statements against the cargo carriers' subsidy, I wonder if he can remember how long I paid taxes to subsidize his airline!

A Cargo Airline Pilot
Hialeah, Fla.

P.S. Please withhold my name as I may be looking for employment with American Airlines if our request for subsidy is refused.

Amateur Incentive

After talking with many people here in California interested in amateur flying, I am convinced that if there was a plane that could be marketed for about $1,800 the business would quadruple in size and number.

CHARLES WOLFE
Port Chicago, Calif.

Change R&D Policy

There are at least two causes for the apparent engineer shortage which I did not see set forth in recent letters to the Editor.

1. In many large companies a significant percentage of the engineers, as far as I can determine, spend the bulk of their time keeping up with the state of the art of what other engineers (fewer in number) are developing.

2. Archaic R & D procurement practices often result in more engineering man hours being spent by competing firms in preparing proposals than are required to perform the research being procured. The government, in its efforts to avoid favoritism, has shirked the responsibility of doing an efficient buying job. The key to intelligent R & D buying is in source selection.

I know of no better way to gain more top-level technical horsepower than to free key engineers from a large amount of proposal work by intelligent pre-selection of R & D sources. Competitive bidding should not be eliminated, but the number of competing sources can certainly be cut down from the current vogue of 25 to 50, to something on the order of three to six.

Such a policy change would save not only industry's engineers, but would eliminate much nonproductive work on the part of the government project engineers who must perform the technical evaluation of the proposals.

If such a policy was adopted, it would reduce overhead expenses and hence save the taxpayers money, as well as result in a higher level of technical competence by easing the proposal burden somewhat.

J. D. WINNINGHOFF
Norwalk, Connecticut

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42 St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Defense Functions

I strongly disagree with the recommendation of Mr. Trippodi in the March 24 Letters column ("Space Force," p. 94). His suggestion would only perpetuate the present division of the services which is based on means of transportation. This division is not valid, as can easily be seen in the present hassle of who fires what missile.

Instead of adding another service, I propose a more fundamental revision of the Defense Department. The structure of an organization should be determined by the functions that organization has to perform. The first goal then is to determine what are the functions of the Defense Department.

In modern war there are two basic functions which must be performed. The first of these is to guarantee to one's own side the benefits accruing from possession of certain pieces of territory. This means occupation and defense of that territory by ground troops. The second function is to deny the enemy the benefits which would otherwise accrue to him from his possession of certain pieces of territory. This is accomplished by aerial bombardment of the territory, air-sea blockade, etc.

These two functions are co-equal, but the proper proportion of each required will depend on the political objectives of the military action. In some cases, one or the other can be used alone, as in the case of the "administration" of certain Central American republics by the U. S. Marines in the 1920s, or the bombing of villages of rebellious tribesmen in the Near East by the R.A.F., likewise in the 1920s. In general, however, both functions will be required.

My proposal is that the Defense Department consist of only two services, each organized to carry out one of these two functions. Each service should have all the weapons needed to carry out its particular function.

The "occupying" service should be equipped with everything from side arms to ballistic missiles which it might require.

The "strategic" service should be equipped with everything from submarines to space ships which it might require. Certain overlapping functions, such as troop transport or air defense; could be assigned arbitrarily.

This revision would not only solve the present question of "who flies the space ships," it would prevent a recurrence of the problem. No matter what future innovations occur in military science, including mental telepathy, death rays or any other device of the science fiction writer, it would be assigned to either or both of the services, depending on which function it could perform.

JOSEPH P. MARTINO
Dayton, Ohio

Value Compromised

A fact that is brought out in this week's Safety Section of AW (Feb. 3, p. 93)—the investigation of the American Airlines Flight 327 accident at Tulsa Airport, Jan. 6, 1957—brought to my attention a condition which I believe is a definite hazard.

When we have such a fine reliable instrument in our cockpits as the altimeter, it is truly a crime to compromise its value by increasing the possibility of human error. I believe this is done by the American Airlines procedure of setting different altitude readings in the captain's and first officer's altimeters. It is obvious to me that following this procedure was the basic cause for this accident. If both altimeters are consistently set the same—either altitude above field elevation, or altitude above MSL—there should never be a question of what "700 feet" means. Seven hundred feet will always be 700 feet, and there should never be a communications error or misunderstanding among crew members if both altimeters are set the same.

This, of course, does not imply that Capt. Mims should be absolved of responsibility in this accident or of monitoring First Officer Johnson's approach, but I contend that if both pilots were accustomed to having altimeters set alike this accident would not have happened

THEODORE A. JONES
Former Air Force Pilot
Greenwich, Conn.

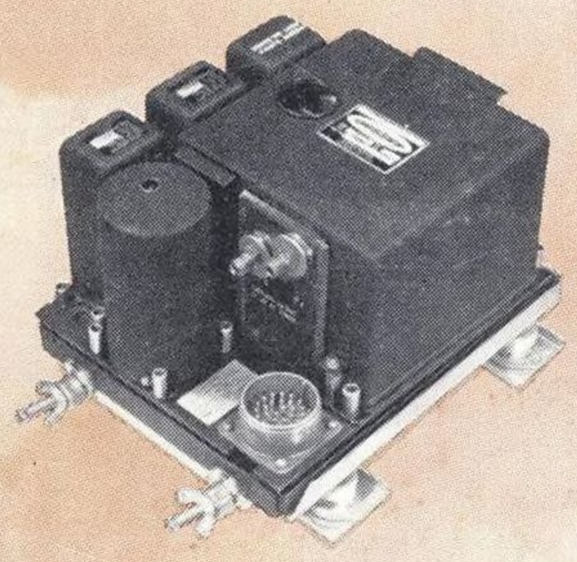
"LOOKOUT" 1958

The modern-day lookout's masthead is the U. S. Navy's long-range Anti-Submarine aircraft. His eyes, electronic. His quarry, unfriendly submarines.

This mission requires constant and complete patrolling of all vital areas in accordance with the pre-planned patrol pattern. Pinpoint navigation and precise positioning of the aircraft at all times is essential. To maximize the navigational capabilities of the Navy's "flying patrol," highly accurate True Airspeed Computers, designed and produced by Servomechanisms, Inc., are now being installed. Utilizing a force balance transducer, designed by SMI, the computer has an exceptional accuracy...within 2 knots in range of from 100 to 250 knots.

This computer is only one of a whole series of True Airspeed Computers produced by SMI. Completely transistorized True Airspeed Computer designs for use on aircraft assigned to various missions, are also available. These computers, which operate over a wide range of speeds, exhibit the same high degree of performance, accuracy and reliability.

The computers are another example of Servomechanisms' Mechatronic Design Philosophy, wherein each major function is accomplished in a separate, functionally packaged module. The plug-in, pull-out design reduces down time to a minimum and enables semi-skilled personnel to maintain this equipment by simple substitution of the plug-in modules.



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