Aviation Week

Including Space Technology

Cents

A McGraw-Hill Publication

December 28, 1959

SPECIAL REPORTS:

Republic F-105

•

Yakovlev Details

Yak-24 Program

Republic F-105 Thunderchiefs

AVIATION CALENDAR

Jan. 11-13—Sixth National Symposium on Reliability and Quality Control in Electronics, Statler-Hilton Hotel, Washington, D. C.

Jan. 11-15—1960 Annual Meeting, Society of Automotive Engineers, Sheraton-Cadillac and Statler Hotels, Detroit, Mich.

Jan. 12-16—16th Annual Technical Conference, Society of Plastics Engineers, Conrad Hilton Hotel, Chicago, Ill.

Jan. 18-20—12th Annual Convention, Helicopter Assn. of America, Disneyland Hotel, Anaheim, Calif.

Jan. 18-21—Sixth Annual Meeting, American Astronautical Society, Statler-Hilton Hotel, New York, N. Y.

Jan. 18-Feb. 5—Aviation Institute for Business Pilots and Commercial Carriers, University of Southern California, Los Angeles, Calif.

Jan. 20-22—Capitalizing on Technology, Special Research and Development Conference, American Management Assn., Roosevelt Hotel, New York, N. Y.

Jan. 25-26—Annual Meeting, Association of Local Transport Airlines, National Aviation Club, Washington, D. C.

Jan. 25-28—28th Annual Meeting, Institute of the Aeronautical Sciences, Hotel Astor, New York, N. Y. Honors Night Dinner, Jan. 26.

Jan. 28-29—Solid Propellants Conference, American Rocket Society, Princeton University, Princeton, N. J.

Feb. 1-4—Winter Conference & Exhibit, Instrument Society of America, Rice Hotel and Sam Houston Coliseum, Houston.

Feb. 3-4—Sixth Annual Midwest Welding Conference, Illinois Tech Chemistry Bldg., Chicago, Ill. Sponsors: Armour Research Foundation of Illinois Institute of Technology; Chicago Section, American Welding Society.

Feb. 3-5—1960 Winter Convention on Military Electronics, Institute of Radio Engi-

(Continued on page 6)

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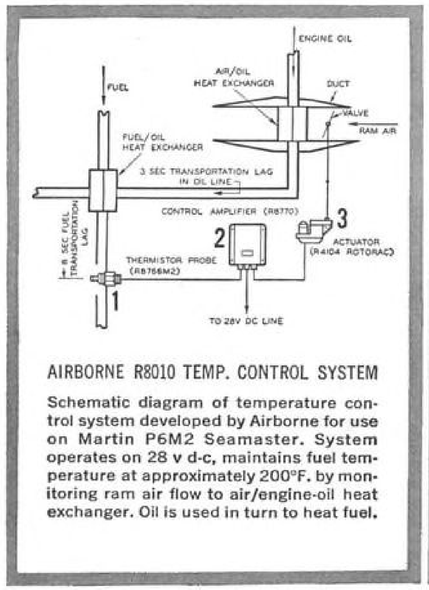

AIRBORNE R8010 TEMP. CONTROL SYSTEM

Schematic diagram of temperature control system developed by Airborne for use on Martin P6M2 Seamaster. System operates on 28 v d-c, maintains fuel temperature at approximately 200°F. by monitoring ram air flow to air/engine-oil heat exchanger. Oil is used in turn to heat fuel.

Airborne electromechanical system regulates jet fuel temperature

An integral part of each main engine installation on the Martin P6M2 Seamaster is an Airborne R-8010 custom-engineered temperature control system. By regulating air flow through a heat exchanger, this system maintains supply line fuel at 180-220°F.

As developed for the P6M2, the R-8010 system consists of a thermistor probe, a control amplifier and a rotary actuator. The probe (mounted in an MS10057-12 fitting) is in direct contact with the temperature-regulated fuel and presents to the control box a resistance which is proportional to fuel temperature. In response, the control box energizes the actuator to change the setting of a ram air intake valve, thus regulating volume of air flow through an air/fuel heat exchanger. This sensing and response continues until prescribed fuel temperature is attained, at which point the system reaches a state of electrical balance.

A fail-safe feature is also provided. In the event of power failure, a magnetic clutch in the actuator is released, permitting the air valve to be pushed open by the force of the ram air.

This application* on the P6M2 illustrates only one of many possible adaptations of the Airborne R-8010 system for temperature control functions on aircraft, missiles and related equipment—cabin temperature control, engine temperature control, temperature regulation of fuel, oil, electronic cooling packages, etc. If you have requirements in these areas, we will be happy to make a proposal. Contact any of our offices.

*Described in detail in new Bulletin PS-4A, available on request.

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AVIATION CALENDAR

(*Continued from page 5*)

neers, Biltmore Hotel, Los Angeles.

Feb. 10-12—Seventh Annual Solid-State Circuits Conference, Philadelphia, Pa. Sponsors: Institute of Radio Engineers; American Institute of Electrical Engineers; University of Pennsylvania.

Feb. 16-18—First National Symposium on Nondestructive Testing of Aircraft and Missile Components, Hilton Hotel, San Antonio, Tex. Sponsors: Southwest Section, Society for Nondestructive Testing; Southwest Research Institute.

Mar. 9-11—Conference on the Mechanical Properties of Engineering Ceramics, North Carolina State College, Raleigh, N. C. Sponsors: North Carolina State College School of Engineering; Office of Ordnance Research, U. S. Army.

Mar. 10-11—National Flight Propulsion Meeting (classified), Institute of the Aeronautical Sciences, Cleveland, Ohio.

Mar. 23-25—Symposium on Optical Spectrometric Measurement of High Temperatures, University of Chicago, Chicago, Ill. Sponsors: University of Chicago's Applied Science Laboratories; Jarrell-Ash Co.; National Science Foundation.

Apr. 6-8—Structural Design of Space Vehicles Conference, Biltmore Hotel, Santa Barbara, Calif. Sponsor: American Rocket Society's Structures and Materials Committee.

Apr. 6-8—1960 National Meeting "Hyper-Environments—Space Frontier," Institute of Environmental Sciences, Biltmore Hotel, Los Angeles, Calif.

Apr. 19-21—International Symposium on Active Networks and Feedback Systems, Engineering Societies Bldg., New York, N. Y. Sponsors: Polytechnic Institute of Brooklyn; Department of Defense Research Agencies; Institute of Radio Engineers.

Apr. 20-22 — National Symposium on Manned Space Stations, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif. Cosponsors: NASA; the Rand Corp.

Apr. 21-22—Southwest Metals & Minerals Conference "Metals and Materials for the Space Age," American Institute of Mining, Metallurgical and Petroleum Engineers, Ambassador Hotel, Los Angeles.

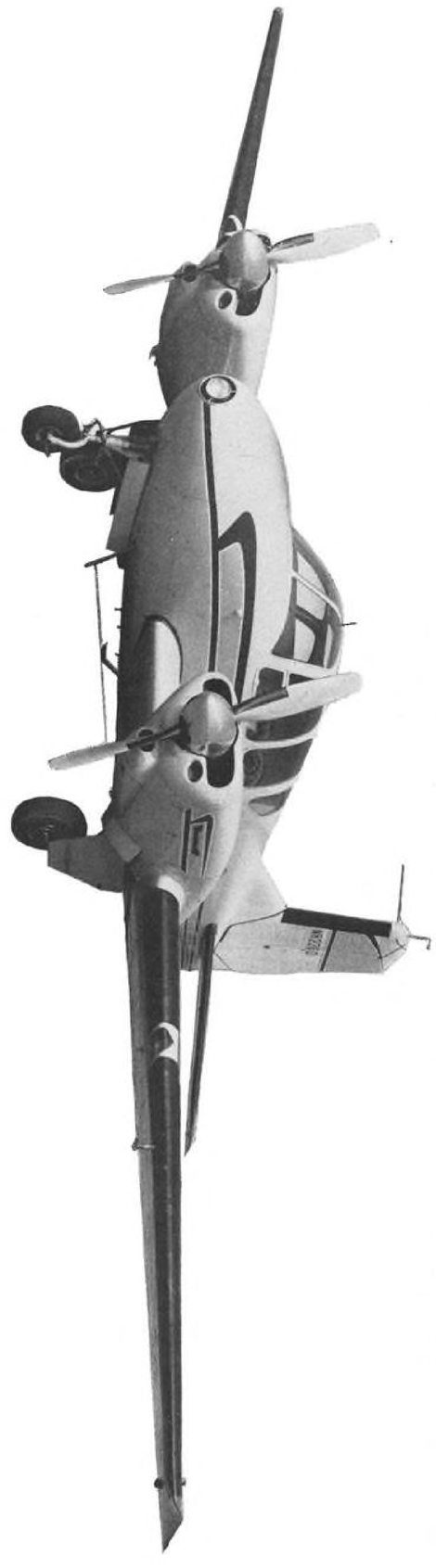
Apr. 25-29—41st Annual Convention and Exposition, American Welding Society, Biltmore Hotel and Great Western Exhibit Center, Los Angeles, Calif.

Apr. 27-28—National Meeting on Space Age Materials, Cincinnati Chapter of the American Society for Metals, Sheraton Gibson Hotel, Cincinnati, Ohio.

May 9-11—1960 Symposium of the Institute of Radio Engineers' Professional Group on Microwave Theory and Techniques, Hotel del Coronado, San Diego.

May 9-13—Second Southwestern Metal Congress and Exposition, American Society for Metals, Sheraton Dallas Hotel and State Fair Park, Dallas, Tex.

May 10-12—1960 Electronic Components Conference, Willard Hotel, Washington, D. C. Sponsors: Institute of Radio Engineers' Professional Group on Component Parts; American Institute of Electrical Engineers; Electronic Industries Assn.; Western Electronic Manufacturers Assn.



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COVER: Republic's F-105 Thunderchiefs, shown in formation, were designed from the start as fighter-bombers for the Tactical Air Command. The supersonic F-105 recently flew 1,216.4 mph. to set a new world's speed record for the 100 km. (62.14 stat. mi.) closed course at Edwards AFB, Calif. For an operational report on the all-weather, single-place Thunderchief, which will be the No. 1 fighter unit for TAC's Composite Air Strike Force, see p. 37.

PICTURE CREDITS

Cover—Republic; 18, 19—Aviation Week (Cameramen, Inc.); 22—Hiller Aircraft Corp.; 24—Cessna Aircraft Co.; 29, 81—Boeing Airplane Co.; 31—Eastern Air Lines; 37, 38, 39, 43—Republic; 46, 47 (top)—Ralph Alex; 47 (bottom)—R. B. Hotz; 67—Bristol Siddeley; 73—Bell Telephone Laboratories; 76—Minneapolis-Honeywell.

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EDITORIAL

Laurels for 1959

We have not only reached the end of another tumultuous year in aviation and its related technologies but also the end of a decade that may well be labeled the "fabulous fifties" from its record of technical developments and the "fatuous fifties" from its record of policy bumbling, executive indecision and the insidious emergence of a complacency that accepted the idea that the United States could slip to second best in technology without endangering its leadership of the free world. New political leadership is inevitable in the decade that looms ahead, regardless of which party wins the national election of next fall, and new policies are bound to result.

This year, like 1958, would find that a list of "goats" who have slowed the wheels of progress probably would be longer and more appropriate for the times than a recital of the constructive achievements in our field. However, here are the people, organizations and equipment we think have made significant contributions to American aviation and its related technologies during 1959:

• **Convair's San Diego Division** and **USAF Maj. Joe Rogers** for bringing the world speed record back to the United States with a 1,525 mph. performance in a standard F-106 Mach 2 all-weather interceptor.

• **Lockheed Aircraft Corp.** and **USAF Capt. Joe Jordan** for setting a new world altitude record of 103,395 ft. in an F-104C interceptor.

• **Republic Aviation Corp** and **USAF Brig. Gen. Joe Moore** for returning the 100 km. closed-course record to the U. S. with an F-105B averaging 1,216 mph. over the course.

• **Brig. Gen. Homer Boushey,** USAF director of advanced technologies, for his persistent, articulate and courageous exposition of a military space program.

• **Rear Adm. John S. "Jimmy" Thach** for his effective effort to organize a broad technical-military attack on the anti-submarine warfare problem and his leadership of Navy ASW forces in the Atlantic.

• **Max Conrad** for his persistent demonstration of the long-range reliability capability of U. S. manufacturers of business aircraft, engines and navigation equipment.

• **Allegheny Airlines** and **its President Les Barnes** for its pioneering program aimed at developing genuine air commuter service.

• **Col. Harry J. Moseley,** chief of the Aeromedical Safety Division for the USAF Inspector General, for his work in design and retrofit of operational aircraft to reduce crew injuries in accidents, particularly in cutting the fatality rate in use of ejection equipment. Col. Moseley was killed in an aircraft accident this year.

• **Sen. John Stennis,** chairman of the NASA authorization subcommittee of the Senate Aeronautical and Space Sciences Committee, and **Max Lehrer,** assistant director of the committee staff, for their planning and execution of the public hearings on the first National Aeronautics and Space Administration program.

• **Gen. Thomas S. Power,** chief of Strategic Air Command, for his valiant efforts to keep the U. S. deterrent power at the maximum possible efficiency with the limited resources placed at his disposal and his persistent efforts to accurately inform the American people on their defense problems.

• **Charles Thomas,** president of Trans World Airlines for galvanizing this airline's employes into an amazing leap from deep in the red to well into the black in the initial year of his presidency.

• **Convair's Astronautics Division,** particularly its chief **"Jim" Dempsey** plus **"Charley" Bossart, "Charley" Ames** and **"Bill" Patterson,** for bringing the Atlas ICBM to fruition as a reliable, accurate and significant weapon in the U. S. arsenal. Atlas made its 13th consecutive successful full range flight in December.

• **Boeing Airplane Co.** and the seven airlines who operated the 707 turbojet transport in regular service this year carrying a total of 1,727,000 passengers and flying 3.3 billion passenger miles in scheduled service without a passenger injury.

• **Igor Sikorsky** for his personal contributions in his 71st year to the development of the S-60 and S-64 flying crane concept for helicopters.

• **Pan American World Airways** for its inauguration of round-the-world service by turbojet transport with a regularly scheduled flying time of 37 hr. 45 min.

• **Jacqueline Cochran,** president of the Federation Aeronautique Internationale Assn., and **Thomas Lanphier, Jr.,** president of the National Aeronautics Association, for their organization and leadership of the American delegation to the FAI conference in Moscow.

• **Arthur Kelley,** vice president-sales for Western Air Lines for one of the most imaginative and forward looking airline sales programs designed for solving jet age problems.

• **The dozens of avionics firms** who by "thinking small" pioneered new molectronic and microcircuitry techniques that promise to revolutionize the avionics field and have particularly promising applications in space technology.

• **Elwood R. "Pete" Quesada,** Federal Aviation Agency chief, for his vigorous leadership of this new agency and its broad scale attack on the major problems of civil aviation.

• **Rocketdyne Division of North American Aviation, Inc.,** for its consistent performance in providing powerplants of high reliability for both U. S. IRBMs, the Atlas ICBM and the Atlas, Thor and Juno space probes.

—**Robert Hotz**

WHO'S WHERE

In the Front Office

Jan Oostermeyer, board chairman, Permanent Filter Corp., Los Angeles, Calif. Also: **Dan S. Mortensen,** chief administrative officer and a director; **Allan D. Greenwood** has resigned as president but will remain available to the company as a consultant.

Walter Sternberg, a director and a member of the executive committee of South Pacific Air Lines, and **Sam Wilson,** vice president and chief of operations. Mr. Sternberg formerly was senior vice president of National Airlines and Mr. Wilson, executive vice president for Transocean Air Lines.

Frank B. Jewett, Jr., president, Vitro Corporation of America, New York, N. Y., succeeding **J. Carlton Ward, Jr.,** who has been named board chairman. **Charles S. Payson,** retiring board chairman, has been elected chairman of the directors' executive committee.

Dr. A. B. Van Rennes, vice president in charge of the Technical Division, United Research, Inc., Cambridge, Mass.

Richard B. Hubbard, vice president and a director, Roylyn, Inc., Glendale, Calif. Also: **Benjamin N. Channesian,** production manager.

Rear Adm. Mell A. Peterson (USN, ret.), executive vice president and a director, Bulova Research & Development Laboratories, Inc., Woodside, N. Y.

John T. Kane, vice president and treasurer, Los Angeles Airways, Inc. Also: **Mervin F. Bagan,** vice president-assistant to the president; **Fred W. Milan,** vice president-transportation.

Rear Adm. Frederick J. Bell (USN, ret.), vice president-Washington, D. C., office for General Telephone & Electronics Corp.

H. E. Riggins, Jr., who is divisional vice president-administration, also appointed assistant general manager, Radioplane Division of Northrop Corp., Van Nuys, Calif.

Harry Davis, special assistant (air defense) in the Office of the Director of Defense Research and Engineering, Washington, D. C. Also: **Albert W. Blackburn,** special assistant to the assistant director of defense research and engineering for strategic weapons.

Wesley L. Hjornevik, deputy director of business administration for the National Aeronautics and Space Administration, Washington, D. C.

Rear Adm. William A. Sutherland, Jr., commander, Fleet, Air, Western Pacific, relieving **Rear Adm. William M. Nation. Rear Adm. Ray C. Needham** will relieve Adm. Sutherland as commander, Carrier Division Two.

Honors and Elections

Howard Cary, a director, Varian Associates, Palo Alto, Calif. Mr. Cary is president of Applied Physics Corp.

Francis M. McDermott has been named executive director of the Air Traffic Control Assn., Washington, D. C.

William J. Hogan, executive vice president-finance and planning for American Airlines, has been named chairman of the company's finance committee.

(Continued on page 87)

INDUSTRY OBSERVER

► Wright Air Development Division is expected to tell Douglas Aircraft Co. next month to initiate research and development of the GAM-87A air-launched ballistic missile, following Defense Department approval. Funding for this phase may run as high as $125 million. Douglas' initial study contract now extends to March.

► **Air Force is considering both television and infrared scanning techniques for general security surveillance of areas surrounding the unattended silo launch sites for the Minuteman ICBM.**

► Proposals for mechanical conversion scheme for SNAP 8 nuclear turbo-electric power generation system are scheduled to be submitted to National Aeronautics and Space Administration early in January. Contract for reactor, under Atomic Energy Commission cognizance, probably will be awarded to North American Aviation Atomics International Division.

► **Air Force plans to outfit the Boeing B-52H with existing electronic countermeasures equipments following recent decision to stop production of the AN/ALQ-27 ECM system at Sperry Gyroscope Co. (AW Dec. 21, p. 18). ALQ-27 represented the first real systems approach to bomber countermeasures in which the ECM operator would have a variety of techniques and frequencies to meet unexpected situations. With its cancellation, USAF will revert to its former "black box" approach in which the selection of ECM equipment carried on each mission is largely tailored to the mission.**

► Douglas Aircraft Co. proposal to Air Force for employment of the Thor intermediate range ballistic missile plus upper staging as ICBMs calls for use of storable propellants. Vehicle has been designated Storic.

► **Development status and projections for support and operation of WS-117L Samos satellite optical reconnaissance phase and Midas infrared early warning capability are being reviewed by Air Force headquarters to define the timetable for critical factors for these two satellite capabilities.**

► General Electric YJ93 turbojet engine for the North American B-70 probably will be developed without the refinements of weight and projected efficiency originally planned, although it is likely that the original date for test stand operation of the engine in the spring of 1961 will be adhered to, despite reorientation of the B-70 program.

► **Growing number of electronic support systems involving automatic data processing and display has prompted Air Force to study possibility of combining one or more of them. Several teams of technical specialists will be formed shortly by Air Research and Development Command to analyze operational requirements established for the 1965-75 period and determine how they can most effectively and economically be met. Results of the study are expected by late spring or early summer. Systems certain to be considered include Strategic Air Command Control System (465-L), Norad Combat Operation Center (425-L), Air Force Control System (473-L), Intelligence Data Handling System (438-L) and Electromagnetic Intelligence System (466-L).**

► North American will probably eliminate the large dive brake on the belly of the Navy A3J-1 in production models. Prototype flight tests indicate the wing spoiler-brake system provides effective short field performance.

► **International Telephone & Telegraph Corp. Industrial Products Division and Electronic Communication, Inc. Air Associates Division are considering a joint venture for expanded participation in supplying avionics products for lightplane and business flying markets.**

► Grumman F11F-1F Super Tiger is being considered with the Swedish Saab Draken J35A and French Dassault Mirage 3 for the fighter role in the Swiss air force re-equipment program, not the Fiat G.91 as earlier reported (AW Dec. 14, p. 23).

Washington Roundup

Promotion Directive

Future promotion of career officers to any of the general or flag ranks will be tied to prior service on a joint staff, combined, or unified command or allied staff unit under terms of a new directive issued by Defense Secretary Thomas S. Gates, Jr. The directive, designed to lessen inter-service rivalry and provide top-level officers who have demonstrated an ability to deal objectively with other nations, is similar to a plan previously recommended by the President. The President's plan, however, called such service desirable rather than mandatory and suggested that it should be applied to promotions above a one-star rank.

Comptroller General Complaint

Comptroller General Joseph Campbell complained last week that Defense Department has refused to turn over two secret reports that would help in analyzing the military assistance program (see p. 20) in a letter to Rep. W. L. Dawson (D.-Ill.), House Government Operations Committee chairman. The two reports involved U.S. European Command recommendations to the Joint Chiefs of Staff on the size of Allied forces that should be supported during Fiscal 1960 and an evaluation of Turkish military plans and capabilities made by a U.S. military mission. Campbell told Dawson that General Accounting Office wants the reports to help determine whether the military aid program is being revised promptly to reflect changes in foreign requirements.

The GAO also reported last week that the President in a letter to the Comptroller General, refused to turn over reports on the handling of International Cooperation Administration aid in Iran and Thailand because, he said, release of the reports would not be compatible with national interest. In a separate report to Congress, GAO accused the Navy of charging more than the authorized price for certain material furnished under the military assistance program.

USAF Waste Charges

In another report, GAO also charged that the Air Force is wasting approximately $2 million a year by repairing dilapidated automotive vehicles rather than buying efficient new ones. In a report to Congress recommending that Air Force make a thorough study of its vehicle replacement program, GAO said:

". . . in the last three years the Air Force has incurred an estimated $5 million more in repair costs and depreciated market values on old vehicles than it would have cost in combined repair and depreciation for new vehicles to replace them.

"Postponing the purchase of replacements for old vehicles has cost the Air Force an estimated $3 million more because of the increase in vehicle prices. In addition, about $2 million will be spent unnecessarily for maintenance purposes each year for the next several years because of the inadequacy of the long-range program for replacing vehicles . . ."

Accident Investigation

The aviation subcommittee of the Senate Commerce Committee headed by Sen. A. S. Mike Monroney (D.-Okla.) has scheduled an investigation of commercial airline crashes as its first order of business in the new session of Congress. Hearings are scheduled to begin Jan. 11. Commenting that the accident record in 1959 has been "one of the worst in recent years," Monroney added:

"Reports received from the Civil Aeronautics Board . . . do not show any apparent pattern as to their cause. Nevertheless, it is imperative that every effort be made to determine what steps can be taken to prevent their recurrence.

Later, the subcommittee plans to consider airspace management, pilot certification, and military participation in Federal Aviation Agency.

Air Line Pilots Assn. also is expected to protest FAA's recently imposed 60-year-old mandatory retirement age for pilots (AW Dec. 7, p. 45; Dec. 21, p. 27) during subcommittee hearings.

MATS Rebuff

Military efforts to obtain doorstep delivery of air cargo to foreign bases failed to crack the technical defenses of the Civil Aeronautics Board last week. Applications by both Trans World Airlines and Seaboard & Western Airlines to land cargo shipments at Torrejon air base in Spain were rejected by the CAB. The airlines had pointed out that new MATS policy required such direct delivery as opposed to past practices of landing at Madrid and trucking cargo the 14 mi. to the military base. Board members based their rejection of the carrier's requests on grounds that TWA already serves Torrejon through Madrid. They also cited an earlier request by Seaboard to provide direct service to the military base which was denied. The Board said that the Defense Department had not indicated a need for service to Torrejon and that neither airline presented enough facts to justify its request.

U. S.-USSR Helicopter Negotiations

Soviet Embassy reports it is awaiting the arrival of technicians to advise on contract stipulations for the possible purchase of U.S. helicopters—probably two Sikorsky S-58s and one Vertol Model 44 (AW Nov. 23, p. 25). The technicians will leave Moscow as soon as they are granted U.S. visas, according to Vladimir Alkhimov, commercial counselor at the Soviet Embassy in Washington.

Southeastern Local Service Awards

Southern Airways received a majority of new route awards granted by the Civil Aeronautics Board last week in the Southeastern Area Local Service Case. Beyond new service to intermediate points on the carrier's system, Southern was permitted to extend its service into New Orleans from Memphis, Tuscaloosa, Ala., and Panama City, Fla. National Airlines' authority to serve Melbourne, Fla., on a Miami-Houston route was extended for five years; Mackey Airlines was authorized to carry persons and property to Miami from coterminals at Tampa and St. Petersburg, Fla., while Eastern Air Lines was permitted to add St. Augustine as an intermediate point between Jacksonville and Daytona and received permanent authority to serve Ocala, Gainesville and Melbourne in addition to providing service between Orlando and Tallahassee.

—Washington staff

Costs Crimp Nation's Top Space Project

NASA reduces Mercury mission, advanced work delayed; funds shifted in effort to maintain progress.

By Evert Clark

Washington—National Aeronautics and Space Administration has reduced the mission of the Mercury manned space flight program, has delayed for a year advanced work that would have extended manned space flight capability beyond Mercury and taken more than $7 million from other research and development programs to maintain Mercury's rate of progress. It also has had to transfer $15 million to the Mercury tracking network account to take care of unexpected telemetry and tracking requirements.

Mercury is the nation's most important space program carrying a priority equal to that of the ballistic missile programs.

NASA told the Senate Committee on Aeronautical and Space Sciences that the "increased costs have resulted from program complexities not foreseeable at the time the fiscal year 1960 budget was drawn up.

It is difficult to obtain a figure from NASA for the expected total cost of Project Mercury, which will not be completed for several years. About the only thing certain is that the cost is going up. NASA Administrator T. Keith Glennan told Congress early this year:

"The 1960 cost of Project Mercury is $70 million, and before we have completed this first U. S. effort to put man into space, the bill will have exceeded $200 million."

On Dec. 7, Glennan told a California audience: "Even the first steps in the manned exploration of space are very expensive as may be inferred from the presently estimated cost of Project Mercury of $250 million or more."

Three days later, NASA General Counsel John A. Johnson told a Washington audience: "The total costs of the project (Mercury) over a four-year period are likely to run around $350 million."

Associate Administrator Richard E. Horner told AVIATION WEEK that direct comparison cannot be made between Glennan's $200 million figure of early this year and the $350 million figure because they are not comparable figures. Among the differences in the two are bookkeeping changes. He said it is difficult to give a meaningful cost estimate for the over-all Mercury program.

Straight cost overruns have increased Mercury's total on the order of $30 million or $40 million, Horner said. He said the main source of cost overruns is determined by suppliers who cannot perform within the original estimates made at the time that contracts were negotiated with NASA.

The Senate Committee staff report, which first called attention to mission changes, work delays and changes in funding for Mercury, did not concern itself with suppliers. It noted that construction and equipment costs for the Mercury tracking network were not included in the figures represented to Congress earlier this year as the cost of Mercury in the Fiscal 1959 supplemental and in the Fiscal 1960 budget. The report also said:

"Although there were very extensive revisions in the programs to be funded by NASA's research and development appropriation in the ensuing months (since last February), no changes were made in the estimates presented to the Congress for Project Mercury.

"It is now apparent, however, that the costs of Project Mercury will be greater than originally estimated—particularly if NASA construction and equipment funds are taken into account.

"On the basis of present programing, the direct investment in Project Mercury during fiscal years 1959 and 1960 exceeds $152 million. This is approximately $24 million more than the amounts previously identified to the Congress by NASA as programed for Project Mercury.

In addition to shifting $7.4 million from other research and development programs into Mercury, NASA transferred another $15 million from its research and development appropriation to fund the tracking network. Whether this $15 million was merely shifted from the Mercury research and development account into the network account or whether it, too, was taken away from research programs other than Mercury, was not clear in the Senate report and could not be learned last week from NASA. It appeared, however, that the $15 million was taken from Mercury rather than from other work.

There are indications the committee feels there is considerable confusion within NASA on the question of Mercury costs. It can be presumed that the committee will make this a first order of business when hearings on NASA's Fiscal 1961 budget begin.

In a letter and a memorandum to the Senate Space Committee's chairman, Sen. Lyndon B. Johnson (D.-Tex.), written last October by NASA Assistant Administrator for Congressional Relations James P. Gleason, the agency said these actions had been taken to meet the "increased costs" that resulted from "program complexities not foreseeable" when the Fiscal 1960 budget was made:

- **"All . . . advanced work"** aimed at extending man's space flight capability beyond Mercury "has been delayed for a year." This refers to "development and construction of more refined versions of the (Mercury) vehicle" that had been planned for Fiscal 1960. Work was to have included "a range of analytical studies and model experiments" to determine basic design requirements. Plans reported to Congress last April still said that "initial development of appropriate vehicles should be undertaken" in Fiscal 1960.
- **"The 18-orbit mission** has been reduced to a 3-orbit mission." An 18-orbit flight in the Mercury capsule would require approximately 24 hr. NASA told AVIATION WEEK that a great amount of additional equipment would be required to provide telemetry and tracking over the areas of the globe that would be covered by the capsule in such a long flight since the capsule would fly over virtually all of the globe between 30 deg. North and 30 deg. South latitude.
- **"An additional $7.515 million** has had to be programed to maintain the Mercury rate of progress."
- **Original estimates** for the cost of the Mercury tracking network were "based on a minimum of detailed study." Appropriations to date totaled $16.42 million. But "detailed engineering studies now indicate an immediate need for an additional $15 million for the fiscal year 1960."

This increase of almost 100% in the network cost resulted partly from suggestions by the seven Mercury space pilots that biomedical telemetry and communications between the pilot and the ground stations should be far more extensive than originally planned. Original plans called for "blackout" periods of as long as 10 min. when the pilot in the orbiting capsule would not be in range of a tracking station.

Technical Considerations

Technical considerations underlying the need for more funds include:

- **"More extensive telemetry** and data display equipment will be added at 15 locations to provide almost continuous contact with the pilot's physiological condition to physicians" on the ground.
- **Additional transportable** tracking and telemetry will be added in Bermuda and West Africa in case an abort becomes necessary during the launch phase; transportable radar will be added in western Australia to fix more precisely the capsule's location on that portion of the orbit for timing of the firing of the retrorocket and prediction of the impact point; transportable radar will be added in west Central America to track the capsule more precisely if it becomes necessary to re-enter after only one orbit instead of three.

Total funding for Mercury in the Fiscal 1959, supplemental 1959 and Fiscal 1960 budgets now is $152,198,333. This includes the $120,778,333 in research and development funds and $31,420,000 in construction and equipment funds.

It is probable that the $350 million figure used by Johnson as an over-all projected total cost includes construction and equipment funds. In the past, NASA has not included the construction and equipment figures when it discussed Mercury totals, partly because the tracking network will be used for other programs, both manned and unmanned. It is expected that at least the network costs directly applicable to Mercury probably will be included in future discussions.

Other factors, not specified in the report, which have contributed to the increase in Mercury's costs include:

- **More spares and more checkout** flights than originally called for are now in the program.
- **Since Mercury** has such high national priority, great effort is being put into keeping it on its time schedule even at the cost of taking funds from other programs.
- **The 1960 budget was** put together in a few weeks just after NASA was created and "the quality of the information available obviously was not very good at that stage," according to one NASA spokesman. "Now we do have substantially better quality information and we should have a better correlation between the next budget figure and the way the costs actually come out."
- **Twenty McDonnell capsules** are now on order instead of the original 12. This, plus changes in the capsules and increased costs, have raised the cost figure from $18 million to $38 million.
- **Launching operations'** cost is being programed at a higher cost than initially.
- **Research and development** costs not included in items above are running somewhat higher than foreseen.

Astronauts' Dispersal

Washington—Three of the seven Mercury space pilots will go to Cape Canaveral, Fla., about one month before the first manned suborbital flight in a Redstone vehicle is to take place, but they will not know which is to take the first ride until nearer to the time for the flight.

Once a pilot is selected, the second man will work in the blockhouse during the flight, and the third will be at an Atlantic Missile Range tracking station.

The other four Mercury pilots will be located at other tracking stations around the world. First manned Redstone flight is expected sometime next year, possibly as soon as spring or early summer.

Titan Blast Cause Explained

Washington—Combination of forces that occurred at liftoff of an Air Force-Martin Titan ICBM and caused an electrical relay to close in the command destruct system is being blamed for the explosion of the missile on Dec. 12 at Cape Canaveral, Fla. (AW Dec. 21, p. 19).

Relays have been redesigned and relocated. The relay that apparently caused the explosion was located on the missile's skin and near the base. All relays have been moved so that they are attached to the frame rather than the skin.

Missiles already at the Air Force Missile Test Center have been fixed but the Christmas holiday shutdown of the Atlantic Missile Range probably will prevent a Titan from being tested again before Jan. 5 or 6 at the earliest.

A shock wave, hitherto an unknown phenomenon, was discovered in tests run at Martin's Denver plant to simulate the forces acting on the missile that exploded. The wave, which was described as "scores" of times the force of gravity in intensity, runs upward along the missile's skin when the engine's 300,000 lb. thrust, the missile's 220,000 lb. weight and the detonation of four explosive hold-down bolts all act upon the missile at the instant it is supposed to lift from its launching stand. A lateral force also occurs. The combination apparently closed the relay.

Although the missile is strong enough to withstand the forces, they caused the suspected relay to "chatter," opening and closing rapidly, in tests at Denver. One closing of the relay is enough to activate the destruct system, which ordinarily would be activated only by a radio command from the range safety officer on the ground. Speculation is that the relay closed and the primer cord blew up the first stage.

Tests on Titan's second stage indicated that firing of the second stage engine also might have caused a destruct relay to close. If the trouble had not been located following the recent explosion, second stages might have been ignited and exploded in flight, making diagnosis of the cause extremely difficult.

Tests on a first stage, using both the revised destruct system and the old system, showed that the relay in the old system closed while the relocated relays in the new system did not. Relays have been arranged at 90 deg. to each other so that no single force can cause the system to malfunction.

Speculation as to why no previous Titan had the same relay trouble is that the critical relay may have been located at a point an inch or two away from the point it occupied in earlier missiles. Nevertheless, the relays have been moved from that general area in the missile.

Primer Cord Explosion

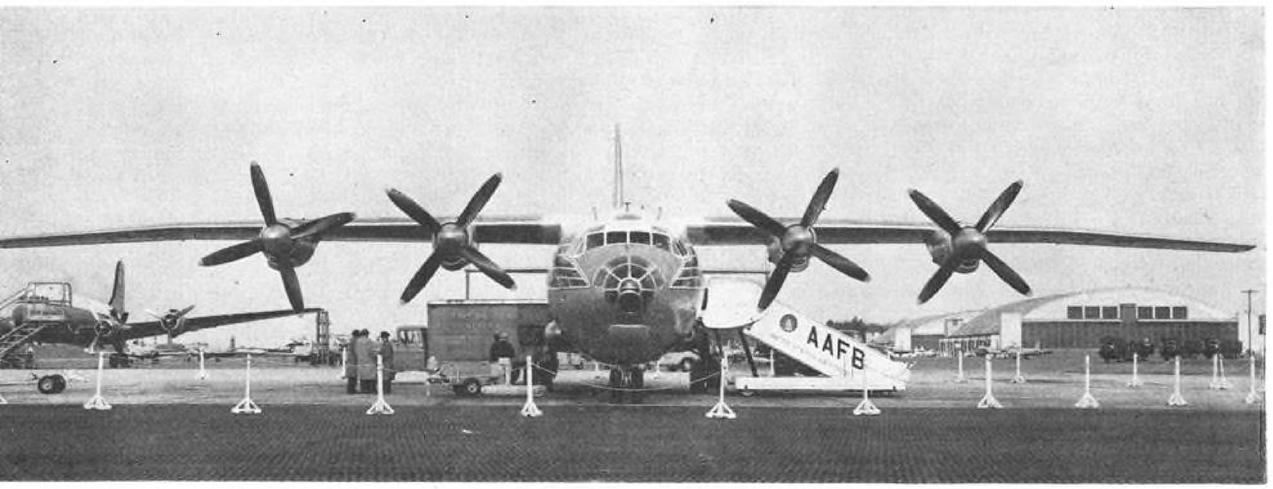
Telemetry provided little help in the investigation because it ended so abruptly. Sixteen-millimeter films shot at 500 frames a second showed normal operation through the first four seconds. The explosion of the primer cord occurred in the first frame past the fourth second. The rapidity of the destruction led investigators to believe that only the destruct system could have been at fault. The relay from the bottom-most point on the missile was recovered. It showed evidence of having closed, and the investigation proceeded to the simulation tests at Denver.

Findings have been relayed to Air Force Ballistic Missile Division and Space Technology Laboratories, Inc., and presumably will be checked to see if they might explain explosions of other types of missiles.

Second Stage Propulsion

The Titan C that exploded was to have provided the first test of second stage propulsion. Missiles now at the Cape include another B model and a C for flight tests and the ground checkout version of the G lot. Titan lots are lettered A, B, C, G and J. Final operation lot will get still another letter.

Meanwhile, Sen. Gordon Allott (R.-Colo.) said last week that he has contacted Air Force officials "at every level and with any connection" with the Titan program as a result of inquiries that followed the explosion, and the Air Force "foresees neither cutback nor curtailment" of the Titan program.



NEGATIVE dihedral of the outer wing panels, circular fuselage section and small frontal area of the landing gear fairings and engines are shown in this front view of the Antonov An-10A at Andrews AFB, Md.

Improved Version of An-10 Flies to U.S.

Washington—First visit of the Soviet Antonov An-10A turbine-powered transport to the U.S. was made earlier this month to bring a personal Christmas gift of 41 trees and shrubs from Soviet Premier Nikita Khrushchev to President Eisenhower. The An-10A, which landed at nearby Andrews AFB, is an improvement of the Antonov An-10 Ukraina which has drawn criticism from the Russian press for entering commercial service behind schedule. According to the official Red Air Force newspaper, Sovetskaya Aviatsiya, the delay was due primarily to stability problems. Evidence of this is that the An-10A has large vertical fins on the tips of the horizontal tail, and the wing tips have a pronounced negative dihedral, while the original Ukraina did not have these features. The dorsal and ventral fins always have been part of the design, however.

Purpose of the An-10 series is to provide a large feederline aircraft that can operate out of dirt and grass fields. Main internal requirements were for quick convertibility between passenger and cargo configurations and for convenient operation with both types of payload. Cost of construction was kept down by the O. K. Antonov Design Bureau by making extensive use of assemblies, parts, hardware and equipment from existing Soviet aircraft. Latest version of the Ukraina, larger than the An-10A, is still in the planning stage. It is designated the An-16.

Differences between the An-10 and the An-10A include an increase of seats from 85 to 100 in six-abreast cabin arrangement, switch from Kuznetzov to Ivchenko engines, both of approximately 4,000 hp. and a new, more underslung nacelle installation.

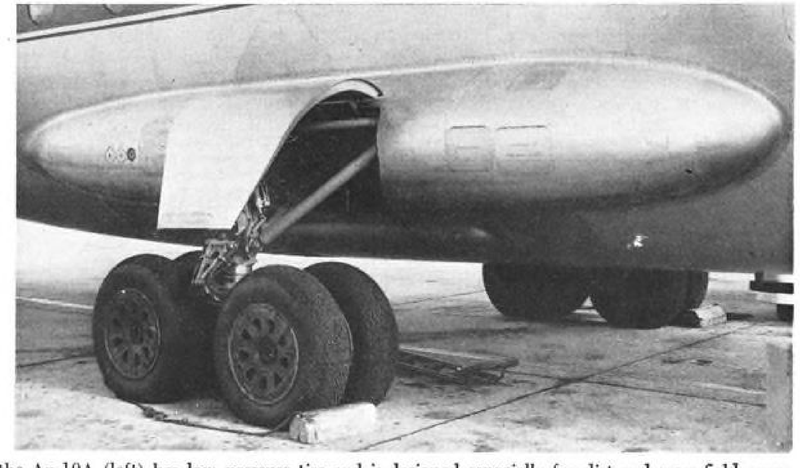
Cockpit layout of the An-10A is similar to that of the Tupolev Tu-114. Navigator sits in glass-enclosed nose; the radio operator is behind and below the copilot. The two pilots sit about five feet above a walkway between their seats. Swiveling seat between the pilots and over the walkway allows the flight engineer to assist them and swing around to monitor other instrument panels to the rear.

Flight of the An-10A to the U. S. included a scheduled stop in Gander, Newfoundland, and an unscheduled landing in Boston because of bad weather in Washington. The aircraft's return trip apparently was made with an eye toward "showing the flag." Its flight plan listed stops in Gander; Keflavik, Iceland, and Prestwick, Scotland. Itinerary of the trip beyond Prestwick was to be given the crew after it arrived in Scotland.

IVCHENKO 4,000 hp.-plus turboprop engines on the An-10A are the same as those used on the Il-18 Moscow transport. The early An-10 Ukraina had Kuznetzov turbine engines of approximately the same power. High wing arrangement reduces the amount of dust and dirt blown up during operation from unimproved fields.

DIRECTIONAL stability problems encountered with the Ukraina series is indicated by the addition of large vertical surfaces on the tips of horizontal tail on the An-10A. The dorsal and ventral fins were on the An-10.

INTERIOR of An-10A flown to U. S. (left) has all but 16 of its 100 seats and all its carpeting removed. Wall and ceiling furnishings are standard for passenger use. Four padded sections against the wall support galley bulkheads. Long strips with tie-down rings attached may be screwed into floor to secure cargo load. Wing carry through structure protrudes slightly into the cabin ceiling. Passenger seats (right) have individual lights mounted on headrest. Three buttons on arm of each seat allow the passenger to call the stewardess, listen to radio with a small earphone and operate his reading light. Movies also are shown on the forward bulkhead.



SHORT, simple landing gear installation on the An-10A (left) has low pressure tire and is designed especially for dirt and grass field operation. Main landing gear on the An-10A (right) retracts into a well under the floor leaving the passenger-cargo compartment free of obstructions. Arrangement also keeps wheels within the fuselage lines and allows a smaller fairing covering the gear attachment point.

Increased Military Aid Support Planned

By Ford Eastman

Washington—With the backlog of military assistance funds nearly gone, more money for the Military Assistance Program will be urged by the Administration when Congress returns next month.

Continuation of the present trend in which expenditures greatly exceed annual appropriations will soon lead to deterioration of the nation's forward defense posture and force basic changes in the present military strategy and alliance system, Administration officials contend.

For the last seven years, expenditures to meet minimum requirements have been from $400 million to more than $1 billion higher than the amounts appropriated. The differences have been made up by drawing from a pipeline of unexpended balances created by big appropriations and low expenditures during the early part of the program.

However, the situation now has reached a critical point where the future role of military aid will depend upon the course of action to be taken during the coming year.

Because of the long, steady drain on the pipeline, carry-over funds have dwindled from $8.4 billion in 1953 to an estimated $2 billion at the end of Fiscal 1960. According to Defense Department International Security Affairs officers, this is below the minimum amount needed to meet high priority requirements within acceptable time limits, considering long leadtimes involved.

For this reason, pipeline funds will no longer be available to close the gap between annual appropriations and expenditures, and future spending levels will depend almost entirely upon the amount appropriated each year.

Military assistance funds are used to provide weapons, material and other assistance in building up the military strength of allied forces throughout the world, including those around the perimeter of the Communist nations.

Military aid, along with defense support and economic assistance, is a part of an over-all Mutual Security Program which is designed to protect the security of the Western nations and, at the same time, serve as a forward military shield for the United States. There are over 40 security pacts between the U. S. and other nations.

During the 10 yr. life of the program, other nations involved have contributed in excess of $140 billion to build up their defensive units, compared with the $22 billion the U. S. has contributed in military assistance to these units.

Unacceptable Risks

However, reduction of the pipeline to a level which will no longer permit provision of modern weapons and force improvements entails risks that the Administration feels are militarily unacceptable.

Congress cut Administration budget requests for military assistance in Fiscal 1960 from $1.6 billion to $1.3, and for the first time expenditures dropped below the $2 billion mark. An estimated $1.8 billion will be spent on military aid during the current year, compared with $2.3 billion for Fiscal 1959.

Although Fiscal 1959 spending was higher than the previous year, congressional cuts in budget requests resulted in $285 million in modernization work being deferred.

Of this, $121 million was for missiles for the North Atlantic Treaty Organization, including $74 million for Hawk, $24 million for Sidewinder, $19 million for Lacrosse and $4 million for Terrier. Also delayed was $38 million in aircraft modernization in which $28 million was earmarked for North American F-100s for Denmark and Turkey and $10 million in modern and anti-submarine patrol aircraft for France.

In addition, ship modernization amounting to $10 million had to be deferred in Korea and Pakistan, $14 million requested to build up war reserve ammunition in France, Greece, Spain, Turkey and Korea had to be deferred, as was $15 million for modernization of electronics equipment in France and Korea.

The offshore weapons production program had to be cut by $16 million, $4 million came out of the internal security program for countries in Southeast Asia and the balance of $67 million is composed of a large number of small items for many countries.

All this spending was to be deferred to Fiscal 1960. However, the Administration requested $1.6 billion for that year, $200 million less than requested in Fiscal 1959, and Congress approved $1.3 billion, $200 million less than it approved the previous year.

There are already indications that the reduction in funding for the Fiscal 1960 military assistance program has brought hints of similar reductions on the part of other nations contributing to the support of the military forces involved.

Lack of modern equipment also lowers morale, the national will to resist aggression tends to be impaired and effective fighting strength declines, according to MAP officials.

Deterioration Impact

Administrators of MAP are aware of the dangers involved and the impact deterioration of the allied forces would have on U.S. defense structure. Defense experts have said it would be economically impossible for the U.S. to maintain its own forces of the size and strength of the combined forces considered the minimum necessary to deter aggression.

Thus, there are strong indications that the Administration will soon ask Congress for a sizable increase in military assistance funds for Fiscal 1961 over the amounts that have been requested for the last three years. This is in contrast to the Administration's general determination to hold U S defense spending at current levels during Fiscal 1961.

The Fiscal 1961 budget request for military assistance is expected to be about $2 billion, the minimum recommended by the Draper Committee earlier this year following a thorough study of Military Assistance Program. At the same time, the Administration will also urge that countries which receive aid step up defense efforts in their own behalf because the dangers facing these countries are even greater than those facing the United States.

Convincing Congress that more money is needed for the Military Assistance Program than has been appropriated during the last few years is not expected to be an easy task during the coming session. Much criticism has been leveled at the program in the past, which is probably best summarized in a report issued by the House Committee on Foreign Affairs last June. The report said:

"There has been overfunding of the Military Assistance Program to meet marginal requirements such as the provision of military equipment having no relation to the capacity of the United States or of other nations to meet major Soviet aggression. In view of this overfunding, it is apparent that the program should be critically examined.

"Inefficiency in the handling of the program is in many instances shocking. The comptroller general over the past several years has issued reports criticizing slipshod programing and faulty execution of military assistance. Numerous instances were reported where material was programed even though the material was already on hand in sufficient quantities in the recipient country or in a neighboring country in surplus quantities. In some cases spare parts have been disposed of as surplus while requisitions for the same items were concurrently being processed for delivery from the United States. It is evident that there has been an inadequate control of documents, inaccurate record-keeping and lags in reporting delivery.

"Much of our military assistance is beyond the capacity of some of the recipient nations to utilize. In many instances, the assistance is resented by local populations as representing an effort by the United States to interfere in the domestic policies of the nations involved. In some cases the economy of the country is depressed in favor of large military budget expenditures. A review of the annual military assistance programs would result in a revaluation of force objectives in each country and more accurate long-range program costs."

Military assistance officials admit there have been deficiencies in the administration of the program, and while they will never achieve perfection in the involved supply, logistic and maintenance management practices of allies, improvements have been and will continue to be made.

The Draper Committee, in its preliminary report to the President, also pointed out there was room for improvement in the administration of the program, but added:

"We are all convinced that the mutual security program, both in its military and economic aspects, is a sound concept. What is needed is the determination to continue it and the ability to administer it well. . . . We recommend that every effort be made within the legislative and executive branches of the government to bring clearly before the American people the relationship between the mutual security program and the national interest, and the need for continuity of this program if it is to make its required contribution toward our world position of strength."

Administration officials blame themselves for the lack of public understanding which cause most of the program's financial difficulties, but find themselves handicapped in telling the full story for security, political and national interest reasons.

Also, attempts to point out the benefits received from such a program often have little or no impact because in most instances it is a case of dealing with intangibles.

For example, military assistance and defense support, coupled with a system of military alliances with other nations, has built up a total Western strength in which U. S. forces represent about one-sixth of the total armies of 5,800,000 men, about 60% of the 72,000 aircraft available and 40% of the 4,200 combat vessels.

There is no concrete evidence that these forces have by themselves been responsible for deterring war, MAP officials observe, and it can only be pointed out that except for various probing actions since the program was started, the Communist threat has been contained.

While the primary objective of military assistance is to build and maintain forces to protect the U.S. and the other Western nations, it also provides a number of side benefits, including:

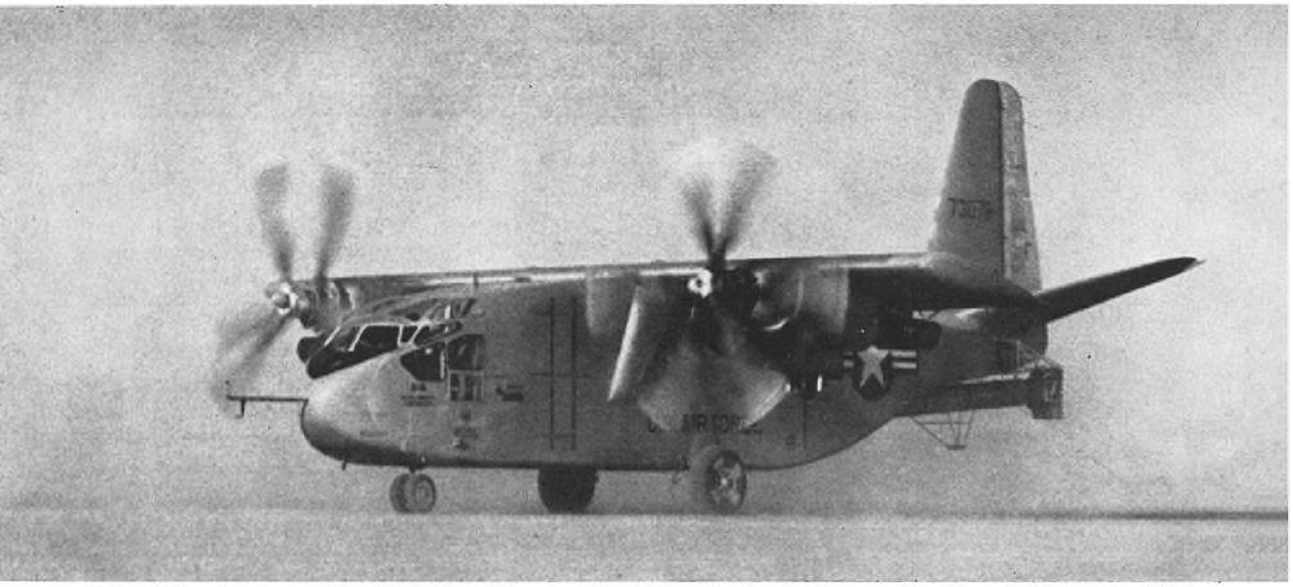
- **As a result of U.S.** contributions to foreign aid, more than 250 installations have been made available on foreign soil as Strategic Air Command or other military bases in the forward defense area.
- **Military aid** serves to improve the economy of recipient nations, which is a further barrier to the spread of communism since poor and underdeveloped countries are prime targets of this type of system.
- **As the economy** of these countries improve, they not only can stand a greater share of the burden of defense, but open up new trade markets in which the entire world benefits.
- **About 85% of MAP** procurement is in the U.S., which creates more work for industry and boosts employment.
- **Big share** of the military equipment is purchased through the Air Force, Army and Navy, which permits the services to get rid of surplus equipment at a fair price and aids in its replacement.

Military Assistance Program Funds

Year	Appropriations Available	Expenditures	Year-End Carryover
1950	$1.3 Billion	$0.1 Billion	$1.2 Billion
1951	5.2	0.9	5.5
1952	5.2	2.3	8.4
1953	3.9	3.9	8.4
1954	2.9	3.6	7.7
1955	0.7	2.2	6.2
1956	1.0	2.6	4.6
1957	2.0	2.4	4.2
1958	1.3	2.2	3.3
1959	1.5	2.3	2.5
1960	1.3	1.8	2.0

Nike Zeus Test Vehicle Firing Fails

Second stage failed to ignite when this Nike Zeus anti-ICBM early test vehicle was launched at White Sands, N. M. (AW Dec. 21, p. 19), the third failure in three attempts. Firing was to have gained data to evaluate structural temperature and erosion on the Army missile.

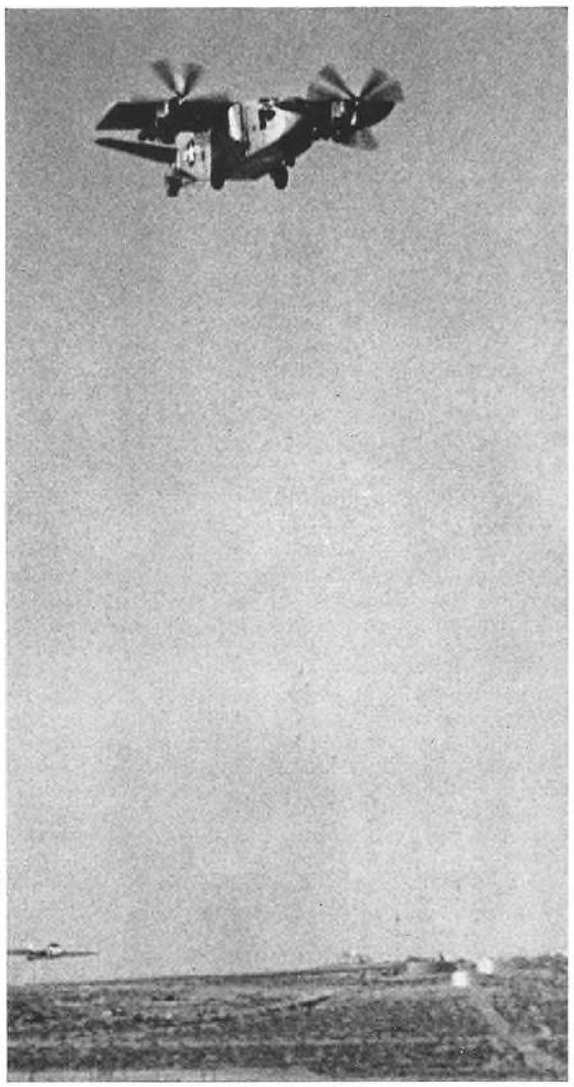


Hiller X-18 makes a conventional takeoff at Edwards AFB, Calif., with wing fixed in normal position. Vehicle weighs 16½ tons.

Air Force's Tilt-Wing X-18 Makes Conventional Takeoff

Hiller X-18 tilt wing airplane built for the Air Force is being flight-tested at Edwards AFB, Calif., as a conventional aircraft with wing-engine combination locked in horizontal position. Tests will be continued until enough flight test data is gathered to permit vertical flight test.

In the vertical flight test plane, which will begin in early 1960, the X-18 will be flown to 15,000 ft. altitude after taking off as a fixed-wing aircraft. Its wing will be rotated for vertical flight after reaching altitude. In later tests the X-18 will take off vertically and will perform short takeoffs and landings.



Tilt-wing X-18 climbs out (left) during test flight with wing locked in horizontal attitude. At right the vehicle gains altitude. Air Force chase plane is just above the horizon. Diverter pipe at tail provides jet blast for pitch control during hover and transition.

NATO Meeting in March Will Seek To Resolve 'Integration' Issue

By Robert E. Farrell

Paris—Brief talks between Presidents Eisenhower and de Gaulle at the Western summit meeting failed to produce any compromise over French resistance to integration of the NATO Air Defense Command (AW Dec. 21, p. 24).

NATO sources indicated, however, that talks on the subject at top levels would be carried out between American and French officials between now and a meeting of NATO defense ministers slated for sometime in March.

It was understood these talks would be carried out within the permanent NATO Council in Paris as well as within the NATO military standing group in Washington. An attempt will be made by French and the U.S. military officials to arrive at a more careful definition of terms as to what each country means by integration.

French sources labeled as premature earlier reports that a compromise had been reached between American and French officials on the integration question. Actually, both sides agreed to postpone a showdown on the subject until the March meeting of defense ministers.

NATO military sources were somewhat disappointed over Eisenhower's failure to budge de Gaulle on the integration principle. This is because it is felt by U.S. and other NATO officials that French objection to integration in the NATO Air Defense Command rests on political rather than military grounds. De Gaulle isn't expected to give any ground until the U.S. backs its bid for more French say within the alliance.

De Gaulle's political attitude toward NATO also casts confusion on the probable outcome of last week's Washington report that France, Italy and West Germany had requested United States technical aid for development of an intermediate range ballistic missile project. Such a program—like the current NATO-nation development of Hawk and Sidewinder missiles—is based on a U.S. policy laid down at the NATO meeting in December, 1957. At that meeting, the then-U.S. Defense Secretary Charles Wilson announced that the U.S. was ready to provide technical assistance to NATO nations for development of modern weapon systems.

The French-Italian-German IRBM bid, however, raises the question of control of the nuclear warhead. While the West Germans and Italians would accept joint control with the U.S. of an IRBM warhead—which presumably would be supplied by the U.S.—it is highly unlikely that the French would do so. De Gaulle already had refused joint control of U.S.-made IRBM missiles. The French instead would prefer U.S. help in developing an IRBM vehicle which would carry a French-made nuclear warhead and would be controlled solely by France. This proposal, however, was rejected by Washington (AW Dec. 7, p. 29).

Talks between Eisenhower and de Gaulle on the integration issue were colored by sharp criticism of the French position made two weeks earlier in Paris by Gen. Nathan Twining, chairman of the Joint Chiefs of Staff. Twining, in reviewing the NATO military posture, complained that national egotism of several NATO nations was preventing NATO military goals from being achieved.

In particular, Twining hit hard at French footdragging. He cited French action in refusing joint control of IRBM bases in France, de Gaulle's refusal to permit NATO atomic stockpiling in France, which forced transfer of French-based U.S. fighter-bombers to West Germany and England, and French refusal to move ahead with integration of the NATO Air Defense Command. Twining's remarks, which were leaked to the press, later were backed up at a NATO ministerial meeting by U.S. Defense Secretary Thomas Gates, despite a French request that Twining's statement be repudiated.

Rather than push the issue toward a showdown, both U.S. and French officials decided to postpone the question until the March meeting.

Renegotiation Board Reports to Congress

Washington—Five airframe manufacturers accounted for $24.5 million—92.9%—of the Renegotiation Board's determinations of excess profits during Fiscal 1959, the board reported to Congress last week.

The board made 22 unilateral determinations involving $26.4 million in excessive profits during the year. The 17 determinations against firms outside the airframe industry involved $1.9 million, 7.1% of the total.

Three of the five airframe manufacturers appealed to the U.S. Tax Court: the Martin Co., Lockheed Aircraft Corp. and North American Aviation.

The board reported that a total of 60 renegotiation cases involving $99.7 million in excess profits were pending in the Tax Court on June 30, the end of Fiscal 1959. Seventeen of the appeals were made by airframe manufacturers and involved $90.9 million. The other 43 cases accounted for $8.8 million of the contested excess profits determinations. The board reported these results from its Fiscal 1959 operations:

- **Of the 1,400 cases completed** during the year, 1,259 were cleared of any finding of excess profits. The cleared cases involved renegotiable sales of $15.5 billion and renegotiable profits of $1 billion.
- **The 141 determinations** issued by the board involved excess profits of $60.7 million. The 119 cases settled by bilateral agreements between the board and contractors involved $34.4 million.
- **The $60.7 million** in excess profit determinations made during Fiscal 1959 was a substantial drop from the amounts for the preceding years. The board reported the following totals in excess profits determinations for past fiscal years: 1958, $113 million; 1957, $151 million; 1956, $153 million; 1955, $167 million; 1954, $119 million; 1953, $[illegible] million. These determinations—made since the inception of the board in October, 1951, through Fiscal 1959—aggregate $784 million.
- **The board also reported** that through Fiscal 1959, contractors made voluntary refunds and price reductions totaling over $1 billion, according to renegotiation data submitted by the contractors. It was pointed out that these voluntary refunds and price reductions are to be distinguished from price reductions made under the terms of price-redeterminable contracts.
- **The board estimated** the net recovery by the government—after tax credit allowances to contractors—during the eight years of the current Renegotiation Law at $681 million. This includes recoveries through voluntary refunds as well as board determinations. The board reported that its cost to the government over the eight years has totaled $29.6 million.

Lockheed-Macchi Deal

Geneva—Lockheed Aircraft International has acquired a large stock interest in Aeronautica Macchi, Varese, Italy. Under terms of the agreement, Macchi is licensed to build a new Lockheed Model 60 highwing light utility aircraft designed and flown by Georgia Division (AW Nov. 23, p. 33).

Both companies said the first airplanes would come off the Macchi lines in mid-1960. Macchi now holds production orders from the Italian air force for the MB.326 jet trainer and also overhauls and manufactures spare parts for Lockheed T-33 trainers. Informal cooperation has existed between the two companies since 1957.

Cessna 310D Features Swept Tail

Cessna trend to vertical swept tail is the major design change in the Cessna 310D twin, ninth in the company's 1960 line of business aircraft (AW Nov. 9, p. 123). Other features include addition of non-congealing oil cooler and interior style improvements. Price remains at $59,950. Plane is offered in any one of 13 three-color paint combinations; high visibility paint stripping is optional. Seats include fold-away armrests as standard equipment to facilitate entrance and exit. Powerplants are two Continental IO-470-D fuel injection engines rated at 260 hp. each. Gross weight is 4,830 lb.

Japanese Deny Electronic Imports Pose Threat to U.S. Security

Washington—Japanese electronics industry has denied that imports of Japanese transistors are or will be a threat to the national security of the U.S., in a brief filed last week with the Office of Civil and Defense Mobilization.

The action was in reply to an Electronic Industries Assn. request that OCDM investigate mushrooming imports of Japanese transistors to determine whether they "threaten American security" (AW Oct. 5, p. 117). The association pointed out that despite a 15% duty, Japanese imports in two short years had grown from a handful to about 25% of the total U.S. production, in terms of units.

In their petition, the Japanese point out that they are competing only in the field of low-cost transistors used for consumer products, such as portable radios, and not in the quality military semiconductor market where the unit price is considerably higher. As a result, Japanese imports were only 2.7% of the U.S. semiconductor industry's dollar output in 1958 and are estimated at 3.5% in 1959.

EIA President David R. Hull, in public statements, has warned that failure to curtail Japanese semiconductor imports would make it necessary for the U.S. to "rely upon foreign producers of equipment indispensable to (its) security," and would commit the nation to "eventual establishment of vital defense industries 4,500 mi. across the Pacific Ocean."

The Japanese petition points out that Japan does not produce quality transistors for military use, because there is no Japanese government sponsorship of, or need for, such developments. The "buy American" provisions contained in U.S. defense contracts, and the need for close liaison between the military semiconductor device designer and the military equipment designer are cited as reasons why Japan poses no threat to domestic producers of military quality transistors.

Electronic Industries Assn., and some domestic manufacturers that have filed briefs in support of its position, says that domestic semiconductor research and development effort is largely supported by the profit from the sale of entertainment type transistors. Loss of such profits, due to imports, would hit hard at development of new semiconductor devices needed for defense, EIA says.

The Japanese sharply deny that profits from entertainment transistor sales finance the bulk of U.S. semiconductor R&D. Rather, they say, it is government funding either directly or indirectly, that supports most of the semiconductor research, development and innovation. The petition cites Defense Department contracts, totaling many millions of dollars, which provide for semiconductor research and development and for establishing semiconductor manufacturing facilities (AW Nov. 30, p. 74).

The Japanese agree with EIA that semiconductor research and development is vital to national security. But they say it is too vital to depend upon the sale of portable transistor radios for financial support. The Japanese suggest that the Defense Department would have been remiss in its duty if it had not provided government support for semiconductor R&D but had relied instead upon industry profits from the sale of the entertainment-type devices.

The Japanese petition also cites a number of major domestic semiconductor producers, including Hughes, Raytheon and Transitron, that have maintained technical leadership and profitability despite the fact that they do not make entertainment type transistors.

Miami Survey Indicates Support For Competitive Space Program

Miami—Of more than 1,000 persons who answered a Miami Herald space quiz, 63% said the U. S. should "adopt a new tighten-our-belt policy and throw all of our national energy into catching up even if it means we must reduce our living standard."

Just over 70% said they would be willing to pay extra income taxes in amounts ranging from $10 to more than $250 next year if it would all be spent for space research.

"Bickering by the military services over space roles" was given primary blame for Soviet Russia's lead in space accomplishments by 33.1% of those who answered. Democratic inaction was blamed by 24.3%, Republican inaction by 22% and failure of the American people to show concern by communicating with government leaders was blamed by 15.5%.

The quiz consisted of 10 questions and each question offered a choice of answers. Although none of the questions called for essay type answers, a number of those who returned the quiz to the newspaper attached their own comments, including criticism of Presidents Roosevelt, Truman and Eisenhower, and the suggestion that the civilian space agency be elevated to cabinet rank and run by a man "who knows how to knock heads together, especially military heads."

The newspaper said the response to the quiz indicated that the subject did not have broad, general appeal and that the answers came mostly from people who could be called "thinkers."

Given a choice of saying they were "ashamed because we were bested (in the space race) and disappointed in the leadership which permitted it" or saying "I am not too concerned because we can catch up if we have to," 79.2% chose the former answer, and 13.2% chose the latter.

Fifty-one and four-tenths per cent saw the greatest danger resulting from the Russian lead as a political one, 33.7% said it was military and 8.8% though it was a moral danger.

Sixty-three and four-tenths per cent thought the U. S. should tighten its belt in order to catch up; 25.8% said the country should "follow our present policy because it is a sane and balanced way to make steady progress without expensive 'crash' programs"; and 5.6% said the nation should "accept once and for all that we are behind, that we probably will stay behind, and spend our effort instead in trying to reach agreements with Russia."

On the question of additional taxes, 25.2% opposed paying more; 8% said they would pay $10; 11.6% were willing to pay $50; 20.2% were willing to pay $100; 21.5% were willing to pay $250 and 9.4% said they would pay more than $250.

Swiss Plan Smaller, Versatile Air Force

Geneva—Swiss military department will reduce the strength of its air force but will carry through its intention of ordering 100 all-purpose airplanes next year as part of a major army reorganization.

Neither atomic weapons nor guided missiles will be acquired now, the Swiss say, but possibilities of obtaining them are not ruled out.

Recommendation by the military to the Federal Council for purchase is part of a complete program for major changes in the army based on a reduction in over-all numbers but increased efficiency through mechanization.

Normal practice of the Swiss air force has been to maintain a 500-plane combat fleet by purchases of about 100 aircraft every two or three years. Use of a 10-year write-off system meant 400 to 500 combat-ready aircraft at all times. But some sources say the great cost of contemporary aircraft means the country can only afford to buy 100 every five years so that force in being will be reduced to about 200 to 250 combat-ready aircraft. This is probably one major reason behind military planning for reduced numbers but increased capability for the air force.

Primary mission of the air force remains support of ground troops but other missions may be assigned including air defense, top cover for troop movements and reconnaissance.

News Digest

Boeing Airplane Co. is scheduled to award a contract to American Machine & Foundry and American Car & Foundry jointly for development of a mobile launcher railroad car for Minuteman solid propellant ICBM. Confirming a previous letter contract, Air Force has awarded a $115 million research and development contract to North American Aviation Autonetics Division for continued development, fabrication and test of inertial guidance and flight control systems, including ground support equipment, for Minuteman. Minuteman was fired from Edwards AFB last week—the fourth successful shot out of a silo.

Western Air Lines signed orders for three additional Lockheed turboprop Electra aircraft, bringing its fleet to 12 (AW Oct. 12, p. 41). Two of the aircraft purchased under the $7.5 million contract will be delivered next July, the third in August.

Grumman Aircraft Engineering Corp. is making a three-month feasibility study to determine application of a nuclear propulsion unit to missiles. Study will cover heat transfer properties, reactor analysis, reactor shielding, radiation effects on materials and reactor materials. It is company funded.

Dassault Mirage 401, prototype for the Mirage 4A supersonic jet bomber, has flown at a speed slightly above Mach 1.5 for 20 consecutive minutes. French military budget has fund authorization for an order of 50 Mirage 4As but final decision on production is being held up (AW Dec. 7, p. 29). Powerplants are two Snecma Atar 9 afterburning turbojets.

Brantly B-2 helicopter began an 11,000-mi. demonstration tour of Central and South America which is expected to touch all major cities and military installations.

North American Aviation received a $73 million letter contract from Navy for additional A3J aircraft production during 1961, including spare parts and special support equipment. Order brings to $300 million the total that Navy has spent on A3J design, development, flight test and production.

Airlines Face Excess Capacity Problem

Trunklines gear to cope with surplus seats in 1960, see no relief next year from present profit squeeze.

By L. L. Doty

Washington—Domestic trunkline industry, rounding out one of its most successful years, is now gearing itself to cope with a series of problems in 1960 that could set the stage for a drastic reshaping of the industry within the next few years.

During recent weeks, AVIATION WEEK has discussed airline activities during the coming year with a number of top officials representing a significant cross section of the trunkline industry. Some difference of opinion exists on several subjects but generally a pattern emerges that shows a strong unanimity of thinking on major issues and gives some clue as to how the industry is preparing to tackle these issues at stake.

Here are a few of the major problems these airline officials feel the industry must face before the end of 1960:

• **Available seat miles.** With twice as many turbojets to be delivered in 1960 as went into service in 1959, available seat miles are expected to expand rapidly throughout the year. Net result will be a strong competitive push by operators of large turbojet fleets in major markets by increasing schedules during heaviest traffic hours. Smaller carriers which do not have either the competitive equipment or sufficiently large fleets of such equipment to meet this impact will suffer. So far this year, the ratio between available seat miles and revenue passenger miles has been satisfactory, but most observers feel that by mid-1960 the influence of turbojets on seat miles will begin to be felt.

• **Utilization of aircraft.** High speed of turbojets will all but eliminate demand for the long-haul night flights which have been popular in the past—particularly on transcontinental routes. In addition, the flow of traffic will not be as widely spread throughout the day as in the past, and peak traffic periods will be fewer and more heavily concentrated over a 24 hr. period, again because of the shorter operating time of the turbojets over major routes. Carriers will be forced to adjust maintenance and overhaul procedures to a lower daily aircraft utilization rate to stabilize costs or divert idle aircraft to other revenue-producing activities, such as incentive plans (AW Dec. 14, p. 36).

• **Load factors.** Major criteria of airline economy, load factors, will suffer seriously on routes where competition is high because of a multiplicity of airline services. Biggest test case on how much competition a major route can absorb before load factors fall below a break-even point lies in the Florida market where seven of the nation's 12 trunklines will compete this year.

• **Profits.** No relief from the continuing profit squeeze is expected this year (AW Dec. 14, p. 39). Several carriers may experience crucial financial setbacks because of heavy deficits.

These problems, a few of which first began to appear in the late months of 1959, present a serious challenge to the industry as it is now constituted and to the Civil Aeronautics Board which must move quickly during 1960 if it is to prevent these problems from overwhelming the industry. CAB failure to act judiciously and prudently could establish 1960 as the year of crisis for some carriers.

Congressional Security

As it is, the Board can expect some criticism, if not sharp scrutiny, of its structure this year from Congress. Although most airline observers do not feel that any serious attempt will be made to revamp the Board along the revolutionary lines recommended by former Board Member Louis J. Hector (AW Sept. 21, p. 26), they think that any major disturbance within the industry could result in some shakeup of the Board as it is now conceived.

Nevertheless, chances that the industry will be freed of tight regulatory practices which will enable the airlines to practice some type of price competition are slight. On the other hand, the fierce competitive struggle now in the making probably will result in rate-cutting on flights operated during off-peak hours in order to sustain aircraft utilization. Excursion and other types of incentive fares will also appear in 1960.

Generally, most airline leaders interviewed feel that the industry, as a group, will prosper throughout 1960 if the nation's economy maintains a rate growth comparable to that in 1959. Gross revenues for the entire U.S. scheduled airline industry are expected to climb to $2.9 billion in 1960 from an estimated $2.6 billion this year.

However, most officials felt that any disruption in the economy during the year would react more violently against the industry's health than such recessions have in the past. This is due primarily to the rapidly expanding available seat miles as more turbojets are introduced, which, coupled with a depression in traffic growth, could create a severe over-capacity crisis.

Even in a strong economy, a number of officials feel that at least two airlines will be hit by an over-capacity problem on both turbine aircraft and piston-engine aircraft because of an inability to match schedule-for-schedule the flight frequencies of their equipment-rich competitors in major markets.

With net earnings marginal throughout the industry, few carriers can run the risk of low load factors for any length of time. One official told AVIATION WEEK that low load factors must be accepted as an integral part of air transportation if the public interest is to be served properly.

He explained that high load factors do not permit a cushion which will absorb over-flow crowds in periods when traffic density rises, adding that high load factors imply weekend stand-by lines, waiting lists and unaccommodated passengers. If his point has merit, it represents a challenge to the Civil Aeronautics Board which must see to it that rates are adjusted to offset the loss per seat mile that would result from a drop in over-all load factors.

Nevertheless, economic factors being what they are today within the industry, load factors must remain well above an established break-even point if the industry is to realize an adequate return on its investment. Most officials agreed that the turbojets and turboprops, together with the widespread advertising and promotional campaigns which have accompanied their introduction, have generated substantial volumes of new traffic during the past year.

They also predict that traffic growth during 1960 will exceed any rate of increase experienced in the past because of the appeal of the turbine equipment. However, they warn that all signs point to a rise in available seat miles next year that will rapidly outstrip increases in revenue passenger miles. They add that this situation will undoubtedly correct itself within three years when major re-equipment programs have been completed and normal traffic growth will have reached a point that will return the industry to a proper seat mile/revenue passenger mile ratio. However, the interim period may prove intolerable for some carriers.

All officials who supported these views drew the same conclusion: the already hot competitive race for traffic within the industry will become so heated next year that there may be some casualties.

Inter-industry rivalry is now especially keen. It has prompted advertising programs aimed directly at competitors. It has created sales and service programs that are sharp diversions from traditional service patterns—use of Hilton and Diners' Club credit systems to supplement industry's universal air travel plan is one example.

This rivalry also has forced individual airlines into costly, yet—to the passenger—extremely advantageous, ground-handling programs designed to extend in-flight services to preflight and post-flight activities. And it has decentralized consolidated terminals such as that at Washington National Airport and encouraged individual terminals such as those either in being or under construction at New York's Idlewild Airport.

The importance airlines are placing on sales as the major weapon in the battle for traffic is reflected in the management structures of leading airlines. Sales officials in recent months have been given more authority and more voice in top-echelon company decisions.

Airline leaders admitted that this emphasis on sales and expanded passenger service has been brought about by recognizing that traffic must be increased to protect load factors if an economical daily utilization of high-speed turbine aircraft is to be maintained. How many carriers can increase the rate of traffic growth through these devices to match the inevitable rise in available seat miles still remains an unanswered question.

AOPA Proposes Compromise Plan In FAA Radio Frequency Dispute

By Robert H. Cook

Washington—Federal Aviation Agency plans to acquire complete control of very high frequency radio bands now used for traffic control by airline and general aviation aircraft moved closer to industrywide acceptance last week on the basis of a proposal from Aircraft Owners and Pilots Assn.

FAA planned to improve air traffic control procedures by taking complete control of the two VHF frequencies commonly used by the airlines and general aviation plus three military VHF frequencies. AOPA proposed that the Federal Aviation Agency require each Air Traffic Control Center to provide at least one frequency in the 123-127 mc. range for light aircraft use.

Under its original proposal, FAA would gain VHF frequencies of 126.825 to 128.825 mc. from the airlines, plus frequencies of 132.025 to 135.0 mc., from the military, to provide the agency with a greater selection of frequencies for both air traffic control and civil defense purposes. FAA would handle all air traffic control communications on the two frequencies acquired from the airlines, eliminating the present duplication of use of these frequencies by both the agency and the carriers. Company communications to their aircraft, on such matters as operational changes or weather data, would then be conducted on the higher frequencies between 128.825 and 132.0 mc.

Although it was strongly endorsed by Aeronautical Radio, Inc., the organization which handles radio communications for the airlines, announcement of the proposal brought immediate objections from aircraft radio equipment manufacturers, and the AOPA, both of which warned that the plan would entail prohibitive expenses for new, more powerful radio equipment on the part of private and business fliers.

FCC Assignment

Actual reassignment of the radio frequencies will be made by the Federal Communications Commission which must pass on the public interest aspects of the FAA proposal after a full study of the plan.

AOPA in particular opposed the plan submitted by FAA and told the FCC that it is willing to support the move, in the interests of air safety, only because the Federal Aviation Agency had indicated it will adopt an alternative providing extra frequencies for the use of the vast majority of general aviation aircraft which presently are equipped with radios unable to transmit beyond the 127 mc. range.

Generally, the organization's alternative proposal would require that each Air Route Traffic Control Center provide at least one frequency in the 123 to 127 mc. range for light aircraft use. Heavy, multi-engine corporate aircraft, similar to those used by the airlines, carry radio equipment powerful enough to meet the FAA-suggested frequency changes, while less than one per cent of the entire general aviation fleet is equipped for radio communications beyond the 127 mc. range, AOPA said.

Aircraft Radio Corp., of Boonton, N. J., and Lear, Inc., of Santa Monica, Calif., both criticized the high cost of converting to new radio equipment for the field of general aviation.

Obsolete Equipment

While endorsing the FAA proposal as a "natural evolution of the growth of aviation," Aircraft Radio told FCC that the plan will make obsolete much of the equipment used by private and business fliers. Actually frequency assignments would leave a three megacycle hiatus in the radio band required for use by non-airline pilots, the company said. As an alternative, the manufacturer suggested airlines be given frequencies between 132 and 135 mc., which FAA plans to use jointly with the carriers, and general aviation be given a band of 118 to 131.95 mc.

Lear urged that the new rule not be made effective until at least a year after adoption to permit manufacturers sufficient time to design and build new, more powerful equipment for sale at low cost to private fliers, a group which accounts for more than 95% of the company's business in airborne communications equipment.

With more than 75,000 private aircraft in the country now, and with a growth rate of 500 new planes a month, the company pointed out that aircraft owners and manufacturers alike would be injured by adoption of the FAA proposal by next July as planned. Lear explained that while electronics manufacturers make a wide range of communications equipment, economic considerations have resulted in aircraft owners usually selecting equipment of lower cost that meets all operational requirements. The practice is so commonplace, Lear said, that it has resulted in a "stabilized" competitive situation between the four major equipment manufacturers. Although Lear and its competitors make more expensive equipment with a greater range, it is not designed for sale to a low cost, high volume market, the company said.

Aeronautical Radio, Inc., has backed the FAA plan as originally proposed except for the inclusion of a 129.50 mc. common band frequency, which the organization feels is unnecessary. It contends that progress in radio design will soon permit airline communications on a 50 kc. spacing, compared with the present spacing of 100 kc. In

practice, this would amount to doubling the number of frequencies available, so that the carriers' remaining band of 3.2 mc. will be sufficient, Arinc said.

Air Line Dispatchers Assn., however, has challenged this stand. The organization contends that none of the airlines has indicated just when it intends to implement the 50 kc. spacing, when they will replace the frequencies surrendered to FAA or who will determine whether the remaining facilities are adequate for service to the pilot or operational control.

Major problem in dispatching is that air traffic control personnel "monopolize" the pilots' communications time on the ATC frequency to a point where pilots and dispatchers often cannot exchange weather and other information or discuss operational decisions, association said.

As an example, said the union, two trunkline Boeing 707s were forced to pass O'Hare Field in Chicago, in November, and proceed to Detroit because dispatchers were unable to contact them to advise of operational decisions to do otherwise.

Claiming that FAA is unable to offer any date for "getting off" the desired frequencies, the union complained that "when next summer rolls around, we will find the FAA, with a spate of new frequencies in hand, leaning on air carrier operations and Arinc communications the same as ever." ALDA added that the agency's request for frequencies "is not apt to be the last" and would likely bring about lessened job opportunities for radio operators because airlines will further consolidate their remaining frequencies for common usage.

Vertol 44 Operates Experimentally Over North Italy Passenger Route

Milan, Italy—Elipadana, a passenger helicopter service in northern Italy, has completed its scheduled weeks of experimental operations between this city and Lugano, Switzerland.

Purpose of the operations was to study the problems of helicopter service in the Val Padana area north of Milan. Route flown connected both cities with the Milan airport at Malpensa, normally more than one hour by bus or car from the Italian city.

Service was flown with a Vertol 44B hired directly from the company by the Italian firm.

Flights were scheduled three times daily.

Eventual route structure of the company could take in a sweeping arc of northern Italy from Genoa to Venice and Trieste. But any such expansion would depend on the economics of the operations, which now are such that any helicopter service would be a continuing and heavy financial loss to the operator.

This northern sector of Italy is a natural for helicopter service. It includes several large cities of more than a half-million population, in addition to Milan which is now edging to the two-million mark. Most of Italy's heavy industry is concentrated here, and so is much of the basic agricultural economy. The only major airport is Malpensa, which serves Milan and the area around it, but Malpensa is much too far out of the city.

Work is progressing on modernization of Linate Airport, much closer to Milan, but size will limit Linate to local services.

Traffic between these cities is mostly by road now. One example shows why: from Bergamo to Milan is about 50 min. by car; from Bergamo to its airport is about 90 min.

Weather Factor

Another problem in the area is the weather. Experienced travelers to or in northern Italy seldom schedule an airplane trip from November to February, because of the great percentage of time that the airports are closed due to weather. Elipadana says that those four months must be regarded as solid IFR conditions in any planning operation. The traffic potential, the long distances from city to airport and the weather combine to hand any helicopter operator the specifications for his rotorcraft: big, economic, reliable, safe and capable of IFR flight.

Elipadana says that this helicopter just isn't available yet and may not be for a couple of years .

Elipadana operated out of the Milan heliport, located just a few hundred feet from the central railroad station. The heliport is conventional with a central circular area hardstand for landings and takeoffs. Total size of the heliport is about 200 sq. ft. with an open grassed area 200 ft. x 2,000 ft. extending the area for emergency autorotation landings.

The approaches to the heliport are very flat in both directions.

Milan's future heliport will be a 250 x 300 ft. area on the roof of the new railroad station now under construction. However, the new area is not expected to be ready before 1965.

Financial Background

Elipadana is financed by private and public capital. The city of Milan has a half interest in the organization, and the other half is split evenly between Milan industries and banking interests.

President of Elipadana is Agostino Giambelli, an engineer and vice-mayor of Milan. Milan lawyer Dino Mattoli is administrative delegate, Paolo Terzi has technical responsibilities, and Commandante Ezio dell'Acqua is chief of operations.

British Halt PanAm Jamaica Jet Service

New York—Pan American World Airways last week was forced to suspend through-plane jet service from New York to Montego Bay, Jamaica, via Ciudad Trujillo as a result of British objections to the new service on grounds that it breached the U. S.-Great Britain bilateral covering the Caribbean routes involved. Pan American previously had served Ciudad Trujillo from New York, and Jamaica from Ciudad Trujillo and also had operated a route from Miami to Jamaica via Ciudad Trujillo. It was the new through-plane service from New York, inaugurated earlier this month for the first time with Boeing 707-120 jet equipment, that caused the British objection.

The U. S. State Department told Aviation Week that the British were justified in preventing Pan American from operating a through flight from New York to Jamaica via Ciudad Trujillo because there is no provision for such service in the bilateral. Pan American had set up the service with a 30-min. layover in Ciudad Trujillo and a change of flight number, but with the single-plane service. State Department said the U. S. probably would make the same demands under the same circumstances. However, the issue, according to State, will be brought up in U. S.-British consultations on the Caribbean area scheduled in Barbados next February. At that time, the U. S. hopes to resolve the problem so the New York-Ciudad Trujillo and Ciudad Trujillo-Jamaica routes can be merged to permit through jet service.

Pan American's flight 227 of last Tuesday, scheduled from New York to Jamaica via Ciudad Trujillo, was the first affected and passengers were advised in a printed memo that they would be inconvenienced by a change from jet to Douglas DC-6B equipment for the second leg of the flight. Pan American told its passengers it believed the problem arose from "intergovernmental misunderstanding."

Air-India's First 707-420 Rolls Out

Air-India International's first Boeing 707-420 Intercontinental is rolled out at Renton, Wash. The transport will enter service in early 1960, flying to Bombay, London, Cairo and Tokyo. The 155-ton aircraft, one of three ordered by Air-India, is powered by four Rolls-Royce Conway bypass engines. This 707 is the 94th to be rolled out by Boeing's Transport Division.

Allegheny, Mohawk Awarded New Routes

Washington—Allegheny Airlines and Mohawk Airlines systems were extended to Boston by the Civil Aeronautics Board in an expansion of local airline service stemming from the Northeastern States Area Investigation.

The Board also severed a number of cities from the route systems of five major trunk carriers in an over-all plan to improve air service in the New England states. Allegheny will serve Boston on a five year certificate, and Mohawk was extended to Cleveland and Boston for a three year trial period.

Need for commuter-type, short-haul air services to cities between Washington and Boston was stressed by the CAB in extending Allegheny Airlines' route system from New York to Boston, creating a new local service Washington-Boston route via the intermediate cities of Baltimore, Md., Wilmington, Del., Philadelphia, Pa., Trenton, N. J., New York City, Islip, N. Y., Bridgeport, New Haven, Hartford and New London, Conn., and Providence, R. I.

While this heavily populated area is presently served by nine major trunk carriers, CAB said that the total of such service follows no definite, planned pattern. Total length of the Washington-Boston route is 399 mi., covering 13 cities with a combined population, including New York, Newark and Islip, of nearly 14 million, the Board noted, requiring a commuter-type service that can not practically be offered by the trunk airlines.

"On the whole, we conclude that if there is to be a sound, integrated and complete local service program for the cities on an Atlantic Coast route, a local service carrier must be authorized to put the program into effect," CAB said.

TCA Jet Surcharge

New York—Trans-Canada Air Lines favors dropping the surcharge for transatlantic jet operations and plans to offer standard fares on its Rolls-Royce Conway-powered Douglas DC-8s when they go on the route next June. International Air Transport Assn. was deadlocked in its Honolulu traffic conference in October (AW Oct. 19, p. 38) and no rate structure has been established for the North Atlantic after Apr. 1, 1960.

TCA, however, believes a special IATA meeting will be held and the jet surcharge will be eliminated in the new rate structure. If IATA does not drop the surcharge, TCA will be forced to apply it. But the carrier will fight for its position in any special meeting.

TCA also expects to be the first North American operator without a jet surcharge. Transcontinental service with standard tourist and first class fares, is scheduled to begin Apr. 1 with the DC-8s.

CAB also authorized a new Harrisburg, Pa.-Washington route segment for Allegheny, added Reading, Pa., to the airline's route system and eliminated restrictions on the carrier's skip-stop authority.

Mohawk Airlines was placed in the New York-Boston market by an extension of the airline's routes from Poughkeepsie, White Plains, and New York, N. Y., to Providence, R. I., and Boston.

Mohawk also got a route segment between Utica and Syracuse, N. Y. and Cleveland, Ohio, via the intermediate cities of Ithaca, Binghamton, Endicott, Elmira, Olean, and Jamestown, N. Y. and Meadville, Pa.

Reviewing trunkline activity in the New England area, the Board decided to terminate Northeast Airlines' authority to serve Belfast, Caribou and Saco-Biddeford, Me.; Northampton and Provincetown, Mass.; Claremont and North Conway, N. H.; Bridgeport, New Haven, Stamford-Norwalk and Waterbury, Conn., and St. Johnsbury, Vt. CAB also voted to suspend Northeast service at New London, Conn., during the period Allegheny is authorized to serve the point.

American Airlines authority to serve Binghamton, Elmira and Utica was terminated, and American service to Bridgeport and New Haven, Conn., and Wilmington, Del., was suspended while Allegheny serves the three cities.

Capital Airlines service at Reading and United's service at Bradford, Pa., were also terminated by the Board.

Eastern Air Lines' $20 million passenger terminal at New York International Airport has two 350-ft. passageways which provide 16 gates. Twenty-four aircraft can be parked simultaneously on the apron. Terminal is used by 104 daily inbound and outbound flights.

Eastern Opens Passenger Terminal at Idlewild

All major Idlewild runways and taxiways and all loading and unloading Eastern aircraft are visible from 83-ft. high coordinator's tower (above, left). Coordinator controls all movement of aircraft and ground vehicles on terminal's apron area, and controls passenger information. Upper and lower vehicular driveways are enclosed behind 375-ft. facade (above, right). Main lobby is on second floor (below, left); zig-zag pedestrian ramps (below, right) connecting first and second levels are hung from stainless steel cables.

Airline Income & Expenses—October, 1959

(IN DOLLARS)

	Passenger Revenue	U. S. Mail	Express	Freight	Charter	Total Operating Revenue	Total Operating Expenses	Net Income Before Taxes
DOMESTIC TRUNK								
American	31,499,278	684,317	383,068	2,203,030	.....	35,216,394	32,656,542	2,559,852
Braniff	5,056,177	155,026	53,944	198,477	72,063	5,636,942	5,231,171	328,918
Capital	8,644,262	211,257	127,062	143,282	29,032	9,297,774	9,096,324	201,450[3]
Continental	4,448,000	61,000	40,000	86,000	24,000	4,753,000	4,450,000	49,000
Delta	7,895,000	172,000	111,000	367,000	.....	8,736,000	8,526,000	191,000
Eastern	20,812,430	411,037	948,304[2]	.....	49,410	22,403,606	23,918,595	−1,837,380
National	3,798,787	91,348	27,703	169,239	88,742	4,277,883	5,302,899	−1,134,654
Northeast	2,034,394	35,921	26,625	50,942	.....	2,184,740	3,140,657	−955,517[3]
Northwest	6,363,247	213,599	620,847[2]	.....	23,283	7,263,267	7,167,925	379,312
Trans World	22,954,250	562,805	1,411,266[2]	.....	240,172	25,286,430	22,296,323	3,157,199
United	22,130,860	786,462	2,123,548[2]	.....	381,200	25,810,279	25,537,387	343,604
Western	5,135,822	118,552	33,218	103,646	23,342	5,471,665	4,480,714	932,057
INTERNATIONAL								
American	441,348	9,786	214	45,832	.....	521,645	594,141	−72,496
Braniff	558,583	14,053	.....	43,426	28,969	663,179	718,998	−66,317
Caribbean Atlantic	185,643	2,371	10,259[2]	.....	200	201,020	207,694	−5,847
Delta	308,000	5,000	1,000	10,000	.....	337,000	421,000	−88,000
Eastern	1,671,122	39,724	88,836[2]	.....	23,084	1,625,823	1,927,296	−128,477
Mackey	118,783	.....	130	3,200	.....	132,946	131,544	1,465
National	258,681	4,037	3,519	17,250	.....	291,068	362,482	−71,414
Northwest	1,857,921	628,400	497,695[2]	.....	3,853	3,013,798	3,041,554	−12,462
Pan American Combined	23,928,000	1,604,000	.....	3,609,000	853,000	31,032,000	28,875,000	1,802,000
Alaska	260,000	20,000	.....	39,000	2,000	333,000	481,000	−148,000
Atlantic	12,342,000	717,000	.....	1,288,000	270,000	15,091,000	12,632,000	2,412,000
Latin America	5,160,000	208,000	.....	1,344,000	498,000	7,447,000	8,765,000	−1,321,000
Pacific	6,166,000	659,000	.....	938,000	83,000	8,161,000	6,994,000	1,172,000
Panagra	1,185,000	48,000	.....	163,000	5,000	1,564,000	1,654,000	−78,000
Resort	.....	.....	.....	.....	384,245	384,496	390,177	−5,861[3]
Trans Caribbean	257,499	.....	122,835[2]	.....	7,879	449,088	484,495	17,180
Trans World	4,204,953	490,681	498,565[2]	.....	111,163	5,542,916	6,615,428	−1,142,488
United	1,075,360	48,459	29,633[2]	.....	.....	1,171,042	1,067,732	93,490
Western	332,454	5,055	.....	4,262	4,496	346,749	367,956	−27,089
LOCAL SERVICE								
Allegheny	701,888	10,650	13,118	24,870	12,896	975,656	1,064,265	−88,609[3]
Bonanza	330,261	3,260	1,812	3,901	9,560	831,434	554,003	257,467
Central	184,984	8,000	2,474	7,207	17,410	457,623	472,237	−14,613[3]
Frontier	502,559	14,045	4,573	30,553	17,020	958,607	1,125,717	−183,990
Lake Central	264,313	5,295	10,402[2]	.....	5,215	436,698	402,047	34,651[3]
Mohawk	776,862	9,374	10,983	13,915	35,389	1,024,856	975,154	45,702[3]
North Central	1,059,801	27,412	21,000	17,123	28,926[4]	1,554,701	1,692,925	−167,524
Ozark	633,242	298,392[5]	9,738	27,898	10,436	991,044	939,653	51,391
Pacific[1]	.....	.....	.....	.....	.....	.....	.....	.....
Piedmont[6]	663,715	8,353	7,847	10,404	44,413[4]	1,010,744	983,663	35,079
Southern	307,385	10,623	5,134	10,464	7,964	543,677	561,020	−17,343[3]
Trans-Texas	432,604	12,180	5,926	18,619	26,823	749,710	683,794	65,169
West Coast	498,565	7,980	3,799	8,277	560	1,823,807	934,595	889,312[3]
HAWAIIAN LINES								
Aloha	314,943	2,033	.....	5,290	112[4]	330,977	349,237	−18,261[3]
Hawaiian	454,535	2,976	.....	71,915	84,537[4]	598,421	570,354	8,061
CARGO LINES								
AAXICO[1]	.....	.....	.....	.....	.....	.....	.....	.....
Aerovias	.....	.....	.....	149,100[8]	.....	233,652	223,567	10,085[3]
Flying Tiger	.....	27,008	1,564,100[2]	.....	407,980	2,034,624	2,032,998	−71,829
Riddle	.....	.....	.....	543,510	.....	548,920	531,483	17,438[3]
Seaboard & Western	.....	.....	.....	.....	.....	1,921,933	2,113,719	−191,786[2]
Slick	.....	.....	.....	.....	1,020,350	1,071,491	1,000,687	70,804[3]
HELICOPTER LINES								
Chicago Helicopter	132,689	151,749[5]	.....	.....	.....	284,467	231,586	50,155
Los Angeles Airways	15,687	10,676	11,106	.....	.....	117,326	114,043	3,239
New York Airways	73,403	3,662	1,250	2,629	.....	274,359	287,751	−14,827
ALASKA LINES								
Alaska Airlines	186,848	48,567	1,231	54,499	215,900	726,609	710,109	4,328
Alaska Coastal	71,451	9,795	.....	8,771	1,971	139,151	174,169	−35,018[3]
Cordova	127,890	100,678[5]	.....	65,668	342,835	1,007,503	961,753	47,880
Ellis	48,000	4,600	7,500[2]	.....	600	90,800	94,300	−3,500[3]
Northern-Consolidated	68,612	42,636	.....	29,239	12,105[4]	190,083	269,206	−79,123[3]
Pacific Northern	440,911	65,398	2,294	78,032	.....	738,392	886,581	−162,616
Reeve Aleutian	103,909	40,346	.....	33,979[7]	7,693	186,912	162,855	21,954
Wien Alaska	60,660	52,636	.....	25,226	23,197	224,955	354,053	−129,099[3]

[1] Not available. [2] Property figure. [3] Net operating income. [4] Non-scheduled transportation. [5] Includes federal subsidy
[6] Airline division figures. [7] Freight & excess baggage. [8] Common carriage.
Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.

AIRLINE OBSERVER

► Congress can be expected to take a close look at subsidies to local service carriers next year, particularly if subsidy costs climb as high as forecast. However, since a vast number of congressmen are on Civil Aeronautics Board records as having supported adoption of routes that are subsidized, it is very unlikely that any severe cutbacks will take place. Chances are strong that there will be another move to pass a bill designed to prohibit a carrier off subsidy from returning to subsidy.

► **Air Traffic Controllers Assn. is calling for the publication of an official glossary of air traffic control terms and phrases in a public flight document so their meanings will be a matter of public record. Controllers want an official glossary to standardize operations and to serve as a final authority in the event of disputes in hearings.**

► Aeroflot plans to build 15 heliports along the southern Crimean coast to provide regular transport and special taxi helicopter service almost to the doors of large sanatoria and health resorts in the area.

► **American Express Co. has broken into the airline credit field with a contract with Alaska Airlines permitting use of American Express credit cards for the purchase of tickets, vacation tours, excess baggage charges and personal freight shipments. Previously, only Hilton Credit Corp. and the Diners' Club had successfully entered the airline credit field (AW Sept. 14, p. 40).**

► Alitalia, Italian airline which last year fought vigorously for a high surcharge on jet flights (AW Oct. 27, 1958, p. 26), is now predicting fare reductions by 1961 of 20 to 30% below current prices on grounds that jet operating costs will be 30% below piston engine aircraft operating costs.

► **Varig Airlines of Brazil has contracted with Lockheed Aircraft Service for maintenance and overhaul of its fleet of Sud Caravelle turbojet transports. The airline began service last week with the new aircraft on its New York-Nassau-Port of Spain-Belem-Rio de Janeiro-San Paulo-Montevideo-Buenos Aires route.**

► Trans-Australia Airlines is claiming a daily utilization of 12.3 hr. for its Lockheed Electras.

► **Pan American World Airways excursion fares between Seattle-Portland and Honolulu to apply on turbojet flights as well as piston engine flights has been upheld by the Civil Aeronautics Board. Complaints by Northwest Airlines and the City of San Francisco that the lower fares were discriminatory since they did not apply to jet service between Honolulu and San Francisco-Los Angeles (AW Nov. 23, p. 39) were dismissed by the Board.**

► Official Soviet specifications on the Tu-114 turboprop transport place the over-all length of the airplane at 177 ft.—about 20 ft. longer than the Douglas C-133 Cargomaster. The Tu-114's height is 49.2 ft., fuselage diameter is 13.8 ft. and wing area is 3,347 sq. ft.

► **Airlines were quick to file protests against a current proposed ruling by the Federal Aviation Agency calling for FAA approval and inspection of all electronic gear installed on aircraft for either permanent or test use. However, complaints were withdrawn when the Air Transport Assn. pointed out to the carriers that such approval and inspection represented a strong legal protection for the airlines in the event the cause of an accident could be traced to electronic equipment.**

► General Electric will flight test its CJ805-23 aft-fan engine in January. The two engines used in obtaining data on CJ805-3 performance (AW Dec. 21, p. 29) will be fitted with aft-fan sections and reinstalled in the company's Douglas B-66A. The CJ805-23, rated at 15,000 lb. thrust, will power the Convair 600 jet transport.

SHORTLINES

► **Aero Engine Division** of Rolls-Royce Ltd., reports its turbojet and turboprop engines have completed 10 million hr. in airline service. The British company said their engines have flown 2.5 billion engine miles on the 490 Rolls-Royce-powered airliners in service in 56 nations on six continents. The company's engines are installed in Vickers Viscount, Fokker Friendship and Fairchild F-27 turboprop aircraft and in de Havilland Comet 4 and Sud Aviation Caravelle turbojet airliners.

► **Braniff Airways** will begin the first commercial air service between the southwestern U. S. and Bogota, Colombia Jan. 6 when DC-7C schedules will be inaugurated through the Houston gateway. Braniff plans to begin its Boeing 707-227 turbojet transport service on its Latin American routes in early spring.

► **Flying Tiger Line** reports air freight revenues of $14,168,469 for the 11-month period ending Nov. 30. During the same period of 1958, the all-cargo airline reported revenues of $10,761,269. Flying Tiger also announced that its November monthly figures were 16.4% above those for the same month of 1958.

► **National Airlines** has received a five year renewal authorization from the Civil Aeronautics Board to serve Melbourne, Fla., on its Miami-Houston route and permanent authorization to serve Panama City, Fla., on the route.

► **Pan American World Airways** has started two weekly round trip flights from New York to Bermuda using Boeing 707 Intercontinental turbojet transports. In addition to the two turbojet flights, Pan American is operating nine weekly flights from New York and three weekly flights from Boston using Douglas DC-6B and DC-7C aircraft.

► **Southern Airways** has received authority to serve 19 additional cities in Tennessee, Alabama and Mississippi from the Civil Aeronautics Board, bringing the airline's service to a total of 56 cities covering 4,658 route miles. The new order will become effective on Feb. 26.

► **Trans World Airlines** has added Paris and Rome to its Boeing 707 Intercontinental service and carried its 500,000th turbojet passenger on the inaugural flight to the two European cities. The 707 made the New York-Paris segment of the trip in 1 hr. 53 min.—52 min. ahead of schedule.

SUPERSONIC all-weather Republic F-105 has flown faster than Mach 2 at 38,000 ft. Petal-type speed brakes operate at Mach 2.

F-105 Spearheads TAC Fighter Forces

By Robert I. Stanfield

Seymour Johnson AFB, N.C.—Tactical Air Command's supersonic Republic F-105 fighter bomber, declared operational on Jan. 1, 1959, has maintained an over-all in-commission average—including test flights and pilot checkouts—of better than 70%. More than 100 pilots have flown the Thunderchief over 4,000 hr. without a single in-flight engine failure or fatality.

First airplane designed from scratch as a fighter bomber for TAC, the F-105 also is the first airplane in Air Force history to fly a full 10 months without a major accident. The almost fully automatic F-105D—with all-weather radar and bombing capabilities (heretofore not possible in TAC)—is being described as the "Tactical Air Command answer to the Strategic Air Command mission."

Fighter Unit

For an on-the-spot check of F-105 operational capabilities, this AVIATION WEEK editor flew to the home base of TAC's 4th Tactical Fighter Wing. The 4th is currently the only Air Force unit that has the big, single-place Thunderchief which, with its nuclear payload, will be the No. 1 fighter unit for TAC's Composite Air Strike Force. The

• **Speeds.** The F-105, approaching the facts were impressive:

2,000 stat. mi. range without air-to-air refueling and with an operational ceiling in excess of 50,000 ft., has flown faster than Mach 2 at 38,000 ft. It also has attained speeds of Mach 1.14 and 1.29 at sea level and at 4,500 ft. On Dec. 12, piloted by Brig. Gen. Joseph H. Moore, commander, 4th TFW, the F-105 flew 1,216.4 mph. for a new world's speed record for the 100 km. (62.14 stat. mi.) closed course at Edwards AFB, Calif. (AW Dec. 21, p. 24).

• **Rate of climb.** The Thunderchief, with water injection, has climbed to 8,200 ft. in 55 sec. from standstill on the runway. From "gear up," at an initial speed of 375 kt., the F-105D has reached 40,000 ft. in 2 min. and 1 sec.

BRIG. GEN. J. H. MOORE

• **Weights.** The F-105 is 63 ft. 1 in. long, with a wing span of 34 ft. 11 in. and a height of 19 ft. 8 in. Empty weight (minus fuel) is about 28,000 lb. Operational weight (clean) approximates 34,000 lb. Fully loaded—with three 450-gal. external tanks, plus bomb bay tanks (it can't carry both fuel and its weapon in the bomb bay)—it will gross about 46,000 lb. This figure is expected to increase to over 52,000 lb. In later models the fuselage may be lengthened and the wing area increased.

• **Engine.** Powerplant is the Pratt & Whitney J75 of 15,000 lb. thrust, plus afterburner. The -P5 engine, which powers the F-105B (only 75 B-models will be built), delivers total thrust up to 23,500 lb. The -P19W series, which power the new F-105D, generate a total thrust of 24,500 lb. (dry) and 26,500 lb. with water injection. The J75, with uptrimming, is expected eventually to reach the 30,000-lb. thrust range.

Private Venture

The F-105 initially was a private venture of Republic Aviation Corp., Farmingdale, N. Y. First experimental XF-105A was flown in Oct., 1955. First F-105B was flown in May, 1956. The all-weather "D" made its first flight

THUNDERCHIEFS of the Fourth Tactical Fighter Wing on the line at Seymour Johnson AFB, N. C. In-commission average betters 70%.

ASSEMBLY line at Republic's Farmingdale, N. Y., plant. Fighter-bomber is 63 ft. 1 in. long. Span is 34 ft. 11 in.; height is 19 ft. 8 in.

F-105 has climbed to 8,200 ft. in 55 sec. from a standstill. Following gear retraction, the Thunderchief has climbed to 40,000 ft. in 2 min. 1 sec. The Pratt & Whitney J75 powerplant is expected eventually to reach the 30,000-lb. thrust range.

June 9, 1959. Some 61 F-105s have been produced to date, including about 16 test airplanes of which two are the F-105D. The last of the Bs are currently running off the Republic production line.

Airplane was first delivered in May, 1958, to the 4th Tactical Fighter Wing's 335th Squadron, the first using organization to test such an aircraft at Eglin AFB, Fla. About 18 aircraft have been delivered to the 335th at Eglin, in addition to 18 going to the 334th and nine to the 336th Squadrons at Seymour Johnson. The 333rd Squadron at that base, now flying North American F-100 Super Sabres, will be the first unit to receive the F-105D. At full strength the wing will have about 72 aircraft.

The F-105D also will replace the F-100 overseas, in U.S. Air Forces Europe (USAFE) and Pacific Air Forces (PACAF), and is earmarked for delivery to the 4520th Combat Crew Training Wing at Nellis AFB, Nev., early next year. About 300 F-105Ds are expected to be deployed to Europe within the next 12 months. To date TAC has negotiated firm contracts for 120 airplanes and has programed for something over 500 aircraft.

Strong possibility exists that TAC will program an additional 400 Thunderchiefs which, with its initial planning estimates, could eventually give it over 900 F-105s. Total upgrading of Tactical Air Command, into a Mach 2 fighter bomber force, should be completed by 1964.

On the European side, Republic, following an assessment by a 10-engineer team, is offering the F-105D at a fly-away cost of $1.4 million (a fixed-price contract) in Holland and Belgium, where the airplane would be built. These countries combined have earmarked about $220 million of their own money for production of from 250 to 300 aircraft. This would be about half the cost for this number of F-105s; the remainder of the money would be funded via mutual aid. Also competing for the Dutch-Belgian Air Force order are the Northrop N-156F, the Lockheed F-104 and the French Dassault Mirage 3A (AW Dec. 21, p. 20).

Pilot Transition

TAC requires its commanders to be proficient in primary aircraft, and Gen. Moore is one of but only three general officers who have flown the single-place F-105. All transitioning is by the pilot alone, who is chased on check-out by an instructor-pilot in another F-105.

Two F-105D simulators being built by Erco Division of American Car & Foundry, are still almost a year away from completion.

The F-105 "is the easiest airplane I've ever flown and checked out in . . . as a high-performance airplane," Gen. Moore told AVIATION WEEK. Key capabilities of the weapon system which, with air refueling, can strike at any target in the world and which, at 40,000 ft., has been defined as "equal to the Boeing B-52 Stratofortress in accuracy," include:

• **Missions.** TAC pilots feel they can now perform missions previously flown by large bombers with large crews. F-105D is capable of treetop-and-up level flight bombing, low-level blind LABS maneuvers, automatic and blind dive-toss bombing. The D model is aimed at any target under any weather conditions, including brush-fire and all-out war concepts. The long bomb bay is also adaptable for an air-launched ballistic missile.

• **Armament.** The F-105 is the first fighter with a bomb bay for internal carrying of a nuclear weapon, negating yaw problems. Airplane carries nuclear and thermonuclear bombs as well as conventional types, in addition to Sidewinder, Bullpup and White Lance missiles. Armament also includes a nose-mounted General Electric M-61 20 mm. Vulcan automatic cannon (a six-barrel rotating "Gatling gun") that fires 6,000 rounds a minute. Cannon incorporates a linkless feed system, saving 16 cu. ft. of space which is utilized to house radar equipment.

• **Navigation.** The AN/APN-131 doppler airborne navigation system (built by Laboratory for Electronics, Inc., Boston, Mass.), installed in the F-105D, automatically and independently of ground installations—through a self-contained computer—supplies the pilot continual present-position coordinates, ground speed, track, heading and distance to target, wind direction and velocity, and alternate destination selection. No dead reckoning is required of the pilot.

NASSAR (North American Search and Range Radar) navigation and fire

control supplement allows the pilot visually to keep track of his route. The all-purpose monopulse R-14A radar is adapted for both low-level and high-level missions—air search, automatic tracking, ground and contour mapping and terrain avoidance—regardless of visibility, ceilings or target area conditions. Ground mapping ranges of 13, 40 and 80 naut. mi. are possible. Under instrument conditions the radar can be used to eliminate doppler errors.

The General Electric FC-5 flight control system, tied to the doppler for automatic navigation, flies the aircraft on a great circle course. The FC-5 maneuvering autopilot, with force stick steering, will negotiate small corrections as the F-105 nears the vicinity of the target or check-point (the autopilot also incorporates automatic coupling to ILS —instrument landing system).

Fire Control

"D" model also incorporates the General Electric AN/ASG-19 "Thunderstick" fire control system, which includes the R-14A radar and a General Electric bombing computer; a Republic concept incorporating this company's ideas on mechanization and mathematics, and tieing together navigation and flight control systems with fire control.

"Thunderstick" arms and takes over the actual release of the bomb and solves such problems as release altitude, flight time to target, angle of attack and crosswind. In certain modes of delivery the system also initiates an escape maneuver following the bomb release. The three-axis automatic flight control (FC-5) functions as an electronic copilot, as an aid to the pilot in both flying the jet or taking over completely.

Thunderchief bombing aids which keep errors to a minimum include:

• **Wings-level aid.** There should be no errors due to the airplane not being horizontal. For instance, the cross-wind measured by doppler is sent to the autopilot so that at the time of bomb release the wings will be level.

• **Bomb release.** Another aid is the toss-bombing computer which negates the pilot having to fly a pre-computed problem. The pilot can pull up the F-105D at any angle; the computer will compensate and release the bomb at the correct time. If escape data is not correct, the bomb will release at high point rather than at low point.

• **Escape maneuver.** Dive-toss, which reduces time of flight of a bomb to a minimum, is the most accurate mode of delivery and necessarily involves an escape maneuver with use of a nuclear weapon. In this instance the computer either gives a release or refuses a release, depending on the "pickle point."

• **Vertical bombing.** A Lear all-attitude (360 deg.) non-tumbling reference system, for vertical bombing, is tied in to the doppler for heading indication. It is also tied in to the bombing computer for true vertical indication and ties in to the flight control system so that the pilot automatically can maintain any heading he sets in.

Bomb Accuracy

Sophistication of the F-105D weapon system could allow for a circular error probability (CEP)—distance from target on average pass—of about 500 ft., which is not improbable with this airplane. A one-kiloton bomb (20,000 tons of dynamite), with a 500-ft. CEP, could easily knock out any target. By comparison, a 1,000-ft. CEP would require four airplanes or a bomb four times the strength. An airplane with a CEP of 1,500 ft. would require a 10-kiloton bomb to do the same work. The F-105 is said to have the smallest CEP of all Century series aircraft.

The Thunderchief can operate from a 5,000-ft. runway, with a drag chute to slow the landing roll. Average takeoff distance is 3,000 ft.; landing roll, 3,500 ft. Without a drag chute the airplane can turn off within 7,000 ft. Installation of a water-injection system reduces the takeoff roll almost 900 ft.

Usual F-105 unstick speed is about

F-105 can carry three 450-gal. external tanks plus bomb bay tanks. Airplane is approaching 2,000 stat. mi. range without refueling.

173 kt. Final approach is flown about 180 kt.; touchdown is usually at about 160 kt., speeds varying with weights. Pattern speeds are comparable to the F-100; initial pitch-out speed is 350 kt. Two vertical and two horizontal dive brakes (petal-type, on tail) decelerate the airplane; when the gear is down, the vertical brakes close up, permitting operation of the drag chute and preventing bottom-petal runway scraping. Fully open, at 50 deg. angle to fuselage, the brakes present an area of 29 sq. ft.

Pilot Requirements

The 4th Tactical Fighter Wing at Seymour Johnson has become "combat ready" a squadron at a time; pilots in the process of checking out in the F-105 have retained this status in the F-100. "Pilot performance can't be mediocre," said Capt. Garry A. Willard, flying training officer for the wing, who himself is crowding 3,000 hr. of jet fighter time (and a crack pilot, too, with whom this editor flew north in an F-100F). Capt. Willard noted that the 4th's F-105 pilot requirements generally run to 1,000 hr. total flying time, of which at least 200 would be in Century series aircraft.

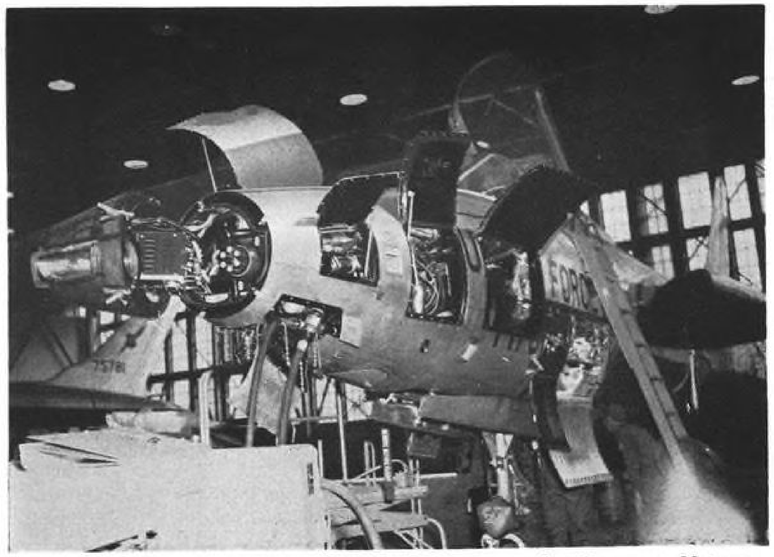
The wing is dominated by captain pilots with an average age of 27 and an average individual flying time running between 1,500 and 2,000 hr. The wing is moving toward putting 25 hr. per month on each F-105. As a wing it is programed to fly a total of 1,800 hr. per month.

The 4th doesn't operate on the "scramble" principle. If the "whistle blew," pilots would operate on about a six-hour movement, which would hinge on readying of aircraft, briefing, setting up aerial tanker movement, etc. The wing has just completed compatability tests with the Boeing KC-135 Stratotanker, which will be used when available. The 4th now uses KB-50Js for aerial refueling. With two additional 450-gal. tanks, the F-105 itself becomes a tanker for "buddy refueling."

Squadron pilot check-out and training runs to about 75 flying hours. Included are 10 transition missions of 1 hr. 30 min. each, plus a combat readiness program including day-night air refueling, special and conventional weapons training. Ground training includes a 16-day program, in addition to steady squadron programs.

Transition from the F-100 to the F-105 is proving easy for the pilots at Seymour Johnson, AVIATION WEEK was told. Wing maintenance personnel are trained by a mobile training detachment

ARMAMENT carried by this F-105B at Seymour Johnson AFB includes two 3,000-lb. T-55 bombs outboard and two 750-lb. Mk.83 bombs inboard. Carried under the belly is a 450-gal. external fuel tank. Long bomb bay will carry a nuclear weapon.



HINGED nose and access panels facilitate F-105 inspections and maintenance. Note nose-mounted General Electric M-61 Vulcan cannon that fires 6,000 rounds a minute.

stationed at the base, as are pilots for system familiarization. Majority of the mobile detachment was trained at the Air Force school located at Republic's Farmingdale plant. Republic also has seven of its own technicians stationed at Seymour Johnson; one with each squadron, plus additional specialists backing up the consolidated aircraft maintenance (CAM) squadron.

Postflight and periodic inspections on the F-105s initially were pulled every 25 and 50 hr. The Thunderchief now has gone to 100 hr. periodicals, with three special inspections pulled in between. Some aircraft have flown 10 straight flights with no maintenance required going into the periodic. Some have made as many as 60 landings before a tire change. Engine changes, with four men, presently average about one day's time.

The F-105, seven feet from the ground to the wing, with a "coke-bottle" shape, incorporates all hydraulic flight controls, similar to present-day operational fighters. Throttle embraces standard mechanical linkage (not an electronic brain). A fin scoop slot at the base of the vertical stabilizer feeds cooling ram air to the aft fuselage section between the tail pipe and shroud. With heating and acceleration, 800 lb. of additional thrust is gained.

The Thunderchief utilizes both leading-edge and trailing-edge flaps to increase lift. Series of dampeners (stability augmentation) give the airplane optimum control, though it has been demonstrated throughout its flight envelope without these aids. Spoilers on the wings act for the ailerons at high speeds.

Variable air inlet ducts allow an excess of air into the engine itself.

Hydraulic pressure for the tandem flight control actuators stems from two engine-driven pumps, each with an independent reservoir. Ram air turbine provides a third power source for flight controls. Should the d.c. generators be lost, the battery will supply enough power to operate the aircraft's entire electrical load for four to five hours.

LONGITUDINAL arrangement for rotor positioning was used for the first time in the USSR on the Yak-24. The helicopter's navigational equipment permits it to make flights at night and under difficult weather conditions. The Yak-24 project was initiated in 1952.

Soviet Management Techniques Detailed

Alexander Yakovlev, a major Russian aircraft designer, detailed Soviet management techniques for high priority programs and technical problems involved in designing the Yak-24 helicopter in his recent book, "Tales of an Aircraft Designer." The following excerpts from the book provide an insight into just how the Soviet Union runs a crash program in technical areas where it is lagging, including the firm deadlines and generous support imposed to ensure success.

During the three decades of its existence, our design bureau has concerned itself mainly with fighters and training planes. Therefore, when newspapers published the report that a gigantic helicopter—a "flying railroad car"—had been built by our design team, it caused surprise in aviation circles both at home and abroad.

The history of the "flying railroad car's" development is somewhat unusual.

At the end of the summer of 1952, I was summoned by the government. On arriving at the Kremlin, I met Tupolev and Ilyushin there, and also the helicopter designers Mil, Kamov and Bratukhin. I was surprised at the unusual combination of designers who had been invited. Helicopters and airplanes are such different craft and have so little in common that helicopter builders and airplane builders rarely met together.

But everything was cleared up as soon as the conference began. It turned out that they had invited us all together in order to get advice: How could our country eliminate its then-existing lag in the field of large helicopter construction?

Actually, at that time we lagged behind the United States of America in this field. We were told that the design forces working on helicopter construction were insufficient; that this matter must be dealt with seriously; and that the government had decided to ask experienced design teams in the airplane manufacturing field to engage in a project that was somewhat unusual for them—help to build large, multi-place helicopters.

Mikhail Leontevich Mil, who had been engaged in helicopter construction for many years, came forward at this meeting with a prepared proposal based on an already-developed design for a

SINGLE-ROTOR helicopter developed in 1932 by the Zhukovsky Central Aero-Hydrodynamical Institute set a world altitude record of 605 meters (1,985 ft.). The Institute provided important assistance for the Yak-24 project.

12-place helicopter. As for us airplane builders, the presentation of the problem was unexpected.

Andrei Nikolaevich Tupolev and Sergei Vladimirovich Ilyushin declared that in view of the enormous work loads already being carried by their design bureaus, and also because of their complete lack of experience, they could not participate in helicopter construction. When my turn came, I said that we, too, were loaded down with work but that we had certain ideas about helicopters. During recent years we had built two small experimental helicopters. If we were given certain assistance, we could consider developing a draft project for a large helicopter. I asked permission to consult with my co-workers and to give my final answer only after that. They gave us 24 hr. to think it over.

After returning to my design bureau, and without laying the matter aside for even a minute since by now we had less than 24 hr. remaining, I sent for Nikolai Kirillovich Skrzhinsky, who had been working with autogyros for 30 years; Peter Dmitrievich Samsonov, a veteran in airplane building and a most experienced engineer: Leon Mikhailovich Shekhter; and Igor Aleksandrovich Erlikh, who was at one time the leading designer of our experimental helicopters.

Difficult Task

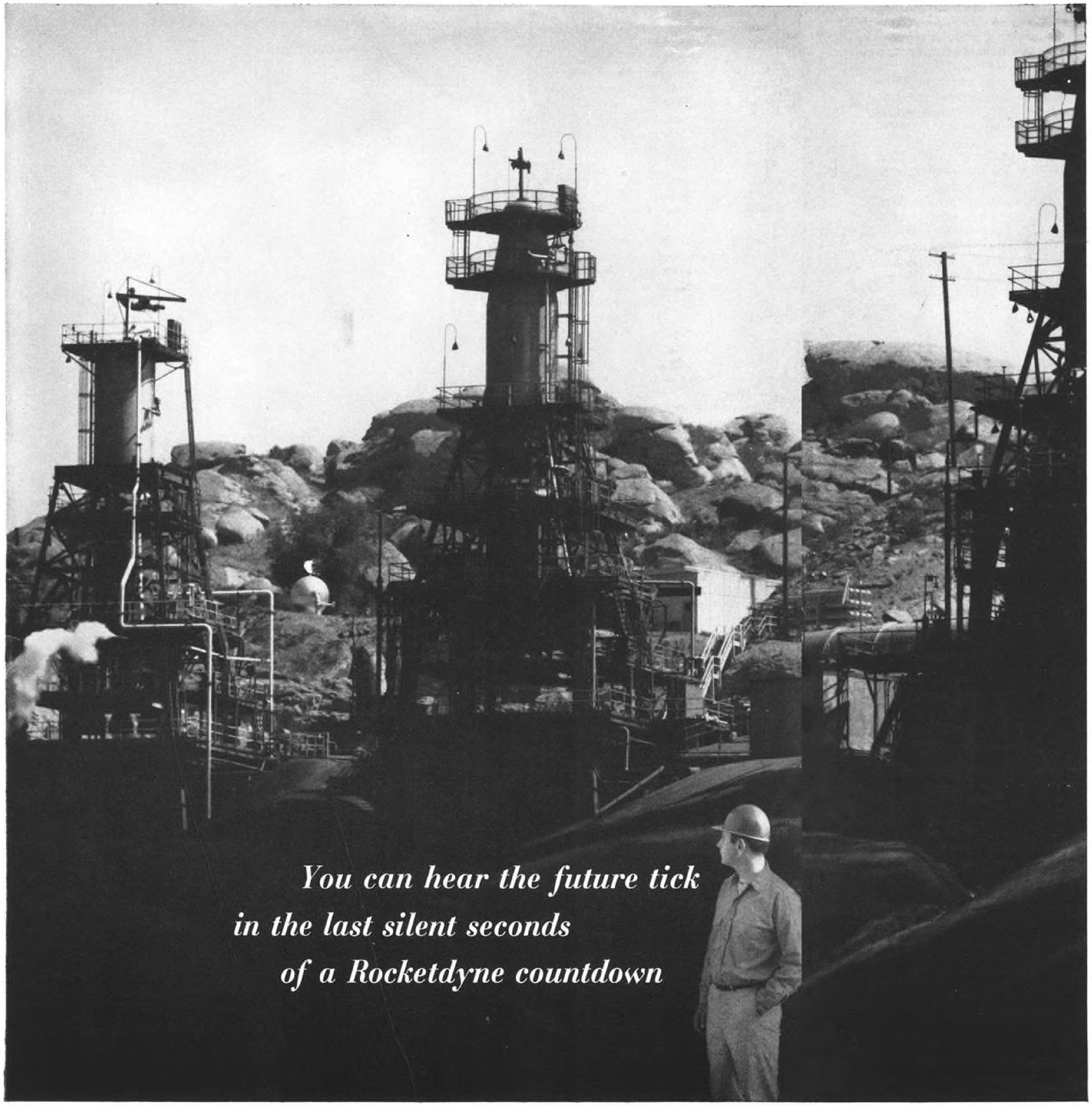
I explained the essence of the matter. We pondered deeply. Everyone thought the task was vague and "ticklish." We recalled the difficulties which were associated with the building of large helicopters in the United States and England. Yes, and it was impossible to take our own experience seriously. Our work with small, experimental craft was one thing—building a gigantic transport and cargo craft was quite another matter. But, since the government had made the request, and since "it is not so difficult to do things as it appears," we decided to undertake development of a design for a 24-place, twin-rotor helicopter. We estimated and calculated that the designing might be accomplished in a year. Reaching this conclusion, the meeting broke up.

We were again called to the Kremlin the next afternoon. Among the designers, only Mil was there. The affair took a turn that was entirely unexpected for us, and for me, in particular.

It was suggested that we examine and give our impressions regarding an already-prepared, government-formulated project for building two helicopters. Construction of a single-engine, single-rotor craft carrying 12 persons was handed over to Mil's design bureau; and the twin-engine, twin-rotor craft accommodating 24 persons was

YAK-24 has carried a four metric ton payload to an altitude of 9,521 ft.

Alexander Sergeyevich Yakovlev is an aircraft designer-in-chief under the USSR Minister of the Aviation Industry and a Colonel General in the Engineering and Technical Service. With no formal technical education, he began his professional career as a laborer at an airport and studied aviation in his spare time, primarily under the auspices of the Society of the Friends of the Air Fleet, a Soviet para-military organization. The first aircraft he designed was a biplane test-flown in 1927. His design bureau had three major fighter designs flying in World War II. Designs he oversees today include light aircraft, helicopters, all-weather fighters and ground attack aircraft. Yakovlev has twice been awarded the title of Hero of Socialist Labor. He is a member of the Communist Party and a deputy to the USSR Supreme Soviet from the Kuybyshev District.



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entrusted to our bureau. The most difficult thing for us was that a period of only one year was specified for designing, building and testing both helicopters.

Just the day before, my assistants and I had believed it impossible even to prepare a design in less than a year. And now we had been given a year to do everything. It had seemed that it would require no less than three-four years to solve such a complex design problem. Mil and I tried to argue about the time allotted, but it was explained to us that since this project had been neglected so much in the past, it was impossible to wait any longer. We were told that we would be given any help we needed without restriction, but that the proposed time limit of one year was final and not subject to discussion. Finally they persuaded Mil, and there wasn't anything else for me to do but "resign myself" to it.

The next day the decree was signed. The period of time specified scared everyone who was faced with working on the helicopter, and "well-wishers" already predicted inevitable failure for us.

Helicopters' History

But before telling about how we nevertheless succeeded in achieving our task, and in order to make clear what difficulties awaited us, it is necessary to devote a few words to the history of the helicopter. . . .

Leonardo da Vinci first had the idea 450 years ago of building a helicopter—a machine which rises into the air with the help of a propeller turning in a horizontal plane A sketch of Leonardo da Vinci's design has been preserved, and we can judge that his idea was entirely sensible.

In 1754, our great compatriot Mikhail Vasilevich Lomonosov, at a meeting of the Academy of Sciences, reported on his design for an "aerodynamic machine" to investigate the upper levels of the atmosphere. Lomonosov even produced a model of the machine, which had propellers that were turned by a clock spring mechanism.

But a design or even a model is one thing, and a flying helicopter is something else again.

Only at the beginning of our century did man succeed in being lifted into the air by a rotary-wing apparatus, or helicopter. Specifically, in Russia before the 1914 war the aeronautical society of Moscow's Bauman Higher Technical School built the first helicopter from the design of student Boris Nikolaevich Yuriev, who later became an academician. But the war interrupted this work, and it was only resumed after the revolution.

In 1932, Prof. Aleksei Mikhailovich Cheremukhin established a world altitude record of 605 meters in a helicopter designed by the Zhukovsky Central Aero-Hydrodynamical Institute.

(First recognized international helicopter performance records were set in 1930 by the Italian Fiat A-50 helicopter. No Russian helicopter record claims were made to the Federation Aeronautique Internationale during the 1930s. First helicopter with satisfactory stability and control characteristics generally is credited to Igor Sikorsky in 1941. —Ed.)

During the thirties and forties, very persevering work on helicopters was done in the United States by designers Sikorsky (who was Russian by birth) and Piasecki, and in England by the Bristol firm, where helicopter designing was directed by the well-known Austrian specialist Hafner, who entered the service of the British after the second World War.

The first big successes were then achieved by Sikorsky, who built a number of small, single-rotor helicopters. Some of these were accepted for equipping the American Army and took part in the Korean War.

Piasecki's work was also successful. He built helicopters of medium lifting capacity. His "workhorse" helicopter found wide use in the United States' airborne forces.

The British had less luck with heli-

copters. Hafner worked very long and agonizingly to perfect the Bristol craft, but he was unable to achieve reliability in flight or to see his machine go into mass production. The British were forced to buy in America a license to build the Sikorsky helicopter.

(The Bristol Sycamore helicopter for which Hafner was the principal designer was under development during the late 1940s and had entered service in substantial numbers by 1952. Bristol also sold the Sycamore abroad. Production of Sikorsky helicopters in England was begun by Westland in 1947—Ed.

At the beginning of the nineteen fifties, all known American and British helicopters had comparatively small lifting capacity—a limit of one metric ton. Only the Piasecki firm widely advertised its projected two- to three-ton YH-16 helicopter. However, great misfortune befell designer Piasecki. The craft was under construction for a very long time, and its designer could not cope with the vibration which developed even during flights and while hovering at low altitude. After eight years of persistent work, YH-16s were readied for flight tests. But it was an unlucky craft: in 1955, on its 21st flight, it fell to pieces in the air; and its entire crew of five men perished in its wreckage.

(Piasecki YH-16A crashed in 1955, killing its two crewmen. The tandem rotor machine had been under development for seven years before it made its first flight in 1953, and Piasecki built two versions—the YH-16 with two piston engines and the YH-16A with turbine engines. The two helicopters made 66 flights out of ground effect before the YH-16 crashed. Accident was traced to failure of a bearing in flight test equipment. Company engineers maintain that excessive vibration had been eliminated and was not a contributing cause of the crash.—Ed.)

Vibration Problems

Piasecki fought unsuccessfully for many years with vibration in the YH-16 helicopter; and Hafner spent many years in trying to cure vibration in the Bristol-173. Vibration was the most dreadful and difficult-to-cure malady of all helicopters. We also were convinced of this as soon as our helicopter was designed and built and began its flight tests at the airport.

(While no helicopter has ever been completely free of vibration, company engineers report that there has been no serious difficulty with the Bristol 173 since it went into service with the Royal Air Force more than two years ago.—Ed.)

During the entire existence of our design bureau, the main objective of the workers was speed and more speed. From aircraft to aircraft and from year to year we strove to give our planes greater and greater speed. But for helicopters, on the other hand, the main thing is not speed but the ability to hover motionless in the air and to have zero speed, lifting a large load vertically from a given spot.

We settled on an original helicopter design—one which was to be used for the first time in our country: a dual-rotor craft with longitudinal positioning of the rotors along the helicopter's axis. This arrangement, as was later confirmed, had advantages as compared with a single-rotor design: such a helicopter is more stable; it lifts a larger load; and, above all, its cargo cabin is twice as spacious, thus permitting loads of greater dimension to be lifted.

We had no experience at all with regard to the chosen design. Therefore, we had to start everything from the very beginning. We were forced to make a large number of the most intensive investigations and had to solve difficult scientific and research problems with the help of scientists in the Zhukovsky Central Aero-Hydrodynamical Institute and the Baranov Central Scientific-Research Institute for Aircraft Engines. The most qualified people were brought together. The combination of designing experience with deep scientific-research analysis enabled us to avoid big errors both in the over-all design and in developing individual components. But when the helicopter was built and started its tests—checking of all the systems and all the working parts—it was demonstrated that every problem in such a complicated machine could not be foreseen by theoretical means. Many new problems arose—for example those connected with cooling. A flying airplane is exposed to a blowing stream of air, and the engine is intensively cooled. But here we had to make a helicopter hover for a long time in one place while carrying a full load. So it was necessary to provide forced cooling for the engine.

But the main difficulty, which provided us with a heap of trouble, was vibration.

The Ministry of the Aviation Industry devoted much attention to the helicopter projects—ours and Mil's. Broad cooperation was organized among the various factories. The Ministry gave the "green light" for manufacturing helicopter parts at other aviation industry plants. The work progressed swiftly.

Four copies of the helicopter were built at once. The first copy was for testing static strength in the laboratory. The second was for checking dynamic strength at the airport—that is, for checking the resource (service life) when the engines and rotors are operating and the helicopter is in suspension on ropes.

The third and fourth copies were for flying—in factory and government tests.

Positive results in testing one of the four copies by no means precluded troubles in testing any of the others. For example, the first copy, which was intended for static tests, can—as was the

case with us—successfully pass all the tests put to it. But the second copy—for dynamic testing—can be tested, worked over and refined for several years. The British and American experience spoke eloquently to us about that.

Besides the tests I have enumerated and which were conducted at our plant, some parts of the craft were checked at other factories and institutes.

For example, the rotor head—a vital unit—was tested at the motor plant where it was manufactured. The blades were tested for vibration stability at the Zhukovsky Central Aero-Hydrodynamical Institute, where they were given 10 million oscillations in order to be sure of their reliability. The entire motor group, with the engine feed system and the cooling, was tested at the Baranov Central Scientific-Research Institute for Aircraft Engines. All of these tests were carried out satisfactorily, on the whole, and in the allotted period of time.

The main difficulties began in the prototype craft. From the very first hours that the engines and rotors operated, the craft started to shake. First, it shook at certain rates of revolutions, then at others; and the shaking was unmanageable. You eliminate it in one place and it suddenly appears in another. And so it went on without end like in the story: "You pull out the nose, and the tail goes in; you pull out the tail, and the nose goes in." Iron-like endurance and persistence were required for us all. But these joltings were nothing by comparison with what awaited us in the future.

Service Tests

It was necessary to conduct 300-hr. service tests in order to check on the reliability of all the helicopter's parts prior to tied-down flight. We tried to put the prescribed 300 hr. on the prototype craft as fast as possible. The agonizing aspect of these tests was that in case of breakdown by any part, regardless of what hour of operation it occurred, it was necessary to start the entire test from the beginning—from zero. Thus, with every additional hour of the system's operation, we rejoiced on the one hand while, on the other, ever-greater anxiety arose within us: will something suddenly break?

After 150 hr. were run off, we were able to cope with the craft's shaking and vibration. We waited with trepidation the results of each new hour of operation which brought the tests to the sacred figure "300." Already confidence had built up that everything would be all right. Then, suddenly one day an agitated voice came over the telephone from the airport:

"Big trouble! The craft has been demolished and is on fire. It's impossible to save anything. The cause is unknown."

"How are the personnel?"

"Nobody has been hurt."

I quickly drove out to the airport. A sad picture appeared before my eyes. There was a pile of burnt wreckage and mangled blades scattered around the area. Nothing more was left of the machine. It had run up a total of 178 hr. It was necessary to start everything from the beginning.

An accident commission consisting of the most prominent specialists, and with us participating, finally determined the cause of the misfortune. It turned out that fastening units on the frame of the rear engine had failed due to fatigue stress. The rear engine and reduction gear, along with the rotor, fell forward, and the blades began to chop up the entire craft. Gasoline from broken gas tanks gushed onto the hot engine, and fire broke out.

All of us were in low spirits then: we had to start everything from scratch!

I consoled my assistants by saying that at least it was fortunate that the cause of the accident had been determined. Necessary measures would be taken which would mean there would be no repetition of the trouble in the future. In addition, everything which had already been studied up to the 178-hr. mark didn't go to waste either. Finally, that's what service tests are for

—to reveal such defects in time.

But consolations are only consolations. And I myself was exceedingly dejected. There was nothing to do but start the tests with redoubled energy, especially since we had already prepared the first flying copy of the helicopter for flight.

Aside from the flight engineers, mechanics and radio operators, a flight test crew was named consisting of test pilots Sergei Georgievich Brovtsev and Egor Filippovich Milyutichev.

Brovtsev had a reputation as a very experienced helicopter test pilot. Milyutichev, who was young and capable, had only just begun testing work. But the Brovtsev-Milyutichev combination was, as it turned out later, an exceptionally fortunate one.

First Flight

After the very first timid flights in the helicopter, both Brovtsev and Milyutichev spoke well of the craft. But these were still small jumps, flights and hoverings at an altitude of 5 to 10 meters above the ground. The pilots tested the machine carefully, trying thoroughly to get its feel.

The helicopter's leading designers were always present during such tests. I discussed all the test results in detail with the pilots and other designers. We worked very carefully.

Hundreds of small flights lasting several minutes each and at reduced engine power had been made when Brovtsev at last announced that a real test flight could be attempted. And we, after discussing all of the previous flight results, decided that such a flight might be made.

When Brovtsev and Milyutichev had taken their seats in the cockpit and prepared for flight, they gave the craft full throttle for the first time. The motors roared powerfully; and the rotors, throwing out a hurricane stream of air, lifted the craft off the ground. It flew the way it should, steadily gained altitude and sped forward. All those present at this huge machine's first flight were numb with rapture.

All of us—designers, workers and pilots—had labored over the helicopter for a long time and knew that it would finally fly. But when it actually did fly our joy knew no bounds.

After 10-15 min. of flight, the pilots landed safely. We shook their hands and could not do without the traditional bottle of champagne.

However, both of the pilots soon became vaguely disturbed and began to talk uncertainly about the appearance of a kind of "mild shaking" in one condition of flight. Special, sensitive, vibration-recording equipment was installed in the helicopter. Actually, it turned out that, in several conditions of flight, there was not a "mild shaking," as the pilots delicately expressed themselves in an apparent effort not to worry the designers, but a very real and intolerable jolting which caused dangerous vibration of the structure.

For five months we searched for ways to eliminate this shaking—five months of intensive studies and calculations. There were tens of experimental flights, and all without result.

Here it is necessary to keep in mind one of the differences between a helicopter and an airplane. With an airplane, moving and turning parts operate only in the engine, and all of the vibrations which develop are absorbed by special shock absorbing devices. But, with a helicopter, anything can be the source of vibration! One engine shakes; the other engine shakes; the reducer shakes; the synchronous connecting transmission between the rotors shakes. A very great amount of time was required to discover the primary source of the vibration. The several months we spent fighting the helicopter's vibrations drove us to a state of semi-stupefaction, desperation and even hopelessness. We began to lose faith that we would ever succeed in eliminating the vibration since it appeared unexpectedly in various places. It got to the point where, instead of calling greetings when we met in the morning, we shouted at each other: "How is it going—still shaking?"

"It's shaking; it's shaking!"

"When will this damned shaking stop?"

The Zhukovsky Central Aero-Hydrodynamical Institute and other scientific-research institutes, under the direction of Deputy Minister S. N. Shishkin, who led the refinement work on the helicopter, gave us good assistance from the very beginning. And then, at my request, A. I. Makarevsky, chief of the Zhukovsky Central Aero-Hydrodynamical Institute, gathered together everyone who might be useful in order to discuss with all of them the entire range of problems associated with vibration. This was a curious meeting. In their statements, Makarevsky, who was him-

Yak-24 Design Details

Several versions of the Yak-24 helicopter have been built, and the aircraft is still being improved. Yakovlev explained a number of the main features of this design development to Ralph Alex, head of component design at the Sikorsky Aircraft Division of United Aircraft Corp., when Alex visited the Soviet Union as president of the International Helicopter Commission of the Federation Aeronautique Internationale and attended the 52nd general conference of the FAI in Moscow.

Yakovlev's discussion of the Yak-24 and Alex's first-hand observations indicate that the design was initiated by borrowing two of the 65-ft. rotors, the rotor hubs and two 1,750 hp. Ivchenko engines and their transmissions from the Mil-4 helicopter in order to make a rapid development program possible. Originally, the Yak-24 fuselage was made of welded steel tube construction and covered with fabric. The latest version has an aluminum fuselage with a new 75-ft.-dia. rotor with the blades made by attaching sheet metal pocket sections to a steel tube spar that forms the leading edge.

The earlier design, which is now operational, uses rotor blades having a round steel tube spar with built-up sheet metal airfoil sections around them. Main purpose of the new design changes is to increase the short haul capacity of the aircraft. In the civil version, the goal is to carry 40 airline passengers.

Yak-24 is considered an all-weather helicopter and is equipped with windshield and blade de-icing, radar altimeter, UHF radio, electric artificial horizon, navigational flight instruments and a red-lighted instrument panel. The automatic stabilization requirement, which is standard, is an adaptation of an aircraft system and does not function below a forward speed of 40 or 50 kt. Development of a new system which will operate during the hover is planned. De-icing unit of the Yak-24 is electrical, in contrast with the alcohol system used on earlier Soviet helicopters which did not prove satisfactory. Cruising speed is placarded at 126 mph., and the maximum speed at 157 mph. on the Yak-24 inspected by Alex. Single point suspension is provided for loads carried externally, and trucks up to five tons have been flown. A rear loading ramp for internal loads is power operated. Maximum allowable center of gravity travel is 40 in.

Alex said that all important features of the Yak-24 were designed primarily for easy maintenance and long life. The rotor hub is oil-lubricated and sealed. The flapping hinge is located near the hub centerline; the drag hinge outboard another eight inches or so. The blade moments are taken out by two radial ball-bearings outside of the drag hinge, and the centrifugal loads are carried by a one-ball thrust bearing. All gear and accessory mountings on the Ivchenko engines, which resemble the Wright R-1820, were heavier than usual by U. S. standards. The Russians explained this by saying that rigidity in gear and accessory mountings were the most important factor in good component life. Aeroflot officials also indicated that no new equipment was considered ready for service until it had a 1,000 hr. life.

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Canadair Forty Four, photographed in flight November 15, 1959

GENERAL DYNAMICS CORPORATION

DESIGNER Mikhail Mil was assigned the project for the single-rotor Mi-4 at the same time Yakovlev was ordered to build the twin-rotor Yak-24. Civilian version of the Mi-4 with Aeroflot markings is shown here on a survey mission.

self a prominent specialist in the aircraft structures strength field; the chief of the strength and vibration laboratory I. V. Ananiev; scientific workers B. P. Zherebtsov and L. S. Vil'dgrube, and several others persistently and stubbornly sought the shortest path toward overcoming the helicopter's dangerous and difficult "illness."

But there were also some scientists who took the opposite road in their analyses. They directed their scientific erudition and technical knowledge in search of more convincing proof that the vibration was inevitable and that, in general, we were fighting an incurable disease.

One of them, an estimable doctor of technical sciences with a very typical appearance—just like in the motion pictures—brought with him previously-prepared diagrams and, making adroit use of scientific terminology, formulae and figures, proved that we would not eliminate the vibration since it was an inherent defect in this helicopter design.

Proposed Solutions

Many and varied hypotheses and suggestions were advanced on what had to be done and how to "treat" the ailing helicopter. Some suggested that the helicopter be made longer, others that it should be shortened. A third group proposed building a fuselage of new design. Still a fourth body of opinion believed that no matter what was done, it wouldn't work. To bolster their stand they advanced this argument:

"The Americans couldn't get rid of vibration in the YH-16. Hafner couldn't do anything with the Bristol-173's vibration. Are you the smartest one of all? Don't waste your time for nothing."

But we didn't waste our time for nothing.

If we had lost our nerve and had believed blindly in theory without checking it by experiments, and if we had not analyzed the conclusions of scientists in the light of engineering experience, it is possible that our helicopter wouldn't have been in existence even today. But, bolstered by faith in our own experience, and leaning on the support of such scientists as Ananiev, Vil'dgrube and Zherebtsov, we finally found the correct engineering solution. And here is how it came about:

Vibration Source

In torturing myself and beating my brains over just what the source or inducer of this vibration was, I came to the conclusion that it was necessary to try to cope with the vibration through the separate elements.

I say "torturing myself" because this really was torture. Neither during the daytime nor at night, neither in the theater nor when I was out for a walk, not even at dinner did thoughts about the accursed vibration leave my head.

Occasionally you got distracted a little, but suddenly a thought about the vibration would permeate your whole being, and you would literally break into a sweat from a feeling of impotence, from sensing some insurmountable obstacle that was confronting us. And then, on one occasion, a thought came to me that of all the possible sources of vibration, the main one, and the most malicious, was the blades. There are four such blades on each of the helicopter's rotors—a total of eight. They all turn at enormous speed, accompanied by the emergence of very complex mechanical and aerodynamic phenomena.

Blades Shortened

And what would happen if we changed the vibration characteristic of the blades? In order to convince myself whether the vibration came from the blades, I suggested that we try cutting off half a meter from each blade and see how this would affect vibration in the whole structure.

Again we all met together—Skrzhinsky, Erlikh and others. We discussed the proposal from all angles and decided that we had nothing to lose.

In two weeks, blades that had been shortened by 50 centimeters were mounted on the craft. Everyone waited: What would happen? The engines were started; the blades turned; the pilots were in the cockpit; Brovtsev made the signal "everything o.k.," and the craft soared upward.

Brovtsev and Milyutichev remained in the air for 20 min. We didn't know how the helicopter had performed, but judging from the smiling, pleased faces of the pilots as they hovered above us and slowly approached the ground, we realized that there had been some results.

What general delight there was when Brovtsev and Milyutichev declared positively, firmly and in unison that, during the 20 min., they had tested all rotor operation regimes and all flight regimes, and that no traces of the shaking remained. It was one of those pleasant surprises which, in designing work, sometimes fortunately confirm the advantage of common-sense engineering over philosophizing and scientific scholasticism. To be sure, in the course of subsequent tests, a large number of different defects were turned up and eliminated. But the main one was vibration, and we had put an end to it.

The helicopter was presented for government tests at the beginning of the winter of 1953. It would have seemed that everything would now be in order. But fate had prepared yet another blow for us. The military pilots weren't even able to make 10 flights under the government test program before there was an accident. During one of the tests at full engine power, with the craft tied down and only a mechanic in the cockpit, one of the tie-down cables broke, then another, a third and a fourth. The craft shot upward. The mechanic, being unable to control the helicopter, did the only thing he could, quickly cutting the throttle. The helicopter, being unable to rise more than six-eight meters, turned over on one

side and crashed to the ground. The altitude was low, so there were no casualties. But the craft was put completely out of commission.

It was terrible. The mishaps had a dispiriting effect and even tempted some weak-hearted engineers to quit the helicopter project. Fortunately, the main engineering core—Skrzhinsky, Erlikh, Bemov, Ogarkov and Brylin—didn't budge.

We had a second flying copy of the helicopter, and we turned it over for continuation of the government tests, after first strengthening the tie-down cables.

But the test on our nerves wasn't over even after we had presented the craft to the Scientific-Research Institute. Maybe it was because we had spent so much time on the vibration problem, or because the prototype machine had been demolished and burned, and the first flying copy had crashed after breaking loose from the cables. At any rate, the Scientific-Research Institute at first showed a distrustful attitude toward the helicopter.

The first months of its tests at the Scientific-Research Institute were a continuous nerve strain for us. This was so because Scientific-Research Institute personnel demanded that we take the helicopter back for refinement of every little detail and every defect they found, even though, as a rule, such faults inevitably accompany the testing of any new machine.

Thus, a decision on the main and fundamental problem—evaluation of the helicopter as a piece of engineered equipment built to perform a definite mission—was delayed. Several months passed, and only 15 or 20 flights were made.

And then one day new aviation equipment, including our helicopter, was shown to the heads of the Ministry of Defense at an airport near Moscow. It was very cold. The generals gathered together. They examined the lineup of fighters and bombers that was on display, and finally the whole party approached the helicopter. Everyone eagerly climbed into its huge cabin to escape from the piercing wind. About 20 people gathered in the cabin.

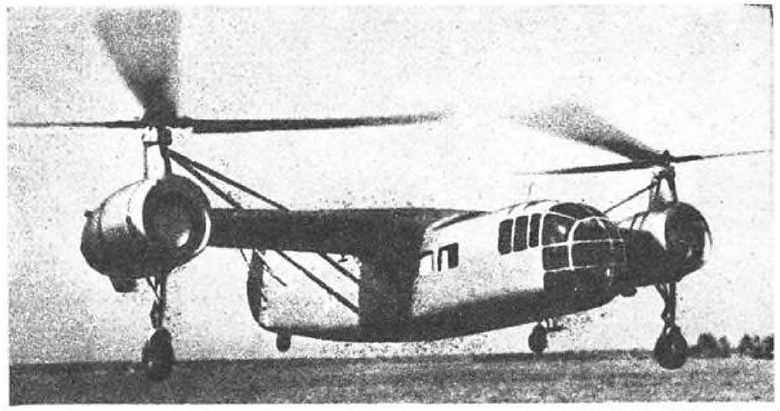
The marshal, turning to the air force commander, asked:

"Well, how's the helicopter? How are the tests going?"

"Well, they aren't flying it as much as they are tinkering with it . . . The craft is green—it hasn't been refined. The designer still has to do a lot of work on it; the list of defects. . . . etc., etc."

The marshal interrupted him:

"Stop indulging in bureaucratism. We don't need any list of defects. Any machine can be drowned in a list of its faults. We need the helicopter! Keep this in mind. The craft is either suitable or it isn't—that's the important thing to determine. And as regards eliminating defects, come to some understanding with the designer. Remember that this is new technology, something we're not used to."



TWIN-ROTOR Omega designed by I. P. Bratukhin was developed in 1939-40. It had "good flying performance which qualitatively excelled that shown by previous helicopters."

Tests Are Completed

As a result, in from one and one-half to two months, the helicopter's tests were completed. During this period, several times as many flights were made as in all the previous time. Co-workers in the Scientific-Research Institute, test pilots S. G. Brovtsev, P. J. Shishov, V. I. Kravchenko and K. D. Tayursky, and engineers A. M. Zagordan and S. Kh. Atabekyan put in a lot of work and displayed true heroism in testing the helicopter. They gave us every assistance in speedy elimination of the craft's shortcomings.

Finally, after the tests were over and the helicopter received a favorable rating, the government accepted it for serial production under the designation Yak-24.

We continued working to improve the craft after serial production began. In particular, the helicopter's control reliability was increased.

The control system was still very capricious, and the slightest inaccuracy in rigging or warping of the fuselage in flight could cause objectionable vibration. But then, while serial (quantity) production was under way, our specialists succeeded in making a remarkable improvement in the control system for large helicopters which completely removed all doubts about control reliability.

This was the last important refinement in the helicopter. After that, we breathed more freely. And it became quite easy to breathe after four of our helicopters made the first public flights at the 1955 aviation parade to the amazement of many spectators, especially the foreign aviation specialists who were present at the parade. And now several words about the helicopter itself.

The Yak-24, in its outward appearance, resembles a car on a subway train or an electric train.

And actually it is a real railroad coach. Up to 40 passengers or a corresponding amount of cargo is accommodated in the helicopter's cabin. The cabin is 10 meters long and about 2 meters in width and height. It holds up to four tons of assorted cargo, including large-dimension items such as two type GAZ-69 or Pobeda automobiles. They go into the helicopter under their own power by means of a ramp in the tail section of the fuselage.

The cockpit, located in the helicopter's nose section, is notable for its spaciousness. Vision from the cabin is excellent. From here, as from a balcony, it is possible to see everything that happens on both sides and below. Every condition for making the helicopter crew's work easier has been provided here. The crew consists of two pilots, a flight mechanic and a radio operator. There are dual controls. The many controls and gages are mounted compactly on panels in front of the pilot's seats.

Yak-24 Advantages

What are the Yak-24's main advantages as compared with other types of similar craft?

Stability and ease in controlling the craft, load-carrying capacity and speed of horizontal flight—these are the main problems that every helicopter designer strives to solve successfully.

Without sacrificing speed, we increased load-carrying capacity sharply. That is the chief and distinctive virtue of the Yak-24.

The longitudinal arrangement for rotor positioning was used for the first time in the USSR on this helicopter. Two huge four-bladed rotors are located on the nose and tail sections of

the fuselage. They turn in different directions. They are driven by two powerful aviation engines connected by a synchronous shaft. If one of the engines goes out of commission, the other will turn both rotors; and the helicopter will be able to continue its flight.

In turning, the rotors, which are horizontally positioned above the fuselage, tear the helicopter off the ground and lift it into the air. But how does this craft change over to horizontal flight?

By moving the control stick or the foot pedal, the pilot operates the lifting rotors' "automatic swash plates." They change the planes of rotation. The rotors are tilted to the right, to the left, forward or backward. When the rotors are simultaneously tilted to one side, the helicopter acquires horizontal motion in the desired direction. Turning the craft is achieved by tilting the rotors to different sides.

Flight Capabilities

What are the flight capabilities of this craft? What can it do?

Milyutichev took a four metric ton load to an altitude of 9,521 ft. in this helicopter. Tinyakov reached 16,674 ft. with a two-ton load. They demonstrated the craft's "ceiling" and load capacity. These results were confirmed as world records in 1956 by the Federation Aeronautique Internationale. In 1957, the load-carrying records were exceeded by a gigantic new Russian helicopter—the Mi-6.

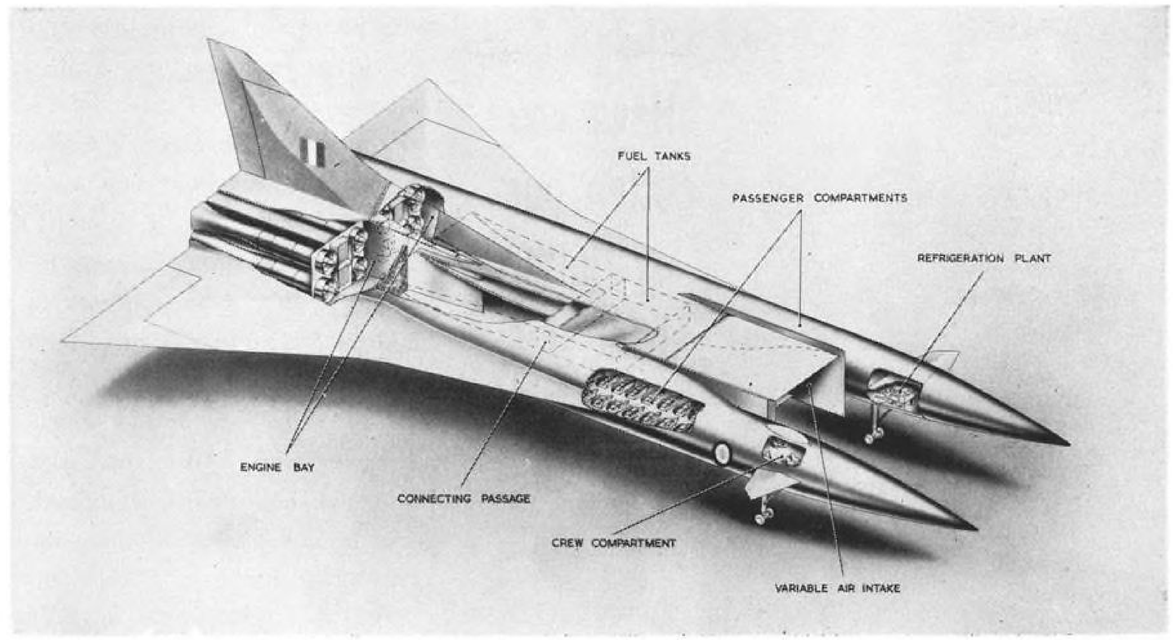
As fot the Yak-24's endurance in the air and flying range without landing, this is testified to by many nonstop flights, in particular those on the Moscow-Leningrad route which were begun by pilot Y. A. Garnaev. The newest navigational equipment permits the helicopter to make flights at night and under difficult weather conditions.

Complementary Vehicles

In conclusion, it must be said that the airplane and helicopter are not competitors. They are craft with different purposes and uses.

The more advanced the airplane becomes, and the higher its speed and load-carrying capacity, the more it is "tied" to the ground: it requires ever-longer and more-durable runways for takeoff and landing. Such runways can't be built everywhere.

As for the Yak-24 helicopter, it needs an area only a little larger than itself for takeoff and landing. It can deliver people and cargo to places where neither a train nor an automobile will go. Under rigorous Arctic conditions, in difficult-to-reach mountain areas and in the boundless spaces of the taiga, this craft can do work that is beyond the capabilities of other types of transportation.



ARTIST'S conception of a Bristol Siddeley supersonic airliner has combination ramjet-turbojet engines mounted in the tail section and fuel tankage in center fuselage. Note positioning of passenger compartments and delta wing configuration.

British Envision Ducted Fan VTOL

By John Tunstall

London—First details of Bristol Siddeley BE.53 powered VTOL aircraft (AW Dec. 14, p. 35) show winged and wingless proposals with the ducted fan, lift/thrust engine used alone and in combination with clusters of pure lift engines.

Development of these unorthodox vehicles both as helicopter replacements or as transport aircraft was backed by S. G. Hooker, technical director-aero of Bristol Siddeley Engines, Ltd., in a talk before the Institution of Mechanical Engineers here.

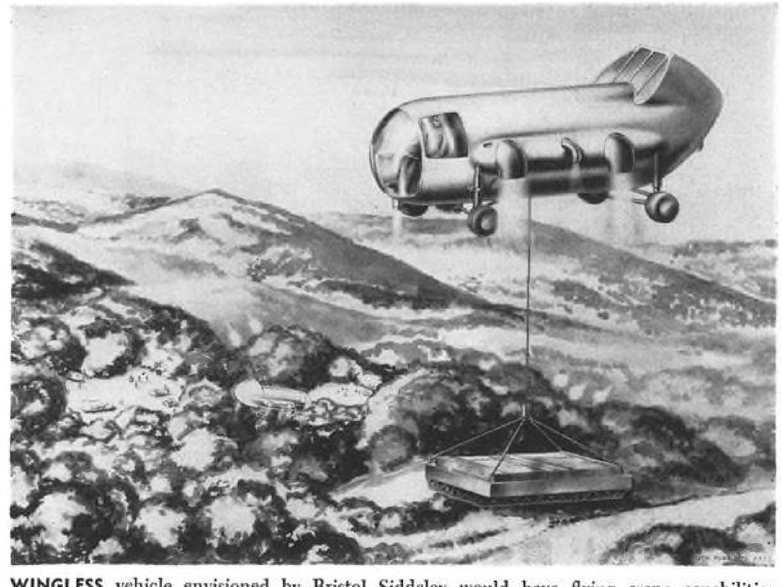
Hooker said Britain has lost its lead in the jet transport field and the intercontinental subsonic jet transport market has gone to the U.S.

Future Powerplant

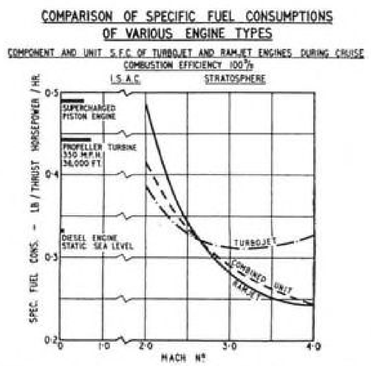
But he claimed that apart from unorthodox applications, the low compression ratio, lightweight, ducted fan engine of the BE.53 type—but smaller—would replace turbojets in the medium range airliner bracket within the next decade. This category formed the great bulk of the airliners flying and he warned that without a government-backed development program to provide a suitable family of these engines, Britain would be swamped by Russia and the U.S. in all aircraft categories.

First application of the BE.53 engine, thought to be in 15,000 lb.—20,000 lb. thrust category, will be the Hawker P.1127 VTOL strike fighter which is due to make its first flight within the next five months. Mode of operation of this aircraft has not yet been disclosed but based on Hooker's description of a hypothetical military application of this type, the engine will be located in a conventional manner with rotor system horizontal and can therefore be run up without creating ground debris.

For short takeoffs, the efflux from the ducted fan is discharged horizontally during initial accelerating ground run and is then deflected downwards to provide both lift and thrust components. This arrangement prevents ingestion of ground debris. For true vertical takeoff the engine is run up to full



WINGLESS vehicle envisioned by Bristol Siddeley would have flying crane capabilities.



COMPARISON of specific fuel consumptions shows ramjet has lower consumption than turbojet, above Mach 2.6; combined unit lies between the two.

power before jet deflection to shorten ground time in debris areas.

An air transport project described by Hooker has a gross weight of 55,000 lb. and combines two 15,000 lb. lift/thrust engines with smaller (10,000 lb. thrust) ducted fan engines used solely for lift and shut down in cruise. Hooker claims a thrust/weight ratio better than 14:1 for both engine categories so that the weight penalty of the pure lift engines amounts to 3,000 lb.

With this penalty, Hooker said, the aircraft could still cruise at subsonic speeds and carry a 10,000 lb. payload.

Wingless Helicopter

The helicopter replacement proposed by Hooker offered a simple airframe, totally sustained by the thrust from a single BE.53 engine discharged from four symmetrical nozzles capable of developing thrust for variable lift reactions. The vehicle would have twice the speed and the same payload as a comparable helicopter. With all allowances, including a parachute capable of sustaining the complete vehicle in the event of engine failure, a fuel and payload figure of 4½ tons was quoted for a vehicle powered by a BE.53 of 14,000 lb. thrust, and capable of 250 kt. airspeed.

According to Bristol calculations, a faster VTOL transport with a small wing just capable of sustaining the aircraft at maximum cruise would show a 60% advantage in range compared with a conventional aircraft of the same takeoff weight, due to weight savings in wing and landing gear structure.

At speeds below cruising, speeds jet deflection would be used to supplement lift.

The BE.53 engine, which has three times the bypass ratio of the Rolls-Royce Conway, has a specific fuel consumption of 0.6 lb./lb./hr. and thrust-to-weight ratio of 14:1.

Raising the compression ratio will eventually drop this consumption to 0.5 lb./lb./hr. Hooker claims that this type of engine will form the main part of the aeronautical engine industry effort in the 1960s. Afterburning in the fan stream will lead to very large thrust boosts and makes the engine suitable for supersonic speeds.

Hooker showed that thrust/weight ratios of turbojets had dropped from wartime figures of 2 lb. thrust/lb. weight to values exceeding four for large engines like the Olympus and Conway and exceed 6 lb. thrust/lb. weight for the comparatively smaller Orpheus engine.

Most guarded feature of the BE.53 is design of the variable nozzle used to deflect efflux. The company is believed to have investigated many systems including multi-petalled elbows, such as used in medieval armored suits. But most practical arrangement from engineering considerations is likely to be bifurcation of the bypass flow into twin ducts parallel to the rotor system. Each branch of the bifurcation can then be hinged in a relatively simple linear bearing so that it is free to rotate in the vertical plane. This arrangement deflects the jet blast from the horizontal to the vertical, covering all takeoff and cruise conditions.

Extending the deflection a few degrees beyond the vertical gives a retardation thrust component for landing purposes.

The advantages of augmenting the thrust by afterburning in a ducted fan engine would suggest the likelihood that the bypass flow and the hot efflux are exhausted through separate nozzle systems in the P.1127.

United Research Plans Engineering Center

Menlo Park, Calif—United Research Corp., a subsidiary of United Aircraft Corp., plans construction of a research and engineering center and a development and test center in the Santa Clara Valley on the San Francisco Peninsula.

The research and engineering center will include three structures—the administrative and engineering offices with executive offices in the administration

Luftwaffe Plane Losses

Bonn—Luftwaffe chief Lt. Gen. Josef Kammhuber told a parliamentary defense committee that 26 planes have been lost since the German air force became operational in 1957. Of these, 20 were Republic F-84Fs, Kammhuber said, including two which recently crashed in Czechoslovakia.

In reply to questions, Kammhuber said radar landing aids are being installed at Luftwaffe installations.

building, the research laboratories and the development laboratories.

Development and test center will include facilities for a solid propellant development plant and extensive test facilities for both solid and liquid rocket engines. Both vertical and horizontal test stands will be included, as will instrumentation facilities for acquiring data.

United Research has outlined the following four general areas of technical work:

- **Research** in advanced high performance solid and storable liquid propellants for thrust and auxiliary power.
- **Development** of high performance solid and liquid rocket engine systems.
- **Research in thermodynamics,** combustion, physics and materials.
- **Propulsion system** studies for optimization of power plants for weapons and space systems.

PRODUCTION BRIEFING

Japanese Defense Agency has ordered a quantity of Bristol Siddeley Orpheus 805 turbojets (4,000 lb. thrust) for the Fuji T1F-2, standard intermediate and advanced trainer for the Japanese Air Self Defense Force.

Aeroproducts operations of Allison Division of General Motors Corp. will develop a 7.5-ft. twin-blade turbopropeller for the 250-hp. Allison T63 engine. The Model 272 propeller will have variable governing, normal and emergency feathering, aluminum hub and blades, ice control and full-enclosed plastic spinner.

Multi-million expansion program is under way at Cessna Aircraft Co.'s Industrial Products Division, which is expected to ultimately cost some $4 million. A 130,000-sq.-ft. addition to the main factory, Hutchinson, Kan., is 95% complete; a new 18,000-sq.-ft. experimental laboratory and a 10,000-sq.-ft. engineering building are also being built, with completion scheduled for Jan. 15. Facility has employment of 700, recorded sales of $10 million in Fiscal 1959, up 70% over 1958.

General Electric YJ85-5 afterburning powerplant for Radioplane's Q-4B target drone will undergo series of extensive ground tests at Van Nuys, Calif., to confirm engine compatibility with airframe subsystems and to familiarize Radioplane personnel with the engine's operating characteristics.

Aircraft Research Assn., Bedford, England, plans to construct a wind tunnel with 1-ft. diameter for Mach 8-9 studies. Completion is scheduled for next year.

Tunnel Diode Applications Investigated

By Barry Miller

New York—Tunnel diodes are starting to fulfill some of the promise which their developers have been claiming for them as they are being designed into a widening variety of experimental circuits.

A primary area of application for the new diodes (AW Aug. 17, p. 73) appears to be in computer circuits—to which they are introducing fractional millimicrosecond switching rates and for which their small size and low power consumption are particularly well suited.

Some results of a Navy-supported investigation of ultra high speed computer logic and memory circuits at Radio Corp. of America were outlined in reports to the Eastern Joint Computer Conference by Jan A. Rajchman and Morton Lewin. Included in these papers were descriptions of three basic tunnel diode logic elements—two binary, one monostable—which can store, amplify and gate.

One of the bistable logic elements consists of a single tunnel diode driven by a current source and coupled to inputs and outputs from a point above the positive terminal of the diode. Normally in the low voltage or "0" state of its characteristic, the diode can be pulsed by the current source beyond the threshold current to the high voltage or "1" state where it remains until it is reset. This change of states enables the element to provide current increments to succeeding stages.

The current generator can be adjusted for a specific logic function. Thus, with proper adjustments and for one or more "1" inputs, the output can be "1" (OR gate) or when all inputs are in the "1" state the output can be "1" again (AND gate).

Logic elements can then be grouped and clocked by overlapping pulses. One experimental unit demonstrating this type of logic and containing 27 tunnel diodes was built at RCA according to Morton who, along with Arthur Lo, directs much of this work under Rajchman. It contains a storage loop, a full adder stage, shifting means and other functions. Designed with early, comparatively slow diodes and driven by a three phase clock at one megacycle, the unit achieved 50 nanosecond switching times (where one nanosecond equals a millimicrosecond).

A second bistable or balanced circuit consists of two tunnel diodes with pulse or sinusoidal signal applied across them. Their composite characteristic, one diode's curve reversed and superimposed on the other one, with one curve effectively the load curve for the other, provides for two stable operating points. A pulsed or sinusoidal input from the source across them forces one or the other diode into the high-voltage "1" state.

Input voltages at the junction between the two diodes trigger one of the two diodes, increase the voltage swing at that point and effectively amplify the input signal. Like the previous bistable units, these elements can be coupled resistively at their midpoints and grouped to form logic networks.

Diode Limitations

The monostable logic element uses a tunnel diode in series with an inductance with the diode biased to a point near the maximum current on the threshold of the negative resistance region, Rajchman says. A small voltage triggers the diode to the high voltage state from which it is automatically reset back to "0" by the voltage induced in the inductor. Here again units can be resistively coupled into logic networks.

One of the more severe drawbacks to the tunnel diode, Lewin says, is that it is not a unilateral device. Because it has only two terminals, both input and outputs are at a common point. Consequently, it is necessary to couple the diode to other devices through a unilateral device such as a rectifier (whose slower speed would militate against its use in some instances) or for microwave applications a Hall effect isolator, gyrator or circulator. In the RCA logic networks using the logic elements mentioned previously, time separation is achieved by multiple phase clocking.

Another answer to this problem, Lewin adds, is to synthesize three terminal unilateral circuits with tunnel diodes. For cascading amplifier stages, transistors could be interspersed between tunnel diode stages.

To overcome possible problems posed by the limited logic gain or fan out of the tunnel diode—the number of circuits a single diode can drive—diodes with uniform characteristics are essential. Unlike high gain transistor design, variations in the low-gain diodes cannot be anticipated with worse case designs. This will require high yields of tunnel diodes matched to within 10% or a relaxation of circuit tolerance requirements and hand adjustments.

Random Access Memory

Ten nanosecond cycle time random access memories that are necessary to go along with the anticipated one nanosecond tunnel diode logic cannot be obtained easily from magnetics, according to Rajchman. Consequently, RCA has selected the tunnel diode for memory systems despite the large number needed and in anticipation of full scale production of the device.

Each bit, Rajchman says, is stored by a current driven tunnel diode with two stable voltages.

Any diode can be properly set by pulses from other adjacent elements which are resistively coupled and arranged on row and column buses. Coincident bit or word addressing requiring two-to-one and three-to-one selection discrimination, respectively, can be used.

Rajchman claims that the simplicity, diminutive size and low power dissipation of the tunnel diode will permit a packaging density of 10 or more elements per cubic inch. Thus, computers with several thousand logic and several tens of thousands of memory elements can be squeezed into a volume with a two-foot diameter. Propagation delays may be kept down to one nanosecond because of the close proximity of the elements in compact machines.

These techniques can lead to billion bit per second information handling machines, Rajchman says.

Tunnel Diode Paramps

Possible application of tunnel diodes in parametric amplifiers for straight-through amplification and frequency conversion is also receiving attention at RCA. A 400-mc. down converter that has both gain and low noise, a combination heretofore unattainable in a down converter, has been designed and operated by K. K. N. Chang.

In this device, according to Chang, a 430-mc. local oscillator beats against the 400-mc. input signal across a gallium arsenide tunnel diode and produces a 30-mc. IF signal. The converter has a measured noise figure of 1.5 db., Chang says, and also provides 20 db. gain.

Mixing Possible

Non-linearity of the diode makes the mixing possible and the negative resistance is the source of gain.

This converter boasts both conversion gain and low noise compared with a crystal converter, and low noise compared with down conversion by a paramp. More power is required of the tunnel diode converter, however, because both a local RF oscillator and a d.c. biasing source are necessary.

Local oscillator signal radiation back through the antenna tends to be trou-

Tunnel Diode Background

Tunnel diodes are heavily doped junction diodes which have a negative resistance region over a forward portion of their volt-ampere characteristic curves (AW Aug. 17, p. 73). The device takes its name from the quantum mechanical tunneling phenomenon by which electrons "tunnel" through the forbidden band of a semiconductor junction to create the unusual negative resistance feature. The device is sometimes referred to as the Esaki diode, after Dr. Leo Esaki, Japanese scientist, who observed and analyzed the tunneling effect in germanium about two years ago.

Negative resistance of the diodes offers the possibility of obtaining gain from the two terminal device. Typically, in the forward region of the characteristic curve, the current rises to a peak, then drops to a valley and rises again like a conventional diode characteristic. Values of peak and valley currents in one germanium unit are 1.1 mil near 5 mv. and 0.1 mil at 3 mv., respectively.

Some important features of tunnel diodes are:

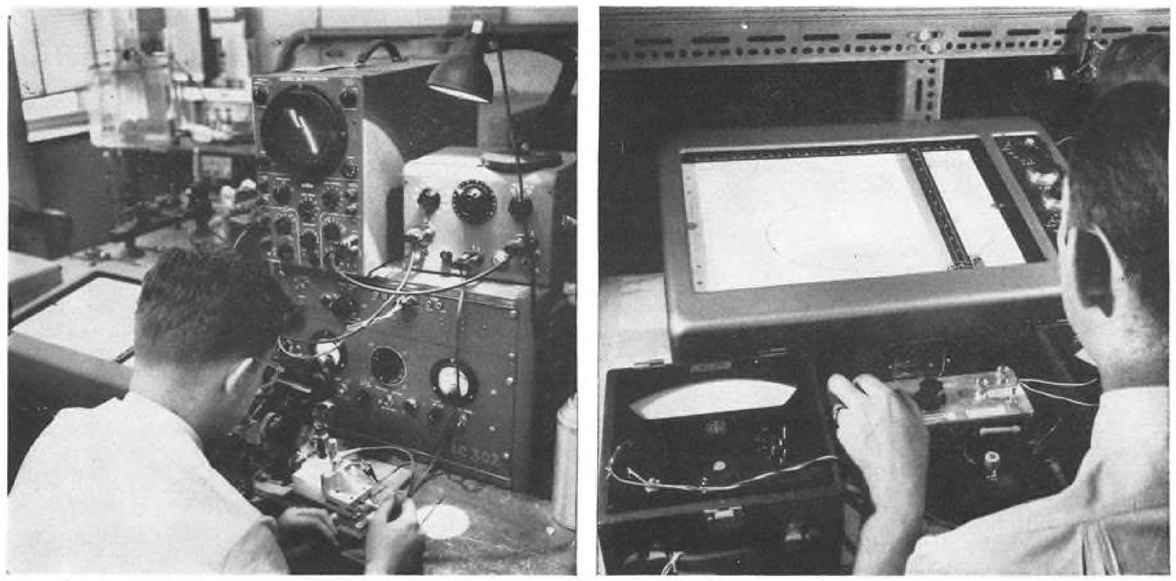
- Extremely high speeds, limited principally by junction capacity and resistive losses. Oscillation frequencies in the kilomegacycle range have been reported.
- Ability to resist neutron irradiation surpasses that of the transistor and semiconductor because the diode's mechanism does not require high purity crystals and radiation damage to the crystal acts as an impurity.
- Little power is consumed and present maximum power output is restricted by the diode's short voltage swings which are a function of the energy gap and the degree of impurity in the semiconductor material.
- Insensitivity to humidity variations.
- Ease of fabrication compared with transistors because of the absence of surface problems, structural simplicity, and freedom from demands for high purity crystals.
- Operation over wider temperatures than transistors because of heavy doping and promise of greater potential temperature ranges with high energy gap materials.

Principal application is expected to be in computers to perform such functions as amplifying, gating, and switching. A limitation arises from the nature of a two terminal device—the need to provide direction of signal flow. In the microwave region the diode may be used where low power requirements are involved. Engineers disagree, however, over the ability of the diode used in a microwave amplifier to give noise figures comparable to those of parametric amplifiers or Masers.

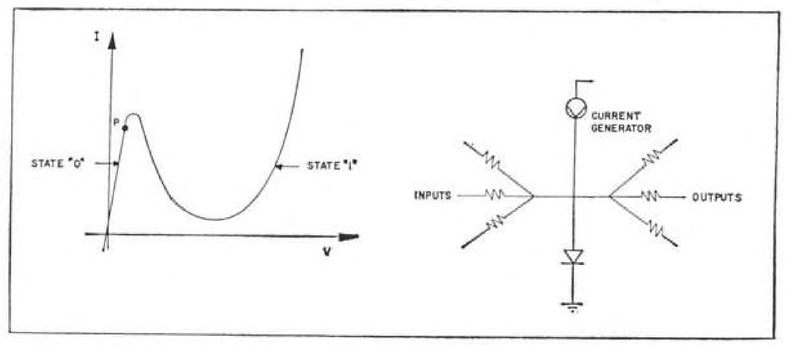
Problems in making the diode include the need to reduce lead inductance in packaging, the control of doping and difficulty in handling and fabricating high-frequency units whose size becomes smaller at the higher frequencies.

Tunnel diodes have been made from germanium and silicon as well as several of the group III-V compounds such as indium antimonide (Bell Telephone Laboratories) and gallium arsenide (Radio Corp. of America).

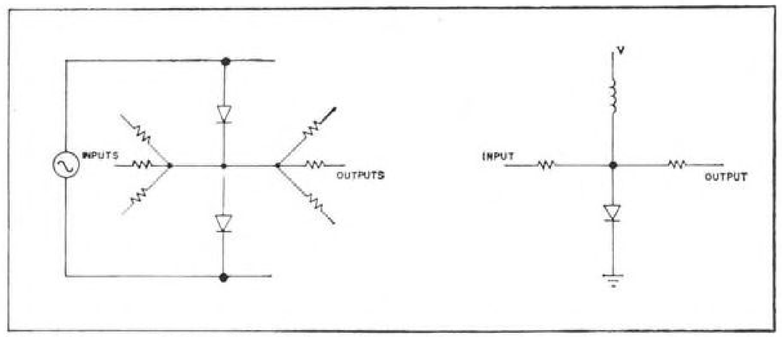
The diodes are now available on a limited sample quantity basis from several manufacturers, including General Electric Co. and RCA.



CHARACTERISTICS of an indium antimonide tunnel diode placed in a square plastic dish containing liquid nitrogen are checked (left) at Bell Telephone Laboratories while recorder (right) directly traces volt-ampere characteristic of a germanium tunnel diode.



SINGLE ENDED bistable tunnel diode logic element is biased in "0" state at point P at left. Diode can be pulsed into "1" state by clocked current source in circuit at right.



BALANCED tunnel diode bistable logic element (left) has one or the other diode in "1" state, determined by polarity of applied signal. Monostable element at right resets itself by voltage induced in inductor.

blesome and must be filtered out. It can also be reduced by increasing the frequency separation between the input and local oscillator signals. Substituting a 215-mc. pump in the same device, Chang operated the converter again with the IF output taken between the second harmonic of the oscillator and the input. Chang hopes to eliminate the local oscillator entirely.

Straight-through paramps—those in which the output signal frequency is the same as the input—have been operated without an RF pump (d.c. bias is the energy source).

Tunnel diode paramps are not frequency sensitive like the reactive paramps, Chang says. He hopes to push their operating frequencies well up into the microwave range.

Higher frequency diodes imply reduced RC time constants to which the frequency is inversely proportional. C is the junction capacity and R the magnitude of the negative resistance. As the area of the junction is reduced, C tends to decrease while R increases at the same rate, thus holding the product of the two constant. Thus, retaining the same area and simply increasing the doping increases the speed of the diode but also drops the diode's impedance. The peak current, which is a function both of doping and the semiconductor material, is increased in the process creating the ticklish problem of supplying a high current power supply. Ideally then, Lewin says, it's desirable to reduce the time constant without altering R. One long-term way of doing this, he explains, as follows: Reduce the area thereby reducing C and increasing R but dropping the peak diode current. Then if the doping is increased, the diode's peak current is restored, its characteristic is essentially the same as before, but C is reduced while R is unchanged. This process can be repeated, and the time constant is shortened by greatly reducing C.

Series resistance of the diode and inductance of the leads and mount can't be ignored as their time constants must be kept small with respect to RC.

Bell Telephone Laboratories indicates an interest in tunnel diodes for microwave applications but expects that diode technology must be improved before tunnel diodes turn out appreciable power. The diodes become smaller and harder to handle at the higher frequencies and the output power decreases as the fourth power of reciprocal frequency.

Bell scientists have been working with indium antimonide tunnel diodes which presently must be cooled to liquid nitrogen temperature. These diodes have low junction capacity and should have high frequency response and high current densities. High current density may provide an answer to the need for higher power.

Extensive tunnel diode circuit applications work is being pursued at General Electric Co. also. Recently, Robert N. Hall, a GE scientist active in tunnel diode development work, described a single tunnel diode receiver in which one diode simultaneously performed the functions of an RF amplifier, local oscillator, mixer and first IF amplifier.

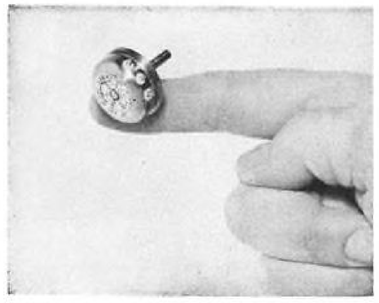
NEW AVIONIC PRODUCTS

Components & Devices

• **Gold-plated connectors** for micromodules and other miniaturized circuitry provide protection against corrosion and ease soldering. Units have 0.5 lb. insertion force, less than 0.25 lb./contact withdrawal force, less than 0.005 ohms/contact resistance and conform to Signal Corps Specifications SCL–6250, according to the manufacturer. Molded Insulation Co., 335 East Price St., Philadelphia, Pa.

• **Solid-state time delay** switches, in three basic types, are designed to handle up to 10, 16 and 50 amp., respectively, without arcing, contact damage, radio interference, audible noise or vibration. Operating voltages are 24-31 vdc. for units in black anodized aluminum case 1¼ in. diameter, 2 in. long. George Harmon Co., 18232 Parthenia, Northridge, Calif.

• **Subminiature rotary potentiometers** ranging in size from ⅜-in. to 3-in. diameter are in 200 kilohm humidity-sealed units operable up to 200C and capable of withstanding 40g vibration. Maker says units have high resolution, good noise level and self-phasing capability. Companion line of rotary trimmers have



shaft torque of 3 oz.-in. and friction clutch for precise setting; can be mounted in two planes without additional brackets. Subminiature Instruments Corp., 3705 Sunnyside Drive, Riverside, Calif.

• **Transistor chopper,** type 6025, with self-contained drive transformer, has spdt switching action for operation over chopping range from 50 to 5,000 cps. Drive may be 6.3 volts square wave or sinusoidal, with less than 20 mw. power required. Signal inputs up to 100 v. with currents up to 10 ma. can be handled by 1-oz., 0.75-in. diameter by 1.4375-in. long unit in zero to 55C temperature range, according to manufacturer, Airpax Electronics, Inc., Cambridge, Md.

• **Floated rate integrating gyro,** M2514-02, designed to be mounted directly on frame of missiles or aircraft, provides linearity of 0.02% and angular momentum of 250,000 gm. cm.sq./sec. Short term vertical drift is 0.01 deg./hr. and azimuth drift is 0.02 deg./hr. Kearfott Co., Inc., 1500 Main Ave., Clifton, N. J.

Systems Analyzer Speeds F-101 Checkout

By Philip J. Klass

Minneapolis—First production models of Minneapolis-Honeywell's new automatic systems analyzer for the McDonnell F-101B, which Air Force tests indicate will slash time required to check out and trouble-shoot the airplane's flight control system by 80% compared with former manual test equipments, have been delivered to the Air Force.

Present model will be used for F-101B flight control checkout, but the basic design is universal in its possible applications. The specific tests, measurements and checkout sequence is controlled by perforated Mylar tape program.

This permits the analyzer to be used with a variety of avionic or non-avionic systems whose operating parameters can be measured electrically.

The Honeywell analyzer is designed to automatically introduce, in logical sequence, a series of precise a.c. or d.c. signals and to measure the steady state or dynamic response of the system to such stimuli. In addition, the device can switch in simulated resistance, capacitance or inductance into circuits under test. It also can supply simulated loads, synchro position signals and automatic switching facilities for connecting subsystems into any desired system configuration.

In its design approach, Honeywell has aimed primarily for reliability and simplicity rather than for high speed and sophistication, a company spokesman says. The analyzer employs analog techniques for introducing test signals and making measurements, digital techniques for programing and switching. The analyzer can perform an average of approximately 60 tests per minute. It is priced at less than $100,000.

Prototype Model

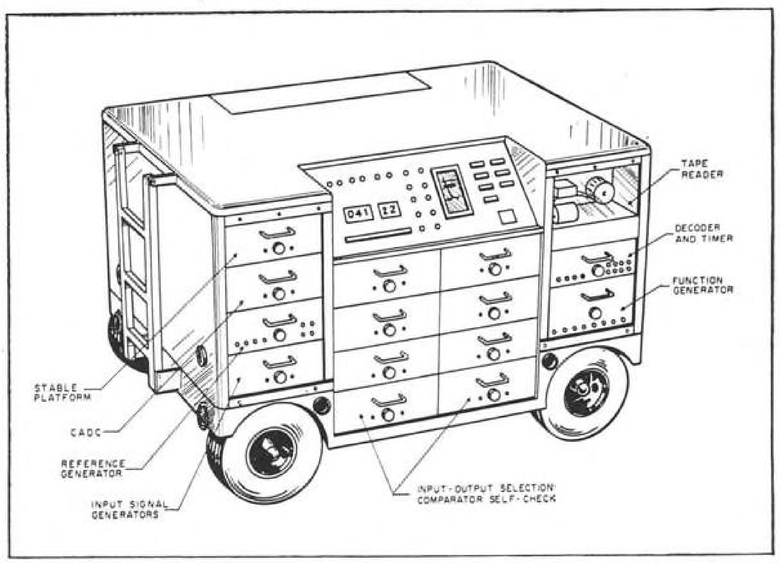
Prototype model, evaluated by the 4750th Test Squadron at Tyndall AFB, Fla., has operated for a total of 842 hr. with only a single failure—a small pilot-lamp. The USAF report on the Honeywell analyzer evaluation, prepared by Capt. Alfred H. Uhalt, Jr., project officer, says the equipment "proved both highly accurate and reliable to an extreme not often found in this type of equipment. During the evaluation, the test set accurately located all induced and actual flight malfunctions assigned to it.

"Use of the set reduced average flight line trouble-shoot time by an estimated 80% and, in many cases, eliminated a functional check flight. This represented a considerable savings in manpower, flight time and dollars," the report concludes.

The Honeywell analyzer is available either in a fixed-base console or mounted in a trailer which is air transportable. The mobile version can be used either on the flight line or in a base maintenance shop. Its mobility permits analyzers to be shifted from shop to flight line or vice versa as required.

The analyzer proper occupies about 40% of the trailer volume. The remainder is used to house cables for

HONEYWELL automatic systems analyzer, shown in use on an F-104, will be used to check out and trouble-shoot flight control system and air data computer on F-101B. Air Force tests indicate new analyzer will slash checkout time by at least 80%.



MOBILE VERSION of the analyzer, which is suitable for flight line or maintenance shop use, includes ladder and reinforced top to permit its use as a work stand to gain access to airplane's avionics equipment. Analyzer is operated from perforated tape.

connecting into the airplane's avionics equipment and to store spare modules for replacement of defective analyzer elements on the spot. Top of the trailer is reinforced and covered with an abrasive walkaway so it can be used as a work platform, with access provided by a small ladder at the rear.

Like most automatic checkout equipments, the Honeywell analyzer will automatically check itself immediately after detecting a fault to determine whether the trouble is in the airplane's avionics equipment or within the analyzer itself.

The analyzer also performs a self-check sequence prior to making a detailed trouble-shooting analysis of the airplane's avionics equipment.

A significant advantage of any automatic checkout equipment for trouble-shooting is the fact that it always uses the same well-planned sequence of tests regardless of the operator's skill level, which in the long run is the quickest way to isolate the fault.

By contrast, the sequence of tests followed by maintenance personnel using manual tester depends upon the skill level and intuition of the individual involved, the case (or difficulty) of making a specific test, and on his recent experience with the equipment. If a specific tube or other com-

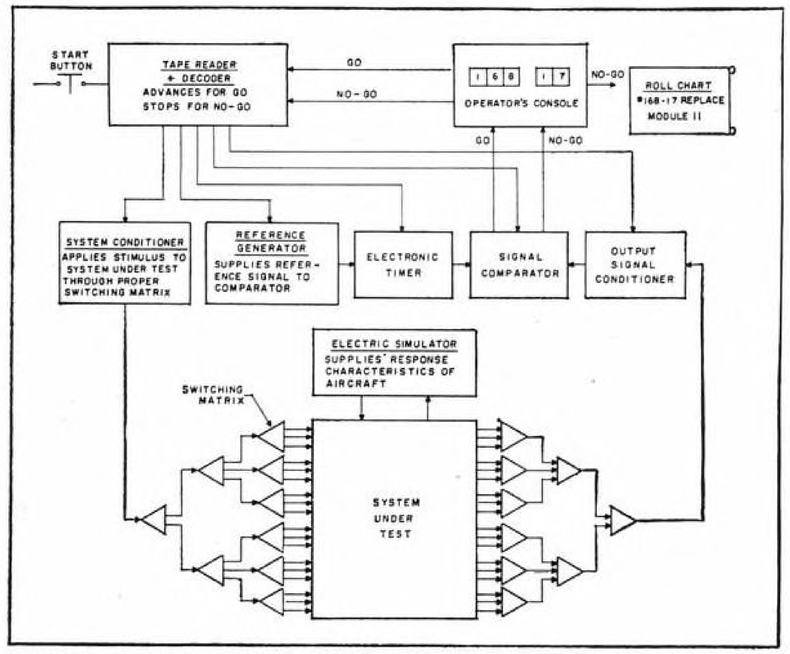


DIAGRAM of Honeywell analyzer shows how tape program controls switching, test signals and comparison of system output. Analyzer uses both analog and digital techniques.

ponent has been a recent trouble-maker, a maintenance man intuitively replaces these items first in his effort to locate the trouble.

The use of an automatic analyzer also assures that the same standards are consistently applied in evaluating whether a system, or subsystem, is operating satisfactorily, removing the element of human judgment.

Readout Device

A digital readout device on the Honeywell analyzer indicates which test is being performed at any instant. If malfunction or malperformance is detected, this is indicated by a red light and a two-digit numerical code. Operator refers to a roll chart corresponding to test number and fault number for instructions on what black box in the airplane should be replaced or what other corrective action is required.

The Honeywell analyzer uses a Mylar tape program with 16 holes (bits) per line. Five of these provide the address; the remaining 11 specify signal input, output and allowable tolerances. Tape is driven by a solenoid mechanism at rates up to 18 lines per second.

The perforated information is converted by a tape reader and transistorized decoder into switching signals which connect required signal generator to correct point in the circuit and connect in appropriate signal generator required to provide a reference signal with which the system output signal will be compared.

If output signal is within prescribed limits, comparator generates a "go" signal which automatically advances the program tape to the next test instruction. If the signal is outside of specified limits, the analyzer first checks its own internal operation. If it finds no internal fault, it then transmits a signal to operator's console which causes it to display a two-digit number indicating the specific malfunction of the system under test. Operator then consults the built-in roll chart to determine what corrective action he should take.

In high performance servo systems used in flight control, a static test is not adequate for determining whether system performance is satisfactory. To perform dynamic system checks, the Honeywell analyzer contains a sine-wave generator whose frequency can be varied as required and a digital timer which can provide a precision time base that is programable in 2½ millisecond increments.

Both the mobile and fixed base versions of the Honeywell automatic systems analyzer employ modular construction with major subassemblies mounted on removable drawers

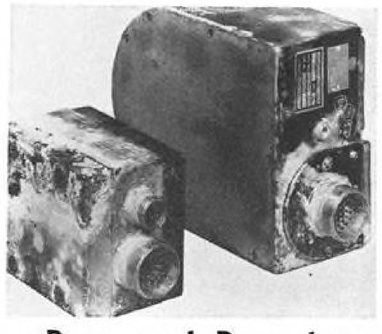
Honeywell has orders for 18 of its UG897 analyzers which will be used by F-101B squadrons, according to Charles F. Mueller, product manager in company's ground support equipment department. Honeywell currently is negotiating for sale of a similar analyzer to West German air force for use with its Lockheed F-104Gs to check out airplane's flight control, inertial platform and air data computer.

FILTER CENTER

► **Thermomagnetic Generator Future Doubtful**—Naval Research Laboratory study of thermomagnetic generator, which transforms heat directly into electricity, indicates its efficiency is too low for development into a useful device. Report on the NRL study, entitled "Efficiency of a Thermomagnetic Generator," identified PB 151736, can be ordered from Commerce Department, Office of Technical Services, Washington 25, D. C., for 50 cents.

► **Cat Eye for Night Photography**—A light amplifier kinescope recorder equipped with a single-stage intensifier pickup tube has achieved a sensitivity equivalent to an ASA number of 10 million. Report on the "Light Amplifier Kinescope Recorder for Night Photography" by Wright Air Development Division Aeronautical Research Laboratory, identified PB 151914, can be obtained for 50 cents from Commerce Dept., Office of Technical Services, Washington 25, D. C. Another report by the same group, entitled "Daytime Detection of Celestial Bodies Using the Intensifier Image Orthicon," identified PB 151866, also is available at $1.25 per copy.

► **Computers Linked by Microwave**—Microwave link has been installed to transmit data from North American's Rocketdyne Division in Canoga Park, Calif., to a battery of six large IBM computers at the company's main plant at Los Angeles International Airport, 39 mi. away, which also will be linked by microwaves with NAA's Missile and Autonetics Divisions at Downey, North



Recovered Recorder

Rugged miniature tape recorder, returned from a Thor-Able nose cone recovered from Atlantic Ocean, reportedly performed satisfactorily despite rigors of its journey, landing and acid burns resulting from ruptured instrumentation battery. Manufactured by Ampex, tiny tape recorder weighs 20 lb., records two tracks of information on a ¼-in.-wide tape.

American says this is first time microwave links have been used to transmit data to central computers. Transmission rate is 3,000 words per second.

► **Transistor Sales Climb**—Sales in September of 8.7 million transistors set an all-time monthly record, according to figures released by Electronic Industries Assn. Total sales for the first nine months of 1959 were 57.9 million as compared with 30.4 million for the same period in 1958. Dollar sales for the first nine months were $154.3 million as compared with $73.2 million last year.

► **New Potting Compound**—Aluminum oxide powder (alumina) offers several attractive advantages over conventional materials for potting transformers and other electrical devices, Bell Telephone Laboratory scientists reported during recent National Conference on Application of Electrical Insulation in Washington, D. C. When alumina is used, damaged components can be replaced by cutting seal on can and pouring out the dry granular alumina powder. Other alumina advantages include: no expansion or contraction over wide temperature range, melting temperature above 1,500C and no curing or vulcanizing required.

► **Cloverleaf Cathode Support**—Cloverleaf-shaped cathode support made of steatite (magnesium silicate) which now is a standard feature of Sylvania Electric Products, Inc., radar cathode ray tubes, improves over-all efficiency and life of the tube, the firm says. Unusual shape of the support cuts area of contact between cathode and support in half, and thereby reduces heat dissipation and speeds warmup time.

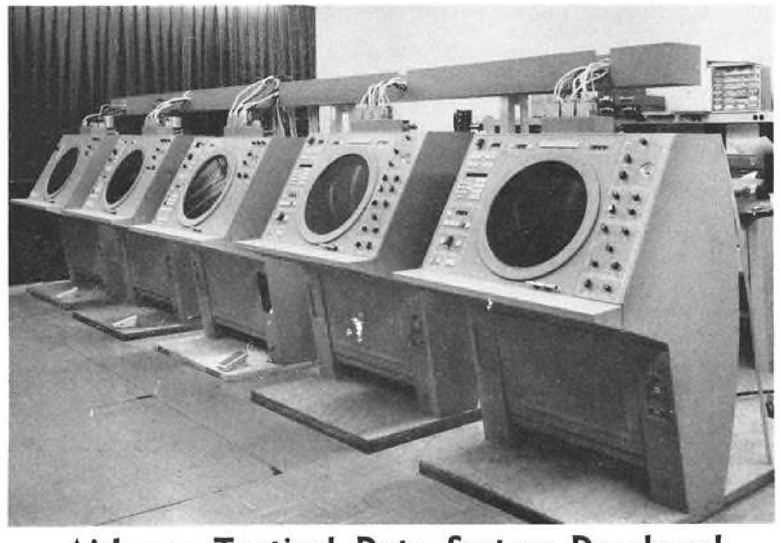
► **Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include the following:

• **Kearfott Co.**, Little Falls, N. J., $100,000 study contract for a solid-state multi-head celestial comparator intended for space navigation, from Wrigl. Air Development Division's Weapons Guidance Laboratory.

• **General Electric**, Heavy Military Electronic Department, $118,000 study contract for Minuteman launch control system communication techniques from Boeing Airplane Co. GE, one of five companies to receive study contracts for the program, will investigate low, medium and high frequency systems.

• **Sylvania Research Laboratories**, Bayside, N. Y., will develop refractory metals, alloys and compounds intended to withstand temperatures above 5,500F under a $270,000 research and development contract.

• **Dynamics Research Corp.**, Stoneham, Mass., has received a $73,338 contract for investigations of the inertial navigation system to be used on Polaris-bearing submarines.



Airborne Tactical Data System Developed

Airborne Tactical Data System (ATDS), AN/ASQ-54, developed for Navy airborne early warning and control aircraft, will provide surface ships with processed radar data on attacking aircraft and also permit AEW&C aircraft to guide fleet interceptors toward the targets, controlling their intercept path directly. Developed by Litton Industries, the ASQ-54 is the first ATDS to be developed. It will be flight tested by Lockheed on a WV2-E Constellation. System includes digital computers, data processors, display and communications equipment. Smaller, lighter version of ASQ-54 is being built for use on carrier-based aircraft. Similar systems are under development for the Marine Corps.

FINANCIAL

Boeing's Allen Cites Trend to Mergers

New York—Economics of the future point toward mergers and consolidations in the U.S. aviation industry similar to those under way in Britain, William M. Allen, president of the Boeing Airplane Co., told the New York Society of Security Analysts.

The tactics used in Britain—forcing consolidation by government fiat—are not likely in the U.S., Allen said in response to a question, but economics might be just as compelling.

This was one of a number of points in Allen's sober but not necessarily gloomy appraisal of the aviation industry, which could be summed up in his belief that neither the military nor the commercial transport market is large enough to support all those competing for it.

"A decade or so ago," Allen said, "one could name a dozen firms—certainly no more than that—and you could say, 'These are the principals of the aircraft industry.' Today such a statement would have little meaning."

"The industry today is a market place for products, for components and for services—most of them technical or managerial—to which a considerable number of very large firms in the national economy have turned their attention.

"Five or six years ago, a competition for Air Force business might have drawn 10 or 12 firms; today when we go to Wright Field or to the space agencies, we find upward of 30 or 40 firms competing for major and minor contracts. Included in that group will be the auto producers, the major electrical firms, the principals in the electronics industry, and of course, the principals in the aircraft business."

Defense Funds

There is not enough money in the defense budget to support all the programs that have been or are now under way, Allen said, and the ax must fall for some. Furthermore newer programs such as Minuteman intercontinental ballistic missile did not involve anything like the production effort or dollars that the Boeing B-47 or B-52 have.

Boeing's solution for falling volume, Allen said, is to try to win more of these lower volume new programs.

On the commercial transport side, Allen said the development and startup costs involved in the various commercial programs have, without exception, been much higher than anticipated. This produces pressure to sell more units to recoup these costs, tightening competition and resulting in terms on sales which, standing alone, make no economic sense.

"In my view," he declared, "there is not a sufficient market for additional sales to permit a recoupment of losses suffered by the contending manufacturers within the foreseeable future." Boeing's total 707 jet transport write-offs are $134 million to date.

Over the long pull, Allen said, commercial business should be rewarding, influenced by continued growth of air transport, improved aircraft efficiency and the potential growth of air cargo that Allen estimated would be at least tenfold by 1970. In addition, he forecast substantial requirements for military jet cargo aircraft in the 1960s.

Traffic forecasts indicate a free world market for 1,800 small, medium and large turbine aircraft worth about $7 billion in 1959 dollars, Allen said. Boeing's share of the 565 turbine-powered airplanes on order or delivered in 1958-59—having a total sales price of $2.3 billion—has been 195 airplanes or approximately 34% of the total.

Allen said there will be increasing emphasis on missiles, unmanned aircraft and sophisticated space vehicles, but he also expects a continuing and substantial requirement for manned aircraft. Specifically he cited reconnaissance and early warning aircraft. The B-52 might be adaptable for such use, and he also be pointed out the possibilities of the KC-135 as an electronics platform.

Vertol Merger

Touching on Boeing's own interest in mergers, Allen noted the proposed acquisition of Vertol Aircraft Corp. to give Boeing an entry into the V/STOL field (AW Nov. 23, p. 29). Allen said Boeing was looking at other new fields for the company that hold promise for the future, but that merger or acquisition would be considered only if the necessary capabilities could not be obtained economically and rapidly enough from within the company.

One example might be electronics. Allen said the company has developed an electronics capability for special

Boeing Develops Manned Tracking System

Manual Angle Tracking Capability system (MANTRAC) has been developed by Boeing Airplane Co. for use in areas where SAGE or alternate electronic systems are not available. The system utilizes triangulation on a Plexiglas map; each plotter is linked to a number of radar sites by phone. Information is relayed to a fighter or missile controller.

equipment required in such programs as Bomarc. The company has not sold electronic equipment to others as such, but has studied the possibility of doing so.

Other points Allen touched on:

• **First of the B-52Hs** powered by the Pratt & Whitney J57 turbofan will roll out at the company's Wichita Division early in 1961 and production will continue through that year. Congress this year provided funds for 62 airplanes.

• **KC-135 production** will continue into 1961 on the basis of orders for 492 airplanes of which approximately 350 have been delivered. Production rate is reported to be eight per month.

• **Boeing has sold** more than 150 small gas turbines to commercial airlines for pneumatic power for jet engine starting. It is exploring the light executive aircraft market for engines such as its Model 520, foreseeing the possibility of turbine engines replacing piston engines in this category in five-10 years.

• **Total 1959 sales** are expected to exceed $1.6 billion and with earnings probably exceeding $12.5 million. Sales next year are forecast to decline, but earnings should improve with the bulk of commercial jet transport written off.

• **More writeoffs** might become necessary to keep the 707 family competitive, either in performance or in price. The latter may include accepting trade-ins, assisting in the financing of purchases or both. The net effect is to put the break-even point even farther down the road.

• **Bank loans of $120 million** based on a $175 million line of credit and $70 million in long term borrowing will cover Boeing's capital requirements for the next several years. Property, plant and equipment expenses will approximate $20 million this year, which depreciation and amortization will equal. After next year, requirements for new facilities for specialized production, engineering and test equipment will somewhat exceed amounts projected to arise from depreciation, amortization.

Westland Aircraft Has Record Profit

London—Westland Aircraft Co., Ltd., British helicopter manufacturer, has reported record profits and a doubled dividend for a 15-month fiscal year. Report includes six-month earnings of Saunders-Roe, Ltd., which was acquired during the period.

Westland's profits as of Sept. 30 were $5.85 million. In its previous fiscal year ended June 30, 1958, total profits were $3.93 million. After deductions, there was a net profit of $3.58 million, an increase of $1.82 million over 1957-58. Dividend has been doubled to 12%.

Sen. Long Charges Defense Patent Policies Favor Large Contractors

Washington—Strongest opposition to the proposal of a Senate Small Business Subcommittee to put an end to all patent privileges arising from government-financed research and development programs is coming from small defense contractors.

On launching a study of patent policies, Sen. Russell Long (D.-La.), chairman of the subcommittee, charged that the patent policies of the Department of Defense are fostering big business and prejudicing the position of small business in the economy.

Defense Department reserves a royalty-free license to use all inventions developed under its contracts. Commercial patent rights on the invention go to the contractor. Long favors government title to all inventions it finances. This is the policy of Atomic Energy Commission and National Aeronautics and Space Administration, although NASA has proposed a change in its system to make it conform more closely with the present Defense Department policy (AW Dec. 14, p. 57).

Large defense contractors are generally satisfied with the Defense Department patent policy.

Small Contractors' Stand

Small defense contractors, on the other hand, want contractors to have exclusive proprietary rights to their inventions—with respect to the government as well as to commercial sales. This was developed at hearings before Long's subcommittee (AW Dec. 14, p. 25). Robert R. Lent, representing the Strategic Industries Assn., an organization of over 100 small and medium-size defense contractors, told the subcommittee:

". . . beyond any question our federal patent policies, far from aiding 'big business' through their liberality, actually most seriously impair our rate of scientific and technological progress in the missile, weapon systems and space explorations fields through their tight repression on creativity. All business, big and small, today suffers most drastic compromise to its creative productivity through virtual elimination of incentive for progress engendered by the recent rapid erosion of our constitutional patent privilege."

Lent protested that SIA members have had to watch the Defense Department award production contracts based upon their inventions to their competitors. As a result of "this confiscatory federal patent policy," Lent said that "hundreds" of small business firms have already refused research and development contracts in the defense field.

"Tragically, this is not a 'golden age' for science because the traditional rewards for creative effort in this land of opportunity have been eroded away through government usurpation of the patent privilege," Lent declared.

Discounting Long's contention that patent rights create monopolies, Lent maintained that they do no more than give a firm a temporary competitive advantage. He added: "There simply cannot exist a single, vastly-superior idea in the scientific field which corners a whole market."

Aerojet Testimony

E. S. Reichard, director-contracts of Aerojet-General Corp., supported the present Defense Department patent policy because, he said, it "effectively prohibits" any monopoly on government-financed inventions with respect to sales to the government but permits the retention of a commercial monopoly by the contractor. Reichard reported that Aerojet's inventions under defense research and development contracts which have commercial use have been few. Out of the 337 patents the company has obtained or applied for on inventions made during the course of government contracts, he said, only three can be described as commercial: the 15KS-1000 commercial JATO unit, the 15NS-250 Junior JATO unit and a pressure sensing device.

The reason defense research and development is concentrated in large firms, Reichard said, is that the profit margin is low and there is no assurance of a follow-on production order. "The productive capabilities of big business . . . place small business at a disadvantage in competing for contracts for the production of items licensed to the government," he said. "For this reason, small businesses tend to develop their own proprietary products, necessarily at their own expense, to ensure future production . . ."

If defense contractors are also denied commercial patent rights on inventions under defense contracts, Reichard said "an even greater proportion of government-financed research will be left to the larger firms, and small business will be compelled to an even greater extent to sponsor its own research in order to acquire the proprietary position which they must have in order to compete." He added:

"Small businesses are in most instances dependent upon a proprietary position of some sort whether it be patents or unique know-how for their

continued existence and future growth. They could not survive and grow if forced to compete with so-called big business in an open, freely competitive market."

The case in favor of giving the government full title to all government-financed inventions was presented to the subcommittee by D. Hamberg, professor of economics at the University of Maryland. Hamberg said:

"We are faced with the unconscionable situation in which the federal government taxes the citizens of this country to secure funds for scientific research on the grounds that such research promotes the general welfare and then turns the results of such research over to some private corporation on an exclusive, monopoly basis. This amounts to public taxation for private privilege, a policy that is clearly in violation of the basic tenets of any democracy."

Acquisitions And Mergers

Olin Mathieson Chemical Corp. has acquired full ownership of Almetco, Inc., by purchasing a one-half interest formerly held by Textron, Inc. Almetco operates an aluminum extrusion plant at Nesquehoning, Pa.

Electrosnap Corp.'s proposed merger into Controls Co. of America will be submitted to stockholders of both companies Dec. 28. Under the proposal each five shares of Electrosnap common stock will be converted into six shares of Controls Co. of America common, resulting in issuance of 110,400 shares of Controls stock. Electrosnap is a Chicago manufacturer of hermetically sealed switches and assemblies, snap action switches and control panel assemblies of illuminated switches and indicators. Controls Co. of America manufactures automatic controls and is located in Schiller Park, Ill.

Harris Intertype Corp. has made an agreement for acquisition of Polytechnic Research and Development Co., a producer of microwave test equipment for advanced work in communications, from the Polytechnic Institute of Brooklyn, N. Y.

Chromalloy Corp., White Plains, N. Y., has acquired Sintercast Corp. of America, Yonkers, N. Y., producer of boron, tungsten and titanium compounds, special tool materials and nuclear reactor metals.

Leach Corp. has purchased the Electronics Division of Pendar, Inc., Van Nuys, Calif., which manufactures static switching, timing and annunciating devices. The acquisition will be combined with the Leach Relay Division headed by G. F. Roswell, general manager, but will function as an operating division with Walter D. Sellers as manager of operations.

Midland-Ross Corp. of Cleveland has purchased Surface Combustion Corp. of Toledo, Ohio, including its Janitrol Aircraft Division in Columbus, Ohio. Janitrol personnel, policies and operation will remain unchanged. Midland-Ross produces automotive components, process industries equipment, heat-treating equipment for glass and metals, and atmospheric control equipment. Janitrol produces heat exchangers, pneumatic controls and duct couplings, combustion and liquid heaters.

Financial Briefs

Radiation, Inc., Melbourne, Fla., has filed a registration statement with SEC seeking registration of Certificates of Interest evidencing options to purchase 27,000 shares of its Class A common stock, together with the underlying Class A shares. In 1957 Homer R. Denius, president, and George S. Shaw, vice president, sold to Kuhn, Loeb & Co. and Johnson, Lane, Space & Co., Inc. transferable options to purchase at $16.50 per share an aggregate of 27,000 common shares (subsequently converted into 27,000 Class A shares) of Radiation. Interests in the options are now evidenced only by Certificates of Interest, which are transferable. Kuhn, Loeb & Co. has transferred all its interest in the option to various of its partners and certain other persons. Because certain holders may sell the certificates of the Class A shares upon exercise thereof, Radiation has undertaken to register same.

Aerotest Laboratories, Inc., College Point, N. Y., has purchased the $6-7 million test cell facilities of the Gas Turbine Laboratory of Fairchild Engine Division at Deer Park, N. Y. Purchase also involves acquisition of Aerotest stock of Fairchild. Consolidation of Aerotest's Test Engine Division and its new Advanced Propulsion Division at Deer Park will be effective the first of the year. L. D. Browne will be chief engineer of the new division.

Electronics Capital Corp., San Diego, Calif., has purchased $400,000 seven-year convertible debentures of General Electrodynamics Corp., Garland, Tex. The debentures are convertible into 47% of General Electrodynamics' common stock. Proceeds from the financing will be used for working capital to fulfill the company's increased backlog and for its continued growth. Electronics Capital Corp. is the nation's largest small business investment company and the first publicly owned; General Electrodynamics designs and manufactures precision electron-optic devices and is a prime contractor to the FAA for scan-converter tubes.

USMC to Evaluate Anti-Tank Missile

Cobra lightweight anti-tank missile, developed by Boelkow Entwicklungen K.G. of Munich for the West German army, will be evaluated by U.S. Marine Corps next month (AW Dec. 21, p. 23). Cobra has range of 2,000 yards and travels at maximum velocity of 191 mph. It can be fired from the ground and is wire-guided from a small control box; cruciform wings serve as launching platform. Missile is 30.7 in. long.

WHO'S WHERE

(*Continued from page 13*)

Changes

Capt. George F. Baird, manager of flight test, American Airlines' Jet Maintenance and Engineering Center, Tulsa, Okla.

Philip J. Koen, director of planning, Hoffman Electronics Corp., Los Angeles, Calif.

Joseph H. Hannigan, director of radar and infrared communications, Technical Liaison Division, National Company, Inc., Malden, Mass.

Hughes Aircraft Co., Culver City, Calif., has announced the following appointments: **David A. Hill,** manager, Semiconductor Division, Hughes Products Group; **Lloyd H. Scott,** manager, Santa Barbara Research Center, a subsidiary; **L. James Levisee,** director of materiel, general office.

William E. Maschal, assistant to the vice president-commercial programs, Douglas Aircraft Co., Santa Monica, Calif.

Rear Adm. A. B. Metsger (USN, ret.), assistant to the president, The Marquardt Corp., Van Nuys, Calif.

Lockheed Missiles and Space Division, Sunnyvale, Calif., has announced the following appointments: **Dr. Wayland C. Griffith,** assistant director of research; **Robert H. Gibson,** production and services manager-Polaris; **Maurice Tucker,** associate director of research for spacecraft and missiles; **J. R. Weiner,** associate director of information processing and computers.