AVIATION WEEK

MAR. 3, 1952

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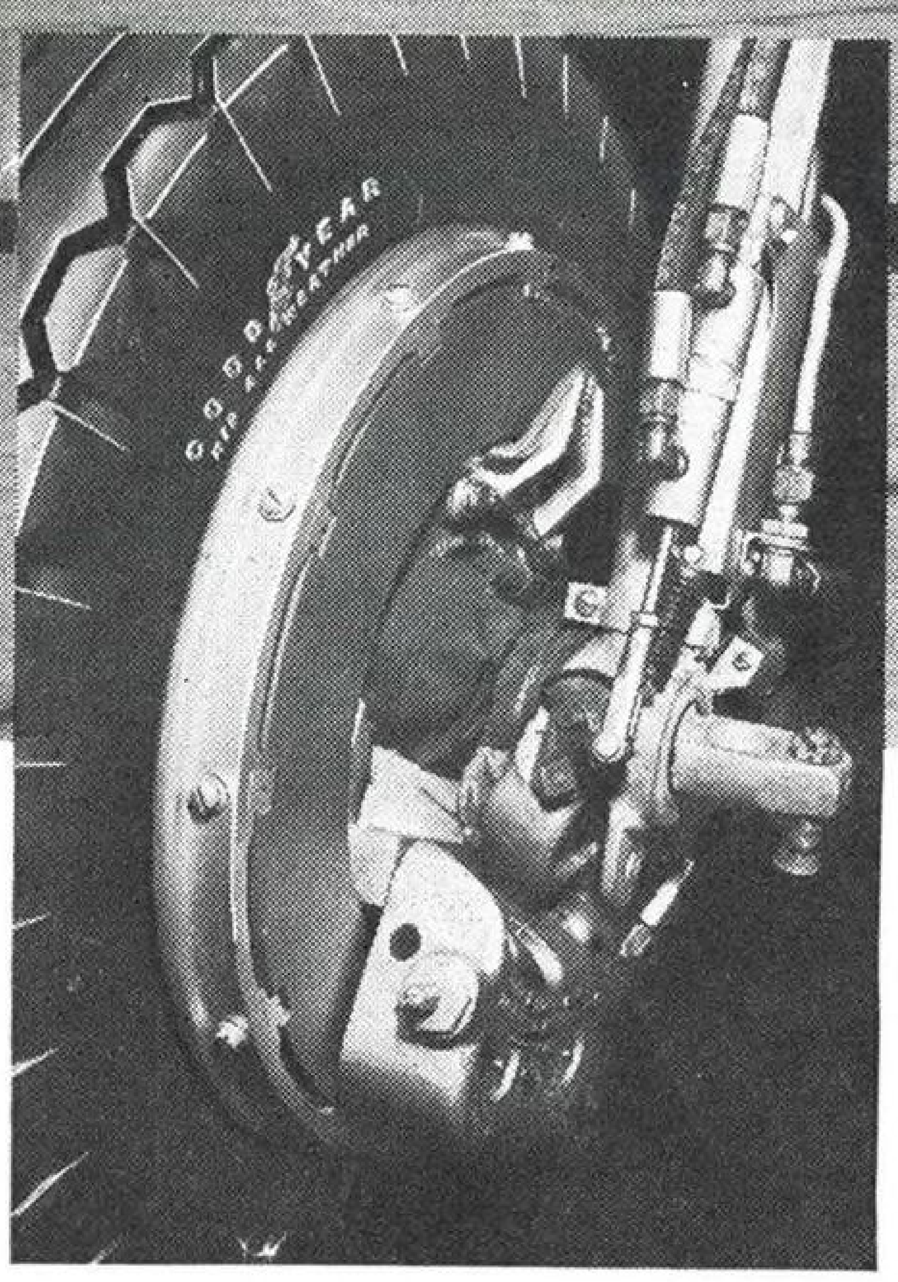

T-6 TRAINER equipped with Goodyear Cross-Wind Landing Wheels; note relative position of gear—parallel to runway as plane crabs into wind. *Inset* shows close-up of Goodyear gear.

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Aviation Week

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NEWS DIGEST

DOMESTIC

General Electric Co. and de Havilland Engine Co., Ltd., have confirmed Aviation Week's announcement of their agreement for exchange of information on jet engines (Feb. 18, p. 11). Pact which has approval of both USAF and British Ministry of Air, covers all of the aircraft gas turbine work of both companies, exclusive of that concerning atomic power.

Cessna Aircraft Co. and Seibel Helicopter Co. have announced completion of negotiations for acquisition of Seibel interests with Sessna stock. Charles M. Seibel will join the Cessna organization as chief engineer of the helicopter division.

Armament for the B-47 will be produced by Crosley division of Avco, under contract awarded by General Electric. GE will also produce the same equipment at Schenectady. The new armament—details restricted—will be installed on the now-unarmed six-jet bomber.

Exports of civil aircraft weighing 6,000 lb. and less totaled 36 units valued at $310,991 in January. December exports were 40 planes worth $260,-288.

Complete civil aircraft shipments in 1951 totaled 2,477, weighing 5,110,000 lb., and valued at $88.8 million. This included December shipments of 152 planes weighing 630,000 lb. and worth $13.1 million. November shipments were 162 planes, valued at $10.5 million. December engine shipments were 367 aggregating 196,000 hp., making a 1951 total of 4,580 aggregating 2,093,-800 hp. Employment in plants making complete aircraft, civil and military, was 362,985 in December, up 2% from November, and 63% above December, 1950. Engine plants employed 81,268, up 4% from November, and 60% from December, 1950.

Heart attack killed UAL Captain L. C. Brown while he was flying Stratocruiser from Honolulu to Los Angeles Feb. 24. Co-pilot took over and brought 43 passengers and crew of seven safely back to Honolulu.

Piasecki HUP-2 production helicopters have gone into Navy service. The tandem-rotor craft carry Sperry autopilots. They are the first production copters to incorporate autopilot control.

FINANCIAL

Douglas Aircraft Co. reports sales of $225,173,000 and backlog of $1,635 million at the end of its fiscal year, Nov. 30, 1951. Backlog on Dec. 31 was $1.8 billion. Net earnings were $6.9 million or $5.76 per share; earnings before taxes were $18.6 million.

Rohr Aircraft Corp. reports sales of over $20 million for the first six months of its fiscal year, giving a profit after taxes of $565,789 or 94 cents a share. Sales for similar period last year were $12.6 million. Backlog is over $110 million.

Sperry Corp. has declared a quarterly 50-cent dividend payable Mar. 19 to stockholders of record Mar. 3.

Garrett Corp. reports unaudited consolidated net profit of $1,137,000 for six months ended Dec. 31, 1951, on sales of $29.7 million. Profit before taxes was $3.7 million.

Aeroquip Corp. has voted to distribute 5% stock dividend of 37,500 shares Apr. 1 to stockholders of record Mar. 1.

Solar Aircraft Co. has increased its quarterly dividend from 15 cents to 20 cents a common share, and has voted an extra dividend of 20 cents. Both are payable Apr. 15 to stock of record Mar. 31.

INTERNATIONAL

Pakistan has ordered three Lockheed Super Constellations for delivery in November, 1953. They are scheduled to be used for a new Karachi-London service.

Avro Orenda jet engine has successfully completed its 150-hr. type test.

Sabena, Belgian airline, is ordering two more DC-6Bs, for delivery in 1954. This brings the carrier's orders for this equipment to eight.

English Electric Canberra flew from London to Tripoli at 538 mph. recently, setting a new record for the 1,451-mi. distance.

IATA clearing house transactions in 1951 totaled $170 million, up 15.1% from the 1950 figure. Since start of clearing house in 1947, over $629 million has been handled, involving cash exchange to accomplish this of only about $58 million.

AVIATION CALENDAR

Mar. 3-6—Institute of Radio Engineers, Waldorf-Astoria Hotel & Grand Central Palace, New York.

Mar. 3-7—Spring meeting of American Society for Testing Materials; symposium on testing metal powders and metal powder products, Hotel Statler, Cleveland.

Mar. 5—Institute of the Aeronautical Sciences meeting, Boston section; "Human Factors in Aeronautical Engineering," by Ross A. McFarland; Main Building, Massachusetts Institute of Technology, Cambridge.

Mar. 10-12—Purdue Airport Management and Operations School, Purdue University, Lafayette, Ind.

Mar. 11-14—National Plastics Exposition, Convention Hall, Philadelphia.

Mar. 14—National Flight Propulsion Meeting, Institute of the Aeronautical Sciences, Cleveland.

Mar. 17-19—Second Midwestern Conference on Fluid Mechanics, to be held at Ohio State University.

Mar. 17-21—American Society of Tool Engineers industrial exposition and annual meeting. Theme: "Tooling for Security," Chicago. (For information, write Denham & Co., 812 Book Building, Detroit.)

Mar. 20—Institute of the Aeronautical Sciences Los Angeles section dinner meeting; speaker—Wellwood Beall, Boeing Airplane Co.; Los Angeles.

Mar. 20-21—Conference, Cooling of Airborne Electronic Equipment, to be held at Ohio State University in cooperation with USAF. Technical papers will be presented by AF, electronics and aircraft industries, and research organizations; Ohio State University, Columbus.

Mar. 24-26—American Society of Mechanical Engineers spring meeting, University of Washington, Seattle.

Mar. 30-Apr. 3—Convention of American Association of Airport Executives, Ft. Worth.

Apr. 3—Conference on safety problems of aviation, in conjunction with 22d annual Safety Convention of Greater New York Safety Council; Col. Gilbert E. Teal, USAF, will preside; Hotel Statler, New York.

Apr. 21-24—National Aeronautic Meeting and Aircraft Engineering Display, Society of Automotive Engineers, Hotel Statler, New York.

May 6—International Air Transport Assn., fifth annual technical conference, Copenhagen.

May 8-9—Fifth annual Wisconsin Aeronautics Conference, Green Bay.

May 12-14—National conference on airborne electronics, co-sponsored by Institute of Radio Engineers' Dayton section and Professional Group on Airborne Electronics, Dayton Biltmore Hotel, Dayton, Ohio.

PICTURE CREDITS

16—Erwin Bulban; 56—(Doolittle) Wide World; (Hunsaker) National Aeronautic Assn.

Navy Shows New 700-Mph.-Plus F7U-3

Typifying the new generation of jet fighters Navy has in production to supersede its present fleet, is this latest Chance Vought Cutlass development, the F7U-3, powered by more powerful Westinghouse J46 axial-flow jets. Carrier air groups are scheduled to have the new Cutlass in operational service next fall, indicating that production is well underway. Noticeable differences from earlier F7U-1 includes larger cockpit, placed to improve visibility; larger engine nacelles and intakes; blunt nose and elimination of most of fin area beneath the wings.

WHO'S WHERE

In the Front Office

R. Paul Weesner has been named president of Resort Airlines, Inc., moving up from his former post as executive vice president and general manager. He was formerly executive vice president of Lake Central Airlines, scheduled local service carrier in the Midwest.

Robert R. Porter has been designated vice president-sales manager for the Ford Instrument division of Sperry Corp., Long Island, N. Y. Prior to joining the division in 1949 as assistant to the president, Porter was with Cleveland Graphite Bronze Co.

Helen C. Fedderson has been made president of Cox & Stevens Aircraft Corp., Mineola, N. Y., maker of aircraft weighing kits.

Edward L. Ladd has been chosen executive vice president of United Aircraft Products, Inc., Dayton, Ohio. Ladd has been with UAP for five years as assistant vice president of contractual engineering.

Bernard F. Coggan, former General Motors' executive, has joined Consolidated Vultee Aircraft Corp., San Diego, as assistant to the president and general manager. He will handle special assignments in Convair's aircraft and guided missile development and production programs. During World War II, Coggan was active in the Boeing B-29 program for GM.

Changes

Arthur Paine has been named chief of Bristol Engineering Corp.'s aircraft design division, Bristol, Pa. Other promotions include **Karl Koehler** to chief of the Mechanical Design division and **George Dixon** to chief of the Electronics division.

John H. Little has been designated manager of aviation sales for the Glidden Co., Cleveland, Ohio, succeeding **F. L. Long** who has gone to the firm's Central Industrial division.

Tore Anderson has been promoted to chief engineer of Airtron, Inc., Linden, N. J., wave-guide components maker for aviation and allied fields.

Charles W. Sanford has been named works manager at Jack & Heintz, Inc., Cleveland.

Richard H. Owen, formerly with Convair, Ft. Worth, has joined Aviation Engineering Corp., Woodside, N. Y. as operations manager.

Marvin L. Nelson has been made works manager of Solar Aircraft Co.'s new 300,000 sq. ft. Wakonda works, Des Moines, Iowa.

James O'Hara has been appointed special sales representative for the Aviation Supplies division of Air Associates, where he will introduce and market new products.

Charles F. Dworshak has been made assistant to the vice president-operations, Slick Airways. **William K. Fowler** has been named assistant to the vice president-sales for the scheduled freighter carrier.

J. Quinn Collins has been designated to head up a new military division in Northwest Airlines' sales department.

INDUSTRY OBSERVER

►USAF and Navy's BuAer are enthusiastic about a new landing and alighting gear, dubbed the hydro-ski, for highspeed tactical float planes. It is designed to replace conventional bulky floats. The new hydro-skis are much smaller and lighter than floats, can easily be retracted. Two versions, floating and submerged, have been developed by Edo and All American Aviation. Navy has already carried out flight tests using a Stinson OY-1, and USAF and Navy are reportedly planning a whole series of new combat planes for the new planing gear. The equipment would also be made up in kit form to install on planes in the field. Highly successful NACA experiments with hydro-flaps to improve military aircraft ditching characteristics spurred the new hydro-ski development.

►Increased USAF interest in stall warning indicators is seen in installation of Safe Flight device on Boeing B-47 Stratojet bomber to indicate safe approach speeds, permitting landings taking up much less roll and allowing use of smaller fields by the six-jet bomber. Evaluation on the Convair B-36 is also being planned.

►Navy is evaluating an external light hooked up to stall warning instrumentation on its jet night fighters to notify aircraft carrier landing signal officers when plane is approaching stall.

►Stick shakers for small Beech Bonanza and Ryan Navions are under development by Safe Flight Instrument Co., which has fitted its own Bonanza with a modified military model for trials. CAA is said to be planning installation of stick shakers on its twin-engine transports; USAF is testing the device at Eglin AFB, Fla., on a C-47 and a North American F-51.

►Second Piper PA-6 Skysedan four-place, low-wing, all-metal personal plane with retractable landing gear, developed by the company as a postwar competitor with the Navion and Bonanza, is being used by Piper as a company executive plane and to pick up scarce materials to prevent production slow-downs. The second model is fitted with a 185-hp. Continental, where the first craft had a 165-hp. engine. Plans to produce the Skysedan were abandoned when climbing costs indicated price would have to be about $8,000, considered too high to meet the competition.

►Cessna Aircraft Co.'s new low-wing twin-engine 5-6 placer has been reported visiting an eastern airport, where some people at first mistook it for a Beech Twin-Bonanza. The new Cessna twin is said to be stressed to take small turboprop engines.

►The new Westinghouse J46 engine which was scheduled to replace the Westinghouse J34 in the sweptwing Douglas F3D-3, now becomes a one-airplane engine as far as production contracts are concerned. It is going into the Navy Chance Vought Cutlass F7U-3, in a twin installation, but that's all. Westinghouse has enough commitments on its bigger J40 engine to take up any slack resulting from the J46 program, however.

►First production use of Allison's big turbojet engine, once called the J35-A-23 and now the J71, will probably be in a new forthcoming version of the Northrop F-89 Scorpion night fighter, replacing the Allison J35-A-21 engines now operational in the F-89A Scorpion. The engine switch probably is a year off, but when it comes the new Scorpions will have approximately one-third more power, since the J71 is rated in the over 9,000-lb. thrust class.

►Convair contract for its delta-wing production prototype XF-102 with electronic interceptor armament system in manufacture by Hughes Aircraft Co. is still snarled in Air Materiel Command red tape. Contract difficulties revolve around inability of Convair and Air Force to agree on patent rights of developments contained in the XF-92A delta-wing research aircraft.

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Three Results of the Stretch-Out on

Financial, Industrial & Military Outlook

Full implications of the stretch-out of military aircraft production only now are beginning to be apparent. Accordingly, Aviation Week asked its financial expert last week for a special report on the stretch-out's effects. Concurrently, the president of the Aircraft Industries Assn. stated the official position of the industry. To round out the perspective, one of the magazine's editors reports military aspects on the basis of recent discussions with top Pentagon officials. These reports for the first time bring the picture into sharp focus.

I. The Financial View

By Selig Altschul

While the "stretch-out" of aircraft production schedules will initially lead to a number of costly consequences, the long-range implications may well turn out to be quite constructive for major segments of the industry.

Previous schedules have now been labeled as highly unrealistic. To attain past goals could have dislocated the nation's economy to an even greater degree than that experienced during the past year. Unemployment is becoming a serious problem in industries shut off from raw materials diverted to the rearmament program. Moreover, the general resistance to further boosts in taxes also may have served to place a brake on the recent scale of accelerated aircraft production schedules.

► **Subcontractors Hit**—It is ironic, however, that the Administration's concern for the nation's economy by imposing cutbacks in aircraft production will prove harmful and costly in other directions. For example, subcontractors who had expected to participate in the heavy aircraft procurement program have been among the first to be hit by cutbacks. Business has either been canceled or stretched out. This will make it difficult and costly for them to retain the necessary labor force employed for full schedules.

It also will serve to increase their operating costs. Without escalation protection in their contracts they are faced with a real squeeze. Moreover, their very existence is threatened as they are unable to obtain more steel, copper or aluminum for normal civilian production to fill the gap created by the defense slowdown. A great many subcontractors are in the "small business" category—a group having the avowed support of Congress and the Administration. Yet, the cutbacks have been very harmful to this group.

There is no question that lower monthly quantities of aircraft will tend to increase unit costs. Moreover, by revising schedules and forcing cancellations in various directions added costs have been imposed upon prime aircraft builders. In most instances this will be passed on to the government. Here again, estimated over-all savings of the cutbacks will be offset to some degree by these various adjustments serving to increase the cost on the existing procurement programs.

► **Industrial Stability**—Yet, once all the present adjustments are satisfactorily effected and absorbed, the prime aircraft builders, as a group, may be entering one of the most stable profitable periods in their history.

To have pursued the now so-called "unrealistic" schedules would have meant a very rapid build-up by the end of 1952 or early 1953, with completion of most of the program in 1954. At that point, unless international conditions were to deteriorate even further, the aircraft industry would have been due for another sharp deflation.

It is these sharp peaks and valleys which in the past have proved extremely costly to industry and government alike. This "accordion" pattern has also made difficult the planning and achievement of long-range engineering programs so essential in the aircraft industry.

Revised production schedules now indicate that the 143-wing Air Force and allied Naval aviation expansion, instead of being achieved in 1954 as first planned, most likely will be accomplished some time in 1956. This is of far-reaching significance and is highly constructive to basic segments of the aircraft industry. Should present plans hold, production will assume a far more normal pattern and be maintained at a high plateau over a longer period of time, extending through 1955 and possibly beyond. Never before has the aircraft industry enjoyed such assurance of sustained high volume output under more orderly conditions projected so far into the future.

► **Funds vs. Sales**—According to latest available figures, aircraft backlogs aggregate some $11 billion. By contrast, 1951 sales were estimated at about $3 billion. For the two-year period ending June 30, 1952, about $25 billion had been appropriated by Congress for aircraft procurement. This total compares with $35 billion appropriated in the first two years of World War II. Hence, it can be seen that available appropriated funds are about ten times that of 1951 industry sales.

While the record-breaking peacetime budgets of fiscal 1951 and 1952 provide for substantial ultimate deliveries of new aircraft, it is highly significant that not a single combat airplane has as yet been delivered as a result of orders placed from these funds. It usually takes about two years from the initial order placement to incorporate such new planes into the military structure.

Yet to come are funds to be provided from the projected

1953 fiscal budget. If approved by the Congress, another $14 billion in contract authorizations for direct aircraft procurement will be made available on top of the appropriations in hand. This would make a total of some $39 billion for aircraft procurement—an amount more than 16 times the actual dollar volume of 1951.

► **Changes Unlikely**—Admittedly, while economy talk for the budget may appear during 1952, an election year, any significant changes in the aircraft procurement program appear unlikely. In fact, as in the past, any international crisis is likely to see an accelerated move for more aircraft purchases. On the other hand, events in recent years have demonstrated that over-all levels of aircraft procurement remain relatively unaffected by outward indications of a lessening of international tensions (i.e., the Korean peace "scare").

Moreover, while actual appropriations may be reduced slightly, an effective build-up can be conducted through contract authorizations to be financed by appropriations of subsequent years. Under current executive and legislative powers, the military services can be authorized to enter into contractual obligations for delivery of equipment in future years. In effect, only such funds are provided from the current year's appropriations to initiate purchases. The balance and bulk of the amounts due on such commitments will come from appropriations of subsequent years. This tends to make believe current appropriations are providing a far larger aircraft program.

► **Favor Strong Air Arm**—With an air-minded Congress, any change in the Administration is unlikely to alter the present build-up of air power. In fact, the leading Republican aspirants for the presidency directly or through their supporters are known to be inclined toward a strong air arm in our national defense establishment.

It must not be overlooked that obsolescence is constantly taking its toll of existing inventories of military aircraft. For example, the Secretary of the Air Force reported that during the current fiscal year 1952 the Air Force inventory contained an average of about 20,000 aircraft of which more than 72% were World War II types over six years old and scheduled to be declared obsolete by June 30, 1952. Accordingly, even without regard to a build-up of the Air Force to 143 wings, more than 14,400 aircraft in that service are due for replacement by more modern and advanced types.

A long-range program for building up our air arm is effectively underway and high volume output for the aircraft industry appears fairly assured in the immediate period ahead.

In any large-scale expansion of aircraft production there is a preparation period where tooling-up, training personnel, assembling materials and components must take place before any volume output can result. In addition to this normal attribute preliminary to large-scale manufacture, the aircraft builders were hard hit during 1951 by shortages of materials, machine tools, and strikes—directly and indirectly.

Strikes in aluminum plants, for example, created shortages of raw materials which prevented production of jet engines on schedule. This, in turn, served to slow down the entire aircraft production schedule.

► **Lead Time**—The long lead time in aircraft production is now largely accomplished for most aircraft companies. Machine tool and components bottlenecks are being solved. Essential materials are also flowing more readily to the industry.

For tangible evidence of improving and mounting deliveries, it is only necessary to examine recently issued annual reports of a few aircraft companies. For example, during the first six months of 1951 Grumman showed total sales of $69.8 million. The report for the year indicates that deliveries for the second half were almost $98 million.

Douglas, despite a five-week strike at its Long Beach plant, reported billings of about $72 million for its fourth quarter ended Nov. 30, 1951. This compares with a sales volume of only $39.3 million for the first quarter ended Feb. 28, 1951.

The aircraft industry remains essentially a contracting business and cannot be evaluated on a short-term basis. Aircraft production currents are too strong to be curtailed sharply. The planning and preparation of 1951 and prior years is bound to be reflected in volume production during 1952 and the immediate years beyond.

II. The Industrial View

By DeWitt C. Ramsey (Admiral, USN, ret.)
President, Aircraft Industries Assn.

Target dates for the air power build-up have been delayed some 18 months. The minimum strength officially pronounced necessary to national security will not be achieved in late 1954, as planned, but in 1956.

These revised goals, which involved a 143-wing Air Force and a proportionate increase in Naval air, became public knowledge when Secretary of Defense Lovett and Secretary of the Air Force Finletter so advised a committee of Congress recently. This followed notification to the aircraft industry that its production rates would be slowed to fit the new schedules provided for in the 1953 federal budget.

► **National Policy**—There is no question that this change eases the ultimate burden of the aircraft industry to a considerable extent. To attain the earlier schedules would have required a much heavier draft on the lifeblood of consumer industries—materials, manpower and machine tools. We would have required priorities far higher than any we have had so far. The national policy, founded on the theory that a healthy civilian economy is needed to support rearmament and the maintenance of a large military establishment over an unpredictable number of years, would have had to give way to a serious extent.

The American aircraft industry proved that it could expand rapidly and outproduce the world in warplanes. In World War II the industry's production rose from 6,000 military aircraft in 1940 to 96,000 in 1944, and in effecting this achievement it became the largest industry the world has ever known. But no such record can be imposed on a business-as-usual economy. And, tense as the world situation is today, our leaders see no need yet for the privations that would be inflicted by the staggering debt of an all-out wartime production effort.

► **Still Building Up**—But it is important that, in the readjustment of the nation's air power sights, we do not lose sight of the magnitude of the task as it stands. The industry has **not** slowed down; it is still building up. Our production rates are increasing and must continue to increase for at least another two years. Our materials and machine-tool and manpower needs have not slackened. Indeed, they will continue to grow. The bottlenecks which have plagued us in the last year show promise of giving way under increasing production of basic materials and machine tools, but they will recur without the constant vigilance of the industry, the military and the civilian government agencies.

There is no alleviation in the serious shortage of engineers, of which the aircraft industry has warned again and again. The output of graduates of engineering courses in the colleges and universities is still diminishing, year by year. While the need will not be so great, there will still be an insistent demand for skilled manpower. Before the end of 1952, the total manpower of the industry will increase to about 750,000, as compared to current employment of some 600,000.

▶ **Higher Cost**—So important a readjustment in scheduling, however realistic it may be, cannot help but have some adverse effects. There is certain to be an increase in the unit cost of aircraft, produced in lower monthly quantities. And there will be losses among many subcontractors and suppliers as prime contractors recall some of the production work farmed out in the base-broadening preparation for heavier schedules.

The industry recognizes that the Government is taking a calculated risk in stretching out the air power build-up. It recognizes the economic basis for such a move. It will do everything possible to maintain these new schedules and at the same time prepare itself for greater production, if the march of events should demand it.

III. The Military View

By William Kroger

While the importance of the stretch-out on the financial and productive situation within the industry over a period of years cannot be over-emphasized, it could be considered over-shadowed immediately by some purely military aspects.

▶ **U. S. Strength**—The stretch-out has the immediate effect of weakening our military aviation at a time when only the Administration, but not the military, really believes Russia will sit tight.

If production were permitted to rise as fast as possible—and no all-out war intervened—a year from now USAF and Naval aviation would almost be modern air forces, nearly ready for emergencies in scattered parts of the world.

Neither arm yet has attained that status.

As of Jan. 1, 1950 (before Korea), USAF had 8,004 combat planes; Navy had 4,900 operating aircraft of all types. A year later, USAF had 8,159 combat planes; Navy 6,200 operating planes.

So in the year 1950, USAF gained 155 combat planes; Navy gained 1,300 operating planes of all types.

During that year our air forces went into action in Korea, some planes were withdrawn from storage, and production for the year totaled about 3,000 for USAF and Navy combined.

Military production for 1951 was approximately 4,500 planes for both USAF and Navy.

Since our military aviation entered combat in Korea in June 1950, total plane losses there from all causes have probably approximated 1,000. An estimate of production in that period would be about 6,500.

▶ **Balance Sheet**—So USAF and Navy have received about 5,500 new planes over and above losses in a combat theater. Now, deduct for all losses or scrappings elsewhere during that period (normal peacetime attrition used) to be calculated at about 25% a year of the total force.

Military production from June, 1950, through the end of 1951 actually comes out to less than the number of planes lost or retired during that period.

On Jan. 1, 1950, USAF had a total of 17,222 planes of all types. One year later, its total was 17,337. Navy on Jan. 1, 1950, had 14,200 planes in all categories. One year later, its total was 13,550.

AIA quotes Gen. Vandenberg that 80% of our present military aircraft are obsolete.

Those are the figures that worry the military when they contemplate the stretch-out.

▶ **NATO Needs**—Two of the outstanding needs of the North Atlantic Treaty Organization air force are fighters (including fighter-bombers) and military transports. The military, naturally, is not breaking down the models of planes hardest hit by the stretch-out. But some conclusions can be drawn from visible evidence.

Some North American F-86s had been ticketed for European countries. With lower schedules now imposed, it is likely that few if any F-86s will go from the U. S. to Europe this year. That is seen as one reason behind the recent U. S.-U. K.-Canada agreement whereby 500 Canadian-built F-86s will be sent to the Royal Air Force.

The cancellation of production of the Fairchild C-119 at the Chicago plant, it is believed, was a direct blow to NATO that has not yet been softened. No European country has a comparable type of troop cargo transport in production and the NATO forces are understood to have been counting heavily on Packets.

It is likely now that no C-119s will be sent to Europe this year as output at the Hagerstown plant will be needed by U. S. forces. An alternate source of supply for the Packet is still being considered, but no decision on this is believed near.

This curtailment of new production to NATO countries has a subsidiary long-range effect. Should stability be returned to the world and our own military aircraft procurement reduced, the foreign market for spare parts and replacement planes could be of outstanding importance to the manufacturers. That market will not exist without planes now to develop it.

▶ **Design**—Despite the stretch-out and its lower rate of production, USAF and Navy can do something to increase the number of planes on hand in the most critical categories. That something is merely to push production of certain types higher, deferring planes which were not scheduled to be in quantity production for some time.

Evidence indicates that is being done.

It is almost certain that North American will be permitted to produce as many F-86s this year as possible. If its schedule has been reduced it is because the original program was unrealistic, and impossible to fulfill.

There is definite pressure in high-level Pentagon circles to freeze designs of most-needed types so production can be stepped up. This is bringing a return to the familiar World War modification plant. One for the B-47 already is being activated at Tucson by Grand Central Aircraft Co.

The influence of the stretch-out on design likely will find another outlet. Some devices that originally were thought to be too far away to be fitted into the program that called for peak strength by 1954 now will be given renewed emphasis for there is another year or 18 months for them to be developed.

This additional development time enables some defenders of the stretch-out to fall back on the explanation that while the U. S. may not have the most planes in the world it will have the best. Under present conditions, there are two obvious weaknesses in that statement.

The potential enemy can be using that extra year or 18 months for the same purpose and in the past has not shown any notable inferiority in design.

Even more dire, we didn't win the last war with qualitative superiority alone. Just as important was quantitative superiority—and now we don't even have that.

New Martin Managers Take Over

Directors vote in Bunker and Wharton; Pearson, Johnson step down; new financing program takes shape.

Management team of G. M. Bunker and J. B. Wharton stepped officially into the Glenn L. Martin Co. late last week following a vote of the company directors which simultaneously accepted resignations of President C. C. Pearson and Richard L. Johnson, vice president-finance.

Bunker becomes president and general manager as well as a director of the company and his running mate, J. B. Wharton, was elected vice-president-finance.

Pearson, who had been president of the company until the directors' meeting Jan. 21, has signified that he would remain with the company "to maintain continuity" until Bunker assumes complete reins. Just what Pearson's future plans may be are conjectural at this point, although military sources express hope he will remain with the Martin organization. He is held in high favor by both Navy and Air Force as an expert in production matters.

▶ **Agencies Approve**—Glenn L. Martin, present board chairman, in naming the new management heads said, "Mr. Bunker is particularly suited to take over this assignment because of his extensive background in manufacturing, budgetary control, production control and business management. Selection of Mr. Bunker has the wholehearted support of all the banking and governmental agencies who are participating in the company's recently announced financing plan."

Just how the pioneer aircraft manufacturer himself will figure in the business management of the new group is not presently known. It is reported that although he considers himself "just a director" he holds considerable sway over company policy by virtue of his large holdings of stock in the Martin company.

Unofficial sources report that Martin likely will retire from active participation in the company in mid-1952. This may be discussed at the next board meeting, called for Apr. 2 to act on details of the company's recently announced financing planning.

▶ **Bunker's Background**—New President Bunker was born in Chicago, Ill., Jan. 2, 1908, and was graduated from Massachusetts Institute of Technology in 1931. He joined the Campbell Soup Co. in 1931 and remained with them until he joined Wilson and Co., Chicago, in 1934.

In 1936 he joined A. T. Kearney and Co., (formerly McKinsey, Kearney and Co.), consultant management engineers, where he became a partner. He became associated with the Kroger Co. as vice president-manufacturing, Cincinnati, Ohio, in 1942. He moved to the Trailmobile Co. in 1949 as president and general manager.

▶ **Wharton's Background**—Wharton was born in Ellwood City, Penn., Mar. 21, 1914, and was graduated from Pennsylvania State College in 1935. He joined D. G. Sisterson and Co., New York, in 1936, and remained with them until 1944. During this same period, from 1942 to 1944, he was consultant to Triumph Explosives, Inc., of Elkton, Md.

In 1944, Wharton was named treasurer of Triumph. In 1945, Noma Electric Corp. acquired control of Triumph, and in 1946 Wharton was elected vice president-treasurer of Noma. He left this position in 1949 to move to the Trailmobile Co. as vice president and treasurer.

Martin stockholders will meet Apr. 2 to approve proposals for the issuance of \$6-million in convertible notes, with voting rights, to be sold to a group of private investors through Smith, Barney & Co., and for authority to issue additional shares of common stock.

▶ **Other Funds**—Other details of the financing plan include a change in the Navy V-loan agreements increasing the maximum credit available to a total of \$27,500,000, of which \$20,500,000 already has been drawn; new loans from the Reconstruction Finance Corporation in an aggregate amount of \$7.5-million and extension of maturities of existing commercial loans from the RFC; acceptance of a \$25,000 increase in price per plane for 101 commercial 4-0-4 airliners by the airlines; extension of maturities on present bank loans, and release of rights by the RFC and the banks to the proceeds from sale of 2-0-2A airliners presently on lease to TWA.

An alternative plan proposed by the company which would call for an increase in the new RFC credit from \$7.5 million to a total of \$12 million if RFC preferred not to release its rights to 2-0-2A sales proceeds was approved by the RFC.

As originally planned RFC would offer a credit of \$7.5 million under Defense Act of 1950. In addition, Martin proposed that it defer and release its \$4.5-million claim on net proceeds derived from 2-0-2A sales. This plan would have resulted in aggregate \$12 million for Martin treasury. Instead, RFC chose to hold onto its \$4.5-million claim and has agreed to authorize a total \$12-million credit using the \$4.5-million claim as security.

CAB Investigation Of Airline Opens

Civil Aeronautics Board has started investigation of Lake Central Airline, a local service operator in Indiana and Ohio, to determine whether the company and its officers "may have violated one or more sections of the Civil Aeronautics Act and the Board's regulations."

Sections in which CAB said it was interested cover fare rebates, stock ownership disclosure, accounting form, limitations of company control and interlocking directorships, profit on securities transfer, reporting of agreements, and penalties for violations and for falsification of records.

The Board's decision to investigate came shortly after it had heard arguments on extension of the line's certificate of public convenience and necessity.

AA Revenues Up 37%, Profits Rise Only 2%

American Airlines—giant of the money-making airlines—gained only 2% in net profit last year, despite a 37% jump in revenues, the AA financial report reveals.

Expenses zoomed 40%, wiping out all the benefits that would normally have been brought about with a powerful upsurge in load factor and total revenues.

American's 1951 revenues of \$162,970,000 yielded a net profit of \$10,548,000 or \$1.42 a share; yet revenues of \$118,684,700 the year before gave almost the same profit—\$10,400,000, or \$1.39 a share. Strongest impact of cost rise hit American the last quarter of 1951.

Here's how American's upsurge in 1951 revenues melted away under increased costs into a nominal change in earnings of the previous year (comparable 1950 figures are shown in parenthesis):

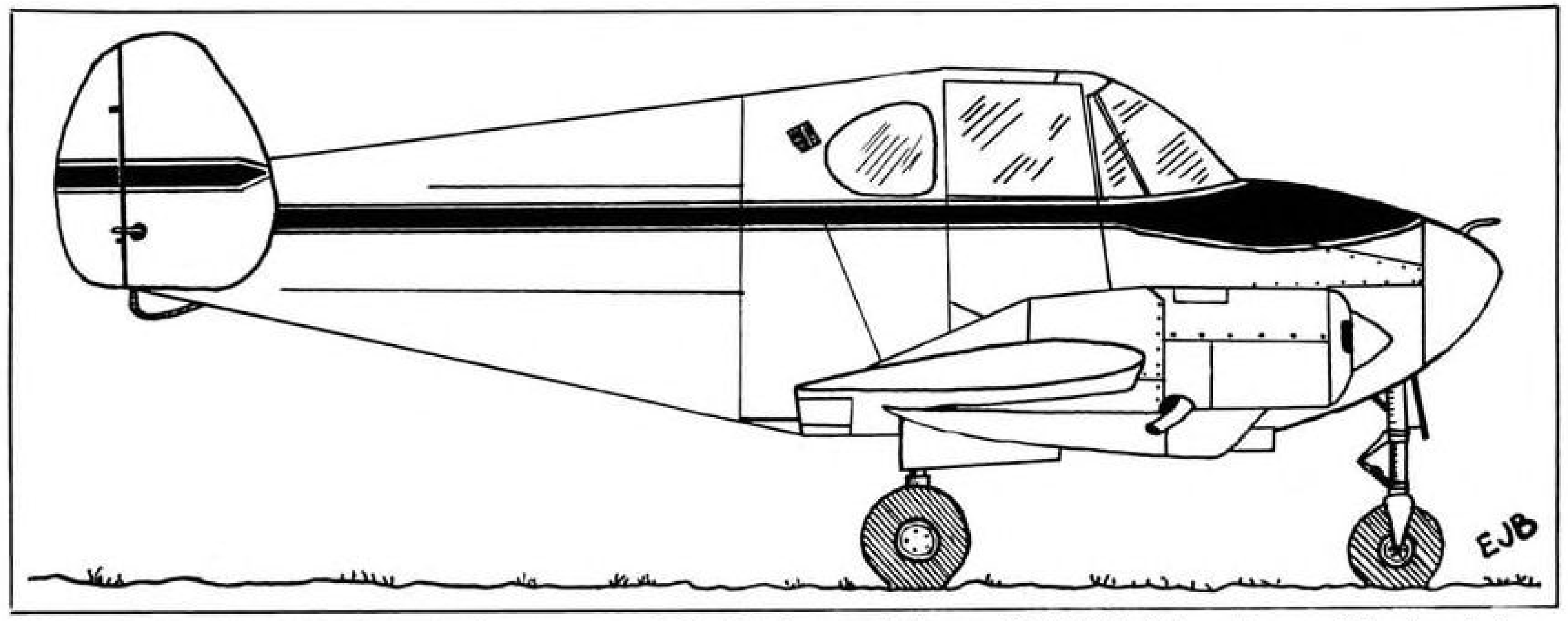
Total revenues \$163 million (\$118.7 million).

Expenses: Direct flight \$66.3 million (\$46 million); ground \$66.6 million (\$49.4 million); interest, misc. \$2.2 million (\$1.5 million). Total expense \$135.1 million (\$96.9 million).

Profit before tax \$27.9 million (\$21.8 million).

Income tax (fed.) \$17.4 million (\$11.4 million).

Net profit \$10.5 million (\$10.4 million).



PIPER AIRCRAFT'S ENTRY in the light transport field with the completely new PA-23 Twin-Stinson is one of the signs that . . .

1952 Looks Good to Lightplane Industry

By Erwin J. Bulban

Lock Haven, Pa.—More than 100 veteran light aircraft distributors and their salesmen, gathered here for the 12th annual Piper distributors convention, generally agreed that 1952 promises to be a solid year for the industry, especially if the defense program continues at its present moderate rate and the international situation does not materially worsen.

That the manufacturer concurs with this optimistic attitude is seen in its introduction during the meet of a wholly new model, aimed at an entirely new field for the company, the novel PA-23 Twin-Stinson low-wing light transport, scheduled for deliveries in 1953. The Twin-Stinson is aimed at the low-cost, twin-engine market, and is tentatively pegged at less than $25,000. Flight tests are slated to begin in the next month.

Bullish feeling in Lock Haven on 1952 lightplane opportunities can be summed up thus:

- The Korean crisis has gradually evened out, with resultant loosening of materials shortages in most important categories, and the official feeling that business planes have a definite place in the defense picture has prompted many executives to look again at the prospect of buying an airplane to help in their work.
- Increasing use of small electronic equipment, including radios and navigating devices such as the small Lear and Narco VHF navigation sets in conjunction with the rapid growth of the omni-range system, is making small-plane flying simpler, more reliable and more saleable, and is paving the way for relatively low-cost automatic flying devices for lightplanes.
- Tax write-off advantages that go with buying a business plane are an important factor in promoting sales, since the customer can depreciate up to 25% of his airplane the first year. Used aircraft depreciation is even more favorable.
- Successful developments in concentrated chemicals are pushing use of the smaller aircraft in the agricultural field. Also, the surplus World War II trainers and bombers which have been handling a large share of agricultural work are rapidly becoming obsolescent and their higher operating costs are steadily opening up the market for new light spray/dust craft.
- Growing feeling in USAF quarters that flight students should get some indoctrination in a Cub-type aircraft before stepping into the relatively complex and high-speed T-6 type trainer probably will lead to a call for several hundred light aircraft to fill this need.
- Military subcontracting, such as Piper does for Grumman, Martin and Bell, provides a steady yearly "production cushion" insuring substantial output and sales volume for some time.

▶ **Dark, Bright Spots**—But this does not mean the lightplane industry is without its headaches; there are still rising prices, lead times and shortages to contend with. There seems to be little, if any, relief from rising prices. Lead times—aluminum, four-five months; engines, ten months; wheels, six-seven months—provide many a production headache. But supplies of other items such as fabric, which has been ample these past two years; control cables, and instruments, of which there is still a fair number from surplus stocks in excellent shape, are in less critical categories.

The supplies are there, it is true, but it very often takes a lot of personal overseeing to get them. For example, Piper uses its own airplanes some 15-20 hours a week to pick up materials it needs for its production lines. Even while the distributors were meeting, the company flew in a supply of oil radiators to fit into some of the 60 aircraft slated to be flown away by the distributors at the end of the meeting.

The overall emphasis was on sales to business men and corporations and for agricultural use. Trainer and personal plane use have suffered a definite eclipse. This is emphasized by comparing Piper sales for 1951 and 1947. Last year, only 19% of the Tri-Pacers and 7% of the Pacers sold went to airport operators and to private flyers for pleasure. In 1947, airport operators took 87% of Piper's production and 13% went to private individuals—distributors remember it as the year they were "really hot" at selling airplanes to each other.

▶ **Mixed Emotions**—The dealers greeted the new Twin-Stinson with mixed emotions. The initial feeling of many: Here's a new selling job I'm going to have to do, on top of all my other problems. But after they had looked the plane over and been briefed by Piper engineers, the general consensus was that the airplane did have decided possibilities. One big "if" was—What will it do on one engine? The answer to that awaits flight tests.

Here are Twin-Stinson details gathered on the spot:

Powerplants are two Lycoming 0-290-D2 rated at 135 hp. each normally, slightly more on takeoff, turning two-blade all-metal, fixed pitch Sensenich props of 74-in. diameter. Props clear the fuselage by about 13 in. Fuel is carried in U. S. Rubber bladder-type cells of 36-gal. capacity each, one in each wing, outboard of the engines.

Fuselage is of composite construction, built up of welded steel tubing, metal-covered to the rear of the cabin and fabric-covered from there to the tail cone. Cabin seats four, is approximately 50 in. wide by about 50 in. high. Entrance door is on the right side. Front seats are attached to the main spar, rear seats are quickly removable for cargo stowage. There is also a large cargo hatch on the right side behind the cabin, with opening capable of taking a standard 55-gal. fuel drum. Windows are of blown Plexiglas.

Large quick-remove panels in the nose provide easy access to hydraulic lines, the 15,000-Btu. capacity Stewart-Warner heater, and the battery. Another big quick-remove panel under the cabin gives access to the control system. Landing lights will go into the nose cone.

▶ **Wings, Tail**—Wings are metal covered and are made in two pieces joined at the fuselage centerline. Wing section is USA 35B, modified slightly for greater thickness. Dihedral is 5 deg. The slotted ailerons are metal covered, have mass balances. Flaps are electric-ally-hydraulically operated.

The large-span tail is also all-metal, has "end-plate" rudders and fins. The horizontal tail is adjustable on the prototype, but will be fixed on the production model.

Tricycle landing gear is electrically-hydraulically operated, main wheels folding forward into the engine nacelles, nose wheel backward. All three wheels protrude slightly when retracted to aid in taking wheels-up landing shocks. Main gear takes these shocks at pads in the engine nacelles, they are then transmitted along the main spar. Nose gear has a special truss structure to take emergency landing loads.

Approximate dimensions: span 34 ft., length 23 ft., wing chord 67 in., wing area 168 sq. ft. The Twin-Stinson weighs approximately 3,000 lb. gross, and 1,775 lb. empty with radios and two gyros.

Vandenberg Future Still Uncertain

As of last mid-week and with less than two months to go until his tenure as USAF Chief of Staff expires, Gen. Hoyt S. Vandenberg still had no clues from the White House as to his official future after noon Apr. 30.

Top Air Force quarters report that a rift between Air Force Secretary Thomas K. Finletter and Vandenberg occurred several months ago during planning stages of 1953 budget preparation. Word is that Vandenberg deplored Finletter's acceptance, without a battle, of Administration desires to hold back immediate build-up of the 143-wing Air Force in favor of a compromise 119-wing structure reported in Aviation Week, Sept. 24 (p. 14).

▶ **Benefits of New Chief**—A Capitol Hill source told Aviation Week it is very likely that a new man as Chief of Staff probably would smooth out some of the difficulties the Air Force will face late this spring when it will be asked along with Army and Navy to explain to Congress the conduct of war in Korea.

On the other hand, this source said, it is entirely possible that from a morale-policy point of view Finletter will ask for Vandenberg's reappointment for a short tour until "danger on the international scene lessens." This would mean, he said, that Vandenberg would remain Chief of Staff at least until he is eligible for full retirement benefits June 12, 1953.

Meanwhile, speculation in official Air Force and Washington industry circles continues to run the gamut in names of possible successors, the latest of which is retired Air Force Lt. Gen. James H. Doolittle, Shell Petroleum executive and presently leading President Truman's newly created Air Safety Commission.

▶ **No Precedent**—Most informed Air Force quarters are inclined to discount Doolittle's possible return to the Air Force as Chief of Staff for several reasons. Main reason is that it would be highly unusual to recall a retired general officer back to duty at a higher grade and particularly as chief executive of a service from which he retired.

Generals mentioned in Aviation Week, Feb. 16 (p. 18), still seem to be leading, although State Department sources say Gen. Curtis E. LeMay is unacceptable from an international political view. Others prominently mentioned are: Vice Chief of Staff Nathan F. Twining, Lt. Gen. Lauris Norstad, Lt. Gen. Laurence Kuter, and Lt. Gen. Thomas D. White.

Not to be discounted, however, according to Air Force sources, are: Gen. John K. Cannon, Tactical Air Command: Lt. Gen. Earle E. Partridge, Research and Development Command and Lt. Gen. Edwin Rawlings, Air Materiel Command.

Expendable Tanks Planned for B-47

Dayton, O.—Use of standard expendable fuel tanks on the B-47 as well as other aircraft is designed to save the Air Force $13 million, according to conclusions reached at a recent conference at Wright-Patterson AFB.

Represented at the session were present contractors, Ryan Aeronautical Co., San Diego, Calif.; Magic Chef, Inc., St. Louis, Mo., and Goodyear Aircraft Corp., Akron, O.

Lightplanes

- **DPA sets 1952 quota of 3,120, next year 3,665.**
- **Upsurge in production is expected for 1953-54.**

Lightplane manufacturers have Defense Production Administration priorities quotas to make 3,120 civil planes this year, 3,665 next year and 1,882 the first half of 1954.

But the outlook is for actual production rates lower than shown in these quotas this year but rising to meet the presently established quotas next year, according to an Aircraft Industries Assn. spokesman. Lightplane production has already started to rise, he says, from the recent low of around 2,000 a year.

Here's why production is currently lower than even the DPA-set maximums. Outbreak of the Korea war hit the lightplane makers with shortages. Mobilization authorities painted a dim picture of chances for priorities for civil lightplanes during the emergency.

▶ **Priorities**—Some companies like Ryan pulled out of civil production altogether. There were no priorities for lightplane production. The first aircraft priority program in the defense effort was the so-called C-1 program, started in the first quarter of 1951. It included priorities for transport aircraft only—none for lightplanes.

Then in the C-2 program the second quarter of last year the Air Coordinating Committee managed priorities for just 2,500 lightplanes a year; this was stepped up to the presently approved annual rate of 3,500 planes in the C-3, C-4 and C-5 program. (See table on p. 18.)

On July 19, 1951 the Air Coordinating Committee had finally come out with a strong statement favoring lightplane production as a useful civil defense reserve; ACC recommended that 3,500 planes a year be established as the minimum rate instead of the maximum.

▶ **Revived Activity**—But because of long lead times, that final upturn in the priorities outlook for lightplanes is just now reaching the production lines in the form of more parts, more production, and reviving sales activity. Perhaps only Beech, Cessna, Piper and Aero Design will meet this year's DPA quotas, according to estimates made by AIA.

That's because of the 1950-51 cutbacks in materials and in sales activity. But the market potential is strong, and the industry is coming back, now that it has a better priorities outlook, AIA says.

Quotas for Non-Carrier Civil Planes—C-5 Program

Manufacturer Facility	Service	Model	Air-Frame Wt.	Engine No.	Engine Model	Engine Mfg.	Propeller Model	Propeller Mfg.	1952 1st Quarter Jan.	Feb.	Mar.	2nd Quarter Apr.	May	Jun.	3rd Quarter Jul.	Aug.	Sep.	4th Quarter Oct.	Nov.	Dec.	Total
Aero Design & Eng. Company	CAA	L-3805	2029	2	60-435-C2	LYC	HC12X	Hart	5	5	5	6	8	8	9	9	9	11	9	9	93
Beech	CAA CAA CAA	35 18 50	1024 3625 2490	1 2 2	E-185-11 R-985-AN14B GO-435-C2	Cont P&W LYC	35-960025 22D30-201 214-101	Beech HS Beech	26 4 2	26 4 2	26 4 2	26 4 2	26 4 2	26 4 2	26 4 7	26 4 7	26 4 7	26 4 12	26 4 12	26 4 12	312 48 69
Total Beech									32	32	32	32	32	32	37	37	37	42	42	42	429
Bell	CAA	47-D1	1002	1	6V4-200-C32	Fr	Rotor	-	1	1	1	2	1	1	2	2	1	1	1	1	15
Bellanca	CAA	14-19	981	1	O-435-A	LYC	HC12-20	Hart	4	4	4	4	4	4	4	4	4	4	4	4	48
Call	CAA	A-3	688	1	C-125	Cont	-	-	1	1	1	1	1	1	1	1	1	1	1	1	12
Cessna	CAA CAA CAA CAA CAA CAA	170 190 195 180 310 195A	706 1293 1293 1293	1 1 1 1	C-145-2 W-670 R-755-A2 E-225-C E-225-C R-755-A2	Cont Cont Jacobs Cont Cont Jacobs	DM7653 2B20 2B20 HC12X HC12X 2320	McC HS HS Hart Hart HS	46 3 10 2	42 3 10 2	63 3 10 2	66 3 10 2	63 3 10 2	63 0 8 7	44 0 8 7	42 0 8 0 7	42 0 8 0 7	46 0 8 0 7	34 0 8 0 7	30 0 8 5 7	581 15 106 5 59
Total Cessna									61	57	78	81	72	78	59	57	57	61	49	50	766
Helio	CAA	H-391	-	1	GO-4035-C2	LYC	-	-	10	10	10	12	12	12	12	12	12	12	12	12	138
McDonnell	CAA	79	-	-	Jet	-	Rotor	-				8	12	12	12	12	12	12	12	12	104
Mooney	CAA CAA	M-18-C M-18-L	313 305	1 1	A-65-8 O-145-B2	Cont LYC	65A66 63160	Flot Flot	1 1	2 1	1 2	2 2	4 4	5 5	2 2	2 2	2 2	2 2	2 2	2 2	27 27
Total Mooney									2	3	3	4	8	10	4	4	4	4	4	4	54
Piper	CAA CAA	PA-18 PA-20	574 643	1 1	O-290-D O-290-D2	LYC LYC	76AM56 76AM56	Sen Sen	32 32	32 32	34 33	50 43	55 43	58 43	58 43	58 43	58 43	58 43	58 43	58 43	609 484
Total Piper									64	64	67	93	98	101	101	101	101	101	101	101	1093
Regent	CAA	Rocket	-	1	GO-435-C2	LYC	-	-	6	8	8	8	8	8	9	9	9	7	9	9	98
Taylorcraft	CAA CAA	19 15	- -	1 1	C-85-12F C-145	Cont Cont	- -	- -	6 14	9 14	9 14	9 14	9 14	9 14	9 14	9 14	9 14	9 14	9 14	6 14	102 168
Total Taylorcraft									20	23	23	23	23	23	23	23	23	23	23	20	270
Grand Total All Aircraft									206	208	232	274	285	290	273	271	270	279	267	265	3120

Manufacturer Facility	1953 1st Quarter Jan.	Feb.	Mar.	2nd Quarter Apr.	May	Jun.	3rd Quarter Jul.	Aug.	Sep.	4th Quarter Oct.	Nov.	Dec.	Total
Aero Design & Eng. Company	9	11	9	9	9	11	9	9	9	11	9	9	114
Beech	26 4 12	26 4 12	26 4 12	26 4 12	26 4 12	26 4 12	26 4 12	26 4 12	26 4 12	26 4 12	26 4 12	26 4 12	312 48 144
Total Beech	42	42	42	42	42	42	42	42	42	42	42	42	504
Bell	1	1	1	1	1	1	1	1	1	1	1	1	6
Bellanca	4	4	4	4	4	4	4	4	4	4	4	4	48
Call	1	1	1	1	1	1	1	1	1	1	1	1	12
Cessna	30 0 8 40 7	30 0 8 40 7	30 0 8 40 7	30 0 8 40 7	30 0 8 40 7	30 0 8 40 7	30 0 8 40 7	30 0 8 40 7	30 0 8 40 1 7	30 0 8 40 3 7	30 0 8 40 5 7	30 0 8 40 7 7	360 0 96 480 16 84
Total Cessna	85	85	85	85	85	85	85	85	86	88	90	92	1036
Helio	12	12	12	12	12	12	12	12	12	12	12	12	144
McDonnell	12	12	12	12	12	12	12	12	12	12	12	12	144
Mooney	2 2	2 2	3 2	3 3	3 3	3 3	3 3	3 3	3 3	3 3	3 3	3 3	34 33
Total Mooney	4	4	5	6	6	6	6	6	6	6	6	6	67
Piper	58 43	58 43	58 43	58 43	58 43	58 43	58 43	58 43	58 43	58 43	58 43	58 43	696 516
Total Piper	101	101	101	101	101	101	101	101	101	101	101	101	1212
Regent	9	7	9	9	9	7	9	9	9	7	9	9	102
Taylorcraft	6 14	9 14	9 14	9 14	9 14	9 14	9 14	9 14	9 14	9 14	9 14	6 14	102 168
Total Taylorcraft	20	23	23	23	23	23	23	23	23	23	23	20	270
Grand Total All Aircraft	300	303	304	305	305	305	305	305	306	308	310	309	3665

Manufacturer Facility	1954 1st Quarter Jan.	Feb.	Mar.	2nd Quarter Apr.	May	Jun.	Total
Aero Design & Eng. Company	10	12	10	10	12	10	64
Beech	26 4 12	26 4 12	26 4 12	26 4 12	26 4 12	26 4 12	156 24 72
Total Beech	42	42	42	42	42	42	252
Bell	1	1	1	1	1	1	6
Bellanca	4	4	4	4	4	4	24
Call	1	1	1	1	1	1	6
Cessna	30 8 40 9 7	30 8 40 10 7	30 8 40 10 7	30 8 40 9 7	30 8 40 10 7	30 8 40 10 7	180 48 240 58 42
Total Cessna	94	95	95	94	95	95	568
Helio	12	12	12	12	12	12	72
McDonnell	12	12	12	12	12	12	72
Mooney	3 3	3 3	3 3	3 3	3 3	3 3	18 18
Total Mooney	6	6	6	6	6	6	36
Piper	58 43	58 43	58 43	58 43	58 43	58 43	348 258
Total Piper	101	101	101	101	101	101	606
Regent	8	6	8	8	6	8	44
Taylorcraft	6 14	9 14	9 14	6 14	9 14	9 14	48 84
Total Taylorcraft	20	23	23	20	23	23	132
Grand Total All Aircraft	311	315	315	311	315	315	1882

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Revolution Brewing in Aviation Design

- **RPI's Prof. Neil P. Bailey advances a new thesis which upsets established thermodynamic fundamentals.**
- **The new concept should make aerodynamics a more exact science, eliminating much of today's cut-and-try.**

A new and revolutionary thesis in thermodynamics—one of the foundation stones of today's aerodynamics—has been developed by Neil P. Bailey, Russell Sage professor of mechanical engineering at Rensselaer Polytechnic Institute, Troy, N. Y.

His ideas are the logical culmination of 15 years of individual researching. They are controversial ideas, comparable—in a rough sense—to asserting that Newton's three laws of motion are wrong.

But they invite detailed re-examination and re-evaluation of one of the bases of thermodynamics—the steady-flow equation.

Early in his long career of working and teaching in thermo, Bailey became aware that errors had been built in somewhere along the line of development of his subject. Measured rates of flow did not check the predicted rates; unexpected temperatures, flow instabilities and discontinuities were found that were not anticipated.

Previous custom was to attribute these differences to experimental or instrument error; but modern techniques and apparatus should have reduced these errors to minima. The only place left to look was in the formulas which supposedly described the flow processes.

This brief survey—first anywhere for the world of aeronautical engineering—shows the trend of Bailey's thinking. It is bound to start arguments, because it differs from a norm which has been acceptable for a century.

Such thinking means that there will be necessary revisions of basic texts in aerodynamics and its root sciences of fluid mechanics and thermodynamics. Vapor and gas tables will have to be revised and presented in a new form.

But with the help of these new formulas, aircraft and engine design can become more of an exact science. Now dependent in large measure on the extrapolation of existing empirical data, the designer will be able to use mathematics for paper studies. He will be freed from some of the more expensive aspects of cut-and-try development.

Where will these formulas apply? Primarily wherever air moves—and that covers the field of aerodynamics.

In subsonic aerodynamics, they apply to the design of engine air inlets and internal ducting; the flow over the wing at high angles of attack near the stall.

Supersonically, they can be used for calculation of flow patterns around and through aircraft and missile bodies and wings. They can predict flow instability and shock formations over wings and other surfaces.

In engine work, they can calculate the characteristics of compressor and turbine blading. They can develop the understanding of flow instability in nozzles and in combustion chambers.

And these new concepts will mark out new avenues of approach for designers and determine new goals of efficiency to reach.

Memo to Engineers:

Here is your first look at the only fundamental change in a century of fluid-flow concepts.

It is a re-examination and revision of the basic principles of thermodynamic processes, advanced by Neil P. Bailey, Russell Sage professor of mechanical engineering at Rensselaer Polytechnic Institute.

Because of the far-reaching effects of Bailey's contribution on engineering thermodynamics and hydraulics—parent sciences of today's aerodynamics—AVIATION WEEK presents this necessarily brief survey of his forthcoming book, "Thermodynamic Processes," McGraw-Hill Publishing Co.

► **Today's Base**—Contemporary aerodynamic theories are based on century-old precepts of thermodynamics and hydraulics. Instead of developing new concepts, we have adapted the old ones. We have invented correction factors. We have rationalized discrepancies between observed and calculated results.

We have, in short, built errors into these subjects.

The intervening years have shown no fundamental changes in thinking, despite the new flow problems of highly compressible fluids, rarefied gases, molecular flow and the other adjuncts of supersonics.

But the years have also brought improvements in measuring techniques and test apparatus. And now we are sure that discrepancies—not attributable to experimental and instrument error—do exist, and that classical theory does not and can not explain them.

These differences between theory and tests started the whole train of Bailey's development. From careful tests with accurate instrumentation, from philosophical thought and discussion, from paper studies, the tracks led right back to the fundamental theorems of thermodynamics.—DAA

The New Concept

Work is uniquely defined by a force acting through a distance, and this states the only way in which mechanical energy can be transmitted from one system to another. Moving fluid streams possess kinetic energy because they are flowing, and gases and vapors possess internal energy by virtue of molecular motion and spacing.

Liquids in elevated positions are often assumed to have energy because of this position; but they actually do not possess such energy. The elevation merely defines a state with respect to the earth. This energy can be received by the liquids only as they move down hill; the force of gravity actually performs this promised work. If they never descend to a lower elevation they will never have this energy.

This is in contrast with the true potential energy of a compressed spring which does have internally stored energy resulting from elastic stress forces having moved through deformation distances.

Fluids are often referred to as possessing energy because they exist under pressure. Again, this pressure merely defines a state and does not represent energy. A non-compressible fluid which will not deform can be raised to any desired pressure with zero work input because the applied compressing force moves through no distance.

When an elastic fluid such as a gas or vapor has its pressure raised there is a work input, because the compressing force acts through a deformation distance. However, just as in the

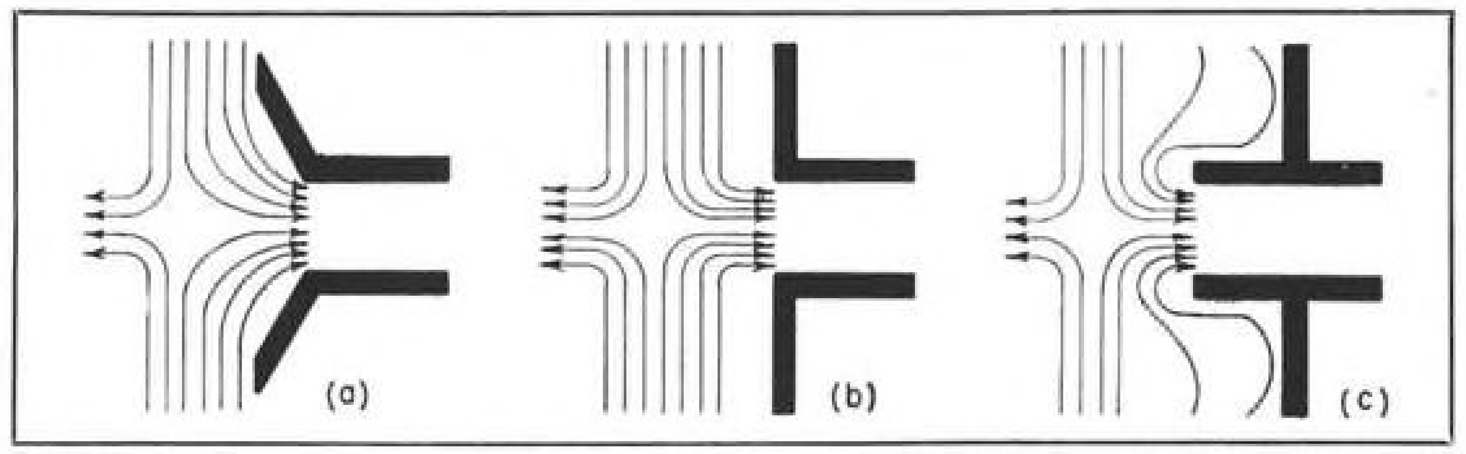


FIG. 1: With partial nozzle (a), entering momentum is increased; with plane tube (b), entrance momentum is normal; re-entrant tube (c) reduces inlet momentum.

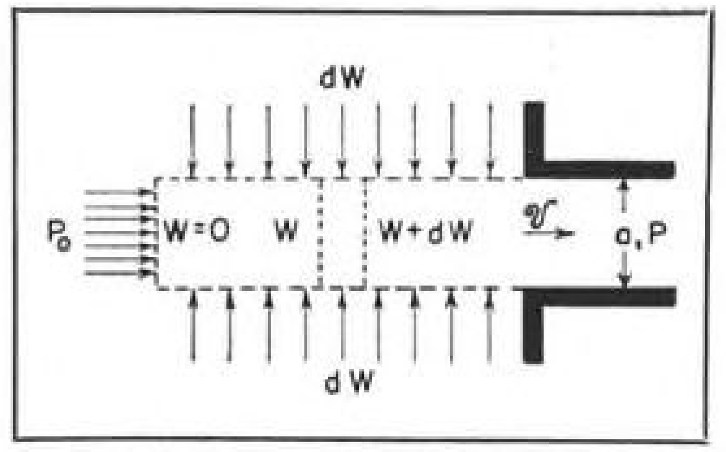


FIG. 2: These parameters define fluid flow from space tube at nozzle entrance.

spring, this input work stays as internal energy in the gas. If work is done on release of this pressure, its only source is the stored internal energy. *A fluid at rest possesses only internal energy.*

Energy Flow. Energy can be moved from one place to another by a flowing stream in three ways. *Kinetic energy* is *transported* at a rate $Wv^2/2g$ by W lb per sec of fluid moving at velocity v ft per sec. *Internal energy* is *transported* at a rate Wu by W lb per sec possessing u ft lb per lb of internal energy.

In addition, the fluid stream *transmits* energy at a rate Pav: An absolute pressure P across an area a constitutes a force Pa moving along at a flow velocity v.

This gives the total rate of energy flow WE as:

$$WE = Wu + Wv^2/2g + Pav \qquad (1)$$

Total = internal + kinetic + transmitted

As a fluid flows along, exchanges between these three forms of energy can occur and their total WE can vary.

Kinetic and internal energy that are *transported* are obvious and measurable, but the *transmitted* energy flow Pav is less evident. Its existence can be seen by thinking of water flowing down a hill to a turbine, through a constant-area pipe. As it comes down gravity does work on it, but its kinetic energy cannot change and its internal energy is negligible.

The work of gravity increases Pav by raising P. The entire work of gravity is delivered to the turbine as transmitted energy flow Pav. Stopping the flow stops the transmitted energy because the existing force Pa is not moving and gravity does no work.

Energy Conversion. Transmitted energy Pav is not physically obvious but is very significant. Only through changes in it can there be changes in kinetic and internal energy. Kinetic energy can change only through a force change $d(Pa)$, and internal energy cannot change without a volume change $d(av)$.

In absence of turbulence or heat transfer, internal energy flow Wu can be changed mechanically only by a force acting through a deformation distance. This means that a change dV in the specific volume V must occur with a pressure P if the internal energy is to be altered. For a steadily flowing fluid:

$$Wdu = -WPdV = -Pd(av) \qquad (2)$$

since for steady flow

$$WV = av \qquad (3)$$

Use the minus sign because a gain in volume $+dV$ represents a loss in internal energy. Change in volume flow av is made up of two parts:

$$Wdu = -Pd(av) = -Padv - Pvda \qquad (4)$$

The change adv is a space change in the flow direction and vda is an expansion in a direction normal to the flow velocity. Both changes are with a pressure P so they both represent internal energy changes. But they have widely different effects on flow.

In classical thermodynamics, volume change dV was used as an algebraic quantity. This was all right in a closed engine cycle when only piston motion could give a volume change dV, but it cannot be so used with a *flowing* medium.

In the special case of a non-compressible medium, such as a liquid, dV is zero and vda must equal $-adv$.

Energy Conversion in Space Flow. Flow in free space, such as a wind blowing or fluid flowing in a large space toward an opening or around an obstruction, involves certain concepts. A *flow tube* is surrounded by an imagined boundary enclosing a varying flow area inside of which there is always a statistically constant flow of molecules. Constant-weight flow, W lb per sec, in such a tube must accelerate and decelerate in equilibrium with surrounding tubes if turbulence and mixing are to be avoided.

In such a tube, energy conversion $Padv$, equation (4), is in direction of flow and can change transmitted and kinetic energies. The transverse energy conversion $Pvda$ is absorbed or supplied by adjacent flow tubes.

To say that the imagined molecular boundary of a tube could retain or reflect such transverse expansion energy would deny the very molecular process by which expansion occurs and internal energy changes are brought about.

This means that with space flow, even though an amount of internal energy Wu is being transported only the energy change $-Padv$ affects the transmitted and kinetic energy. The transverse energy change $-Pvda$ represents an exchange between flow tubes. For space flow, equation (1) becomes:

$$d(WE) = d(Wu) + d(Wv^2/2g) + d(Pav) \qquad (5)$$

$$-Pvda =$$

$$-Pvda - Padv + d(Wv^2/2g) + d(Pav) \qquad (6)$$

$$(W/g)vdv + vd(Pa) = 0 \qquad (7)$$

$$(W/g)dv + d(Pa) = 0 \qquad (8)$$

Equation (8), derived for space flow from an energy approach, can be recognized as a constant-weight flow version of Newton's second law, the rate of change of momentum equals the applied force or

$$d(Wv/g) + d(Pa) = 0 \qquad (9)$$

This says that for space flow where there are no forces exerted by duct walls, flow is at constant momentum.

Energy Conversion in Duct Flow. When a steady-weight flow W lb per sec of fluid is guided non-turbulently by the solid walls of a duct, the energy conversion is somewhat different. As before, the energy change $-Padv$ acts directly to alter the kinetic and transmitted energy. The transverse energy conversion $-Pvda$, which was exchanged between flow tubes in space, is now contained within solid duct walls. Through the mechanism of molecular reflections at the solid walls, this transverse energy change is redirected into the flow direction.

This means that the total energy flow WE of (1) is constant so

$$-Pd(av) + d(Wv^2/2g) + d(Pav) = 0 \qquad (10)$$

$$(W/g)vdv + aidP = 0 \qquad (11)$$

but

$$WV = av \qquad (12)$$

$$(vdv/gV) + dP = 0 \qquad (13)$$

Equation (13) for duct flow is usually derived from a force point of view by summing up forces on an element in the flow direction. Because the same force diagram is always drawn, it has been assumed to apply also to space flow.

However, an energy approach makes it clear that:

a. *Flow in ducts is at constant energy and variable momentum.*

b. *Flow in space is at constant momentum and variable energy.*

Flow From Rest. Fluid flowing in any duct must at some point enter from a large space so this entering process is of primary importance. At rest in space a fluid possesses only internal energy regardless of the pressure at which it exists. Pressure does influence the amount of energy that can be removed from a space by a flowing fluid, but the only source of such energy is the internal energy stored in the space or the energy source supplying fluid to the space.

From equations (1) and (3) energy flow into an opening of area a is:

$$\frac{WE}{a} = \frac{uv}{V} + \frac{v^3}{2gV} + Pv \qquad (14)$$

This changes with varying velocity depending on how velocity affects the leaving pressure and internal energy.

The manner of this variation is influenced somewhat by the way the walls direct the entering flow, Fig. 1. The most common and important case[1] is the plane entrance of Fig. 1b. For this case, the only entering momentum is that supported by the supply pressure P_o.

When W lb per sec of fluid flows in a tube in space, (9) gives the condition at any point as

$$(Wv/g) + Pa = constant \qquad (15)$$

This form of the constant momentum equation is useful for studying the flow of Fig. 2 by combining it with (3) to give

$$a[P + (v^2/gV)] = constant \qquad (16)$$

This equation applied to Fig. 2 gives

$$P_o a = a[P + (v^2/gV)] \qquad (17)$$

$$P_o - P = v^2/gV \qquad (18)$$

Tests[1] indicate that the wall shape around a duct entrance can cause a variation of as much as plus or minus 20% in the pressure drop $(P_o - P)$ required to produce a flow velocity v into a duct opening. Value for a plane entrance given by (18) may be safely taken as a normal condition because the maximum variations observed do not all change the nature of the conclusions that follow from combining (14) and (18)

$$\frac{WE}{a} = \frac{uv}{V} + P_o v - \frac{v^3}{2gV} \qquad (19)$$

This equation says that *for a fluid leaving a still space, the energy per second leaving through an opening of area* **a** *builds to a maximum and then decreases as the leaving velocity increases.*

Working Variables. Since flowing fluids possess both kinetic and transmitted energy, the flow situation is not defined without

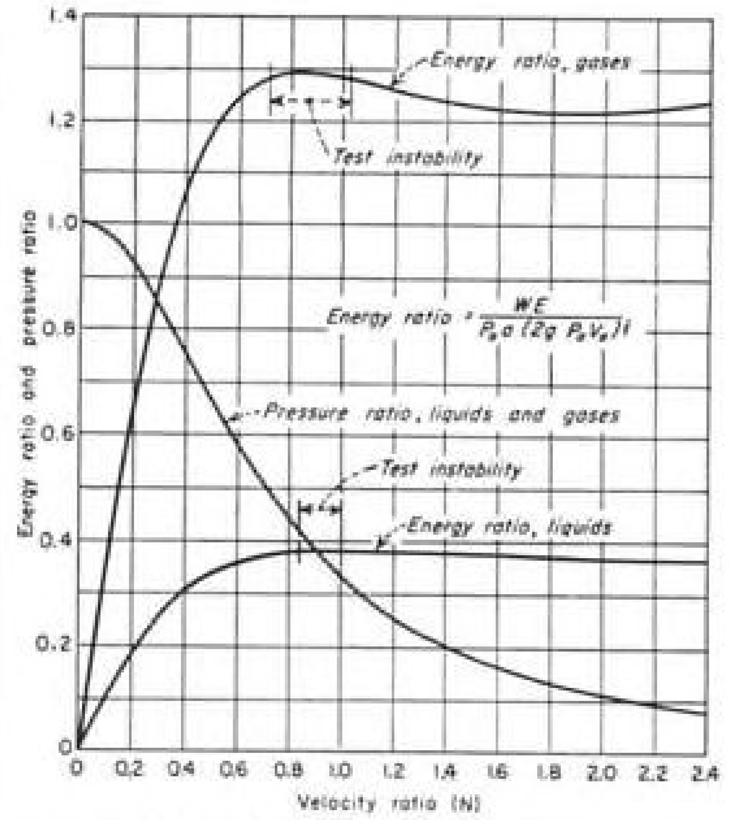


FIG. 3: Variations in energy and pressure ratios with velocity ratio for space flow of gases and liquids.

specifying both of them. A certain amount of kinetic energy with a low transmitted energy will not result in the same flow situation as the same kinetic energy with a higher transmitted energy.

This means velocity v alone is not a proper variable to use in studying flow. It is vital to consider the pressure P that accompanies the velocity; otherwise transmitted energy is not defined.

To care for this the *kinetic energy ratio* N^2 is defined by

$$N^2 = \frac{\text{kinetic energy}}{\text{transmitted energy}} \quad (20)$$

$$= \frac{Wv^2/2g}{Pav} = \frac{v^2}{2gPV} \quad (21)$$

Corresponding internal energy ratio is

$$\text{Internal energy ratio} = Wu/Pav = u/PV \quad (22)$$

Another very useful concept is

$$N = \text{velocity ratio} = \sqrt{\text{kinetic energy ratio}} = v/\sqrt{2gPV} \quad (23)$$

In terms of these ratios, entering pressure ratio for all fluids from (18) is defined by

$$P_o/P = 1 + 2N^2 \quad (24)$$

When gases and vapors undergo internal energy changes, value of the transmitted energy during the conversion is significant. Another very useful concept is

$$\text{Conversion factor} = \int \frac{W\,du}{Pav} = \int \frac{du}{PV} \quad (25)$$

Liquid Flow Into Ducts. For liquids, internal energy u is considered zero and energy flow equation (19) takes the form

$$\frac{WE}{a} = P_o v - \frac{v^3}{2gV} = Pv\left(\frac{P_o}{P} - \frac{v^2}{2gVP}\right) \quad (26)$$

$$\frac{WE}{P_o a (2gP_oV)^{1/2}} = \left(\frac{P}{P_o}\right)^{3/2} \frac{v}{(2gPV)^{1/2}} \left(\frac{P_o}{P} - \frac{v^2}{2gPV}\right) \quad (27)$$

Combining this with (24)

$$\frac{WE}{P_o a (2gP_oV)^{1/2}} = \frac{N(1+N^2)}{(1+2N^2)^{3/2}} \quad (28)$$

This, with (24), completely defines the energy flow of a liquid entering a duct from a pressure P_o for normal entrance of Fig. 1b.

Fig. 3 shows that maximum possible energy flow of a liquid from a free space occurs at a velocity ratio of $N = 1.0$ and under pressure ratio $P/P_o = 1/3$. Careful tests[2] of straight tubes of length-diameter ratios of 1.0 to 4.0 show instability in the range given on Fig. 3.

Below $P_o/P = 3.0$ and $N = 1.0$, the tube flows full, and at or near $N = 1.0$, the flow breaks clear of the tube walls. Simultaneously a high-pitched whistling begins, indicating an instability at the zero slope point of Fig. 3. At higher-pressure ratios the jet remains separated and between P_o/P of 4 and 5 the whistle passes out of the audible range (12,000 cycles per sec).

Upon again reducing the pressure ratio carefully to a value less than P_o/P of 3.0 the jet often remains separated for a time in a metastable state. In the range just below $P_o/P=3.0$, straight-walled tubes are extremely unstable.

Gas Flow Into Ducts. When a gas flows from a space into a duct both the specific volume V and the internal energy u change so the complete energy flow equation must be used (14). This can be written as

$$\frac{WE}{aP_o(2gP_oV_o)^{1/2}} = \left(\frac{P}{P_o}\right)^{3/2}\left(\frac{V}{V_o}\right)^{1/2} N\left(\frac{u}{PV} + N^2 + 1\right) \qquad (29)$$

where P_o and V_o refer to conditions in the supply space. Pressure required is given by (24).

Specific volume V and internal energy u can be related for a gas through the conversion factor (25). For no heat transfer or turbulence

$$du = -PdV \qquad (30)$$

$$-\int\frac{dV}{V} = \int\frac{du}{PV} \qquad (31)$$

For an ideal gas

$$PV = RT \text{ and } du = JCdT \qquad (32)$$

where T is temperature in deg R, and C is internal energy specific heat. Equations (31) and (32) can be combined with

$$\gamma = \frac{R}{JC} + 1 = 1.4 \quad \text{for air} \qquad (33)$$

to give the familiar relationship

$$\left(\frac{V_o}{V}\right)^{\gamma} = \frac{P}{P_o} \qquad (34)$$

This gives for an ideal gas

$$\frac{WE}{aP_o(2gP_oV_o)^{1/2}} = \left(\frac{P}{P_o}\right)^{3/2}\left(\frac{P}{P_o}\right)^{-1/2\gamma} N\left(\frac{JC}{R} + 1 + N^2\right) \qquad (35)$$

Using (24)

$$\frac{WE}{aP_o(2gP_oV_o)^{1/2}} = \frac{N\left(\frac{\gamma}{\gamma-1} + N^2\right)}{(1 + 2N^2)^{3/2 - 1/2\gamma}} \qquad (36)$$

Energy flow of a gas entering an opening from a supply pressure P_o shown by Fig. 3 reaches a maximum at $N=(\gamma/2)^{1/2}$ and $P_o/P=1+\gamma$, and a minimum at $N=(\gamma/\gamma-1)^{1/2}$, after which it again increases.

Repeated tests of many tubes show instability always at the top of the energy flow curve, as on Fig. 3. In the previous case of water, the jet separated from the tube walls, but with air, instability takes another form. The flow surges violently, appearing to completely collapse and reform each cycle. The frequency is lower than for water and heavy energy surges are involved.

Fig. 4 shows typical traverses for such a tube with a pressure ratio just before bad instability starts.

Liquid Nozzles. Space flow of a liquid into a straight-walled tube becomes unstable at an absolute pressure ratio of $P_o/P_1=3.0$ because this point represents the maximum energy flow that can enter the duct.

Requirements for a stable liquid nozzle can be deduced from Fig. 5, in which the flow from P_o to P_1 is space flow at constant momentum. Flow from P_1 to P_2 is duct flow at constant energy. From Eqs (19) and (14) for a liquid, the entering energy at 1 is the same as that leaving at 2.

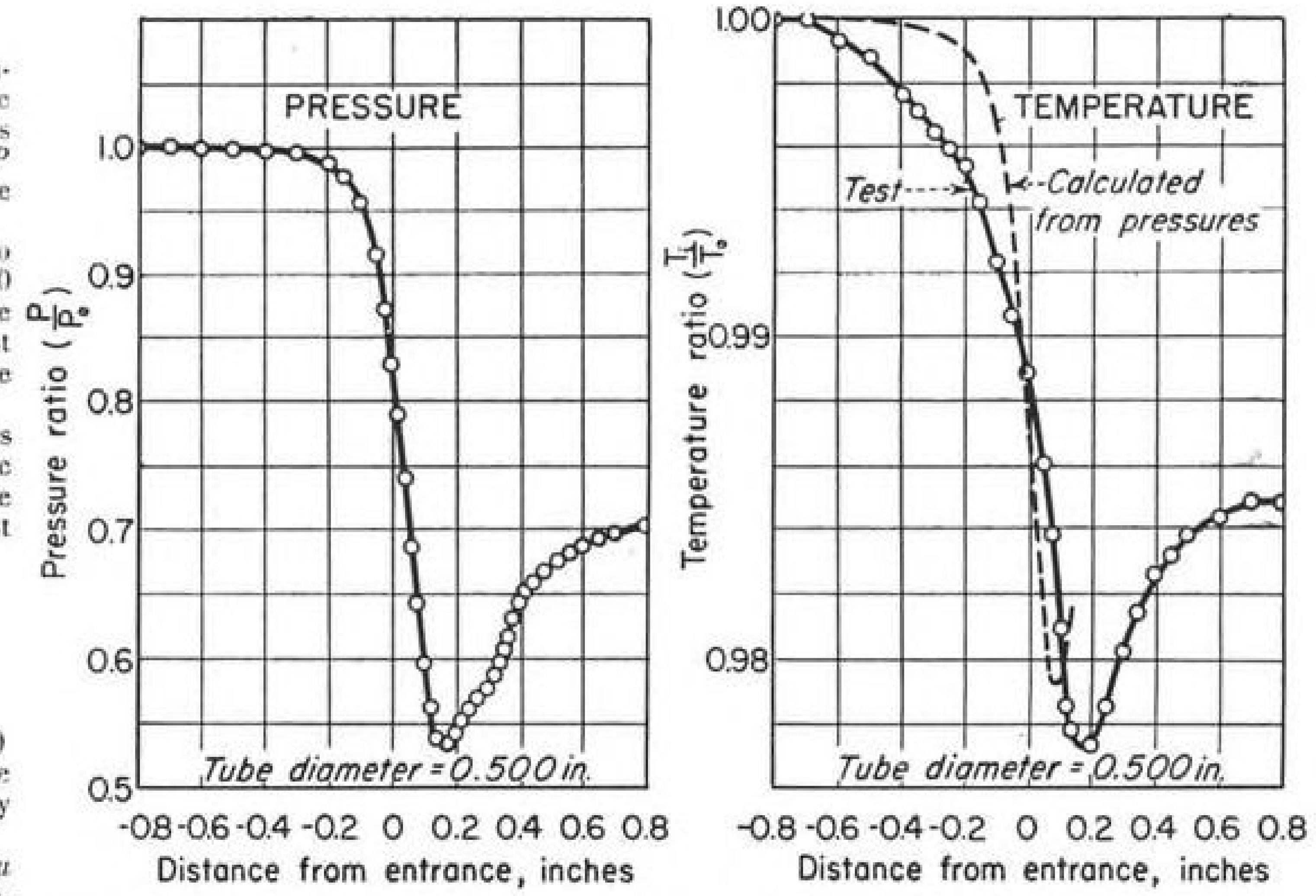


FIG. 4: These are typical pressure and temperature traverses for space flow into a half-in. dia. tube. Test pressure ratio was just below pressure ratio at which bad instability of flow occurs.

$$WE = P_ov_1a_1 - \frac{v_1^3a_1}{2gV}$$

$$= \frac{a_2v_2^3}{2gV} + P_2a_2v_2 \qquad (37)$$

For steady flow

$$WV = a_1v_1 = a_2v_2 \qquad (38)$$

$$\frac{P_o}{P_1} - N_1^2 = \frac{N_1^2a_1^2}{a_2^2} + \frac{P_2}{P_1} \qquad (39)$$

Critical entering condition occurs when

$$N_1^2 = 1.0 \text{ and } P_1 = P_o/3 \qquad (40)$$

This gives a critical pressure ratio for any area ratio

$$\left(\frac{P_2}{P_o}\right)_{critical} = \frac{2 - a_1^2/a_2^2}{3} \qquad (41)$$

This says that while a straight-walled tube becomes unstable at $P_2/P_o=1/3$, a tube with a taper of $a_1/a_2=(2)^{1/2}$ will have no critical pressure ratio.

a_1/a_2	Critical P_2/P_o *Theory*	*Test*
1.0	.33	.38
1.21	.18	.28
1.44	none	none

Table above gives a summary of many tests of tapered tubes. A taper of a_1/a_2 of 1.44 resulted in a tube that could not be put into instability as predicted. Tests on tubes of area ratio a_1/a_2 of 1.0 and 1.21 became unstable at lower than predicted values of P_o/P_2, primarily because of the flat-topped nature of the energy-flow curve.

Since about 1860 it has been accepted practice to assume space flow is at constant energy, the same as duct flow. Equation (13) has been applied to the nozzle of Fig. 5 to give

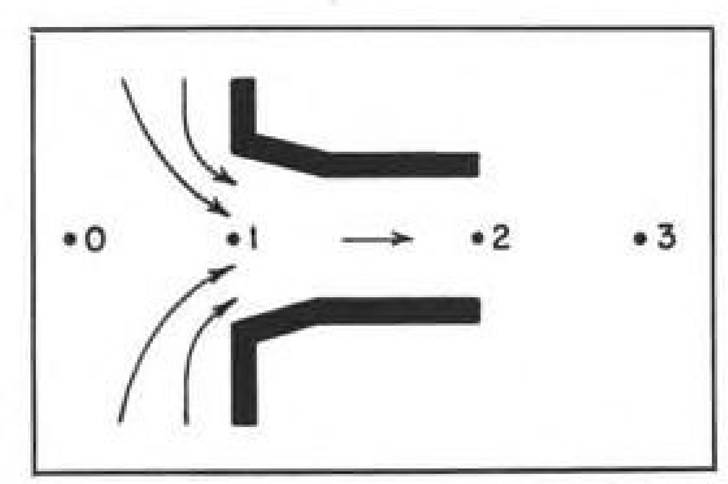


FIG. 5: Sketch of typical points for measurement of pressure and temperature for space flow through a stable nozzle.

$$\frac{1}{gV}\int_o^{v_2} vdv + \int_{P_o}^{P_2} dP = 0 \qquad (42)$$

or,

$$\frac{v_2^2}{2gV} = P_o - P_2 \qquad (43)$$

The discharge so calculated has failed to check tests, so a discharge coefficient C_D was then used to give

$$\textit{Flow rate} = C_Da_2\left[2gV(P_o - P_2)\right]^{1/2} \qquad (44)$$

However, using space flow ahead of the nozzle from (38) and (37) gives

$$P_o - \left(\frac{a_2}{a_1}\right)^2\frac{v_2^2}{2gV} = \frac{v_2^2}{2gV} + P_2 \qquad (45)$$

or,

$$\textit{Discharge rate} = a_2v_2$$

$$= a_2\left[\frac{2gV(P_o - P_2)}{1 + \frac{a_2^2}{a_1^2}}\right]^{1/2} \qquad (46)$$

Comparing Eqs (46) and (44) shows

$$\frac{1}{C_D} = \left(1 + \frac{a_2^2}{a_1^2}\right)^{1/2} \qquad (47)$$

a_1/a_2	Test C_D: *Below critical (full)*	Test C_D: *Above critical (separated)*	*Calculated C_D Eq (45)*
1.00	.81	.63	.71
1.21	.88	.76	.77
1.44	.91	.91 (stable)	.83

Table above shows typical test results for small tubes of a length-diameter ratio of 4.0. Comparison should be made between the calculated values and the test values below the critical. Assumption that space flow ceases and duct flow begins immediately at point 1, Fig. 5, does not square with test observations. Space flow appears to persist some into entrance of tube, so more energy actually enters than was assumed.

Gas Nozzles. When a gas flows into a nozzle, Fig. 5, the fact that it is constant-energy duct flow from 1 to 2 is stated by

$$WE = Wu_1 + W\frac{v_1^2}{2g} + P_1a_1v_1$$

$$= Wu_2 + W\frac{v_2^2}{2g} + P_2a_2v_2 \qquad (48)$$

Using Eqs (33) and (34) gives

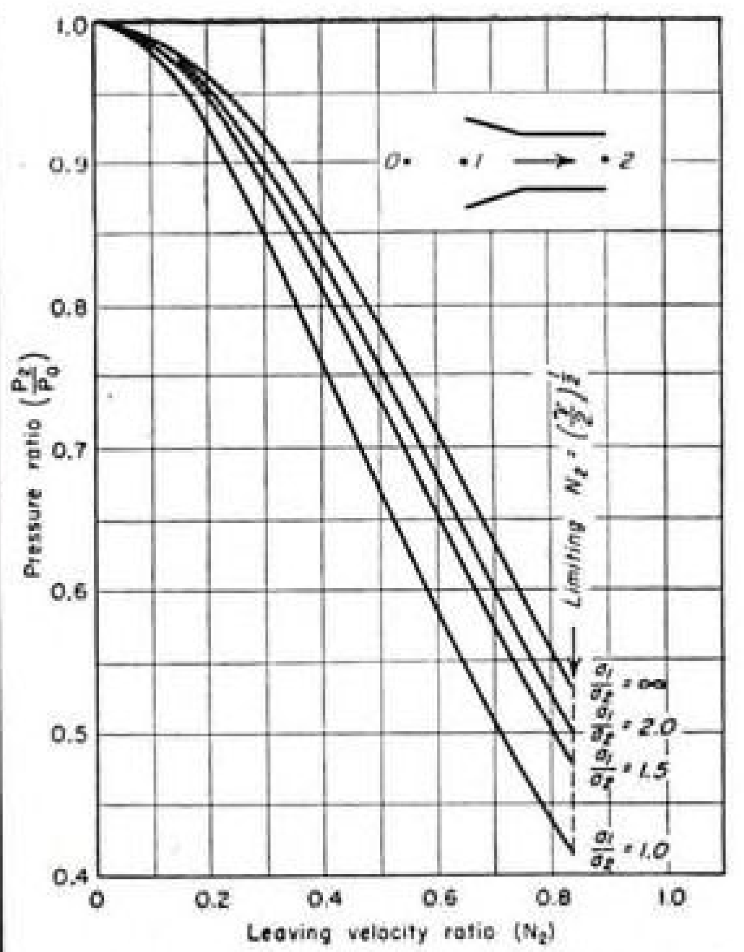


FIG. 6: These curves map the variation of exit velocity ratio with pressure ratio for various values of inlet and exit area ratios of a nozzle.

$$\frac{P_1}{P_2}\left(\frac{\gamma}{\gamma-1}+N_1^2\right)^{\gamma/\gamma-1} = \left(\frac{\gamma}{\gamma-1}+N_2^2\right)^{\gamma/\gamma-1} \quad (49)$$

The steady-flow equation

$$W = \frac{a_1 v_1}{V_1} = \frac{a_2 v_2}{V_2} \quad (50)$$

may be written as

$$\frac{a_1 N_1}{a_2 N_2} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma+1}{2\gamma}} \quad (51)$$

These can be combined to give

$$\frac{N_1}{\left(N_1^2+\frac{\gamma}{\gamma-1}\right)^{\frac{\gamma+1}{2(\gamma-1)}}}\frac{a_1}{a_2} = \frac{N_2}{\left(N_2^2+\frac{\gamma}{\gamma-1}\right)^{\frac{\gamma+1}{2(\gamma-1)}}} \quad (52)$$

Function of N_2 of (52) reaches a maximum value at $N_2 = (\gamma/2)^{1/2}$, so for any nozzle, a_1/a_2 the entering velocity ratio N_1 cannot become greater than that corresponding to an N_2 of $(\gamma/2)^{1/2}$.

Physically, this means that as P_o, the supply pressure, is raised, the pressure ratio across the nozzle and its approach will not exceed a value to produce this N_2. Further increases will only cause P_2 to rise.

Equations (49) and (51) can be solved in many ways, together with the space flow equation

$$P_o/P_1 = 1 + 2N_1^2 \quad (53)$$

One very useful form, Fig. 6, shows that the velocity ratio N_2 produced by an overall pressure ratio P_2/P_o depends on the area ratio a_1/a_2 of the nozzle. Also, it shows that the critical pressure ratio at which N_2 reaches a maximum of $(\gamma/2)^{1/2}$ depends on the nozzle design. It is small wonder that so many values of nozzle coefficients have been necessary in the past. The conclusions of Fig. 6 are well substantiated by tests.

Temperature Concepts. It has been the custom to assume that a liquid flowing from a region at pressure P_o removes with it an amount of energy P_oV_o per lb. However, it can be shown that with space flow

$$\frac{E}{P_oV_o} = \frac{1+N^2}{1+2N^2} \quad (54)$$

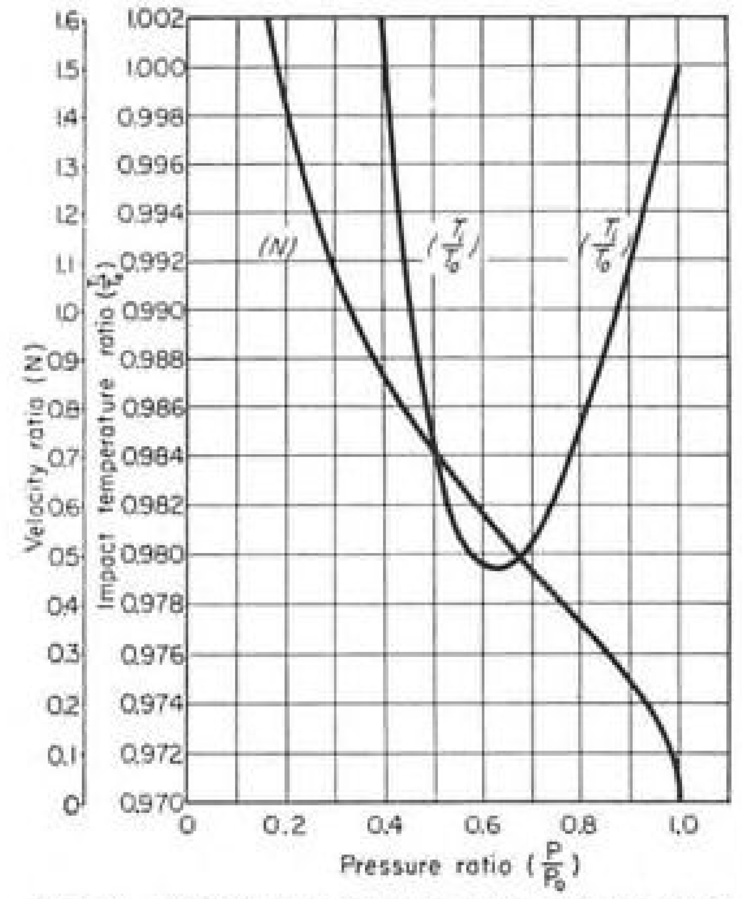


FIG. 7: Impact temperature ratio goes through minimum for air flow from space.

where N is the leaving velocity ratio. This varies from unity at an N of zero to a minimum of $E/P_oV_o = 2/3$ at the limiting leaving N of unity.

With ideal gases it has always been assumed that the energy removed per lb is

$$E = JCT_o + P_oV_o = \frac{P_oV_o}{\gamma - 1} + P_oV_o \quad (55)$$

or,

$$\frac{E}{P_oV_o} = \frac{\gamma}{\gamma - 1} \quad (56)$$

It can be shown that with space flow

$$\frac{E}{P_oV_o} = \frac{\frac{\gamma}{\gamma - 1} + N^2}{(1 + 2N^2)^{\gamma - 1/\gamma}} \quad (57)$$

This varies from a maximum of E/P_oV_o of $\gamma/(\gamma - 1)$ at a leaving N of zero to a minimum value of $[\gamma(1+\gamma)^{1/\gamma}]/[2(\gamma - 1)]$ at the maximum stable leaving-velocity ratio of $N = (\gamma/2)^{1/2}$.

Temperature concepts can be readily visualized in terms of energy equation (1).

The *static temperature* T measures only internal energy u and is not conscious of transmitted or kinetic energy. A stationary thermometer, which reads *impact temperature* T_i, is not aware of transmitted energy Pav, which can only be calculated.

Ratio of impact temperature T_i to original supply temperature T_o is

$$\frac{T_i}{T_o} = \frac{Wu + W\frac{v^2}{2g}}{Wu_o} = \frac{PV}{P_oV_o} \frac{\left(\frac{u}{PV} + \frac{v^2}{2gPV}\right)}{\frac{u_o}{P_oV_o}} \quad (58)$$

For space flow into a duct

$$\frac{T_i}{T_o} = \left(\frac{P}{P_o}\right)^{\gamma - 1/\gamma} \frac{\left[\frac{1}{\gamma - 1} + N^2\right]}{\frac{1}{\gamma - 1}}$$

$$= \left(\frac{P}{P_o}\right)^{\gamma - 1/\gamma} \left[1 - \frac{\gamma - 1}{2}\left(\frac{P_o}{P} - 1\right)\right] \quad (59)$$

Fig. 7 for air shows that with space flow T_i/T_o has a minimum value of .979 at a pressure ratio $P/P_o = 1/(3 - \gamma) = .625$ corresponding to $N = .546$. Fig. 4 shows typical experimental values and a comparison of calculated and experimental temperatures. The calculated temperature curve was reckoned from pressure curve and theoretical curve of Fig. 7. Classical thermodynamics assuming total temperature remains constant for all flow involves two misunderstandings:

First, it assumed that an amount of en-

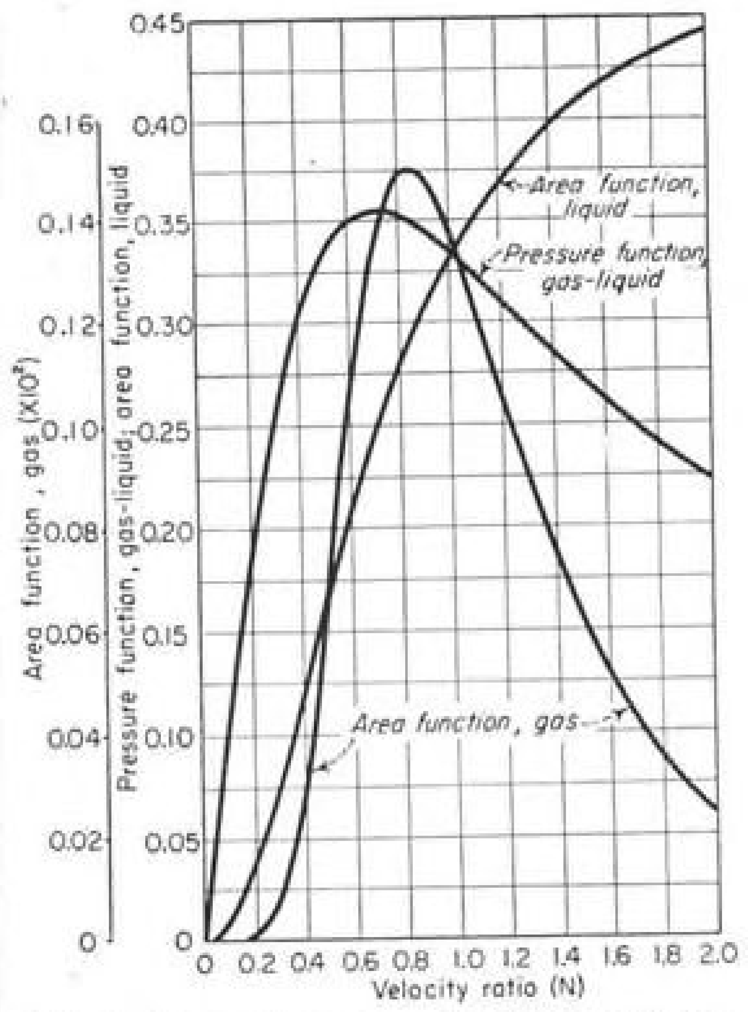


FIG. 8: Area and pressure functions vary like this for space flow of gases, liquids.

ergy $E/P_oV_o = \gamma/(\gamma - 1)$ always came from a space with each pound of gas. Actually, this can be as little as 0.94 at times.

Second, it was thought that the impact temperature measures total energy E. As shown by Fig. 7 and 4, it measures only kinetic and thermal energy and is unconscious of transmitted energy.

Space Flow of Fluids. When fluids in space already flowing at conditions 2 have to adjust to new conditions 3 as when leaving the nozzle of Fig. 5, it is again space flow at constant momentum.

$$\frac{W}{g} v_2 + P_2a_2 = \frac{W}{g} v_3 + P_3a_3 \quad (60)$$

For steady flow

$$W = a_2v_2/V_2 = a_3v_3/V_3 \quad (61)$$

Eliminating areas gives

$$\frac{N_3}{1 + 2N_3^2} = \left(\frac{P_3V_3}{P_2V_2}\right)^{1/2} \frac{N_2}{1 + 2N_2^2} \quad (62)$$

For gases this becomes

$$\frac{N_3}{1 + 2N_3^2} = \left(\frac{P_3}{P_2}\right)^{\frac{\gamma - 1}{2\gamma}} \frac{N_2}{1 + 2N_2^2} \quad \text{(gas-press. function)} \quad (63)$$

For liquids it is

$$\frac{N_3}{1 + 2N_3^2} = \left(\frac{P_3}{P_2}\right)^{1/2} \frac{N_2}{1 + 2N_2^2} \quad \text{(liquid-press. function} \quad (64)$$

Fig. 8 shows this space flow pressure function $N(1+2N^2)$ has a peak value at $N = (1/2)^{1/2} = .707$. From either Eq (63) or (64) it may be seen that a fluid flowing in space toward a lower pressure P_3 can do either of two things, depending on the initial N_2. If N_2 is less than 0.707, the flow will flow to the lower pressure at decreasing N_3. If N_2 is greater than 0.707, it will flow into the lower pressure with an N_3 greater than N_2.

If pressures are eliminated from Equation (63), the result for gases is

$$N_3\left(\frac{N_3}{1 + 2N_3^2}\right)^{\frac{\gamma + 1}{\gamma - 1}} = \frac{a_2}{a_3} N_2 \left(\frac{N_2}{1 + 2N_2^2}\right)^{\frac{\gamma + 1}{\gamma - 1}} \quad \text{(gas-area function)} \quad (65)$$

and for liquids

$$N_3^2/1+2N_3^2=(a_2/a_3)(N_2^2/1+2N_2^2) \quad (66)$$

(liquid-area function)

These area functions and the pressure function of (63) and (64) are shown on Fig. 8. By using these curves with their corresponding equations space changes of flow can be readily calculated. If N_2 is known, the appropriate function of N_2 from Fig. 8 can be multiplied by the appropriate area or pressure fraction to obtain the corresponding function of N_3. Thus N_3 can be picked off of Fig. 8. This procedure can be reversed.

Since the area function for liquids has no peak value, any space flow approaching a pressure region P_3 less than P_2 will continue to increase in velocity ratio if the original N_2 is greater than 0.707. If it approaches at less than $N_2=0.707$ it will decelerate into the lower pressure region. When accelerating, its area decreases and it receives energy from space. When decelerating, its flow area increases and it yields up energy to surrounding space.

This is the basic phenomenon of inlet cavitation of pumps. If the flow approaches the minimum pressure region of a blade curve at $N_2>0.707$, it will suddenly accelerate to a very low pressure. Typical tests[3] of $N_2=1.0$ flow attempting to pass around a $-12°$ turn show the absolute P_3 to go as low as 2 in. Hg.

With ordinary water supplies at normal temperatures when a pressure of much under 2/5 of an atmosphere is reached, air suddenly flashes out of solution. Once this process starts, violent surging occurs.[4]

When velocities are high in pump and turbine inlets, supercharging the inlet to a higher P_2 has the effect of decreasing $N_2^2=v_2^2/2gP_2V_2$ to a safe value.

Fig. 8 shows that the area function for gases, (65), increases up to $N=(\gamma/2)^{1/2}$ or 0.8367, and then decreases as N increases further. This means that, when gas flow approaches the rapidly changing section of an airfoil or compressor blade at a local $N_2>0.707$, space flow will accelerate with decreasing pressure and area until $N_3=(\gamma/2)^{1/2}$ is reached. When this point is reached further acceleration calls for an area reversal in space which terminates in discontinuity and unstable behavior.[5, 6]

This same effect also shows up in nozzles when the supply pressure P_o is raised above the critical ratio shown on Fig. 6. For the nozzle represented by Fig. 5, whenever N_3 exceeds $(\gamma/2)^{1/2}$, P_2 rises above P_3. Repeated tests[3] of such nozzles reveal visible shock diamonds soon after P_3 exceeds P_2.

When air at various values of N_2 above 0.707 is asked to pass around −6, −10 and −12 deg turns the same checks are observed[3]. In the range from an approach N_2 of 0.60 to 0.70 the flow is noisy, erratic and often unstable, but once the transition occurs little noise is present. Velocity and impact temperature traverses verify energy transfer inward from the outer stream tubes. Velocity near the surface increases greatly and decreases further out, and the same is true of impact temperatures.

1—Unpublished tests, ME Dept, Rensselaer Polytechnic Institute, 1951; p 836, *Theoretical Mechanics*, by Weisbach, Van Nostrand, 1882; p 364, *Mechanics and Engineering*, Vol 1, by Weisbach, Lea and Blanchard, 1848.
2—*Flow Stability in Small Orifices*, by R P Northrup, presented at Nov 30, 1951 annual meeting of American Rocket Society. 1951-52 unpublished tests in RPI ME Dept laboratories.
3—Unpublished tests of RPI ME-Dept 1951-52.
4—*Measurement of Turbine Vibration*, by J Parmakian and R S Jacobson, Paper No. 51-a-88, Nov 1951 annual ASME meeting.
5—P 368, *The Brown Boveri Review*, Oct 1950.
6—P 44, NACA *Technical Note 2251*, Dec 1950.

Highlights From IAS Conference

These digests continue AVIATION WEEK'S *presentation of subjects discussed at the 20th Annual Meeting of the Institute of the Aeronautical Sciences in New York, Jan. 28-Feb. 1. Other summaries appeared previously.*

Aircraft Design

▶ Some Aspects of the Aircraft Noise Problem. Harvey H. Hubbard and Leslie W. Lassiter, Langley Aeronautical Laboratory, NACA.

This paper presents some of the results of NACA research on the physical characteristics of the noise from various aircraft noise sources. Frequency spectrums and associated intensity levels are given for the noise from various types of propellers, jets, and rockets which are in use and being considered for aircraft propulsion.

Parameters significant in noise generation are evaluated; and the discussion includes the effects of tip Mach number up to 1.30, number of blades, and blade planform on the noise from propellers; and the effects on jet noise of nozzle size, exit gas velocity, temperature and density, and position of observer.

In addition, some existing information relative to the physiological aspects of the problem and some methods of protection from noise are discussed.

▶ **Reduction of Gun-Gas Explosion Hazard in Combat Aircraft.** J. J. Horan, J. R. Onderdonk, and E. Witkin, Aviation Armament Laboratory, U. S. Naval Air Development Center, Johnsville.

When the gas which propels a bullet from a gun is diluted with air, the resulting mixture may be exploded. An analysis was made of the circumstances under which such an explosion might occur as a consequence of gunfire in combat-type aircraft. The various sources of combustible gas and the manner in which the gas is diluted with air to produce an explosive concentration were studied. A system was designed by the NADC specifically for aircraft application to detect the presence of these explosive mixtures and to indicate the concentration of the combustible gases.

The system has been used to investigate gas concentration as a function of time and space, and appropriate calculations have been made to determine the pressures generated in the course of an explosion. Criteria have been established to define a dangerous condition in terms of the space distribution of the gas.

Techniques have been developed to reduce the hazard, and design criteria have been evolved to assist the aircraft manufacturer in new design.

Electronics

▶ **Radomes and Aircraft Design.** Ernest W. Schlieben, Supt., Control and Guidance division, Electronics Laboratory, Naval Aviation Development Center, Johnsville.

Radomes (radar housings) are dual function components; being at the same time part of the aircraft and part of the radar system.

Radomes therefore are the product of design of both aircraft and electronic engineers. Satisfactory radome performance is dependent upon recognition of the electrical, aerodynamic, structural and environmental requirements that comprise the design problem, judicious use of engineering compromise in cases where either aircraft performance requirements or electrical performance requirements cannot be satisfied fully without impairment to the other, and the fullest use of advanced theoretical design methods, materials data, and environmental performance data available in this restricted sector of aircraft design.

The paper describes briefly the effects of radomes on radar performance, design parameters of mutual interest to the electronics and aircraft engineer, and specific design data relating to materials and constructions for high temperature use, rain erosion resistance, icing protection, hailstone and gunblast resistance.

▶ Design Limitations on Aircraft Antenna Systems. J. V. N. Granger, Assistant Chairman, Engineering Department, Stanford Research Institute.

Modern civil and military aircraft are equipped with a large number of radio systems to provide for the vital operational functions of communication, navigation and control. In order that satisfactory performance be realized from these equipments, the associated antenna systems must exhibit characteristics which, in most cases, place severe limitations on size, configuration, and location of the antenna elements.

Since the antennas must be mounted on or submerged into the airframe, the antenna design problem becomes one of obtaining the required electrical performance from a configuration which is acceptable from the aerodynamic, structural and mechanical standpoints.

This paper translates the electrical performance requirements on the various antennas into terms which will clarify their relationship to mechanical and aerodynamic considerations.

▶ **Heat-Transfer Design Problems in Aircraft Electronic Equipment.** Leonhard Katz, Raytheon Manufacturing Co.

With the greater compactness of electronic equipment in aircraft the heat dissipation per unit volume has increased, resulting in large temperature increases inside the equipment. Special cooling systems had to be developed which could take care of this increased heat dissipation, not only under sea level conditions but also at extremely high altitudes.

Inasmuch as airborne electronic equipment operates over ranges of temperatures and air densities which are quite unique, very special problems are encountered in the cooling of aircraft electronic equipment which require special designs. Certain trends have been found which profoundly affect not only the aircraft electronic equipment but also the aircraft design.

Examples are shown of systems and components in which the weight and volume have been reduced by a factor of three by the proper application of cooling while still permitting operation at extremely high altitudes. The result of the new cooling theories indicates that the design of a centrally cooled electronic package is most efficient and will insure long life and trouble-free performance.

▶ Integrated Instrumentation for Modern Aircraft. Cmdr. Lynn S. Beals, Jr., (MC) USN, Director, Human Engineering division, Special Devices Center, ONR.

This paper deals with the inadequacy of bits-and-pieces approach to aircraft instrumentation development. Modern aircraft present an ever increasing complexity of inter-related problems pertaining not alone to instrument display, but equally to control, navigation, and special additional equipment required for unique aircraft missions.

The Special Devices Center recognized the need for a more integrated plan and initiated the development of a number of new instruments aimed at satisfying some of the fundamental requirements for a comprehensive information display.

In the light of new problems, however, it appears unwise to pursue our original plan that dealt primarily with the instrument problem alone. What is needed now is a planned program of development which puts instrument development in proper relation to the total flight problem.

Such a plan is described in terms of six basic elements, the applicability of which is demonstrated in several familiar areas. Finally a technique for applying this master plan is described in some detail.

The paper concludes with reaffirming the importance of an integrated approach to research and development on instruments, controls, aircraft, and Man.

▶ **Storm and Clear Air Turbulence, an Analysis of the Problem and a Search for Solution.** Frank C. White, ANTC Division, Air Transport Assn., and A. F. Merewether, Chief of Weather Services, American Airlines, Inc.

Some of the questions analyzed and answered:

How far can we fly in a modern, high-speed transport aircraft, in clouds of clear air, without encountering turbulence of sufficient intensity to spill the coffee or orange juice in our lap? How much smoother would the flight be in clear air than in clouds? Is high altitude flight in clear air plagued with frequent turbulence that cannot be detected? Can airline meteorologists forecast cloud and clear air turbulence?

▶ **Automatic Flight Control.** Captain James L. Anast, U.S.A.F., All-Weather Section, Flight Test division, Wright Air Development Center.

This paper discusses the additional requirements for improved automatic aircraft controls as a result of characteristics of modern aircraft. The advantages of automatic control are discussed along with some specific problems that have been encountered and the proposed solutions.

Rotary-Wing Aircraft

(Joint session in cooperation with the American Helicopter Society)

▶ **Helicopter Transmissions: Weight vs. Cost.** Thomas J. Harriman, Assistant Chief Engineer, Helicopter Division, Bell Aircraft Corp.

The conclusion of this study is that helicopter transmissions, while apparently far too expensive, require expensive materials and processes to achieve lightness. In fact, further refinement to save weight looks practical, even though first costs would increase. Many helicopter transmissions use lower unit loadings than those now considered common practice in automobiles.

The problem consists of two parts: (1) How much is one pound of helicopter empty weight worth? (2) How much does it cost to eliminate weight?

The worth of one pound is determined by the revenue that one pound of payload capacity brings in during the normal life span of the helicopter.

The cost involved in saving weight is attacked in two ways, along the lines of arrangement and refinement. The logical transmission arrangements for a popular sized helicopter, the 200 hp. class, are investigated for their effects on weight and estimated production cost. On the assumption that less fussy tolerances reduce allowable loadings, the decreased cost of cheaper materials and processes is compared to the increased size and weight of one typical arrangement.

▶ **Performance Data and Operation Experience of a Pressure Jet Helicopter.** Igor B. Bensen, Chief of Research, The Kaman Aircraft Corp.

The paper presents the results of an extensive evaluation study conducted on a pressure-jet helicopter, with particular emphasis on the thermodynamics of its power cycle. Operational experience, mechanical problems, and over-all performance of this type of helicopter jet-propulsion power plant are discussed.

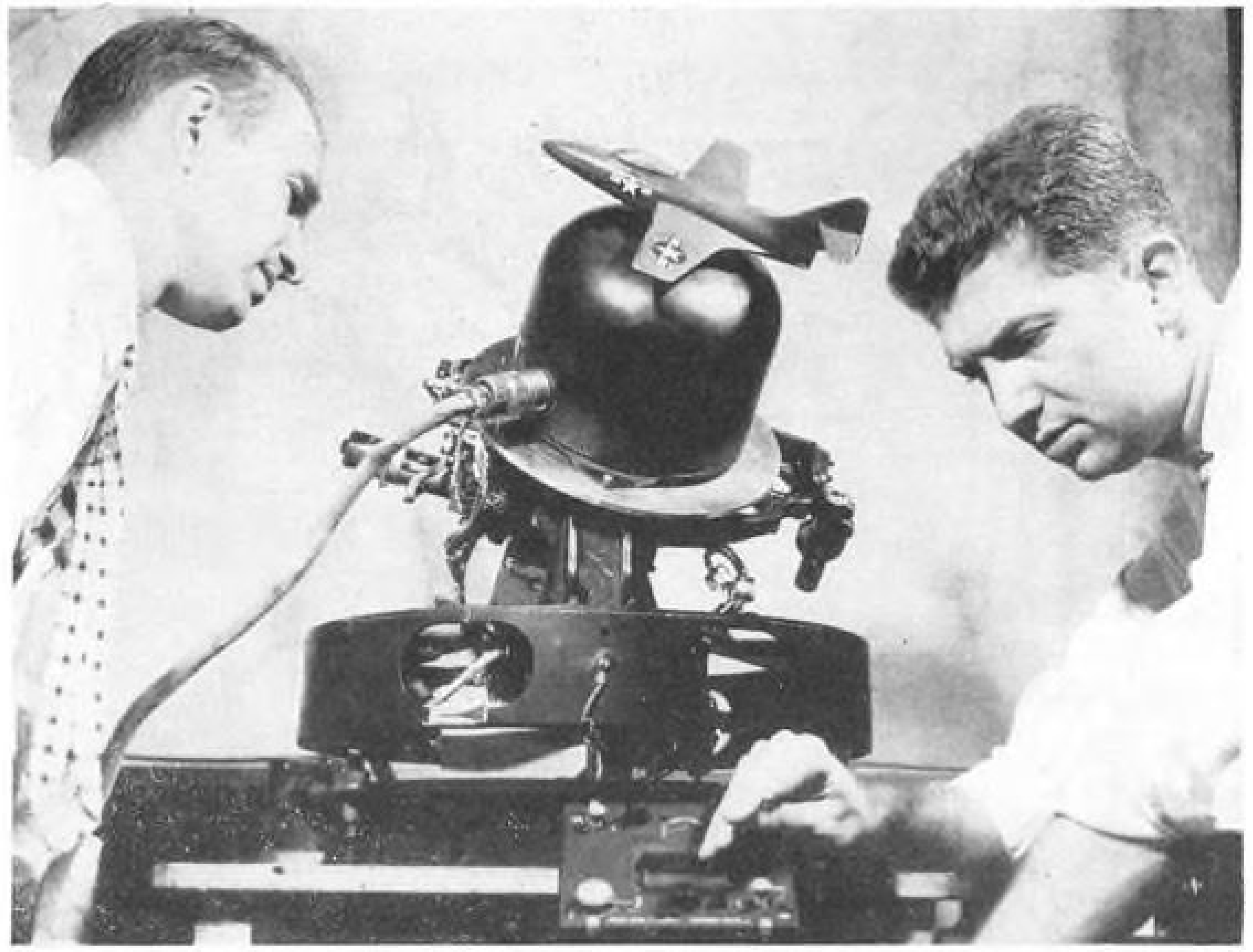
A captured German jet helicopter was subjected to a series of rigorous tests and measurements aimed at ascertaining the design parameters employed in it, their inter-relations and the relative importance of each parameter on the efficiency of the integrated rotor-powerplant combination. Part of the intent of the evaluation was also to verify the existing theoretical methods for predicting performance of this type of helicopter prime mover.

The measurements showed that the hovering performance was marginal and generally below the standards established in the helicopter industry, even at the time of its construction. The theoretical method, with some corrections, was substantially confirmed by the measurements of helicopter thermodynamic elements.

On the basis of data obtained, however, the pressure-jet power cycle shows great promise as the most efficient jet cycle proposed to date.

Pressure-jet rotors are also quite insensitive to variations of tip speed; this permits their operation always at optimum lift condition.

AVIONICS



FLIGHT SIMULATOR helps GE engineers check operation of highspeed autopilot.

New Autopilot Going on Navy Jets

GE-developed unit has many new features, including built-in yaw damper: tight stabilization claimed.

By Philip Klass

A new all-electric automatic pilot has gone into operational use in the Navy air arm with the assignment of the Douglas F3D-2 to Marine night-fighter squadrons. The new autopilot is also scheduled for use on the Grumman F9F-5P (photo reconnaissance) and the newly announced sweptwing Grumman F9F-6P, as well as the turboprop Douglas A2D attack plane.

Developed and produced by General Electric, working with the Bureau of Aeronautics, the new autopilot is called the Navy Type G-3. It is the Navy's answer to the previously announced USAF fighter-type autopilots developed by Lear and Westinghouse.

The G-3 announcement indicates Navy and Air Force agreement that flying, navigating, and fighting hot jet all-weather fighters is just too much for a single pilot. Automatic flight control equipment is a must.

▶ **New Features**—Weighing slightly more than the USAF's fighter autopilots (about 105 lb., uninstalled), the G-3 provides Navy fighters with additional automatic and control features. These include a yaw damper system for improving the plane's stability during manual flight, barometric altitude control, novel "level out," "maneuver-hold" provisions, wide-angle attitude of autopilot engagement, and others.

According to C. G. Yates, head of GE's autopilot development group, the G-3 maintains airplane heading within $\frac{1}{2}$ degree and attitude within $\frac{1}{4}$ degree in smooth air. This is in spite of the more difficult stabilization problem at high speeds. Like most postwar autopilots, the G-3 is self-synchronizing, relieving the pilot of the nuisance of trimming up the autopilot to airplane attitude before engagement.

The airplane can be in any attitude up to 75 degrees in pitch or bank when the autopilot is engaged. The autopilot then takes over and holds the airplane in that attitude until the pilot wants to level out. He does this by pushing a "level" button on his console controller. The autopilot then smoothly levels out the plane.

▶ **Maneuvering**—The pilot maneuvers his airplane while on autopilot using a miniature flight stick on his console controller. Pushing forward or pulling back on this stick dives or climbs the plane at a proportional angle. Deflecting the same stick left or right introduces proportional turns up to 65 degrees bank angle at any airspeed. During turns, the autopilot automatically introduces the necessary rudder for ball-centered turns and up-elevator to prevent loss of aircraft altitude.

The G-3's use of a miniature flight-stick to introduce autopilot maneuvers, in contrast with the knob or dial-type controller used in the Air Force fighter autopilots, involves some weight penalty for the G-3. However, BuAer feels that a fighter pilot is more accustomed to maneuvering his plane with a stick than with knob or dials.

A fighter pilot may want to place his plane in a steady climb, letdown, or other maneuver for an extended period of time. With his many other duties, he'd like to have both hands free. The G-3 has a "maneuver-hold" provision for that purpose. With his plane maneuvered into the desired attitude, the pilot momentarily pushes the "hold" button, releases the small stick, and the maneuver is "frozen" into the autopilot until changed.

▶ **Altitude Control**—An attitude (vertical gyro) reference is becoming less useful in maintaining level flight at today's high speeds. For example, a $\frac{1}{4}$-deg. gyro error in vertical determination could mean the loss or gain of about 500 feet altitude per minute in a 600-mph. airplane. This explains the trend toward using barometric altitude control to supplement attitude control in new autopilots. The G-3's barometric altitude control will hold the airplane at the selected altitude within plus or minus 25 feet at 10,000 feet, with proportional tolerances at higher altitudes, according to GE.

▶ **Yaw Damper**—The autopilot is never completely inactive, even during nonautomatic flight. The yaw channel is rigged to operate as a yaw damper to prevent any tendency of the plane to "dutch roll" while under manual control. The G-3 provides yaw damping in turns, as well as in straight flight.

Automatic turn coordination during manual flight is a by-product of the design, but can be easily overpowered if side -slip is desired.

▶ **Lead Time**—The G-3 is an example of the length of time required to develop and place complex avionics equipment in production, particularly where its performance ties in closely with airplane characteristics.

Initial development of the G-3 began in 1946, but was pointed toward the slower-speed reciprocating-engined fighters. Although the fleet did not then have a requirement for fighter autopilots, BuAer's Airborne Equipment section recognized the pending need and launched the development.

An experimental (XG-3) system was delivered in the summer of 1947, and tested on a Grumman F7F in 1948 by the Navy's Aeronautical Instruments Lab in Philadelphia under the supervision of GE's F. A. Gaynor.

By the spring of 1949, when BuAer indicated an interest in placing the G-3 in production, jet fighters were coming into the picture. The higher speeds and the maneuverability requirements of the jets resulted in the loss of some of the inherent stability of previous piston-aircraft. This in turn imposed more difficult stabilization problems on the autopilot design.

Flight tests of the XG-3 at Philadelphia, and later at Patuxent on a Lockheed TO-1 (F-80), pointed up desirable configuration improvements. For example, the XG-3 had used servo actuators which were engaged and disengaged by cables operated from a handle in the cockpit. The cable rigging problem from an unpressurized actuator location to the pressurized pilot's compartment was considerable. This resulted in changing to electric-solenoid operated clutches for engaging and disengaging the servo's output pulleys.

The increased jet speeds required the addition of barometric altitude control. Demands for improved attitude control dictated abandoning the XG-3's panel-mounted vertical gyro for a larger remotely located design. This raised new problems of erecting and controlling a vertical gyro to which the human pilot had no access.

Then in the spring of 1950, when delivery of the first production G-3s was only a few months off, BuAer asked for the addition of a yaw damper. This required the development of a new component, a rate-type gyro. By the time the first G-3s began to roll, there was not a single component which had not changed from its XG-3 configuration. However, General Electric's basic servo system approach, using tachometer (rate) generators and auxiliary servo loops remained unchanged.

▶ **Heading Intelligence**—The Navy Type G-2 compass provides the signals for aircraft heading stabilization. The G-2 is a compass-monitored panel-mounted directional gyro which is used as a flight instrument in most Navy planes. It combines the inherent advantages of a remotely located compass with those of a gyro. Thus it provides a drift-free heading indication (and signal) which is free of momentary disturbances of an ordinary compass. Compass monitoring is automatically cut off during turns when the device is used with the G-3. A small synchro within the gyro provides the heading signal for the autopilot.

▶ **Attitude Intelligence**—Pitch and bank stabilization signals are obtained from a remotely located vertical gyro with universal gimballing. The latter permits unlimited maneuvers in pitch and roll (under manual control) without danger

AUTOPILOT CONTROL by stick is preferable to knobs, BuAer feels, but knobs (1, 2 and 3 above) are still used for engagement, trim changes and altitude.

of tumbling the gyro and resulting loss of vertical reference. Although the gyro does not have 360 degrees freedom of movement in pitch, an ingenious design arrangement causes it to do a controlled "flip-flop" during an aircraft loop. The result is that the gyro's spin axis is approximately vertical when the aircraft comes out of the loop.

To prevent drift, the gyro is monitored by two pendulums within the gyro case. These detect the apparent direction of gravity and operate through two torque motors in the gyro to keep its spin axis vertical. Because of a relatively long time constant in the monitoring servo system, the gyro spin axis is not affected by momentary disturbances of the pendulums. During turns, when the pendulums would take up a false vertical position, the gyro is automatically cut free of the pendulum monitoring.

Because of its inaccessible location, the gyro's initial erection must be done automatically. Since the normal-operation erecting rate is slow (3-4 deg./min.), a fast rate of about 180 deg./min. is used when the gyro is first started.

▶ **Altitude Intelligence**—Signals for the barometric altitude control are generated by a sensitive-altimeter movement, vented to the static line, and driving a synchro through a solenoid-operated clutch. The synchro is spring loaded to center so that the unit is always ready for instant engagement.

▶ **Yawing Rate Intelligence**—A small spring-restrained rate-type gyro is used to introduce yaw rate (phase lead) signals into the autopilot. It has its gimballed element floated in liquid to relieve partially the bearing load and to provide damping. The gyro has a natural frequency of 20 cps. and a damping factor of about 0.6. These characteristics should permit its use on newer highspeed aircraft.

▶ **Turn Coordination Intelligence**—This signal is provided by a small pendulum-type accelerometer. The unit has dashpot damping and positions its suspended member according to the apparent direction of gravity. The unit is mounted in the same case as the rate-type gyro since both have certain mounting requirements relative to the plane's principal axes.

▶ **Pilot Commands**—The small panel controller which houses the miniature flight stick also serves as the command control station for the human pilot. It is located in the cockpit console and illuminated by indirect lighting. The unit contains the push buttons for engaging and disengaging the autopilot, engaging the altitude control, leveling the airplane, and trim knobs for small changes in heading or pitch attitude.

▶ **Control Amplifier**—This component might be called the "brain" of the autopilot. It contains the three main power amplifiers, one for each of the yaw, pitch, and roll channels, for operation of the servo actuators.

The unit also contains four identical "synch" amplifiers. Each of these control a small 2-phase a.c. motor used for synchronizing and to introduce maneuver signals into the main autopilot channels. Two identical vertical gyro erection amplifiers are also included.

All major amplifier units use miniaturized components and are constructed on quick-disconnect type of plug-in assemblies. As a result the G-3 will be the first Navy autopilot amplifier on which internal amplifier repairs will be attempted as a line-maintenance function. This is possible because of the ease of replacement of the major amplifier sub-assemblies. The amplifier also includes sequencing and time-delay circuits for starting the autopilot. Elsewhere in the amplifier are relays for switching to various modes of autopilot operation, as well as small safety interlock amplifier circuits and the plate power supply for the amplifiers.

▶ **Servo Actuators**—Control surfaces are actuated by three identical servo actuators. Each servo consists of a split-field series-wound d.c. motor driving a 3½-in. pulley drum through suitable reduction gearing. The unit also contains the solenoid-operated engaging clutch, and a synchro and tachometer to provide follow-up and rate-stabilizing signals.

Because the G-3 servo is the Navy's first electric autopilot actuator without at least emergency cable disengaging provisions, considerable effort went into the design to assure fail-safe operation of the disengaging mechanism. The servos are explosion-resistant (any explosion will be retained within the unit). This is a must since some of the servos are located near fuel tanks.

The servos were originally designed for higher output torques to assure tight autopilot control. The torque has since been reduced to approximately 150 inch-pounds (at the servo pulley) to permit easier pilot overpowering. The servo can be quickly disengaged by a push button on the pilot's console. However it is generally recognized that in the event of autopilot malfunction, the pilot's first reaction is to grab the main stick to get the aircraft out of a possibly dangerous maneuver. Hence servo over-power forces must be kept reasonably low, but not so low as to compromise performance.

▶ **Safety Provisions**—The increased complexity of modern autopilots, due in part to their many more automatic features, requires considerable engineering effort toward fail-safe design. According to General Electric, the G-3 amplifier is designed so that no tube failure (other than certain inter-electrode shorting) can cause the autopilot to place the plane in a dangerous maneuver. The more common type of filament failures will, it is reported, result only in slow drift of the plane or cause the autopilot to "go dead" in one or more channels.

When flying on barometric altitude control, a monitoring signal from the vertical gyro prevents the autopilot from calling for too sharp a climb or dive to maintain constant altitude. This provision is particularly desirable for flight in turbulent air.

The G-3 has been designed so that it can be placed in full operation without any pilot pre-engagement checks or duties, by pushing a single button. This simplicity of engagement has required the use of safety interlock circuits. They will prevent autopilot engagement if the amplifier hasn't had time to warm up, or the autopilot hasn't had time to synchronize, or the gyro has not had time to erect. Any system failure which might result in a "run-away" servo actuator at the instant of engagement is said to prevent the autopilot's taking control. Loss of a.c. or d.c. power, or low voltage in either source, will disengage the autopilot automatically, or prevent its engagement.

EQUIPMENT

FIRST of United's 40 new Convair 340s is shown in flight wearing Mainliner colors.

UAL Makes Major Engine Change

Maintenance shops boom as carrier converts its 230 P&W R-2800s from CA-15 to CB-16 configuration.

By George L. Christian

San Francisco—Business is booming at United Air Lines' maintenance shops here.

- **Scheduled seat miles** on commercial routes will jump 30% over last year. In addition, UAL expects to provide 6½ million seat miles for the Pacific Airlift.
- **UAL is adding 40 Convair** 340s to its fleet, at a cost of $23,117,000. The first is scheduled for delivery this month; the last in June, 1953.
- **An engine and prop** modification program—estimated cost over $2 million—is now underway.
- **Main overhaul base expansion,** costing about $1.5 million, will add a new hangar, engine overhaul facilities, larger ramp areas and three new run-up emplacements.

The airline will not substitute the 340s for all DC-3 operations at present, UAL officials told Aviation Week; some of the old workhorses will continue to fly United's colors to intermediate cities. The carrier has not yet made firm plans for the disposal of any DC-3s made surplus by the new fleet additions.

UAL expects an average 30% saving in time on the routes where the Convairs replace the DC-3s.

Powerplants

United is undertaking a sweeping powerplant modification, involving both the Pratt & Whitney R-2800 engine and the Hamilton Standard propeller.

The airline's maintenance shops here are converting 230 R-2800s from the CA-15 to the CB-16 configuration.

Primarily a blower change, UAL engineers anticipate these advantages from the modification:

- **Full power critical** altitude will be raised from practically sea level to 3,500 ft. This will make considerable difference at high altitude fields such as Denver, through which the carrier operates.
- **Low blower operation** will be used for much greater percentage of flight time. Reason is that the CB-16 engine can operate up to about 17,000 ft. in low blower. The CA-15 top low blower altitude is about 13-14,000 ft.
- **Altitude of shift** to high blower during climb will jump about 3,000 ft.

R. A. Young, UAL powerplant engineer, noted the economic aspect of operating as much as possible in low blower—fuel consumption increases some 4% when an engine is operated in high, power settings and altitude being equal, he asserted.

▶ **Consolidated Power**—UAL is now operating three R-2800 engine configurations:

- **DC-6s with dry R-2800CA-15** engines, used for short haul flights.
- **DC-6s with wet R-2800CA-15** engines, used for long, transcontinental operations.
- **DC-6Bs** with wet **R-2800CA-16** engines. These engines are operated wet to accommodate the aircraft's additional weight.

Object of the conversion program is not only to achieve operational benefits, but to have DC-6 and DC-6B engines standardized.

Simultaneous with the CA-15 engine conversion new Ham Standard, high-activity propeller blades (No. 6895) will also be installed on the powerplant. Combination of the CB-16 configuration and high-activity prop gives performance equivalent to the CA-15 engine, plus old style blade (No. 6873), plus water injection, Young claims.

Obvious result is elimination of weight and maintenance of the anti-detonant injection system without performance sacrifice. Moreover the short-haul, dry-engine DC-6s (which constitute about half of the entire fleet, according to Young), will have considerably better takeoff, climb and high-altitude performance because of the CB-16, high-activity prop combination.

Engine conversion, at an estimated cost of $1.2 million, should be completed by mid-1953, Young estimates; the $800,000 propeller changeover will last into early 1954.

All UAL DC-6 and -6B engines will be completely interchangeable with the soon-to-be-delivered Convair 340s, as a result of the conversion.

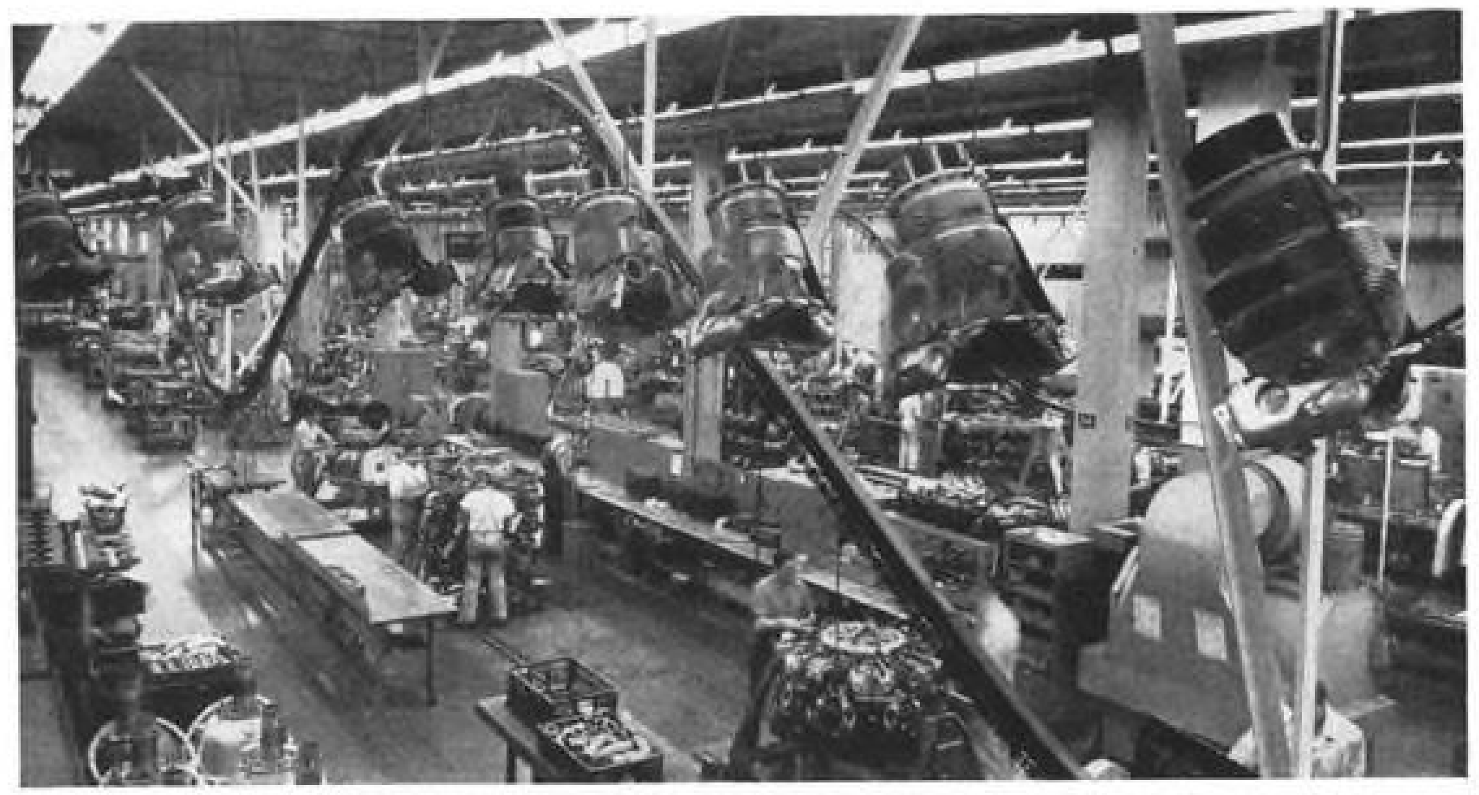
R-2800 engines are distributed this way in UAL's fleet: 43 DC-6s, 172 engines; 21 DC-6Bs, 84 engines; 40 340s, 80 engines; spares, 102; total, 438 R-2800s.

▶ **Powerplant Comments**—Young had these comments to make about various powerplant components:

- Great majority of engine parts are replaced "on condition." About the only exception is the piston pin.
- Thompson Products TPM valves are giving "incredible performance." In November, 1950, on a fleet of seven Boeing Stratocruisers mounting R-4360 engines, UAL experienced 209 unscheduled valve removals. A year later, after conversion to TPM, unscheduled valve removals dropped to eight. Benefits on the R-2800 engine have been comparable. To date not a single failure has been experienced on a TPM valve in the R-2800, Young said.
- Low tension ignition (R-2800) prototype installation has operated satisfactorily for one engine overhaul period. First production low tension system has been completed. From now on, all new engines installed on UAL DC-6s will be low tension-equipped. Entire conversion should be completed in about five months. DC-6Bs were delivered with low tension and Convair 340s to be delivered will come similarly equipped.

United engineers attributed these

UAL's big maintenance base at San Francisco includes such conveniences as this . . .



OVERHEAD conveyor system for cylinders in its modern engine overhaul shop.

advantages to low tension ignition: spark plug erosion rate for low tension is 30% that of high tension; spark plug removal rate on DC-6s will be 600 hr. A 400-hr. removal rate has been established for the DC-6Bs because of the increased power pulled from their engines. (UAL uses Champion R37S-1 plugs in all its engines except for the rear row cylinders of the DC-6B engines which mount BG RB27-R plugs.)

• Spark advance is going into UAL's engines. Engines now in overhaul are receiving first production installations of the Adel Precision Products system. For takeoff and climb, normal 20-deg. advance position will be used. This will be advanced to 25 deg. during cruise. Result should be a 4% saving in fuel consumption. Young translated this into a yearly economy of $500,000.

Other advantages from spark advance involve the engine exhaust system. Because of lower exhaust temperatures, UAL engineers expect better cylinder and exhaust valve guide life. And on the Boeings, the cooler exhaust should benefit turbosuperchargers.

• Concurrently with spark advance installation, United will undertake a modification program on the R-4360 Boeing engines, changing them from the TSB3G to the B6 configuration. This includes new crankshaft, crankcase and reduction gearing, new, simplified torque meter and low tension ignition.

• This employe suggestion is saving UAL $6,650 yearly; because the No. 1 cylinder on R-2800 engines failed at frequent intervals between engine change, the cylinder is now changed at mid-point. Unscheduled engine changes have been materially reduced.

Avionics

United Air Lines has long been an exponent of automatic pilots and associated equipment. The airline's DC-4s have been operating with the Sperry A-12 autopilot, automatic approach control and automatic elevator trim for the last five years.

▶ **Autopilots**—To evaluate competitive equipment, UAL ordered Eclipse Pioneer PB-10 autopilots delivered on its DC-6 aircraft.

E. P. Buckthal, electrical and instrument staff engineer, said UAL made a test installation of Bendix' automatic approach coupler labeled Flight Path Control, plus automatic elevator trim a year and one-half ago. The aircraft were already provided with automatic altitude control.

Although Eclipse Pioneer offered automatic airspeed control in conjunction with its automatic approach, UAL has declined it, at least for the present, according to Buckthal. The expense, added weight and maintenance of the equipment was not justified because of the limited time the component operates—only during IFR—Buckthal said.

FPC, however, can direct the aircraft on any VOR range, as well as orient it on the ILS localizer and glide path.

Six months after the initial PB-10 installation, UAL put a second unit in a DC-6. As a result of the performance of these two test units, the airline decided to go ahead with a fleetwide DC-6 installation of the PB-10.

Buckthal stressed that the instrument was fully CAA-approved. Hazardous aircraft maneuver rates caused by autopilot malfunction have been eliminated, he added, by imposing specific limits on servo motor torque output. These limitations encompass the approach coupler used during minimum approach altitudes.

The two DC-6s will continue service tests with the PB-10. Detail and final engineering of fleet equipment is almost ready for release. Installation is contingent on delivery of equipment. Target is to start putting in units in early summer, complete program by fall.

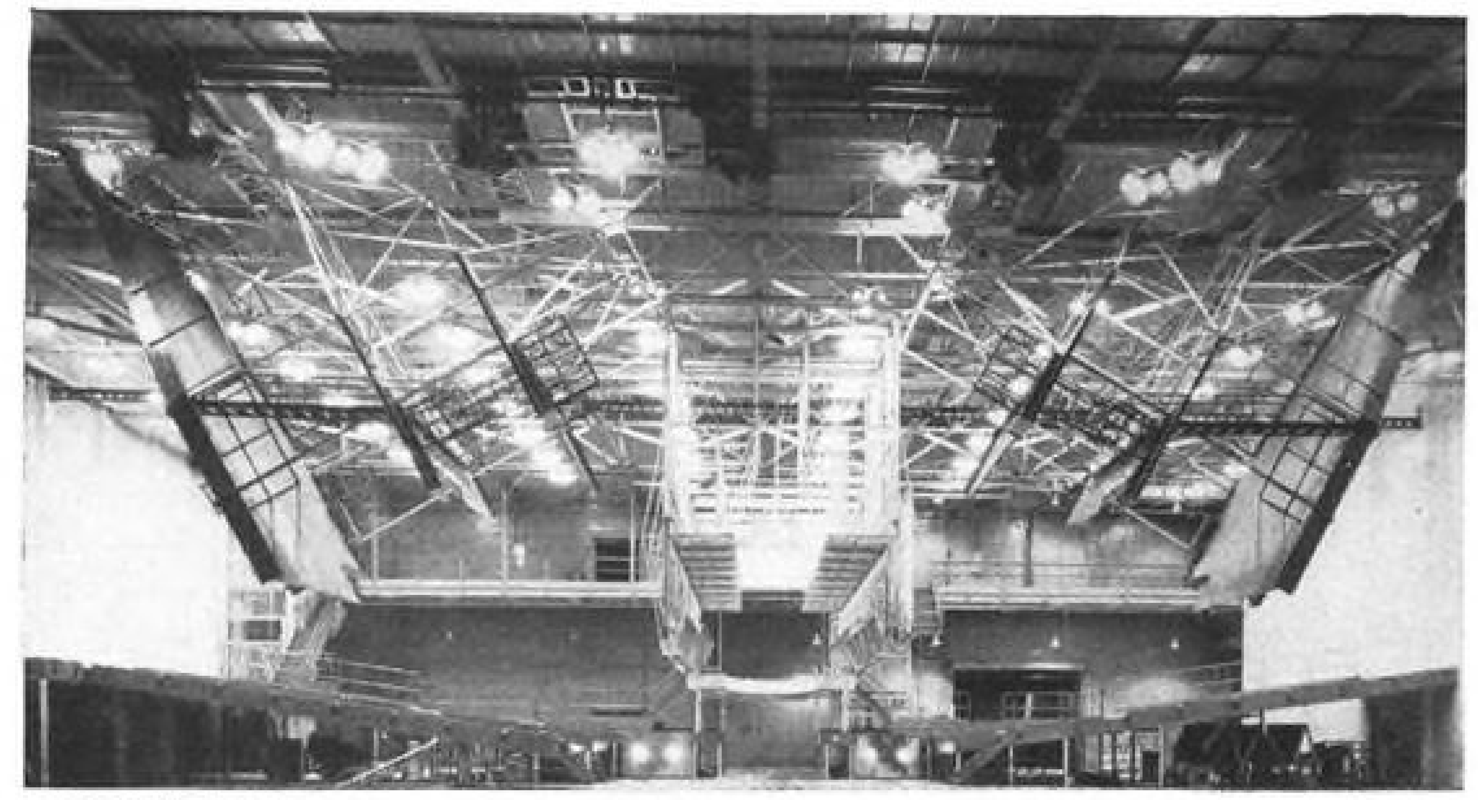
The A-12, with AAC, will go into United's Convair 340s.

▶ **Test Program**—When the decision to service test the Eclipse Pioneer PB-10 was reached, Eclipse and UAL assigned two and three engineers respectively to the job of flying the line continuously for two months to observe the autopilot's action. Several changes resulted from this intensive snooping.

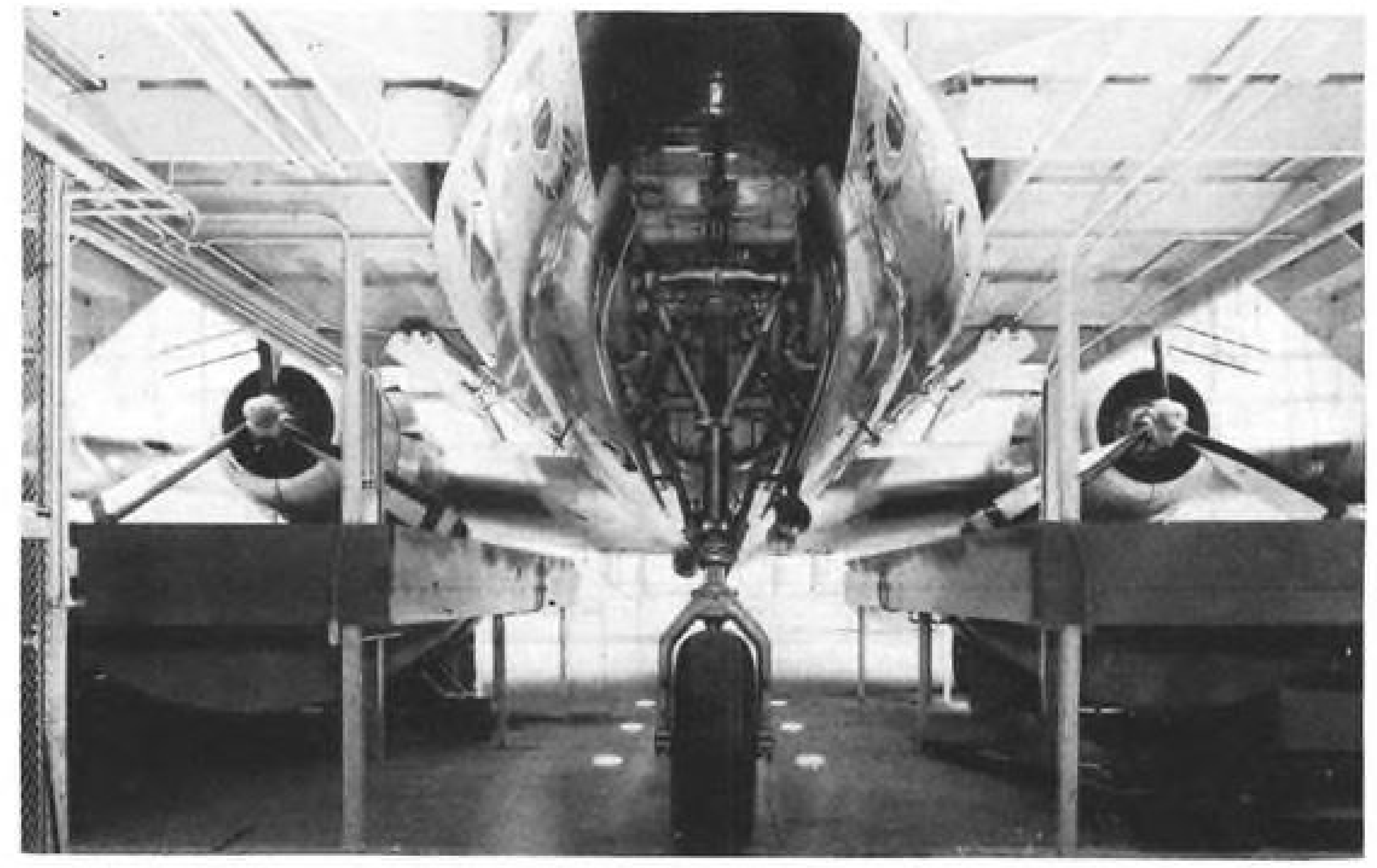
One direct result of this line flying program was an improvement suggested and incorporated by Pioneer. In comparing manual to automatic approaches, observers noted that under the latter condition pilots felt that the aircraft banked excessively and wingtips got too close to the ground for comfort.

Pioneer devised a method of reducing localizer sensitivity control by approximately 50% to reduce rolling moment. One of its spokesmen said that this would in no way affect the Flight Path Control's ability to keep the aircraft aligned with the runway since the plane has been securely "anchored" to the localizer far out from the field, prior to reaching the middle marker.

▶ **Preparing for Jets**—Underlying reason behind United's whole autopilot/automatic approach program, as expressed by Buckthal, is that jets will have to have them and automatic approach couplers too, since commercial jets will



MAINTENANCE framework for Mainliners is raised and lowered by a push button.



DOCK fits snugly against the plane and floor lighting eliminates shadows.

have little operating margin to miss one approach, if that. A fully developed autopilot system will be necessary also, because, as cruising speeds increase, landing times become a greater and greater percentage of total en route times.

Autopilot and associated equipment may not be absolutely necessary to operate current transports, Buckthal says—at least one major carrier has no autopilots, and a second is just starting autopilot installation in its fleet of four-engine aircraft—but, "you can't take a piece of avionic equipment as complex as an autopilot off the drawing board and stick it in a plane and have it give flawless performance from the first day. . . . It takes time and study and experience to develop the black boxes into a well-behaved, properly integrated family of mechanical and avionic components."

At the moment, United makes no distinction between minimums flown with or without approach couplers—its lowest minimum, Buckthal says, is 300 ft. Pilots may leave auto approach on for another 100 ft. of descent before switching it off and taking over manually. Next logical step, he points out, will be to reduce minimum ceiling to 200 ft. and cut off the coupler when the pilot becomes contact.

UAL engineers feel that work still needs to be done on the ground ILS system to improve it to the point where the entire air/ground system is operationally "perfect."

▶ **Economy Angle**—Autopilot operation saves money for an airline. Here is what a United captain, flying PB-10-equipped Boeing Stratocruisers on the San Francisco-Honolulu run has to say about the equipment: "I get approximately 7 mph. more on climb-out with a gyro-stabilized aircraft. At cruise, I have noted up to a 15-mph. increase in airspeed when the automatic altitude control locks the airplane in a constant pitch attitude preventing shallow dives and climbs which are inevitable when the ship is hand-piloted."

▶ **Flight Recorders**—United engineers claim that the carrier has had more experience with flight recorders than any other U.S. airline. It installed the Friez recorder over ten years ago and is currently using these recorders in the majority of its fleet of two- and four-engine aircraft.

UAL feels that the use of reliable flight recorders permits an accurate analysis of aircraft operating conditions, with the result of increased operating efficiencies. "A 1% increase can be translated into a lot of dough," UAL says.

The Air Transport Assn. is cooperating with UAL on its flight recorder program.

▶ **Weather Mapping Radar**—United's Convair 340s have provisions for weather mapping radar. A space has been left in the middle of the instrument panel. At the moment, the airline says that it has no idea whose equipment it will use, what the units will do, or how much they will weigh.

Engineers are, however, actively pursuing a program to improve radio altimeter functioning—primarily to eliminate false readings and simplify maintenance.

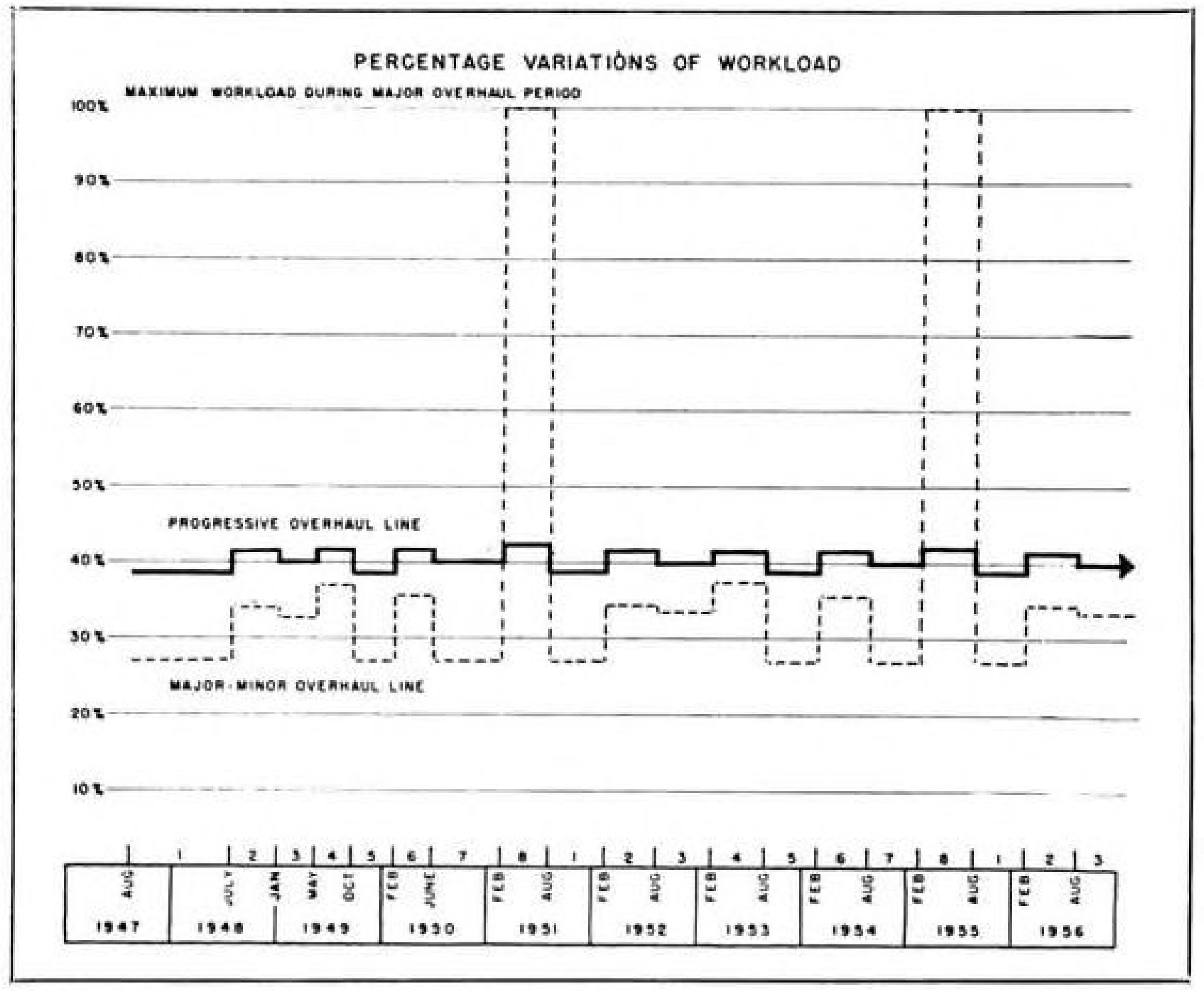
▶ **Tube Tester**—UAL's radio shop has developed a radio tube testing panel which has saved the carrier considerable money by reducing unscheduled removal of radio equipment, has noticeably improved life of the ARC-1 set and has practically eliminated open filament failures. Many scarce tubes were salvaged with the device. Principle of the tester is matching of tube filament resistances going into a single set. This assures balanced voltages across tube filaments connected in series, largely eliminating overheating and consequent failures.

▶ **Ignition Analyzers**—N. Davis, powerplant engineer, says United has settled on the Scintilla ignition analyzer for installation in its fleet of DC-6s, DC-6Bs and Boeing 377s, the DC-6B analyzers being for service test. Decision was based largely on price of the equipment, he added. Wiring installation engineering is now in progress.

Davis feels that the analyzers will be used primarily for trouble shooting and for preventive maintenance and periodic engine checks rather than as permanent airborne installations.

Mechanical

Unscheduled removal rate of General Electric turbosuperchargers used on the Boeing 377s has undergone a substantial reduction. Peak of about 30 per month in 1950 has skidded to a current 2 to 3 a month. Improvement was primarily due to induction system pressure checks, according to Davis. Elimination through pressure checks of large waste of turbosupercharger output through air leakage in the induction system was largely responsible for this welcome reduction, according to



UAL graph shows steady workload of progressive as compared to major-minor overhaul.

Davis. He anticipates further improvement in the unit's unscheduled removal rate as a result of reduced exhaust temperatures resulting from incorporation of spark advance on the R-4360 engine.

▶ **Spark Plugs**—UAL is overhauling its Champion plugs. And it continues to overhaul them until there is insufficient material left on either electrode. United's justification is economic: it costs 22¢ to overhaul a plug, including labor and overhead; a new plug costs about $1.60, says UAL engineers.

▶ **Anti-Skid Device**—United expressed considerable interest in anti-skid devices for its aircraft.

This is the program engineers outlined for service test and fleet-wide installation of the mechanism: Convair 340s will be delivered with provision for use of the Westinghouse Decelostat. Engineers anticipate making a prototype DC-6 installation in July, 1952, and possibly a fleet-wide installation on DC-6s, DC-6Bs, 340s and 377s in '53.

Which anti-skid device will be used on planes other than the Convair has not been decided.

These budgets have been set aside for anti-skid provisions: Convairs, $84,000; DC-6s, $96,000; Boeings, $24,000; total, $204,000.

▶ **Fuel Guage**—Minneapolis Honeywell fuel guages used on United's Boeing 377s came in for the highest praise from the airline's engineers and maintenance personnel alike. One engineer expressed his opinion this way: "The units give incredibly trouble-free performance." Mechanics on the floor confirmed his statement.

▶ **Reading Lights**—A new reading light is being installed in the carrier's DC-6s which will give more light and not require adjustment.

United Air Lines is squarely in favor of progressive maintenance as the most economical method of servicing commercial airliners, and has the figures to show why.

UAL claims for progressive that less manhours are needed to do given jobs, and more of the fleet is making money flying, instead of taking up valuable hangar space. United says that this servicing system reduces hangar requirements by two-thirds.

Other large carriers, such as Pan American, and smaller ones, such as Frontier, endorse the scheme, but Western Air Lines still sticks by periodic maintenance, and claims for it the same advantages UAL sees in progressive (AVIATION WEEK Jan. 7, p. 51).

▶ **The Difference**—Principal difference between the two plans is this: With progressive overhaul the peak work loads, otherwise stacked up at the aircraft's major overhaul period—usually 8,000 to 10,000 hr.—are lopped off and redistributed to fill up the low valleys of minor overhauls stretching between the major peaks.

After almost five years of experience with progressive overhaul, UAL says it has been able to "reduce labor costs, reduce facilities requirements, and have fewer airplanes out of service."

▶ **The Figures**—Specifically, United quotes these actual savings figures to back up its statement.

• "We have saved approximately 6% on labor during the first cycle of overhauls ended in July, 1951, and will save approximately 14% from that date on during the life of the fleet.

• "We eliminated the need for four hangars and docks at a cost of approximately $500,000 each, or a total of $2 million.

• "We have avoided the necessity of holding four additional airplanes out of service during the six-months' major period. To maintain our scheduled flight hours, we would have had to procure these four airplanes either by purchase or lease. The new cost of the DC-6 is approximately $1 million or a total outlay of $4 million. . . ."

▶ **Less Crowded**—Still another advantage of progressive overhaul is avoiding the typical congestion caused by large numbers of mechanics congregating in congested areas of the plane (cockpit is the classic example) and getting in each other's way to the point where work was seriously hindered.

Aircraft maintained under UAL's progressive overhaul system are 50 DC-6s, 23 C-54s and 6 Boeing Stratocruisers. The carrier's 56 DC-3s are excluded from the plan because of the imminent retirement of the aircraft (progressive overhaul pays off more the longer it is in effect) and also because the major overhauls are fairly well distributed.

▶ **Maintenance Analysis**—United has evolved a thorough, comprehensive and efficient system of maintenance analysis. Airline spokesmen cite these advantages: it points the finger at any offending component immediately, it quickly differentiates between a chronic aircraft, or a malfunction that is chronic on a fleet-wide basis.

As UAL expressed it, "The system is designed to flag out any accessory or system that does not function properly in the minimum time possible."

The maintenance analysis group monitors performance of equipment for unsatisfactory conditions. Corrective action required is reported through pilot's log or reparable tags on components involved in unscheduled removals. Tags show reason for removal, cause of trouble, repairs made. This information is posted on individual sheets by maintenance analysts. They have the responsibility of notifying the proper person or department (usually service engineering or an engineer responsible for a certain system) as soon as a malfunction or chronic condition is indicated.

Data posted on the sheet include: pilot's comment, mechanical corrective action taken, date, station, time since overhaul. A glance at the sheets reveal not only chronic offenders among aircraft components but also those that give trouble-free operation.

▶ **Irregular Replacement Chart**—A corrolary set of statistics to enable the airline to establish intelligent overhaul intervals of aircraft components is the Irregular Replacement Chart.

Kept on over 300 separate units per type of aircraft, the charts compile troubles, broken down by component, and show all types of malfunctions, cause of trouble, frequency and date of last overhaul. Number of irregular replacements per 1,000 hr. enables the analysts to plot a performance curve that is a realistic presentation of what is going on in the airline's fleet as far as component service is concerned.

Carried over a five-year span, the sheets readily reveal operating time at which troubles tend to become chronic on a certain component and also show the general trend over a five-year period. Monthly trends are also shown to permit rapid evaluation of equipment's performance.

Final tool used by UAL to keep track of its operation is Overhaul Period Analysis. This curve shows at a glance the optimum overhaul life of all components, and number of failures in 100-hr. increments of all components, including engines and propellers.

▶ **Morning Meeting**—Every morning, in United's large and modern engineering offices here, men of the manager level assemble in an engineering meeting. Purpose is to review the current list of "Pinkies" received from the Air Transport Assn. If anyone feels that any of the incidents is applicable to UAL in general, or his department in particular, he is assigned the job of further investigating the case and reporting corrective action.

Included in the meeting is a review and discussion of all incidents that occurred to UAL's fleet during the preceding 24 hours plus an exposition of any unusual events or problems that have developed in any particular department.

A counterpart of the engineering meeting is held at United's Operations Headquarters in Denver.

Tire Test By Sound

The British have come up with a new application of the beyond-sound realm. This time it is an ultrasonic tester to check aircraft tires.

Developed jointly by General Electric and Dunlop, the machine is designed to determine whether an aircraft tire which appears superficially sound is actually worth retreading.

The ultrasonic tester revolves the tire through a water bath. Ultrasonic sound waves, transmitted from inside the tire, are projected through the bath and are picked up by receiving crystals. A fault within the tire varies the transmitted signal strength.

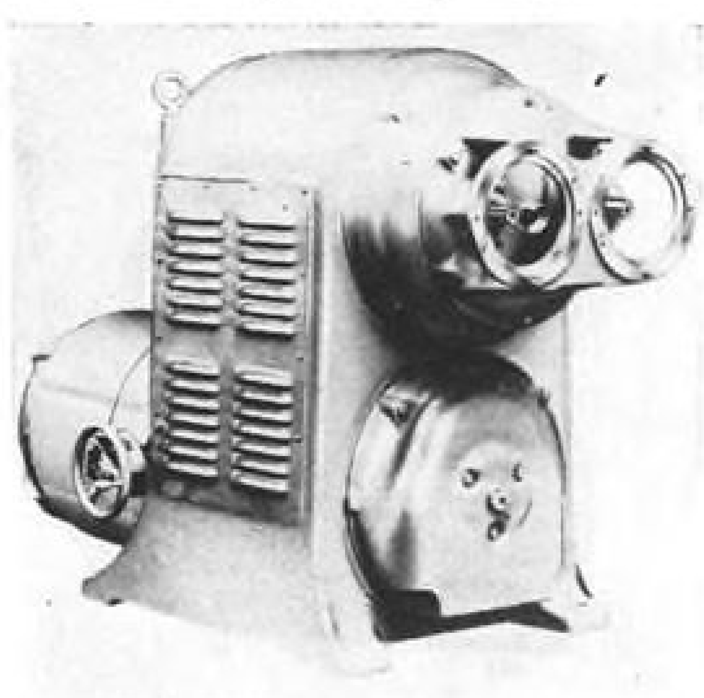
NEW AVIATION PRODUCTS

Flying Small Fry

Traveling with toddlers should be easier in Pan American-Grace Airways DC-6s now.

That's because these planes are being equipped with "Tour-A-Beds" for flying babes, according to the Kantwet Co. When baby wants to sit up, bed can be converted to seat. A safety belt secures it to the passenger seat so it won't slip off and every hinge on the collapsible frame has a safety lock to keep it rigid. Baby is supported in a heavy gage plastic envelope. The entire unit is easily carried by handles on the ends. The bed is priced at $8.98, is sanitary and easy to clean, Kantwet says.

Kantwet Co., Newton, Mass.



Accessories Tester

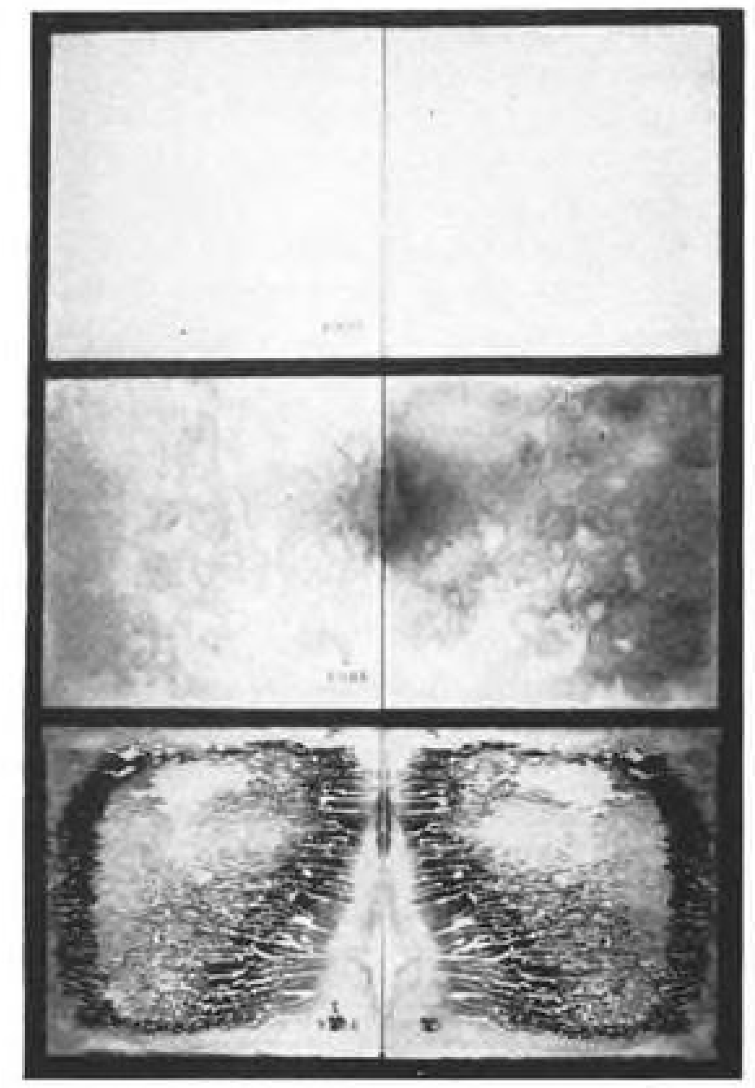
A new test stand for determining operating characteristics of aircraft engine-driven generators, vacuum pumps, magnetos, hydraulic pumps, compressors and other accessories, has been introduced by U. S. Electrical Motors, Inc.

The stand has two drive shafts permitting a wide selection of speeds. Ratio between shafts usually is 2:1, but this can be modified as desired.

For example, one particular unit, Type VEU-GSDT, has a highspeed shaft with a range of 1,950 to 10,800 rpm., and lowspeed shaft with range of 1,070 to 5,900 rpm.

Speed of the motor, delivering 7½ to 50 hp. continuously or 10 to 75 hp. intermittently, can be varied by turning a control dial. A tachometer gives direct rpm. readings for both drives.

U. S. Electrical Motors, Inc., 200 E. Slauson Ave., Los Angeles 54.



Protects Aluminum

A new specially treated tissue paper which prevents water staining of stacked aluminum sheets, has been developed by the division of Metallurgical Research of the Kaiser Aluminum and Chemical Corp.

The product, being produced by a number of paper manufacturers, is impregnated with a chemical inhibitor which also prevents abrasion. Flat sheet delivered to the production-line retains a clean, new appearance, unmarred by the discoloring prevalent in sheet warehoused without any protection or that sometimes appears on stock protected only by conventional interleaving tissues, according to Kaiser. This is illustrated in the picture above, showing completely unprotected sheets (top), sheets protected by ordinary interleaving paper (center), and stock interleaved with the new chemically-treated tissue (bottom).

Kaiser points out aluminum that gives good weathering performance and isn't stained by moisture outside, still is subject to this type of corrosive attack in the warehouse.

Kaiser Aluminum and Chemical Corp., Oakland 12, Calif.

FINANCIAL

Another Good Year Coming Up

Industry and transport will be humming, but carriers will not do as well as manufacturers, Value Line says.

A look into the future for aircraft and airlines is again attempted by Value Line, an investment advisory service. Continued optimism prevails as to the sales and earnings prospects of the two groups.

▶ **Manufacturing View**—In viewing the aircraft manufacturers, Value Line declares: "Production of planes is likely to accelerate considerably this year, particularly in the second half, and wide gains in dollar volume are indicated. Special expenses in connection with preparation for production of current models were widely absorbed in 1951 income accounts. **The maximum tax rate (to which most of these companies will be subject) will only be a shade higher than in 1951 (70% vs. 68%). Thus, earnings comparisons in this group promise to be favorable throughout 1952."**

Looking at longer term trends the advisory service further asserts. ". . . Regardless of intermediate business trends, this industry should be kept humming at the highest levels of production since 1941-1945 on the strength of government orders. . . . Profit margins on military planes are traditionally low and production schedules are frequently subject to costly rearrangement and modification as military planners shift their emphasis, introduce engineering refinements, etc. Yet, the fact remains that a large number of aircraft will be produced over the next four years. These companies can be expected to report large sales and satisfactory earnings.

"Furthermore, heavy excess profits tax payments in the current period (most companies will be in the 70% maximum bracket) will provide these companies with 'money in the bank' to draw on when business slackens off."

▶ **Transport View**—An appraisal is also made by Value Line of the air transport group. While an optimistic viewpoint prevails as to the outlook of the air carriers, it is tempered with a conservative note.

"Further gains in revenues and earnings are in prospect this year," Value Line states, "but it appears doubtful that comparisons on a percentage basis will be as favorable as in 1951. Costs have risen considerably in recent months. The rate structure is deteriorating as air coach services are rapidly extended. With most carriers now approaching maximum use of existing equipment, the leverage factor which took hold so spectacularly in 1951 can no longer be relied upon to the same degree.

"From this point forward, installation of additional equipment will be a more important determination of revenue gains than the boosting of load factors (now at the 70% level) on planes already in service. Thus, revenue and earnings progress may be at a slower rate."

▶ **Down the Line**—The Value Line also appraises the position and outlook of each of the 15 aviation companies it normally evaluates in its regular service. The significant observations on the companies involved follow:

• **Boeing.** 1951 earnings are now estimated at $5 a share on sales of $325 million . . . A contributing factor in the 1951 earnings decline was the fact that the B-47 program is on a fixed-price basis whereas previous government work was on a cost-plus-fixed-fee arrangement. (Under cost-plus accounting, a proportionate share of the fee is recorded as income while work is in progress. Under fixed-price accounting, income is not reported until planes are delivered.) . . . While 1952 sales may not show quite so wide a gain as was first thought likely, due to the rescheduling of production throughout the industry, earnings are nonetheless likely to recover sharply from the indicated 1951 figures.

• **Curtiss-Wright.** The company's J65 Sapphire jet engine will attain larger scale production in 1952. Jet engines have proved one of the serious bottlenecks in the aircraft rearmament program, so that Curtiss-Wright should enjoy a clear field in boosting production of this engine. . . . The replanning of the aircraft procurement program is not an important consideration for this company which specializes in aircraft engines rather than in airframes.

• **Douglas.** Sales and earnings last year were held back by a long strike in the final quarter. As a consequence, earnings are estimated to have been only $5.25 a share, somewhat below the fiscal 1950 figure. . . . A moderate reduction has been made in 1952 sales and earnings estimates to $300 million, or $8 per share, because of the rescheduling of the aircraft procurement program now under way. However, the company's production is not expected to be seriously affected.

• **Grumman.** Although sales increased sharply (about 70%) in 1951, per share earnings were relatively unchanged from the 1950 level. Reasons: (1) heavier tax accruals under provisions of the Revenue Act of 1951; (2) a slightly narrower profit margin due to tooling up costs in preparation for mass production on government contracts. . . . Production is accelerating and fourth-quarter 1951 volume is believed to have been the best for any three-month period in many years. Dollar volume in 1952 is expected to rise to about $250 million.

• **Lockheed.** Operations in 1951 were hampered by difficulties in obtaining component parts and, particularly, by a shortage of aircraft engines. As a consequence, production was not accelerated so rapidly as had been expected earlier. Sales for the year approximated $235 million. Heavier taxes and large make-ready expenses are estimated to have reduced earnings to about $3 a share. . . . A sharp recovery in earnings is visualized this year. The company is coming into a period when it will make substantial deliveries of Constellation airliners to Eastern, TWA, and several other operators.

• **Martin.** If financing arrangements can be completed, Martin will face the future with a huge carry-forward tax credit and a backlog of military contracts aggregating about $350 million. If production against these contracts is accelerated at a good rate, substantial earnings can be generated under the tax shelter in a relatively short period of time once the loss on the 4-0-4 program has been written off.

• **North American Aviation.** For the fiscal year ended Sept. 30, 1951, earnings were stated at $1.87 a share on sales of $179.4 million. While volume was at the best level since the World War II period, earnings were held down by an uneven flow of materials and component parts, expenses in connection with tooling up for increased production on government contracts in fiscal 1952, and heavier income tax liability ($8.8 million vs. $5.6 million in the preceding year) . . . Although the rescheduling of the aircraft procurement program has resulted in a slash in the monthly production peak on the company's T-28 trainer, the main production model, the F-86, Sabre, has not been seriously affected.

• **Republic Aviation.** While there has been no indication as yet that the rescheduling of the military aircraft procurement program has affected schedules at Republic, it is conceivable that production of the Thunderjet will be cut back somewhat. Furthermore, there have been delays in the processing of the new F-84F. Indications now are that this plane, the successor to the present Thunderjet, may not be ready for production as early as had been hoped. This may be significant for the longer term, because continued advances in the aeronautical art by other companies serve to undermine the strategic position of the company's present model.

• **United Aircraft.** This company is not likely to be seriously affected by the current rescheduling of the military aircraft procurement program. Powerplants have proved the chief bottleneck in acceleration of aircraft production. As a major manufacturer of aircraft engines, United can be expected to attain production schedules previously established if flow of raw materials and parts is satisfactory.

• **American Airlines.** Prospects in the new year, while extremely favorable from the standpoint of continued traffic and revenue gains, are more uncertain at the net income level. The spread of coach service will depress the company's unit revenues at a time when operating costs in general are rising substantially. However, the

$15 million gain in dollar revenues which is foreseen is expected to enable net earnings to show a satisfactory increase despite the pressure on profit margins.

• **Eastern Air Lines.** Eastern Air Lines had a highly successful fourth quarter last year; so good, in fact, that it catapulted the company into the excess profits tax bracket. The effective tax rate for 1951 was almost 60%. Indicated profits of about $3 a share were almost 40% above the record 1950 figure. . . . Airline traffic has shown an outstanding long-term growth trend which is expected to persist in 1952. Eastern is in an especially favorable position to capitalize upon the heavy volume of traffic because it has recently received and installed the initial complement of its new equipment—Martin 4-0-4s and Lockheed Super-Constellations.

• **Northwest Airlines.** A satisfactory further increase in gross revenue in line with the general growth in airplane travel is expected. The increase in earnings promises to be small. Wage, fuel and material costs have increased considerably in recent months and profit margins are under pressure. . . . Northwest has an adverse equipment situation in that its competitors have already installed and will continue to accept delivery of the most modern equipment (DC-6s, Constellations, and Convair-Liners) while Northwest continues to rely on DC-4s and DC-3s to supplement its ten Boeing Stratocruisers.

• **Trans World Airlines.** The outlook for earnings in 1952 is clouded by some uncertainty. Like its competitors, the company faces a profit margin squeeze due to a deteriorating rate structure and rising labor, fuel, replacement part and other costs. . . . CAB has ruled that the company has been overpaid $4.8 million during the past five years for carrying the mail on its international routes. These revenues have been included in past earnings reports and therefore presumably will now have to be deducted from current and future earnings.

• **United Air Lines.** United is broadening its air coach activities in keeping with current CAB policy that this type service be extended as rapidly as possible. 1952 should be a big air year. With United fully participating in the movement, the company should show a wide gain in revenues to perhaps $140 million. It is not likely that the revenue gain will be translated into a corresponding increase in net earnings.

(The opinions reviewed are those of Value Line advisory service and not necessarily those of this writer. Neither the writer nor AVIATION WEEK *stands sponsor to or endorses the service.)*

—Selig Altschul

Airline Programs Backstop Air Evacuation

- **Four carriers complete test projects to pave way for modification of planes to military airlift standards.**
- **And one change will fit planes for air evacuations hailed as military medicine's greatest advance.**

Government and airlines have finished their pilot program to find out what it will cost in dollars and effort to modify a sizeable part of the civil airline fleet to meet emergency airlift needs of the military.

TWA last week finished modifying a Constellation; Pan American World Airways has finished its DC-4; United Air Lines its DC-6 and Northwest Airlines its Stratocruiser.

Data on all four planes now will be studied by government officials before work is authorized on the approximately 60% of the airlines' four-engine transports that have been designated as the first and second-line airlift reserve.

The modification, while minor in its effect on the airplane structure—consisting chiefly of provision for installation of additional navigation and communication equipment—is major in its effect on an important part of our military airlift. For one significant modification is installation of brackets to hold litters, making it possible to use the planes for air evacuation.

And doctors throughout all military services have hailed air evacuation of wounded, sick and injured as the greatest purely military advance in treatment of casualities.

▶ **More Than Military**—Actually, air evacuation is more than a purely military advance. It has enormous humanitarian benefits and propaganda value for air transport.

• **By order of the Joint Chiefs of Staff** no incapacitated U. S. military personnel outside the United States will be brought home by ship. Since Nov. 1, 1949, air evacuation has been required, and the Military Air Transport Service is the agency. Within the U. S., all Korean casualties are moved by air.

• **No patient has been killed** during air evacuation operations, and nearly 50,000 have been flown back from Japan/Korea alone.

• **Patients are hospitalized** nearest their homes where visits from families and friends give a psychological boost to their recovery. Air evacuation makes it possible to scatter military hospitals throughout the country, rather than near sea coasts, and even to lodge military patients at civilian hospitals when desirable and possible.

• **No civilian doctor shortage** is regarded as likely in case of another world war. Air evacuation reduces the required number of doctors in the armed forces from about 5.7 per 1,000 military personnel to about 3. In addition, civilian specialists can continue to practice at civilian hospitals and military patients be brought to them. Air evacuation planes, except in rare cases, do not carry doctors—only medical attendants and flight nurses. Hospital ship transportation of patients requires 21 times more medical personnel.

• **Mortality rate** from within Korea is less than one-half the rate experienced in World War II. Doctors say that three factors are responsible—better forward aid stations and use of plasma; "miracle drugs," and air evacuation—and the most important of these is air evacuation.

Distilling those facts down to two outstanding impressions, those who are familiar with air evacuation say it has proved that the airplane is the safest and most comfortable method to move the sick as well as the healthy. And the airplane, a symbol of death and destruction in its military phases, has been adapted by the military as a savior.

▶ **Airlift**—Prior to the outbreak of war in Korea, MATS monthly patient load from Japan to the U. S. was about 300. In the last seven months of 1948, MATS moved 12,000 patients worldwide and within the U. S. In 1949, the number of patients totaled 22,000. In 1950, the patient load, including Korean casualties, jumped to 40,250. In 1951, the number of patients was 53,408.

Except for about 1,000 casualties sent back to the states by ship by mistake, all Korean casualties returned to this country have been evacuated by air. In the peak month, December, 1950, 6,352 were moved. In one day of that month, 448 patients from Japan were landed in the U. S., and Brig. Gen. Wilford F. Hall, MATS surgeon who directs air evacuation says more could have been handled.

The latter part of that statement is one of the outstanding characteristics of air evacuation. It is probable that there will never be a shortage of space for air evacuation. Air evacuation from Korea now is using less than half the available space on planes which are returning to the states.

▶ **Logistics Simple**—The space available for movement of patients always will be determined by the airlift to the combat theater. And it is this fact that makes Dr. Hall and other doctors so gratified with the activation of the transport mobilization plan as it pertains to modifying the airline planes. If each plane flying cargo to the theater can be quickly adapted to haul patients back, there will be no problem about enough space for patients.

The logistics of air evacuation are simple and startling.

A hospital ship can accommodate 300-500 patients. It will make a roundtrip across the Atlantic in about 30 days; across the Pacific in about 40 days. Five C-97s can do the job of six 500-bed hospital ships in carrying 3,000 patients from the Far East in the same period of time.

A C-97 carries 65 patients. It can be dispatched when that number of patients is at hand, instead of waiting for several hundred. It can be sent by any route, either over land or water. More frequent trips and smaller number in each reduce the requirement for beds at embarkation and debarkation points by 50%.

▶ **Base Hospitals**—Yet, the investment in hospital ships in the Korean campaign are floating base hospitals—generally far better equipped and staffed than any land base hospital and with the additional benefit of mobility.

The air evacuation system in Korea is supplemented by the great contribution of the helicopter. A typical case might be: A wounded soldier is picked up by helicopter on the battlefield and flown to a hospital ship. His wounds are treated and it is determined he will be out of action for 90 days because of them.

He is taken by copter again to a Korean airfield, flown by C-47 to Japan, put aboard a four-engine plane and landed less than 24 hours later in Hawaii. He stays overnight there and the next day a plane takes him to California. He is either off-loaded at Travis AFB or, if on a C-124 or C-97 may fly direct to San Antonio from Hawaii. Either at Travis or San Antonio he is re-routed by C-47 to a hospital in the interior.

So fast, so efficient is the air evacuation system that Maj. Gen. Harry G. Armstrong, USAF Surgeon General recently told the 52 Assn. in New York City of an officer who left Travis, was flown to Korea, fought 40 minutes, was wounded, and was back at Travis six days after he had departed that field.

Capital, NWA Plan To Keep All Routes

Industry reports that Capital Airlines might sell its southern routes to Delta Air Lines are flatly denied by a Capital spokesman.

Capital and Northwest Airlines will keep all their present routes when they merge, a Capital spokesman says. And Capital has not negotiated with Delta or any other line for sale of its routes, he adds.

The present Delta-Northwest merger application is contingent on acquisition of a linking route between the Northeast and Delta systems, preferably New York-Atlanta. This fact has led to some speculation that Delta might try to buy Capital's Route 55, or merge with National Airlines.

But Capital considers its New York-Atlanta route (on Route 55) as one of the best and has no plans to sell it, the company says. And Capital and Northwest believe Capital's southern route system is a growing money-maker. It also will help offset the winter slump of the northwestern part of the Northwest-Capital system, the two managements believe.

Price for a sale of Capital's southern system therefore would be so high that no airline would be able to try it, the Capital spokesman indicated.

Connie Flies Nonstop Sidney to Singapore

Lockheed Aircraft Co. has announced that Qantas Empire Airways, Ltd. Model 749 Constellation recently made the first nonstop flight in the history of aviation from Sidney to Singapore.

Piloted by Captain Jackson, the "Lawrence Hargraves" took off from Sidney at 1315 GMT Feb. 4 and landed at Singapore at 0500 Feb. 5. The 15.45 hr. flight covered 3,939 statute miles, Lockheed spokesmen declared.

AIRPORT SAFETY will be the aim of a special commission recently appointed by President Truman. The President is shown explaining the project to Lt. Gen. James H. Doolittle (seated right), chairman; CAA Administrator Charles F. Horne (standing right), a member, and S. Paul Johnston, executive secretary and staff director of the commission Dr. Jerome C. Hunsaker, NACA chairman, is third member of the commission.

Airport Safety Study Under Way

Lt. Gen. James H. Doolittle, chairman of the special Presidential Commission on Airport Safety, announced last week that the main efforts of his commission will be to provide for "the safety, welfare and peace of mind" of residents near airports. U. S. defense needs will be considered, too.

Doolittle made it clear that he's confining his task strictly to airport planning—not to general air safety. "I desire to emphasize that this commission has not been directed to investigate accidents but will, of course, consider statistical analyses of those which have occurred so that it can formulate a sound airport development policy for the future," Doolittle said.

Doolittle announced that the working staff of his commission would be: executive secretary and staff director—S. Paul Johnston, director of the Institute of the Aeronautical Sciences; other staffers—Philip A. Hahn, CAA Office of Airports; A. D'Arcy Harvey, CAB economist; John W. Crowley, Jr., associate director for research of NACA; Capt. W. P. Cogswell, BuAer; and Col. Ross Milton, USAF.

The other two members of the three-man Doolittle Commission are CAA Administrator Charles F. Horne and Dr. Jerome C. Hunsaker, chairman of the NACA and head of MIT's aeronautical engineering department.

Dr. Jerome C. Hunsaker

▶ **Hearings Not Public**—Hearings of the commission will not be public.

Doolittle says he has no idea whether Newark Airport will be reopened. (Meanwhile, Commerce Secretary Charles Sawyer said last week that Newark Airport would re-open "fairly soon on a restricted basis.")

Doolittle also pointed out that jet aircraft operation at airports will be an important part of the commission's study. The commission is talking with aircraft manufacturers to find out whether present airports meet the requirements of future aircraft.

The commission is soliciting the opinion "in writing" of all individuals and agencies concerned with airport use and construction. Only after gathering this information will the commission make field studies of individual problem locations like New York, Chicago and Los Angeles, Doolittle said.

Nonskeds Bow Backs for Battle

Fighting for survival as Civil Aeronautics Board closed in with more restrictive orders, the nonscheduled airline members of Air Coach Transport Assn. last week announced new counterattack programs voted at their general membership meeting:

• **Anti-trust suit** against the scheduled airlines, charging conspiracy among themselves and with CAB "to drive the independents from the field of air transportation. . . ." The nonskeds plan an initial request for CAB investigation to determine if there is evidence of unfair trade practices.

• **Agency campaign** to eliminate (through joint carrier action) the "unscrupulous independent ticket agents." The ACTA members passed an ACTA code of fair advertising and agreed on various means, such as recommendation of local ordinances requiring bonding, to freeze out the cut-throat agents plaguing their commercial business. An agency relationship committee was set up to enforce ACTA's fair advertising code.

• **10-point safety program** to appoint ACTA safety agents, set up uniform maintenance, airport survey on safety and noise, flight training standards, local aviation gas tests with the Bureau of Standards, and a request that the Air Force assign ACTA a C-46-F for engineering tests aimed to develop commercial safety data.

• **Money for the C-46 Engineering Council** to be assessed at $1,000 for each C-46 operated by a member. The council standardizes C-46 procedures and develops engineering programs to improve the plane. A public demonstration of the C-46 is planned to show that the plane handles on one-engine takeoff and that the CAB order reducing its allowable load "was an economic regulation masquerading as a safety order," as ACTA charges.

• **Military transport lease bill,** to be urged on Congress. ACTA proposes a so-called airlift preparedness bill to develop and build transports for lease to civil operators in return for one-half the profits which would accrue from civil operation.

ACTA and the Independent Military Air Transport Assn. have agreed on a 3-member Joint Traffic Control Board to set up a single agency to handle military business. It is handling all bids on official military contracts the next 30 days; the same board (with four members from each of the two nonsked associations) will also work out a program for joint handling of unofficial military business.

▶ **Business Bid**—The Joint Traffic Control Board will bid for official military business against the scheduled airlines' Air Transport Assn. and against the railroads and bus associations. Previously, the IMATA bid for all official business, and IMATA and ACTA divided unofficial business (with IMATA taking Air Force and Marines and ACTA taking Army and Navy travel).

In joining the unofficial business representation, one problem is that ACTA has a field staff of about 100 employes with 56 offices at Army and Navy bases for securing unofficial military travel business.

The new joint board is drawing up plans for sharing the cost of this field representation.

ACTA and IMATA last week sent telegrams to all members asking them to decide which of the two associations they would belong to. A few nonskeds have held representation in both associations, but the Defense Department insists that the carriers deal through only one association each.

ALPA Test Team Gives Nod to 4-0-4

An Air Line Pilots Assn. flight test team finds that the Martin 4-0-4 should be an excellent medium transport. TWA Pilot Bart Hewitt, after completing the ALPA test program and a course in the TWA ground school for the 4-0-4, commented:

"The single engine performance of the ship at high gross loads is excellent, and the built-in safety features in the general aerodynamic design should make it one of the finest medium transports for some time to come."

Here are highlights of findings by ALPA and Pilot Hewitt, writing in "The Air Line Pilot":

• **Structure:** Stronger all around.

• **Aerodynamics:** Similar to the 2-0-2, but lengthened fuselage actually has smoothed the airflow over tail assembly. This has improved control of elevators at slow speed so the pilot can make a smoother flare-out and landing. The Martin variable stabilizer trims the plane automatically as the flaps go down, thus relieving the pilot of that job.

• **Electrical System:** "Design-wise this should be a very good electrical set-up provided all its components are of the highest quality and durability. . . . It is an entirely new system and the bugs which were in the 2-0-2 have mostly been eliminated. . . . On this ship as on most highly electrical new models, the battery is not much of a storage plant for electricity."

• **Propellers:** Props are now completely electrically operated throughout their range from high to low pitch and in reversing. Various problems of past prop arrangements have been licked. "There is one remote possibility of reversing a prop in flight. That is when, in coming out of a full feathered configuration, a blade switch short might make it possible for the blades to proceed through low pitch to reverse position.

"If this should occur, the feathering pump will return the prop to feathered position at which time the nacelle buss should be de-energized, preventing the cycle from continuing."

• **Hydraulic:** "It looks like a very good system and should offer little trouble."

• **Cockpit:** "From the cockpit viewpoint, the 4-0-4 like the 2-0-2 has one of the most beautiful designs." The windshield height has been increased four inches; one more pane is added on each side, also.

Texas Interchange Shelved by CAB

CAB has shelved the proposed Braniff-Capital Airlines interchange application that would have brought competition to American's N. Y.-Dallas and Eastern's N. Y.-Houston routes.

The Board "deferred further procedural steps" in the interchange, primarily on grounds that it complicates the New England-Southern States merger investigation, presumably by reducing incentive for mergers. American and Eastern also claimed the Braniff-Capital application amounted to a request for totally new routes. Application was for flexible routing of through flights over the Braniff and Capital systems between New York and Texas, flying over intermediate points.

Another case may be near completion to bring competition to Eastern's New York-Houston route. CAB completed hearing last month on a case in which Chicago and Southern, Capital, and American are vying for permission to give New York-Houston service by interchange with TWA.

PanAm Rate Set

CAB has set Pan American World Airways' final mail rate for Alaskan operations at $4,300 a day or 2.15 cents a passenger seat mile flown, whichever is lower in any month. Effective July 11, this rate is equivalent to about 80 cents per revenue plane mile flown.

CAB has also set final rate for earlier periods: Jan. 1, 1946 to June 30, 1951—63 cents a plane mile or a total of $8,683,000; July 1, 1951 to this June 30—$3,140 a day or 1.57 cents a passenger seat mile flown, which ever is lower; this is estimated as the equivalent of 41 cents a revenue plane mile flown.

CAB Examiner Finds Against 2 Airlines

A certificated airline may transport only that type payload specified in its CAB-granted certificate, regardless of whether the flight is charter or common carriage, according to the finding of CAB Examiner Curtis Henderson in the "Charter Flight Tariff Investigation" case.

Flying Tiger Line and Resort Airlines claim in this case that charter operations aren't limited as to type service rendered.

Flying Tiger Line is certificated for cargo operations only; it had filed a passenger charter tariff with CAB.

Resort Airlines is certificated for passenger service, subject to the condition that "the holder shall furnish the aforesaid transportation only as a part of an all-expense escorted tour. . . ." Resort had filed a special services tariff to offer an individual roundtrip fare for passenger travel between Jacksonville, Fla., and the Bahama Islands.

► **Act Cited**—Main question in this case is what Congress intended when it wrote Section 401 of the Civil Aeronautics Act. Last sentence of clause "F" of this section reads:

"Any air carrier may make charter trips or perform any other special service, without regard to the (geographic) points named in its certificate, under regulations prescribed by the authority (CAB)."

Tiger Line contends that Congress meant that any airline engaged in any transportation can operate any charter or special service business. Resort says an airline's certificate automatically permits charter operations, and type charter operation is defined in Section 401(F) of the Act. Both contend that charter trips and other special services aren't subject to the CAB-written limits put on their common carriage business in writing their certificate.

CAB Examiner Henderson does say: "From a casual reading of the last sentence of 401(F) of the Act, one reasonably may conclude that there is some merit to respondents' contention. However, it is an elementary rule of statutory construction that effect must be given, if possible, to every word, clause, and section of the statute."

► **Interpretation**—But Henderson adds that the context of Section 401 and all its clauses leave no doubt that Congress did not mean that certification of an airline with restrictions on its type of service gave it unlimited authority in charter or special service. One example he cites is the second proviso of the first sentence of the controversial Section 401(F):

". . . And there shall be attached to the exercise of the privileges granted by the certificate . . . such reasonable terms, conditions, and limitations as the public interest may require."

However, the examiner rebuffs CAB counsel and the complainant airlines on one contention—that Resort Airlines has no right to make charter trips or perform special service. Both Resort and Flying Tiger may fly anywhere over irregular routes under CAB regulation "so long as the service rendered does not exceed the service authorized and specified in its certificate," the CAB examiner finds.

UAL Head Sees Need For Fare Adjustment

Increased volume of airline business, ranging from 20-29% over 1951 for 1952, was predicted by W. A. Patterson, president of United Air Lines in an address before the New York Society of Security Analysts. Volume in the New York area was estimated to have declined 10% as a result of the Elizabeth, N. J., accidents. Despite this development and other "emotional uprisings" throughout the country as a result of the New Jersey crashes, the airline president saw no reason to adjust his 1952 forecast.

Patterson further asserted that the airline industry cannot continue to absorb rising wage and materials costs without raising fares. In this direction, he suggested adjustments of the present rate structure. This would include eliminating roundtrip discounts, reducing the size of family-fare discounts and correcting ticket agency commission systems before increasing basic fares.

Little concern was expressed on the competitive inroads of nonscheduled carriers. Less than 3% of the country's coach traffic is estimated to come from this source. Moreover, Patterson felt that "nature would take its course" as far as nonscheduled operators are concerned.

In commenting on the proposed merger of Capital and Northwest, Patterson said this arrangement is "constructive" for the companies involved and would make for a stronger industry. He also expressed the hope that if the merger is consummated certain restrictions now written into United's certificates to protect Northwest and Capital over certain routes would be eliminated. This would make for more truly competitive route pattern, he said.

About 15-20% of present air travel is attributed to the national defense effort. This was reported as a source of concern because the defense effort may be curtailed from its present levels a few years hence. In any event, he said, the industry by 1954 should show an increase of 35-40% over present activity.

Avon Engine Comet Makes First Flight

The de Havilland Aircraft Co.'s 26,000-lb. thrust Avon-powered Comet II has made its first flight. The flight lasted nearly two hours, at heights up to 25,000 ft.

The company is still not predicting outright whether this longer-range Comet will be capable of routine passenger operation over the competitive North Atlantic route when it is placed in service.

But de Havilland does say this Comet "will be capable of carrying a capacity payload of some 44 passengers, with freight and mail, on the world's very long stages."

There are 24 Series II Comets and 21 shorter-haul Ghost-powered series on order for delivery. BOAC plans to have the Series II in scheduled service within two years.

De Havilland's chief test pilot, John Cunningham, piloted the maiden flight of the Avon-powered Comet from Hatfield, England.

SHORTLINES

► **American Airlines** air freight, express and mail gained 40% from 1950 to 90 million ton miles in 1951. Commercial freight gained 2% to 37 million ton miles; mail 51% to 16 million; express 19% to 9 million; AA's military cargo on the 1951 Pacific airlift was 28 million ton miles. . . . Company's 13 DC-4 freighters carried 28% of the total cargo and 144 passenger combination planes the other 72%. . . . Cargo capacity jumped during the year with delivery of 17 DC-6Bs capable of combined lift of 52 luxury passengers and ten tons cargo capacity (about equal to that of a DC-4).

► **Braniff-Mid-Continent** merger hearing by CAB is set for Mar. 19—promising extraordinarily quick disposition of the case. CAB has dropped its earlier-proposed Braniff-Continental merger investigation.

► **California Central Airlines** reports a 63% gain over 1951 traffic to 14,075 passengers carried the first five weeks this year.

► **Civil Aeronautics Administration** reports total 1951 avionics contracts at $15 million, of which 63% were small business and 37% with major manufacturers. . . . Is organizing a National Aviation Noise Reduction Committee. . . . Will sell its 1952 Airworthiness Directive Summary for $1.50, but will continue free distribution of the bi-monthly supplements.

▶ **Civil Aeronautics Board** staff is gathering airline wage and supplies cost increase data to decide whether to raise fares. . . . Has suspended a storage valuation charge that eight lines wanted to place on cargo shipments undelivered after 24 hours—at 50 cents per lb. or per $50 value. CAB will investigate the question.

▶ **Eastern Air Lines** has signed a union shop and pay raise contract with the IAM Machinists Union (AFL). Terms call for employes in the IAM category to join the union within 60 days. Raise is 2 cents an hour retroactive to Oct. 1, and another 2 cents this July 1. Pay increases of 6 cents every six months seniority up to the maximum rate are also provided. . . . Has started a Detroit-Miami nonstop flight with Super Constellations in a move to meet competition started last year by a Capital-National interchange. The nonstop cuts former time by about an hour and almost doubles Eastern's service on that run.

▶ **National-Colonial** merger application may get expedited approval by CAB even though it's consolidated with the catch-all New England-Southern States merger investigation case; the Board is considering separate hearing of the one issue of simple merger of the two lines, leaving all other issues consolidated in the investigation case.

▶ **North American Airlines** plans to make inquiries with Douglas and Lockheed about possibilities of lease-purchase deal for about ten new DC-6Bs or DC-7s or Super Constellations. The North American group, headed by Stanley Weiss and James Fishgrund in Los Angeles, handles close to one-fourth the nonskeds' commercial passengers.

▶ **Northwest Airlines** has set up a military division of its sales dept. to expedite domestic troop movements. . . . Passenger load factor of 56% this January compares with 46% a year ago; passenger miles totaled 40,889,800.

▶ **Pan American World Airways** employes in the Transport Workers Union, CIO, would get these wage increases if the union accepts recommendations of the Presidential Emergency Board: raises of 10 to 15 cents an hour for ground workers and of $16 a month for flight service personnel. PanAm accepted this immediately; union had asked 14 to 16 cents an hour gain for ground and $34 a month for flight service personnel. The Emergency Board criticized both company and union conduct of the wage dispute.

▶ **Pioneer Air Lines** delivered 10,857 passengers to American Airlines last year, handing American $500,000 revenue, almost half Pioneer's total interline payout for the year.

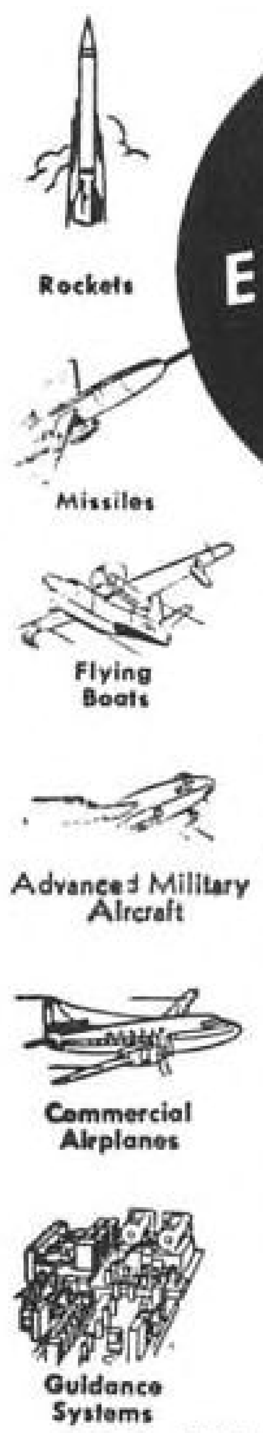
▶ **Sabena** starts trans-Atlantic coach service May 1 using 60-passenger DC-6s carrying luxury passengers aft and "tourists" forward—three flights a week. On June 15, company will add an all-coach 55-passenger DC-4 flight. By July 1 it will offer four coach and two luxury services per week.

▶ **Slick Airways** hauled 6,663,816 ton miles domestic air freight in January, a 24% gain over a year ago.

▶ **Southern Airways** starts serving Biloxi and Gulfport on its Mobile-Jackson route this month.

▶ **Trans World Airlines** reports 145,000,000 revenue passenger miles flown in January, 24% over a year ago.

▶ **United Air Lines** flew 157,146,000 revenue passenger miles in January, 25% over 1950. Air freight declined 9% to 1,969,000 ton miles. Jan. gain over Dec. was 1% for passengers and 18% for freight. . . . Company will offer 31% more trans-continental cargo capacity this year than last.



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42	SF5RN-12 (manufacturer's part No. 10-26170-1)	Bendix Scintilla Magneto
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30,000	LS-6S9A	Bendix Scintilla Spark Plug

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236	PR48-A1	Stromberg carburetor
29	PR48-A2	Stromberg carburetor
31	PR48-A3	Stromberg carburetor

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500	3506	Flange
130	8288	Follower Ass'y
814	35814	Blower Ass'y
53	48362	Shaft
175	48363	Shaft
56	48392	Sump
390	48461	Gear
78	76236	Gear
1178	84289	Bearing
113	84487	Housing
77	84591C	Nose Housing
200	48350-D	Crankcase Ass'y
200	84083	Cylinder
100	84084	Cylinder
200	84085	Cylinder

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30000	KP4R16-2
3300	KSF5
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28000	KS6A
34600	NR6L12
7000	38KD4
6600	RE3MR3
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38	18597-2	Airesearch	Aluminum Oil Cooler
120	MF9-713-15A	Vickers	Hydraulic Pump
160	2E492E	Pesco	Fuel Pump
700	TFD 8600	Thompson	Fuel Booster Pump
125	D7818	Adel	Anti-icer Pump
50	2P771-A	Pesco	Fuel Booster Pump
250	AN4014	Erie Meter	Wobble (D-3) Pump
300	1H260-K & KA	Pesco	Hydraulic Pump
19	AN5531-1	G. E.	Tach. Generator
1000	AN5780-2	G. E.	Wheel & Flap Position Indicator
400	AN5780-2	Weston	Wheel & Flap Position Indicator
16	76B19	Lewis Eng.	Cyl. Head Temp. Gauge
10	46B2	Lewis Eng.	Air Temp. Ind.
31	47B21	Lewis Eng.	Temperature Ind.
12	47B22	Lewis Eng.	Temperature Ind.
20	47B23	Lewis Eng.	Temperature Ind.
36	47B24	Lewis Eng.	Temperature Ind.
10	76Z2	Lewis Eng.	Air Temp. Ind.
11	76B4	Lewis Eng.	Temperature Ind.
20	77C4	Lewis Eng.	Temperature Ind.
21	77C5	Lewis Eng.	Temperature Ind.
85	727TY72Z2	Weston	Left Wing Anti-icing
88	727TY73Z2	Weston	Right Wing Anti-icing
83	727TY74Z2	Weston	Tail Anti-icing
11	2227-11D-3A	Eclipse	Dual Tachometer
44	5BA25DJ4B	G. E.	DC Motor (½ HP)
83	A4934	Delco	Motor
50	RDB2220	Holtzer Cabot	DC Motor
49	FD65-5	Diehl	Motor
47	FD65-6	Diehl	Motor
116	A371205	Dumore	Motor
780	A371206	Dumore	Motor
115	P4CA2A	Parker	Primer
70	AN3213-1	Scintilla	Ignition Switch
450	A-9 (94-32226)	Nasco	Ignition Switch
687	RS-2	Mallory	Selector Box
90	JH950-R	Jack & Heintz	Starter Motor
492	S-841 (94-32253)	Electronic Labs	Box
53	AN6203-3	Bendix	Accumulator 10"-1500 P.S.I.
1000	13018-A	Bendix	Interphone Box
140	K14949E	Marquette	Windshield Wiper Kit
188	EYLC-2334	Barber-Colman	Control
11	12086-1C	Eclipse	Amplifier
174	450-0	Skinner	Gasoline Filter
250	558-1A	Eclipse	Oil Separator
100	716-3A	Eclipse	Generator (NEA-3A)
37	117-47	Edison	Detector
89	318	Edwards	Horn
20	794-F	Stewart-Warner	Heater
280	921-B	Stewart-Warner	Heater (200000 BTU)
340	981280	Kidde	Co2 Cylinder
85	12924-2	Adel	Lock Valve
90	923748	Kidde	Oxygen Cylinder
80	DW28	Eclipse	Transformer
97	6041H-146A	Cutler Hammer	Relay (B-12)
22	0655-D	Aro	Oxygen Regulator
148	PG208AS1	Minn. Honeywell	Air Ramp Switch
33	DW47	Eclipse	Transformer
11	DW33	Eclipse	Transformer
65	ASDC2	CO2 Mfg. Co.	Fire Detector
750	ND21	American Gas Accumulator Co.	Time Delay Relay
30	U6005-DV5	United Air Prod.	Oil Temp. Reg. 5"
29	UA-3160	United Air Prod.	Oil Temp. Reg. 6"
95	UA-3160C	United Air Prod.	Oil Temp. Reg. 6"
73	UA-6007-CF-DV5	United Air Prod.	Oil Temp. Reg. 7"
14	UA6009-S-30	United Air Prod.	Oil Temp. Reg. 9"
11	UA-6012K—S30K	United Air Prod.	Oil Temp. Reg. 12"

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STRICTLY PERSONAL

Did you hear the story from the Banana River, Fla., missile launching area about the **Martin Matador** whose tail was twitched by a lady in Galveston? This missile was within minutes of being fired. There were the usual signals and counting off of minutes. Only two workers were left, making final adjustments to the gleaming projectile. Everyone else had dispersed to protected observation stations. Suddenly one of the workers noticed a tail elevator twitch. It did it again. Then an aileron showed nervousness. The test was called off and the experts swooped down on the Matador to investigate. The trouble was traced to interference from a commercial short wave radio station in far-off Texas. A lady dispatching taxicabs in Galveston was twitching the Matador's tail in Florida. That's the kind of thing that helps retard our progress on guided missiles . . . Up at **Wayne Weishaar's** ATS training conference the other day in Washington Spartan's **Max Balfour,** without his glasses, mistook Aviation Week's own **Alex McSurely** for **Wayne Parrish.** Both McSurely and Parrish were indignant . . . American Aviation has switched back to a straight military and commercial transport magazine again, and abandons its every-other-week four-page newsletter . . . Aero Digest publisher **Fred Hamlin** quietly took over the weekly Washington contract listing periodical, Government Advertiser, recently . . . **Hy Sheridan's** recent philosophy expressed in Flying: "Motto for thunderstorm pilots—hail and farewell." . . . Hill & Knowlton's AIA publicity boss, **Avery McBee,** was sitting quietly through a lecture at the Washington meeting of the Helicopter Council the other night when his wrist watch alarm went off noisily . . . **Air Force Secretary Finletter** told us the other day during an off-the-record discussion of censorship that he hopes to review the whole USAF security policy . . . USAF wants to borrow **Burt English** from AIA to start the project, which would include reclassification of hundreds of documents . . . The old Aviation Magazine team of **Les Neville** and **Gene Miller** is about to be reunited; Miller left NACA last week to join Neville's new Armed Services Technical Intelligence Agency . . . Some of that public indignation in Elizabeth, N. J., appears to have been helped along by the local Communist party, which mailed out handbills demanding the end of Newark Airport, according to the Elizabeth police chief . . . We find no evidence to indicate that Newark Airport will be closed permanently; construction shifts were doubled, upon recent shut-down, to speed completion of new projects . . . There are still aviation folks who think **Del Rentzel** holds considerable sway in aviation, despite his new job, apparently a non-aviation post for Grace. He is said to have a desk and secretary still in the Commerce Bldg. . . . Morale on the staff of the CAB is low these days; a new report-writing unit nettles the examiners . . . **Harry Bruno,** the publicist, sounded very bushed on the phone the other morning, and we asked him why. It seems that famous freighter, the Flying Enterprise, had just sunk a couple of hours earlier and his company had only recently taken on the Isbrandtsen Line as a client! . . . When the PAA Stratocruiser bringing the intrepid **Skipper Carlsen** over here had to turn back because of mechanical difficulties, PAA's news bureau chief, **John Creedy,** was very down at the mouth. "I suppose one of our competitors will pick him up and bring him on in," he moped to his wife. "I don't think so," she replied, "That's one man that'll stick with the ship." . . . **Bob Mountsier,** ex-New York Sun aviation & auto editor, is named to handle the history and records of the Automobile Old Timers, at 22 E. 38th St., NYC . . . **Vern Haugland** becomes aviation editor of the AP, headquartered in Washington . . . Our own pilot-columnist, **Ace Robson,** is getting around more this month; you may see him throttling Convairs out of Washington to NY, Memphis or Chicago . . . Imagine our surprise in Memphis the other day to see the Press-Scimitar aviation editor quoting our own **Dr. Von Flugen's** Aviation Glossary. We hear the Doktor is leaving Washington to return to sun-smogged Southern California . . . Aviation Week just received subscriptions for 59 copies of every issue, to be sent USAF intelligence GHQ for forwarding to air attaches all over the world. Or is that secret information? . . . **Hy Sheridan** in looking over the recent CAA safety reorganization says "There sure are a lot of unemployed people who have jobs." . . .

R. H. W.

WHAT'S NEW

New Publications

Bibliography on the Measurement of Gas Temperature, by Paul D. Freeze, National Bureau of Standards Circular 513, iv, 14 pages, 15¢. Order from Government Printing Office, Washington 25, D. C.

National Bureau of Standards has prepared this bibliography as an aid to its broad program on temperature measurements now underway.

About 400 references are cited, covering the 20 years prior to January, 1951. Introduction to the pamphlet reviews the various temperatures which are of interest in hot gases moving at high speeds.

Telling the Market

Standard and special relays are described in a catalog covering the entire line made by Advance Electric & Relay Co., 2435 N. Naomi St., Burbank, Calif. . . . Miniature combination **fixed and variable speed drives** for low power applications requiring variable speed at nominal output speed are covered in Technical Data Sheet M1, put out by Metron Instrument Co., 432 Lincoln St., Denver 9.

Hermetically sealed MH disk type and CH strip type Neoprene-protected **bimetal thermostats** are tabulated and described in Bulletin L-4609, available from Stevens Mfg. Co., Inc., 69 Walnut St., Mansfield, Ohio. . . . An educational catalog, which not only describes **capacitors, interference filters and molded paper tubulars** but also gives the history of each type unit, its use and exact specifications is available from Astron Corp., 255 Grant Ave., E. Newark, N. J. . . . Data on cast alloy metal cutting tools is available to designers and engineers in 44-page manual and catalog. **Haynes Stellite Metal Cutting Tools,** available by writing Haynes Stellite Co., 30 E. 42 St., N. Y. 17.

Publications Received

- **Engineers' Illustrated Thesaurus,** by Herbert Herkimer, published by Chemical Publishing Co., Inc., 212 Fifth Ave., New York 10, N. Y., 1952, $6.00—A comprehensive guide containing over 8,000 illustrations of machine elements and assembled machinery for the engineer, designer, draftsman and manufacturer.
- **Tool Steel Handbook,** published by Allegheny Ludlum Steel Corp., Pittsburgh 22, Pa.—A 197-page volume designed for engineers, teachers, metallurgists and others interested in tool, die and allied steels.
- **Wings in the Sun,** by William C. Lazarus, published by Tyn Cobb's Florida Press, Orlando, Fla., 1951—The history of aviation in Florida.

ADVERTISERS IN THIS ISSUE

AVIATION WEEK—MARCH 3, 1952

EDITORIAL

Politics & Safety

The newest reshuffling of the Office of Aviation Safety in the Civil Aeronautics Administration made good newspaper headlines and may fool the public for a while, but it's hoodwinking few people in aviation or CAA, who can read between the lines. The political hacks reign supreme over integrity, ability and public service, in the opinion of many of our readers.

A two-paragraph editorial on this page Feb. 11 ("What Goes on at CAA?") expressed our vote of non-confidence in those who manipulated the reorganization and those who direct the office. These two paragraphs started a barrage of phone calls, telegrams and letters pouring into our office, and they are still coming in.

These messages came from CAA employes and from officials of aviation companies who are fed up with the politics of E. S. Hensley, director of the office, and his deputy director, William Davis. These two men incidentally, were the only men of Grade 13 or above in Aviation Safety who were not compelled to take "examinations" for jobs in the reorganization. It was their idea. Both, we understand, now have applications in process for higher grades for themselves.

It is obvious that morale in CAA Aviation Safety is low, and that many aviation individuals and companies who have been suffering under dictatorial decisions from Hensley, Davis and some of their men, are still afraid to complain because of recrimination.

Seasoned observers see the newly revitalized Office of Aviation Safety as regurgitation of the old General Inspection division set-up of CAA that held sway until it was abolished in November, 1945. Even this division, however, did not control the Medical division, nor the Aircraft Engineering division. Hensley now has both of these important groups in Aviation Safety.

The GI crowd, described in aviation as "the old guard," was an empire-building bureaucracy within CAA that became so notoriously dictatorial and political, and so lacking in proficiency and service to the public, that it was finally split up.

But in recent years, other skillfully planned "reorganizations," culminating in this latest one, have gradually returned the old guard—in new dress—to even greater power than it ever had before. Our informants indicate that only those who can be counted on as loyal members of the Hensley-Davis clique, masters of politics and cover-up, received reprieves or new appointments or promotions. Others were banished to the sticks, their jobs abolished entirely, or they were cut in grade and salary.

Integrity, technical ability and public spiritedness to achieve safety seem to have been rather widely ignored in this latest reshuffling of men around the country in jobs so vital to aviation and human life.

Research shows that six to eight U. S. senators and several representatives became concerned about the reorganization and made official inquiries. They were told that "the best men" were being installed in all key position of CAA Aviation Safety "to stop these air crashes." Actually, there are many jobs in Hensley's set-up not directly connected with the airlines, and Air Carrier Safety division—which Hensley acquired in his own reorganization—is still headed by E. B. Franklin, who has held the post for some time.

Naturally, members of Congress were reluctant to interfere if the changes would improve air safety. It is our opinion they won't. If there are more fatal airline accidents in the near future, the whole Hensley-Davis empire may come under very heavy fire.

Meanwhile, a story in the New York Journal-American created a sensation within CAA. It described how some of Hensley's men smuggle liquor into the country on aircraft. Easterners circulated the clippings widely; CAA people elsewhere are circulating typed copies.

Aviation Week will continue to look into various aspects of CAA Aviation Safety activities, and we welcome further suggestions from those in business who have been victimized, as well as from those on CAA's payroll who are eager for a new deal. Obviously, names of those who send us material will not be divulged to anyone.

Here are some of the telegrams only, with names and originating cities eliminated:

APPRECIATE YOUR EDITORIAL ON CAA REORGANIZATION. KEEP UP THE GOOD WORK IN THE INTEREST OF GOOD GOVERNMENT.

CONGRATULATIONS ON YOUR EDITORIAL RE CAA REORGANIZATION. EVIDENTLY HONESTY, INTEGRITY, AND KNOW-HOW HAVE NOT BEEN CONSIDERED AS BEING MORE DESIRABLE THAN BOOTLICKING IN SELECTING KEY PERSONNEL.

GLAD ONE MAN COULD SEE, UNDERSTAND AND HAD WHAT IT TAKES TO EXPOSE CAA REORGANIZATION. IT'S A GOOD START. KEEP IT GOING, EVEN IN THIS WILD WORLD TODAY, SUCH AN ATTEMPT TO IGNORE INTEGRITY, HONESTY AND QUALIFICATIONS IN SUCH TOP-LEVEL APPOINTMENTS, IN FAVOR OF "YES" MEN, CANNOT BE TOLERATED BY THE INDUSTRY. IF THIS SHOULD HAPPEN WE SHOULD SELL OUT THE INDUSTRY AND BUY RAILROAD STOCK. WE KNOW THEY WILL PROFIT, BECAUSE EVEN THOSE OF US IN AVIATION FOR MANY YEARS ARE BUYING TICKETS ON THEM FOR FEAR, REPEAT FEAR, OF OUR SAFETY ON AIRLINES.

CONGRATULATIONS ON YOUR PUBLICLY EXPRESSED STAND CONCERNING CAA REORGANIZATION. MANY OF US IN THE INDUSTRY, LIKE YOURSELF, CONSIDER MANY OF THE NOW TOP-LEVEL APPOINTMENTS WERE 100 PERCENT INTERNAL POLITICS AND THAT CAPABILITIES AND COMPETENCE WERE NOT CONSIDERED. CERTAINLY THE SAFETY AND PROMOTION OF AVIATION AS SET FORTH IN THE CIVIL AERONAUTICS ACT OF 1938 WAS IGNORED BY THOSE PEOPLE RESPONSIBLE FOR MANY OF THESE NEW APPOINTMENTS. I AM PREPARED TO FURNISH YOU WITH CONSIDERABLE INFORMATION CONCERNING INTERNAL POLITICS IN CAA THAT RELATES DIRECTLY TO THE EXISTING SITUATION AND THAT HAS RETARDED COORDINATION WITHIN CAA AND REFLECTS DIRECTLY UPON AVIATION SAFETY . . . THAT I WILL BE GLAD TO FURNISH UPON YOUR REQUEST. WE MAKE OUR WHOLEHEARTED REQUEST THAT YOU SEE THIS THROUGH AND ADVISE YOU THAT YOU CAN DEPEND ON OUR ASSISTANCE AND BACKING.

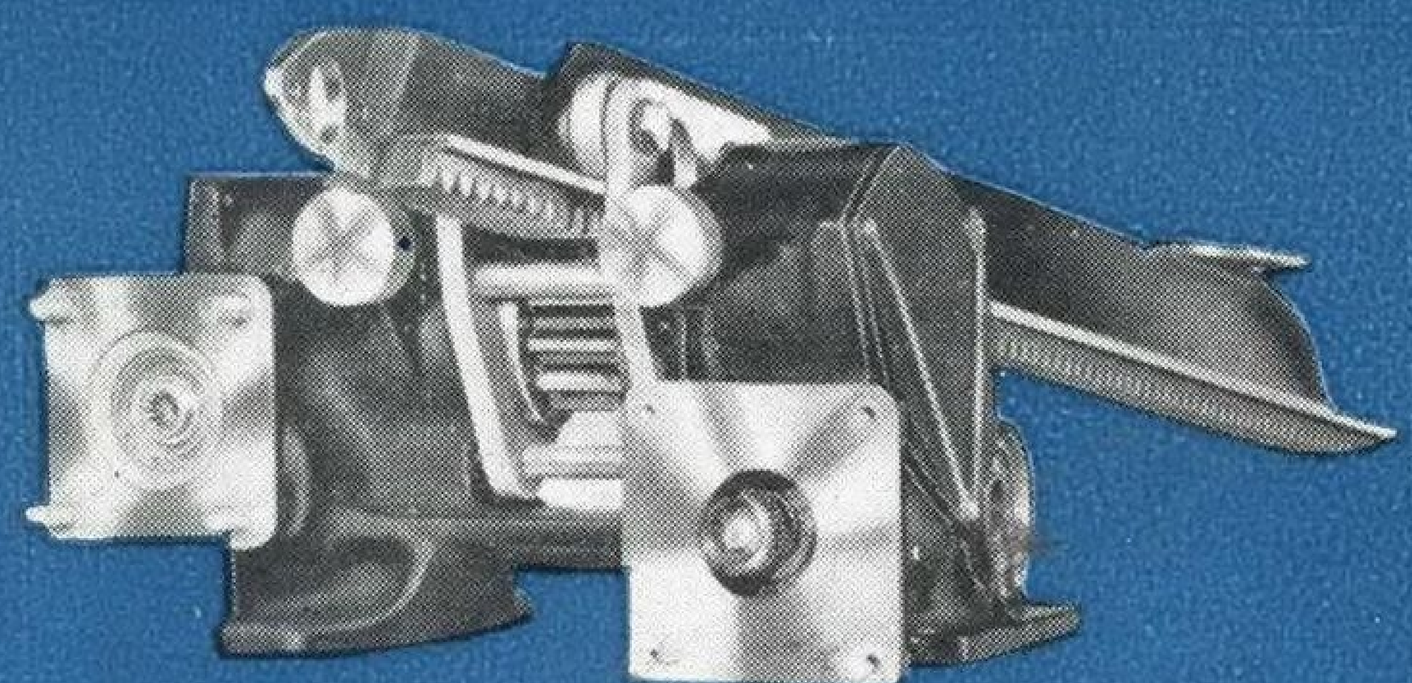
THANKS FOR TIMELY EDITORIAL ON POLITICAL FOOTBALL. PUBLIC NOW ALERT ANGRY AND READY FOR SOME ACTION IN REDUCING POLITICS IN CAA. WE NEED MORE AND STRONGER EDITORIALS SPEAKING OUT AS YOU HAVE DONE.

This is the reorganization that American Aviation Daily described Feb. 15 as a "well-planned, two-year project which should improve CAA's dealings with the industry." Well-planned it was. But even well-laid eggs can smell.

—Robert H. Wood

Official U. S. Navy Photo

Mission accomplished



The coast line fades in the distance as the swift twin-jet Banshee returns to the aircraft carrier—mission accomplished.

On this shark-slim jet fighter, the McDonnell F2H-2, are actuators developed and produced by Foote Bros. to the exacting requirements laid down by the U. S. Navy and McDonnell engineers. These actuators must be rugged in construction—light in weight—designed to fit a confined space envelope. Above all, they must operate swiftly—surely.

Foote Bros. gears, actuators, and mechanisms are today serving on many of the nation's leading aircraft and aircraft engines.

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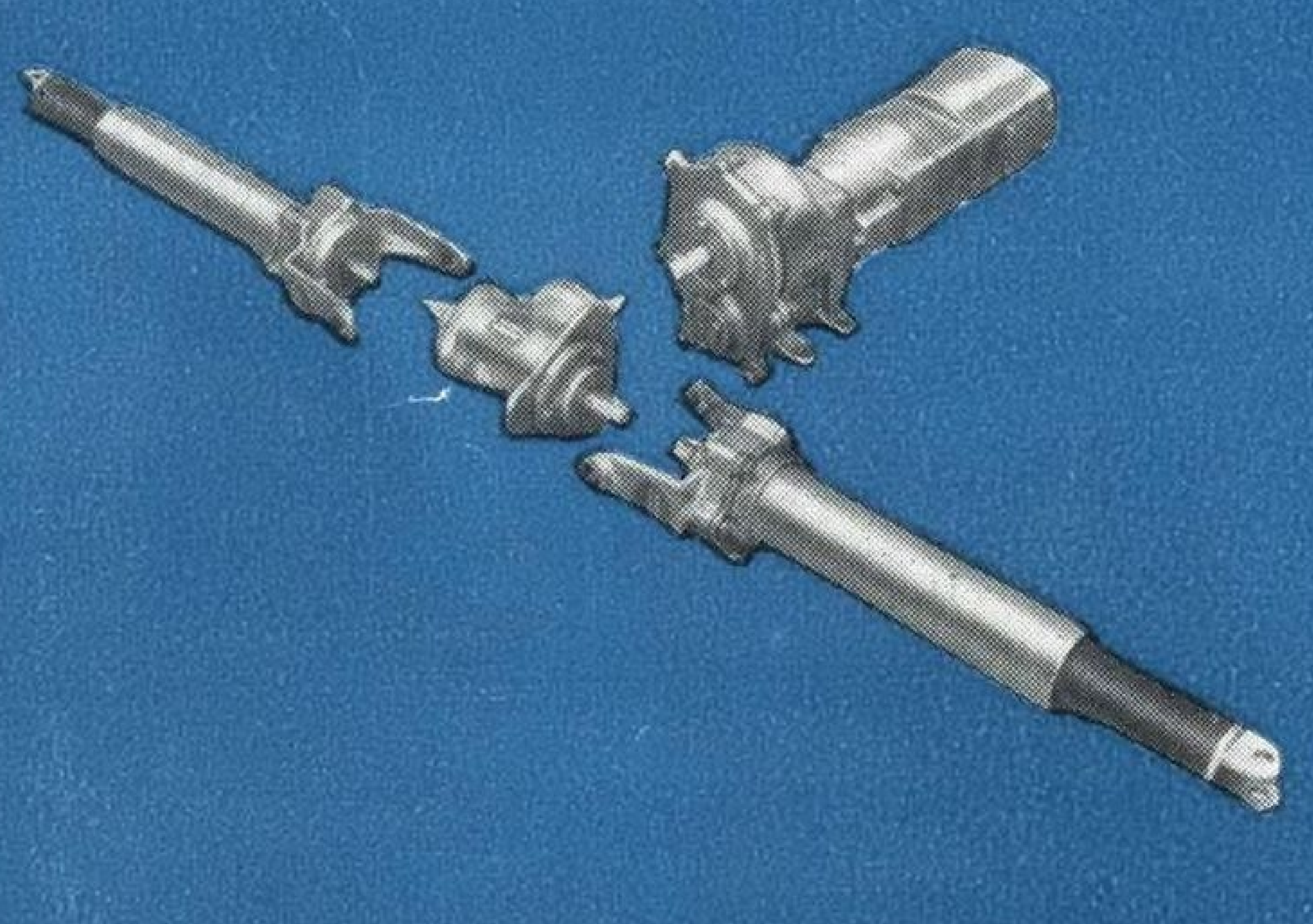

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