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NEWS DIGEST

Domestic

Douglas XA3D-1 sweptwing twin-jet carrier-based bomber has made its first flight, of 30-min. duration, at Edwards AFB, Calif.

The Musick Memorial Trophy for 1951, awarded annually by Royal New Zealand Aero Club, was presented to two American engineers, John E. Lindberg, Jr., and James W. Wheeler, for their joint development of the Electronic Sperry Engine Analyzer, at a luncheon given by the Institute of the Aeronautical Sciences in New York. The award commemorates Capt. Edwin C. Musick, who, with six companions, was lost on first commercial flight from U.S. to New Zealand in 1938, and is awarded yearly to the group or individual making most effective contribution to aviation safety. This is the first presentation of the award since 1940.

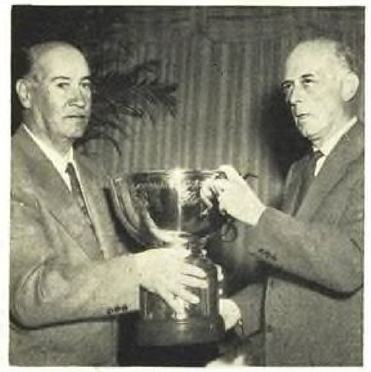
All-American Airways stockholders voted 300,000 to 5,000 favoring split of the company into All-American Engineering Research Corp. with former AAA treasurer Charles Wendt as president and treasurer and Allegheny Airlines with Robert M. Love continuing as airline president. They hope for CAB approval of the split by Jan. 1.

Maj. Gen. George W. Mundy, assistant deputy commanding general of Air Materiel Command, has been appointed to AF HQ as director of supply and services.

Associated Aviation Underwriters have revised their international airline trip insurance policy to provide round-trip coverage at no increase in cost, according to D. R. Scarritt, manager. Policy limit has been increased from $25,000 to $50,000.

Air Force officially confirmed AVIATION WEEK's report that General Curtis E. LeMay would remain as commander of the Strategic Air Force instead of succeeding General Nathan Twining as USAF vice chief of staff (AVIATION WEEK Aug. 25, p. 16). USAF said action to retain General Twining in the post was taken by AF Secretary Finletter with concurrence of Sen. Richard Russell, chairman of Senate Armed Services Committee.

Wiggins Airways has been slated for Dec. 31 demise by a 3-2 majority decision of CAB. Northeast Airlines will take over some routes, Mohawk Airlines others, while weakest points lose air service altogether. Majority found Wiggins present and future hopeless, while the minority said bad CAB route assignments made it that way.



IGOR SIKORSKY, dean of American helicopter designers, receives the annual trophy of the National Defense Transportation Assn. from USAF Secretary Thomas K. Finletter (right) in Washington, D. C. In making the award for being "the person contributing most to the field of transportation," Secretary Finletter called the veteran designer and builder "Mr. Helicopter."

Southwest Airways, Pacific Coast local service airline, has purchased four 40-passenger Martin 2-0-2s. SWA also has ten DC-3s.

Financial

United Air Lines reports record revenues for first nine months of 1952, with net earnings after taxes of $8,263,000; of this $4,480,000 represents net earnings after taxes for the third quarter alone. Operating revenues for this quarter amounted to $46,179,000. United declared a quarterly dividend of 25 cents per share and an extra dividend of 50 cents per share on common stock, payable Dec. 15 to stockholders of record Nov. 14.

Republic Aviation Corp. showed a net profit of $1,563,886 for the quarter ending Sept. 30, compared with $791,875 a year ago. For the first nine months of 1952 gross sales totaled $215,302,294, compared with $83,077,697 last year. Unfilled orders at end of September were more than $1 billion.

Northwest Airlines reports net profit after taxes of $962,634 for first three quarters of 1952, of which $719,273 represented net profit for September.

Northrop Aircraft shows a net income after taxes for the year ended July 31 of $2,420,605 out of sales and other income of $187,456,926. Net income for the preceding year was $3,276,053. Company's backlog of orders at close of fiscal year was $416 million.

Ryan Aeronautical Co. has declared a regular quarterly dividend of 10 cents per share and an extra dividend of 10 cents per share, payable Dec. 12 to stockholders of record Nov. 21.

California Eastern Airways report a total net profit after taxes of $948,505 for period ending June 30, compared to a net of $82,064 for corresponding period last year. This does not include $23,034 earned by **Land-Air, Inc., a** wholly owned subsidiary. A breakdown of the profits shows that company operations resulted in net profits of $133,151, $815,354 profit from capital asset sale.

Delta Air Lines has declared a dividend of 25 cents per share, payable on Dec. 1 to stockholders of record on Nov. 14. Capital stock has been increased to 1.5 million.

International

A British Overseas Airways Corp. jet Comet made a belly landing at Rome Airport Oct. 26 shortly after taking off for Johannesburg, South Africa, the first major accident in which a Comet has been involved. None of the crew or passengers was injured. An engine is reported to have failed.

Dassault Mystere 2 has exceeded Mach 1 while being piloted by USAF Maj. John M. Davis, French air ministry discloses. It is the first French craft to achieve supersonic speed.

British Overseas Airways Corp. has announced intentions to purchase five freighter versions of turboprop Bristol Britannia, subject to government approval. Delivery is due in 1955-56.

Canadian Pacific Airlines has been licensed by Canadian government to operate passenger, mail and freight service from Vancouver to Mexico, Lima, Sao Paulo and Rio de Janeiro. This service would mark first Canadian move into Central and South America.

New engine factory, costing $15 million, has been opened by Canadian Pratt & Whitney Aircraft, Ltd., at Jacques-Cartier, Quebec. Production has started on R1340 Wasp engines for Canadian-built, North American Aviation-designed Harvard trainers.

AVIATION CALENDAR

Nov. 6-7—National fuels and lubricants meeting, Society of Automotive Engineers, The Mayo, Tulsa, Okla.

Nov. 7—IRE symposium on microwave circuitry, Western Union Auditorium, New York.

Nov. 8—Annual Midwestern Tool Engineering conference, University of Illinois, Urbana, Ill.

Nov. 10-11—Eighth annual convention of The Magnesium Assn., Hotel Biltmore, New York.

Nov. 11-12—Piper distributors' annual meeting, Lock Haven, Pa.

Nov. 13-15—Acoustical Society of America symposium on aircraft noise, San Diego, Calif. (For details, write ASA, 57 E. 55 St., New York 22.)

Nov. 17-20—National Aviation Trade Assn. annual convention, Hollywood-Roosevelt Hotel, Los Angeles.

Nov. 19-21—Fourth Annual Safety Seminar sponsored by Flight Safety Foundation, Hamilton, Bermuda.

Nov. 30-Dec. 5—Annual meeting of ASME, Hotels Statler and McAlpin, New York, N. Y.

Dec. 2—Symposium on light-metal heavy forgings and extrusions for aircraft, SAE, ASME, IAS and AIME, Hotel Statler, New York.

Dec. 2-5—Aviation Distributors and Manufacturers Assn. tenth annual meeting, The Kenilworth, Miami Beach.

Dec. 3-5—Society for Experimental Stress Analysis, annual meeting, Hotel McAlpin, New York.

Dec. 17—Annual Wright Bros. dinner, 7:30 p.m., Statler Hotel, Washington, D. C. Wright Bros. lecture to be presented by IAS 3 p.m., U. S. Chamber of Commerce auditorium.

Jan. 12-16—Annual meeting and engineering display of Society of Automotive Engineers, Sheraton-Cadillac Hotel, Detroit.

Jan. 14-16—AIEE-IRE-NBS conference on High Frequency Measurements, Statler Hotel, Washington, D. C.

Jan. 19-23—Plant Maintenance Conference, Public Auditorium, Cleveland, O.

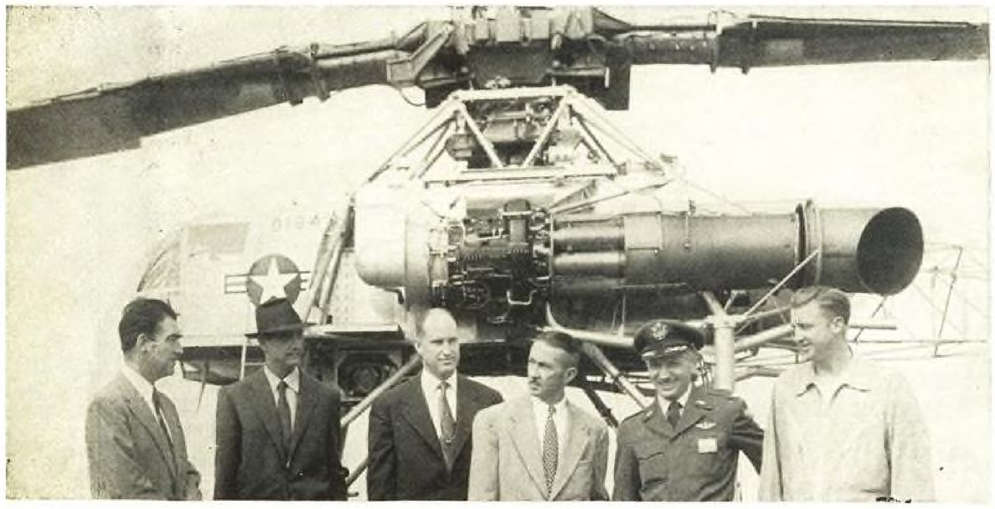
Jan. 19-23—Winter general meeting of the American Institute of Electrical Engineers, Hotel Statler, New York, N. Y.

PICTURE CREDITS

7, 15—Wide World; 16—Fairchild Aircraft; 18—NACA; 21—Lockheed; 22, 24, 27, 28—Solar Aircraft Co.; 84—NACA.

ALOFT — Giant Hughes XH-17 on its first official flight hovers some 40 ft. above the ground at Culver City, Calif. It is powered by two modified General Electric J35 turbojet engines. Air is transferred from the engines through the rotor blades to burners at the blade tips.

Hughes XH-17 Cargo Copter Goes Aloft



PERSONALITIES—Closely connected with development of the XH-17 were (left to right): Rea Hopper, Hughes Aircraft Aeronautical division director; Howard Hughes; Clyde Jones, chief of aeronautical engineering; Warren Reed, assistant; Col. Carl E. Jackson, USAF Air Research & Development Command Headquarters, Baltimore, Md., and Pilot Gale J. Moore.

GARGANTUA—Two full-size autos beneath the XH-17 emphasize the flying crane's dimensions. It stands more than 30 ft. high, its rotor blades have a diameter of more than 125 ft. The craft is designed to straddle large, heavy equipment such as bridge sections, artillery and vehicles for delivery across natural barriers such as rivers and mountains.

WHO'S WHERE

In the Front Office

Harold E. Gray has been designated vice president in charge of Pan American World Airways' Atlantic division. His former post as vice president-Pacific-Alaska division is being filled by vice president **Clarence M. Young. Humphrey W. Toomey** has been elected a PAA vice president.

Donald G. Royer has been named assistant to the president of Slick Airways with offices in Burbank, Calif. He previously was station manager of the carrier's New York terminal.

J. W. Miller, president-general manager of Mid-Continent Airlines prior to its merger with Braniff, has moved to Dallas, Tex., and assumed his duties as vice president of the combined company. He is also a director.

Angel Martin Perez has been named executive vice president of the newly formed, partially state-owned Aeronaves de Mexico y Central America, which reportedly will open routes to Spain, France, Holland and England. Named to the board: **Manuel Palavicini, Eduardo Ampudia** and **Luis Garcia Larranaga.**

Rear Adm. Willis E. Cleaves, USN (Ret.), has joined Bendix Radio division of Bendix Aviation Corp., Baltimore, Md., as staff assistant to the division general manager and Bendix vice president. Cleaves recently was director of aviation sales for Collins Radio Co. He retired from the Navy in 1946.

Emery B. Kerekes has been designated assistant to the vice president of Hydropress, Inc., and its subsidiary Loewy Construction Co., Inc., N. Y.

Harvey H. Morrison has joined Stillman Rubber Co., Culver City, Calif., as vice president-production. He formerly held a similar post with Los Angeles Standard Rubber Co.

Donald L. Herr has been elected president and a member of the board of American Electronic Mfg., Inc., Los Angeles, a new firm handling precision computors, components and instruments.

Harold Graham, Jr., has been designated vice president in charge of the Air Cruise division of Resort Airlines. Graham has been with Pan American World Airways and Panair do Brazil.

Changes

Ray Ryan, formerly an executive with Consolidated Vultee Aircraft Corp., has joined Atlas Corp. to advise its affiliated companies on production problems. He will remain available for part-time consultation for Convair.

John H. Seaton has been named superintendent, aircraft wheel and manufacturing for B. F. Goodrich with offices at Troy, Ohio.

George T. Keller has been appointed sales manager of the Engine division, Burbank, in a reorganization of Pacific Airmotive Corp.'s Sales division. Other changes: **Roy Backman** to sales manager, Products dept. and **Ernest L. Black,** sales manager, Manufacturing division.

INDUSTRY OBSERVER

► Enthusiasm for the new Rolls-Royce Conway (RCo.2) by-pass engine —filling the gap between turbojet and turboprop—is tempered in some quarters by knowledge of the special problems involved. One example: The engine is planned around a specific requirement; if the requirement changes, a new engine is needed. Installation of ducting—which by-passes some engine inlet air around combustion chambers to mix with exhaust gases in tailpipe—is complicated and difficult. Another stumbling block is drive mechanism for the fan, used to boost energy of by-passed airstream.

► Watch for a serious reconsideration of the biplane configuration in future fighter competitions. Layouts will feature extremely low aspect ratios, narrow gaps between wings and large staggers. Design affords high strength and stiffness with requisite wing area and possible flow improvement. Another application would be a ramjet aircraft in which the biplane wings served as lifting surfaces and contained the ramjet engine between them.

► **Top airline engineers from United, American, Eastern, and Pan American visited General Electric's Lockland (Ohio) aircraft gas turbine plant last week for a three-day technical rundown on new and future GE powerplants which could find use in jet transports. Airline personnel were cleared by military to permit GE to disclose newest classified jet designs.**

► First production North American Navy FJ-2 carrier-fighter version of the Air Force Sabre is due to fly at NAA's Columbus, Ohio, plant about the end of November, with deliveries to Navy starting about the first of the year. Two prototype FJ-2s which passed carrier tests did not have wing-folding provisions, but these are included in production version.

► **Airline service testing on propeller governors equipped with high-pressure hydraulic by-pass "safety valves" to prevent inadvertent reversals should be ready to start in November, according to CAA. Meanwhile, Air Line Pilots Assn. has asked CAA to permit wiring for the new changed mechanism to be included in rewiring that is now taking place in propeller systems as another preventive measure.**

► Corporation aircraft owners poll shows the average business plane owner wants a plane that will carry 13 passengers, cruise at 256 mph., and have pressurization, tricycle gear and no less than 72 in. headroom.

► **North American's new F-100 version of the Sabre, unlike most of the new planes being purchased by USAF, was a company-sponsored project, sold to the military to fill an obvious requirement, rather than an airplane built to meet pre-set military specifications.**

► Air Defense Command has notified its Ground Observer Corps to be on the lookout for 800 military balloons a day with diameters ranging from 9 ft. up to 73 ft. These balloons are being released for weather observations at various points across the continent. Many are being released at three points along the Pacific Coast to drift eastward across the country at 80,000 to 100,000 ft. altitudes.

► **Navy observers have been favorably impressed with the early test flights of the Douglas F4D Skyray despite the fact that the delta-wing interceptor has been flying with an Allison J35 turbojet instead of the more powerful Westinghouse J40 originally scheduled for prototype and production versions.**

► Tail-rotor on the jet-powered Hughes XH-17 giant helicopter (pictures, page 9), operates from a mechanical drive off the two jet engines and has no gas ducting system like the main rotor. Actually, it is a standard tail rotor system built for a Sikorsky H-19, which was adaptable to the much larger Hughes machine because of the absence of torque in the gas-driven main rotor.

NATO Air Power — A Staff Report

The air forces of the North Atlantic Treaty Organization are like a skeleton that has recently added some flesh to its bones but still lacks sufficient muscle to wrestle with a formidable foe.

The buildup of NATO air power has accelerated during the past year but it will fall short of its announced goal of 4,000 tactical aircraft in operation by the end of this year. To measure the scale of the NATO contributions it is interesting to recall Air Force Secretary Thomas Finletter's recent disclosure that Russia has provided its Chinese and North Korean allies some 4,400 aircraft, including more than 2,000 jet fighters, and is currently moving toward investing a sizable force of twin-jet bombers in the Korean war. During the recent Blue Alliance NATO maneuvers in Germany the Allied Air Forces in Central Europe (by far the largest of the NATO AF commands) was proud of its record in operating some 1,200 jet aircraft.

▶**The Lineup**—The NATO air power lineup now includes three main commands:

• **The Allied Air Forces Northern Europe** with headquarters in Oslo, Norway, and commanded by Major General Warren Carter. This includes the Norwegian and Danish air forces.

• **The Allied Air Forces Central Europe** commanded by Gen. Lauris Norstad with headquarters at Fontainebleau, France. AAFCE includes U. S., British, Canadian, French, Dutch and Belgian units.

• **Air Forces Southern Europe** with headquarters in Naples, Italy, commanded by Lt. Gen. David Schlatter. This includes Italian, Greek and Turkish units.

Although all three commands are headed by American airmen they are subordinate in their theater commands to a British admiral, an American general and an American admiral. Nowhere does an airman exercise overall command. In both the northern and southern commands the bulk of the air power actually available is afloat aboard naval carriers and is not under the air command.

Welding air units of eleven nations into a coordinated military force capable of operating under a single command is a formidable task and nobody in the NATO air forces would deny that tremendous obstacles must still be surmounted before this goal can be achieved.

Perhaps the basic problem is aircraft. Not until the plans to bolster NATO air forces with a significant force of F-86 Sabres are implemented will there be much chance of successfully controlling the air over Europe. At present there are USAF and Canadian Sabre groups based in England and the first contingent of Sabres for the RAF has already reached England. All of these units are outside the NATO commands. For NATO a Canadian Sabre wing is scheduled to move shortly into French and German bases and at least one USAF fighter wing in Germany is scheduled to replace its F-84s with Sabres.

By the end of this year a respectable Sabre force could be mustered to do battle with MiG-15s and their successors over Europe and provide protective cover for the obsolescent jets with which the NATO forces are now equipped. As day fighters they now have British Vampires and Meteors and American F-84 Thunderjets. For night fighters there are some radar-equipped Meteors and Venoms. In the bomber category there are only piston-powered B-26s. For transports they have two wings of C-119s and a wing of C-82s.

▶**Standardization**—Strides have been made in standardizing communications and field maintenance for the varied nationalities and equipment the NATO air forces are operating. As a result of Operation Dedale, cross-servicing techniques were developed so that a squadron of any type fighters can now land at any NATO airdrome and be serviced and re-equipped to fly another combat mission. A program of standardized airfield construction is well along to provide 8,000-ft. runways, but snags developed because actual construction must be done by the country where the bases are located. In France this has caused particular trouble.

Basic supply problems of the NATO air forces are handled by the various countries for their own units. This presents a logistical knot that is admittedly impractical for sustained combat operations. At present, American air units in Europe are in the process of a basic realignment, withdrawing to bases on the west bank of the Rhine and building up in northeastern France. A major shift in the logistical pipeline to support these forces is also in progress. Instead of the post-war pipeline through German North Sea ports to southern Germany which was only 90 mi. from Red territory, a new supply line is being built up from French Atlantic ports. This has required an enormous American investment and will require even heavier expenditures if such basic items as adequate jet fuel supply are provided.

The forces that the various NATO countries have contributed to the joint air effort in Europe represent an effort to build a dike against the combination of the Red army and its supporting air power as fast as possible. But behind this temporary dike lie varying national theories on the kind of air power required to counter Soviet aggression.

At the moment there is a strong feeling in Europe that the danger of a general war between Russia and the Western Powers has receded and there is more time than originally anticipated to rebuild western defenses. The American viewpoint is still predicated on our ability to deliver a crushing atomic aerial attack as the prime deterrent to Soviet aggression.

▶**Foreign Views**—The British seem convinced that instead of a hot war the Western Powers must be prepared to fight a "cold peace." As a result, the British are re-orienting their air effort to provide more air transport to rush their limited military manpower resources to the world's trouble spots and more tactical air power to support these ground forces wherever they may have to fight in new Koreas.

The French are bent on building up a military establishment in their classical tradition, complete with battleships, submarines, a full repertoire of naval and land-based aircraft and jet transports. Convincing the French that this is militarily unnecessary and economically impossible is one of the tougher problems faced by NATO planners.

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F-86 SABRES SWEEP SKIES over Korea, keeping wary eye open for MiG-15s that might sneak across Yalu to attack UN fighter-bombers.

Combat Report From Korea

Sabres Still Rule Skies Over MiG Alley

- **Scoreboard shows F-86s destroy Russian fighters at 15-1 rate; ratio for all UN planes almost 11-1.**
- **But basic concept still is air superiority, isolation of battlefield by interdiction, plus close support.**

By R. P. (Pepper) Martin
(McGraw-Hill World News)

Tokyo—One of the longest sustained air battles in history is still being fought in the narrow northwest corner of Korea, debris-strewn MiG Alley. In a sense, it is a battle between a moderate-sized Goliath and an overgrown David. The Red Goliath has superior strength and possibly a better all-around weapon, but victory has gone to his slighter, more skillful opponent.

The Reds are using their first-team pilots, but their second- and third-stringers are gradually catching up to them in skill. They are mounting a greater number of sorties a day than at any time during the war. The pilots are more aggressive and teamwork between individuals and between flights has greatly improved.

▶**Sabre Gadget**—The F-86 Sabre, which bears the brunt of the air fighting, has been improved, but so has the MiG-15. There has been a considerable increase in the thrust of the enemy's jet engines. In combat at high altitudes, the MiG-15 is pulling away at a much faster rate. Some pilots thought the Reds were using afterburners, but this is now generally discounted, since there is no photographic evidence to support the belief.

The Sabres have a "gadget" but it is not yet in wide use, and it does not seem to have played a major role in air combat.

The Reds, apparently dissatisfied with their cannons, have been experimenting with cannon-machine gun combinations. Most Americans are waiting eagerly for air-to-air rockets as the answer to their gunnery problems.

The Reds are fighting defensively, where the odds favor them. They can probably put three to four times as many jet interceptors as the United Nations into any single fight. They have excellent ground radar. Fighting close to home, they have a longer period of airborne combat. They have a retreat across the Yalu River, to which they can flee if hard-pressed. And a damaged Red aircraft has a greater chance of landing safely at its home base only a few minutes from the battle area.

▶**Scoreboard**—Despite these advantages, during the three-month period ending Sept. 30, 107 Russian-type MiG-15s were destroyed in air combat. The U. S. Air Force lost seven F-86 Sabres and three F-84 Thunderjets in the same battles. The F-86 superiority in combat is better than 15 to 1, while the ratio of all UN planes in air combat is almost 11 to 1. Figures for October are not yet available, but the ratio may be even higher than the three-month ratio.

What, then, is the source of David's strength, or the reason for Goliath's comparative weakness?

The major factors accounting for UN superiority at present are pilot efficiency, training and gunnery, rather

New AW Writer

Robert P. (Pepper) Martin is serving as AVIATION WEEK's Tokyo correspondent while A. W. Jessup, chief of McGraw-Hill World News' Tokyo bureau, is on leave of absence. A war correspondent in World War II in the Chinese theater, Martin has been in Japan for the Columbia Broadcasting System three and a half years. He returned to Tokyo recently after completion of a Nieman Fellowship at Harvard. Jessup is studying at Princeton under a research fellowship awarded by the Council for Foreign Relations.

DOWN THE RUNWAY taxi more Sabres bent on harassing North Korean jets.

than plane superiority. Some pilots contend that Russian or German "volunteers" have appeared in the air war. Some of the tactics appear to be of Luftwaffe derivation. But regardless of the enemy's nationality and skill, American pilots have been able to outshoot and outmaneuver them. Five of the 61 MiGs destroyed in September, a record month, crashed when they went out of control during high-speed maneuvers.

▶**Reds Aggressive**—General Otto P. Weyland, FEAF commander, insists there is no single explanation for the victory ratio. A few "traps" have been successful. The Reds have been more aggressive and willing to accept combat. They have put more planes into the air. Weather during the summer was ideal. The fighter-bombers were heavily engaged in "Operation Strangle" and this meant a large proportion of the F-86 squadrons were in battle areas.

These factors, according to Weyland, meant that more planes were "available" for destruction. And American experience, improvements in the Sabre, training and know-how "have been slightly better than the enemy's accumulation of experience, technique and training."

The Air Force, for security reasons or simply because it shies away from enthusiasm engendered by "hush-hush" secret weapons that promise to win wars overnight, has been in a turmoil of confusion ever since Air Secretary Thomas K. Finletter referred vaguely to a "gadget" that gave the Sabre complete superiority over the MiG. He subsequently retreated slightly, saying he referred to "continual improvements" that are being made in U. S. interceptors and fighter-bombers.

There is a "gadget" but it is still classified. The Communists may know what it is because at least one Sabre so equipped was shot down in enemy territory. Only a few of the F-86s carried the secret device, and there is no reason to believe these few were responsible for more than their normal share of "kills." (One disadvantage of fighting over enemy territory is that any UN plane shot down, unless it burns, is available for enemy inspection.)

Brig. Gen. John W. Sessums, commanding officer of the 13th Air Force at Clark Air Base, added spice to the speculation when he said "the F-84E model is equipped with the radar gunsight or Sperry sight which has been used with deadly results in Korea." But FEAF says flatly the radar gunsights have been used by both the Thunderjet and Sabre in Korea for about a year. The general's revelation was not as spicy as it had first appeared.

▶**Gun vs. Cannon**—Despite their victory ratio, Sabre pilots still vigorously argue the merits of weight-of-fire against rate-of-fire. The Reds appear to be searching for a compromise by adding 50-cal. machine guns to their normal four 23-mm. cannon. The cannon shell does great damage when it hits but the 23-mm. has a shorter sustained rate of fire and the ammunition that can be airborne is limited. The 50-cal. projectile, on the other hand, is heavy enough to hurt anything it hits, the rate-of-fire is high and the dispersal area is wide.

Neither the Reds nor the U. S. Air Force is using its maximum potential in day-to-day operations. If the Red air force is primarily Chinese, it has been expanded to a greater degree than anyone dreamed possible a few months ago. New units appear overnight on the Antung fields. Repair bases are deep inside Manchuria, and if a unit is hit hard it is pulled out and replaced by a new one. There seems to be a large reservoir of skilled and experienced pilots.

Figures can be very misleading. For instance, the two air forces are about even in the total number of planes in the theater. But the UN force includes Mustangs, Corsairs, AD's and a great number of transport planes.

Secretary Finletter's statement that there has been a 50% increase in the Fifth Air Force's striking power is comforting, but somewhat misleading. Two new F-84G wings are in Japan and Korea, and they comprise much of this 50% increase. The long-range fighter-bomber, redesigned for in-flight refueling, has made two mass crossings of the Pacific, proving that aerial refueling has moved out of the experimental and into the operational stage. But the F-84G is a potential weapon, to be used at its maximum only if the character of the air war changes.

▶**Red Buildup**—The Reds also have an unused potential. They are known to have a number of twin-jet IL-28 light bombers in Manchuria, none of which have yet appeared in action. One report said that 23,000 North Koreans are being trained in Manchuria for air force duty. If the report is true, a large proportion of them will probably be packing A-frames while building airfields.

From July 1 to Sept. 30, FEAF aircraft flew 65,630 sorties. The F-86s flew about 12,000 of these, and the F-80s and F-84s between 11,500 and 12,000. These fighter-bomber sorties were not close-support. The Reds average about 10% of FEAF's daily accumulation of sorties. On their best days they have reached a sortie rate of about 20% of our effort. But almost all of the enemy sorties are by MiG-15s, and they are concentrated in MiG Alley. As a general rule, the Reds challenge only when they have superiority in numbers.

Sabre successes have been so great the Air Force flatly states it can establish local air superiority any place in North Korea at any time that it wishes. But there is a decided difference of opinion on the potentials of the two opposing air forces. No one is intensely worried about the MiG, even if it is converted to a fighter-bomber. Operating from their present bases, the MiG pilots would not be able to stay over UN front lines or forward air bases long enough to do much damage. But the possibility of a surprise all-out attack by MiGs and IL-28s against our forward bases has many pilots in a sweat.

▶**Not Attrition**—General Weyland said the UN could "take care" of any Communist air assault on our front lines, and "if they try to come into our backyard, we will whip them even worse." Many combat pilots are somewhat more modest. The most experienced veterans frankly say: "We'd get a lot of planes, but if the Reds wanted to put in the effort they'd sure raise hell with our bases."

There is far more method and planning to the air war in MiG Alley than is superficially apparent. This is not primarily a war of attrition, even though it seemed this might be our objective after Secretary Finletter optimistically claimed that U. S. overall jet production is now equal to that of the Soviet Union. The basic concept of the application of tactical air power remains the same in Korea: to establish and keep air superiority, isolate the battlefield by interdiction, and provide close air support. Within this broad concept, the Sabre sweeps function with smooth precision.

The F-86s cover the fighter-bomber attacks on the key railway and highway systems that converge as they cross the Chongchon River before continuing on to Manchuria. FEAF headquarters in Tokyo believes that a major reason for the strong Communist air resistance during the summer was the cumulative effect of the bomber attacks.

The North Korean economy, devastated by earlier raids, was grinding slowly to a complete halt. Food was being shipped in from China but was not reaching the civilian population. The Kim Il Sung government in Pyongyang, beset by pleas from the devastated areas, demanded more effective air intervention. Ground commanders insisted that their supply lines be kept open even if it meant committing a large portion of the Chinese Air Force.

▶**Broad Objective**—In strategic terms, the Fifth Air Force's broad objective is to keep the Red air force bottled up in northwest Korea. During the past six months, not more than six enemy planes (the majority of them PO-2s, a World War II biplane with a top speed of 80 knots) have crossed the UN lines. The air strategists reason that if Sabre pressure were lessened, the Reds would begin to creep southward. This would increase the hazards of the UN air interdiction program and probably in the end subject UN forward bases, supply lines and the front to Communist air assaults.

The Sabre mission thus falls into perspective in relationship to the total air effort. It is the key to the success or failure of this effort. As long as the Reds are bottled up along the Yalu, and the Fifth Air Force is able to establish local superiority over any part of North Korea, the tacticians have more or less free reign to modify the pattern and method of applying air power.

As in past wars, the Air Force is able to shift rapidly the amount of power and the point of its application. This makes it difficult for the Reds to adopt effective defensive measures. At the height of the interdiction campaign on the network of highways and railways, the Reds had begun to shift most of their anti-aircraft batteries to these key communications lines. The Air Force then switched its assault to supply dumps and collection points which were relatively undefended.

▶**Red Missiles**—The Reds have greatly augmented their anti-aircraft defenses, and their radar network is increasingly effective. At least twice they have used ground-to-air rockets against B-29s. Apparently they were fused to explode on contact only, and no damage was suffered. Despite these improvements in Red defenses, the Air Force has been able to keep a few jumps ahead of the enemy. This advantage is reflected in the Air Force casualty rate, which has been averaging about two men a day, including wounded.

The interdiction program has been severely criticized because of its failure to prevent Red supplies and reinforcements from reaching the front. Gen. Lemuel C. Shepherd, Marine Corps commandant, charged the program was a "fizzle," a remark that enraged many Air Force officers. Said one: "I hope the Air Force will not engage in a long-range debate with a short-term expert."

Interdiction, according to the Air Force, can rarely, if ever, completely halt the movement of troops and supplies. Its function in Korea is to limit such movement to the point that the enemy can not launch and sustain a major decisive offensive. Ground action, fierce as it has been on short sectors of the front, has not been great enough to force the enemy to expend what he manages to accumulate each day. This gap between supply and expenditure means the Reds can build up reserves, and they have used these prodigiously in their limited offensives. But Air Force officers believe the buildup has not been great enough for the Reds to mount a sustained offensive of any great magnitude or duration.

The largest proportion of North Korean industry already has been destroyed. Bombing of the Suiho powerplants on the Korean side of the Yalu River certainly caused some disruption of production in Manchuria. It probably slowed down production of small-arms ammunition and mortar shells in the underground factories known operating in North Korea.

But from the strictly military point of view, the Air Force still faces an insurmountable handicap in shutting off the flow of supplies. That is the rigid curtain between them and the production sources in Manchuria and Russia.

Aviation Safety

Plane Seating

- **Restrictions on design scored by AA engineer.**
- **Seats facing any direction can be safe, he says.**

Proposed Civil Air Regulations, to restrict transport airplane seating to rearward-facing seats, would put an unnecessary restriction on the aircraft designer and engineer, in the opinion of William L. Littlewood, American Airlines vice president, engineering.

Current trend to turn all air transport seating backward as a greater protection to the passenger does not consider all the facts, the well-known airline engineer and industry member of National Advisory Committee for Aeronautics told AVIATION WEEK.

A safe seating structure can be faced

NEW FRENCH FIGHTER TESTED

The new SO 4050 Vautour twin-jet night fighter and ground support plane (model shown above) made its first flight recently near Paris. Initial powerplants are Snecma Atar 101Bs of approximately 6,000 lb. thrust each, but more powerful engines are to be installed later to provide supersonic performance. Engineers of the French company have designed the single-seat SO 4050 for fast and economical production.

forward or sideways, as well as rearward, Littlewood contends. He maintains it is quite possible to design a seating and cabin structure in which an individual can survive a 25G deceleration, no matter which way he is facing, if he is equipped with a proper seat belt.

Thus, in the Littlewood view, the direction in which the seat is faced should be determined only by economic or other considerations, not under so-called "safety" pressures.

▶ **Extra Protection**—Actually, the rearward-facing seat offers its passenger extra protection only if the airplane lands directly forward. If it swings around sideways, or ends up tail first when the pilot ground-loops the plane in a final effort to stop it (as frequently happens in an emergency landing), the protection may be less than adequate.

"Great things can be done with seat structure," Littlewood said. "Design for progressive failures to absorb deceleration energy is important. Stronger seat attachments and floor structure, with attention to side loads as well as straight front and rear loads, will help. . . ."

Littlewood expects that an Orlon seat belt, with extra elasticity to absorb some of the deceleration shock without breaking, may ultimately succeed present-type belts.

Present airliner seats which have been sturdy enough to save lives in a number of crashes would not be equally safe if turned around because of the reclining feature.

▶ **Reclining Device**—Eventually, the reclining device may disappear from airline seating, he feels; this is partly because of the extra protection, under loads of any direction, that can be built into rigid seats, and, partly, because the higher speeds of future air transportation will seldom require the long sitting-still that is necessary in some of today's long flights.

The Littlewood views provide an interesting commentary on the recent Civil Aeronautics Board proposal, considered at the annual Airworthiness Review, to make rearward-facing seats mandatory on air transports. As a result of adverse comments at the review, the proposal was deferred for further discussion. It was not included in the recent draft release of proposed Airworthiness Regulations offered by CAB's Bureau of Safety Regulation for industry consideration and ultimate CAB action later this year (Aviation Week Oct. 27, p. 16)—A.McS.

Gloster Meteor to Brazil

Brazilian Air Ministry is completing negotiations to buy approximately 70 Gloster Meteor Mk. 7 and Mk. 8 jet planes for nearly $17 million. The contract reportedly has already been signed by President Vargas.

New Constitution Adopted by ALPA

An executive board of eight active airline pilots, plus the president, Clarence N. Sayen, will govern the Air Line Pilots Assn. between conventions, delegates to the recent Chicago convention of the American Federation of Labor-affiliated organization decided.

Pilots voted to adopt a new constitution and by-laws aimed at eliminating any future recurrence of the so-called "one-man rule" of their first president, David L. Behncke, in providing for such a board.

Reelected were: Sayen, president; Jerry Woods, Eastern Air Lines, first vice president; F. A. Spencer, American Airlines, secretary, and Lyle H. Hincks, Trans World Airlines, treasurer. Hincks had been appointed treasurer by executive action shortly before the convention to succeed R. G. Strait, who died suddenly. These officers, with five regional vice presidents soon to be chosen from the pilot membership, will make up the new executive board.

▶ **For President?**—The 225 delegates, representing approximately 8,000 active airline pilots and co-pilots, declined to endorse either Stevenson or Eisenhower for President.

Recognizing that some ALPA members are making GCA landings regularly, using radar as a primary aid at stations where there is no ILS, the convention voted to withdraw the old requirement that ILS be considered the only primary aid, but in conditions where there is a choice to continue indicating a preference for ILS, which leaves the initiative with the pilot, over GCA, which involves a "talk-down" from a ground controller.

▶ **Behncke's Pay**—After hot discussions over a proposal to suspend the $15,000-a-year life salary of the ousted president and to withdraw his life membership in ALPA, the question was turned over to a committee, headed by Sayen, with authorization to take final action. Some sources predicted a final compromise at $7,500 a year.

The hot internal question of how to determine pilot seniority was not finally determined, either. Proposed is a seniority clause which would make length of service a governing factor, but with other factors considered also.

The pilots voted their annual resolution calling for an independent air safety board, separating federal safety regulation from economic regulation, and will continue to work actively for congressional action creating such a board, a spokesman said.

FAIRCHILD'S SKYBORNE TRAILER

Fairchild Engine & Airplane Corp. recently began road and flight tests of a new trailer unit designed by the company for speeding loading and delivery of cargo to front-line units. In top photo the trailer is hitched to a light truck, center view shows it being hoisted beneath the Fairchild XC-120 Pack Plane. Bottom photo depicts it airborne with doors locked partially open to form fairings for cutting air resistance. The trailer can handle as much cargo as can be carried in a C-119 Packet, has truck-bed level floor and can be loaded from either end. Fairchild designed the unit with an eye to its future adaptation to civilian applications.

USAF Orders F-100 Into Production

USAF has ordered the F-100, a new and faster version of today's best fighter, the North American Sabre, into production.

The new fighter is designed to be capable of tangling with the forthcoming Soviet-built successors to the MiG-15 as successfully as its predecessors are meeting the sweptwing Russian jets over MiG Alley.

The F-100, originally designated by the company as the Sabre 45, takes the company name from the angle of sweep in its wings. These are raked back to 45 deg., or 10 deg. more than the F-86 Sabre wings. But the wing is still a swept wing, not a delta.

For additional speed, the designer is powering the F-100 with a Pratt & Whitney J57 engine with afterburner, which probably will deliver about twice the thrust of the current Sabre powerplant, the General Electric J47. With afterburner the J57 can be conservatively rated at 15,000 lb. thrust, at least.

▶ **Bigger Than F-86**—The split-compressor engine, with afterburner and additional fuel requirements for longer range, all add up to a bigger airplane. The F-100 is expected to have a gross weight well over the 20,000-lb. mark, as compared to the 16,000 lb. quoted for the F-86A. The nose intake arrangement which has been so successful in the F-86 will be substantially the same. Beefed-up landing gear and heavier armament than the Sabre's .50-cal. machine guns will be provided.

Production of the F-100s will be at the North American Los Angeles plant.

Announcement of the F-100 rounds out the production orders for the next generation of USAF jet fighters, by providing a fast general purpose air superiority fighter to team up with two other supersonic stablemates, the long-range McDonnell F-101 for bomber escort and ground support use and the missile-carrying Convair F-102 delta-wing interceptor. A fourth high-speed fighter, the Republic F-103 interceptor, has not yet been disclosed as a production article, but this may come soon.

Aviation Safety

Pilot Congress

- **ALPA takes new step in setting safety policy.**
- **Association also works with other safety groups.**

By Alexander McSurely

Expanding emphasis on seeking solutions to flight safety problems from the pilot's viewpoint gets higher priority in Air Line Pilots Assn. (AFL) under its new reorganized status.

Last week at Chicago, ALPA voted to establish an annual Safety Congress, in which representatives from each airline's pilot membership and other ALPA members working on safety projects, will meet each March to set Association safety policy on operational and equipment problems (Aviation Week Oct. 27, p. 15).

It will also give pilots the opportunity to review projected airworthiness regulations in advance of the annual CAB-CAA-industry Airworthiness Review in August. Airframe, engine and accessory manufacturers' representatives will be invited to discuss specific problems relating to their equipment, and CAA and CAB safety engineering representatives will be asked.

The new Safety Congress move is seen as a development which will mean closer coordination of the aviation safety projects which the pilots have been carrying on for years, with pilot representatives in virtually every industry-wide program.

These are major safety objectives of the association, as defined by President Clarence N. Sayen:

- **Coordination** of pilot representation in each council, airline and region for effective analysis and reporting of safety problems.
- **Implementing** association safety policies.
- **Participating** in industry projects and conferences on safety.
- **Representing** pilot viewpoint in forming or revising safety regulations or any other municipal, state, federal or international authority's action to regulate air commerce.
- **Participating** in safety activities of International Federation of Air Line Pilots Assn. (IFALPA) and International Civil Aviation Organization (ICAO).

Pilots are organized with council air safety committees handling local problems; with a central air safety committee for each airline handling airline safety problems and with regional air safety committees including representatives of each airline's pilots based at one terminal point. (Pilot accident investigation teams are being established for each region.) There also is an Airworthiness Advisory Committee advising the national officers on air safety problems.

ALPA lists 15 current safety engineering projects which it has assigned to various pilot members as chairmen and which are actively carried on:

- Prevention of inadvertent propeller reversing, Charles Daudt, (AA), New York.
- Rational Aircraft Performance Standards, W. W. Moss, (PAA), New York.
- Radar traffic control, W. A. Jensen, (AA), Washington.
- Radio Technical Commission for Aeronautics, R. C. Robson, (AA), Washington.
- Approach and airport lighting, E. A. Cutrell, (AA), New York.
- Aircraft exterior lighting, R. A. Stone, (UAL), Chicago.
- Cockpit standardization, H. G. Portman, (UAL), Chicago.
- Emergency evacuation, J. C. Burn, (PAA), New York.
- Cockpit coordination, Larry Shapiro, (UAL), Los Angeles.
- Fire hazards, V. H. Brown, (AA), New York.
- Terrain warning indicator, D. L. Phillips, (TWA), Chicago.
- Airport vehicular traffic, J. Henslee, (TWA), Chicago.
- European-Mediterranean navigation and traffic, R. A. Young, (PAA), London, ALPA and IFALPA representative to ICAO.
- Cockpit ventilation and pressurization, V. A. Peterson, (EAL), New York.
- South American-South Atlantic navigation and traffic, E. D. Avary, (PAA), Rio de Janeiro, IFALPA representative to ICAO.

To round out ALPA's safety participation, the airline pilots have representatives taking part in: each CAA regional air space subcommittee; the National Air Transport Coordinating Committee, Civil Aviation Air Defense Advisory Panel, Scheduled Airline Air Safety Committee, and the National Aviation Noise Reduction Committee.

SCOOP INTAKES alongside cockpit mark No. 1 North American YF-93A while . . .

FLUSH INTAKES are fitted on No. 2 plane used by NACA for experiments.

Four Planes From Two YF-93As

Fast jets supplement windtunnels in NACA studies on inlets for missiles and high-speed aircraft.

A pair of not-quite-identical twins—two high-speed sweptwing jet airplanes—are opening up new avenues in flight-testing for the Ames Laboratory of National Advisory Committee for Aeronautics at Moffett Field, Calif.

The two planes, both North American YF-93As, were transferred to NACA a few months ago by the Air Force. Their unique value as tools for flight-testing lies in the fact that they are identical planes except for two important differences:

No. 1 plane has scoop air inlets on the sides of the nose, while No. 2 plane has flush inlets in the same location; the first is fitted with an afterburner, the second is not.

With the simple expedient of combining the nose section of one plane with the tail section of the other, NACA flight-test staff can get a total of four different airplanes to use in its airflow flight-testing program, with virtually identical characteristics except for the planned variations.

▶ **Most of the Answers**—NACA researchers have been studying various types of inlets for the thousands of cubic feet of air which the jets inhale. Prior to the development of jets the researchers were studying air intakes for use on piston engines.

As of now, they have most of the answers for air inlets for high subsonic and perhaps transonic flight, but their research is continuing on inlets for higher speed flight of both aircraft and missiles.

Most of their research in this field thus far has been in simulated flight in high-speed windtunnels.

Now the YF-93As make it possible for them to correlate and extend their windtunnel data with flight tests, providing supplementary information they could not get in any existing windtunnels in full-scale condition.

These two airplanes are powered with Pratt & Whitney J48 engines, with 6,250-lb.-thrust rating dry, and capable of about 9,000 lb. thrust with afterburner. Although a change in Air Force requirements eliminated quantity orders for the F-93, there are few airplanes in service today that are as fast, or that are equipped with such a powerful engine.

▶ **Airflow Problems**—NACA also has a test North American F-86 jet plane, from which the YF-93A design was largely developed, which gives the research organization a nose-inlet airplane with somewhat similar characteristics for another basis of flight comparison with the other inlet types.

In simple terms, the problem of high-speed airflow for jet aircraft involves the mingling of three separate streams of air.

- **The outside air** through which the plane is moving.
- **The main stream** of air which enters the airplane at the main intakes and passes through the engine to be exhausted at the tailpipe.
- **A supplementary stream** of cooling air which enters through smaller inlets farther back on the fuselage and also exits through the tailpipe.

The basic problem is to make the air flow into the inlets and out of the exit as smoothly as possible. Complications are numerous.

Airflows act differently at different speeds. Flow characteristics differ with and without afterburner. And the way the exhaust mixes with the outside air at the exit, where the actual thrust is delivered, is one problem that is especially worrisome.

▶ **Summary**—In fact, NACA has found that the biggest difference in high subsonic speed flight performance comes as a result of varying exit conditions, rather than inlet conditions.

In summary, NACA has found out that any one of four inlet designs will do an adequate job for the subsonic jet airplane, if proper attention is given to design detail. These include the three types of inlets on the North American planes, plus the small wingroot inlets found in several other U.S. jets.

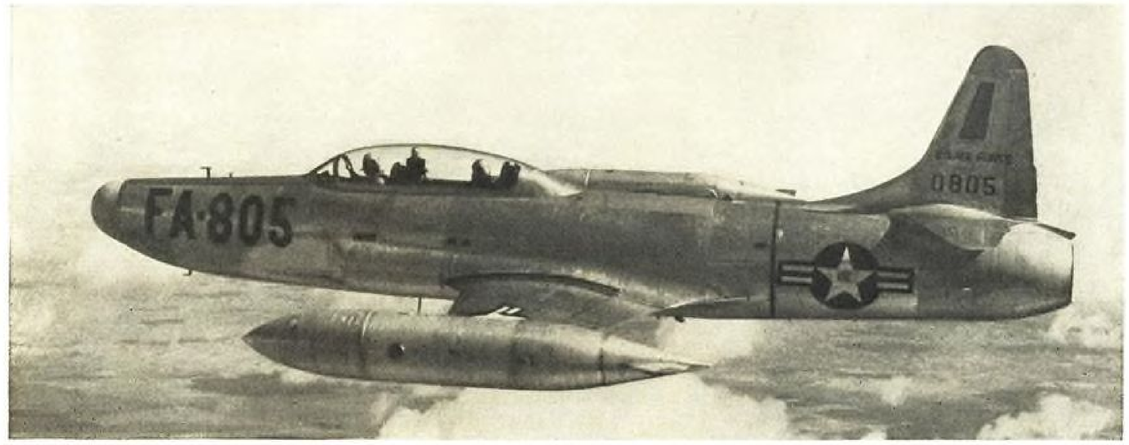
However, as the speeds go higher across the transonic range and into the supersonic regions, the design of the inlet becomes an extremely critical factor in the overall performance of aircraft or missile.

One interesting feature of the flush inlets on the No. 2 YF-93A is a bleed-off for boundary layer air, designed to smooth out the main flow through the inlet by separating out the turbulent air next to the fuselage skin.

NACA scientists say that this is an "extra" which their studies had indicated would not be necessary for flush inlets, but that, presumably, North American designers included it as an added assurance of smooth flow.

▶ **Private Venture**—At least one other U.S. experimental airplane has been fitted with flush inlets: a Republic YF-84, which needed the space occupied by the usual F-84 nose inlet for radar.

The Republic flush-inlet plane was developed as a private venture and made several flights, but did not win an Air Force production order. Air Show attendants saw its fuselage at Detroit last September as part of Air Materiel Command's static aviation exhibit. Apparently, Republic decided the flush inlets were less satisfactory than wingroot intakes; at least, the new RF-84F, a sweptwing plane with a solid nose, now has wingroot inlets instead of flush ones.



AFTERBURNER on this Lockheed F-94B fighter speedily gives extra jet power when needed for successful interception, typifying how . . .

Engineers Meet Afterburner Challenge

- **There's much more to getting that extra thrust out of the engine than just extending the tailpipe.**
- **Solar Aircraft Corp. engineer tells of techniques used to beat high-heat and combustion problems.**

The afterburner has been in the jet engine picture for a good part of the turbine powerplant's history. A lot of data on the afterburner's thrust-adding potentialities, how it works and its general makeup has been collected.

But there has been very little detail on specific design and construction.

▶ **Not Just a Pipe**—Contrary to a wide belief, even in aviation circles, the afterburner is not just a simple pipe. Essentially, it is a special engine tandemed to the basic turbojet, breathing its exhaust and burning additional fuel for thrust boost required during takeoff, climb or combat maneuvers. As a special engine, it is crammed full of design technicalities. And it still offers a many-faceted engineering challenge.

Early work on combustion and performance of the afterburner was revealed in AVIATION WEEK Jan. 28, p. 23. Now, more wraps have been taken off this jet auxiliary, for a close look inside. At the recent National Aeronautic Meeting, in Los Angeles, of the Society of Automotive Engineers, a detailed analysis of afterburner makeup and problems was unfolded by Ralph Kress, design engineer in Solar Aircraft Co.'s Development Engineering division.

▶ **Heat Problems**—The afterburner involves special design considerations. To get a substantial amount of added thrust, the gases in the unit's tailpipe reach more than 3,000F after combustion. This is more than 500F above the melting point of the best alloys.

Thus, the tailpipe and components introduce complex problems in high-temperature engineering for serviceability and reliability.

Detail design needs a special look to assure that all hot surfaces be cooled—normally the high-heat gases would quickly melt an uncooled surface.

Another big task is to get smooth, efficient combustion of afterburner fuel. With gas velocities of 300-400 mph., combustion instability produces a force that rapidly causes service troubles.

When afterburners were first hooked to jet engines in planes, it was soon shown that major improvements were desirable to improve afterburner installed performance, Kress points out. Refinement of basic afterburner design and improvement of performance and efficiency were indicated.

▶ **Nozzle Studies**—One of the prime problems concerned the variable-area jet nozzle. Aircraft with afterburners had to have a smooth variation of power from normal to the full augmented thrust, instead of the surge experienced with the early two-positioned-nozzle afterburners. Also, advance engine designs would give better fuel efficiency by using the afterburner nozzle for no-burning operation. These factors pointed up the desirability of the fully-variable-area jet nozzle.

Numerous other details, too, came in for their share of study, because experience showed that no part of the afterburner is so small as to be considered unimportant.

Kress analyzes afterburner design by considering the installation as consisting of four major components—diffuser, burner, controls and variable nozzle. This front-to-end approach gives a good sequence picture of the how and why of afterburner makeup.

▶ **Diffusers**—Gases leaving the jet engine's turbine wheel are led through the shortest distance to the jet nozzle. This is done with a streamlined tailcone fastened to the turbine flange.

Leaving the turbine wheel, the gases usually have near-sonic speeds—much too high for afterburning. To cut this exit speed to proper value, a diffuser section is required before the afterburner combustor. General practice, Kress says, is to diffuse the gas to a speed of 400-500 feet per second at the combustion section. The diffuser usually is made integral with the tailcone to cut down on afterburner tailpipe length.

A cross-section typical of today's tailcones (Fig. 1) discloses that it has an outer shell with flanges for attachment to the turbine flange and balance of the afterburner, an inner cone, support struts and fairings. There also may be a ducting system for air-cooling the

turbine wheel. Bosses and pads take care of engine instrumentation and controls.

The inner cone is mounted off crossbars tied in to the outer shell, to transfer cone loads to the shell. The cone-crossbar connection is not rigid, allowing a floating action to take care of differential expansion. The strut-like fairings covering the crossbars serve to smooth the gas flow.

► **Integral Makeup**—Another type of tailcone, an integral design (Fig. 2), has solved many of the operating and production difficulties found in other cone types, Kress reports.

When the cone is integral with struts, the latter become structural members instead of fairings, permitting the elimination of the structural crossbars.

Retention of cone to shell usually is by means of pins inserted from the outside, with liberal clearance for full thermal expansion of the parts.

The cone-shell attachment always has been a problem, says Kress, both in no-burning and afterburning tailcones. Actual gas loading, due to pressure differential within the assembly, generally is not very high, indicating that a relatively light attaching member is required.

But this is not true, experience has shown, because field and test cell data have pointed to a long history of cone and shell fractures. Close study has shown that these probably are caused by severe pounding and buffeting produced on the shell by the relatively large and heavy cone, subjected to variations in pressure and vibrations during operation.

With afterburning this condition is much more severe, failures having occurred after a very short time, Kress reveals.

► **Fracture Fix**—To lick this difficulty, an attachment was designed to isolate the cone from the shell with high-temperature-resistant resilient pads. The cone-to-shell connection uses the usual pin, but the resilient pad prevents contact of shell and pin. This method has proved very successful, eliminating the tendency of the shell to fracture—particularly in afterburner tailcones—Kress says.

Tailcones are welded assemblies usually fabricated of AISI Type 321 stabilized corrosion-resistant steel.

But the afterburner design sometimes dictates the longitudinal or beam stresses in the outer shell, especially in cantilever designs, Kress reports. In this case, he says, the longitudinal stress—factored for G-loading requirements of the airframe—indicates a higher strength material than 321. Inconel W and N-155 are typical materials used in the shell in this case.

Inner cone materials also are 321 corrosion-resistant steel, except where burner design enters into the tailcone configuration. Loads taken by the cone usually are light and primarily are due to the differential gas pressure across the cone. The resilient cone pin support alleviates buffeting and impact loads.

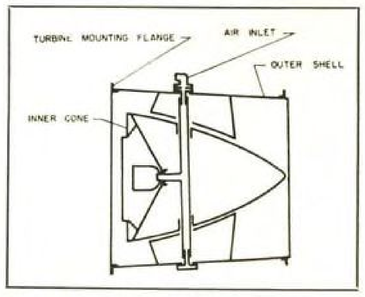


Fig. 1. Cross-section of typical tailcone.

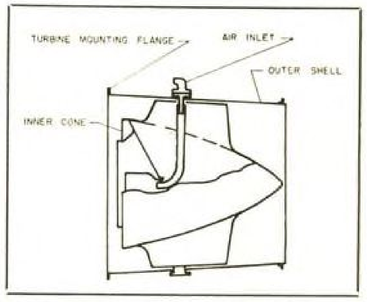


Fig. 2. An integral tailcone design.

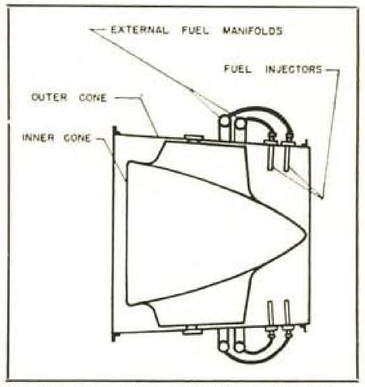


Fig. 3. Externally manifolded fuel injectors.

► **Burners**—In the afterburner's combustor section, fuel is injected into the relatively high-oxygen-content exhaust gas from the turbine, and the mixture burned to raise the energy level of the gas stream. This burner section usually consists of two major components—fuel injection system and flame holder.

Frequently the burner section is incorporated within either the diffuser or the nozzle section to save weight and avoid complexity, Kress points out. For maintenance and replacement ease, it is more convenient to have the burner a separate section.

Fuel injection generally is through a number of spray bars in the gas

stream, with perforations adjusted to give a particular fuel pattern. Usual supply to the spray bars is via a tubular manifold. When dual injection systems are used, more than one manifold is needed, the installation being either external or internal.

With external manifolding (Fig. 3) the gas flow area is left clear. But because of the many connections between spray bars and manifolds, there is a possibility of joint leakage—a serious fire hazard.

With internal manifolding, there is only one, or possibly two, connections for fuel to the afterburner, thus cutting down on leakage risk. Also, joints are welded, and if cracks do develop, fuel leakage is into the gas stream, which offers no hazard.

► **Internal Arrangements**—The internally manifolded fuel injector (Fig. 4) brings in the problem of differential expansion within the unit, caused by the non-homogeneity of temperature profile across the gas stream and those differentials within the manifold resulting from fuel flow.

In smaller injector rings, Kress points out, this condition is neglected, materials strong enough to withstand the thermal stresses being used. But in larger rings, this design leads to short life, and some provision such as a slip pin-mounted crossbar must be used to take care of thermal expansion in the manifold itself.

Other designs incorporate the fuel injectors in the tailcone, so the afterburner has an overall shorter length. Here the manifolding is inside the tailcone, easing the leakage problem (Fig. 5). Fuel leakage in this system isn't a danger for the engine compartment, but raw fuel in the tailcone, Kress says, may burn and deform the cone.

Fuel injector size is selected to pass the fuel at optimum internal velocity,

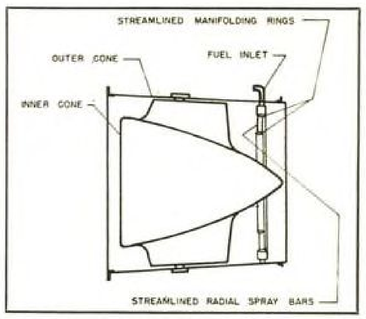


Fig. 4. Internally molded spray bars.

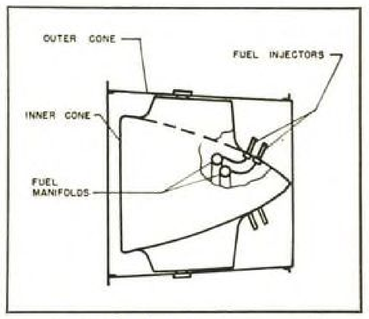


Fig. 5. These fuel injectors are tailcone-mounted to keep afterburner length down.

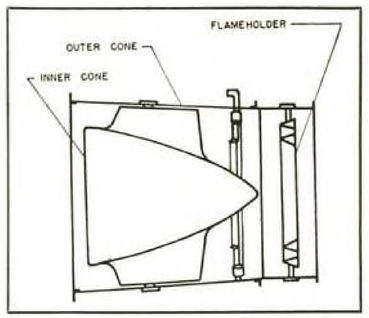


Fig. 6. Diagram of flameholder installation mounted downstream of fuel injector.

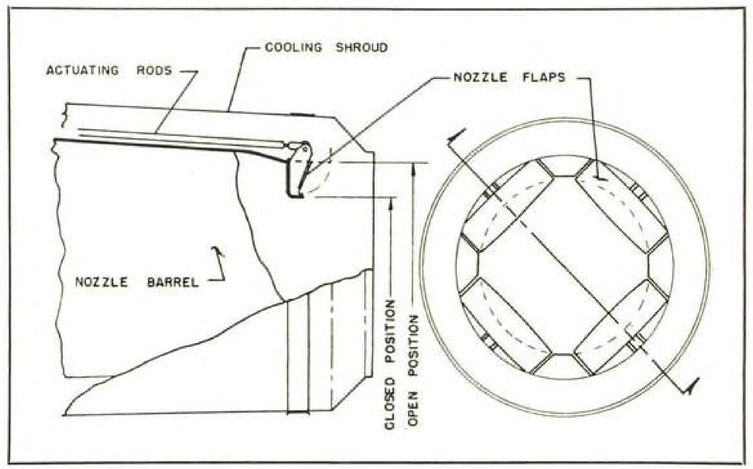


Fig. 7. Detailed drawing of a four-flap variable nozzle for afterburner.

so that tendency to boil and coke will be minimized, yet not give an excessive pressure drop.

Injector cross-sections are usually circular, but resultant gas flow turbulence sometimes causes attachment of flame to the injector, bringing serious combustion disturbances leading to failure of the injector and other afterburner parts. Aerodynamically streamlined injectors have been developed, which almost entirely eliminate this problem. The section must withstand internal fuel pressure without permanent deformation, because pressures may reach 500-600 psi.

Loads imposed on fuel injectors result chiefly from gas speed and are relatively light. Injector material usually is AISI 321 corrosion-resistant steel.

► **Flameholder**—The unit in Fig. 6, mounted downstream of the fuel injector at a distance to give proper fuel dispersion, maintains a stable flame front across the tailpipe. It is a turbulence-producing device which causes pressure losses from gas stream drag. Extreme care is required in the design so that flow losses do not cause substantial thrust loss when the afterburner is not operating or that thrust gain is not seriously reduced with afterburner on.

The flameholder may be supported from the afterburner skin, but allowances must be made for differential expansion—flameholder reaches very high temperatures, while the skin remains relatively cool. Support is usually through externally installed pins, through threaded bosses, to a loose slip fit on mountings on the flameholder.

Struts between flameholder and outer shell must be streamlined, Kress claims, to reduce turbulence which tends to propagate flame, causing hot streaks on tailpipe skin. Any connections or protuberances in the gas stream must be checked to eliminate hot streaks. These deform the tailpipe, damage the nozzle, shorten afterburner life.

To alleviate hot streaks from struts, flameholders have been mounted off internally manifolded fuel injectors, also off the inner cone.

In each case, the parts must be strengthened to take the heavier loads brought by violent combustion forces on the afterburner. Flameholders are made of N-155 or other high-heat alloys, rather heavy gages being needed. They are usually fabricated sections, but cast units have been used.

► **Nozzles**—In a jet engine without afterburner, nozzle diameter is chosen to give best operating efficiency over a wide range of flight conditions. In an afterburning jet plant, the diametral range required of the nozzle is so great that a variable nozzle is used.

Early afterburner nozzles were of the two-position type. Only one afterburner nozzle area was available, usually for

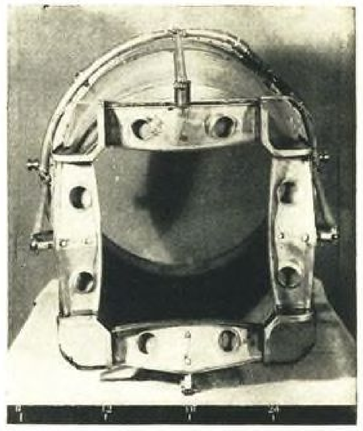


Fig. 8. Here's a full-scale working model of a four-flap variable nozzle.

the maximum possible thrust. In this type, two stainless steel clamshells are hinged at the end of the tailpipe, so arranged that they restrict the flow in the closed position, swinging out of the way of the gas stream in the open position, thus affording the nozzle area change required for afterburning operation.

Kress mentions an adaption of the clamshell nozzle to fully variable operation. He reports that very high actuating friction and imperfect sealing, because of distorted parts, resulted in poor performance and rapid deterioration.

An investigation was begun on the design of a fully variable flap-type nozzle. Preliminary studies showed good possibilities for a design that would be relatively free from distortion and also adaptable to production processes. Aerodynamically, the design was sound, too.

As a first study, a nozzle was designed that incorporated four large flaps, which were so made that no seals were necessary and clearances were adequate at running temperatures, Kress reports. Studies showed that the loading would not be excessive, although too high for the simple air cylinder actuator then used.

► **Flap-Type Details**—Nozzle makeup features an orifice (Fig. 7) varying from approximately a square shape in the closed position (flaps project into the gas stream at right angles), to a circular shape when open. Flap actuation is by pushrods connected to synchronizing yokes on nozzle section forward end. To bring orifice losses as low as possible, the gas stream end of the flap is generously rounded.

An actual full-scale working model of this nozzle design (Fig. 8) was constructed of sheet metal, arc- and spot-welded together. Nozzle barrel, including hinges, are 321 steel. Flaps are N-155 spotwelded assemblies. Hinge is the piano type, each half section welded in place. Because all leakage from hinges and flaps is parallel to the gas

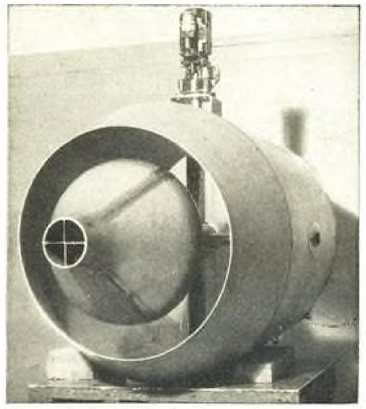


Figure 9. Variable bulb nozzle, in closed position.

stream, it was felt that no seals would be required.

Test-stand runs for many afterburning and no-burning hours showed no great degree of deterioration. Nozzle losses were low, with slightly better efficiency in the more open position.

Major disadvantage of this design, Kress reports, was the relatively large-clearance diameter required in the airplane at the jet orifice. Because airplane base drag is a function of the base annulus area between the jet stream and the airframe airstream, it was felt that further work should aim to make nozzles more dimensionally efficient.

▶ Other Approaches—A nozzle in which the tailpipe area is varied by a bulb moved in or out has also been under consideration (Fig. 9). This has shown some success in a non-afterburning engine, but when used in the intensely hot stream of the afterburner, the actuation problem—together with the structural loads induced in the bulb—presents an extremely difficult problem, Kress reveals.

Additional studies led to the requirement for a larger number of individual flaps which would give a more circular orifice and be planer in all positions. This would allow a nozzle flow shape that could lead to high nozzle coefficients.

Kress reports that numerous multi-flap nozzle designs have been developed over several years, many having accumulated many hours on the test-stand in both afterburning and non-afterburning conditions. They have proved, he says, that the multi-flap nozzle can be extremely rugged, and it can be manufactured easily.

▶ Actuation—Early afterburner nozzles of the clamshell type, having two positions (fully open or fully closed), required an actuator adjustable only to these two positions. The nozzle was aerodynamically balanced, so that most

actuator force was spent to seat the eyelids (shells) against the closed-position seal. Compressor air usually was enough for this job.

But the variable-thrust afterburner, with its fully variable area nozzle, made necessary an actuator infinitely adjustable from fully open to fully closed, and also capable of locking at any point in this range, Kress points out. For the fully variable actuator, greater power became a prime requisite, because unlike the balanced clamshell, the variable flap-type nozzle is aerodynamically unbalanced and the actuator must overcome both friction and internal gas pressure acting on the nozzle segments.

► **Electrical Actuation**—On a jet engine, actuators are limited to four practical sources of energy—electricity, hydraulic pressure, lubricating oil pressure and pneumatic pressure. Each has its pros and cons, none is ideal.

Kress says an electrical actuator is a natural choice for an afterburner—it has been made for many years in all shapes, sizes, and for a variety of operating conditions; electrical energy is readily available in a plane, is easy to control, and actuators are easily designed into electronic control systems.

But because the actuator must be placed near the variable nozzle and the high heat involved, the electrical unit needs complicated cooling means. Also, power requirements of flap-type nozzles are about 3 hp. and up, and this probably is the most serious drawback of the electrical actuators, because units of this power are not known to be "flyweights," he says. The electrical actuator has been limited more or less to the balanced-type clamshell nozzle.

► **Hydraulics Role**—Hydraulic systems—high-pressure installations—can provide high forces with small, lightweight actuators. However, fire hazard dictates particular care in joints and packing, and all lines and equipment subject to leakage must be kept clear of the hot afterburner surfaces.

High ambient operating temperature of the jet engine is a serious problem in the operation of many types of control valves used with the hydraulic actuator, Kress says. The hydraulic fluid could boil or decompose under high heat. But with the new high-temperature hydraulic fluids, this problem could be alleviated, he claims.

All jet engines have pressure lubricating systems, which could be used as sources of energy for afterburner nozzle actuation, but limited forces would be produced because of the relatively low pressure available.

► **Pneumatics**—Jets also can provide relatively high-pressure air from the compressor section, for accessory power.

Kress holds that quite a bit of air may be used before serious loss of power is noted in the engine. He considers

compressor discharge air attractive as a power source. It is always available while the engine is running; exhaust air may be dumped almost anywhere without danger; a one-line system is used—no reservoir or return line is needed; air is unaffected to any great extent by high pressure; design of packings and seals could be relatively simple—leakage introduces no safety problems; and because air is compressible, it is a source of potential energy.

Disadvantages, he reports, are serious, but can be circumvented. Available compressor discharge pressure on most jets is relatively low in comparison to a standard hydraulic system. This pressure also is a function of altitude and airspeed. Also, because air compresses, it acts like a spring—when used in actuating cylinders, it gives the piston bouncing action. Thus, positioning of the piston is very difficult.

▶ **Actuation Answer**—Solar has designed and built a practical actuator that involves stabilization of an air cylinder to make it fully positionable and act like a hydraulic cylinder, Kress reports. It incorporates an integrally sealed and self-contained hydraulic system.

This actuator is of the servo type and is designed to operate at an ambient temperature of 400F. Hydraulic system, including fluid and seals, is composed of materials capable of withstanding this temperature.

Pneumatic section is fabricated of stainless steel and aluminum with special piston rings designed for lubricationless operation. Aircraft quality with as low as possible weight-output ratio are other features. —Irving Stone

Saucer Shape Seen Best for Spaceship

There is a logical and acceptable reason for a flying saucer, says Dr. W. F. Hilton, well-known British aerodynamicist, because such a shape appears to offer the best solution to the problem of braking within the atmosphere of a planet.

What you need for best deceleration, assuming that braking rockets are not used, is a vehicle with maximium drag per unit area, he says. Spheres, which show such drag, are out because you also need lift. Thus a disk, rotated for stability, and thick at the center to take payload, seems to be promising for certain classes of spaceship.

▶ **The Problem**—Dr. Hilton made these points at a recent meeting of the Midlands branch of the British Interplanetary Society, where he considered the aerodynamic problems of landing and takeoff.

Since most of any interplanetary flight would be spent in space—where vehicle shape is unimportant—it would be the short time spent in the atmosphere that would dictate the design of the craft.

Takeoff is a negligible factor in design of spaceships, Hilton feels. Takeoff would be vertical and from the highest point available to minimize drag losses. Acceleration would be low, and no serious aerodynamic problems would arise, he says.

But on the return journey the arrival velocity would be the same as that of escape—7 miles per second, roughly—and the vehicle would make contact with the upper layers of the atmosphere at a Mach number of about 35. As one clue to the magnitude of the problem, Hilton states that a steel bullet will melt at a Mach number of 5.5 in the absence of thermal radiation.

Thus a returning spaceship will have to reduce speed from Mach 35 to Mach 5 before sustained flight in the atmosphere is possible.

▶ **Path Solution**—To slow down most efficiently, the spaceship must make grazing contact with the atmosphere, absorbing as much heat as either the ship or occupants can take, and then climb out to radiate heat into space. Contact in such an orbit—similar to that of a flat stone skipped across the surface of water—would be made on the dark side of the planet to increase the

available temperature difference.

(Such a "skipping" flight path was originally proposed by Dr. Eugen Saenger, in his wartime studies of a hypersonic bomber for the Germans. Saenger's reason was to get extra range by means of this technique, rather than to transfer heat efficiently.)

Hilton proposes that the initial contacts be short—one or two minutes in an elliptical orbit of several hours—and that the maximum lift should be directed towards the planet in order to increase the time in the atmosphere.

▶ **What Shape?**—Contrary to normal aircraft design, the spaceship will have to show maximum drag per unit of exposed area. Of all geometric solids, the sphere produces the highest drag per unit of surface area, but has no lift.

A circular or square shape at a high angle of incidence would be most satisfactory, and the drag produced could be turned off by flying at zero angle of attack.

Such shapes would be slightly unstable, but if a disk were used, it could be rotated for spin stability about a perpendicular axis through its center. The spaceship would be quite thick through the center to take the payload, and thin at the edges—the general concept of a flying saucer.

Planing surface of the saucer would be alternate layers of steel and asbestos. Most of the aerodynamic heating would occur behind the strong inclined shockwave on the lower surface; the upper surface would be little affected.

▶ **Aerodynamics**—Hilton suggests that an angle of attack between 20 and 30 deg. would be most satisfactory. This would produce a lift coefficient of unity and a drag coefficient of 0.25.

All the vehicle's kinetic energy would be converted into heat, and at low angles of attack this heat would appear in the vehicle itself. At high angles, the strong shock sent out below would heat the air passing through it; thus much of the kinetic energy would heat air remote from the spaceship.

Dr. Hilton said that hypersonic windtunnel tests would be needed before it could be said that the spinning disk was the perfect answer, but that it looked very promising as a shuttle vehicle between a planet and its satellites.

—John Humphries

P&W Metalsmith Course

A jet engine metalsmith training program begun in January 1950 at Pratt & Whitney Aircraft has borne first fruits. Fourteen men have completed the 6,000-hr. apprenticeship course to create skilled metalsmiths for special turbojet-production jobs.

Another group of 72 men are still in training, and a third group of 26 began the program in October.

Castings Seen Best For Missile Casings

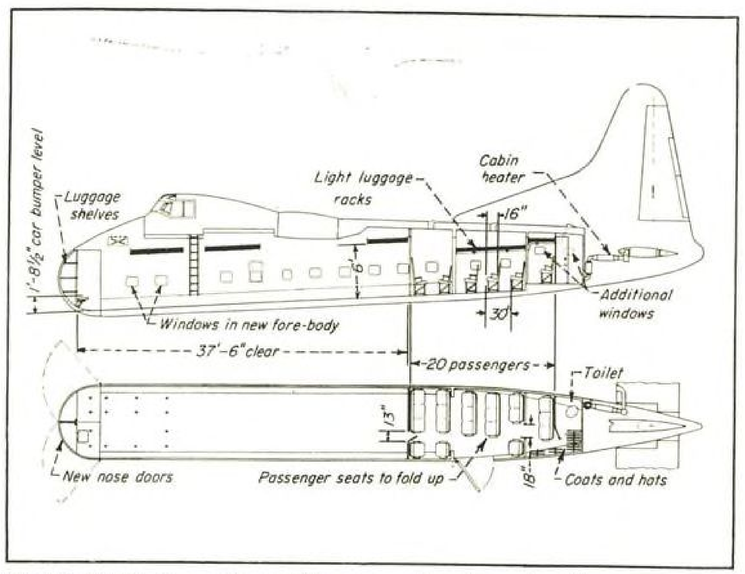
Air Force accent is being put on castings for guided missiles.

Brig. Gen. William T. Hefley, AMC assistant for material program coordination, recently told the American Foundrymen's Society that castings—the cheapest method of fabrication known—will provide a cheap, disposable shell for this type of weapon. For quantity production, the Air Force will be looking for the least expensive, expendable container that will do the job, and Hefley said that everything points to the foundry industry as the place to get it—if the nation's casting companies have kept up with defense needs.

Air Force thinking on missile components considers improved techniques to give stronger, lighter, more heat-resistant castings at reduced costs in manhours and raw materials as major factors in the missile program.

Hefley reported that aluminum castings capable of taking pressures of 70,000 psi. will be produced soon. Also, a recent experimental project involving Northrop Aircraft, Inc. and Aluminum Company of America, was for casting an AZ-92 magnesium-alloy, 16-ft.-long wing, with exacting tolerances.

BRISTOL FREIGHTER has been re-engineered for greater speed, payload.



SILVER CITY'S planes will carry 20 passengers, three long automobiles.

New Bristol Freighter Beefed Up

Six Bristols ordered by Silver City for cross-Channel service have longer nose, more powerful engines.

The phenomenal growth and future potential of Britain's Silver City Airways Ltd.'s cross-Channel ferrying operation has prompted an order for six new, improved-type twin-engine Bristol Freighters. Cost will be $252,000 each and complete delivery is expected by May 1953. The company's future thinking embraces four-engine planes and a copter-pod transport.

▶ **Impressive Record**—Silver City is toting cars, motorcycles and bicycles between England and France in a big way (AVIATION WEEK June 2, p. 69). Starting with a single Freighter (Type 170), the line made its first scheduled car-ferry flight in July 1948 between Lympne and Le Toquet and in the following months of that year carried 170 cars along with their passengers.

Last year, Silver City operated as many as six Freighters for the job and hauled 13,000 vehicles and 30,000 passengers across the Channel. At peak periods as many as 42 daily roundtrip crossings were made. At the end of 1951, the line bought two more Freighters and this year added still another, bringing the present fleet to nine.

▶ **New Plane**—The new, longer-nosed Freighters (Type 170 Mark 32) primarily will give more room than is available in the standard type. Passenger accommodation will be boosted from 12 to 20. Car hold is extended from 31 ft. 8 in. to 37 ft. 6 in. (length of hold floor is just over 35 ft. but room in nose doors gives an effective length of 37 ft. 6 in.). The eight extra passengers will be seated forward of the structural bulkhead separating the hold from what is normally the passenger cabin in the standard Freighter.

When 12 or less passengers are carried, a wooden partition between hold and cabin will be moved back to the structural bulkhead so that hold length will be extended from 37 ft. 6 in. to 42 ft. 3 in. This will permit carrying of three 14-ft.-long cars or two of the longest American makes.

Aft of the passenger cabin a toilet compartment will be provided by moving the batteries to the forward section of the fuselage.

▶ **External Changes**—Extension of the nose increases the fuselage length a little over 5 ft. to 73 ft. 6 in. The nose door opening remains the same, but door hinge line moves forward to a point even with the tip of the standard Freighter's nose. Shortened landing gear legs will reduce height of loading sill.

Because the new Freighter's side area is increased forward of the plane's CG, about 10 sq. ft. will be added to the fin area—accomplished with a semicircular extension at the top of the fin and a buildup of the dorsal.

▶ **Speed Same**—The plane will have more powerful Hercules engines than the present Freighter, and with a maximum speed of 230 mph. at 3,000 ft. and cruise of 166 mph. at 5,000 ft., its performance will be the same as the current standard type.

Range will be 370 mi. for 11,000 lb. payload, 795 mi. for 9,000 lb., 1,215 mi. for 7,000 lb., and 1,680 mi. for 4,875 lb.

▶ **Universals Eyed**—Silver City believes that by 1955 cross-Channel traffic will have developed to a point where a London-Paris ferry hop will be feasible. For this job it is considering first the four-engine Blackburn and General Aircraft Universal Freighter. It would want three of these planes with a multideck arrangement—capable of accommodating eight small cars or six of average size, plus six motorcycles, 12 bicycles and about 40 passengers. But if the military doesn't also order the plane, cost of the three units would come to too high for Silver City.

There is another possibility — the Breguet Deux-Ponts, already in production, which puts delivery on a reasonably soon basis.

▶ **Plan for Copter**—This doesn't mark the end of Silver City's planning. After a few years, when its present Freighter fleet approaches old age, the line contemplates using a fleet of huge copters fitted with detachable, cargo-passenger pods to permit quick turnabout—similar to the Pack Plane which was developed here by Fairchild Engine & Airplane Corp., Hagerstown, Md.

THRUST & DRAG

The second Space Travel symposium held at the Hayden Planetarium recently produced a fine technical argument over when we'd be getting to the moon. The camp was divided into a 15-yr.-time-lag group and a considerably larger, unspecified-time-lag group.

Not wishing to hold with either side at the moment, T&D would like to point out a few angles to those who feel that it can be done starting now on today's technology with lots of money.

The physical rocket could be built; there's no quarrel with that premise. But the supporting industries and logistics and test areas never are figured into the overall sum. Test firings might cost a couple of million dollars each, and you wouldn't get away with much under ten or a dozen.

And as for the base in today's knowledge, consider 30 or 40 years ago. If the Wright brothers had been given $1 billion, they never could have produced a single V-2 rocket. If Marconi had been given the billion, he never could have developed radar.

Scientific progress is made by extrapolation with occasional flashes of individual genius along the line. The general trend of the progress curve against time is continuous, not discontinuous. We'll get to the moon—but we can't start now.

* * *

Tau Beta Pi, honorary engineering organization, has again defeated a resolution to admit women engineers to that learned organization. However they will continue to award the Woman's Badge to outstanding gals in engineering.

Just what Tau Beta Pi hopes to gain by this is hard to see. I consider such a stand by the society as indefensible. There are many women engineers in the profession today; I've worked with some and been glad of their technical prowess and their decorative value around an otherwise dull office.

The only qualification for membership in a professional organization should be competence. It shouldn't matter if the applicant is a beautiful blonde or—as is bound to happen some day—a gilled Venusian. Give 'em the key and congratulate 'em.

* * *

Anybody who wanted to see a model of the Navy's new secret air missile, the Sperry Sparrow, could have done so—until a short time ago—by looking in the window of Arbaugh's restaurant on Connecticut Ave. in Washington. A model of one of the Douglas AD series was displayed, complete with four wing-mounted Sparrows. So that there could be no mistake, the birds were lettered with the correct designation. This is security?

* * *

Western Air Lines has come a long way from the original Douglas M-2 biplane which led off its inaugural fleet 26 years ago. And with Western announcing the fall delivery of five shining new Douglas DC-6Bs, the comparison between these huge new airliners and the little M-2 is extremely interesting.

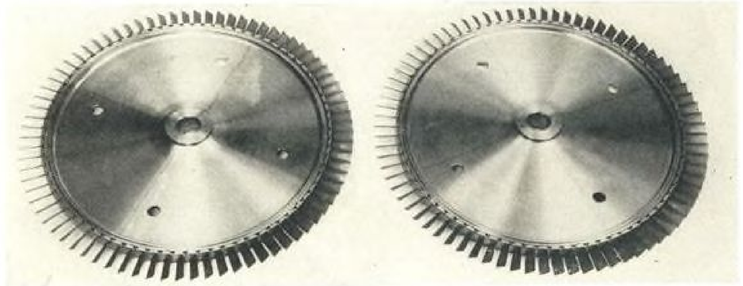
The total load capacity of the M-2 (1,750 lb. of pilot, passenger, mail, fuel and lubricants) was less than the weight of the electrical system of the DC-6B (1,783 lb.).

The DC-6B at $1,050,000 costs about 100 times the M-2 price of $11,000. The 400-hp. engine of the M-2 pulled it through the air at a whistling 115 mph.; today, the 9,600 hp. available in the DC-6B produces a top speed of 360 mph. The M-2 could be handled by one man, and it carried one passenger; the DC-6B needs a crew of five, but carries 66 people.

And the associated paperwork has increased, too. Specs for the M-2 took eight typewritten pages; but the complete specifications for the DC-6B require a 175-page volume. —DAA

Titanium: Headache With a Future

- **GE notes drawbacks as well as advantages.**
- **Ductility, cost, quality, are unsolved problems.**



COMPRESSOR WHEELS of titanium are light, but hard to fabricate.

Titanium has established itself as a very important member of the family of metals aviation engineers use. But like many other metals with promising general characteristics, getting down to specific aviation applications has posed problems.

Data on one of these applications—the use of titanium forgings for jet engine components—has been compiled by L. R. Frazier, General Electric Co. metallurgical engineer.

▶ **Requirements**—Frazier outlines GE's findings in the light of material requirements for jet engines, with regard to weight, corrosion-resistance, and ore abundance.

Titanium fulfills these requirements. But, Frazier emphasizes, jet metals also must have ductility with strength, aircraft quality, allow practical fabrication and eventual low cost. These requirements, Frazier says, titanium will fulfill only with the most vigilant attention of supplier and user.

Keyed to these requirements, he offers findings on jet engine parts made from titanium forgings. These parts, recently under consideration at GE, include compressor wheels, blades and a portion of the compressor housing, and smaller parts such as gears, couplings and bearing housings.

▶ **Compressor Wheels**—For these forged components, strength and ductility are needed, the latter a highly important factor in rotating parts.

At the strength levels of commercial alloys such as Ti-150A and RC130B, GE has designed wheels which can save 100 to 200 lb. per engine.

On the debit side, tests on dimensionally identical Ti-150A titanium disks have shown a broad range of speeds for bursting. Frazier reports that this has been accounted for largely by differences in ductility. Unless a highly stressed part can readjust itself locally by plastic deformation, stresses rise locally to the fracture level at bearing points and section changes.

▶ **Composition Factor**—Composition affects ductility more through variations within an alloy than through contrast between alloys.

Heating and working schedules during forging also affect ductility. As an example, Frazier reports that Cr-Fe-Ti alloys exhibit a grain boundary brittleness after heating above 1,650F. The large grains resulting from high heating appear to be ductile, he says, but the fractures are nearly 100% along the grain boundaries.

Evidently a constituent is ejected by the beta grains to the boundary region where it causes brittleness. Brittleness from heating to the all-beta region is the usual case. Minor variations, probably in composition, have occasionally permitted heating to the all-beta range without embrittlement.

Frazier points out that if a large forging reduction—of the order of 50% decrease in thickness—is made while the titanium alloy is cooling down to the alpha-beta range, the beta boundaries are broken up and ductility is restored to the finished forging even if forging were begun above 1,900F.

Many of GE's earlier disk forgings were made with several reheatings in the vicinity of 1,800F. Most of these, Frazier says, showed the intergranular brittleness—some being much worse than others. He believes that the beta boundary brittleness is caused by some element not listed in the nominal compositions of the alloys.

▶ **Quality**—Frazier stresses aircraft quality in titanium products as an essential to successful applications. For disk forgings, billets must be clean, inside and outside. Discontinuities such as tungsten or graphite inclusions or segregations from incomplete fusion of alloy additions, he contends, can dangerously lower ductility in local regions. GE tests have shown definitely that broken tungsten particles seriously lower elongations.

Titanium melted under graphite electrodes also has shown regional deficiencies in ductility. While these are far less common than with tungsten, Frazier says, they represent a hazard which can be tolerated only while the melters perfect their consumable electrode techniques.

A disk forging produced with a good surface, well-filled contours, and adequate properties is still no good, he contends, if there are internal discontinuities. Extreme vigilance on the part of the melters and users is necessary, he insists, to avoid finished wheels with internal defects.

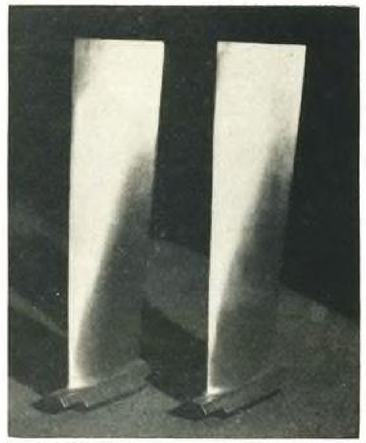
▶ **Fabrication**—Practical fabrication of titanium wheels from forgings will depend on machining techniques to overcome such difficulties as metal pickup, excessive tool wear, coolant problems, etc.

Frazier says that rough machining would be greatly aided by some method for removing the forging surface before actual machining is started. The case-hardened layer below the forging scale probably causes more grief to machinists than any other single factor, he says.

The 100 to 200 lb. that can be saved per engine by using titanium alloys in compressor wheels is an attractive advantage. But at present costs of finished titanium parts, it probably will not pay to make the substitution, Frazier points out. A customer would have to be willing to pay about $12,000 more for an engine to justify titanium compressor wheels, he says.

▶ **Cost Cuts**—Several avenues of cost reduction are open:

- If suppliers increase quantity production, substantial price cuts probably will be possible.
- More efficient use of material in forgings through die improvements is another approach.
- Quality enters, too. Frazier says, "If we can scrap fewer pieces for material



COMPRESSOR BLADES of titanium alloy offer weight-saving opportunity, as about 2,000 are used in a jet engine.

GEARS still pose fabrication problems.

defects and can obtain forgings with less material to be machined off, we shall have many more forgings for our money."

Progress with these factors of price, utilization and quality should make it possible to produce forged titanium wheels within economic reason, he says.

▶ Compressor Casings—Application of titanium forgings for compressor casings opens weight-saving possibilities second only to that in compressor wheels.

Toward the hotter end of the compressor, cast aluminum alloys creep rather badly under operating stresses. Rather than use steel for such a large heavy part, GE is trying to use titanium. Several designs for forming and welding have been suggested, but Frazier says, " . . . we know of no method to produce ductile fusion welds in the higher-strength titanium alloys. Consequently, the welded designs will have to stay on the shelf until weldable alloys appear."

Meanwhile, GE is making casings by contour-forging of quadrants from titanium alloy plate. This contour-forging of the outside of the casing has made fabrication more nearly practical.

The casing also must have strength and ductility. Ductility is important because there are many stress raisers in the vicinity of the joining flanges on these longitudinal structural members. Surface quality is important because the outer surface is stretched dur-

ing forging, and the inner surface must have sufficient material for machining to accurate dimensions, without too much waste. The machining of the casing is a "terrific" job, Frazier says. This, as well as the price of the material, makes the cost of the casing in titanium much too high.

▶ **Blade Applications**—Use of titanium stator and compressor blades could offer a large advantage in weight saving. Each blade weighs only a few ounces, but considering the total number—nearly 2,000 per engine—weight cut adds up to many pounds.

As a result of changes in directionality or alignment of brittle constituents within the material during forging, ductile titanium alloy bars can give very brittle blades. But because of severe stresses imposed during blade assembly and under operating conditions, some ductility is required. GE tests every blade for ductility and is trying to arrive at bar acceptance tests which can be met by suppliers and give ductile blades.

Frazier reports that GE has never made a brittle blade from bar which was below Rockwell C 36. But, he says, hardness is not well correlated with ductility—at the higher hardness of Rockwell C 39 some blades are very brittle, while others have more than adequate ductility.

Careful selection of bar, control of forging schedule and testing of all units have insured that reasonably ductile titanium blades are put in GE engines.

It appears that there is sufficient difference in stress levels for stator and rotor blades that the two may be made from different titanium alloys, says Frazier. Stator blades have air loading and vibrational stresses, but no centrifugal loading, hence it may be feasible to use a lower-strength alloy such as RC70 and Ti-100A. The lower-strength alloy is apparently more ductile and should eliminate the chance of producing brittle blades, he contends.

▶ **Other Considerations**—Final blade results will depend on such factors as local composition differences in the bar, heating time and temperature, smoothness and cleanliness of forging dies, amount of surface removal in descaling, and grinding and finishing operations. No folds or other surface imperfections are tolerated and finishing marks must be removed as far as possible to eliminate sources of fatigue failure.

Cost of titanium blades is not so far out of line as that of larger forgings for wheels and casings. Material becomes a small fraction of the total cost because there are so many forging operations on the blades. There is room for a large cost reduction, Frazier says, by some process such as blade rolling.

He summarizes the blade forging picture: ". . . The forgings are not easy to produce. When good forgings are produced they will adequately replace steel blades as shown by many successful operational tests."

▶ **Parts Ahead**—Every steel part is under consideration for titanium substitution where temperature permits, he says.

Already being developed are shaft couplings, accessory drive gears and bearing housings. These can be machined from titanium, but probably can benefit from forging, he says—more efficient use of material can be realized as well as mechanical property benefits from proper grain flow developed in the metal during forging.

Titanium gears will require more successful hard surfacing than has been produced to date, but there are several promising prospects. If a plating is used, there's no doubt it will have to be backed up by one of the harder titanium alloys, Frazier says.

A bearing housing seemed to offer a simple, straightforward substitution of titanium for steel, but proved otherwise. The titanium couldn't be forged in the dies used for steel forgings—corners and ears wouldn't fill and numerous folds were produced, Frazier reports. And machining was difficult because of the high tool loads on thin sections.

But these problems are being licked and several more pounds will be shaved from engines with titanium forgings used for these parts, he says.

Thus, titanium forgings open the way to jet engines giving more thrust per pound of weight, but with constant strong effort for ductility with strength, quality, practical fabrication and lowered cost.

NEPTUNES MOVE ON TRACKS

Elevated track on Lockheed Aircraft Corp.'s P2V Neptune fuselage assembly line speeds sections around—one of the assemblies can be moved from station to station in ½ hr. as against a 3-hr. period for the old method of rolling the heavy supporting dolly along the floor. The elevated railway scheme also permits accessibility to the entire assembly, cuts down on worker's walking because tools and parts supplies are stored in bins adjacent to the line, makes more floor space available, simplifies utility services because quick-disconnects for electricity and compressed air lines run adjacent to the tracks, and allows more workers to be engaged on a single assembly at the same time. A similar system has been in use at Temco on Boeing B-47 rear fuselage assemblies.

McDonnell Tackles Engineer Shortage

McDonnell Aircraft Corp. and Washington University have joined in an effort to ease the critical shortage of engineers. A new arrangement between the two insures that adequate courses in aeronautical science and related fields will be made available continuously at the university.

Another feature of the arrangement provides for promoting interest of promising students in postgraduate courses leading to masters' and doctors' degrees. McDonnell engineers will be given the opportunity to make use of these courses to continue their professional training. Under the agreement, certain resources of the university's library and laboratories, as well as staff advisory engineering assistance, will be made available to McDonnell.

The new contract—running for three years—will be financed by McDonnell at a yearly cost of $25,000.

PRODUCTION BRIEFING

► **Marman Products Co., Inc.,** Los Angeles, has completed a $1 million expansion at West Los Angeles to step up clamp, band and strap production.

► **Marquardt Aircraft Co.,** Van Nuys, Calif., has built a large ramjet test facility at San Fernando Valley Airport under USAF contract.

► **Midwest Tool & Engineering Co., Inc.,** Indianapolis aircraft products company, has been acquired by H&B American Machine Co.

► **Milford Rivet & Machine Co.,** Milford, Conn., has purchased Pacific River & Machine Co., Alhambra, Calif., bringing to five the plants it owns.

► **Pastushin Aviation Corp.,** Los Angeles, has acquired a factory building at 5300 W. Century Blvd., Los Angeles, to increase aircraft components output.

► **Pratt & Whitney Aircraft division,** United Aircraft Corp., E. Hartford, Conn., has started construction of a large addition to its service hangar on Rentschler Airport, with completion scheduled for mid-summer 1953.

► **Precision Gears & Products, Inc.,** Paterson, N. J., has opened an 11,000-sq. ft. addition to its plant.

► **Hogan Paint & Chemical Corp.,** Edgemere, L. I., N. Y., has acquired Titanine Corp., Union, N. J., longtime maker of aircraft finishes.

► **Kaiser Aluminum & Chemical Corp.,** Newark, Ohio, has awarded a general contract for construction of its forging facilities for the USAF heavy press program. Principal building and auxiliary structures will cover 360,000 sq. ft. One forging press, rated at 35,000 tons, will be nine stories tall. It and a 25,000-ton unit will be built by E. W. Bliss, Canton, Ohio.

► **Luscombe Airplane Corp.,** Garland, Tex., has started overhaul of Republic F-47 wings, landing gear, horizontal and vertical stabilizers, elevators and rudders under contract from Temco Aircraft Corp.

► **Robinson Aviation, Inc.,** Teterboro, N. J., has established an engineering laboratory at its West Coast engineering office, Burbank, to test and evaluate vibration control equipment used in airframe and electronics industries.

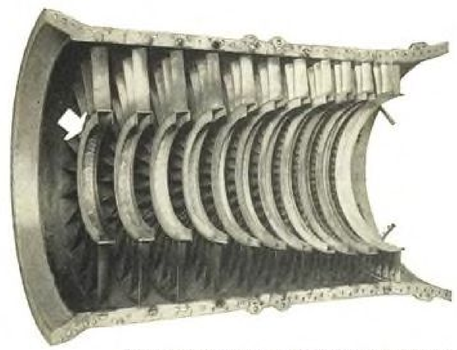
TOMORROW'S AIRCRAFT: What barriers remain?

"Increased reliability of mechanical parts such as compressors"

Westinghouse early recognized the need for extra reliability of compressor stationary diaphragms. Today, Westinghouse stands first for their contribution in stationary or stator blade design and construction. How well they have developed a thoroughly dependable shrouded steel stationary blading on the compressor is dramatically demonstrated by Banshee performance over Korea. For the fact is . . . there has not been a single operational loss of the Banshee (with Westinghouse J-34 turbojet engines) because of stator blade damage. Breakage at this point would be serious of course, ripping out all the other blades in the compressor. Westinghouse construction avoids a complete break, the blades may bend if hit, but won't tear out . . . both ends hold tight to the shroud.

Lighter, more durable jet engines, like the powerful, new J-40 which recently passed the Defense Department's grueling 150-hour qualification test, will aid our country's defense. Though other jet aircraft problems remain to be solved, Westinghouse axial-flow design, proved over Korea, points the way to the solution of future jet fighter and transport problems.

Westinghouse is investing millions of dollars and man-hours to help build American jet-propulsion leadership. Jet engines are produced at South Philadelphia and Kansas City plants by Westinghouse, America's Jet Engine Pioneer. J-91002



Shown above is one half of the stationary element of a Westinghouse jet engine compressor. It consists of steel-fabricated diaphragms assembled in machined grooves in a cast aluminum housing. The white arrow above indicates one of the inner steel support shrouds.

THE SCOPE OF WESTINGHOUSE IN AVIATION

Basic aircraft systems

Turbojet Engines, Fire Control, Radar, Autopilots, Communication Equipment and Electrical Systems.

Ground equipment

Wind Tunnels, Airport Lighting, Industrial Plant Apparatus.

Airborne system components

Transformers, Rectifiers, Instruments, Gyro-motors, Temperature Control Panels, Generating Equipment and System Control, Circuit Breakers, Contactors, Motors, Actuators and Hoists, Electronic Tubes, Magamps®, Micarta®.

YOU CAN BE SURE...IF IT'S

Westinghouse

USAF CONTRACTS

Following is a list of recent USAF contracts announced by Air Materiel Command:

Cessna Aircraft Co., Wichita, airplanes, 2 ea., spares, 1 lot, $65,030.

Chandler-Evans div., Niles-Bement-Pond Co., W. Hartford, Conn., spare parts, $2,359,489.

Chicago Pneumatic Tool Co., 570 East Larned St., Detroit, stationary air compressors, 35 ea., $323,385; pneumatic portable tools, 3,533 ea., $492,143.

Chrysler Corp., Detroit, spare engine assembly, $100,462.

Cine Products Supply Corp., Evesham Ave., Ashland, N. J., photographic spare parts, $45,741.

Clark Equipment Co., P. O. Box 178, Battle Creek, Mich., spare parts $217,520.

Collins Radio Co., Cedar Rapids, electric tuner, 93 ea., $81,305; communication receivers, 135 ea., $155,454.

Collyer Insulated Wire Co., Pawtucket, R. I., power cable, 2,181,000 ft., $422,084.

Consolidated Plastics & Mfg. Co., Chicago, spare parts—Plexiglas, $38,686.

Continental Motors Corp., 205 Market St., Muskegon, Mich., special tools, $60,316.

Continental Electric Co., Inc., 327 Perry St., Newark, N. J., maintenance parts, $54,581.

Continental, Inc., Danbury Airport, Danbury, Conn., sighting unit, 25 ea., $98,718.

Cook Electric Co., 2700 N. Southport Ave., Chicago, switch, 654 ea., $39,777.

Cornelius Co., The, 550 39th Ave., Minneapolis, regulating valves, $101,528.

Courter Electric Products, Inc., 440 Sixth St., N. W., Grand Rapids, single channel amplifier, type A-13, 2,470 ea., $140,435; amplifier, single channel, type A-13, 2,470 ea., $165,041; amp. single channel, type A-13, DO-A1, 2,470 ea., $158,164.

Crescent Insulated Wire & Cable Co., Trenton, N. J., cable, 694,000 ft., $59,690.

Crucible Steel Co., Oliver Bldg., Pittsburgh, steel chrome nickel sheet, 131,000 lb., $76,837.

Curtis, Helene, Ind., Inc., 4401 W. North Ave., Chicago, miscellaneous parts, $123,270.

DeJur-Amsco Corp., Northern Blvd. & 45th, Long Island City, N. Y., instrument maintenance part, 51 ea., $62,145.

DeVilbiss Co., Toledo, spray guns, 3,918 ea., $53,306.

DeVry Corp., 1111 Armitage Ave., Chicago 14, spare parts, $79,320; spare parts, $41,507; miscellaneous parts, $34,980.

Dumont Aviation Associates, 1401 Freeman Ave., Long Beach 4, Calif., aircraft hardware, bolts, $38,249.

Dynamic Electronics, Inc., 73-39 Woodhaven Blvd., Long Island, N. Y., tuned amplifier, 72 ea., $31,672.

Eastern Rotorcraft Corp., Willow Grove, Pa., type B-1A tiedown, cargo aircraft, 6,860; type D-1 tiedown, cargo aircraft, 15,854, $743,276.

Eclipse Pioneer div., Bendix Aviation Corp., Teterboro, N. J., transmitter, type J-4, 565 ea., transmitter, type J-2, 2,226 ea., $475,412; transmitter, fuel flow, type J-2, 534 ea., $103,587; indicator oil pressure, type MS28010-2, 1,882 ea., $92,820; indicators, ID-250, 7,516 ea., indicators, ID-251, 1,445 ea., indicators, ID-249A, 3,099 ea., $1,518,816; generators, 518 ea. $201,491; spare parts, $187,078; indicator, 443 ea., $25,353; indicators, 6,149 ea., $5,905,014; miscellaneous spare parts, $312,513; phase inverters, 1,000 ea., $568,805; regulator, spare parts and data, 15,652 ea., $565,619.

Eisner Co., Sigmund, 2-40 Bridge Ave., Red Bank, N. J., canopy assembly, 6,000 ea., pack assembly, 16,835 ea., $938,090; G-13 parachute, 12,515 ea., $927,637.

Erie Mfg. Co., 300 N 8th St. Milwaukee, bag assembly, 3,612 ea.; bushing, 1,052 ea.; controller assembly, 32,412 ea.; nipple-emergency 02 cylinder valve, 32,412 ea., $26,237.

Executive Furniture Inc., 911 S. Walker Ave., Oklahoma City 1, sideboard quarters, 260 ea., $38,532.

General Tire & Rubber Co., 1708 Englewood Ave., Akron 9, Ohio, wheel assembly, nose, 22 x 7.25-11.50, spare parts & data for F-86D, F-86F, & T-33A aircraft, 2,433 ea., $144,392.

Famco Machine Co., 1320-18th St., Racine, Wisc., drilling machine, electric, 600 ea., $68,310.

Fashion Frocks, Inc., 3301 Colerain Ave., Cincinnati, riser, 4,088 ea., parachute assembly, 7,500 ea., $1,191,433.

Firth Sterling Steel & Carbide Corp., 3113 Forbes St., Pittsburgh 30, tool steel, 101,100 lbs., $44,203.

Foley Mfg. Co., 3300 Fifth St., Minneapolis, saw filers, 60 ea., $27,002.

FR Corp., The, 951 Brook Ave., N. Y., photographic chemicals, $402,258.

Furniture Guild of California, Inc., 1601 E. 15th St., Los Angeles, table quarters, 1,066 ea., $49,883.

General Electric Co., Bridgeport, Conn., cable, 25,000 ft., $39,160.

General Electric Co., Dayton, induction voltage regulators, 78 ea., $221,960.

General Electric Co., One River Rd., Schenectady, N. Y., indicator electric tachometer, 2,071 ea., $221,185; transformer rectifiers, spare parts, 256 ea., $57,322; maintenance and overhaul parts, $1,500,000; indicator electric tachometer, 1,363 ea., $121,036; regulator assembly, 100 ea., $34,980.

General Motors Corp., United Motors Service div., General Motors Bldg., Detroit, spare parts, $146,016.

General Tire & Rubber Co., The, Akron, lifting bag, 108 ea., $42,687.

Goodrich Co., The B. F., 803-14 Winters Bank Bldg., Dayton, wheel assemblies, 56 x 16, brake assemblies, 2⅞ x 3½, 879 ea., $1,014,429; wheel assembly, spare parts and data, 300 ea., $61,132.

Goodyear Tire & Rubber Co., Inc., 1144 East Market St., Akron, wheel assembly, 652 ea., brake assembly, 520 ea., spare parts, $186,410; wheel assembly, 537 ea., brake assembly, 555 ea., spare parts and data, $162,739; wheel assemblies, 412 ea., brake assemblies, 468 ea., spare parts and data, $287,279.

Graflex, Inc., 154 Clarissa St., Rochester 8, N. Y., photo equipment, $29,889; 390 identification equip., 390 ea., $245,155; identification sets & spare parts, 115 ea., $149,663; glass, 310 ea., slider, photographic, 2,095 ea., tripod, 65 ea., holder, 10,483 ea., $41,091.

Grimes Mfg. Co., Urbana, Ohio, light assemblies and data, $130,325.

Hammond Mfg. Corp., 3600 E. Foothill Blvd., Pasadena, hose assembly, bracket and regulator assembly, 4,300, $90,374.

Handley Brown Heater Co., Jackson, Mich., bomb rack & spare parts, 1,857 ea., $144,364.

Hartman Electrical Mfg. Co., The, 175 Diamond St., Mansfield, Ohio, cutouts, spare parts, 6,776 ea., 158,350.

Hathaway Instrument Co., 13155 Clarkson St., Denver 10, kit-aircraft weighing, electric, 570 ea., $537,270.

Heil Co., The, 3000 W. Montana St., Milwaukee, spare parts, $37,515.

Hercules Motor Corp., 101 11th St., S. E., Canton, Ohio, spare parts, $118,239.

Hevi-Duty Electric Co., Milwaukee 1, furnace, electric, 50 ea., $54,950; regulator, 400 ea., $148,075.

Holliston Mills, Inc., The, 70 W. 40th St., N. Y., tracing cloth, $67,803.

Houston Fearless Corp., The, 11801 W. Olympic Blvd., Los Angeles 64, processor A-9, spare parts, data, 185 ea., $1,311,790.

Howe Scale Co., The, 3438 Duck Creek Rd., Cincinnati 13, scale, counting & weighing & data, 60 ea., 121 ea., $29,745.

Hussey & Co., C. G., div. of Copper Range Co., Pittsburgh, brass bar & rod, 190,850 ea., $75,820.

Irving Air Chute Co., Inc., 1670 Jefferson Ave., Buffalo, canopy and pack assembly, 720 ea., canopy-personnel parachute, 18,795 ea., cushion-back type parachute, 2,816 ea., $1,654,366.

Jack & Heintz, Inc., 17600 Broadway, Cleveland, maintenance overhaul parts, $54,496; phase inverters, 250 VA 3,630 ea., $244,642; generators, 3,360 ea., $1,183,259.

Jacobs Aircraft Engine Co., Barium Steel Corp., Pottstown, Pa., maintenance spare parts, $47,707; spare parts, 11,232 ea., $372,226.

Kearney, James R., 4236 Clayton Ave., St. Louis 10, machine-swaging, bench type, 331 ea., $246,873.

Kelley-Koett Mfg. Co., The, Covington, Ky., chamber-pocket, charger-reader, 838 ea., $27,735; dosimeters, 590 ea., charging boxes, 56 ea., handbook data, $39,747.

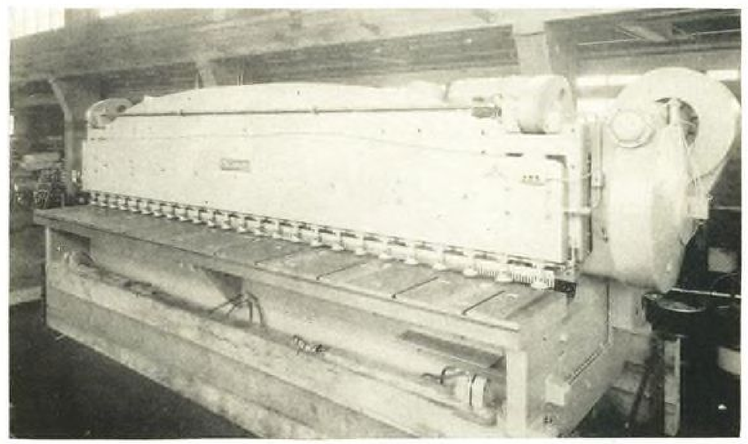
Kidde & Co., Inc., Walter, 675 Main St., Belleville, N. J., cylinder & valve assembly CO Dwg 50 B 3832, 1,131 ea., cylinder & valve assembly CO dwg 50B 3832-2, 4,120 ea., head assembly, 5,439 ea., valve assembly-application, 4,198 ea., $173,078.

Kinsey Co., E. A., 335 W. 4th St., Cincinnati, milling machine, 1 ea., $29,445; radical drilling machine, 9 ea., $114,112.

Knickerbocker Products, Inc., 1600 Broadway, N. Y., production of a motion picture, 1 ea., $30,151.

Knox Metal Products, Inc., Thompson, Ga., large collapsible wheel chocks, 15,000 ea., $206,250.

Kollsman Instrument Corp., Elmhurst,



GIANT SQUARING SHEAR

This squaring shear, capable of cutting 24 ft. of ¼-in. mild steel plate, was built for Douglas Aircraft Co. by Cincinnati Shaper Co. Weighing 149,000 lb., shear has cutting cycle of 20 strokes a minute. Hydraulic holddowns can exert 22 tons of force for holding work securely. Machine has 24-in. throat, 48-in. back gauge range, light beam shearing gauge, and air clutch control fitted with two foot valves.

N. Y., indicator multi-purpose, 5,520 ea., $365,199; spare parts, 129 ea., $315,961; tachometer indicators, 282 ea., $27,122.

Lawson Co., The F. H., Evans & Whately Sts., Cincinnati 4, receptacles, 29,905 ea., $46,173.

Lear, Inc., Grand Rapids, actuators, 396 ea., $99,091; controls, computers and data, 3,000 ea., 1,000 ea., $600,000.

LeBlond Machine Tool Co., The R. K., Cincinnati 8, lathes, 2 ea., $67,645.

Lee Electric & Mfg. Co., 2806 Clearwater St., Los Angeles 39, rectifier, Lee part BB 2037-1, 800 ea., $46,400.

Leland Electric Co., 1501 Webster St., Dayton, 750 VA inverters, 1,035 ea., $448,063.

Lewis Engineering Co., Naugatuck, Conn., engine exhaust temperature indicators, 1,042 ea., $44,859.

Lewis Electrical Mfg. Co., 1943 Walton Ave., N. Y., rectifier & charger, 144 ea., $61,530.

Lincoln Engineering Co., 570 Natural Bridge Ave., St. Louis, grease hose, 2,046 ea., $27,732.

Linde Air Products Co., div. Union Carbide & Carbon Corp., 30 East 42nd St., N. Y., acetylene cylinder 5,000 ea., Freon cylinder, 1,000 ea., installation of valves, 1,000 ea., $148,910.

Linde Air Products Co., div. of Union Carbide & Carbon Corp., 30 E. 42nd St., New York, torch-cutting, 1,500 ea., $34,935; liquid oxygen, 40,000,000 cu. ft., liquid nitrogen, 10,000,000 cu. ft., liquid nitrogen, 10,000,000 cu. ft., containers, 12 mo., deliveries under maximum, 30 ea., $210,150.

Link Aviation, Inc., Binghamton, N. Y., recorders, assemblies, automatic standardization, 300 ea., $56,995.

Lockheed Aircraft Corp., Burbank, Calif., kits, F80/SB-71, 39 ea., kits, F80/SB-72, 24 ea., kits, F80/SB-85, 56 ea., kits, F80/SB-119, 75 ea., $45,969.

Lycoming-Spencer div., Avco Mfg. Co., Williamsport, Pa., exhaust riser assembly, 3,000 ea., $101,250.

Magnaflux Corp., 5900 Northwest Highway, Chicago, kit, 1,559, $59,631.

Masland and Sons, C. H., Carlisle, Pa., aircraft protective covers, 4,100 ea., $151,-216.

Massillon-Cleveland-Akron Sign Co., The, 681 1st St., S. W., Massillon, Ohio, line lead-tow target, 30,000 ea., $192,700.

McColpin-Christie Corp., Ltd., 3410 W. 67th St., Los Angeles, rectifiers, 68 ea., $56,910.

Mechanical Appliance Co., 810 W. Ohio St., Chicago, spring cable tension, 600 ea., shroud brake, 650 ea., pin-positioner, 800 ea., stud-mtg., 2120 ea., cable assembly-power, 2,000 ea., $48,031.

Mercury Electronic Co., Box 450, Red Bank, N. J., voltage divider, data, maintenance spare parts, 988 ea., $45,852.

Milburn, Inc., Alexander, 1231-45 Ridgely St., Baltimore, regulator-oxygen, 65 ea., torch-cutting, 716 ea., $31,187.

Mills Mfg. Corp., 569 Broadway, N. Y., parachute, 10,750 ea., $819,687.

Minneapolis-Honeywell Regulator Co., 2600 Ridgeway Rd., Minneapolis, components, spare parts, $3,000,000.

Mitchell Camera Corp., 666 West Harvard St., Glendale 4, Calif., spare parts, $30,066; chronograph camera, 11 ea., CMY-5 16mm cameras, 26 ea., $212,745.

Norse Instrument Co., The, 21 Clinton St. Hudson, Ohio, printer-A-17, 69 ea., printer-A-18, 135 ea., printer-A- 14A, 250 ea., timer-C-1B, 507 ea., spare parts & data, $456,160.

Mosier Company, K. C., 18 W. Monument Ave., Dayton, connect-air hose, 7,500 ea., coupling assemply, 33,000 ea., $80,670.

Motorola, Inc., 4545 W. August Blvd., Chicago 51, transceivers, radio VHF, 48 ea., $58,786.

Neumade Products Corp., 330 West 42nd St., N. Y., rewinders, $36,668.

New York Air Brake Co., The, 420 Lexington Ave., N. Y., 17, parts for hydraulic valves, $32,481.

North Electric Co., 501 S. Market St., Galion, Ohio, telephone equipment, 102 ea., $2,953,924.

Northport Corp., 148-06 Cross Island Parkway, Whitestone, L. I., N. Y., surplus material, $96,820.

Nuclear Instrument & Chemical Corp., Chicago, survey meters, 200 ea., $67,895.

Ohio Hoist & Mfg. Co., P. O. Box 1794, Cleveland 5, electric hoist 1 ton, 60 ea., data, std. commercial handbooks, 245 ea., $33,424.

Olympic Radio & Television, Inc., 3401 38th Ave., Long Island City 1, SCR-573, 574, radio set, 53 ea., SCR-575, AN/CRD-4, 64 ea., $8,963,369.

Pachmayr Gun Works, 1221 South Grand Ave., Los Angeles 15, dispenser, radiosonde, type MA-1, $36,809.

Packaging Industries Ltd., Inc., 50 Church St., Monte'air, N. J., machine, heat sealing, 333 ea., $240,583.

Parker Appliance Co., 17325 Euclid Ave., Cleveland, valve assemblies and data, $27,779.

Perfection Stove Co., 7609 Platt St., Cleveland, maintenance data, $29,855.

Permutit Co., The, 330 W. 42nd St., New York, kit assembly, 28,595 ea., $344,569.

Pesco Products, Borg-Warner Corp., 24700 N. Miles Rd., Bedford, Ohio, spare parts, $284,632.

Phila. div., The Yale & Towne Mfg. Co., 11000 Roosevelt Blvd. & Haldeman Ave., Philadelphia 15, hoist, electric, 43 ea., hoist, electric, 13 ea., $27,709.

Photostat Corp., 303 State St., Rochester, 269 items of photographic equipment, $30,323.

Pioneer Parachute Co., Inc., 168 Forest St., Manchester, Conn., canopy assembly, 12,000 ea., $1,040,040.

Popper Equipment Co., Matawan, N. J., degreasers, 30 ea., $58,821.

Portable Electric Tools, Inc., 320 W. 83rd St., Chicago, phase inverters, 3,641 ea., $1,827,851.

Pressed Steel Tank Co., 1445 S. 66th St., Milwaukee, chlorine cylinder, 4,500 ea., Freon cylinder, 5,000 ea., installation of valves, 9,500 ea., $166,000.

Propeller division, Curtiss-Wright Corp., propeller assemblies, model C634S-C414/-830-21C4-0, 10 ea., blade & cuff assemblies, P/N 143134, 60 ea., bill of materials, $299,163.

Radiant Mfg. Corp., 2627 W. Roosevelt Rd., Chicago, tow targets, 10,530 ea., $222,-638; projection boxes, $48,022; miscellaneous parts, $49,377.

Radio & Television div., Sylvania Electric Products, Inc., 254 Rano St., Buffalo 7, N. Y., radio receiver, radio transmitter, power junction box, $50,000.

Randall Mfg. Inc., N. Y., degreasers, 292 ea., $193,193.

Reliance Mfg. Co., Inc., 212 W. Monroe St., Chicago, cushion para. seat, 350 ea., cushion para. back, 525 ea., para. assembly pilot type, 350 ea., para. assembly pilot type, 175 ea., para. assembly back style, 7,500 ea., $1,182,531; canopy-personnel rescue parachute, 750 ea., cushion assembly-parachute seat, 343 ea., $77,726.

Republic Aviation Corp., Farmingdale, L. I., N. Y., maneuvering stabilizer, $362,411.

Revere Copper & Brass, Inc., 5851 W. Jefferson Ave., Detroit, brass rod and bar, 166,600 lb., $76,385.

Robbins & Myers, Inc., 1345 Lagonda Ave., Springfield, Ohio, hoist, electric cable, 19 ea., hoist, electric wire, 45 ea., $48,915.

Roth Office Equipment Co., The, 113 E. Third St., Dayton, chair, 9,155 ea., $132,417.

Saxon Drafting Equipment Co., Bayway Terminal Bldg. #14, Elizabeth, N. J., drafting tables, 873 ea., $54,086.

Schutting & Co., Inc., 9th & Kearney Sts., N. E., Washington, D. C., radio receivers, $34,642; components, 4,700 ea., $987,629.

Scintilla Magneto div., Bendix Aviation Corp., Sidney, N. Y., spare parts, $64,980.

Seifreat-Elstad Machinery Co., The, Dayton, grinders, 10 ea., $146,793.

Selby Shoe Co., The, Portsmouth, Ohio, helmets, 4,353 ea., cover lens, 13,367 ea., plate assembly, 8,510 ea., visor-mechanism, 4,780 ea., binding-shell, 4,730 ea., pad assembly, 4,730 ea., sling assembly, 780 ea., spring-visor, 4,730 ea., $201,102.

Setchell-Carlson, Inc., New Brighton, Minn., radio receiver, $85,778.

Seymour Wallas & Co., 1200 S. 8th St., St. Louis 4, Mo., insulation blanket, 47,890 sq. yd., $94,486.

Sikorsky Aircraft div., United Aircraft Corp., Bridgeport 1, Conn., special tools, 85 ea., $38,533.

Simmon Brothers, Inc., 30-28 Starr Ave., Ll., N. Y., processing equipment, 353 each., $217,318.

Sirchie Fingerprint Laboratories, 922 Chestnut St., Philadelphia, camera, spare parts, literature, 663 ea., $74,645.

Skinner Purifier div., Bendix Aviation Corp., 1500 Twombly, Detroit, spare parts, $36,290.

Sprague Eng. & Sales Corp., 1144 W. 135th St., Gardena, Calif., test-stand, D-5, test-stand, D-6, 161 ea., 66 ea., $855,334.

S. S. Co., 830 Humboldt St., Brooklyn, kit-welding portable, 1,496 ea., regulator-cylinder, 936 ea., torch-welding, 1,260 ea., $156,340.

Stamford Electronics Co., 69 Southfield Ave., Stamford, Conn., signal generators, 96 ea., $45,398.

Sun Ray Photo Co., Inc., 309 Lafayette St., N. Y., 12, enlarger, related equipment, instrument book, mfg's dwgs., spare parts, 265 ea., $124,917.

HAM STANDARD'S NEW QUARTERS

Hamilton Standard's new plant at Bradley Field, Windsor Locks, Conn., has gone into full production after its move from East Hartford, Conn. Factory is turning out a large range of parts for Air Force and Navy planes. Production schedule in 500,000-sq. ft. factory includes propellers, jet engine fuel controls and starters, cockpit cooling and air conditioning units and hydraulic pumps. Plant is under three-shift operation and employs about 6,000. Move here from old site took three months, involved more than 1,400 trips with loads ranging as high as 40 tons. Helicopter landing circle (right) allows close-proximity letdown for Sikorsky copter that United Aircraft Corp. operates.

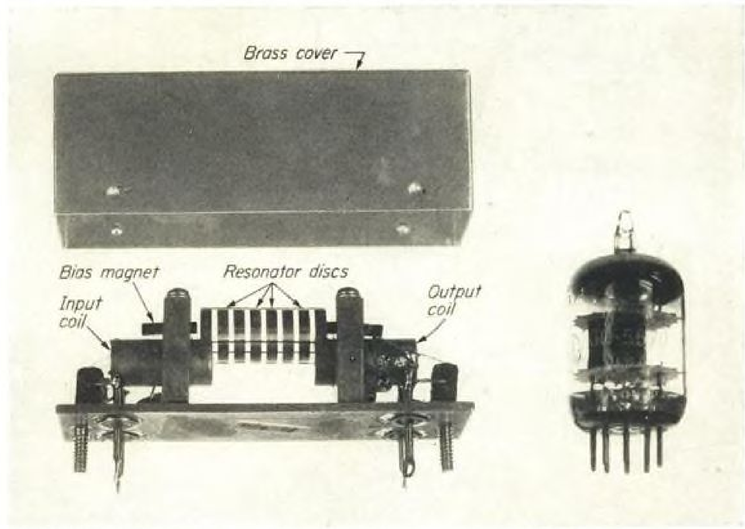
New Filter Slices Air Waves Finer

- **Collins device makes more channels available.**
- **Mechanical unit solves this electronic problem.**

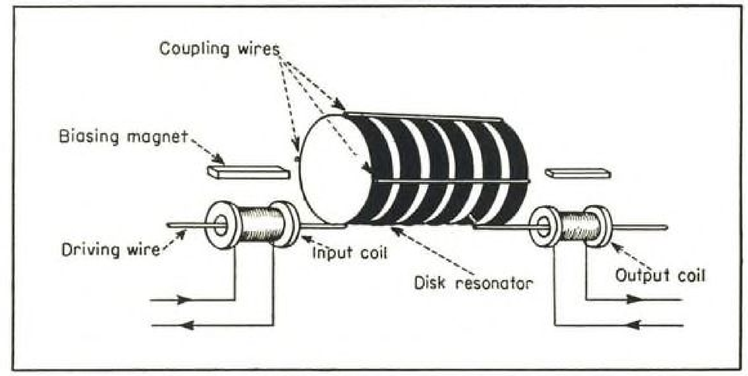
By Philip Klass

A mechanical engineer frequently turns to electronics to help him solve his problems but it's seldom that the communications engineer calls on mechanical devices to solve his problems. However, a new mechanical filter developed by Collins Radio for intermediate frequency (IF) radio circuits appears to reverse the picture.

The purpose of a filter is to pass certain selected frequencies and reject all others. The new mechanical filter will allow the communications engineer to squeeze more channels into the already crowded radio spectrum by spacing them more closely in his transmitter. It will also allow him to design radio receivers capable of rejecting unwanted adjacent channels.



MECHANICAL FILTER compares in height with acorn-type tube (right).



BASIC OPERATING PRINCIPLES of new filter are illustrated by schematic.

▶ **Industry Interest**—There's lots of industry interest in the new Collins filter. Bendix, RCA, Lear, Bell Laboratories, and Pan American Airways are reported to have purchased filters for experimentation. Collins has shown its confidence by using the mechanical filter in its new 144-channel Model 618S high frequency airborne transceiver.

Collins thinks the mechanical filter will be extremely useful in single-sideband (SSB) communications equipment which some airlines are cautiously eyeing as a possible solution to the problem of finding more radio channels in the crowded spectrum.

Here's what makes the mechanical filter so attractive:

• **More selective.** The mechanical filter has the nearly ideal rectangular shaped characteristics needed for selectivity when adjacent voice communications channels are very closely spaced.

• **Smaller.** In the 100-to-500-kc. region, Collins says its mechanical filter is smaller than any of the IF transformers normally used. And one mechanical filter replaces several transformers.

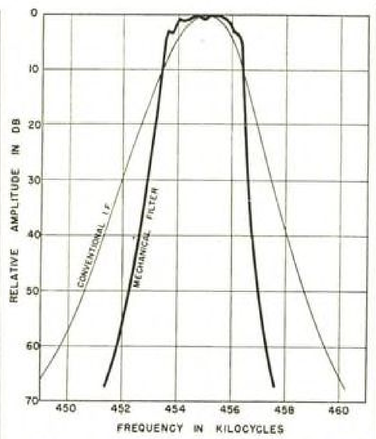
• **Low loss.** Present production design units have losses below 26 db., and experimental work indicates that these can be cut to below 10 db. in the future.

• **Fixed characteristics.** Once the mechanical filter is constructed, its frequency characteristics are permanent and it needs no trimming, Collins says. The units are hermetically sealed so that coil aging and humidity, both of which afflict IF transformers, are no problem for the mechanical filter, according to Collins.

▶ **How It Operates**—The Collins filter converts its input signal into a mechanical vibration, then damps out unwanted vibration frequencies, and converts the passed vibrations into an electrical output signal of the corresponding frequency.

The filter consists of eight nickel-iron alloy disks, two of which function only as end supports for the six center resonators. All eight disks are connected to each other by means of three coupling wires welded to each disk. A nickel driving wire is attached to the second disk, and another to the seventh disk (first and last of the resonator disk). One driving wire "floats" inside the input coil; the other inside the output coil.

When a signal is applied to the input coil, its magnetic field causes the nickel driving wire to expand and contract (due to magnetostrictive effect) setting up longitudinal vibrations. These are transmitted to the input-end resonator disk, and on to the other resonator disks through the coupling wires which act as springs. At the out-



COLLINS mechanical filter has desirable band-pass characteristics.

put end, vibration of the driving wire induces an electrical current in the output coil by the reverse process. Small permanent magnets near the input and output coils serve to establish a biasing magnetic field.

Small mica condensers are shunted across the input and output coils to provide a low-Q resonant circuit. Input and output coil impedance is 6,500 ohms, which allows the filter to be directly connected to vacuum tube plate and grid circuits. The complete filter is housed in a hermetically sealed brass case whose size is about 1 x 1 x 3 in.

► **Filter Characteristics** — The filters which Collins is currently producing have a center frequency of 455 kc. However Collins says that mechanical filters can be built, and should show up favorably, for any frequency in the 100-to-500-kc. region. Below 100 kc., the filter size gets objectionably big; at higher frequencies, the fabrication of tiny elements becomes a problem.

Collins has built its 455-kc. filters with a 6-db. bandwidth of 1 to 6 kc. on a laboratory basis. A 3-kc. bandwidth filter is now in pilot production and Collins expects to be producing the 1- and 6-kc. units soon. Other characteristics of the pilot-production 455-kc. filter are:

- **Peak to valley ratio:** 3 db. in pass band (experimental units have been built with 1.5-db. ratios).
- **Insertion loss:** 26 db. (which may eventually be improved by better coupling between the coils and driving wires).
- **Overload input power:** 0.035 watt.
- **Time delay:** ½ to 1 millisecond in pass band.
- **Operating temperature range:** 15C to 80C (without temperature compensation).
- **Meets AN-E-19 vibration requirements.**

Collins subjected the filter to vibration in the 10-to-55-cps. range while passing a 455-kc. carrier through the filter to a low-frequency receiver. Any vibration-induced modulation would then show up at the receiver, but none did, Collins reports. Tests of filter characteristics before and after the vibration tests showed no change due to vibration.

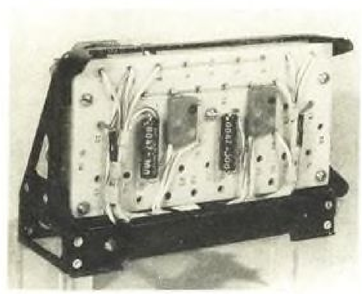
Easy to Produce, Easy to Service

Ford Instrument Co. (division of Sperry Corp.) uses an interesting technique in packaging the avionics components for an aircraft computer which it builds for the Navy. The Ford procedure simplifies its own manufacture and assembly and the Navy's maintenance and replacement problems.

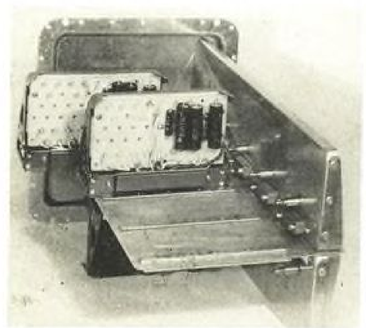
Sub-assemblies are constructed on pre-punched standard terminal boards. This simplifies wiring and soldering operations and permits each board to be completely wired before installation. Once the terminal board is wired, it is screwed to an L-shaped chassis.

Tube sockets and a quick-disconnect

PREWIRED avionic components are . . .



MOUNTED on chassis, which is then . . .



INSTALLED with other sub-assemblies.

type connector slip underneath and are quickly secured to the chassis shelf. Tubes and transformers are added and the transformer taps soldered. The chassis is then ready to join other sub-assembly chassis on the main assembly.

Individual chassis are mounted on the leg of a T-shaped frame by sliding them between the rails and tightening a jack screw which secures the chassis. The female connector on the chassis mates with a male connector on the T-frame. The T-frame itself fits inside of a case which can be filled with inert gas or can be pressurized up to 20 psi.

FILTER CENTER

► **RCA To Build Hughes Fire Control**—The USAF is setting up the Radio Corp. of America as a second source to build the Hughes Aircraft fire control systems used on current crop of interceptors (F-94C, F-86D, F-89D). Navy also is reported to be eyeing RCA as a second source for its Westinghouse interceptor fire control system.

► **Assist For Radar Designers**—General Electric has developed a circular slide rule to make it easy to determine the maximum range of pulse-type radar when major system design parameters are known. The GE device saves the tedious calculation involving exponential powers of seven variables (pulse duration, repetition rate, peak power, antenna gain, wavelength, receiver sensitivity and target size). The 8-in. plastic rule should be useful in determining the effect of a change in one or more system variables on radar performance. Reverse side of the slide rule contains other scales, including one for calculating antenna gain. The new rule may be purchased for $7.50 from General Electric, Commercial and Govt. Equip. Dept., Electronics Park, Syracuse, N. Y.

► **New Collins Course Indicator**—Collins Radio is flight-testing a new 3-in.-dia. course indicator as a possible replacement for the larger (5-in.) indicator now used in its Integrated Flight System. Course indicator gives a graphic presentation of plane's position relative to omnirange or ILS localizer beam.

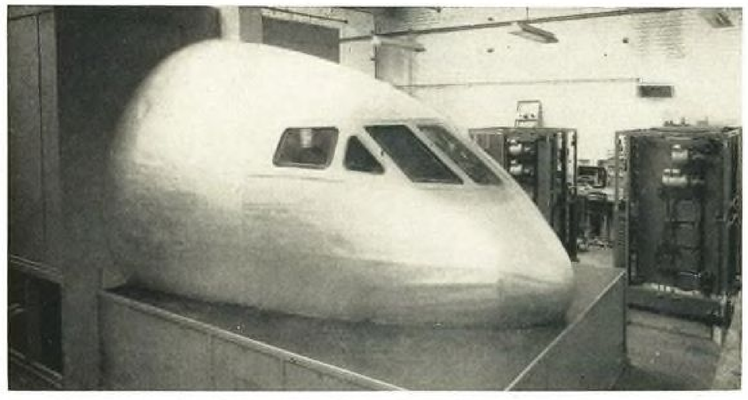
► **New Technical Bulletins:**

• **Specialty transformers** for avionics equipment are described in recent brochure published by Goslin Electric & Mfg. Co. The publication lists custom-engineered transformers for radar, gyros, or communications equipment in either open-frame or hermetically sealed types which meet military specifications. (Dept. AT, 2121 West Olive St., Burbank, Calif.)

• **Stabilized quartz crystals** for communications equipment and other applications are described in a new catalog issued by James Knights Co., Sandwich, Ill. More than 45 different crystals are listed.

• **Mica dielectric capacitors** of the transmitter type which meet JAN-C-5 are described in catalog No. 31 now available from Sprague Electric Co. (327 Marshall St., North Adams, Mass.)

• **Airborne and ground telemetering** equipment, including plotting and tabulating devices, are described in a four-page brochure by the Applied Science Corp. of Princeton. Building block accessories which can be assembled into a system to meet individual requirements are listed. (P. O. Box 44, Princeton, N. J.)



REDIFON BUILDS COMET SIMULATOR

Britain's activities in the flight simulator field, as evidenced by this Comet jet liner unit, have gotten a big boost from a $3-million order by the Canadian Government to build F-86 Sabre trainers. The order goes to Redifon, Ltd. which previously built a Boeing Stratocruiser simulator, under license to Curtiss-Wright, for BOAC.

FINANCIAL

CAB Estimate of Mail Ton-Miles

Carrier	Mail Ton-Miles Flown Fiscal Years Ended June 30: 1951	1952	1954	1954 Increase Over: 1951	1952
American	12,490	16,861	21,069	68.9%	30.8%
Eastern	5,410	5,718	7,636	41.5	33.4
TWA	10,718	11,824	13,488	25.8	14.1
United	14,647	20,715	25,939	77.2	25.3
Braniff/Mid-Continent	1,870	1,987	2,449	31.2	23.3
Capital	1,778	1,999	2,679	39.4	34.1
Chicago & Southern	646	740	884	36.7	11.9
Delta	1,509	1,881	2,377	57.7	26.4
National	837	1,326	1,828	118.5	38.0
Northwest	2,351	2,566	2,718	15.6	16.9
Western/Inland	1,313	1,382	1,822	38.6	31.8
Colonial	104	124	140	34.6	12.9
Continental	255	521	641	151.0	22.9
Northeast	138	160	206	49.4	28.6

SOURCE: Administrative Separation of Subsidy From Total Mail Payments to U. S. Air Carriers, October 1952 revision.

CAB Expects Rise in Air Traffic

Although the prime purpose of the Civil Aeronautics Board's October 1952 mail pay study is to establish an indicated level separating service and subsidy rates for individual carriers, a measure of the anticipated growth for the carriers involved is an interesting by-product of this study. And to judge by the study, CAB foresees a wide variation in rate of growth for the various domestic trunklines.

To forecast future operations, even for a limited period, for a single airline is a formidable task. To do so for all airlines, domestic, international and local service, is indeed a courageous project that very few would dare attempt. The Board, prodded by the Senate Interstate and Foreign Commerce Committee, has attempted to estimate the future for all of the airlines in order to ascertain the measure of subsidy believed present in air mail pay.

▶ **Lesser Scope**—In its original and extensive report in this program released under date of September 1951, the Board study not only estimated future levels of mail ton-miles and mail revenue but of all non-mail revenues as well. These projections covered the period up to and including the 1953 fiscal year.

In the current October 1952 report, the Board study is less bold and confines the projections to mail ton-miles and mail revenues only.

Nevertheless, this estimate of mail ton-miles is interesting as it may be presumed to indicate the Board's current thinking as to the level of airline volume for future years. The flow and volume of mail in transportation channels have frequently been regarded as an excellent harbinger of probable air passenger business. (This was the keystone of a number of erudite studies on traffic trends issued by the Board under the guidance of F. H. Crozier some ten years ago.)

Accordingly, if mail volume is to be used as a reliable guide, the Board may now be presumed to expect that airline traffic will continue to show substantial increases in the years ahead. The accompanying table presents the mail ton-miles projected for the individual domestic trunk airlines. It can be seen that individual increases for the fiscal year to end June 30, 1954, over the 1951 fiscal year range from 15.6% to 151.0%.

Stated in comparison with fiscal 1952, the 1954 projections anticipate individual gains ranging from 11.9% to 38%.

▶ **Wide Variations**—The variations among the separate carrier projections are very wide and may be difficult to justify. For example, among the Big Four the rate of increase for United is expected to be 77.2% for fiscal 1954 over fiscal 1951 while TWA is projected to develop only a 25.8% increase. Stated in terms of growth for fiscal 1954 as compared with the 1952 fiscal year, the same relative pattern continues. In other words, for this period United is expected to gain 25.3% to TWA's 14.1%.

It is noteworthy that Chicago & Southern is projected for only an 11.9% gain for fiscal 1954 over 1952, the lowest for the entire group. National, with an estimated gain of 38%, is the highest for this period.

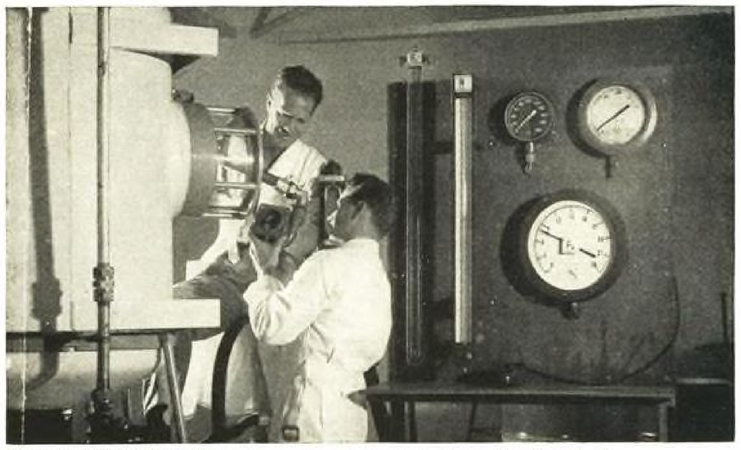
The contrasts among the carriers operating in the same general areas provide interesting case studies in themselves. For example, Eastern's projected 1954 gain of 33.4% over fiscal 1952 compares with 26.4% for Delta, 38% for National, and 34.1% for Capital. All of these carriers are on service rates for carrying the mail decreed by CAB standards.

However only Eastern is to be paid at the rate of 45 cents a ton-mile, while the other three are to receive 53 cents a ton-mile. While the Post Office Department has indicated it is not discriminating between carriers, it is difficult to believe that this condition will continue indefinitely under existing circumstances. These varying rates of mail compensation can prevail, however, under the provisions of the bill S. 436 passed by the Senate last year. In the meantime, these service rates do not appear to have been detrimental to any of the carriers involved.

In any event, the Board's projections as to future mail ton volume denotes an expectation of a continuing upsurge in airline business.

It is interesting to observe that, in its September 1951 projections of 1952 fiscal results, the study underestimated the extent of the business upswing for the airlines. Presumably, in its current October 1952 report, an attempt is being made to correct this. Only time will demonstrate the correctness of these forecasts. Airline forecasting remains a hazardous business.

—Selig Altschul



EXPERIMENTAL fuel booster pump equipment at Hydro-Aire is part of . . .

New Setup to Test Air Accessories

Hydro-Aire's new facility is designed to 'fabricate, evaluate, qualify' equipment for aviation firms.

William J. Coughlin

Burbank—New test and research facilities for fabrication, development and qualification of aircraft accessories have become available to the aviation industry with the opening of Hydro-Aire, Inc.'s new main plant here.

This new plant covers 78,000 sq. ft. and will up production capacity 400%. The engineering research laboratory, expanded to 7,200 sq. ft., will test fuel, hydraulic, pneumatic and electrical-mechanical aircraft accessory equipment. The lab was nearing completion when inspected recently by AVIATION WEEK. It houses $500,000 worth of test equipment, is staffed by 18 engineers, technicians and machinists.

▶ **Temperature Extremes**—"Given a preliminary design, the laboratory is equipped to fabricate a prototype part, evaluate the performance under conditions simulating actual operation, and to qualify the unit according to customer and military specifications," says O. A. Wright, chief design and research engineer.

A liquid carbon-dioxide tank feeds a refrigeration circuit to all sections of the laboratory. This "dry ice" can be bled from the main manifold in liquid form and used through spray nozzles for cooling such items as temperature cabinets or condensers. A walk-in cold chamber with a 100-sq. ft. working area will take test temperatures down as low as —104F. Smaller semi-portable boxes will simulate altitudes up to 65,000 ft. One large chamber capable of maintaining regulated temperatures up to 600F is used for high heat testing.

▶ **Fuel Section Facilities**—New equipment now being installed will permit simulation of actual in-flight refueling conditions.

Three basic flow circuits are used to test accessories in the fuel laboratory. Components such as large gate valves or surge flow valves are tested on a large circuit with a variable flow up to 600 gpm. and shutoff pressure of 100 psig. This circuit consists of a single-stage centrifugal pump with a variable speed drive, a 1,450 gal. reservoir, and a hot and cold heat exchanger.

The second circuit, which includes a two-stage centrifugal pump and a 200 gal. reservoir, is used for testing of accessories as part of a complete system. It provides a variable flow up to 200 gpm. with a shutoff pressure of 250 psig. It also is connected to a separate fuel bench.

The third flow circuit is part of a second fuel bench, which has a hand-operated pump for leakage and low flow tests, and accommodates a flow of 70 gpm. and a shutoff pressure of 70 psig.

The test stands in the fuel area are built to handle both submerged fuel pumps and engine-driven pumps. The test stands are connected to an altitude system capable of a climb to a simulated altitude of 30,000 ft. in one minute.

▶ **Pneumatics**—One-third of the laboratory is set aside for the testing of pneumatically operated accessories. It consists of a test room and an adjacent compressor room. Heavy machinery in the compressor room is capable of supplying air at 1.5 lb. per sec. at 125 psig. Other machinery will provide air at pressures and flows up to 3,000 psig. and 45 cfm. free air. A gas-fired heater can heat the air to 800F and the air also can be centrifugally and chemically dried. This supply of hot and cold air is piped into the test room to a system with several outlets to allow for more than one test setup at a time.

▶ **Other Check Work**—Hydraulic testing is done on a large test bench, which includes a piston pump capable of flows up to 25 gpm. and pressures up to 5,000 psig.

Electrical test setup includes a power supply with several d.c. generators (voltage adjustable from 10 to 32, and capable of supplying 200 amp.). A three-phase 10-kva. alternator can produce a.c. from 187 to 510 cps. at voltages from 100 to 250.

Exciter on the vibration machinery has a capacity of 25 lb. through a frequency range from 4 to 500 cps., 18 lb. up to 1,000 cps. and a maximum frequency of 70,000 cps. It thus will test accessories in accordance with requirements of AF Spec. 41065-B and MIL-E-5272.

The research lab has its own machine shop to reduce interference with production facilities.

The laboratory has recently acquired a nine-trace recording oscillograph with a carrier amplifier for recording temperature, pressure and electrical transients.

Ted Scott, head of the testing laboratories, hopes to add by the end of the year fuel resistance test equipment and a 100-hp., 10,000-rpm. dynamometer as well as salt spray and humidity test equipment.

Unit Tests Plane Circuit Breakers

A portable tester for checking out circuit breakers in aircraft is one of several new pieces of equipment recently announced by Greer Hydraulics.

This new model, CBT-1, has been ordered by A. V. Roe, Canada, Ltd., the firm reports. It indicates how long a circuit breaker takes to trip from an over-load to protect the circuit. It will test breakers rated up to 150 amp. at 28 v. d.c.

The equipment includes a voltmeter, a dual-scale ammeter (0-30 amp. and 0-150 amp.), negative input terminal ports, 11 loading switches to try the breaker, and a 1,000-sec. manual reset timer.

▶ **Accessories Kit**—Greer also introduced

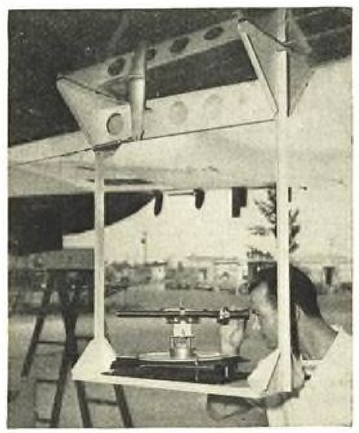
recently an accessories kit, EST-104, for use with its JH 10600 aircraft starter test stand, a prony brake stand which tests performance and clutch setting (holding torque) of piston-engine starters, with either 6- or 7-in. pads.

The new kit supplements this equipment by permitting tests of actuators and retraction motors. It includes:

- **Adaptor ring** to mate with retraction motor and actuator mounting flanges.
- **Couplings to connect** retraction motors and actuator output driveshafts with the test-stand jaw.
- **Clamp extensions** to accommodate smaller motor bases.
- **Two torquemeters** with a range of 0-150 and 0-500 ft. lb. (another torquemeter of 0-1,500-ft. lb. capacity is already included).
- **Tachometer gear reduction** unit to be used with dual-scale tachometer on the stand when speeds higher than 150 rpm. are used.

► **Jet Starter Test**—Greer also has another test stand primarily designed for checking out jet engine starters prior to installation. The machine simulates inertia loads imposed on the starter at initial starting and up to jet engine working speed. It can be used for newly overhauled Class E1 and E2 starters. Flywheels on a rotating shaft provide inertia while power to the starter is supplied by a built-in motor-generator. The equipment includes all instrumentation and controls for complete tests.

First of the stands have been delivered to the Navy.



Compass-Swinger Mounts on Belly

Accuracy of ¼ deg is claimed for a new pelorus or sighting device for flux gate compass-swinging, designed and developed by the electronics engineering section of Eastern Air Lines' Communications dept. at Miami.

The device, which will fit interchangeably in the bellies of EAL's DC-4s, 4-0-4s, L-749s and L-1049s, is

accurately aligned with the fuselage center line and is quickly attached with anchor nuts. Maximum visual obstruction caused by landing gear, wheel doors, etc. is a 4-deg. sector. Height of the attachment bracket is adjustable, making the instrument accessible whether fastened to the low belly of a 4-0-4 or high underside of a Connie.

Use of the pelorus for compass-swinging is not new, but previous installations were mounted on top of the aircraft. EAL found many drawbacks to this method, including inaccuracy due to the operator feeling insecure in his precarious perch atop the plane.

▶**What It Is**—The pelorus has the qualities of being straightforward, simple and inexpensive. The azimuth dial is a 10-in. drafting protractor calibrated in ½-in. increments through 360 deg. Readings of ¼ deg. may be interpolated. The sight is a Mossberg 2M4-D, 4X rifle scope. A battery-powered "wheat grain" bulb in a pen-light case illuminates telescope reticle for night work.

▶**Putting it to Use**—Installation of the pelorus takes less than five minutes, says EAL, and fool-proof alignment eliminates possibility of personnel error.

After adjusting pelorus to his height, the operator sights the instrument on predetermined, easily-recognizable objects, all over one nautical mile distant. The bearing of each object has been determined by celestial azimuths and calculated to minutes of an arc.

The operator informs the cockpit of the aircraft's headings through various connections of interphone system.

Eastern says, "The accuracy of heading . . . of ¼ deg. far exceeds the calibration limitation of the flux gate compass."

Hot Air for Testing

A rig that heats high-pressure air or other gases to be used in testing components, has attracted the interest of jet engine manufacturers, according to the maker of the device, Thermal Research & Engineering Corp.

The unit, gas or oil-fired, delivers air at a temperature of about 1,200F; with special modifications it has reached 1,600F at 135 psig., and the company claims it can be made to go higher. The heat exchanger is sold as a complete package, including burner (with or without controls).

The equipment comes in two versions—Model 1010 weighs 850 lb., provides 750,000 Btu./hr.; Model 1030 weighs 2,300 lb., puts out 2,500,000 Btu./hr. The units use new high-velocity burners, said to give extremely high heat release in minimum combustion space and provide products of combustion at maximum velocities and temperatures.

Thermal Research & Engineering Corp., Conshohocken, Pa.

OFF THE LINE

Trans World Airlines has run into a sticker at its engine test stands at Kansas City. Exhaust gases from newly erected jet engine test cells get sucked into the carburetor air intake of TWA's engines being run in and tested. Carburetor air temperatures as high as 135F are what have given the airline trouble.

Pacific Airmotive Corp. will overhaul and convert all of Pan American World Airways (PAD) R4360-TSB3G engines under a contract that runs to November 1953, the overhaul agency announces. The Burbank firm will modernize the engines from the TSB3G to the B6 configuration and do any work required by Pan Am's detailed engine overhaul specifications. PAC says it is the only privately owned maintenance facility equipped to overhaul the Stratocruiser engine.

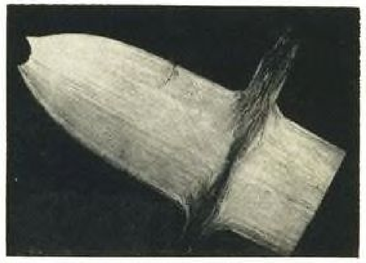
Aircraft curtain fading is a minor but real source of annoyance to many airlines. Northwest is experimenting with a new product that purportedly reduces outside heat by refraction, prevents fading, fireproofs the material and allows curtains to retain their "drape" almost indefinitely. The product, called "Raylon," is said to be aluminum in vaporized form which condenses on the curtain fabric to form a protective coating. Producer is Minnesota Mining and Manufacturing Co.

Environmental test chambers for temperature-humidity tests on aircraft and other components have been standardized into five basic models by Tenney Engineering, Inc., 26 Ave. B, Newark 5, N. J.

HEATER PUMP-MOTOR

Aircraft combustion heaters are supplied fuel by this pump-motor combination, Romec RG-9540, rated to deliver high aromatic aviation gas at 35 gph. Discharge pressure is uniform from sea level to 40,000 ft. altitude. Pump weighs 3.4 lb. and measures 7⅛ in. long. Romec division, Lear, Inc., Elyria, Ohio.

Koldweld hand tool developed by Utica.



Microphoto of Koldwelded wire section.

Firms to Boost Koldweld Process

The Koldweld process, a low-cost method of welding nonferrous metals with pressure alone, has received impetus from Utica Drop Forge & Tool Corp.

The firm has made arrangements with Koldweld Corp. to develop and supply tools for the process. The plans envision development and sale of large production machines, as well as hand tools already developed by Utica.

Koldweld Corp. is the only licensee in the U. S. The process is owned by General Electric Co., Ltd., England (no relation to the American firm). It was brought here two years ago by Koldweld's president, William Dubilier, a founder of Cornell-Dubilier Corp.

At present, parts are cold-pressure-welded by special hand pliers. Utica expects to lighten and streamline the now cumbersome tool for everyday use by workers and homeowners. Koldwelding already has been used in the aircraft industry by Piper Aircraft for joining two sections of a metal fuel tank. Koldweld and Utica are now investigating

other applications of the method and see many possibilities in the aviation field.

Only hand pressure is used, no flame, flux or other chemical is applied. Yet the weld is said to have greater tensile strength in some applications than the metal itself. Pressure and the manner in which it is exerted by the plier heads causes an inter-molecular flow between parts being joined, microphotographs show. The pliers can be used after short instruction, it is claimed.

Removal of the oxide film on the metal surfaces is required before the welding operation. This can be accomplished with a wire brush.

Utica says hand tools for welding wire and for metal sheets soon will be available. These and later tool developments will permit "welds of uniform excellence . . . at unprecedented low cost . . ." Koldweld states.

The method has been used to weld terminal lugs to bonding cables of the type used in aircraft, to butt-weld aluminum wire and electrical conductors, for joining flat sheets and for seam-welding of tubes. With tubes, the joint can be made virtually flush; with wire the connection is the same gage as the wire itself after a small flash of metal at the bond has been removed. Utica reports a number of companies in England are adopting this method of connecting cables for its speed, reduced radio interference through improved connections, and elimination of electrolysis caused by foreign metals. The butt-weld is made in seconds.

Utica and Koldweld believe the process will prove a boon in welding copper lines to aluminum chassis. Small copper disks can be Koldwelded to the aluminum chassis, then the copper wire soldered to the disk.

SOLENOID VALVE

Redesigned F-84 fuel system incorporates this solenoid valve made by Valcor Engineering Corp., Newark, N. J. Unit serves as pilot valve and has exclusive floating shear seal, providing reliable operation under extreme back pressure and minimum pressure drop, according to firm.

Fast Camera Speeds Engine-Knock Study

A research camera so fast its maker claims it would go through a million frames if operated for 10 sec. is being used to study of the causes for knock in spark-ignited piston engines.

The study is sponsored jointly by the Navy Bureau of Aeronautics, the aircraft, automotive and oil industries, it was disclosed at the recent International Symposium on High-Speed Photography. Details of the unit, known as an "Isotransport" camera, were given in a talk prepared by C. D. Miller and Arthur Scharf of Battelle Institute, independent applied research organization.

The camera also can be used to record high-speed phenomena associated with ballistics and jet engine operation and for a variety of other tasks. It is said to be about ten times faster than other high-speed cameras commercially available and was developed to fill the need for equipment in the speed range of 10,000 to 100,000 frames/sec.

The Isotransport is a faster model of a design developed by Miller when he was associated with the National Advisory Committee for Aeronautics. Photographs are said to be comparable in clarity and detail with those obtained in cameras operating at much lower speeds. Distortion of objects from frame to frame is avoided because pictures can be taken through the same lens from the same viewpoint, according to Miller. A single series of 500 frames can be projected as a motion picture immediately after development of the film without reprinting and reregistering the frames.

Camera has only one moving part.

ALSO ON THE MARKET

Portable X-ray of ¼-million-volt capacity and weighing 150 lb. can inspect steel 3½ in. thick, has snout to poke inside of castings for complete going over. Beryllium window of X-ray tube permits inspection of lighter metals by allowing escape of softer, less-penetrating X-rays from tube. General Electric Co., 4855 Electric Ave., Milwaukee 14.

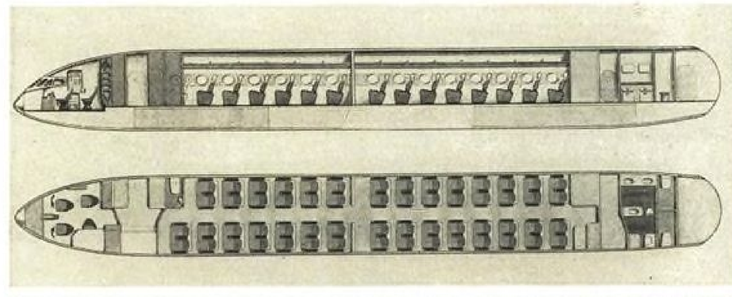
Miniature test point jack has new protective collar around contactor to permit safe circuit voltage readings up to 3000 v. a.c. from the front of equipment panels. Collar protects personnel from flashovers during high-voltage checks. Made to JAN-P14, MTS-E1 and MIL-P-14A-CFG specifications by Alden Products Co., 117 N. Main St., Brockton, Mass.

BOAC Says Comets Now Pay Own Way

- **First four months of new service net profit.**
- **Problems: speedup of ground, operating pace.**

By Robert Hotz

DH COMET (Series 3 model shown): Crews learn quicker but training costs more.



SERIES 3 COMET (top) will seat 58 passengers compared with 1's 36-seats, high-density version (above) will have this cabin layout for 76.

London—Contrary to some American opinion, British Overseas Airways Corp. is operating its initial Comet jet transport service at a profit.

BOAC treasurer Basil Smallpiece told AVIATION WEEK that the first four months of Comet operations—carrying 4,536 fare-paying passengers on the London-Johannesburg-Springbok route—resulted in a net profit of $16,800.

"This is not simply an operating profit," Smallpiece emphasized. "It was arrived at after the Comet unit had borne its fair share of the corporation's general and commercial overhead and after bearing its share of the whole corporation's cost of Comet development. Current Comet development cost, including route familiarization, are borne by the Comet unit alone and are not spread over the whole corporation."

BOAC's Comet development costs are being amortized over the life of the aircraft—estimated at about eight years. BOAC also reports that the Comet's cost per capacity ton-mile is running higher than normally because extra fuel is being carried as an additional safety precaution with a new-type aircraft.

"We are flying with braces [i.e., suspenders] and belt now," explains BOAC's chairman Sir Miles Thomas. "Soon we will be flying with just braces."

►**Load Factors**—For the Springbok route, BOAC calculates the break-even load factor for the 36-passenger Comet 1 at 72%. During the first four months of operation (May-August) the actual load factor was 79.1% with a rise to 81% in the early fall. Extremely heavy advance reservations indicate that high load factors will be maintained at least through next spring.

The BOAC Comet unit headed by Capt. M. J. R. Alderson has already logged several thousand hours of jet transport time and is now flying its nine Comet 1s at a rate of 800 hr. a month. Capt. Alderson told AVIATION WEEK the transition time for Comet crews is less than that required on Stratocruisers and Constellations but route familiarization took a good deal longer. BOAC now has some 20 crews checked out on Comets and is training flight personnel for Pan American Airways, Canadian Pacific, RCAF, British Commonwealth Pacific Airlines and the French UAT. BOAC pilots report a marked preference for the Comet, claiming it is simpler to operate than a piston-powered transport and much less fatiguing.

BOAC has found the Comet crew training and route familiarization more expensive than had been anticipated. In addition to the regular Comet services, BOAC is using one Comet for route familiarization and another for transition training.

Some commercial charter flights are also made with Comets, including ferrying the Duke of Edinburgh to and from the Olympic games held at Helsinki.

The BOAC Comet unit put in more than 1,000 hr. of route flying before inaugurating passenger service on the Springbok route.

Biggest difference in Comet flying and conventional transport operations is the increased tempo of both flight and ground operations and the rigid, pre-planned flight pattern required for most economical operations.

Here are some of the things the BOAC Comet unit has learned about jet transport operations:

►**Engines**—Civil version of the Ghost turbojet used in the Comet is now operating at a 250-hr. interval between overhauls. This is expected to increase shortly to 375 hr. and eventually to 450 hr. De Havilland is now doing all Ghost overhauls but BOAC eventually

plans to do its own jet overhaul work at its maintenance base in Wales. BOAC now makes its own combustion chamber inspection each 175 hr. An average of two liners require replacement on each inspection.

Most of the replaced liners are repairable for further use. A spare engine is spotted at each station along the Comet routes.

► **Flight Operations**—Takeoff is made after an engine runup to full rpm., holding the aircraft with the brakes. The brakes are released and the Comet allowed to build up speed to a margin of 15% above stalling speed. This is considered a satisfactory takeoff safety speed by the BOAC Comet unit.

Experience with three-engine takeoffs indicates no swinging tendency of the aircraft even when an outboard engine is cut off. The close grouping of the engine minimizes asymmetrical power loads. Lack of a prop on the jets eliminates drag encountered from windmilling or feathered props on failing piston engines.

De Havilland has designed a door that retracts over both main landing gear wheel wells when the gear is down, thus eliminating drag from an extended door and also increasing the efficiency

BOAC'S CAPT. ALDERSON: Pilots prefer the Comet because of its simplicity.

of the wing during the critical periods of landing and takeoff. At landing weight the Comet can maintain a 1,100-ft.-per-min.-rate of climb on three engines with wheels and flaps up.

The large amount of fuel burned off en route brings the wing loading of the Comet down to about 30 lb. per sq. ft. during approach and touchdown. This low wing loading at landing weights makes it possible to use approach and touchdown speeds slower than those normally employed by a Stratocruiser or Constellation.

Loss of an engine en route necessitates a "drift down" procedure to the altitude where three-engine cruise can be maintained. Operational calculations over a 1,500-mi. stage length with a "drift down" to 27,000 ft. from a simulated engine failure at the half-way point show a fuel penalty equal to 17% of full payload can be expected. A similar calculation with the three-engine cruise executed at 15,000 ft. would result in a fuel penalty equal to 64% of full payload.

Although the Comet's climb and descent through icing conditions is so rapid that its thermal de-icing system requires little actual use, flight experience has shown that it would be an absolute necessity in case of three-engine cruise in tropical conditions forcing a "drift down" to altitudes where heavy icing is prevalent.

Normal cruising is done between 34,000 and 40,000 ft. Comet pilots have been on instruments at 40,000 ft. and on occasion have gone to 43,000 ft. to avoid weather. Comet pilots report cloud tops are generally much higher than forecast and they frequently detour around storm clouds at 40,000 ft.

The effect of higher temperatures on en route cruising operations has been much less than was anticipated but the temperature at takeoff points has an important effect on maximum gross loads. Above the temperature limitations normally calculated for Comet operation, each additional degree centigrade at takeoff point reduces the Comet gross by the weight of a passenger and his baggage. During cruising conditions an increase of 7 deg. C. is required to exact a similar weight penalty.

► **Navigation**—Basic navigation is done by radio with celestial procedures used as a backstop in case of radio failure. Comet pilots feel that a universal navigational aids system is needed for global jet operations both for en route and terminal procedures. More VHF homing beacons, distance measuring equipment with range up to 200 mi. and more instrument landing systems are needed along present and future jet transport routes.

► **Weather**—Precise forecasts on surface winds and temperatures at takeoff points and good high-level wind forecasts en route are necessary for jet operations. Prompter information on deteriorating weather conditions at terminals is also a must since the farther out a Comet can be diverted to an alternate, the more economically a flight path can be planned to the alternate.

Little clear air turbulence has been encountered in Comet operations to date. BOAC recommends airways meteorologists include 24-hr. forecasts on the location of high-altitude jet streams as these can be an important factor in planning flight operations. The jet streams vary considerably in width but they are seldom more than 5,000 feet deep.

► **Traffic Control**—Actual flight operations have proved high-altitude stacking offers no particular advantages in fuel consumption over a normal traffic pattern descent. Since the Comet normally begins its letdown about 200 mi. from destination it should be diverted to an alternate from this point if terminal weather has gone sour.

Comets ask for no special landing priority in the Heathrow Airport traffic pattern over London. A Comet has stacked as long as an hour over London and has diverted to as far away as Prestwick (500 mi.) when all of its southern England alternates were fogged-in solid.

Stacking technique calls for two engines throttled back almost to idling and the other two maintained at high rpm. Use of air brakes and the flexible cabin pressurization system make descents of 3,000 ft. per minute operationally standard under instrument conditions.

► **Ground Handling Problems**—The Comet must be taxied relatively fast to avoid excessive fuel consumption and must be guided quickly into its ramp station. The jet intakes and tailpipes are 7 ft. off the ground and do not present a hazard to people on the ground even at full engine runup. It now takes about 40 min. from doors-open to doors-closed to complete technical operations at normal refueling stops but customs, immigration and public health officials combine to lengthen actual ground time well beyond the technical requirements.

From a technical viewpoint the BOAC Comet pilots feel that they are now operating over too-short stage lengths to get the most out of a jet transport. The shortest hop is the 609 mi. between Livingston and Johannesburg and the longest 1,360 mi. from Beirut to Khartoum.

The Comet pilots feel that as more experience is logged a good deal more operational flexibility will appear in the now-rigid pattern of flight operations. None of the pilots checked out on the Comets have expressed any desire to return to piston-powered transports.

LOCKHEED R7V-1 SUPER CONSTELLATION is tugged out for runup of Wright Turbo-Compound engines.

Turbo-Compound Super Connie Debut

Lockheed Aircraft Corp. has rolled out its first Wright Turbo-Compound-powered Super Constellation, which, according to company officials, will give the 12 foreign and domestic airlines that have ordered 69 of the transports a speed and long-range performance combination "unbeatable even by today's jets."

Even superficial comparisons seem to put the Burbank, Calif., transport builder on firm ground for these optimistic claims since de Havilland hardly will claim that their present Comets can match the new Super Connie's ability to fly a larger number of passengers over longer, non-stop distances. Its non-stop capability over the Atlantic, for example, gives the Turbo-Compound Super Connie definite speed and load advantages over the shorter-range Comet 1 and 2, which are not true trans-Atlantic passenger aircraft.

The 1049C Super Connie will have a top speed approaching 400 mph. with cruising speeds on long hops in the neighborhood of 340 mph. Engines are designated 972TC18DA1 and have a takeoff rating of 3,250 hp. (dry). Recent Navy tests on a military Turbo-Compound engine achieved a rating of 3,700 hp., with water injection, indicating the engine's capability for further development.

The first Turbo-Compound Super Connie, scheduled to make its maiden flight this week, is going to Navy and carries the designation R7V-1. It can carry 106 passengers, up to 19 tons of cargo or 73 stretcher cases. The nose is tipped with a large black radome housing anti-collision radar.

Another R7V-1 is undergoing static tests in a specially built $60,000 test rig, whose powerful hydraulic jacks have been applying multiple overloads on the structure. No permanent distortion is reported as a result of these tests.

A later Navy Super Connie, the R7V-2, will have P&WA T34 turboprops.

Commercial operators will begin to take delivery of the Turbo-Compound 1049C in January 1953, with KLM Royal Dutch Airlines and Air France among the initial customers. By spring

1049C Orders

Eastern Air Lines	16
Seaboard & Western	5
Air France	10
Air India	2
Avianca	3
Braathens	1
Iberia	3
KLM	13
LAV	2
Pakistan Intl.	3
Qantas	3
TCA	8
Total	69

the planes will be in luxury service on the highly competitive Atlantic run.

On trans-Atlantic duty the new Super Connies can carry 59 passengers, luxury class. On tourist service overseas, the planes can seat 89 with a large galley; 94 with a small galley. Domestically, with small galley, 99 passengers can be carried.

Considerable interest is being shown in the engine installation, which hitherto has been an exclusive military development. Each engine incorporates three small turbines which convert otherwise wasted exhaust gases into additional horsepower, making possible more power or longer range. These engines are also slated for the new Douglas DC-7, for which domestic operators have placed orders for 58 planes. Thus the Wright Turbo-Compound promises to fill the gap until the gas turbine takes over.

If desired, present owners of earlier model Super Connies can convert to compound engines with little difficulty. Many of these were ordered with the earlier Cyclones because the carriers were able to take delivery in 1952.

An interesting feature of the 1049C orders, according to a Lockheed spokesman, is that the company was able to sell all its dozen customers on accepting the same basic interior—the first time it has done this in its history. The plane features rail mounting for the seats, permitting rapid conversions to any desired layout and capacity.

Dimensions are: span 123 ft., length 113 ft. 7 in., overall height 23 ft. Maximum takeoff weight is 130,000 lb.

TWA Interest In Viscount Reported

London—The British press talked confidently last week of a new U.S. order for British jet transports. This time it is to be Trans World Airlines buying the Vickers Viscount turboprop medium-range transport.

Neither Vickers-Armstrongs, Ltd. nor TWA's London office would confirm or deny the report, but other sources spoke confidently of a pending order for a dozen or more.

Production-wise, Vickers is in a position to deliver Viscounts to TWA, at the latest, early in 1955. New facilities at Hurn in Hampshire make it possible to foresee Viscount production up to six a month or more at that time. The first production models of the Viscount are coming off the large Vickers production line at Weybridge, Surrey, now at the rate of one a month. British European Airways, with 28 Viscounts on order, expects to take delivery on its first in mid-November, put into scheduled service in February or March.

▶ **Firm Orders**—So far, Vickers owns up to 58 Viscount orders, not all earmarked yet to specific airlines. Announced are 28 for BEA, four for Aer Lingus, 12 for Air France and four for Trans-Australian. Air India and Australian National Airways are known to have contracts drawn up. Some 50 new orders also are under negotiation.

There's a good chance that if TWA does sign a contract, some provision will be made to provide an aircraft early in the game for U.S. certification. Assuming this process takes a year or a little more, TWA still could put Viscounts into service on U.S. routes early in 1955.

Meanwhile, Pan American, which will take delivery on its first Comet 3s in 1956, may face more delays for certification. Preliminary talks between CAB and the British Air Registration Board concerning certification of Pan-Am's Comets are likely to open pretty soon. But until there is an aircraft to put through CAA's obstacle course, no certification can be granted. Experience with the Series 1 and Series 2 Comets may cut down certification time a good deal, but it still looks like 1957 before a PanAm Comet will be in service.

There isn't much doubt here that certification will be granted on British jet-liners purchased by U.S. operators. While there is little hope of drawing up any agreed list of specifications on jet transports in general, the U.S. did agree last spring to consider certification of a specific British type after CAA had passed its verdict through flight tests.

Meanwhile, some Americans in London thought the PanAm order for Comets took on a different complexion with the quiet announcement by BOAC that it had purchased two Constellations from PAA. BOAC, faced with a possible equipment shortage for the expected heavy tourist traffic across the Atlantic next summer, took up PanAm's offer for equipment now being mustered out of its fleet. BOAC denies there are any further purchases contemplated. Its tourist-class fleet next summer will now consist of seven Constellations. But if BOAC should change its mind—and PanAm has more cast-off equipment to sell—not many dollars will change hands between the two countries in PAA's Comet order.

Six Cargo Carriers in Trans-Atlantic Case

The reopened trans-Atlantic cargo case in which six companies are contending for Civil Aeronautics Board certificates may be settled within a year's time.

CAB decision to throw open the five-year-old case to new hearings and new applicants was influenced by insistence of chief examiner Francis Brown and executive director James Verner of the Board that oral argument could be held as soon as next June. Besides, they reasoned, objectors to a closed case could delay it in the courts.

▶ **Special Rights**—Meanwhile, the Board has handed special business rights to two, but not the third, of the three original carriers in the case—Seaboard & Western, Transocean and European-American. Because of an important secret government contract of Seaboard's, President Truman asked special exemption for the carrier to fly more frequently than CAB's restrictive regulations allowed.

Then Transocean asked the Board for the same right and got it. But European-American applied and was refused, although the President had expressly asked CAB to consolidate European-American's application with the other two. Now European-American—an investor proposal company, not an operating concern—may drop out of the case. It feels that without these business rights it cannot fly enough to prove fitness and ability near that of the big operators.

▶ **New Applicants**—After CAB reopened the case of these three carriers recently, three new applicants asked consideration along with them. The Board now has decided to admit the newcomers—Overseas National Airways, Trans-Caribbean Airways and Flying Tiger Line—into the case.

The original applicants have petitioned for reconsideration. Seaboard charges that the proceeding was reopened mainly because of mistakes on eight points in the Board's original interpretation of the record. The carrier argues that CAB would save time, money and effort by re-reading the record now to see if a carrier and route might not be certificated. Meanwhile, Seaboard reasons, the Board could simultaneously open a proceeding to look into the only new point—the recent loss of U.S. position in trans-Atlantic airfreight business—since the case record closed.

SHORTLINES

► **Air Transport Assn.** reports that certificated domestic airlines' aircoach service the first half of this year gained 70% over a year ago to over a billion passenger mi.

► **California Central Airlines** has started a mid-week roundtrip rate Los Angeles-San Francisco at about $20, which is $8 under the regular Cal Central rate on the same 44-passenger Martin 2-0-2 service.

► **Capital Airlines** has won its fifth consecutive annual first prize in a competition by the Direct Mail Advertising Assn.

► **Civil Aeronautics Administrator** Charles Horne proposes a joint promotion program by aircraft manufacturers with the indirect aid of CAA to "rebuild wide public interest in flying." CAA interest in such a program is authorized by the Civil Aeronautics Act, which charged CAA to encourage and sponsor the development of civil aviation, Horne notes. . . . CAA reports 1951 general aviation dropped 22% from 1949 to 8,623,000 hours.

although business flying gained 21% and agricultural 52%.

► **Civil Aeronautics Board** urges charter operators who occasionally cross the Canadian border to comply with U. S.-Canada regulations requiring application in triplicate to both CAB and Board of Transport. One such application legalizes the operation for an indefinite time. . . . CAB investigation hearings on what to do about nonsked airlines' business growth is slated to move to Miami Nov. 10 to Dec. 20. . . . CAB sent 16 legal and economic staffers to American Airlines' giant Tulsa maintenance base for education on complexity and cost of modern airline operations.

► **North Central Airlines** will be new name of former Wisconsin Central Airlines.

► **Northwest Airlines** load factor the first half of October was 65%, compared with 70% in the last summer month, September.

► **Oakland Aircraft Engine Service** has developed self-propelled engine test units on bus chassis to save over 3,800 manhours a year and cut noise around work areas by moving the runups to other parts of the airport. Oakland airport commissioners say this "may cause a radical change in the operational procedures of engine repair systems."

► **Pan American World Airways** has ordered five more "super" DC-6Bs (for 1954 delivery), bringing total to 48, worth $60 million, of which 18 have been delivered. Passenger versions are convertible to coach, standard, or luxury sleeper and three are cargo, PAA says.

► **Trans-Canada Air Lines** this month starts service to Germany through Dusseldorf—TCA's second continental Europe service.

► **Trans World Airlines** reports its January-August international cargo ton-miles gained 26% to 8,369,148. . . . Company plans a survey flight Bombay-Tokyo, leaving New York Nov. 5.

► **United Air Lines** reports its average passenger trip length has grown to 640 mi.—up 13% from 1950 and 8% from last year.

► **Washington National Airport** director Bennett Griffin recommends airline pooling of fuel at major airports. Different brands "may be co-mingled without any change or lessening of quality," he says. Air Line Pilots Assn. spokesmen are skeptical.

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26	827TY14Z2	Weston	Cyl Head Temp Indicator
40	119862	Weston	Carb. Air Temp Indicator
10	15401-1	Eclipse	Amplifier (PB10)w/ED3 MOUNT
66	10078-1AG	Eclipse	Gyro Indicator
62	CQ-9	Eclipse	Clutch Switch (PB10)
20	12078-1	Eclipse	Amplifier (PB10)
57	MF45-3911-20Z	Vickers	Hydraulic Pump (3000PSI)
327	PF4-713-20BCE	Vickers	Hydraulic Pump
75	1416-12C	Eclipse	Starter
142	28008	Airesearch	Jack (Cowl FLAP)
6	12011-1	Eclipse	Transmitter
85	3123-3A	Eclipse	Warning Unit
45	AN4103-2	Clifford	Brass (Valve #U4785) Oil Cooler
120	MF9-713-15A	Vickers	Hydraulic Pump
550	TFD 8600	Thompson	Fuel Booster Pump
125	D7818	Adel	Anti-icer Pump
250	AN4014	Erie Meter	Wobble (D-3) Pump
1000	AN5780-2	G.E.	Wheel & Flap Position Indicator
400	AN5780-2	Weston	Wheel & Flap Position Indicator
115	P4CA2A	Parker	Primer
70	AN3213-1	Scintilla	Ignition Switch
450	A-9 (94-32926)	Nasco	Ignition Switch
90	JH950-R	Jack & Heinz	Starter Motor
53	AN6203-3	Bendix	Accumulator 10'–1500 P.S.I.
140	K14949E	Marquette	Windshield Wiper Kit
188	EYLC-2334	Barber-Colman	Control
11	12086-1C	Eclipse	Amplifier
250	558-1A	Eclipse	Oil Separator
100	716-3A	Eclipse	Generator (NEA-3A)
89	318	Edwards	Horn
230	921-B	Stewart-Warner	Heater (200000 BTU)
97	6041H-146A	Cutler Hammer	Relay (B-12)
22	0655-D	Aro	Oxygen Regulator
65	ASDC2	CO_2 Mfg. Co.	Fire Detector
384	564-2A	Eclipse	Oil Separator

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130	8288	Follower Ass'y
814	35814	Blower Ass'y
53	48362	Shaft
75	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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19	1375F	Holley carburetor
407	SF9LN-2 (manufacturer's part No. 10–12453–6 Spec. AN9511)	Bendix Scintilla Magneto
42	SF5RN-12 (manufacturer's part No. 10–26170–1)	Bendix Scintilla Magneto
185,000	LS4AD1	Spark Plug (Aero)

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Military Services

One of the first steam catapults for Navy carriers will be installed—not on a carrier, but in connection with the 12,000-ft. runway at Patuxent.

Worried about gaps in its domestic radar screen, Air Force has ordered "a number" of high-altitude radar planes from Lockheed, earlier announced as military transports. These are versions of the Super Constellations, similar to the WV-2 radar command planes ordered by the Navy. Importance of these ships is indicated by Lockheed's announcement that there will be no commercial deliveries of Super Connies in the last quarter of 1952.

Navy now has on order 11 Convair R3Y-1s, transport version of Convair's XP5Y-1 turboprop flying boat.

Industry

Should government agencies and universities compete with industry for scientific contracts and personnel? Aircraft industry leaders are getting adamant in their replies of "No." Recent military contracts which make the National Bureau of Standards, Cornell Aeronautical Laboratory and MIT prime contractors on missile programs, for example, are disturbing managements of several missile firms. They feel strongly that these prime contracts should be given industry, and that federal agencies and schools should be consultants to the missile industry—not competitors.

Reason behind the tremendous expansion at Douglas' El Segundo plant: Firm expects to have these planes in production within two years: AD-5, F4D, A2D and A3D.

Curtiss Propeller division denies that its powerplant for the Bell X-2 is being reworked, as reported here last week. We are rechecking our report, which came from excellent source.

Glenn L. Martin Co. will definitely discontinue production of commercial transports when the 4-0-4 line is completed.

Transport

Pan American's announcement of a contract for Comet 3s is considered a master publicity stroke by airline observers. Old-timers recall that PAA has always been able to win headlines by announcing orders for new transports, even though some did not materialize—such as the Republic Rainbow, the original Douglas DC-7, and a giant civil version of the six-engine Consolidated B-36.

Belated CAA action to recommend regulation of reverse pitch prop indicator lights to CAB was mailed Sept. 29, following two requests from the Board, in May and July, for CAA action. The CAA proposal is substantially that which CAB has already put in its draft release of proposed new regulations, except for retroactive application. CAA suggests that props which do not readily permit installation of pitch indicators should have lights which are actuated when the propeller auxiliary pump or the voltage booster is in operation, or should have some other positive indicator to show even reversing is underway. CAB's draft release proposal does not provide retroactive installations of planes already in service.

Eastern's President Rickenbacker contended in a press conference that in 1948 Britain's technical and engineering lead over us in jet transports was 10 years, but now it's only three or four, and by the time U.S. industry can compete in 1959-60, the British will be ahead of us only a year or two.

Responsible airline people deplore what they call inaccuracies and warped interpretations of radio commentator Frank Edwards.

A compromise on wingtip tanks which may appear on some jet transports to extend their range is an airfoil-shaped bulge, outboard of the engines, which will be an integral part of the wing structure, yet thick enough to carry a substantial fuel load. An engineer with a major airline says these tank sections, not as thin as the rest of the wing, would still provide lift.

Some of the best technical minds are trying to figure how to keep passengers aboard high-speed jet transports from having to sit with seat belts fastened most of every flight. Clear air turbulence is encountered occasionally at high altitudes, with little or no warning.

WHAT'S NEW

New Books

Aeronautics at the Mid-Century by Dr. Jerome Clark Hunsaker. Published by Yale University Press, 116 pages, illustrated, price $3.

This slim new book contains a lot of meaty historical data, interesting photographs and drawings and some thoughtful, conservative interpretation of aviation's economic and social significance.

Purpose of the book is defined as: to examine mobility (in a third dimension) and to demonstrate that the good or evil of the new mobility depends on the adjustments society makes to human flight.

Probably not since Horizons Unlimited was written by S. Paul Johnston (Duell, Sloan & Pearce, 1941) has any American writer wrapped up aviation history in a capsule so well as Jerry Hunsaker.

But he does more than update history. He also projects into the second half of aviation's first century.

Significant because of his conservative scientific background, is Dr. Hunsaker's considered conclusion that there appears no real power limits in sight for whatever aircraft speeds are found necessary. Limits on speeds will be determined by usefulness, depending on fuel consumption, range and payload requirements and controllability, he feels.

Space travel research he considers "an adventure for which no time schedule can be set" until associated technical problems are solved.

Proposed use of atomic power for an interspace rocket only shifts the main problem from the source of power to the means to apply it, Dr. Hunsaker feels. Nuclear energy must be transferred to a working fluid such as hydrogen, to be ejected at high velocity. Material that can withstand the temperature involved is unknown and engineering data for development of a practical design are not available, he says.

Aeronautics at the Mid-Century was originally in the form of three lectures which Dr. Hunsaker delivered at Yale in 1951. They were the 28th series of Dwight Harrington Terry lectures on religion in the light of science and philosophy.—A.McS.

New Addresses

Flying Tiger Line, Inc., has opened a new receiving station at Air Freight Haulage, Inc., 474 Tenth Ave., N.Y.C. The carrier's sales office is at 207 Fourth Ave., N.Y.C.

ADVERTISERS IN THIS ISSUE

AVIATION WEEK—NOVEMBER 3, 1952

SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.

EDITORIAL

The Complexity Problem

(The following letter is one of a series, written by aviation leaders at the request of AVIATION WEEK*'s Editor, discussing the vital subject of aircraft complexity. Mr. Northrop is president of Northrop Aircraft, Inc., and is internationally known as a leading aircraft engineer and designer.)*

Dear Mr. Wood:

In response to your letter we feel there are two approaches to the problem of aircraft complexity—which has everyone concerned, not only in the military but in industry as well.

The first of these is the obvious one of being satisfied with less performance or less equipment. We do not believe the first assumption is tenable so have made extensive studies on the effect of equipment on size and cost. As a result of these studies, we feel a perfectly good day fighter, having phenomenal rate of climb and supersonic speed, with reasonable range and fire power, could be built, having a combat weight of approximately 10,000 pounds. On the other hand, if we carry all of the electronic radar and communication gear presently available for all-weather aircraft plus the latest air-to-air missiles and maintain the same high performance, the combat weight is likely to approach 70,000 pounds. The decision as to where to draw the line is a difficult one and must be based on complex studies of costs and kill probability such as are being made in great number these days.

John K. Northrop

The second basic approach is to view the whole complex aircraft, engine and equipment weapon as a carefully integrated machine without duplicate elements. Current methods of design and specification lead to a great deal of duplication of equipment functions. For example, four vertical gyros are installed in one airplane. One of these is on the instrument panel in the gyro horizon, one in the autopilot, one in the fire control system, and one in the zero reader. They all cost money and weigh pounds, and each pound multiplies itself seven to ten times if performance is to be maintained.

Another example of duplication is found in the compass system. There are a total of six directional indicators required in a single airplane including a basic system with remote indication, a standby system, a radio compass, a directional indicator in the Zero Reader, and a compass in the autopilot. In addition, equipment is installed for reading direction from the omni range.

Many other examples could be cited, such as the number of times we provide altitude indication or control, each having a bellows and gearing arrangement of its own. The above condition is a perfectly natural one resulting from the multiplicity of sources from which various items of necessary equipment must be procured. It can only be changed by a new viewpoint such as outlined at the first of this paragraph.

Recent study has indicated that approximately 800 pounds of complex equipment of the sort mentioned could be removed from one airplane design without affecting the basic mission of the airplane. If we multiply this by the seven-to-ten-pound overall factor for a gross weight indication, it becomes very important.

Our studies indicate the need for a careful evaluation of all equipment going into an airplane. We believe that many items of questionable value are installed in some airplanes and that a unification of all the equipment and controls in a basic design can be achieved to great advantage in cost and weight saving. JOHN K. NORTHROP

Who Won This Strike?

When a strike ends, the spotlight of news publicity usually turns elsewhere. This is regrettable. Sometimes the results of a strike are most significant.

Lockheed Aircraft Corp. recently went through a three-week strike. Its management compiled the costs of this strike, and wrote an informative letter to its employes.

The letter, signed by President Robert E. Gross, itemized the losses of this strike, which was called off at the personal request of President Truman in the interest of national defense.

"... We are right back where we were before the strike began. No agreement for a new contract has been reached," Mr. Gross writes.

The nation lost 90 combat airplanes when they were urgently needed.

The company's California division sales for the year will be off nearly 9%, or more than $35 million under forecasts.

The community lost in extra police expenses; and there were extra deputy sheriffs and court cases. The average payroll lost each week of the strike was $1,593,000, which meant less business for local retail firms.

The average striking employe lost about $70 wages each week, or about $4,780,000. He will get no retroactive increase in wages for the striking period, if any new wage agreement is made, and the strike may have delayed the effective date for all employes of any increase in fringe benefits that may be agreed upon.

The union, Mr. Gross said, "failed to obtain any gains for employes that could possibly justify the losses caused by the three-week walkout. ..."

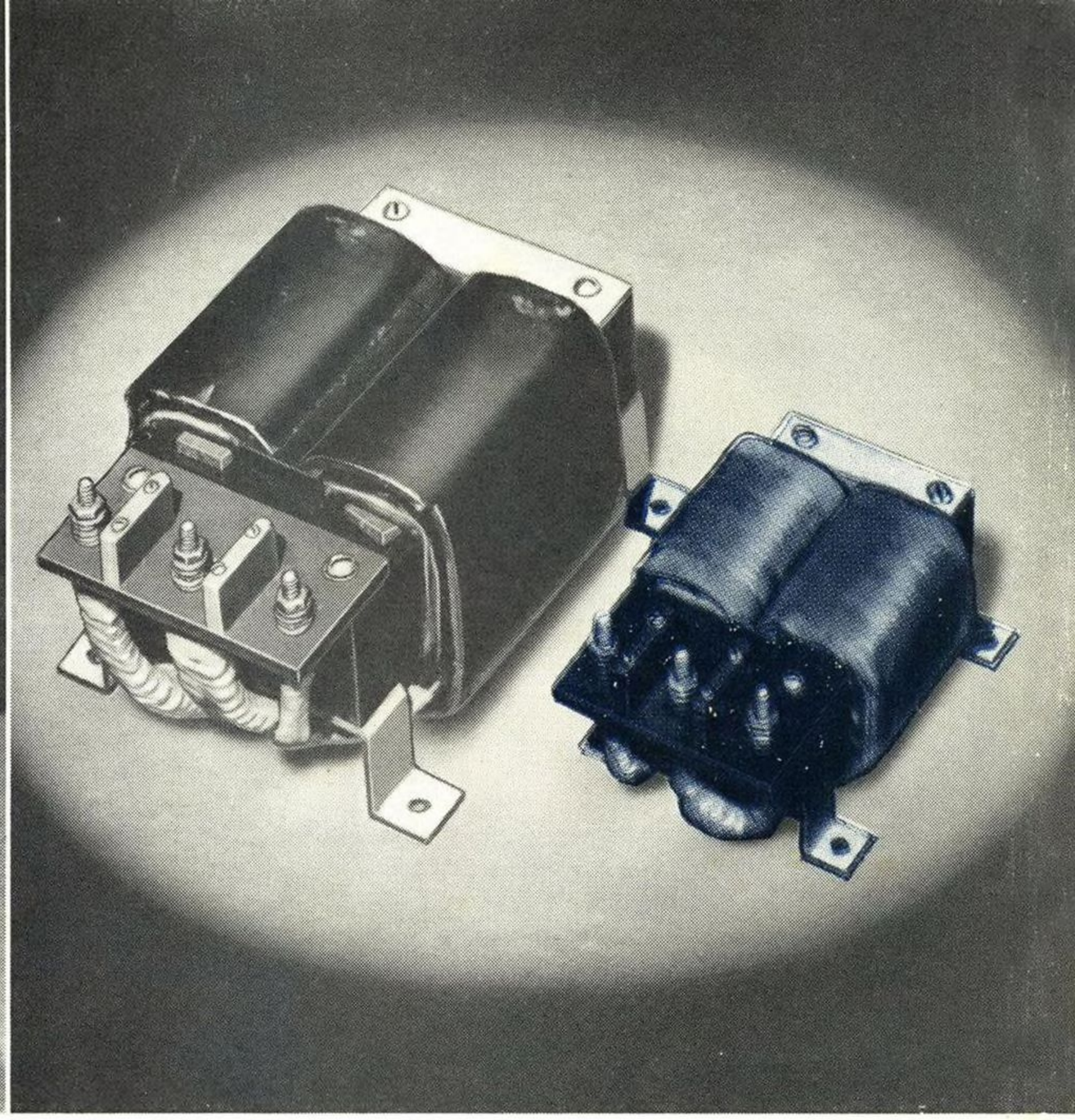
Mr. Gross believes union leadership suffered a loss of confidence among its members, and says the company has received formal notification from more than 1,650 members that they have resigned.

The company has lost confidence in union leadership. It was the first aircraft company in the area to recognize a union and sign a union contract.

Who did win the Lockheed strike?

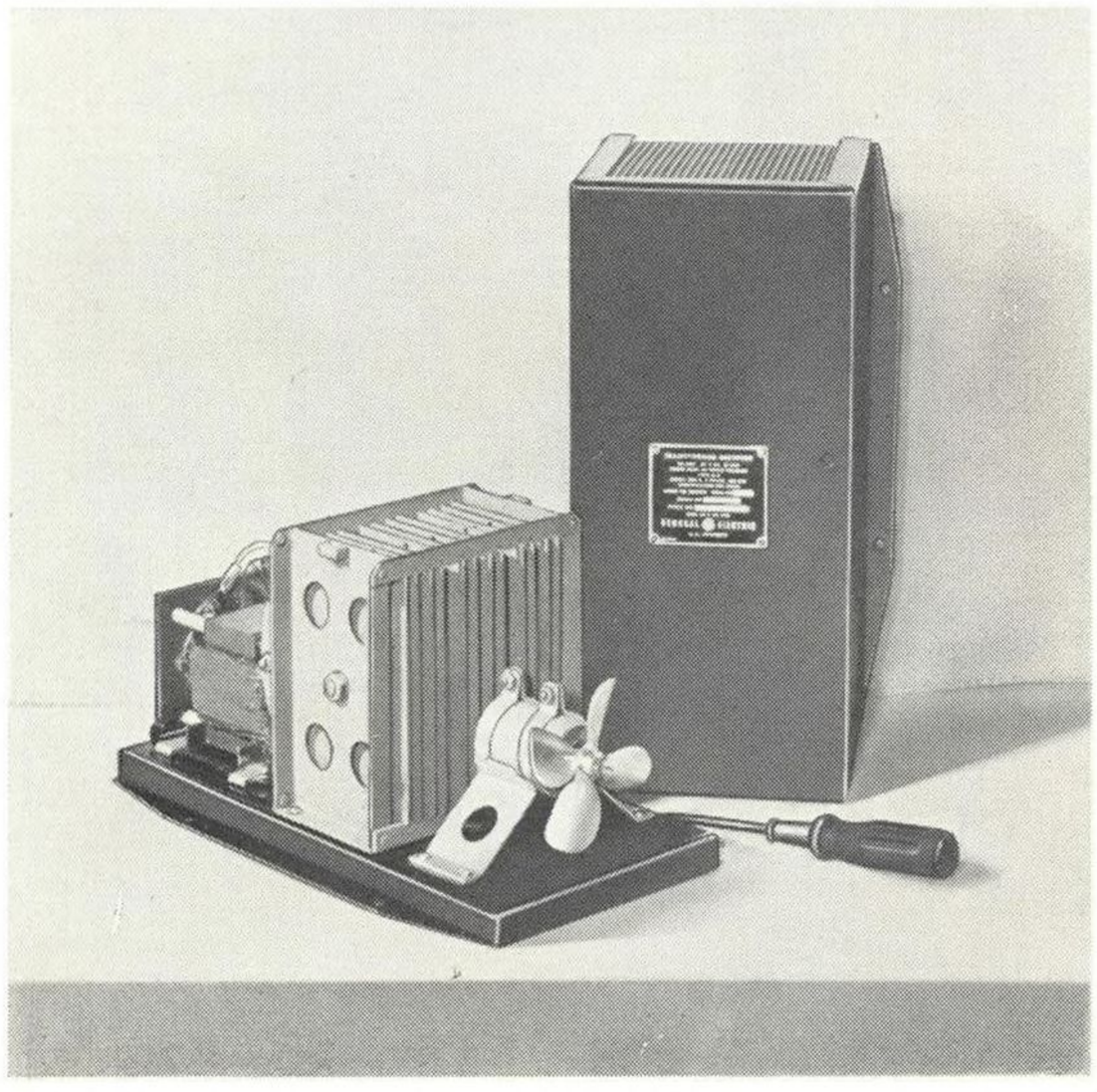
—Robert H. Wood

G.E 's PERMAFIL D-C CAPACITORS operate for 10,000 hours or longer at full-rated voltage in ambients up to 257F. *They are 1/5 the size of liquid-filled capacitors derated to operate at that temperature.*



G.E. "FLYWEIGHT" SILICONE AUTOTRANSFORMER is ½ to ⅓ lighter, delivers 14 volt-amps per ounce compared to four volt-amps produced by a transformer of conventional materials.

G-E COMPONENTS REDUCE WEIGHT SAVE SPACE—UP TO 80%!



G.E.'s AIRBORNE TRANSFORMER-RECTIFIERS assure a light dependable source of d-c power with little maintenance. Used with an alternator, they cut weight by eliminating long bus runs and d-c generating equipment usually required. Available in 50 and 100-amp units.

For electrical equipment that saves space and weight, take a look at these G-E Aircraft Components. Up to 80% smaller, carefully built and tested, they can mean greater efficiency for your aircraft's electrical system.

Check the features of the G-E "Flyweight" Silicone Autotransformers—the most spectacular transformer design in years.

Note the tiny size of the Permafil d-c capacitor . . . every bit as dependable as larger liquid-filled units. And see what G.E.'s Airborne Transformer-Rectifiers can do towards eliminating heavy, unnecessary d-c generating equipment and long bus runs.

The next time you specify electrical components, call on your local G-E representative. He can recommend just the equipment you need for better aircraft performance. And for more information on the units shown on this page, write to *Section 210-38, General Electric Company, Schenectady 5, N. Y.*

You can put your confidence in—

GENERAL ELECTRIC