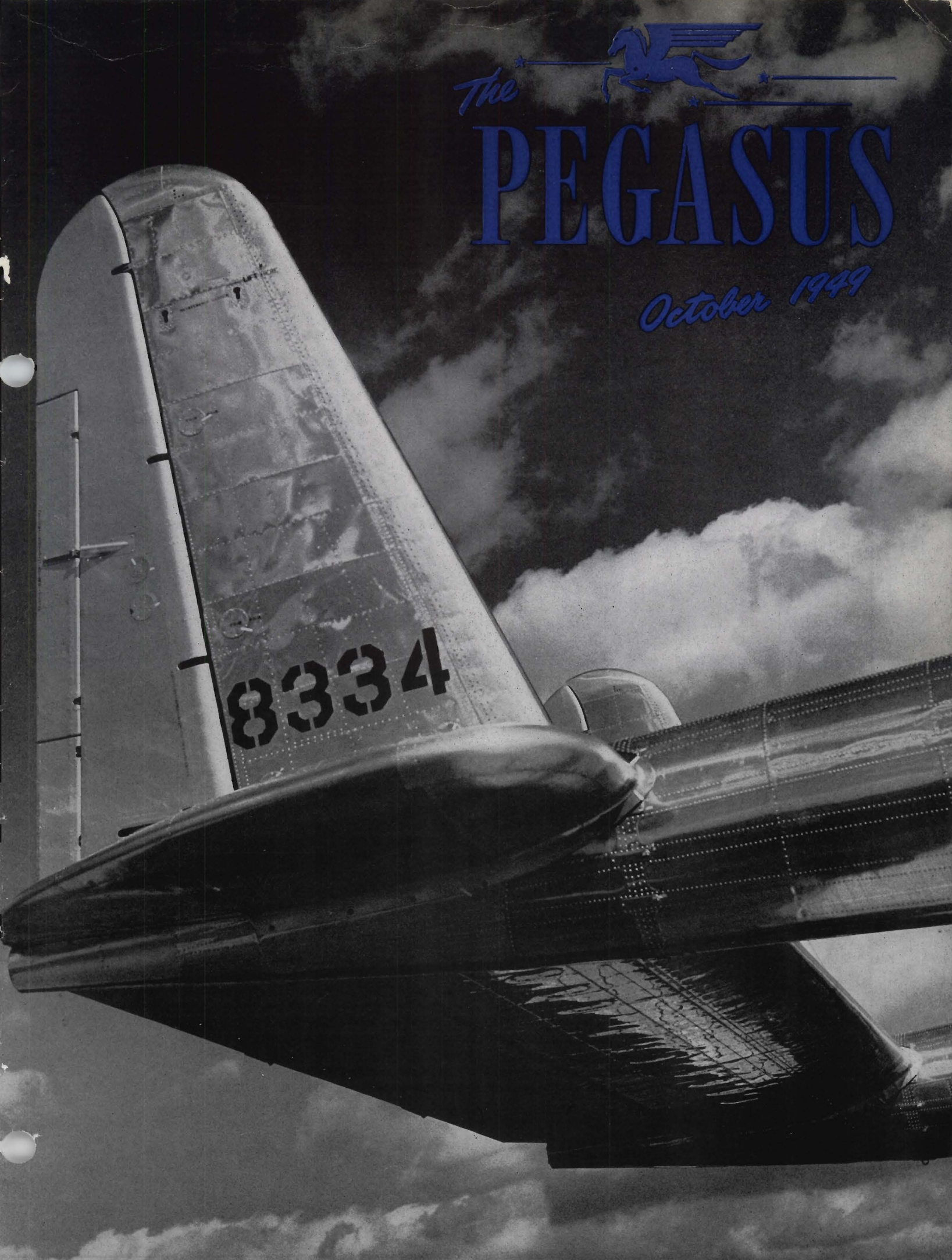
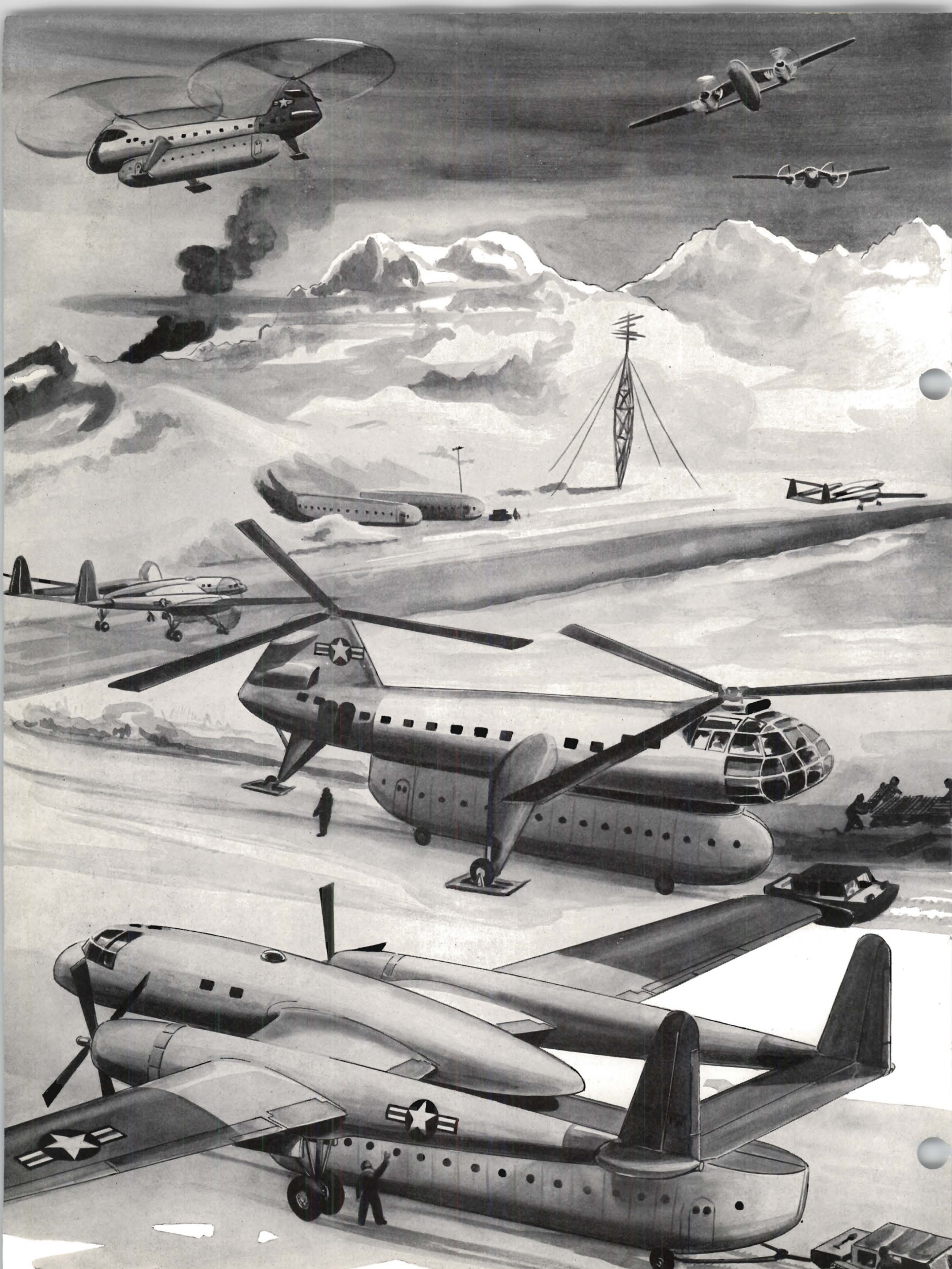
The PEGASUS

October 1949





October, 1949

The PEGASUS

Airlift to Anywhere

By E. J. Huber

JUST as sure as there are death and taxes, tomorrow's "Operations Vittles"—whether it is supplying Outer Patagonia or Inner Tibet—will be done by helicopters operating from an air-head supplied by long-range aircraft.

On our drafting boards, in our studies, in mock-ups; and already accepted in the advanced proposal stage is a good answer to the problem which confronted the Air Force in the supply of Berlin. It is a huge helicopter. It is designated the XH-16 helicopter by the Air Force, as the monitoring agency for the project.

In general shape and aerodynamic design—and size—the XH-16's all-metal body is about as big as a 40-passenger Convairliner. That's pretty big. It has a lot of cabin room and a good payload.

To the XH-16 which we'll build for the services (the Navy has money in the project), we've added a cargo capsule. And that quickly-attached and detachable capsule is just about the same size and general shape of an overland bus.

Add the two together—and you've got a fairly big and versatile air carrier.

By adopting the tandem rotor configuration which we have pioneered and already proven successful in our ten-place ship—the HRP-1 "Rescuer", which the Navy, Marines and Coast Guard have in service in quantities—we get a proved design and a stable ship and one that can meet the joint Air Force-Navy specifications.

What we've actually got in the XH-16 is a "truck-and-trailer" of the air. Separately, and together, the combination is the answer for short haul delivery via the unrestricted lanes of the air in one move from point of origin to destination.

True, the big helicopter is still a couple of years off. We expect to have a flying prototype of the XH-16 ready for acceptance in about two years. An emergency, naturally, could cut that time.

Without going into details too much—because of the security restrictions—I can provide a rather quick-sketch picture of how we visualize meeting future problems of supply, as were forced on us at Berlin by the Russians.

Should the United States once again be forced to break through barricades and blockades to feed an isolated area, this is the way it can, and probably will be done:

Capsules can be quickly loaded here in the States and flown to dozens or scores of airfields in and near the point to be supplied by a "packplane" of the C-120 type. Detached, the capsules—and they can be fitted with wheels—can be moved anywhere and quickly attached to a helicopter such as our XH-16. Nothing has been loaded and unloaded—only the capsule has been handled. Time is saved, money is saved—the whole operation is quick, simple and efficient.

The XH-16 simply takes off, makes the flight to the designated point within the besieged area, deposits the capsule—either by landing, or by lowering it—and takes off. This shuttling can go on and on, day and night, without respect to the weather. Within the blockaded area, the capsules can be trucked to any number of points of distribution or storage, and after unloading brought back to the many points of pick-up by the helicopter.

Bad weather would have to be spread over a tremendous area to prevent the bringing in of the capsules from the States by the long-range "packplane." So, logically, it is conceivable that the combination of the long haul capsule-carrying aircraft and the short-haul capsule-carrying

An airhead transfer point visualized by an artist, depicting "pods" being brought in by long-range tactical transports for quick transfer to pod-carrying helicopters

Mr. Huber—usually "Bud" Huber—was a lieutenant-colonel in the Eighth Air Force and is now Public Relations Director of the Piasecki Helicopter Corp., Morton, Pa.

helicopter is a very specific answer to the problem as similar to the one we wrestled with in Germany with inadequate equipment.

The capsule-carrying airplane is no further away than our XH-16. As a matter of fact, it looks now as though both will come into use at about the same time, for Fairchild is making considerable progress with its capsule-carrying C-120.

In a show of strength and in a diplomatic "cold war" effort such as we Americans undertook in the Berlin matter, cost is seldom a factor. Yet, the airlift cost us millions and millions of dollars. It was costly, very costly, because we were not able to fit the right equipment to do the job right at the least cost.

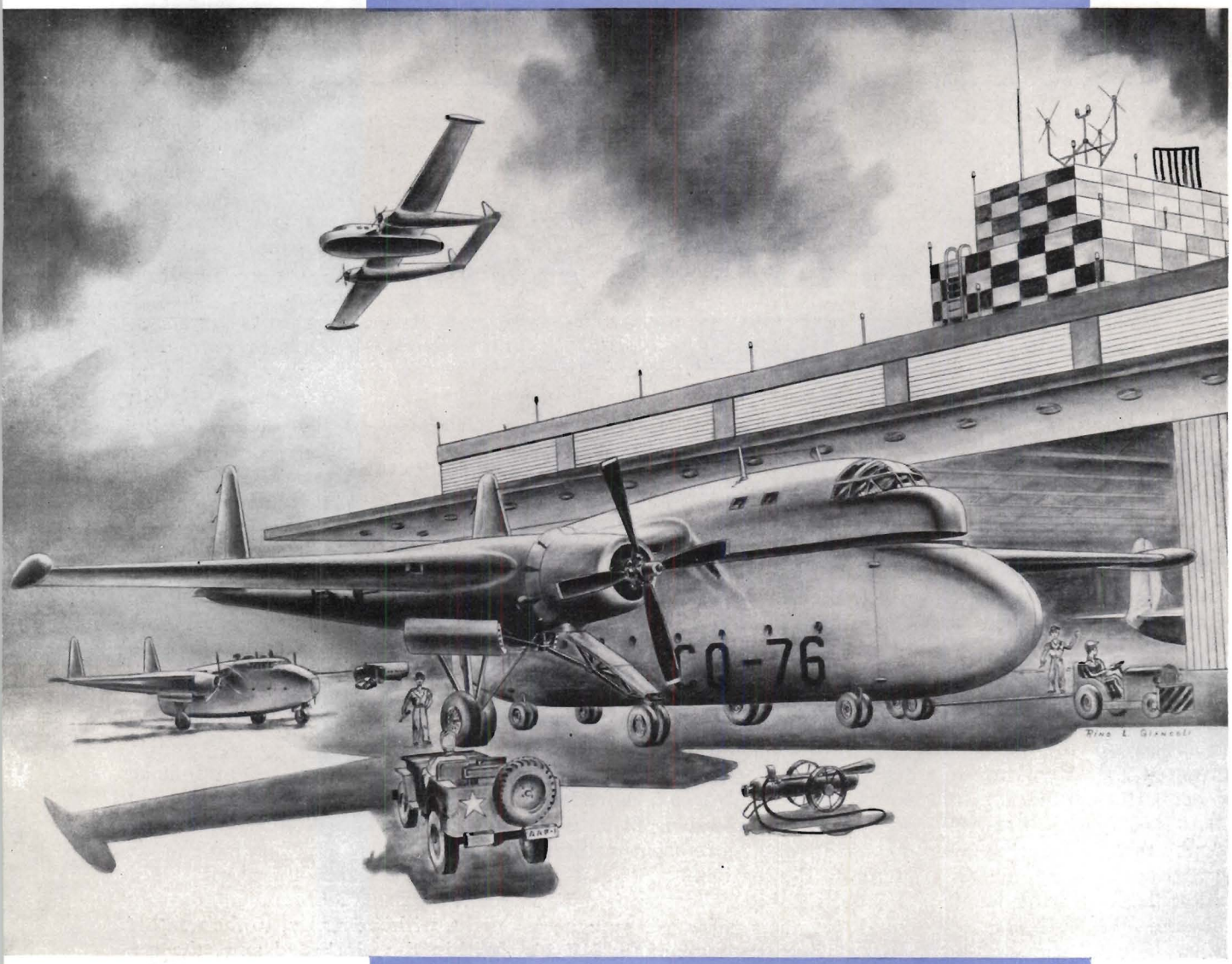
As wealthy as we are, we can stand the luxury of an "expediency" just so long. Somewhere along the line we've got to look at such operations in the cold light of cost. Shuttling helicopters should prove very effective in this connection and indications are that they will be so employed, teamed with multi-engine planes in fast-moving operations.

Air Force and Naval air commanders recognize the shortcomings inherent in our air transportation system as it stands at present. It has taken something like "Operations Vittles" to bring the whole problem into clear focus and revalue the situation accordingly. During the war, under all-out orders and conditions and when there were none of the limiting factors of the Berlin task with the narrow corridors, shortage of airfields and air space at the destination—as for instance over the Hump and during the Battle of the Bulge—airborne transportation worked satisfactorily.

And with new problems, new means must be sought and used. Our air strategists realize that—as I said before.

That is why something like the Piasecki XH-16 capsule-carrying helicopter is being watched with interested eyes by the military services.

We have a responsibility. We are given the job of developing, building, testing and proving the concept that we have held for sometime in our company. As a matter of fact, we had the idea of a capsule-carrying, long-range helicopter back in 1942 and presented plans and proposals to the military services. They were interested. They saw the possibilities. They had choices to make and the choice back then—as during most of the war—called for "fighting" planes as the top priority . . . the need was for bombers and fighters. Many trans-



Forward view of the C-120 Fairchild Packplane shows "pod" being positioned under flight structure. Earlier Packets in background and in flight. The C-120 is now under development for the Armed Services

port planes had been taken over from the airlines, more were coming off the production lines, and under the expediency of the war, the experts felt that the present equipment would answer and do the job. Of course, they were right. The airlift over the Hump, and the airlift carried around the world by ATC and NATS did meet the demands.

However, these men did look ahead, and when the war was ended felt that the inadequacy of air transportation was such that new and more improved and more advanced means should and must be explored. They called for bids after setting forth specifications for a large transport-type helicopter. We, at Piasecki, won the contract.

Coincidental with the use of the transport-type helicopter by the military for more efficient air transportation are the advantages gained in the actual economies.

The important advantage of the helicopter in short-haul air transport is the reduction in both space and time required for the airplane's landing, take-off and ground maneuvering and the time of passenger travel —or ground cargo hauling—from the city to the airports. The shorter the block distance, the greater the percentage of the total time this saving becomes.

Helicopter transport requires little or no ground maneuvering and is able to descend on and take off from very small areas even in congested districts. Because of the small-sized areas required for a helicopter landing, the safe altitude for operation can be reduced, which will again be an important economy in short-haul hops by reducing the time required for ascent and descent to the operating altitude.

Again, the low altitude operation of the helicopter is made further possible by its extreme maneuverability and precise control, enabling it to be taken over charted "channels" through congested areas with safety in case of engine failure. The low altitude operation further allows a separate air traffic pattern for the helicopter without interfering with the airline traffic controls.

When the big multi-engined helicopter is combined with the cargo capsule the answer to many problems becomes quickly apparent.

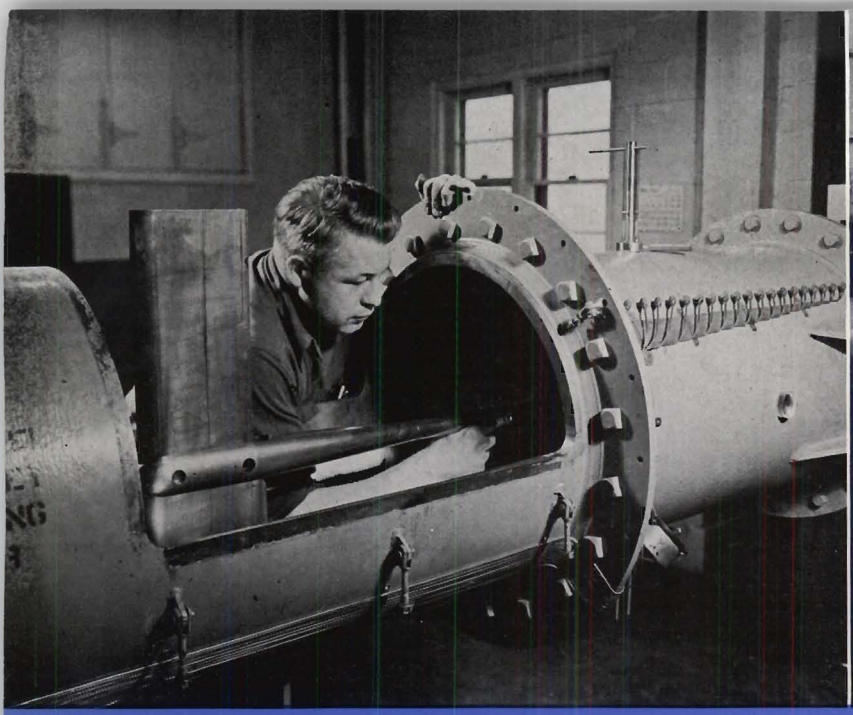
To all the advantages of the helicopter as cited before, we now add:

1. Excellent access to the cargo capsule at a cargo dock, factory or even on the aircraft.
2. Ten or twelve capsules (in loading positions) can be accomodated at a dock in the space required for two or three conventional planes.
3. Sorting and loading operations are consolidated.
4. Entire capsule can be transferred from one airline to the other at a junction point, to be later picked-up by the helicopter for the short-haul into the congested area.
5. Congestion on the ground is reduced because of the short time on ground per unit—fewer loading positions needed.
6. As far as the cargo planes are concerned faster schedule times and/or more economical and lower cruising speeds are possible because of the reduction of lost and expensive time on the ground.
7. The short-haul helicopter "truck-and-trailer" can make deliveries ordinarily not possible because of inadequate fields for the heavy transport planes.
8. The capsule-equipped helicopter system assures more frequent and reliable deliveries in the main metropolitan areas because the ship can get into the congested areas and make frequent and uninterrupted deliveries.

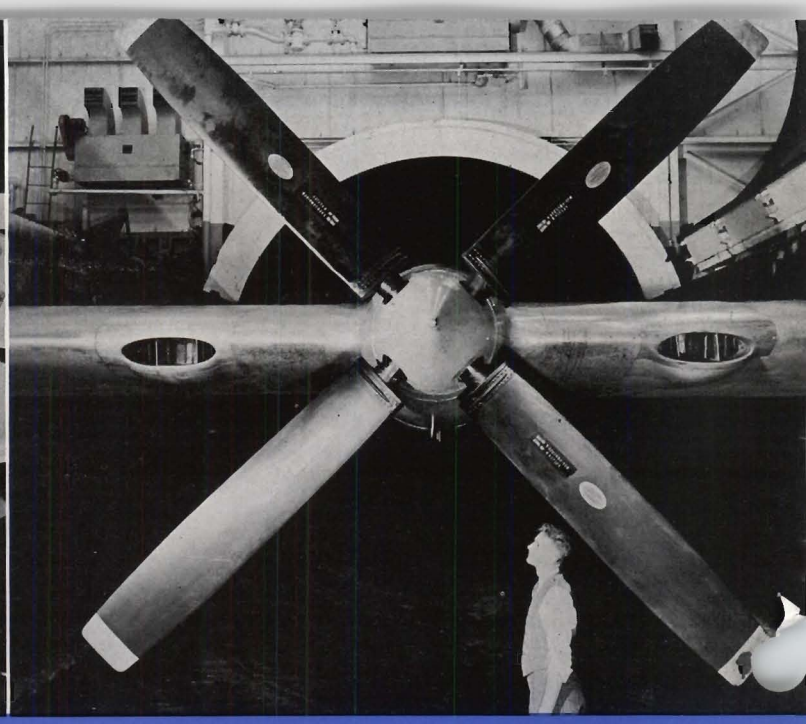
Actually, the use of the capsule-carrying long range "packplane" combined with a capsule-carrying helicopter parallels the development of other carriers forced to meet competition. The rails, for instance, came up with the container idea which embodies the loading of a container, say, in Chicago's loop, which is then trucked to the freight yard and put aboard a freight-car for haulage to Boston. At Boston, the container is taken from the freight-car and hauled by truck to the assignee or to the point of re-distribution. A considerable amount of individual handling and sorting is eliminated.

As a matter of fact, the air cargo lines estimate that the average piece of cargo is handled from about 16 to 20 times at the different stages and points from start of delivery until the time the piece reaches the final addressee. That, in itself is not a very economical set-up. But the reduction in time and cost of handling cargo destined for travel via the air achieved by the combination of capsules, "packplanes" and capsule-carrying helicopters is bound to lower the ton-mile cost considerably—especially in the shorter haul bracket.

Major General Robert M. Lee, Commanding General of the Tactical Air Command; Major General Robert C. Macon, Deputy Chief of Army Field Forces, and Major General W. J. Wallace, Director of Marine Aviation, inspect an earlier configuration of the XH-16 helicopter



Lewis research scientist adjusts supersonic model in 20-inch circular tunnel capable of speeds up to twice that of sound



Turbo-prop installation being readied for tunnel tests at simulated altitudes up to 50,000 feet and temperatures of —50°

Some recent developments at

NACA

In its August issue, *Pegasus* reviewed current research efforts centered on aerodynamic problems in the transonic-supersonic range. In this article were described the research tools being used at the Ames and Langley Laboratories of the National Advisory Committee for Aeronautics to secure the basic data needed for the design of aircraft which could operate with reasonable efficiency in the transonic and supersonic ranges. Now, in this companion article, *Pegasus* considers the research devoted at NACA's Lewis Flight Propulsion Laboratory on the equally important problem of power.

"SUSTAINED supersonic flight speeds for aircraft are imminent. Supersonic flight speeds of short duration have already been accomplished. . . . The basic supersonic propulsion problem is that of obtaining engine types capable of developing extremely large powers."

So said a research scientist at the September inspection of NACA's Lewis Flight Propulsion Laboratory in Cleveland. Before the inspection was over, the 1,300 representatives of the nation's aircraft and engine industries, the Department of Defense, government and educational institutions in attendance had been brought up to date on research progress covering compressor and turbine problems, the search for non-critical materials, new jet fuels specifications and new rocket propellants, and heat transfer problems. The guests inspected the new 8 x 6 ft. supersonic wind tunnel—the world's largest faster-than-sound tunnel—and watched it operate.

But throughout the program, the basic theme was constant: the key to faster speed is power—power and still more power. Nowhere was the problem more graphically presented than by the display of models of hypothetical airplanes, of the same gross weight, together with power requirements to attain speeds.

First shown was a model of a twin-engined, prop-driven conventional subsonic airplane designed for flight at 400 mph at an altitude of 30,000 ft. Such a straight-wing airplane would require 3,000 hp at the design condition. Next shown was a conception of an airplane designed to fly at the supersonic speed of approximately 1,000 mph (M 1.5) at an altitude of 50,000 feet. Markedly different in appearance from the conventional model because of its sweptback lifting surfaces, this airplane would need 15,000 hp.

The third conception model was of a type designed to ffy 1,500 mph (M 2.5) at an altitude of 70,000 feet. This unconventional-appearing airplane is equipped with wings having thin supersonic sections, fuselage of high fineness ratio and canard arrangement of the stabilizing surfaces. To make the desired speed, it is estimated that 45,000 hp would be needed.

To boost speed 2½ times, from 400 to 1,000 mph, would require a 5-fold increase in power. To raise the speed 3¾ times, from 400 to 1,500 mph, would require a 15-fold increase in power. But even these enormous pow-

Jet engine burner pot being tested under operating conditions for inner-liner life, performance and combustion efficency

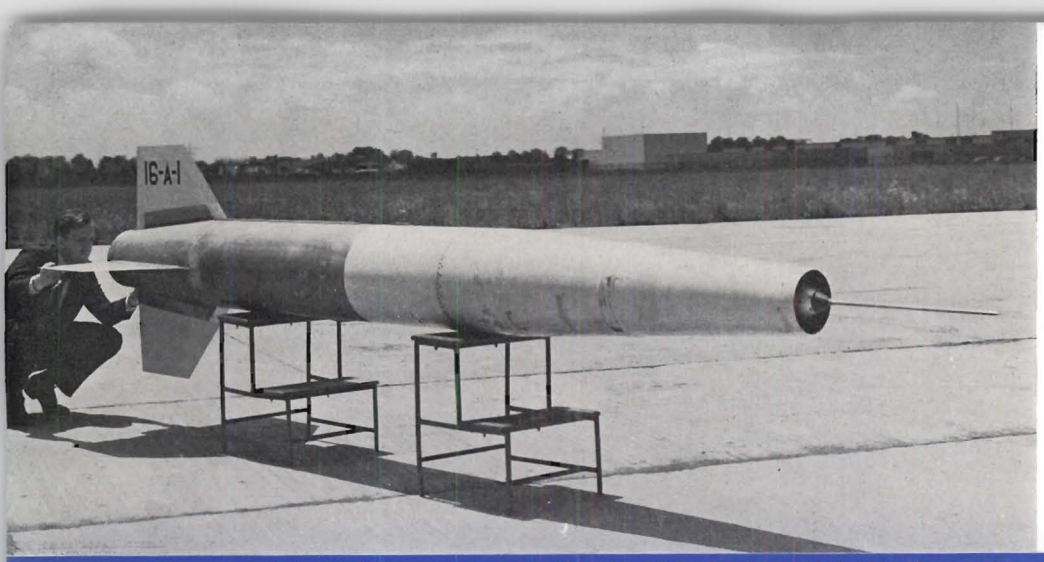
Propulsion engineer instruments stator blades of axial flow turbo-jet engine for measurements of pressure distribution

er requirements are calculated on higher altitudes as the speed increases. To ram the 1,500 mph airplane through the air at 30,000 feet altitude, instead of 70,000 feet, would require not 45,000 hp but 90,000 hp, while a fabulous 200,000 hp would be necessary to achieve such speed at sea level.

Because of their ability to handle large quantities of air relative to their size, and because their power increases with flight speed, turbo-ram and ram-jet engines are suitable for supersonic flight, and problems concerning these engines are the subject of intensive research investigation at the Lewis Laboratory.

The attack on these problems is carried on, both on the ground in the laboratories and tunnels and also in the air. Problems common to supersonic engines are efficient compression of the air, combustion of the fuel, aerodynamic efficiency of the engine, and inter-related effects between engine and airplane. Efficient conversion of the heat energy of the fuel to useful propulsive energy requires that the process occur with the highest possible compression of the combustion air. In the ram-jet engine, compression is obtained by slowing the air from flight velocity at the inlet to a low speed in the combustion chamber. In slowing down, the air converts its velocity energy to pressure energy. This ram compression increases with flight speed. Special inlet designs are necessary to obtain efficient compression at

Model installation nears completion in 8- by 6-foot tunnel at Lewis Laboratory, the world's largest faster-than-sound tunnel, only recently completed



This 16-inch free-fall ram jet test missile, when dropped from high altitude, reaches speeds 2.5 times that of sound, as data are telemetered to ground receiver

supersonic speeds by reducing shock losses at the inlet.

All three of NACA's principal research centers—Langley in Virginia and Ames in California, as well as Lewis—are investigating the compression problem at supersonic speeds. Already considerable improvement at all speeds have been achieved, but research continues to bring actual compressions even closer to the theoretical maximum compressions.

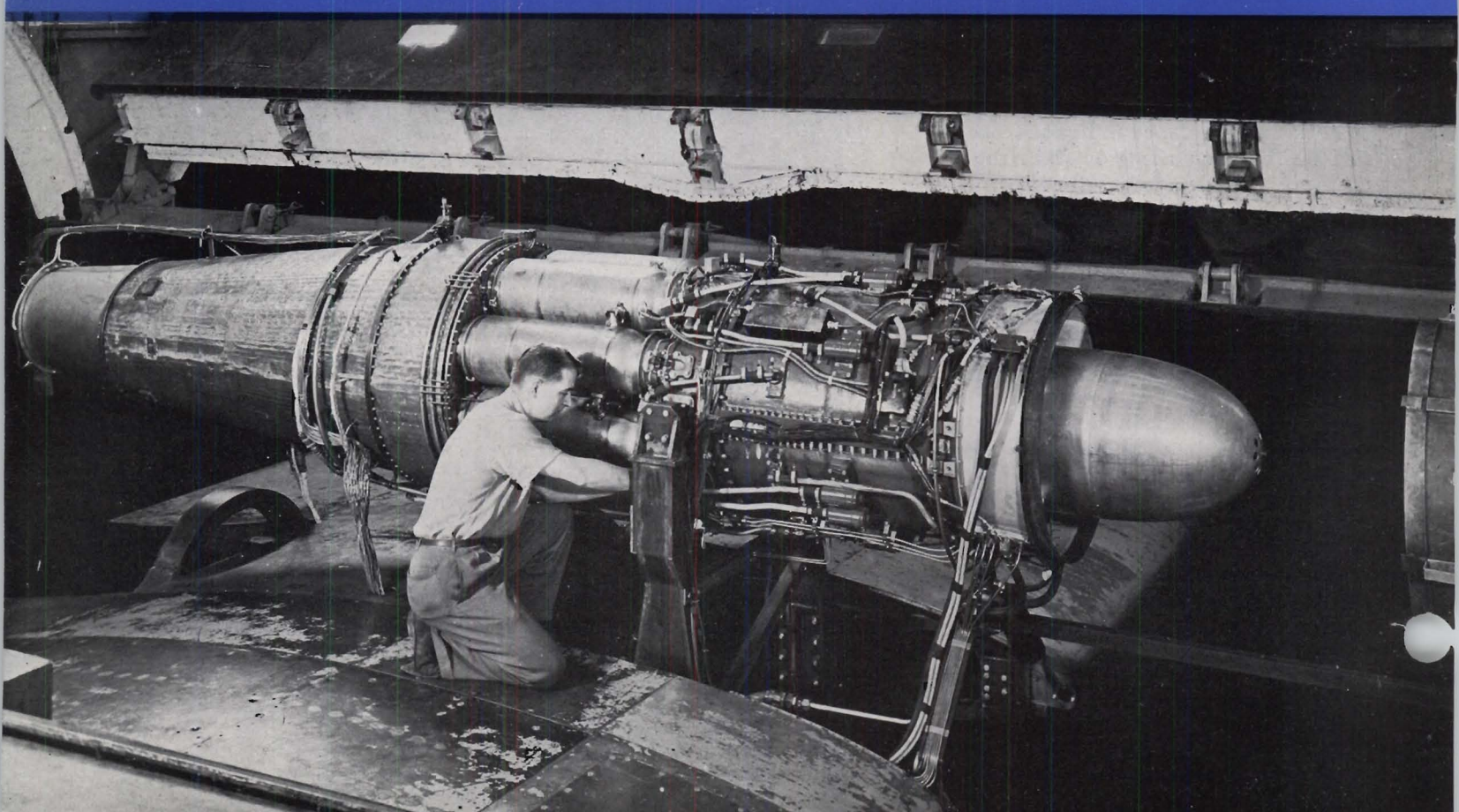
The problem is made more difficult by the great sensitivity of inlets at supersonic speeds to operation at altitudes and speeds other than those for which the engine is designed (off-design point). This sensitivity is largely expressed as compression loss and increased engine drag. Research is directed to evaluate the off-design characteristics of different supersonic inlets to determine how they influence the utility of engines of fixed design.

Earlier work shows that pressure pulses associated with combustion may seriously reduce ram compression, and present indications are that both engine design and operating conditions influence this pulsing problem. Research now is underway to learn how the pulsations occur and whether the problem is an inlet or combustion phenomenon. Determining the quantitative effects of pulsations on compression over a range of operating conditions is another research task occupying scientists at the Lewis Laboratory.

Another vexatious problem crying for solution is the tendency for the flame in the ram-jet to blow out, as air passes through the combustion chamber at high velocity. Operating the engines at high altitudes without resulting low pressures also makes combustion difficult. Since 1945, the velocities at which good combustion efficiencies can be maintained have been increased almost three-fold and still further progress is expected. Similarly, progress has been made increasing the altitude limits for satisfactory combustion, a result of intensive research on flame-holding devices, fuel-injection methods and combustion chamber designs.

As a joint project, the Lewis and Langley Laboratories have been using a 16-inch diameter ram-jet engine enclosed in a 14-foot -long shell designed to permit attaining supersonic speeds.

This axial-flow turbo-jet engine, when fully instrumented, will be given operating test in Lewis altitude tunnel



Performance information, in free fall, at speeds up to M 2.4 have been thus achieved. The test engine is dropped from extreme heights by a mother airplane. The power from the ram-jet engine, plus the gravitational force, accelerate the vehicle, while telemetering apparatus sends pressure and other information to a ground station. Inside the inlet section are the radio transmitter, fuel and all controls. Four fins attached to the jet exit at the rear provide aerodynamic stability.

At supersonic speeds, the problem of designing engines having the lowest possible drag becomes important, and much research on this subject remains to be done. Air flow disturbances induced by the engine inlet or exhaust jet may seriously alter the effectiveness of the lifting and control surfaces of the airplane, whether the engine be located in a nacelle or totally submerged in the fuselage. Supersonic propulsion systems no longer can be isolated for separate study but must be investigated with the complete aircraft configuration.

To conduct such work the engine nacelle must be completely submerged in a supersonic air stream, and reliable data can only be obtained with large-scale models. The free-flight technique mentioned above has been especially valuable in collection of data in the transonic speed range.

Already, the 8 x 6 ft. supersonic wind tunnel is showing itself especially useful in the study of such problems in the higher speed ranges. Similar to all the supersonic tunnels at the Lewis Laboratory in that it is of the non-return-passage type, to permit burning fuel and air in the engine under actual operating conditions, the new wind tunnel required several years for its construction. It was first placed in operation some months ago, then calibrated and now is being used in the production of useful research data.

To prevent condensation and velocity disturbances in the test section, air passing through the tunnel must be extremely dry. At maximum operating conditions, as much as 2,000,000 cubic feet of air per minute—weighing almost 75 tons—are drawn into the tunnel. Air is dried by passing through beds of activated alumina, which remove as much as a ton of water each minute on a hot day. Taken from the dryer building, the air moves into the inlet of the compressor, which is powered by three electric motors providing 87,000 hp and connected in tandem. The air leaves the compressor at pressures up to 1.8 atmospheres but at low velocity, and then is expanded to produce the desired speed in the test section. This speed can be varied from 1.4 to 2.0 times that of sound.

The air reaches the speed of sound as it moves into the minimum area of the tunnel, and as the tunnel passage expands, the air accelerates until the desired supersonic speed is reached. The amount of area expansion downstream of the minimum section of the nozzle is controlled by flexing two stainless steel side plates, 35 feet long, 8 feet high, and 1 inch thick. To do the flexing work, 14 hydraulically operated screw jacks on each side are employed.

This new tunnel provides the first opportunity to study large models of turbojet and ram-jet engines in actual operation at speeds up to twice that of sound, and under conditions of temperature and pressure the same as would be found at 35,000 feet altitude.

Another approach to the quest for sufficient power to propel tomorrow's aircraft at the demanded supersonic

(*Continued on page* 16)

Instrumented experimental rocket engine fired at Lewis Laboratory test house to give thrust and propellant efficiency data

Combat-ready Packet with full complement and equipment demonstrates fire-power that can be lugged on this tactical transport

By Major John Urban

"Wings for the Army" in the September *Pegasus* told the history of airborne operations from the standpoint of tactical use. This is the story of their development and the methods used to insure that a majority of ground forces are indoctrinated in air-mobility.

AIRBORNE training in this country began in earnest in 1940 when a parachute test platoon was established at Fort Benning, the Georgia post that mothered the victorious army of World War II. By June of 1944, when airborne troops dropping in Normandy heralded the invasion of Europe by allied forces, five airborne divisions and six separate parachute regiments had been activated. During the war, these forces proved conclusively the success which airborne troops can achieve by surprise landings in mass behind enemy lines, striking at decisive targets.

No less spectacular than the parachute operations were the air-transported operations. Most of these were not on as large a scale as the parachute and glider operations of airborne units, but nevertheless the trend has been established. As the war progressed and as military type transport aircraft came off the production line in sufficient quantity, larger and larger air-transported operations were planned and executed. It is logical to assume that this phase of warfare, or more specifically this method of transportation, will be widely used in any future conflict.

Early training in air transportability in this country began with the activation of the 88th Airborne Infantry Battalion at Benning. This pioneer unit was activated on 10 October 1941 for the purpose of developing techniques and equipment to be used in air landing and glider landing operations. The battalion later was moved to Fort Bragg, North Carolina, now the headquarters of our Air Army operations. Here it continued its experimental work. It was used primarily to train glider units for the first airborne divisions.

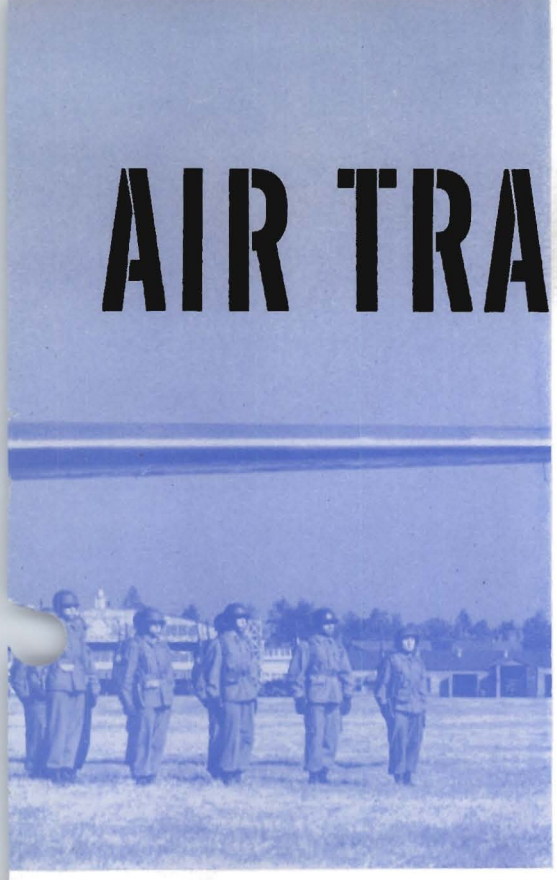
Activation of the 82d and 101st Airborne Divisions in July of 1942 indicated there were sufficient parachute personnel to fill units to full strength. However, there was a shortage of glider personnel, and personnel with training in air landing techniques. To overcome this shortage, volunteers were recruited to serve as airborne troops, and they were trained as glidermen after assignment to the airborne divisions. Many of these men were trained by personnel previously in the 88th Airborne Infantry Battalion.

In addition to training in parachute and glider landing techniques, it was planned that all ground units would be trained in air landing methods and procedures, not as parachute troops but accustomed to flight and to combat loading and unloading. Such a plan would require a large number of instructors, and would of necessity add some time to the training period required before units could be sent overseas. This plan was only partially successful since wartime pressure for basic-trained infantry was overwhelming and proved the necessity for continued training of air-able cadres. Only three infantry divisions and several smaller units received this training.

Despite German successes with an airborne-air transported task force during the attack on Crete, where they employed a total of 15,000 airborne troops, and 20,000 air transported troops, further training in air transportability technique could not be given to other units because of the

Students in air transportability course lashing an ambulance into a C-82

AIR TRANSPORTABLE



A Ground Army ready for plane movement is goal of training at Infantry Center

speeds with which our forces were moved to overseas theaters. It was realized in this country that the German operations on the island in the tideless sea were merely forerunners of the operations to follow, but it was felt that the training required before our troops participated in such operations could be given as needed within specific theaters of operation. Several weeks could be lopped off the training program if air transportability training before units went overseas were omitted.

During the war, many successful air transport movements were made by United States forces. Those of large scale were simply ferrying movements of units from one place to another; shuttle movements in which troops were landed in previously secured area. Movements on the largest scale were the transfer of the 17th Airborne Division from England to France during the battle of the Bulge in December of 1944, and the hurriedly organized shift of the 11th Airborne Division from the Philippines to Okinawa and finally the crucial primary occupation of Japan after the Nipponese surrendered.

It is noteworthy that these divisional air transported movements were made by airborne units, thoroughly acquainted with aircraft and movement by air. Despite the lack of suitable aircraft, these units performed the movements expeditiously and proved large scale air movements complete feasible. Although the movements were made into secured areas, there is no reason why they could not have been launched into an area behind enemy lines previously seized by airborne troops.

Since the war, the United States Army has stressed air transportability training to such an extent that an experimental separate training course for air transportability was established at the Infantry School at Fort Benning. The course was of three weeks duration and covered such subjects as loading and lashing equipment into aircraft as well as planning procedures used in preparing for air transport movements. This course is not to be confused with the regular airborne instruction, during which students are given intensified training in loading and lashing of equipment in combat transport aircraft in addition to the primary training in parachute and airborne combat technique. The course is designed to as-

Mock-up area of the Infantry School at Fort Benning. Mock-ups save wear and tear on actual planes, free them for operational use

sure that the maximum number of ground units can be air-transported.

A complete history of the many small and large scale air transported operations made in the past war was given to the students during the air transportability course. It served to acquaint the student with tactical employment of such forces. German as well as Allied operations were discussed.

A series of conferences were conducted covering familiarization with aircraft, during which students learned the characteristics of currently used cargo aircraft and gliders. Included in this broad general heading were the logistics of air movement and air movement forms used to simplify and standardize planning procedures. Personnel in the course were walked through various types of aircraft to familiarize them with the planes that could be used in air transport operations and to give them a clear picture of what the instructor meant when he talked about the "Fairchild Packet" or the "C-82."

Flight procedures, use of parachutes and safety belts, crash landing and ditching techniques were explained fully, not only to prepare the student for an emergency, but also to give the prospective instructor accurate information to take back to his own unit where he would set up his own air transportability course.

Airfield operations and complete flight briefings were discussed to prepare the student for teaching his own troops back at his home station. Flights in planes and gliders were an integral part of the training, and during several of the flights, students dropped parachute equipment loads from aircraft in flight. Usually twenty students went up in each plane and 12 bundles were dropped at successive passes of the field. The students were eager to try their skill at being able to drop the bundles right on the panels displayed on the ground.

Students preparing to load vehicles in C-82 mock-ups at the Infantry School

After a demonstration glider pick-up came the tedious loading and lashing training, at which the students were destined to become quite adept. With experience came confidence and dexterity, and soon the students were called off in groups of six-man loading teams. Each team was to load a large vehicle or other items of equipment into a Fairchild C-82, lash the material securely to the tie-down fittings, then check the procedure. The pilot then checked the load, and if it was to his satisfaction, he taxied the plane to the runway and took off. The students had a great deal of pride regarding how well the loads held in place, and each loading team swore that the weather was bumpier while they were in the air than while the other loads were aloft, and that their load had not shifted a fraction of an inch during the flight. It was justifiable pride, too, since many had not even been in a plane just two short weeks before, and since that time they had learned not only to load and lash equipment into a plane, but also had determined how to compute safe loads for aircraft.

Loaded C-82 ready for takeoff

Preliminary training was given in aircraft mock-ups to save wear and tear on the few planes available. Loading techniques are readily transferred to the real plane after learning to load in a wooden replica. Coordinated with this technical training, each student was given instruction in the staff planning required to enable him to take his place on the staff of any commander and assist in planning air transported operations.

Attending the air transportability course were personnel from the Army, Navy and Air Force, as well as many representatives from friendly countries. Principal among these were Mexico, Canada, and Great Britain. Other South and Central American republics also sent officer students to the course.

The formal course was discontinued in 1947, at which time much of the tested instructional material was incorporated in the curriculum for regular and associate courses at the Infantry School. Instead of presenting the instruction to a special class, the material was embodied to some degree in other courses at Fort Benning. Concurrent with the adoption of this plan of instruction at the Infantry School, other Army and Navy schools adopted the same system. Courses in air transportability are given in most service schools to prepare officers who attend them as potential air transportability instructors and planners.

This training, although decentralized, permits a broader coverage of the subject, and indoctrinates more members of the Armed Forces with the practicability of air transport operations. Furthermore, this method of instruction permits concentrated instruction in the phases of instruction most needed by the student. For example, the Infantry Advanced Class, composed for the most part of majors and lieutenant colonels, has a large dose of staff planning procedure and a small dose of loading and lashing technique. Noncommissioned of-

ficer classes have a small amount of lower level planning, and a great deal of training in loading and lashing. Thus each student gets a concentrated course in what he will actually be doing prior to mounting an air transported operation. The higher ranking officer will plan the operation, arranging details of timing, scheduling, and coordinating with the Air Force, while the junior officers and noncommissioned officers follow instructions given by higher headquarters. This "division of labor" is the same as that followed in any business concern wherein the higher executives set the policy, the intermediate officials do the planning and coordinating, and the foremen and craftsmen carry the policy into execution.

Most service schools offer courses in air transportability through their correspondence course departments, and all give similar instruction to resident classes. Book shops at many schools offer material for sale to authorized personnel at nominal prices, so that National Guard and Reserve components can augment their instructional materials by purchasing outlines or in some cases complete courses in air transportability. Much material on air transportability is available at the Book Shop of the Infantry School.

Army units have available "air transportability kits" which include conferences, training schedules, and in some cases, reproductions of training aids which can be used in preparing air transportability courses. An infantry division can obtain from Army Field Forces all of the material needed for a complete course in air transportability. With these kits are included instructions for construction of mock-ups and hour by hour conferences of what should be given to the troops. Much of this material has been prepared at the Infantry School to insure that uniformity of training is achieved.

"Fairchild has been given a contract to develop the C-120, an aircraft to carry a "pod." The "pod" has many desirable features. It will reduce turn-around time considerably and permit maintenance being performed while cargo is being loaded. Sectionalized pods can be delivered by aircraft as far forward as available aidromes permit. There the sections can be picked up by helicopters and moved to forward dumps. Various types of shops can be constructed within the pods. The Air Surgeon is very interesting in utilizing the pods for mobile emergency hospitals and for evacuating the sick and wounded from the forward areas. Fuels in tank pods could be carried. Complete weather stations and air transportable GCA units could be housed in pods.

"In the present stage of development, the helicopter is a special-purpose piece of equipment, due to its relatively low weight-lifting capacity and short range, but it does have possibilities. Piasecki is designing a helicopter with 80-foot rotors capable of lifting a load of 6,000 pounds. Helicopters capable of lifting a heavy load would be very useful in moving a small mobile force across a river."
—Major General William D. Old

There is a move starting to get a few special air transportability courses of 1 week duration for the purpose of training additional personnel as instructors in air transportability. The students for these special classes are to come from all branches of the service as in the air transportability course outlined above.

Teams from the 11th and 82d Airborne Divisions and the Infantry School have been sent to various stations to instruct in loading and planning techniques.

General Devers in a recent interview in United States News and World Report (9 September 1949) stated: "At present troop carrier groups are converting to C-119B from C-82. The C-119 will give us more range. Maybe we will eventually go to jet troop carriers wherein parachuters will not be bothered by prop wash of conventional aircraft. I further feel that delivering troops by parachute is inefficient. The best way is to roll in on the ground in an airplane." He goes on to explain the technique of delivering parachutists and further states, "I am particularly interested in air transportability for all types of divisions. We must be able to go into a zone of action with tractors and men, construct a runway quickly and then follow up with troop carriers transporting all types of troops."

Thus thinks the former chief of Army Field Forces, and his enthusiasm and realization of what air transported forces can accomplish is permeating through the entire army. Training in this method of transport is taking place in all units of the army, because far seeing leaders realize the effectiveness of transporting troops and equipment by air. Just as the Army is not static, so we find manufacturers developing better aircraft. A great stride was made when we switched to C-82 and C-119 type aircraft.

Keep these bigger and better planes coming, for if another war comes along we'd like to be like General Nathan Bedford Forrest — we'd like to "get there first with the most." In addition we can add: "with the best."

Flight Test

By Colonel Franklin K. Paul

ASK an Air Force experimental test pilot a stock question, you're pretty sure to get a stock answer.

Ask him, for instance: "Is this plane any good?"

Automatically, he'll say:

"We'll take it up and find out."

"Finding out" is the mission of the Air Materiel Command's Flight Test Division—a serious, round-the-clock, round-the-calendar operation that is, actually, the trial-by-fire through which every aircraft and every piece of related equipment must pass before it becomes part of the USAF.

Home ground for AMC's Flight Test Division is Wright-Patterson Air Force Base, Dayton, Ohio. Here, to a comparatively small group is entrusted the big job of flight testing new planes and equipment — a job that is a full-time occupation for some of the most highly-trained, highly-skilled pilots in the world.

The work of AMC's Flight Test Division breaks down into two major categories. First—and most highly touted—is that of evaluating new aircraft prior to acceptance by the Air Force. This means putting a new plane through its paces to see if it meets the manufacturer's guarantees; testing every phase of performance—in short, eliminating the question marks.

Most of this performance evaluation is carried on at Muroc Air Force Base, AMC's California desert test ground. Surprisingly, it totals only about 15 per cent of the Flight Test Division's over-all work. The remaining 85 per cent is done in conjunction with AMC Engineering Division Laboratories. It consists of taking aircraft component parts—like the pilot ejection seat, tractor-type landing gear, or even personal equipment such as flying clothes, parachutes, G-suits, and oxygen masks—and putting them through complete airborne tests to eliminate the "bugs" before they become standard USAF equipment. At present, about 250 aircraft at Wright-Patterson are being used for this type of experimentation.

It was the Flight Test Division which tested and proved the feasibility of RATO (rocket-assisted-take-off) for big bomber and cargo plane take-offs in short distances and under heavy loads.

The AMC Electronic Subdivision's tested flush mounting for radio antennas—and the Flight Test Division put in more than 30 hours of flying time to provide a basis for evaluating the new idea. For the Armament Laboratory, Flight Test pilots are completing a series of tests designed to evaluate the ability of B-50 bomb bay doors to open and close at extremely high speeds.

These are only a few random examples of the least-sung, but most time-consuming, phase of Air Force flight testing — that of development testing of component aircraft parts and related equipment.

Still another element in Flight Test operations is pure flight research—a continuous quest for new and more efficient methods by which flight testing itself can be made easier, safer, and more accurate.

One advance in this direction is the all-altitude speed course at Wright-Patterson. It is used to determine air speed errors caused by all types of air speed measurement systems. Utilizing parallel radio beams, the speed course enables pilots to obtain accurate measurements of velocity at high altitudes in greater safety where high speed aircraft exhibit dangerous qualities at critical Mach numbers. This method replaces airspeed tests in which pilots flew over a measured course at dangerously low altitudes.

At present, pure flight researchers are busy developing a means accurately to measure the thrust of jet aircraft in flight. When they find it, they will add another boon to the business of flight testing.

The actual flight test program that every military plane undergoes prior to AF acceptance is divided into four phases, two of which are handled by the contractor and two by the Flight Test Division.

Contrary to popular belief, an Air Force test pilot is not the first man to take a new aircraft off the ground. This maiden flight falls to the contractor's civilian test pilots, who fly the Phase I tests on every plane proposed for Air Force adoption. Actually, Phase I of the test program is designed primarily to prove a given plane airworthy. The contractor's pilots take it off the ground—they prove that it will fly.

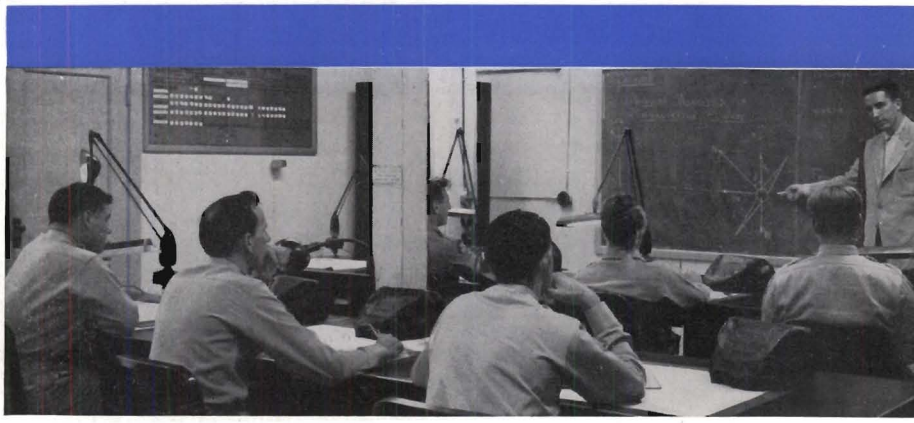
After the plane has been flown about 30 hours, usually by the contractor, it is ready for Phase II testing. The first question—"Will it fly?"—has been answered. Now, AMC's Flight Test Division steps in to find out how well it will fly. Early in Phase I a pilot, crew and test engineering personnel were selected from the Division and briefed thoroughly on the plane's background. For Phase II, they customarily visit the contractor's facility and put in from 30 to 50 hours of flying time on the new aircraft, securing data for official Air Force evaluation of the plane.

Every flight test is a painstaking routine. One day the pilot will fly speed runs. The next, saw-tooth climbs. Then ceiling climbs. Next, turns and banks, dive, and spin tests. Throughout the tests, every performance detail is carefully recorded and later consolidated into a report which will prove or disprove the value of a

Major N. B. Robins and test pilot plotting flight

Pilot Dennen checks out on Beechcraft C-45

A point in aerodynamics from Robert B. Allan



given plane. To augment the pilot's observations, an instrument known as the barograph goes along on every run, detailing on a small chart the exact change of barometric pressure (altitude) with time during the entire test.

Perhaps the most difficult test is the saw-tooth, so called because it creates a saw-toothed barograph record. Its purpose is to determine the best climb speed of a plane and it entails a gruelling grind of dipping, diving, and climbing at various speeds and heights.

In addition to the barograph results, photographic records are made of the tests. When a pilot takes up a fighter plane, for example, a camera goes along as a second observer. Mounted so that its wide-angle lens films a set of instruments that indicate speed, altitude, manifold pressure, RPM, fuel flow and other vital statistics, the camera records the readings of all these instruments during the entire flight. Other cameras are mounted on engine nacelles to record bullets as they pass through the whirling propeller. And color cameras are used to record the color of exhaust stacks and similar metal parts.

Takeoffs and landings are also filmed. A course is marked off, and camera crews follow the airplane from the start of the takeoff until the plane reaches the 50-foot altitude. The same procedure is used on landing, the crew photographing the airplane from a 50-foot altitude down to earth and through its complete landing operation. In this way, Flight Test engineers learn how long a runway the plane will require.

Next step is Phase III which—like Phase I—is conducted by the contractor. It is in this test period that the deficiencies discovered during Phases I and II are corrected and the desirability of the plane as a production product is further determined.

The ultimate testing of any aircraft comes in Phase IV, an exhaustive series of complete performance and stability tests carried out by Flight Test Division pilots and sometimes encompassing as many as 100 flying hours. Phase IV, usually conducted on the production model of the aircraft, includes complete cooling and drag tests. The Air Force knows its new plane inside out when Phase IV is over. The aircraft is then ready to be turned over to AMC laboratories for any component tests that may be indicated or required.

There are about 75 pilots assigned to AMC's Flight Test Division and they are in the air an average of 700 hours a year each. These men are among the best fliers in the world, chosen because of their experience, reliability and efficiency.

Their's is a job more of grime than glamour. The Air Force wants facts about its new planes, and only by flying hard, grinding hours can those facts be obtained. The experimental test pilot must have a good analytical

and technical mind, and he must bring both acquired know-how and innate alertness to his job—for him rests the over-all responsibility of the successful flight testing of any airplane. Test flying involves almost endless detail—much of it routine, some of it drudgery, all of it hard work.

These men do not consider flight testing an abnormal hazard. It is, instead, a well-calculated risk. For proof, they cite the fact that no fatal accident has marred the Division's record in more than a year.

The requirements a potential Air Force test pilot must meet are rigid. For multi-engine planes, he must have a total of 1,500 hours flying time and a minimum of two years of college leading toward an engineering degree, or equivalent credit. A bachelor of science degree, while not required, is preferred. For single-engine aircraft, the same educational credits and 1,000 hours of flying time are needed. While there is no age requirement, most test pilots are between 25 and 35. If accepted, it is hoped they will remain in the Flight Test Division at least five years. This factor is especially important because the first nine to twelve months in the Division are spent attending its special performance and stability schools.

For the potential AMC test pilot, the first step is a four-month-long stint in the Division's Performance School at Wright-Patterson. This is followed as closely as possible by five months training in Stability School.

In both courses, the neophyte test pilot puts six familiar aircraft through an entire flight test program—using the same procedures and writing the same type reports he will prepare later in testing aircraft of yet unproved performance.

He gets, in effect, on-the-job training. First the student "flight tests" the C-45 with the aid of an instructor. Next he solo tests the T-6 trainer and then progresses to the F-51, F-80 and B-25.

In the Performance and Stability Schools students run the gamut—they are trained in air speed calibrations, altitude and free air calibrations, speed points at medium and high al-

(*Continued on page 16*)

(Above) Lt. Dennen (c.) and Capt. Yeager (b.), first to break through sound barrier; (Below) Lt. Dennen ready for first Mustang take-off

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FLIGHT TEST

(Continued from page 15)

titudes, climbs from ground to service ceiling, and new saw-tooth climbs. They fly pacer mission, one in which an aircraft is paced by another with an already determined air speed calibration. They run myriad tests to determine control, stability, and handling characteristics of aircraft. When both courses are completed, the pilot is ready to apply his knowledge to yet untried aircraft. As a test pilot, he is in business.

The achievements of Flight Test Division fliers rank high in aviation annals and the laurels they have brought home are many. In 1946 and 1947 the Division held 90 per cent of the world's aviation records.

It was in 1946 that Col. William H. Councill, then deputy for operations of the Division, set a new Los Angeles to New York speed record, making the cross-country non-stop flight in an F-80 in four hours and 13 minutes. The next year, Col. Albert Boyd, then Division chief, brought home the biggest prize of them all when he flashed across a three-kilometer course at Muroc AFB averaging 623.8 miles an hour to recapture the world's speed record for the United States for the first time in 24 years. (Colonel Boyd left the Division this August to become commanding officer at Muroc.)

Actually, there are few pure "desk jobs" in the Division—most of the administrative staff members have come up through the ranks of the test pilots. They know flight testing and they continue to participate in test programs.

The present world speed record is held by another Flight Test Division pilot, Major Richard L. Johnson, who averaged 670.98 miles per hour in a North American F-86 over the speed course at Muroc in September of 1948. A new, but unofficial, transcontinental speed record was hung up five months later by experimental test pilots Maj. Russell E. Schleeh and Maj. Joseph W. Howell in the flashing Boeing XB-47 jet bomber. They flew from Moses Lake Air Force Base in the state of Washington to Washington, D. C. in three hours and 46 minutes, averaging 607.8 miles per hour.

The history of the Flight Test Division is studded with records and with firsts. Flight Test carried on the test program for the fabled X-1—and it was a Division pilot, Capt. Charles E. Yeager, who was the first man in history to fly faster than the speed of sound.

But the real history of the Flight Test Division is written in its continual evaluation of the planes that make up the United States Air Force. Right now Division pilots are performance-testing the B-45-C. The B-36-B has been undergoing flight tests for the last three months, and before the end of the year programs will have begun on the needle-nosed F-90 jet penetration fighter and on the F-91 jet interceptor fighter. Tests have just been completed on the F-89, Northrop's all-weather night fighter, and on the F-88 McDonnell penetration fighter.

A stability program is being carried out on Consolidated's XB-46—the same type tests which were completed on the Martin XB-48 last month. And the B-50-B is currently in Phase IV tests at Boeing's Seattle plant.

Constantly, Flight Test is seeking and finding the answers—the answers that keep America first in the air.

NACA

(Continued from page 7)

speeds is the research attack on rocket problems. Its ability to provide super-performance, although for only short periods at the present time, has caused it to be used as a primary power plant for military missiles and upper-atmosphere research vehicles.

A major problem in rocket engines is to secure the highest possible thrust from a unit of propellant. Investigating this problem, Lewis Laboratory researchers have, both on paper and experimentally in engines and in the laboratory, determined the extent to which fuels can be improved.

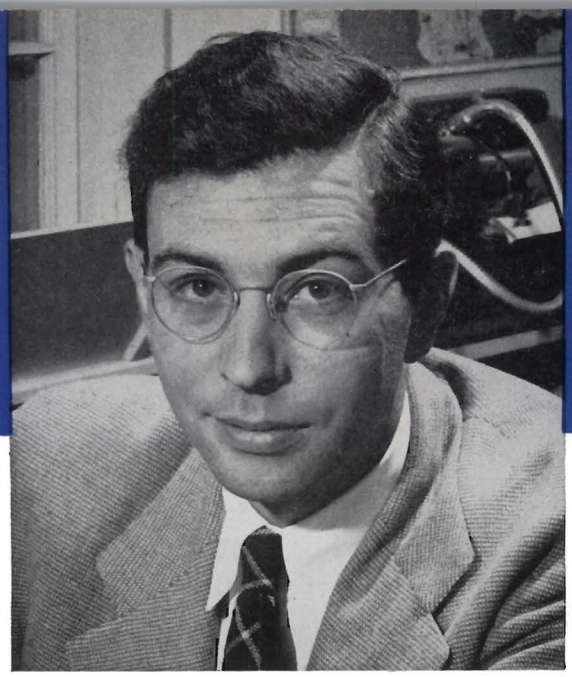
Much progress has thus been made towards providing the more powerful engines and fuels which will be needed for the impending age of supersonic flight. But much, much research, to provide the basic information needed for design of still more potent engines, remains to be done.

PEGASUS PICTURES

FRONT COVER—The massive boom and tail of the Fairchild C-119 frame the skies in which the Packet gives Wings to the Army. This striking photograph and its companion on the back cover show the graceful strength of this workhorse of the air.

PHOTO CREDITS: Front and back covers, Dan Frankforter; inside front cover, drawing by Arthur Simmons; inside back cover, NEPA; 2, drawing by Rino L. Giancoli; 4, 5, 6, 7, NACA; 8, 9, 10, 11, USAF, Signal Corps; 12, Dan Frankforter; 13, 14, 15, USAF.

The Manly Medal



Andrew Kalitinsky

HAND-IN-GLOVE with the aircraft industry's swift progress in the past two decades has gone an increasing emphasis on scientific research and the fundamental studies made possible by modern research and engineering techniques.

While inventiveness, experimentation and testing in use have continued to play important roles in the industry, scientific research and imaginative engineering have provided the extra push needed for the very many and very rapid forward strides in the structure and propulsion of ultra high speed aircraft and in the safety, reliability and economy of more conventional designs. In the process, the aircraft industry has come of age as a center of general scientific research and has won recognition for its mastery of the complex organizational, administrative and planning problems implicit in successful operation of major research projects.

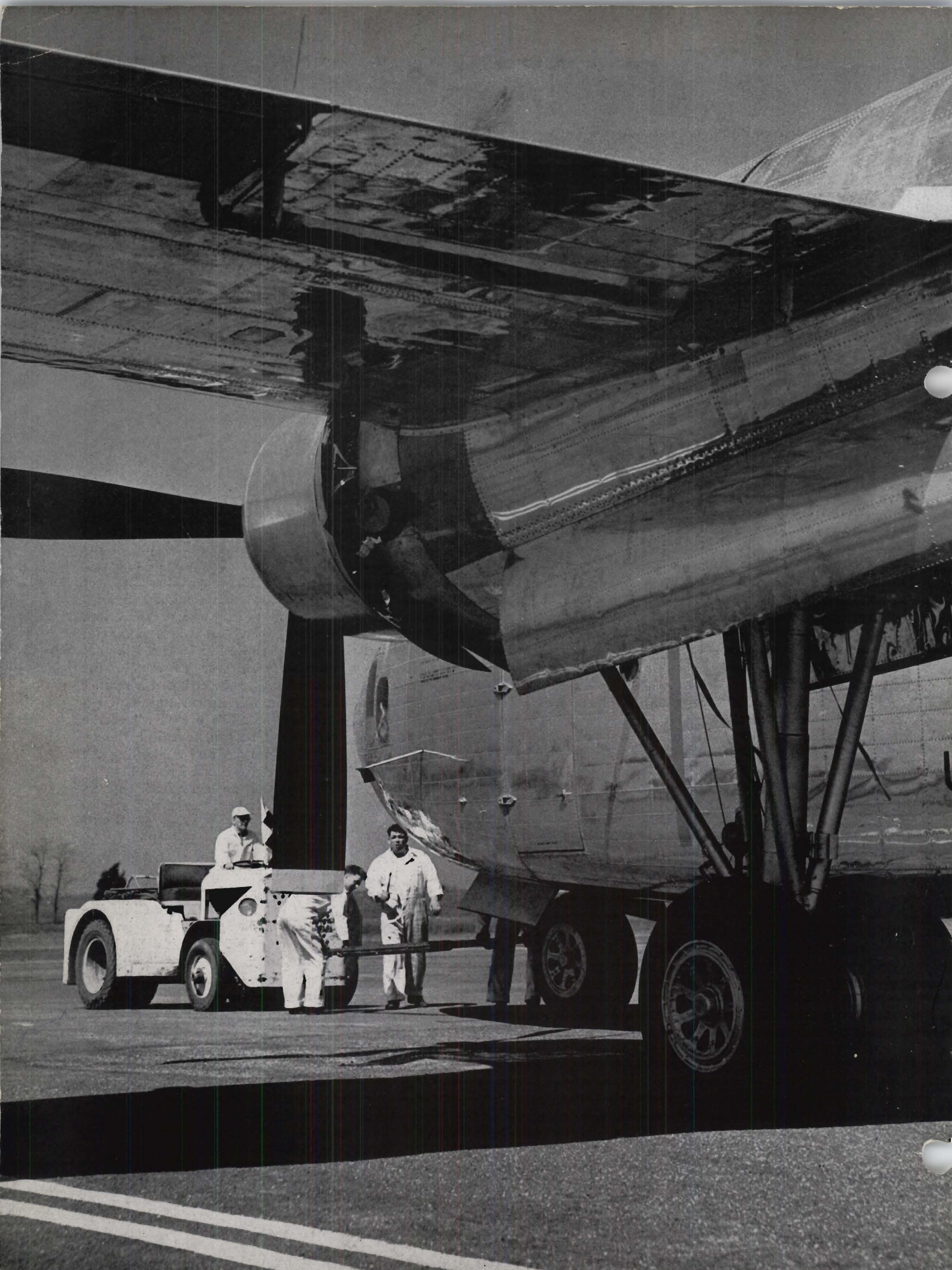
Recognition has come from many sources, but, of these, two are the most valuable. The military forces, by placing basic and applied research contracts with airframe and engine manufacturers, have provided both scientific and financial stimulus, as well as recognition of the companies' accomplishments. Recognition for individual accomplishments—and equally vital stimulus—has come from the annual awards of technical societies, foundations and institutes. Outstanding among these awards is the Manly Memorial Medal of the Society of Automotive Engineers, given since 1928 to the author of the paper judged to make the greatest "*new* contributions to existing knowledge of the aeronautic art" in the powerplant field.

The significance of the Manly Medal can be found in the continuing eminence of its winners and their organizations. Established in honor of the late Charles Matthews Manly, a pioneer of the multi-engined bomber, holder of 40 patents and designer of the 5-cylinder radial aircraft engine that was for years the best, the medal has constituted a small history of progress in aircraft propulsion.

Among its past recipients have been Sam Dalziel Heron, Dr. Oscar C. Bridgeman, Ford L. Prescott, Sir Harry Fedden, Rex B. Beisel, A. L. MacClain, F. M. Thomas, Guy E. Beardsley, Jr., Raymond W. Young, Richard S. Buck, A. L. Berger, Opie Chenoweth, E. W. Hives, F. L. Smith, John Dolza, H. C. Karcher, J. O. Almen, Kenneth Campbell, C. D. Miller, E. F. Pierce and H. W. Welsh, some of whom received the award for group papers.

Preparation of the winning papers was undertaken in such industrial organizations as the Ethyl Corporation, United Aircraft, Rolls-Royce, Ltd., Bristol Aeroplane Company, Ltd., Allison Division of General Motors, and Wright Aeronautical, and at the U. S. Bureau of Standards, Wright Field and the National Advisory Committee for Aeronautics. In four separate years, no paper was judged worthy of the award.

The national meeting of the Society of Automotive Engineers at Los Angeles this October saw the Manly Memorial Medal for 1948 awarded to Andrew Kalitinsky, Chief Engineer of the NEPA Division of Fairchild Engine and Airplane Corporation, for his paper, "Atomic Power and Aircraft Propulsion." One of the youngest men ever to receive the honor, Mr. Kalitinsky based his paper on NEPA Division work, giving engineers a "neutron's eye view" of the inside of the atom, revealing the secret of its power, and explaining the problems that must be solved.

All papers on aeronautic powerplants which were presented before the 45-year-old Society or any of its Sections were automatically considered by the three judges before making the award. The Society has more than 15,000 members.

Born in Russia, NEPA's Chief Engineer was educated at the Swiss Federal Institute of Mechanical Engineering in Zurich. He served with the Navy as a consulting engineer and did research on superchargers at the Massachusetts Institute of Technology before joining the Fairchild project at Oak Ridge, Tennessee, in 1946. Fairchild Engine & Airplane is the prime contractor to the U. S. Air Force on the NEPA task, working with the collaboration of the Bureau of Aeronautics of the Navy, the Atomic Energy Commission, and the National Advisory Committee for Aeronautics. NEPA means Nuclear Energy for the Propulsion of Aircraft.