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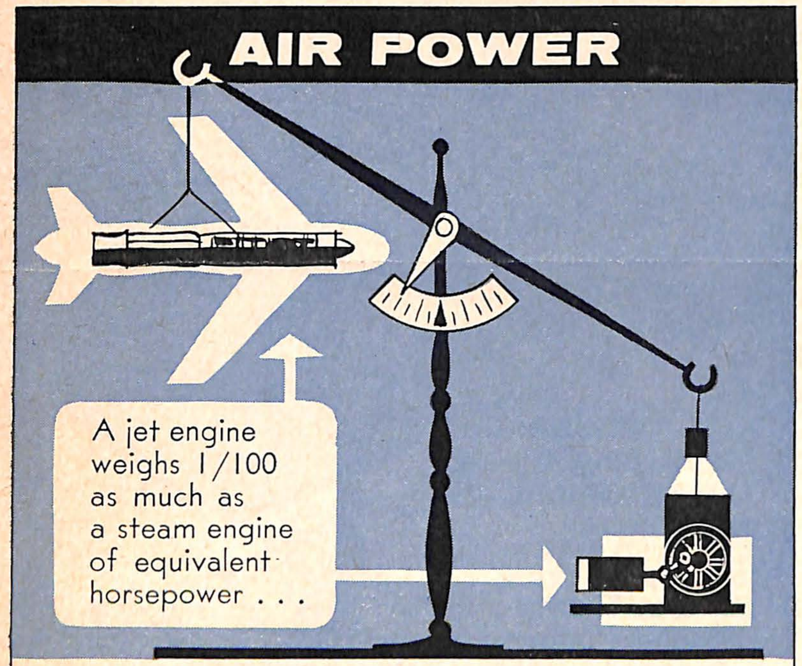
U. S. AIRCRAFT ENGINES CAPTURE WORLD LEAD



One of the precision-built jet engines used to power a modern jet bomber weighs only one-hundredth as much as a 3,000 horse power steam engine. It would take 25 of these steam engines to match the full power delivered by only six engines of this 600 mile-per-hour jet bomber.

'PLANES'

Engine Industry Overcomes Development Lag Caused By Wartime Production Effort

By
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President, Aircraft Industries Association

Recent developments in both military and civil aviation have served to bring more sharply into focus the tremendous advances made by the American aircraft engine industry in the decade since World War II.

Almost monotonous has become the procession of American combat aircraft through the sonic barrier and into quantity production for our air services. More lately, the impact of this progress of power has been felt in the announcements by America's airlines of vast new equipment programs involving both turboprop and jet transports, with airframes and engines built in this country.

A major milestone in American jet engine progress was marked recently when a speed of 823 miles-per-hour over a measured course was established by a standard Air Force jet combat fighter. This achievement reflects great credit on both the aircraft and aircraft engine manufacturers. The power plant of this great plane, designed and produced in the U.S., delivers more than 25,000 equivalent horsepower.

The newly established 823 miles-per-hour speed record gives new evidence that the "Made-In-U.S.A." label on jet engines is the worldwide standard for quality, reliability and efficiency.

The pressures of winning World War II had dictated that America concentrate its engine production genius on manufacturing the tremendous quantity of piston engines needed to insure victory over the Nazi Axis Powers. No other nation among the allies could even approach the piston engine production requirements of World War II.

As a result of this wartime preoccupation, the British were able to devote a markedly greater effort toward the development of jet engines than were American aircraft engine manufacturers. The Germans, with their Me-262, proved the worth of the jet engine for modern aircraft, at the same time sounding the death knell of the piston engines for military combat operations.

U.S. Overcomes British Lead

It was not until America emerged victorious from World War II that the scientific talent of America's engine industry could be given free reign in creating jet power plants. That they successfully met the challenge and overcame a head start of several years, is evidenced by the fact that the most powerful and most successful production engine in the world today is of American design and manufacture.

In the past few years American manufacturers designed and produced jet engines of ever increasing performance and efficiency. Not only were they challenged by entirely new concepts in engine design,

(*See 85,000 ENGINES, page 4*)

Titanium Is Costly, Yet Reduces Plane Costs

Titanium, the aircraft industry's new "beauty queen" of metals is like other beauty queens in one respect. It's expensive.

In the building of today's highly complex and expensive aircraft which provide air superiority for the United States, the aircraft industry is continually searching for ways to reduce aircraft costs.

Considering the fact that a modern jet bomber costs the nation roughly $50.00 per pound it seems a paradox that the industry is turning to Titanium—a virtually precious metal.

But titanium is preferred to either steel or aluminum, in some integral places in the manufacture of aircraft, because it resists heat better than aluminum—yet is lighter than steel.

One screw of a certain type, for a new jet bombers, soon to enter production, costs $1.36. Formerly, this same screw was manufactured of steel and cost only a half-cent. But by using the new Titanium screw the aircraft manufacturer is able to lop off 99 precious pounds from the plane's weight, representing $4,950 saving in the aircraft's cost.

A titanium bolt used in the same plane costs the manufacturer $3.65 each. The same bolt manufactured of stainless steel cost only 45 cents. Yet, the weight saved by using the titanium bolt amounted to 228 pounds—a saving in aircraft dollars of approximately $11,400.

Sonic Plane Equipment Heat Poses Serious Problems To Research

The aircraft industry, striving constantly to improve the quality and performance of American aircraft and equipment, is now waging a battle to find materials and structures that will withstand the heat and stress caused by the increased use of electronic equipment in modern supersonic planes.

One rack of electronic gear in a large jet airplane, for example, generates enough heat to keep two five-room houses comfortable in a North Dakota winter. But it makes the inside of the airplane cabin about as comfortably cool as a Finnish steam bath.

Airborne electronic equipment is usually cooled by apparatus which rams cold air around it and dumps the heated air overboard. However, as the size and complexity of the electronic gear in aircraft have gone up, so have their heat output, and, unfortunately, the volume and weight of the cooling apparatus have climbed right along. Therein lies the problem—for if there's one industry that must watch its weight more than any other, it is the business of building airplanes.

Aircraft manufacturers are all engaged in advanced research to find an improved cooling system for supersonic airplanes. Simple ram-air cooling, research engineers know, can do the job at speeds up to 900 mph. However, a supplemental cooling system must be carried for higher speeds. Applied research has indicated that it will probably be done with a mechanical refrigerator, a water evaporative system, or a fuel heat-sink system, but at the present time, each of these methods still present some knotty problems.

Apart from but integrated with equipment conditioning is the study of personnel conditioning. Efforts are being concentrated on the man and to a lesser degree on the cabin. Cooled, ventilated flying suits for crew members are now being considered.

Aerodynamic heating, the high skin temperature caused by a supersonic airplane's friction against

(*See HEAT POSES, page 4*)

PLANES

Planes is published by the Aircraft Industries Association of America, Inc., the national trade association of the manufacturers of military, transport, and personal aircraft, helicopters, flying missiles and their accessories, instruments and components.

The purpose of *Planes* is to:

Foster a better public understanding of Air Power and the requirements essential to preservation of American leadership in the air;

Illustrate and explain the special problems of the aircraft industry and its vital role in our national security.

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Qualitative Quality

In terms of urgency of current production and work in progress, no industry in America, in a sense not even that at Oak Ridge or its satellites, is more important to the freedom of the free world than the U. S. aircraft industry.

The members of the nuclear bomb family, of course, represent the acme of the destructive power of U. S. weapons. There was a time when the naked threat of the U. S. to "drop" the bomb might have been sufficient to ensure world peace. But since the secret is no longer ours alone, the prospect of retaliatory atomic warfare subtly shifts the emphasis to the ability to "deliver" the bomb with rapidity and precision. Henceforth, the potential foe will be afraid to strike only as long as he respects and fears the quality and efficiency of the vehicles that transport our explosives to critical targets.

The United States aircraft industry—air frame, engine, electronics and associated components and accessory manufacturers—more than ever before is concerned with the quality and efficiency of their aviation products and how they perform in the aerial weapons system. This concern is generated by two considerations. First, that the increasing cost and complexity of equipment demands exceptionally high levels of quality and reliability. Secondly, the vastness of the aircraft industry supply system itself makes it extremely difficult to keep an eye on quality.

In the aircraft industry the process which assures "built-in quality" is called quality control.

Quality control doesn't begin at the end of an aircraft company's production line, nor even at the beginning of it. It begins in the aluminum and steel mills in Pennsylvania and Nevada, in the rubber factories in Ohio and electronics labs in New Jersey. The superior quality required in the highly complex fighter craft and civil transports today, has to be built into the equipment during the entire aircraft manufacturing and assembly operation.

The very complexity and interdependence of all components of modern aircraft means that quality must be kneaded into an airplane at every stage of its development and manufacture. It cannot be bestowed with a rubber stamp after the plane is finished. Today an army of quality control men, armed with pressure gauges, reflectascopes, torque meters, and many other intricate devices of great accuracy, measure, test and check from the time the raw material comes out of the ground until the airplane flies away, and even after.

As an example, one large aircraft manufacturer is now spending $5½ million on quality control annually in one production plant alone, and this corporation has three other divisions in two other states.

"How to do it" experts at this typical plant take the engineers' drawings and determine how to form sheets of aluminum to difficult contours without compromising material strength; how to evenly heat treat large pieces of highly tempered steels to increase their reliability; how to drill a hole at tolerances of two ten-thousandths of an inch, etc.

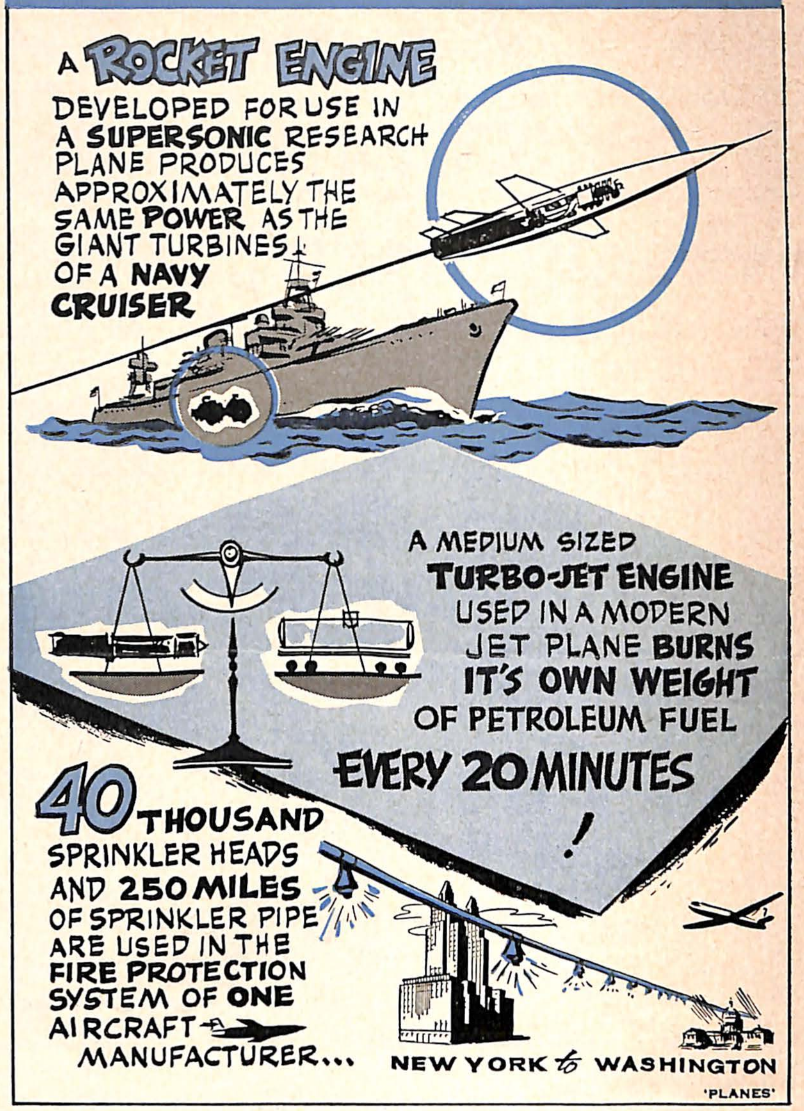
Another group of the quality control team prepares and continually updates inspection directives to see that the processes worked out by the "how" people are complied with.

A third group—the working inspection team—do the actual measuring and testing. These experts have the run of the aircraft plant. They poke their noses into everything, and if they don't like what they find, they order instant corrective measures.

Today we fly at speeds measured in Mach numbers instead of mere multiples of hundreds of miles per hour. To get to Mach one (the speed of sound), a fighter must have an engine that will develop upwards of 10,000 pounds of thrust or, in the case of 600 mile-per-hour jet bombers, multiples of engines developing as much as 100,000 equivalent horsepower. In addition, these planes must perform faultlessly at altitudes where, save for artificial protection, the pilot's blood would boil and his body would explode like a balloon.

And every foot of altitude, every new knot of speed, every new mile of range adds to these stresses and strains. Yet, we must not fail; for on the quality of our aircraft will depend much of this nation's ability to withstand the great stresses and strains of international relations.

PLANE VIEWS



Device Turns Blueprint Into Finished Part

A new method of producing vital parts for America's jet engines is now doing a job in two to four hours that normally required at least five to ten weeks production time.

Called a "cam machine," the revolutionary new device uses electronics to turn a blueprint into a complex finished product. The device automatically produces an intricate cam, which is the heart of a jet aircraft engine fuel-metering and fuel-control system, removing one of the bottlenecks in the production of today's jet engines.

Although developed to meet a special problem in the production of aircraft fuel systems, the new development is expected to have wide applications in machine tool processes.

It converts the blueprint into the finished product through the use of servo-mechanisms actuated by a computer. Coded information is punched onto a paper tape and the computer then reads the data as to the shape of the required cam, sending instructions through the servo-mechanisms to the tool that does the actual cutting of the part being produced.

The computer also checks itself for error, making any adjustments required while the machine tool cutting process is under way.

PLANE FACTS

- 72,000 fluorescent lights are required to illuminate one production plant operated by a major U. S. aircraft company in the manufacture of one of this nation's latest military transport planes. More than 70 miles of fluorescent light tubes are serviced from 40 miles of catwalks. The company uses 38 carloads of these lights each year.
- The crew of one of this nation's strategic bombers has spent more than three months in the air during the last 12 months. During this time they have travelled 430,000 miles. Their plane has burned enough fuel to drive an automobile around the world 818 times. The oil used would fill the crankcases of 5,374 automobiles.
- Every time a guided missile is fired, the ground crew knows more about what it is doing than any one of them knows about how his automobile is performing as he drives it over the highway. Engineers have developed missile-borne automatic radio "telemetering" devices that transmit simultaneously over 100 different categories of information about the missile in flight, temperature, altitude, roll, pitch, direction and other key data as the missile soars upward perhaps 100 miles in two minutes.

AOPA Claims General Aircraft Owners Will Number 100,000 By 1965

General aviation, which accounted for some 93,000 airplanes last year and flew more than 8.7 million hours, is just beginning to come into its own, according to the Aircraft Owners and Pilots Association.

These aircraft engage in all the flying that is done with the exception of the scheduled airlines and the military, and last year they were in the air almost three hours for each hour flown by the big commercial transports.

After researching the status of general aviation today and its prospects 10 years hence, AOPA says that one light aircraft manufacturer expects to have at least 6,000 of its twin-engine models in operation in 1965. Another estimates a total of 2,500 of its twin-engine type will be flying at the end of the decade and another sets its figure at 1,500. Just these three types from only three manufacturers account for 10,000 planes, nearly seven times that of the scheduled airlines combined.

This figure doesn't include the tens of thousands of other types of light planes that will be flying at the time. One manufacturer of popular four-place aircraft says his company will have as many as 18,000 of these single-engine aircraft in operation during this period and another sets a figure of 12,000 for the 1965 total.

Since the precision and skill that goes into the manufacture of these planes, plus the completeness of maintenance required by the Civil Aeronautics Administration, gives light aircraft unlimited years of useful life, the number of planes engaged in general aviation in 1965 should easily exceed 100,000.

Airline Subsidy Doesn't Amount To Peanuts

The cost of air transportation to the people of the United States doesn't amount to peanuts, and the only big thing about airline subsidy is the return which the country gets for its money.

These facts were disclosed at the 10th Anniversary General Meeting of the International Air Transport Association (IATA) in New York by Sir William P. Hildred, director general of the organization.

It was recently announced that the U.S. government estimates that it will pay out during the new fiscal year approximately $30 million in subsidies for overseas and territorial carriers.

Sir William points out that this is less than one third the amount American youngsters spend each year for comic books, and is a good deal less—nearly $15 million less—than the government spent in 1954 on price support for peanuts.

The low cost of modern air travel to the world's governments is further emphasized in the report by the fact that the $60 million paid annually by the French government for beet root subsidy is much greater than that paid for public support of transport costs.

Also, the capital cost of London's airport is equal to only 10 per cent of the subsidies presently being paid to British agriculture in the course of a year. By contrast, 340,000 tourists arrived in Britain last year and spent upwards of $98 million.

Ben Franklin's Kite Aids Air Industry

Instruments sensitive enough to measure electrical current as low as 1/1,000 million millionth of an ampere are being used by aircraft industry research scientists to probe electrical secrets in the stratosphere.

Scientists temporarily loaned to USAF's Air Research and Development Command, elaborating on Benjamin Franklin's famous kite-and-key experiment, have started launching special electronic "field strength meters" soaring aloft with huge plastic balloons from a Florida Air Base.

These meters, designed by research engineers of a large aircraft electronics company, are capable of measuring electric current as low as 1/1,000 of a million millionth. Roughly speaking, one hundred million million times as much current would be needed to momentarily light a pencil flashlight. They are being used to measure the electrical charges set up by thunderstorms. The mid-Florida site was chosen because it is the scene of frequent summer thunderstorms.

The electronic instrument, hanging about 500 feet below the balloon, records such things as the change in voltage, the presence of invisible clouds (charged masses of air) and the electrical characteristics of thunderclouds. The moment the meter picks up electrical measurements, it simultaneously radios the findings to a ground recording station.

Data gathered will be invaluable to American researchers in learning more about the nature of the electrical current constantly flowing toward the earth. This alone is a mystery scientists have been trying to fathom for a half-century, although they do know that at sea level the electric field may be equal to something like 50 volts per foot, tapering off to about ½ volt per foot at 100,000 feet up.

The stratospheric explorations are preliminary research to piloted flight in the 60,000 to 100,000-foot altitude. The research project is also expected to have great impact on long-range military and civilian communications and weather forecasting.

Computer Lops $29,970 Off Taxpayers' Bill

Electronic computers used in engineering America's jet aircraft save the taxpayers many thousands of dollars every year.

As an example, mathematical problems which would cost $30,000 for every million operations by a clerk using a desk calculator are now done on these complex computers at a cost of only three dollars per million operations. And, further, it is estimated that in the future through wider uses of the electronic wonders, the cost for the same number of operations may be reduced to as little as 30 cents.

Not only behind the closed doors of aircraft engineers and scientists are these revolutionary new machines paying for their keep, but they have also added enormously to the operational ruggedness and reliability of modern supersonic military aircraft and commercial transports.

Devices Aid Other Industry

The development of electronic units capable of withstanding extreme changes in temperature and severe pressures and shocks encountered at jet speeds and altitudes has also been essential in manufacturing the delicate electronic components. Ultra-premium tubes are capable of withstanding temperatures as high as 550 degrees Fahrenheit.

Borrowing from the control principles used for aircraft and missiles, these electronics are now being used in many industrial processes.

Air Quotes

We need the strongest, healthiest possible domestic and international airline system. Time after time in emergencies our commercial airline crews, equipment, and staffs have helped to contribute to a crucial military margin, as in the early days of the Korean conflict.

The aircraft and airline industries are not a luxury for America. They are not simply another business which we may blithely watch lagging or encountering difficulties.

America's free enterprise airline industry today requires enormous stockholder and bondholder investments, simply for necessary constant modernization, let alone for expansion. Every effort to encourage sound modernization and sound expansion needs be made.

Meanwhile, we can ill afford an arbitrary "stop and go" military aircraft production system, alternately expanding overnight, then being slashed overnight. I realize that as the world situation changes, our military plans change, but surely we can provide greater continuity in our planning. Similarly, mass inductions of our cadets and then mass release of trained pilots doesn't make sense. Meanwhile, the mighty civilian aircraft and airline industries remain as mainstays—mainstays of the very life of this nation in an age strewn with peril.—*Honorable Alexander Wiley, Republican from Wisconsin, United State Senator, July 16, 1955.*

U.S. Aircraft Engine Builders Have Delivered 85,000 Jet Engines

(*Continued from page 1*)

but whole new fields of science had to be explored.

Jet engine tooling requirements meant that almost 100 per cent of the reciprocating engine tooling had to be discarded in favor of precise machines of new design. Entirely new manufacturing techniques had to be perfected and elaborate test facilities constructed.

During World War II, "fast" 400 mile-per-hour fighters had engines which produced about 1 horsepower for every 1½ pounds of engine weight. Today, U. S. supersonic jet fighter engines produce 1 horsepower for every *4 ounces of engine weight*. The best engine of World War II delivered 3,000 horsepower. Yet, as a result of advanced U. S. aircraft engine research, engineering and manufacturing techniques, we are now developing engines with a thrust output substantially in excess of 25,000 equivalent horsepower.

The aircraft engine manufacturers invested tens of millions of dollars of their own money to supplement federal funds in hastening new engine research and development, as well as in building these new facilities and production equipment. The magnitude of these privately invested funds of the aircraft engine manufacturers for development of jet engines primarily for military use is unique in the annals of modern industry and warfare.

It was indeed important to the successful prosecution of the air war in Korea that our engine manufacturers had made such rapid strides in the five previous years, for the United States was the only free nation that had military jet aircraft of the required quality and in sufficient number to turn back the threat of Communist air power in the Far East. The 14-to-1 ratio of kill set by the United States F-86 over the Mig-15, left no doubt as to the superiority of American made aircraft and engines.

Reliability Saves Millions

Paralleling tremendous advances in performance and in the weight power ratio, have been the increasing reliability and economy built into our jet engines. This is best illustrated by the fact that the government was recently able to cancel an order for some 1,600 jet engines, representing a savings of more than 56 million dollars of the taxpayer's money.

This economy did not result from any reduction of the combat capability of the military services; rather it resulted from the fact that engine reliability and engine life was much greater than had been expected, and was a tribute to the painstaking thoroughness in the design, engineering and manufacturing, which is the hallmark of America's jet engine manufacturers.

For example, the jet engine used to power a current multi-engined jet bomber is giving engine manufacturers a great deal of experience data. Engines of this one type are now flying more than 5,500,000 miles every day, or 11,000 flight hours daily. This experience is the equivalent of a normal monthly airline schedule involving 340 four-engined transports. The experience factor of this one engine is still climbing.

The American aircraft engine industry record of production is unmatched throughout the world. In the short-lived span of jet propulsion, the engine industry in the United States has delivered more than 85,000 turbojet engines, a great number of which are in the 10,000 pounds thrust class. Yet, as recently as five years ago, engines producing thrust of this magnitude were little more than a designer's dream.

Accompanying the progress made by the manufacturers of the turbojet engines, has been the developmental record in the turboprop field. Two of America's largest airlines have placed orders for 75 turboprop transports powered with American designed and built turboprop engines, and options have been taken on an additional 35.

The U. S. Air Force has also placed substantial orders for a new type of U. S. military transport using American made turboprop engines.

Progress in the development of the turboprop engine in America, because of the over-riding military priorities, has not been quite as rapid as has been the progress in the turbojet field. However, recent and significant orders by military and by commercial operators for these engines are evidence of the fact that our engine manufacturers and designers have met the challenge of foreign competition in this field as well.

The most recent testimony to the success of American jet engine design is the announcement that 45 jet transports had been ordered by one of America's leading airlines. This order heralds the advent of the jet transport age .It opens a new era in commercial flight and reaffirms the confidence of the airline industry in American aircraft and especially in American power plants as the most efficient and economical engines in the world today.

The turboprop and turbojet engines will not compete in favor for airlines operation, for each is best suited for its particular job.

The turboprop engine will meet the airlines' requirement for load-carying abiilty on short and medium range passenger flights and long range cargo flights, at considerably higher-than-present speeds. These speeds probably will be in the 400 to 450 mile-per-hour class.

The turbojet, with its very high efficiency at high speed and altitude, is ideal for long range deluxe passenger travel. This will be the 550 to 600 mile-per-hour plane, which will slice hours, instead of minutes, off travel time coast-to-coast and on transoceanic international flights.

Thus, as we phase from our piston engine transports to the new equipment which will meet the new, higher speed requirements, the U. S. engine industry is ready with two proven engine types — each meeting a particular need.

Air Fireman

For the first time on record, a forest fire has been put out by spraying water from an aircraft. The fire covered 50 acres near Wenatchee, Washington. A ground party, and the aircraft, were dispatched to the fire at the same time. By the time the ground party arrived, the aircraft had completely suppressed the fire.

Heat Dissipation Poses Research Problem

(*Continued from page 1*)

the air, is another heat source which will require additional cooling equipment

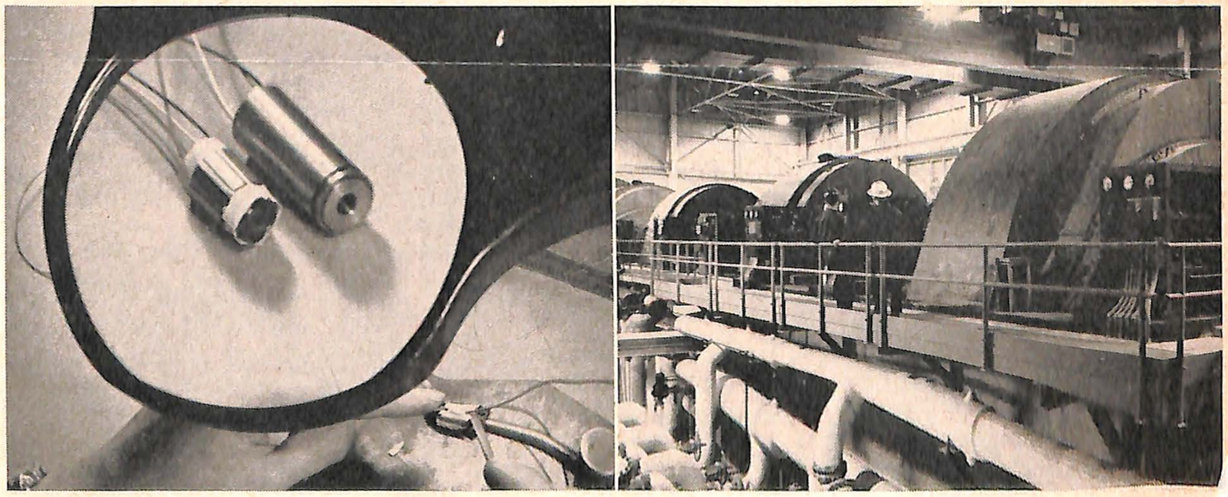
At twice the speed of sound, or about 1500 miles per hour at sea level, friction generates heat on ai plane surfaces as high as 215 grees F. At this temperature t strength characteristics of the aluminum in an airplane begin to decrease. At three times the speed of sound—Mach 3, or about 2300 miles per hour—the temperature reaches a sizzling 600 degrees F. where aluminum loses practically all of its strength. Other metals, such as titanium or stainless steel, are required for these speeds. But even the present commercial grade of titanium begins to lose its strength at a point between 800 and 900 degrees F.

Aircraft engineers are working on another approach to the heat problem—that is, to install equipment that will operate efficiently under very high temperatures.

Instead of cooling parts to keep the grease in them from melting, researchers seek a grease that won't melt. Instead of cooling tires to keep them from blowing up, the need is for tires that won't blow up. Instead of cooling airplane skins to keep them from melting, materials that won't melt are sought for skins.

One major aircraft company has already partly whipped the problem by the development of aircra bearings which will operate at hig temperatures and high altitudes Fantastic as it sounds, bearings have been built which will operate dry at temperatures of 100 degrees F.

The aircraft industry is progressing steadily in finding new ways to beat the heat. There is no doubt they will succeed, if past performance in maintaining American aircraft superiority is any indication.



Pictured above is a striking example of the extremes of motive power needed in the building of American air superiority by the United States aircraft industry. Shown at left is the assembly under a magnifying glass of a tiny, electric, servo motor weighing one and two-tenths ounces. It develops one two-hundredth horsepower. This smallest electric motor ever built for aircraft use has a maximum speed of 19,250 revolutions per minute and is used in the mechanism of a new aircraft gyro compass system. Note two other of the miniature motors in different stages of completion, caught by camera angle under the magnifying glass while a worker's fingers dwarf the third being assembled. Pictured at right are the world's two most powerful electric motors used to develop supersonic gales for a giant wind tunnel needed to test new aircraft designs. Each giant motor develops 83,000 horsepower and weighs 225 tons—as much as a railroad locomotive. Two "small" electric motors, each developing 25,000 horsepower, are required to start the two big motors. Combined horsepower rating of all four is 216,000 horsepower. The entire installation occupies space as long as two football fields.