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planes

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AIR SUPERIORITY FORMULA: COOPERATION

USAF Retires Last Piston Fighter

Recent retirement of the last piston-powered fighter plane to an Air Force museum points up the remarkable progress made by the USAF and the nation's aircraft industry in just over a decade.

It was only in 1945 that the just-retired piston-engine fighter plane was the hottest thing in the Air Force's inventory. Its top speed was 450 miles per hour. Its maximum altitude was about 40,000 feet.

Just as World War II ended, the aircraft industry had started turning out jet-powered fighter planes which could reach speeds of nearly 600 miles an hour and altitudes beyond 45,000 feet.

With each passing year, aircraft manufacturers' research gave the USAF faster and more potent aircraft. Engine manufacturers, whose first turbojet engines produced 1,600 pounds of thrust, are building gas turbines 10 times as powerful.

As a result, in the years between 1945 and 1957, fighter plane speeds have moved from 450 miles an hour in the piston plane to better than 1400 in today's turbojets. Further speed increases are just around the corner as studies continue on gas turbine engines capable of delivering up to 25,000 pounds of thrust and aerodynamicists do research on new configurations and materials capable of handling such ultrasonic speeds.

Similarly, the 12-year period has seen tremendous advances in firepower. The piston fighter of 1945 used machine guns manually fired by the pilot. But the 1957 jet fighter in most cases carries a fast-firing cannon or air-to-air missiles. Automatic fire control systems lock on the enemy plane, zero in and fire the missiles or cannon with deadly accuracy.

These advances by the aircraft industry in the fighter field have been paralleled in bombers and cargo planes as well. All USAF first-line tactical and strategic bombers are now jet powered, except for the heavy-bomber fleet which is rapidly being converted from a combination of piston and jet engines to an all-jet force. And many cargo, refueling and training aircraft are being replaced by jets or turboprops.

These advances are typical of the foresight, research and production required of the nation's aircraft companies to keep U. S. military air arms supreme.

GERMAN AIR MISSION VISITS U.S.—Lt. Gen. Josef Kammhuber, Chief of Staff of the German Air Force (left), spoke before a recent meeting of the Export Committee of the Aircraft Industries Association. He is shown with Maj. Gen. J. M. Weikert (USAF-Ret.), Chairman of the AIA Export Committee, and Gen. Thomas D. White, Vice Chief of Staff of the U. S. Air Force. Gen. Kammhuber said the German Air Force must be put into condition by 1959 to defend against Russian planes capable of operating in the Mach 1.3 to Mach 1.6 speed range. "If that is not possible," he said, "it would be better to have no German Air Force." The German Air Force, now a part of NATO, will be composed of ten tactical wings and eight to ten air defense wings with 1,326 aircraft.

Faster! Faster!

Alice in Wonderland Would Find Technology Pace in Aircraft Industry Familiar Gait

An aircraft industry executive, casting around for opening remarks for a speech he was planning, recalled a scene from *Alice in Wonderland*.

"*. . . still the Queen kept crying 'Faster! Faster!', but Alice felt she could not go faster, though she had no breath left to say so. However fast they went they never seemed to pass anything.*

"*'Well, in our country,' said Alice, still panting a little, 'you'd generally get to somewhere else—if you ran very fast for a long time as we've been doing.'*

"*'A slow sort of country,' said the Queen. 'Now* here, *you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that.'*"

The Queen's description of the pace in Wonderland, the executive decided, precisely fitted the technological situation of the aircraft industry. It requires all the running the government-industry team can do just to keep up with the breathless technological pace, and to get ahead and stay ahead requires running twice as fast.

It all goes to underline the World War II slogan: "The difficult we do immediately; the impossible takes a little longer."

118 Million Air Passengers Predicted by 1970

The Civil Aeronautics Administration predicts that by 1970, 118 million passengers a year will be flying U.S. domestic airlines, compared with 42 million in 1956. CAA foresee 66 million passengers a year by 1960; 93 million by 1965, and 118 million by 1970.

On overseas routes, CAA estimates an annual volume of 6.2 million pasengers by 1960 — as against 4 million in 1956—8.9 million by 1965, and 11.5 million by 1970.

Additionally, a leading airline executive figures the world's air transport fleet will be called on to carry 12.5 billion ton-miles by 1961.

This means there will be no surplus of transportation in the future with new jets entering service.

Military, Industry Work Closely

By Orval R. Cook
President, Aircraft Industries Association

The balance of power that the free world holds today—U. S. air power—stems directly from a relationship between the government and the aircraft industry that is unique in the history of customer-producer dealings.

This relationship retains all of the inherent advantages of competition for the customer and, at the same time, charges industry with the greatest responsibilities ever vested in private enterprise. The close government-industry teamwork has produced a succession of superior aerial weapons.

The demand for greater performance, reliability and automatic functioning breeds complexity. The aircraft of World War II bear a resemblance to modern aircraft roughly comparable to a crystal and cat's-whisker radio set and a combination television, radio and phonograph set. Modern aeronautical vehicles are more accurately termed weapons systems.

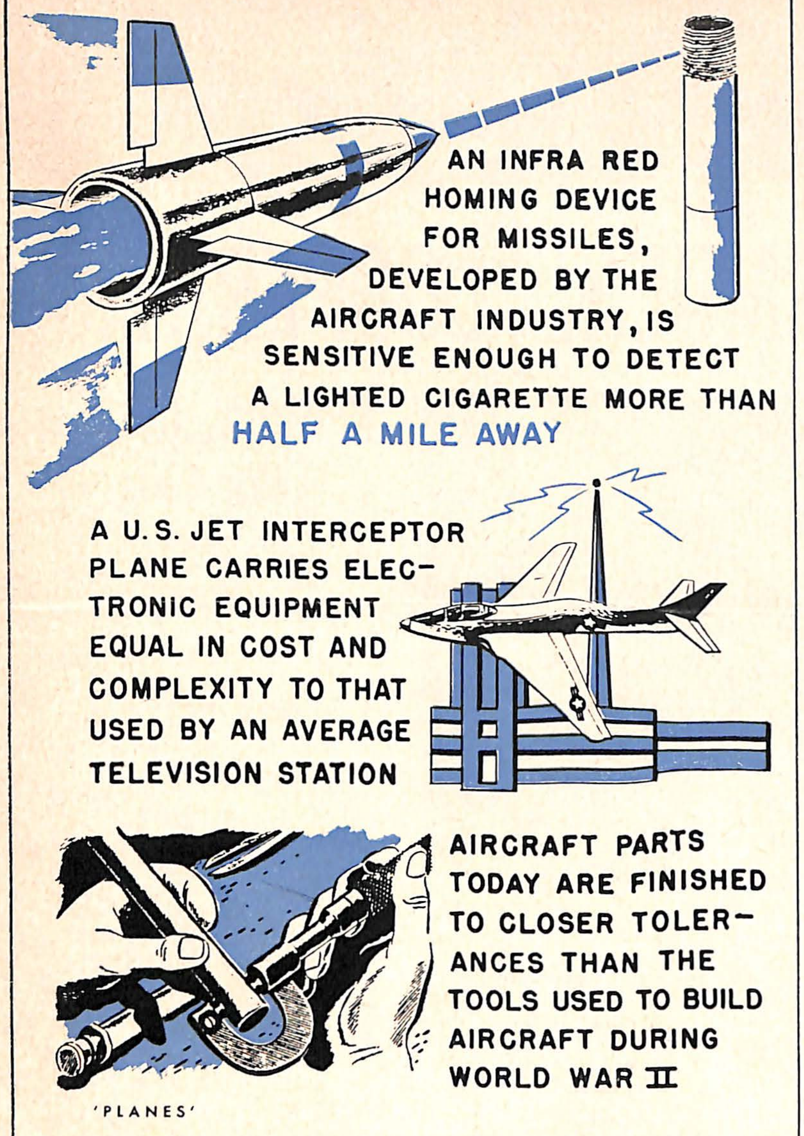
Today's aircraft and missiles have sped past the point where the government could economically direct in detail their design and production. The manpower requirements would be prohibitive. As complexity grows apace with performance requirements, the aircraft industry must assume even greater responsibility for future aircraft and missiles.

A supersonic bomber now undergoing flight tests has 16 major, highly complicated sub-systems that function almost automatically. To mold these systems within the basic airframe, balancing weight against performance increases, requires the highest order of technical management by industry.

Even the largest aircraft manufacturer could not alone produce a modern plane. The prime contractor—or weapons system manager—relies on a vast network of more than 50,000 subcontractors and suppliers for the greater part of the weapon. This broad base of highly specialized skills, which was brought about by

(See *COMPETITION*, Page 7)

Plane Views



Roof or Plane— All the Same

Back in 1944, a roadhouse proprietor on the outskirts of Johannesburg, South Africa, was unable to buy corrugated iron roofing to patch up the leaky roof of his cafe.

Undaunted, he purchased a war-weary twin-engined transport plane which had crashed in the Transvaal, and perched it atop the roof of his establishment. For 12 long years, the transport adorned the roof as an unhappy groundling, keeping the patrons free of rain and snow.

Last year, however, the war-weary craft was bought by a representative of an undesignated American firm for a handsome price, dismantled, and shipped by land and sea to Durban and Natal.

And to what purpose was the vintage aircraft assigned? Flying—what else?

Today, completely refurbished, the venerable but sturdy plane is back in service, occasionally flying over its former nesting place.

Commented the restaurateur: "I am sorry to have lost the old girl, but it is nice to know that she is flying again."

He might have added that the saga of his former roof was also a glowing tribute to the durability of American-built aircraft, no matter how ancient.

AIR QUOTE

"Right now we are coming into the missile era.

"In 1954, about 90 per cent of our procurement money went for aircraft, and only 10 per cent went for missiles.

"In the 1958 budget, about 35 per cent of our procurement money will go for missiles, and in 1961, that will be split 50-50 between aircraft and missiles.

"Just as the aircraft required new flexibility in military thinking and planning for its most effective use, missiles will require even more. Our main challenge during the coming years will be to integrate missiles into our combat force without losing effectiveness. In short, our problem will be one of when and how to substitute missiles for aircraft without endangering our security at any time along the line. Just as new aircraft have led us to certain changes in our organization structures, it is more than likely that missiles will create the need for entirely new structures. It is obvious that we must keep our minds free to move ahead rapidly if we are to get the most effectiveness from our progressing technology."

—General Nathan F. Twining, Chief of Staff, USAF, December 18, 1956.

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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Power Sets The Pace

The history of aeronautical powerplants is brief—little more than fifty years. But in this brief period there has occurred a kaleidoscope of mechanical accomplishments. The United States engine industry has progressed from a 12-horsepower engine capable of sustaining flight for a few hundred feet to rocket engines delivering hundreds of thousands pounds of thrust that will soon propel a missile out of the atmosphere into space and strike a target 5,000 miles from the launching site. A chart on Page 8 of this issue of *Planes* depicts the various types of aeronautical engines now being developed and produced.

The greatest single advance in powerplant history has been the adaptation of jet propulsion as an aircraft engine. The piston engine, which was remarkably refined to a point where the weight-to-power ratio was 1-to-1, was unable to push flight to the speed of sound.

The jet principle has made supersonic flight routine in military operations, pushed open new frontiers in the air. The basic simplicity of the turbojet gives few clues to its great power. The turbojet runs with only a single rotating part: the shaft on which the compressor and turbine wheel are mounted. It scoops in huge quantities of air (several tons a minute), compresses and ignites it with fuel (anything from kerosene to powdered coal) and spews the expanding gases through the tailpipe at speeds of 1,200 miles per hour.

Behind this simplicity lie thousands of hours of design engineering and testing. The turbine blade, which is a miniature airfoil, must be manufactured to tolerances of two-thousandths of an inch; ball bearing tolerances are held to fifty-millionths of an inch. Hundreds of different designs involving the inlet diameter and contour, the flow of air, injection of fuel, the search for metals to withstand the searing heats, are all reflected in its simple great power.

The swift development of the gas turbine engine was made possible by military demands. But there was an important commercial dividend. Jet transports are scheduled for delivery to airlines next year, powered by a jet engine thoroughly proven in military aircraft. When this engine lifts the first production jet transport off the runway it will have accumulated 4,500,000 operational hours, insuring the same high degree of reliability that has made U. S. piston-powered aircraft the standard of the world.

The turboprop—a jet engine turning a propeller—also has important military and commercial applications. The turboprop is faster than the piston engine but lacks the speed of the pure jet. But it has the advantage of lower fuel consumption for economical long-range operations. The turboprop engines which will be used on passenger planes also have been proven in extensive military use that includes 1,000 or more flight hours in weather conditions more severe than airlines normally encounter.

The first turbojet engines manufactured in the U. S. were based on foreign designs. During World War II the American engine industry concentrated on the production of piston engines and was unable to expend the effort to develop gas turbine engines. But immediately after World War II, our engine industry brought the full force of a vigorous and imaginative research and development program to bear on the gas turbine. Within a few years after the war, the engine manufacturers were producing models of their own design in the 10,000-pound thrust class.

The U. S. today leads the world in the production of jet engines—more than 90,000 have been built in the last ten years.

The next step beyond producing gas turbine engines of greater power and efficiency could be coupling the gas turbine with ramjet or rocket power forms. The turbojet could be utilized at its most efficient altitudes, giving way to the ramjet or rocket at their peak efficiency altitudes. Industry experts predict that jet propulsion will be the primary form of power for the next fifty years.

Power is the pivot upon which the aircraft industry turns, the pacemaker for aviation progress. The engine industry already is preparing for a future that will open up space itself as a highway for air travel.

The MEN Behind the MISSILES

By Maj. Gen. Samuel R. Brentnall (*USAF-Ret.*)

MAJ GEN. SAMUEL R. BRENTNALL (USAF-Ret.) was Assistant Chief of Staff for Guided Missiles, U. S. Air Force, until his retirement last year. His 32 years of military service covers a broad span of command and staff positions. He is a graduate of West Point, and has a degree in mechanical engineering-aeronautical from Leland Stanford University. During World War II he served overseas with the U. S. Strategic Air Forces in Europe. He served in various key posts until 1953 when he was transferred to Washington and assigned to guided missiles work. Gen. Brentnall is now Vice President and Assistant General Manager of the Military Division of Motorola, Inc., Phoenix, Arizona.

THE nation's guided missile program, now well out of the diaper stage, is not quite ready to be labeled fully matured. And even when the Army, Navy, Marine Corps and U. S. Air Force have acquired a well-rounded inventory of accurate weapons in each of the major guided missile categories, we will still not be in the midst of what some highly imaginative individuals like to call "the era of push-button warfare." Even the most optimistic missile men in the military services concede that the missile will never completely take over all the functions of the manned airplane.

There has never yet been a new military weapon which attracted as much attention from the American public as the guided missile. Photographs and films of launchings, coupled with the inevitable long-range flights at speeds and altitudes which stagger the imagination, have led the public to believe that we are on the verge of what former President Harry S. Truman once called "fantastic new weapons." In one sense, the guided missile does act in a fantastic manner. A group of uncanny black boxes, filled with tubes, transistors, relays and data processing machinery, takes over the functions of the pilot, navigator and bombardier in the conventional airplane, knocking out an airborne, surface or underwater target at ranges extending up to 5,000 miles. Certainly any such equipment deserves to be eligible for the "fantastic" label.

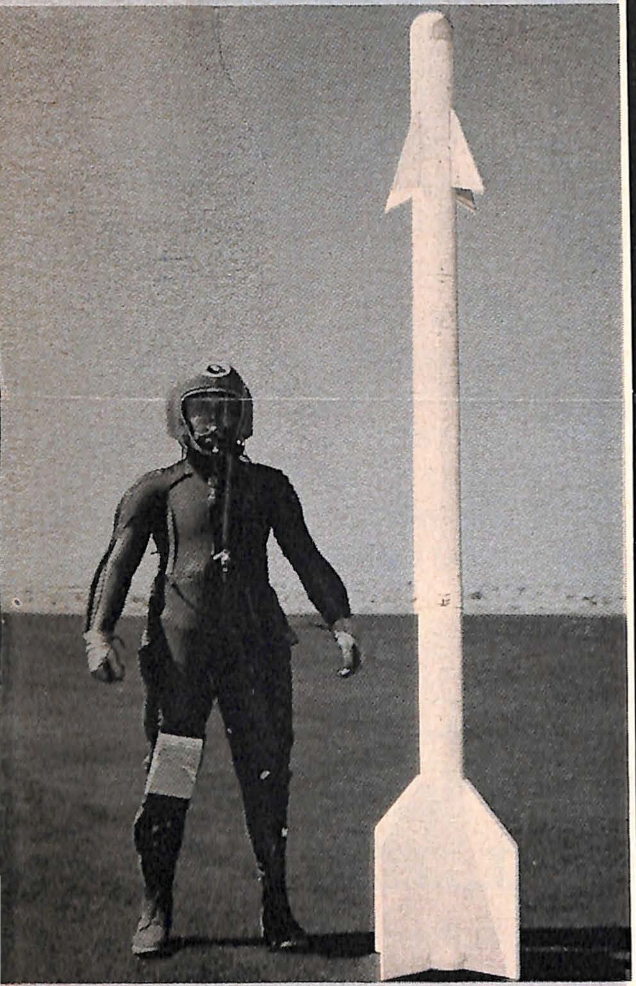
On the other hand, the machinery, production processes, skilled manpower, research studies, wind tunnel tests, fabrication techniques and other factors necessary to develop and mass produce a successful guided missile are not in the least fantastic. They are the same elements so vital to the evolution and output of piloted aircraft—activities which the American aircraft industry has been conducting so successfully for so many years. It

ARMY: HONEST JOHN
Surface-to-Surface

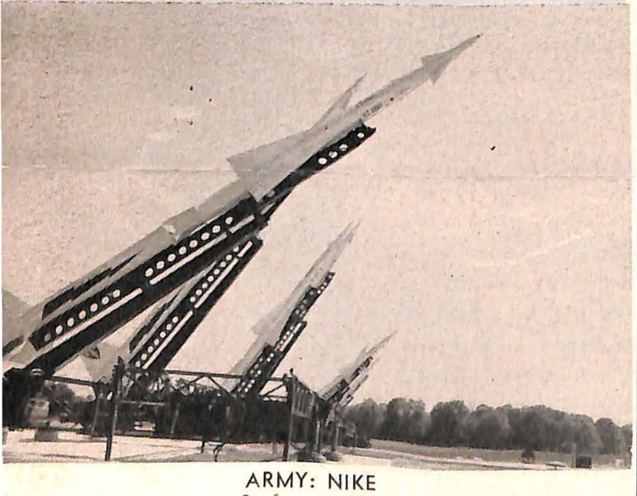
NAVY: PETREL
Air-to-Surface

ARMY: DART
Surface-to-Surface

NAVY: SPARROW
Air-to-Air



NAVY: SIDEWINDER
Air-to-Air



ARMY: NIKE
Surface-to-Air

would not be unfair to state that the industry know-how which made manned aircraft and air power the deciding factors in World War II and the Korean War is certain to make the guided missile (and the airplane) the dominant factor in any future conflict.

The guided missile is not actually a new weapon of warfare. The Bible tells us that David overpowered an aggressor, Goliath, by propelling a sort of missile, a stone fired from a slingshot. The Chinese used rockets against the Tartars in the thirteenth century. Fire arrows were launched from catapults during the Crusades. In the eighteenth century, the famous British Rocket Corps used rockets with startling results.

Even if the definition of guided missiles is made more strict—i.e., an unmanned aerial vehicle which, while in flight, can change its trajectory and be guided, the U.S. Air Service by 1919 was using production models of a "flying torpedo." Orville Wright, Charles F. Kettering, Elmer Sperry and General H. H. Arnold headed a group of engineers who began promoting this "flying torpedo" just a little more than a decade after the 1903 Wright Brothers flight. By September 1919, the first successful launching of the "flying torpedo" —a small aircraft-type missile powered by an internal combustion engine and propeller—had taken place.

DURING the 1920's and the 1930's, Professor Robert H. Goddard, of Clark University, Worcester, Massachusetts, carried on scores of high-altitude rocket experiments, but his findings were all but ignored in the United States. The same was not true of Europeans, especially the Germans, who made careful note of the Goddard experiments and expanded on them.

By World War II, advances in military technology permitted increased use of guided bombs like the American Azon, Razon and Tarzon and the German Fritz X. Later in the war, the Germans started using the V-1 buzz bomb. On September 8, 1944, the Nazis' first successful launching in anger of their V-2 ballistic missile took place. Fired in Holland, it fell 180 miles away at Chestwick, England. Several seconds later, a second V-2 dropped on Epping and the guided missile era began.

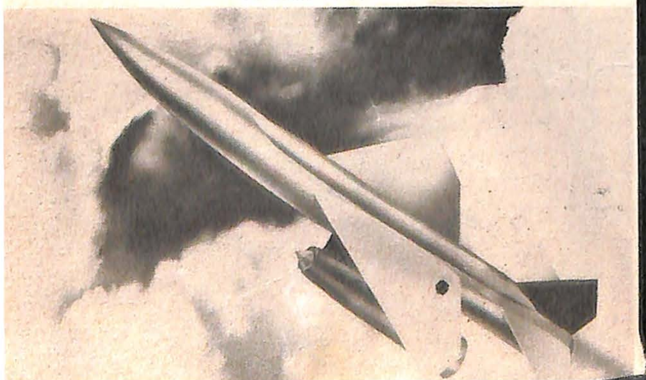
There is now little doubt that if these V-2's had been equipped with nuclear warheads, the victor in World War II might not have been the Western Allies. From our point of view, it was very fortunate that the V-2's payload of 3,000 pounds of high explosive was small and the accuracy relatively poor. Despite these shortcomings, the V-2 ballistic missile became a constant and irritating threat to the Allies for the duration of the war.

WITH V-E and V-J days came the cry of "bring the boys home." Contracts for billions of dollars worth of airplanes and for research and development on both manned aircraft and guided missiles were cancelled. Military planners were fully aware at the time that the era of jet propulsion for aircraft and the age of the missile were just beginning. But the funds necessary to fully finance research and output were simply not to be had. Much of the job fell to the aircraft companies, who were in no position to pay for the needed studies because their production contracts had been cut back and they were deep in the red. Similarly, the American people, through the Congress, at that time convinced that aggression had been ended for all time, kept appropriations for guided missile research at a very low level.

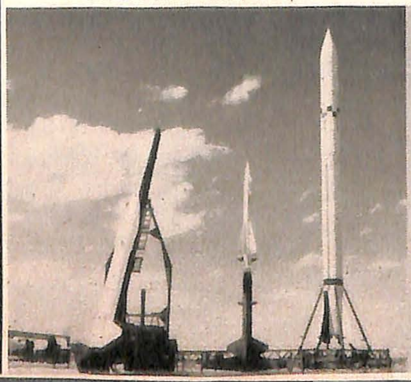
Despite these drawbacks, the aircraft companies and associated firms began studies on the various guided missile types. Included were air-to-air missiles for defensive actions against enemy bombers and fighters, air-to-surface and air-to-underwater missiles for offensive use, surface-to-air anti-aircraft-type and interceptor-type missiles to down enemy bombers before they could reach targets in the United States, and several varieties of surface-to-surface missiles. Included in the last category were tactical missiles to support our ground troops, ship- and submarine-based weapons usable against targets ashore, and longer-range missiles in both the air-breathing and ballistic categories.

Many of these missiles are already in mass production and operational use and others are

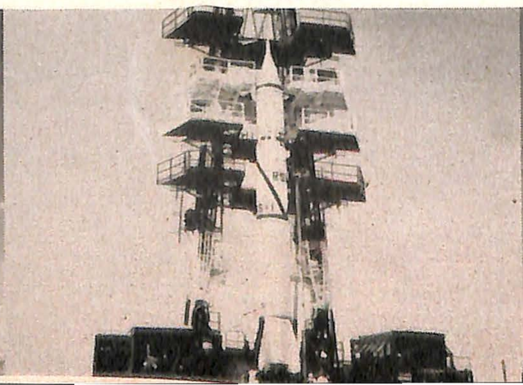
USAF: BOMARC
Surface-to-Air



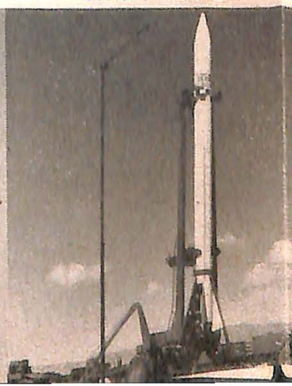
ARMY
Honest John, Nike, Corporal

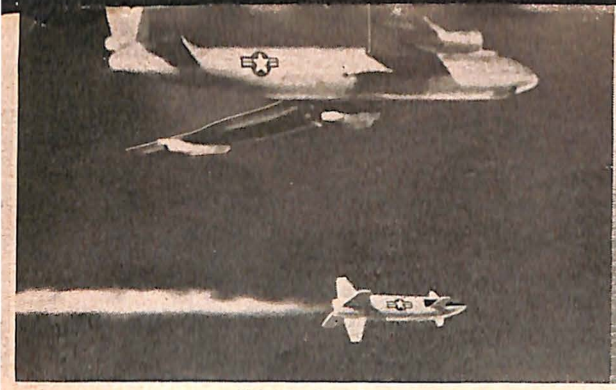


ARMY: REDSTONE
Surface-to-Surface



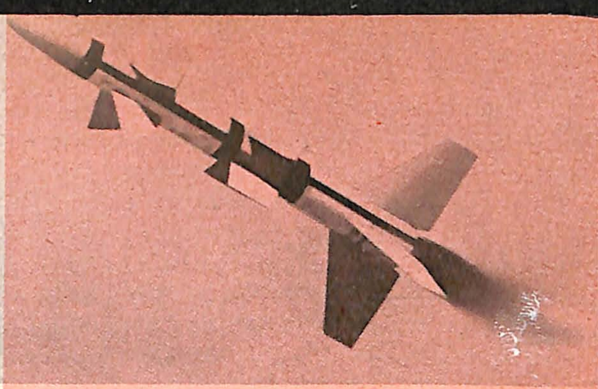
ARMY: CORPORAL
Surface-to-Surface





USAF: RASCAL
Air-to-Surface

NAVY: REGULUS II
Surface-to-Surface



NAVY: TALOS
Surface-to-Air

currently at the stage where they are ready for production. Each passing year brings with it improvements in existing missiles. As evidence, it need only be pointed out that the Army's Nike Ajax anti-aircraft missile is scheduled to be replaced by Nike Hercules, which has improved range and performance. The Navy's ship-to-surface Regulus I is to be supplemented by Regulus II, which travels farther at supersonic, rather than subsonic, speeds. And the Air Force's TM-61A Matador, designed to support Army troops, has been replaced on the manufacturer's production line by the TM-61B, which provides better guidance and therefore greater accuracy.

THE nation's long-range-bomber striking force ultimately is destined to be augmented by both intermediate range and intercontinental ballistic missiles. These ballistic missile projects, which have been assigned the top priority over all other military programs by the National Security Council, include the Air Force's Thor IRBM and Titan and Atlas ICBM's and the Navy's Polaris IRBM. It is no accident that the prime contractor and the power plant producer on each of these top-priority ballistic missiles is an old-line aviation company, each well-schooled in the problems of aerodynamic heating, thrust augmentation, construction materials and all the other areas common to both manned and unmanned aerial vehicles. The only other long-range ballistic missile under development in the United States at present, the Army Jupiter IRBM, has been assigned to the Air Force for possible use, but research funds available after July 1, 1957 will preclude the Air Force from carrying on studies on both the Thor and Jupiter IRBM's. One of these will be eliminated as a research project during the 1958 fiscal year.

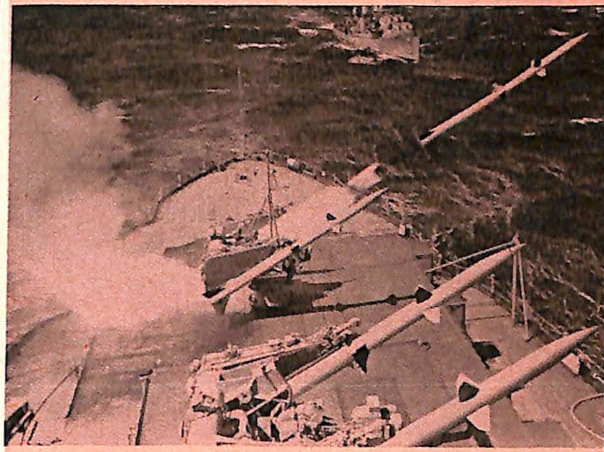
Neither the IRBM nor the ICBM will be ready for operational use for several years. But the aircraft industry has evolved two air-breathing intercontinental missiles, the turbojet-powered Snark and the ramjet Navaho, to serve in the inventory. The Snark is already in limited production and the Navaho is close to that stage.

An interesting point about the frequently expressed confidence of most informed officials that the ballistic missile is almost certain to be attained in accordance with the present highly optimistic time-table is that we would be at least one year behind current planning had not one of the pioneer aircraft companies in the field had considerable foresight. In the late 1940's, the Air Force found it necessary to cancel Project MX-774, the forerunner of the Atlas program, for economy reasons. But the company involved in the project carried on research solely with its own money for one full year and with only limited military support for several other years before the Atlas project was begun in earnest in 1951.

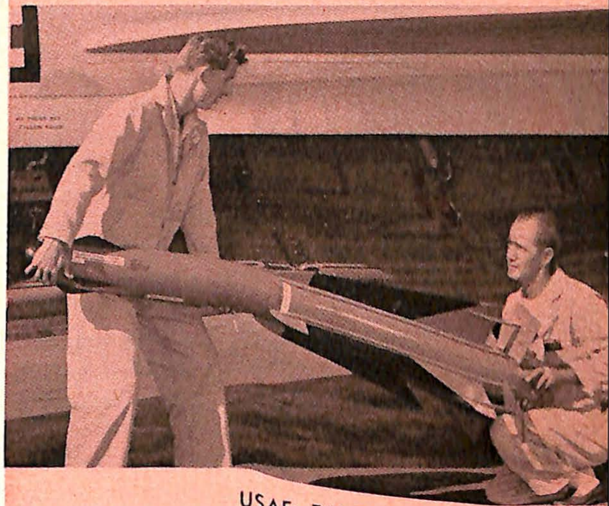
The most significant event causing present optimism about the ballistic missile program took place in 1952-1953. This has since been labeled the "thermonuclear breakthrough," and made it possible to achieve higher destructive yields from smaller warheads in the nose cone of the ICBM. The reduction in size and weight of the warhead, tied in with the increased yield of the fusion reaction, permitted the ICBM to be effective.

WITH the knowledge of the thermonuclear breakthrough, a team of the nation's top scientists, headed by the late Dr. John von Neumann and former Assistant Air Force Secretary Trevor Gardner, recommended in February 1954 that the ICBM program be accelerated. The scientific group's recommendations were accepted and the intercontinental ballistic missile program was made the top priority program in the Air Force. Later on, on the advice of a second panel of top-level scientists, the IRBM program was started and placed on a co-equal status with the ICBM, the over-all ballistic missile program being assigned the No. 1 priority in the Defense Department late in 1955.

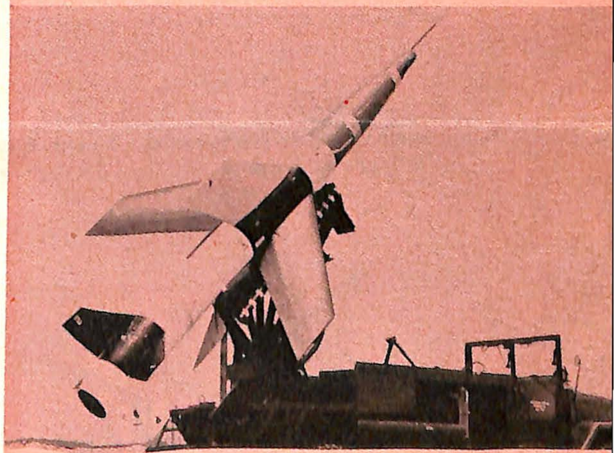
We in this country must realize that if we can develop ballistic missiles successfully, the same must be true of the Russians. They garnered as many documents and scientists from the German missile research center at Peenemunde as possible right after V-E Day and have been carrying on crash programs de-



NAVY: TERRIER
Surface-to-Air

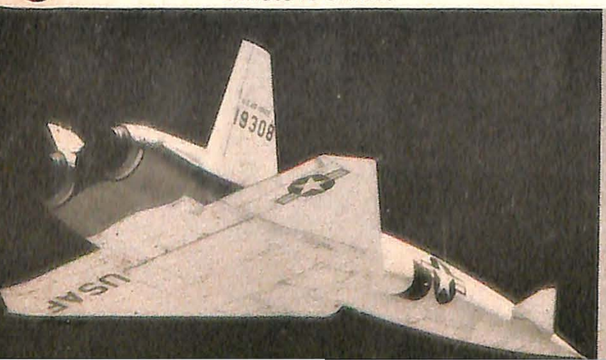


USAF: FALCON
Air-to-Air



ARMY: LACROSSE
Surface-to-Surface

USAF: NAVAHO
Surface-to-Surface



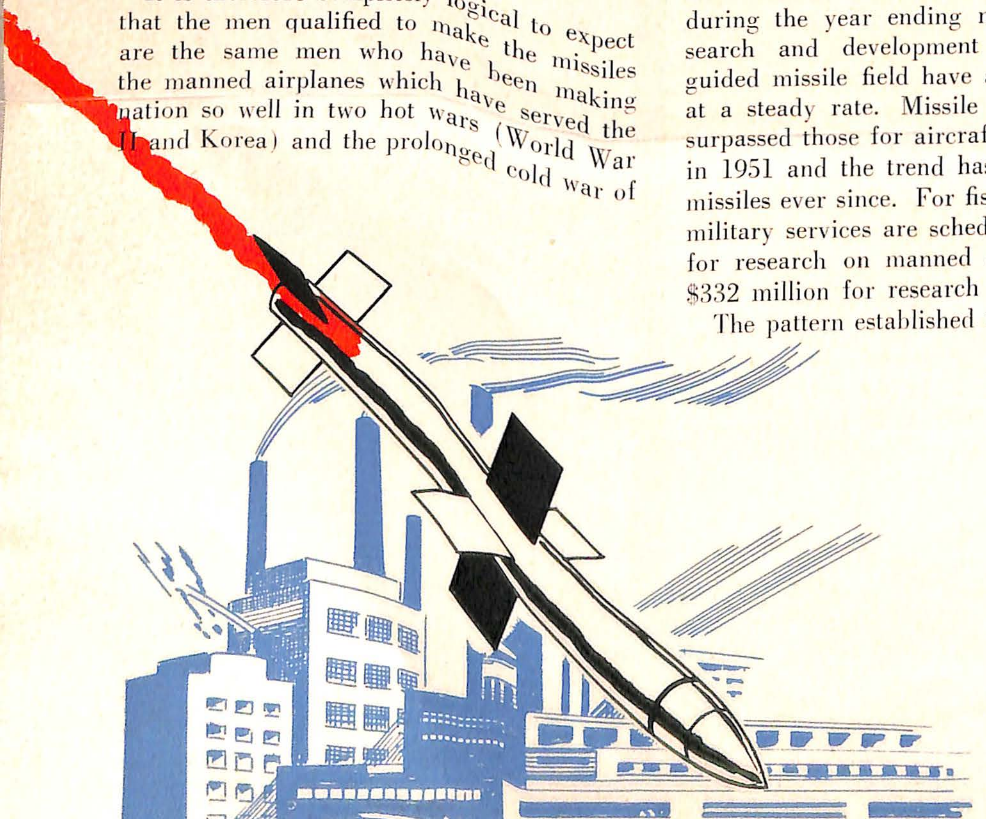
USAF: SNARK
Surface-to-Surface

USAF: MATADOR
Surface-to-Surface

signed to attain ballistic missiles since that time. Their leaders have made periodic references to "over-water rockets" and the like, meaning that our own aircraft industry scientists must also cope with the problem of developing an anti-missile missile, which will be able to knock a Soviet ballistic missile out of the sky before it can do any damage to American cities. Efforts like these take more than money, which can always be made available in a nation as rich as ours. Development projects for potent missiles of any sort take certain priceless commodities—time (which can never be bought), technical experience (basically similar to the problems of manned aircraft), skilled manpower (familiar with the necessity of working to extremely close tolerances), management capability (comparable to that found in an industry which increased aircraft production from 6,000 to 96,000 annually in the years between 1939 and 1944) and specialized research and production facilities.

TO the uninitiated, it might appear that the modern guided missile is little more than a shell housing electronic black boxes. But the missile of today is much more than that. It is an airframe with wings and fins, in the same sense that manned bombers, fighters and transports are airframes. It requires a propulsion system which must be "married" to the airframe for efficient operation, just as in the piloted plane. Provision must be made for the missile warhead just as the right amount of space must be left in a bomber for the bombload. The various gyrocompasses, radios, automatic pilots, radar and other pieces of electrical and electronic equipment must be integrated into a complete weapon system in the guided missile, just as they are combined to make an airplane a self-sufficient, highly effective weapon of war. Any external appendages to the guided missile must be planned so that they will not spoil the ideal aerodynamic configuration, just as external stores and wing-tip tanks on airplanes are designed to maintain as perfect an aerodynamic shape as possible.

It is therefore completely logical to expect that the men qualified to make the missiles are the same men who have been making the manned airplanes which have served the nation so well in two hot wars (World War II and Korea) and the prolonged cold war of 1946-1957. Who knows whether this nation would still be free if the aircraft industry had not done so efficient a job? Much as the manned intercontinental bombers and high-speed fighters have successfully prevented the outbreak of a full-scale nuclear war, their new companion in arms—the missiles being evolved and built by the nation's airplane, engine and system producers—may be the future deterrent.



IN a real sense, the companies in the aircraft industry are making tremendous strides in developing new weapons which will make some of their older products unnecessary. It might be defined as a case of "technological unemployment" for certain types of piloted aircraft.

A good example is found in President Eisenhower's budget message to Congress for the coming fiscal year. In that message, the President noted that the Army's growing guided missile capabilities and the increased effectiveness and mobility of tactical airplanes had made possible a planned reduction in the number of Tactical Air Command wings.

Among the missiles responsible for the scheduled reduction in TAC are the Air Force's Matador and the Army's Corporal, Lacrosse and Honest John surface-to-surface weapons. These four missiles are being produced by two of the leading airframe companies. Under the present plan, the TAC wings due to be eliminated involve fighter-bombers built by other manufacturers. But the same two companies which are making the missiles for tactical use are traditional suppliers of tactical bombers to the Tactical Air Command. If they keep designing and manufacturing tactical missiles, which do a fine job supporting ground troops, their tactical bomber business will fall off.

The nation's guided missile activity is now a multi-billion dollar business and all signs point to further increases. Spending for missiles during the coming fiscal year will total more than $2 billion, as against $1.5 billion during the year ending next June 30. Research and development activities in the guided missile field have also been climbing at a steady rate. Missile R&D expenditures surpassed those for aircraft for the first time in 1951 and the trend has been in favor of missiles ever since. For fiscal 1958, the three military services are scheduling $276 million for research on manned aircraft as against $332 million for research on missiles.

The pattern established in research back in 1951 is rapidly being followed in procurement. In 1952, only four cents of the Air Force's "aircraft and related procurement" dollar went for purchase of guided missiles. Two years later it was a dime; by 1956 it was 12 cents. For 1958, about 35 per cent of the USAF's procurement money will go for missiles and it is expected that the 50-50 split between aircraft and missiles will show up in the budget submitted in January 1960 for fiscal 1961. The USAF's percentages are paralleled by the missile procurement figures of the Army and Navy.

Despite the increasing emphasis that is being placed on all types of guided missiles, it must be remembered that they are actually another weapon of war. The manned airplane will always be able to accomplish everything that the guided missile can, although perhaps not always quite as quickly. As a supplement to the piloted aircraft, the guided missile has certain advantages, notably its ability to fly higher and faster. For these reasons, the missile is bound to be less susceptible to interception than the airplane. One other advantage inherent in the missile is that there are no men aboard, meaning that the lives of air crewmen are not endangered.

LIKE the missile, the military airplane has one basic purpose in life—the destruction of enemy targets. Our manned aircraft are now fully capable of reaching any target and eliminating it through the use of fission and fusion weapons. In the case of the airplane, which is more vulnerable to interception, it may take more than one plane and more than one attempt. In other words, for certain missions, the missile, which ultimately may be able to destroy a target on the first try, would be more effective than the airplane.

Of course, we will never be able to be completely certain that our missiles will be able to get through to the target on the first attempt because of enemy countermeasures. It will therefore be necessary to procure enough missiles to provide an "offensive in depth" to assure the necessary amount needed to destroy the target.

Much has been said about the possible consequences if the Soviet Union should attain either the IRBM or the ICBM, or both, before the United States. Naturally, such a development would not be very pleasant. But it would not necessarily handicap our ability to deter aggression. The thousands of jet fighters and light bombers already built by the Russians give the Red Air Force enough short and medium range striking power to carry out near its borders just about what could be accomplished by use of the IRBM.

Similarly, a Soviet ICBM would not automatically mean that our manned bombers would be rendered useless. As long as the men in the Kremlin are convinced that the piloted planes delivered by American aircraft manufacturers are capable of inflicting unacceptable damage on Russian targets, our airplanes, supplemented by missiles, will continue to be a deterrent to war.

And as long as the aircraft industry and its associated companies keep evolving potent guided missiles, the lead which this country holds over the Russians in the missile field will be maintained and possibly even increased.

Competition Sets Progress Pace

(*Continued from Page* 1)

the efforts of large aircraft and engine companies, is the basic reason the industry is able to assume weapon assignments of such technological magnitude.

The usual development of a weapons system starts with a general requirement laid down by our defense leaders; for example, they may want an aircraft capable of Mach 2 speed, 75,000-foot operating altitude, a range of 5,000 miles carrying a 2-ton payload. The government, working closely with the aircraft industry, makes a decision to go ahead with the project, based largely on the technical judgment of the aircraft industry as to its feasibility. This is cooperation of great fineness and trust. It remains throughout the design, production and operational stages of the aircraft.

The aircraft industry often contributes plans for entirely new weapons for which an operational requirement has not been developed. In other cases, aircraft manufacturers, using their own funds, proceed with the design and development of an aircraft for which there is only an indicated need. A case in point is the jet tanker. Long before the Air Force formally asked for proposals on a jet tanker, an aircraft manufacturer was well along on design work and a prototype was under way. The manufacturer invested $16 million of the company's funds in a calculated gamble that it would receive an Air Force order.

There was no guarantee that the Air Force would place an order. In this case the risk paid off. The principal beneficiary was the Air Force. The first production tanker was delivered to the Air Force early this year, at least two years ahead of the time this vital plane would have been delivered in an ordinary customer-seller relationship.

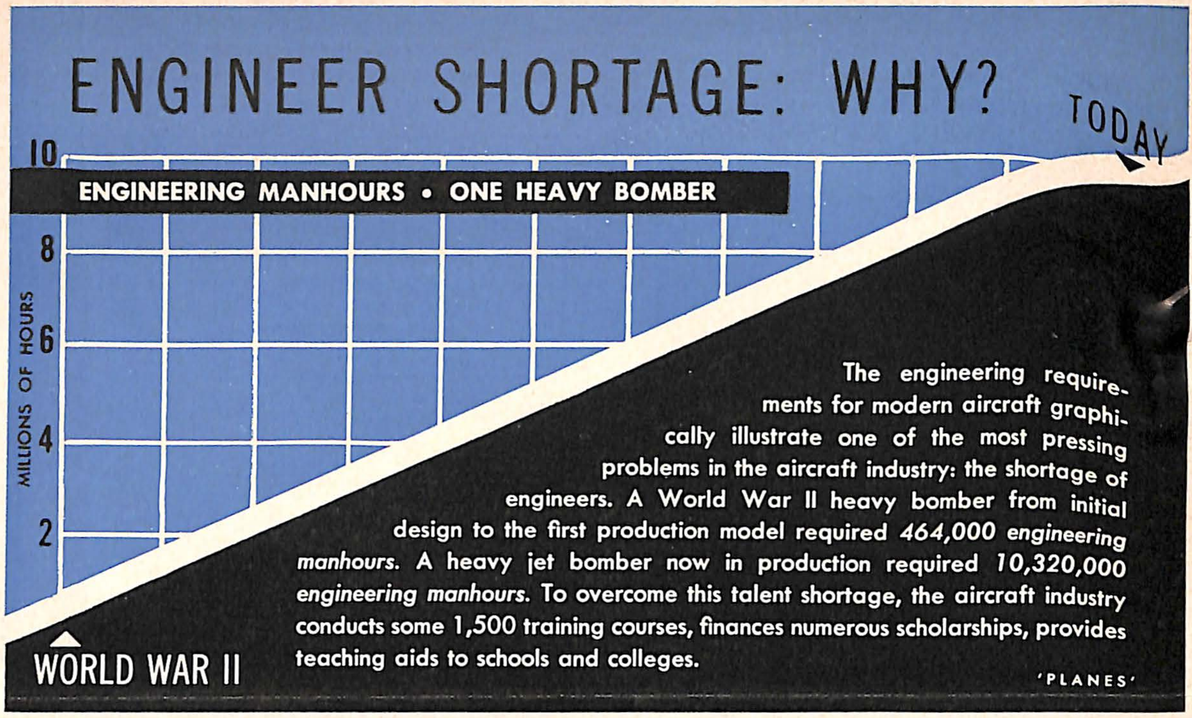
The competitive drive within the industry is not diminished by the fact that individual companies have the same major customer; rather, the competition is intensified. Technological advances in the aircraft industry have come so rapidly in the last few years that companies failing to maintain aggressive, well-financed programs of research and development soon find themselves without orders.

Because of the rapid technological pace, the industry finds itself in the curious position of being overtaken by the future. The high cost of new facilities and talent to explore new ideas demands a substantial reinvestment of earnings aimed at supplying a market that could shift quickly or disappear. The aircraft industry as a whole plows back about 65 per cent of its earnings—higher than any other American industry, even though its profits-to-sales are far below the national industrial average. But without the high reinvestment rate, even the opportunity for new business would be lost.

Despite the keen competition and the risks and responsibilities shouldered by the aircraft industry, there still exists in some quarters the erroneous impression that doing business with the government is a short, happy road to corporate success; that the government stands ready with a blank check to bail out inefficient companies. Nothing could be further from the truth. The history of a company's performance is a key factor in contractual considerations.

But the impression, however erroneous, has sometimes led to demands for restrictive, even punitive controls that would inevitably freeze the free flow of ideas, destroy the incentive to take on and carry out responsible assignments.

The aircraft industry is proud that the government is its principal customer, and willingly accepts the challenge of the heavier responsibilities that the future will bring.



The engineering requirements for modern aircraft graphically illustrate one of the most pressing problems in the aircraft industry: the shortage of engineers. A World War II heavy bomber from initial design to the first production model required *464,000 engineering manhours*. A heavy jet bomber now in production required *10,320,000 engineering manhours*. To overcome this talent shortage, the aircraft industry conducts some 1,500 training courses, finances numerous scholarships, provides teaching aids to schools and colleges.

Housewife's Automatic Washer Is Converted To Speed Jet Engine Part Production

To speed production of complex steel jet engine components, one aircraft company's midwestern plant uses a specially designed and built tumbling machine which bears a striking resemblance to the family automatic washing machine.

By using the new automatic tumbling machines, the components manufacturer estimates, finishing operations on engine assemblies are completed in one-fourth the time previously required.

Looking like large rotary laundry washers, the tumbling machines use a drum about six feet long and four feet in diameter. A central shaft in the machine holds up to 14 vane and shroud assemblies, major components of a turbojet engine.

In use, the jet components are held rigidly on the central shaft while the large tumbling barrel slowly revolves. The barrel contains an abrasive charge—a mixture of aluminum oxide chips, pieces of mild steel wire and water. As the barrel rotates, the abrasive mixture hones and polishes the sharp edges and nicks of the engine parts, wearing them smooth and clean. The vane and shroud units finished in the tumbling machines are intricate assemblies, consisting of inner and outer shroud rings connected by as many as 160 air foil vanes.

The tumbling units cost more than $50,000 but are well worth installation and upkeep cost, as they completely eliminate hand deburring, vapor blast and wash operations, and are 75 per cent faster, the company reports. This is another example of ingenuity and cost-consciousness on the part of U. S. aircraft manufacturers which helps to explain why American airplanes and engines are the best in the world.

'Inner Ear' Guides Missile Flight

Taking a lesson from that master engineer — nature — research engineers at one of this nation's major aircraft companies have developed a tiny but powerful "brain" for use in advanced missile guidance programs.

The device, weighing little more than one ounce, duplicates the balance mechanism of the human inner ear. In fact, its designers say, the device even resembles the convolutions of the inner ear in shape.

Made of glass tubing, this new man-made brain can be made ultra-sensitive electronically to provide a report to missile guidance equipment of the slightest course deviation.

Unlike nature's mysterious method of making things work, this tiny device built by man uses an electrolytic solution to cover tungsten electrodes fused into the glass material. The electrodes are connected into an electrical circuit and when the missile strays in the slightest from its planned course, signal voltages are transmitted to the guidance system, which, in turn, activate corrective controls.

Aviation Booklet for Children

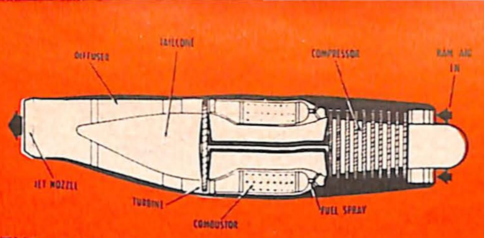
Programs aimed at indoctrinating the youth of America in aviation have been stepped up by the National Aviation Education Council. Made up of a group of leading educators, the non-profit organization aims at enrichment of the general study features of aviation education, performing this vital service through reaching youngsters both in the school and the home.

NAEC has, in line with this program, published several teacher-prepared booklets with a sound educational and an accurate aviation point of view.

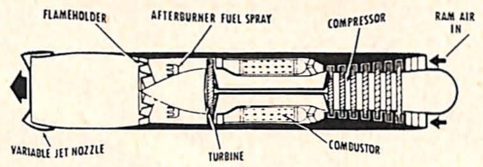
For the harassed parent who has despaired of ever keeping his animated offspring absorbed in anything—let alone in educational pursuits, we recommend the booklet *Aviation Activities*.

Included in the fun-filled pages, is a picture dictionary, with which they can cut out words, such as; helicopter, control tower, pilot, etc., and paste them under the right picture. There are cut-outs of stewardess and pilot hats which can be colored, pasted together and worn. The child can play the role of pilot, navigator or even the jet plane itself with this booklet. There is also an airport game which can be played by as many as four children, and a variety of other fascinating items for any youngster in the 4 to 8 age group. Interwoven in all of this is real instruction. The kiddies will be absorbed and delighted—and they will learn.

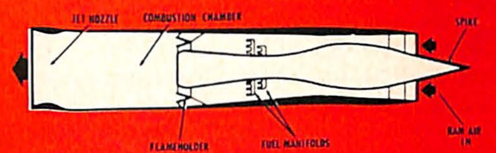
Aviation Activities may be obtained by writing to the National Aviation Education Council, 1025 Connecticut Ave., Washington 6, D. C. The price is 30 cents. The National Aviation Education Council is sponsored by the Aircraft Industries Association.



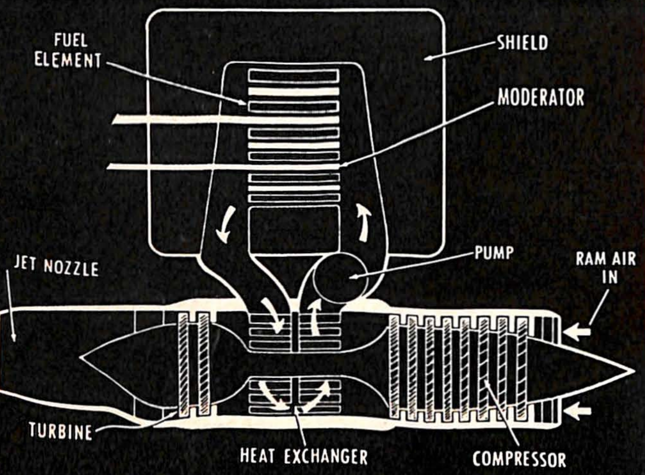
TURBOJET — Air is compressed after entering the inlet and then passes to the combustor where fuel is injected and ignited. Thrust is provided as a result of reaction from the gas leaving the exhaust nozzle.



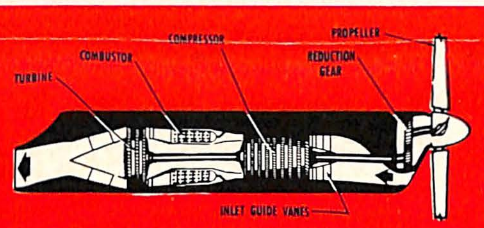
TURBOJET WITH AFTERBURNER — Gases from the turbojet exhaust contain unburned oxygen. By adding fuel to the afterburner it can be burned to further heat and expand the gases beyond what is possible in the turbojet.



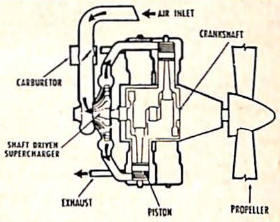
RAMJET — This simple but precisely manufactured engine must be pushed to high speed by another engine before it will deliver thrust. Air is then rammed into the engine, ignited and expelled to produce power.



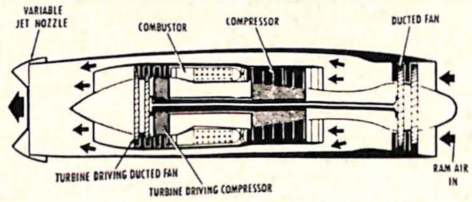
NUCLEAR — Fission of materials such as uranium 235 produces great heat. Air from the jet compressor can be forced through the reactor, or an intermediate fluid such as liquid sodium can be circulated to transfer heat from the reactor to the air passing through the engine.



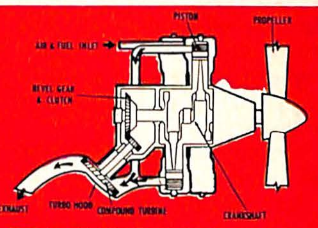
TURBOPROP — This power plant is similar to the turbojet in principle, but the hot gases expanded through the turbine drive both the compressor and the propeller which provides most of the propulsion.



PISTON—Air is first compressed in the supercharger, then forced into the cylinders where it is further compressed and ignited. Fuel is injected and the expanding gases push pistons which rotate the shaft and propeller.

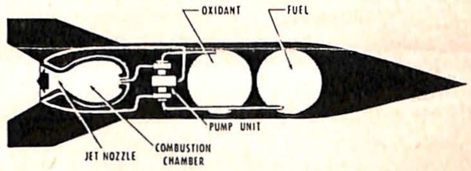


BYPASS — A variation of the basic turbojet, the bypass (or ducted fan) engine uses oversize inlet stages to the compressor. Only a part of the airflow goes to the compressor; the balance goes around to mix with the exhaust.



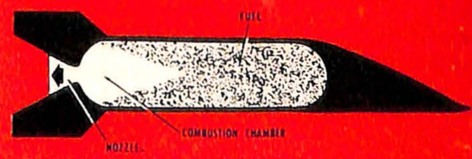
TURBO COMPOUND — Exhaust gas leaving the cylinders is carried to a turbine and expands through it before reaching the atmosphere. By reclaiming this energy, the efficiency and fuel economy are greatly improved.

AERONAUTICAL POWER PLANTS



LIQUID FUEL ROCKET — Combinations of the oxidant and fuel are injected into the combustion chamber by pumps where they burn at temperatures ranging from 3,500 to 10,000 degrees Fahrenheit.

America's aircraft engine industry leads the world in the design and production of the power plants that are the basis of our air superiority. They have produced 1,000,000 piston engines in the past 50 years and more than 90,000 gas turbines in the past ten years. Large numbers of ramjet and rocket engines have also been manufactured. The growth in power of two of the more recent power forms has been astounding. Production turbojet engines gained from 1,600 pounds of thrust to 16,000 pounds of thrust in 14 years. Rockets that will produce hundreds of thousands of pounds of thrust have been developed in the last few years. This is the engine that some day will literally take man out of this world, since it can operate without air. It will power the 5,000-mile range intercontinental ballistic missile (ICBM). The turbojet engine or combinations of turbojet and rocket or ramjet power will probably be the dominant power form for the next fifty years. But the engine industry already is reaching out through its vigorous program of research and development for new types of power such as atomic, photon, electronic and anti-gravitational systems.



SOLID FUEL ROCKET — This simple engine requires only a combustion chamber where the fuel and oxidant are stored, a nozzle for converting pressure energy to thrust and an igniter. It will burn until the fuel is exhausted.

'PLANES'