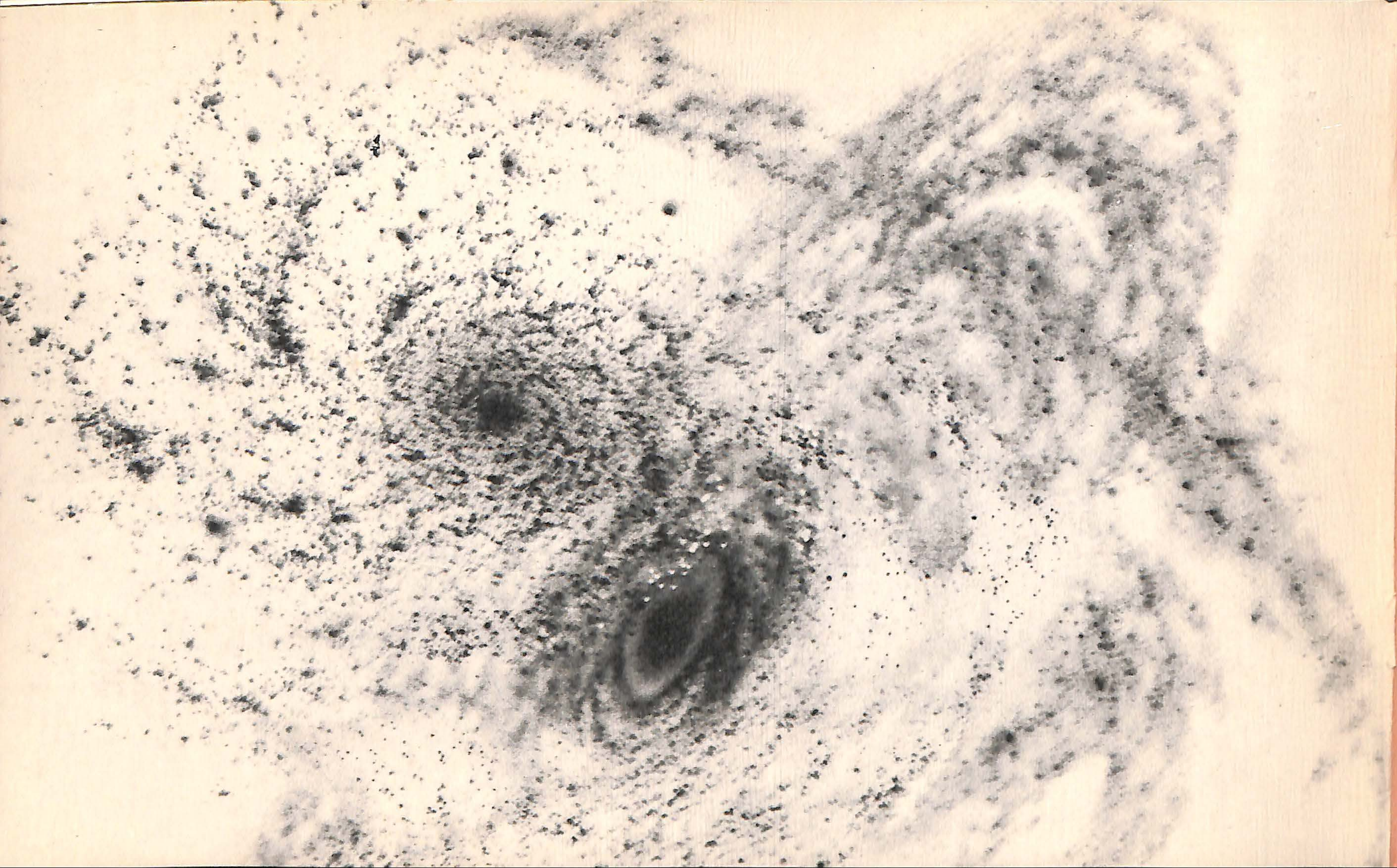
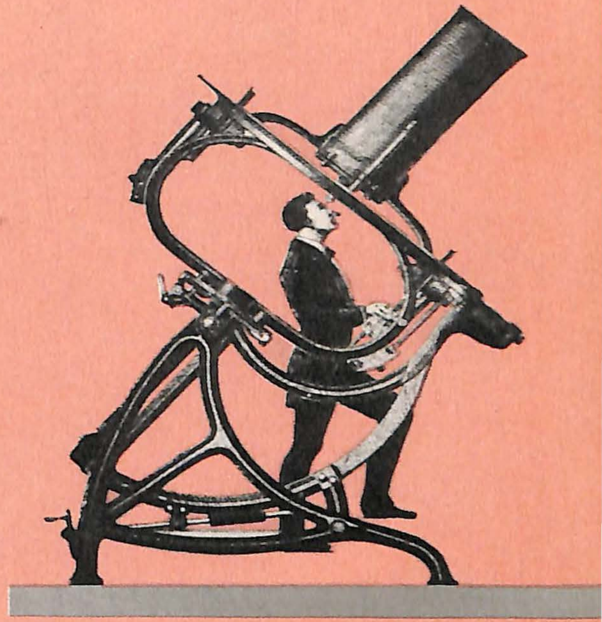
SPACE

Challenge and Promise



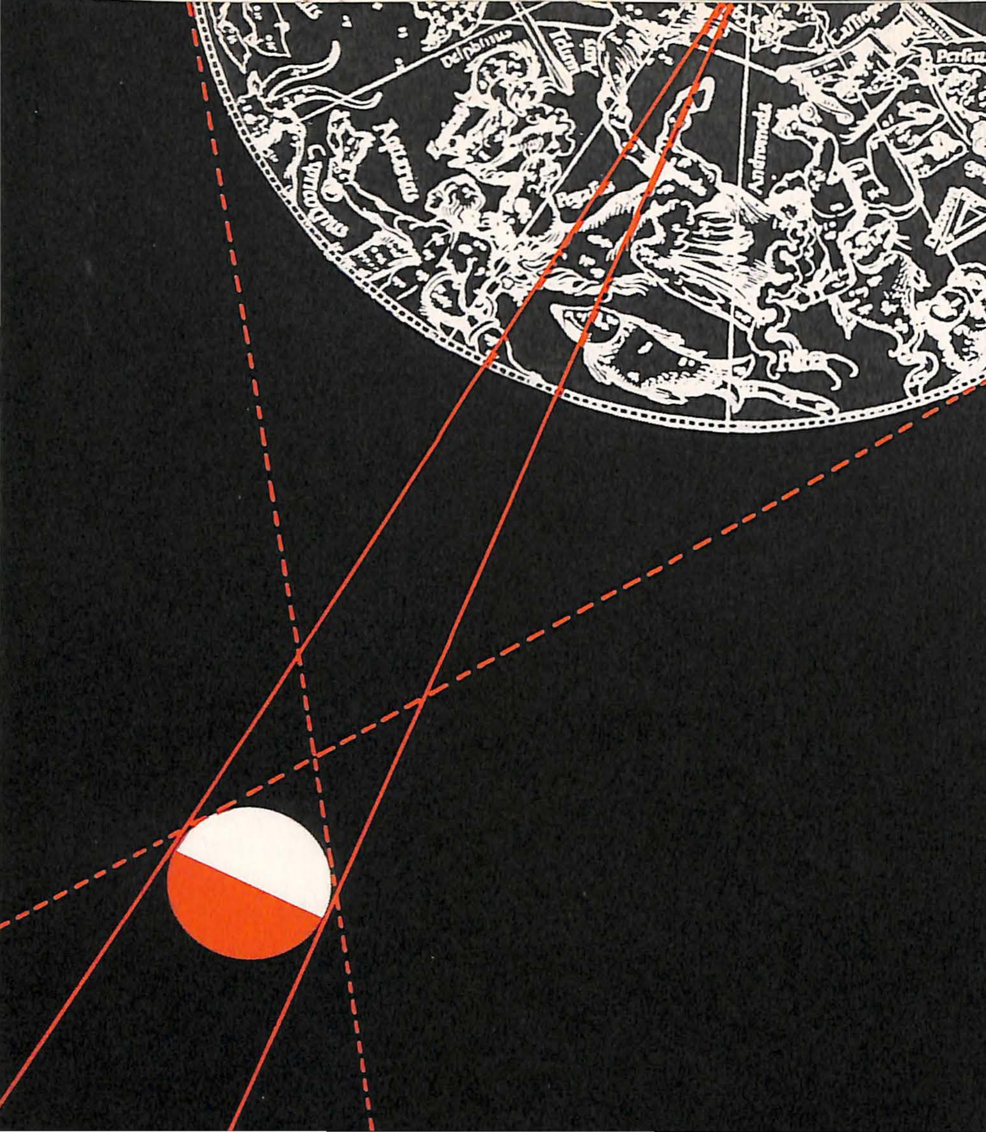
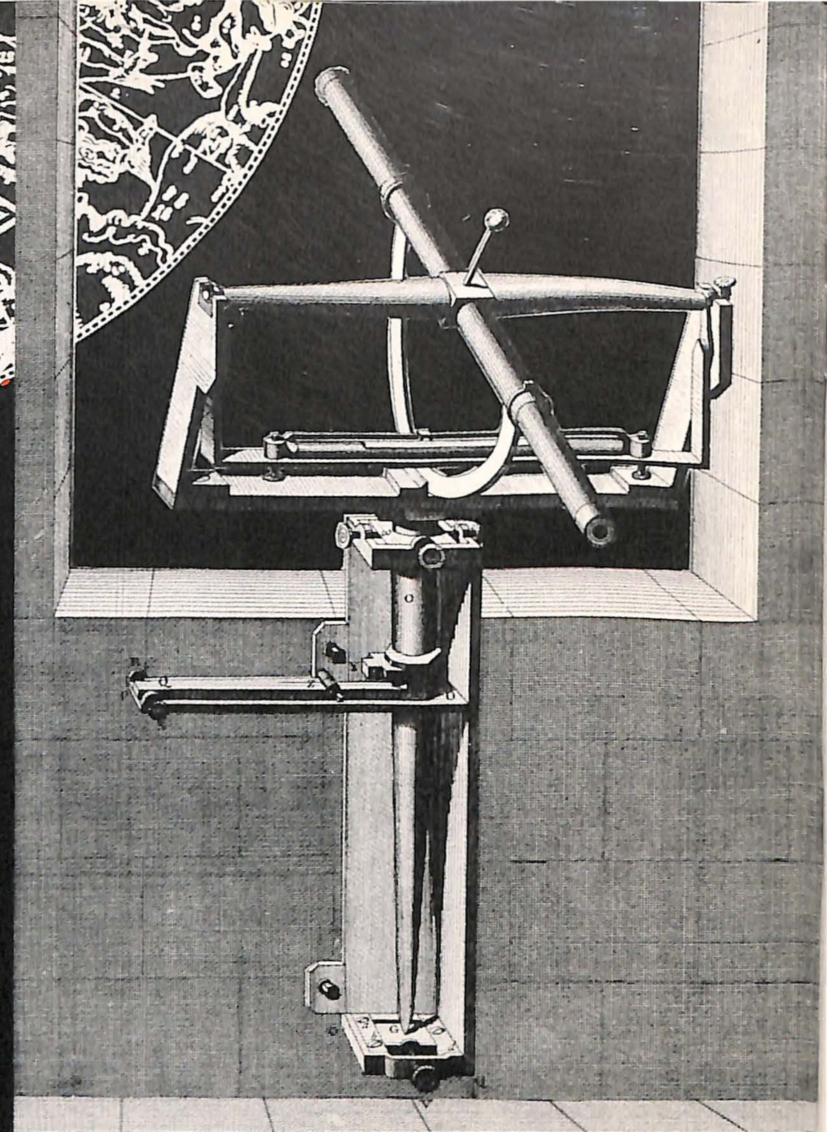
A HISTORY OF SPACE RESEARCH



The Space Age officially began on October 4, 1957, when the first man-made object ever to orbit the earth was successfully launched. It is presumptuous, however, to use this date as the start of space flight. Any great project must start with a dream, and man was dreaming of probing the space beyond his planet centuries before the word sputnik was added to our lexicon.

The name of the first dreamer is unknown. Surely, at some point in unrecorded history when man's intelligence had progressed sufficiently to contemplate the idea, a man looked at a star and realized that it was not part of his planet. The first recorded beliefs that there were other bodies in space pre-date the birth of Christ. The first science fiction story—an indication that man had already started to think about moving beyond his planet—was published about 160 A.D.

The next major steps toward achieving flight in space did not occur until the 16th and 17th centuries. With the invention of the telescope, astronomy became a science. In the 16th century, Copernicus laid the groundwork for modern space cartography with a published work called "On the Revolution of Celestial Bodies." He was

followed by Johannes Kepler, who discovered the laws of planetary motion, and by the Italian astronomer Galileo.

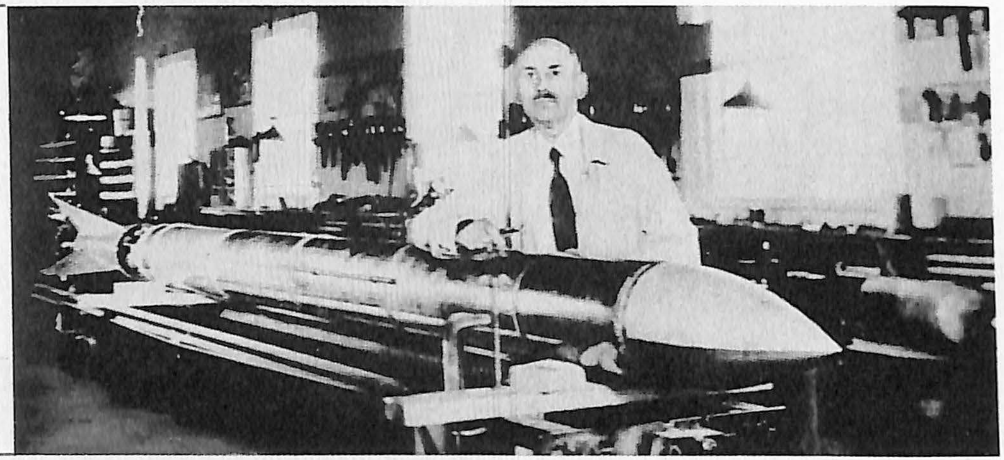
During the next two centuries there were a great many people who contributed to thought about space flight, some scientists, some dreamers. Certainly not to be overlooked were the early science fiction writers who aroused the interest of the populace, for without general interest, few dreams achieve reality. Among the more important of these, prior to the 20th century, was England's Francis Godwin, who wrote about a journey to the moon—by bird propulsion—as early as 1638. Then there were the great Jules Verne and H. G. Wells, whose works are still read today. In 1865, a little known Frenchman named Achille Eyraud wrote about a trip to Venus in which he employed the reaction principle of propulsion.

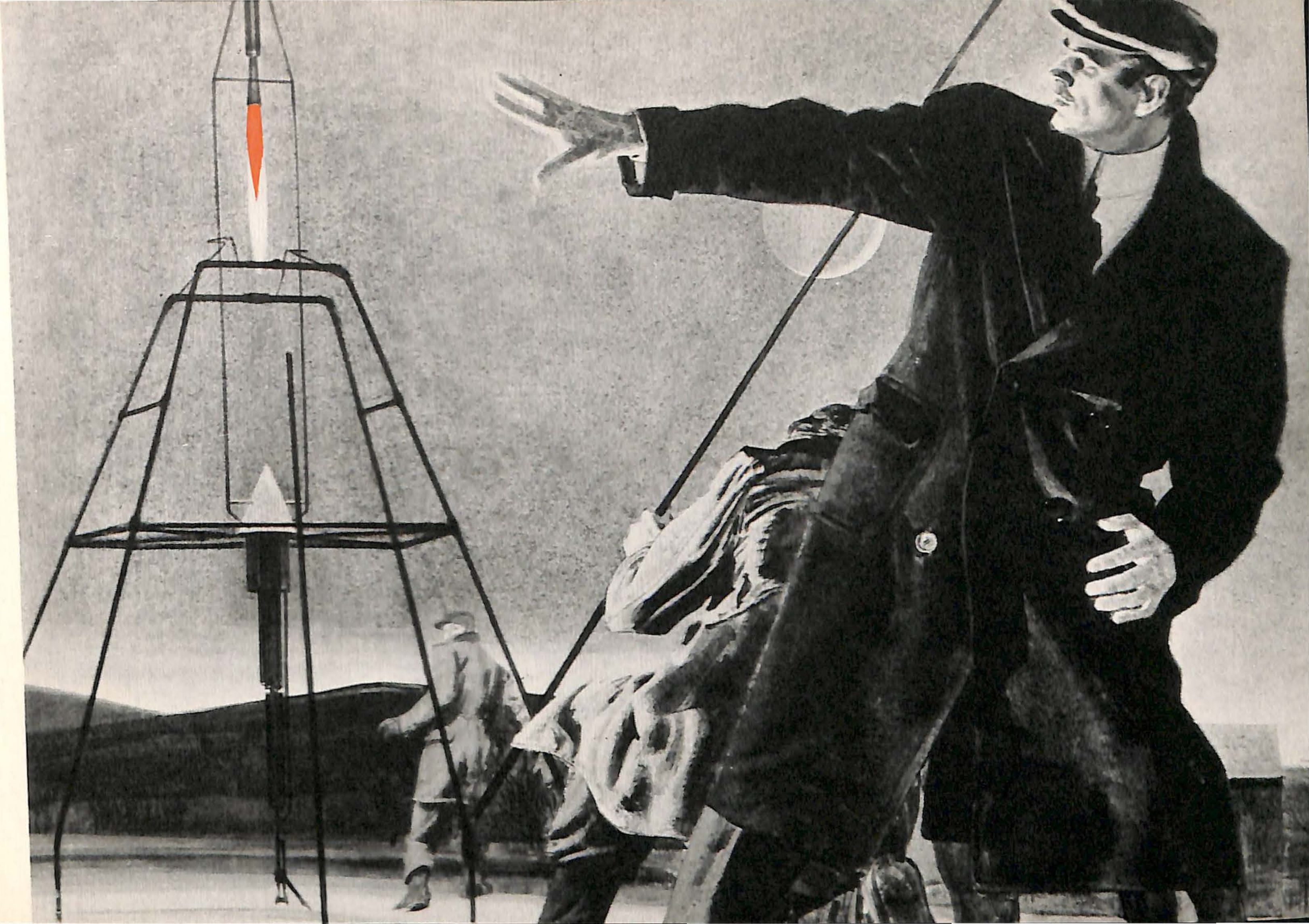
At the start of the 20th century, the dream of space travel took on more concrete aspects. The first real scientific thinking is credited to the Russian, Konstantin Ziolkovsky, who did considerable theoretical work on space flight and rocket propulsion in the early years of the century.

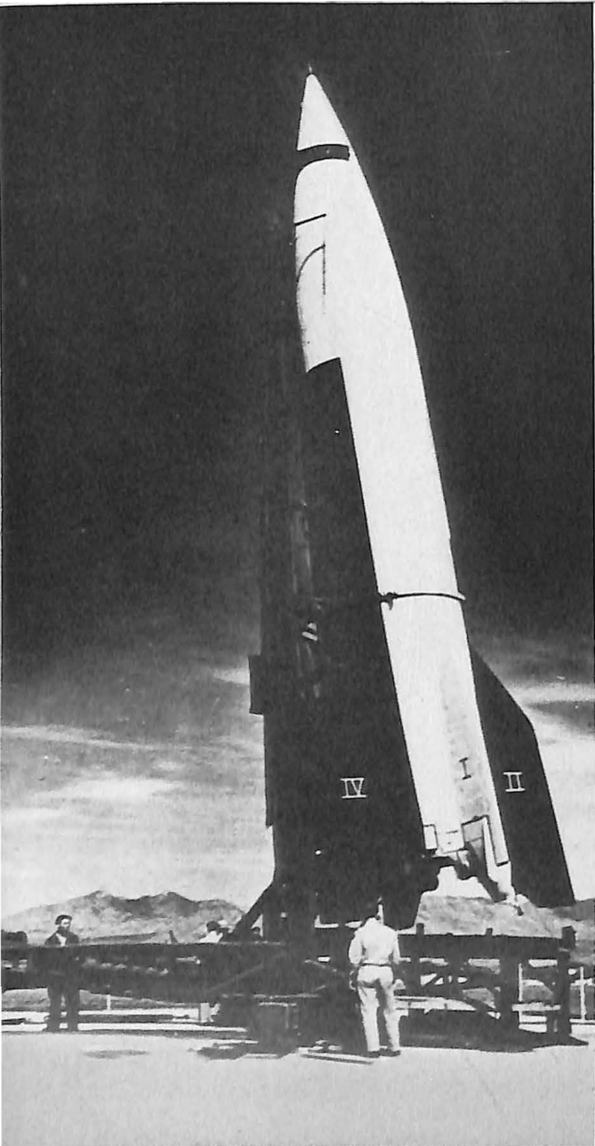
Generally acknowledged as the father of space flight, however, is Dr. Robert H. Goddard, an American. Starting before World War I, Dr. Goddard translated the dream and the theory into hardware. He built a number of rocket motors and ground tested a liquid fuel rocket as early as 1923. On March 16, 1926, Dr. Goddard successfully fired a liquid rocket. This date might be accepted as the start of space hardware.

Dr. Goddard continued his rocket work until his death, but he was unable to arouse enthusiasm in the United States. In Europe, however, rocket power got new impetus. The German Army, aware of the military potential of the rocket, started a research program which culminated in the famed Peenemunde project and the V-2 missile.

The Russians were also aware of the potential. According to the well known space



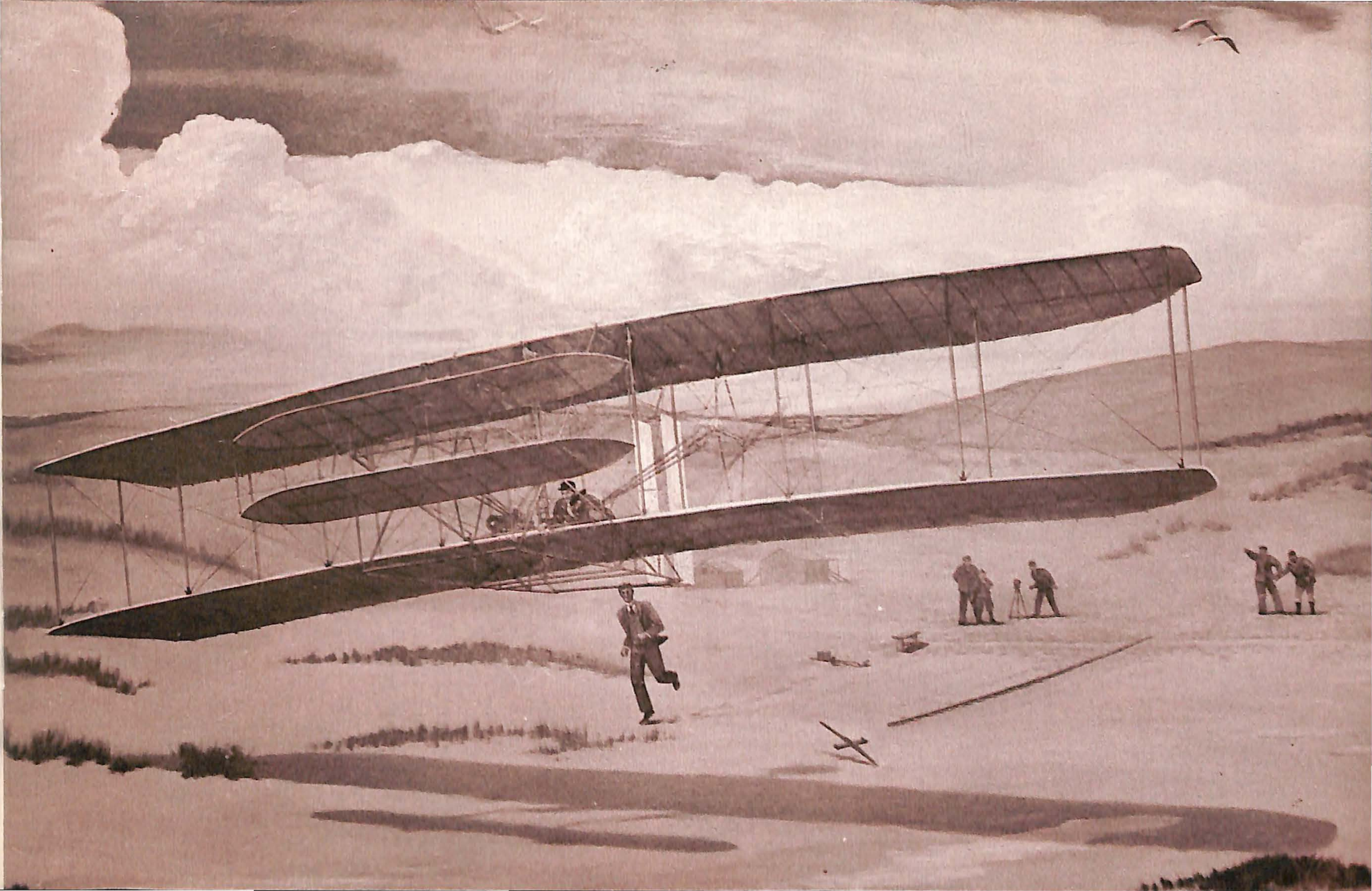




historian Willy Ley, the Russians fired a liquid fuel rocket to 12 miles altitude in 1936. The Germans had attained 6,500 feet in the same year, and in 1935 Dr. Goddard had sent one of his rockets to 7,500 feet.

The Russians apparently did not pursue rocket research with any great fervor after 1936 until the post-World War II years. Dr. Goddard, unable to raise money, was not able to fulfill his dreams of larger rockets. The Germans, however, continued to work diligently in the field. During the war years, great rocket progress was made at the German experimental station of Peenemunde, under the direction of Dr. Wernher von Braun and Dr. (then Major General) Walter Dornberger, both now eminent American citizens. The V-2 developed at Peenemunde is the modern forerunner of our current space boosters.

Post-war progress in rockets, missiles and space flight is too well-known to be recounted here. One final note must be included in any history of space flight: the research of Orville and Wilbur Wright on airplanes merits mention. Although the Wrights were not thinking in terms of either missiles or space flight, their memorable first flight at Kitty Hawk started a continuing program of research and development in aerodynamics and propulsion which later contributed to missile progress, hence to space progress. More important, perhaps, the success of the airplane in the first half of the 20th century accustomed man to thinking in terms of moving above the earth and prepared the citizenry for the public support that space flight needed to make it a reality.



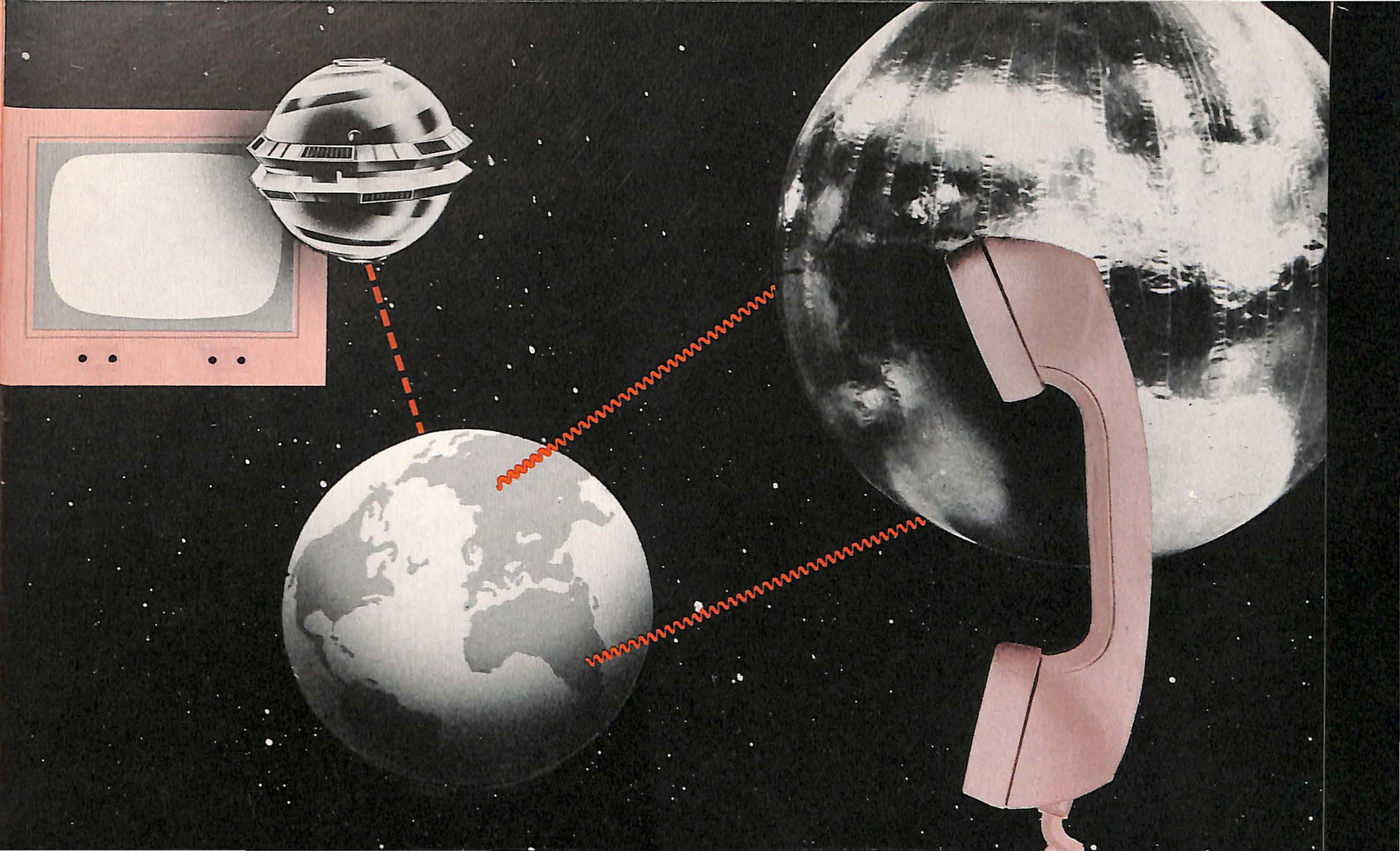
THE REASONS FOR EXPLORING SPACE

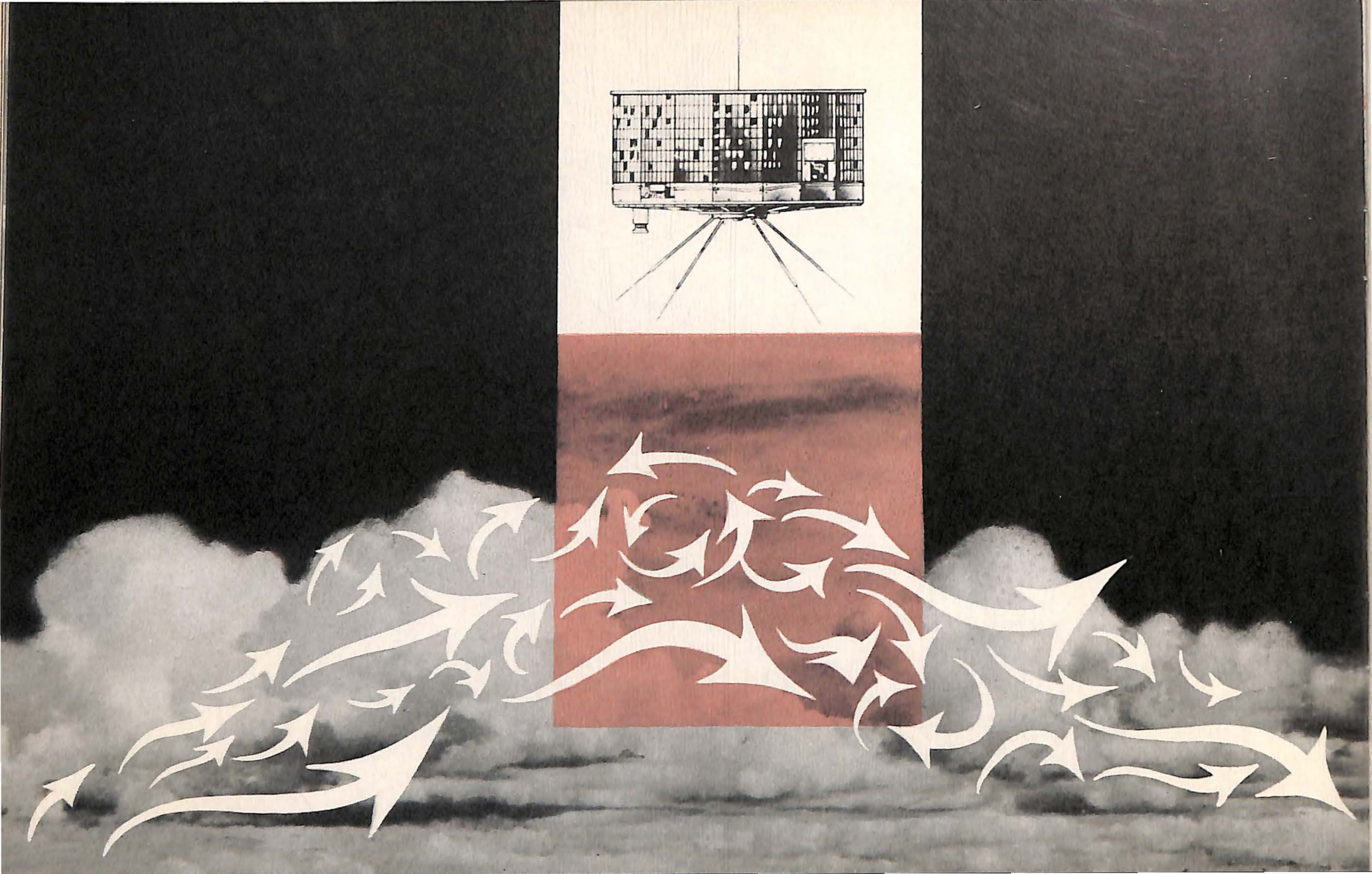
In general, the public is enthusiastic about the possibilities of space exploration, but occasionally scientists are asked, "Why do we want to explore space? What return will such research bring? Are we spending vast amounts of money to satisfy man's natural curiosity about the void beyond his atmosphere, or are there concrete benefits which will accrue?"

The main goal of space research is knowledge. Continued probing of the universe will bring a great accumulation of knowledge as the mysteries of space are unlocked. This knowledge will in turn be translated into benefits to mankind.

In the peaceful application of space research, there are already apparent a number of areas in which tangible benefits can be provided. For instance, there is the field of transoceanic communications, vital to commerce, a good portion of which is handled by cable. Overseas cable messages have increased many fold in the past few years, and they are continuing to increase. The cables now available will soon be saturated and even projected expansion of the cable system may not be adequate to handle the predictable message rate.

One answer to this problem appears to be the communications satellite. The National Aeronautics and Space Administration, in cooperation with the aerospace





industry, has already launched communications satellites of two different types. One type is the "passive" system, in which radio signals are "bounced" off a satellite in orbit. The signal is transmitted to the satellite, which reflects it to another radio station across the ocean. The other type is the "active" repeater satellite. In this technique, a signal from a ground station is sent to the orbiting satellite, which has its own equipment to receive the message and re-transmit it to the distant receiving station.

Communications satellites are, of course, in their infancy, and a great deal of work remains before they can become practical instruments. Their commercial potential, however, is enormous. Not only could they solve the cable problem, but they also offer less expensive and more rapid overseas message transmission. In addition, they offer the possibility of long-awaited international television.

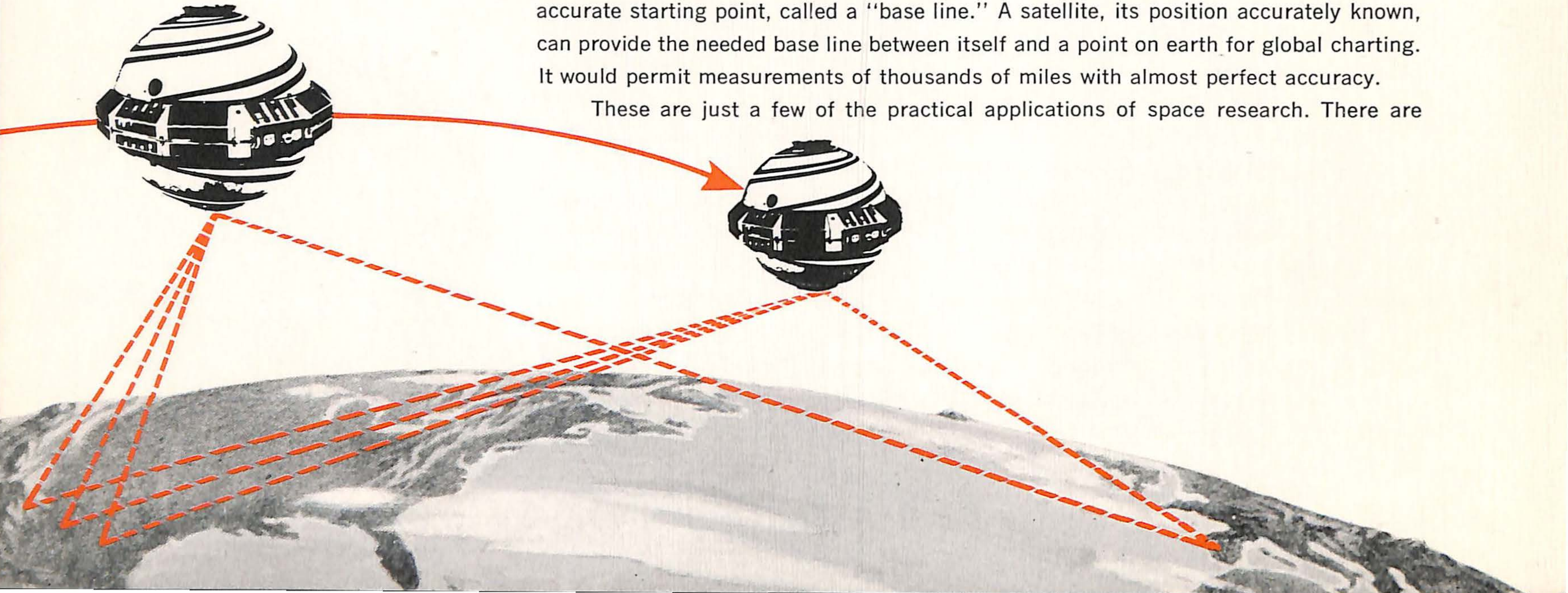
Accurate weather prediction is another area wherein space research can play a part. The major difficulty in predicting weather has been lack of data on cloud distribution. Only about 20 per cent of the earth's surface is regularly observed. Equipped with television, radar and other instruments, a weather satellite can provide a detailed picture of global weather. This space weather station can give forecasters on earth the complete information they need to provide accurate weather predictions. It is certainly within the realm of possibility that, once man has mastered accurate forecasting, he may be able to do something about changing the weather.

Prototypes of weather satellites have already been hurled into space, and more advanced types are under development.

There is also the navigation satellite. Placed in a precise orbit and equipped with a radio transmitter, it could provide position reports of high accuracy for ships and aircraft. It would, in effect, be an artificial transmitting star whose position is always precisely known, permitting ships and aircraft to fix their own position in relation to that of the satellite. Some experts feel that a device of this type may supplant most existing navigation aids.

World mapping is still another area where space research can provide benefits. Even today, large portions of the earth cannot be precisely charted for lack of an accurate starting point, called a "base line." A satellite, its position accurately known, can provide the needed base line between itself and a point on earth for global charting. It would permit measurements of thousands of miles with almost perfect accuracy.

These are just a few of the practical applications of space research. There are



many more. In addition, there are the intangible benefits: more knowledge about space. A scrap of new information about the universe may have no immediate practical application, but as thousands upon thousands of such scraps are accumulated, a complete encyclopedia of space lore will emerge. This storehouse of knowledge will open up new fields for practical application. Thus, peaceful space exploration offers a variety of near-future practical benefits and an unknown number of other applications which time and continued accumulation of knowledge will bring forth.

The products of military space research cannot really be termed benefits, for mankind benefits little from the invention of new methods of destruction. Military research in space is, however, a *must.* As long as the threat of foreign aggression exists, we must continue to develop new methods of defense, and it appears that the next step in warfare is into space. While the Nation's peaceful space exploration program will provide considerable basic knowledge toward the development of defense in space, military research programs must also be undertaken to develop the specific vehicles and techniques for space warfare. It is not yet clear what forms space warfare will take, but the need for investigating the possibilities is apparent.

There is one final why for space research. The Soviet Union has proved masterful in exploiting its space gains for propaganda purposes. To maintain its international prestige, the United States must match or better its competitor's efforts. The Soviets have taken an early lead in the international space competition, but the race will be a long one. The U. S. has the capacity to lead the world in space exploration, but this capacity must be exploited by a strong and continuing program of research.

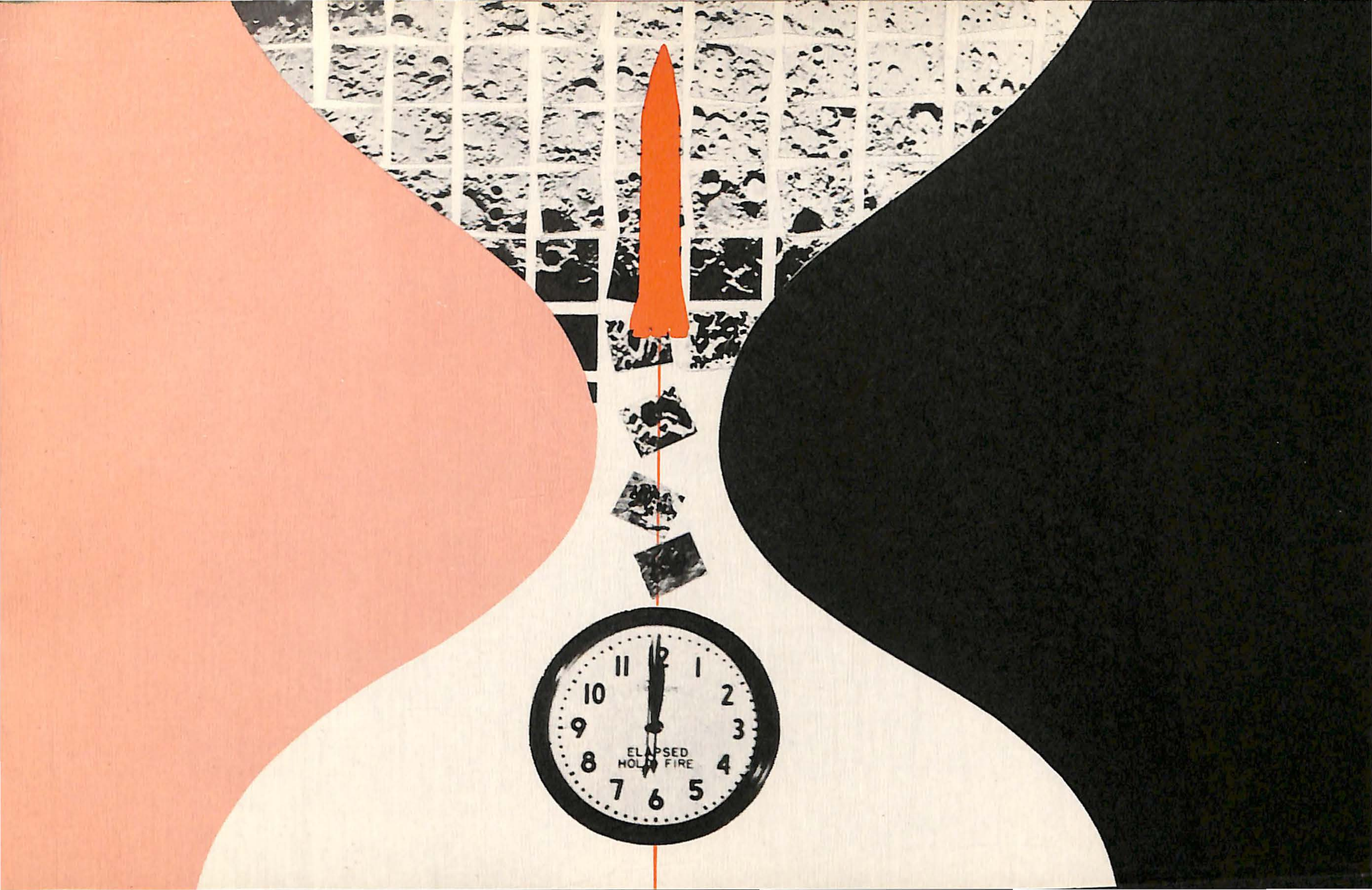
THE NEXT STEPS IN SPACE EXPLORATION

The fantastic achievements of the first years of the Space Age have whetted the appetites of the populace for the even more incredible feats of space exploration believed possible. When, asks the layman, can we visit Mars and Venus, or distant Pluto, or even voyage beyond our own solar system?

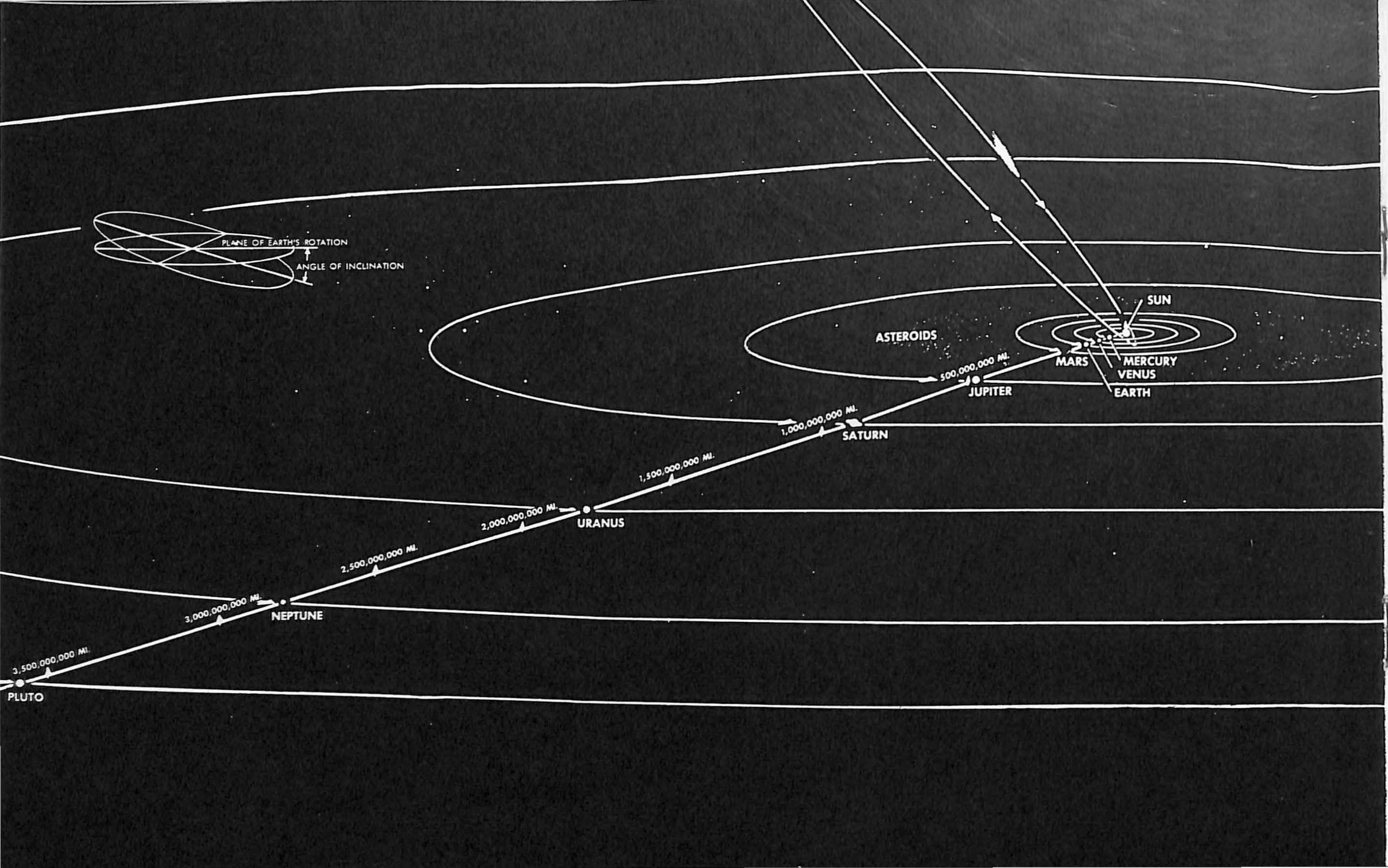
It is the brash scientist, indeed, who would attempt to set a timetable for such great events. Manned trips to even the nearest planets impose incredible demands upon science. Consider that the star nearest our sun is four and one-half light years away; in other words, it would take four and one-half years to reach it were it possible to travel at the speed of light, 186,000 miles per second!

One scientist with an aerospace manufacturing company has advanced the theory that man's exploration of the universe may be limited to the very closest stars because of what he termed the "disintegration barrier." At speeds approaching that of light—assuming they can be attained—collision with microscopic interstellar dust particles would result in disintegration of the space vehicle.

Even exploration of our own solar system involves incredible distances. The planet Pluto, the most distant satellite of our sun, is three and a half *billion* miles



ELAPSED
HOLD FIRE



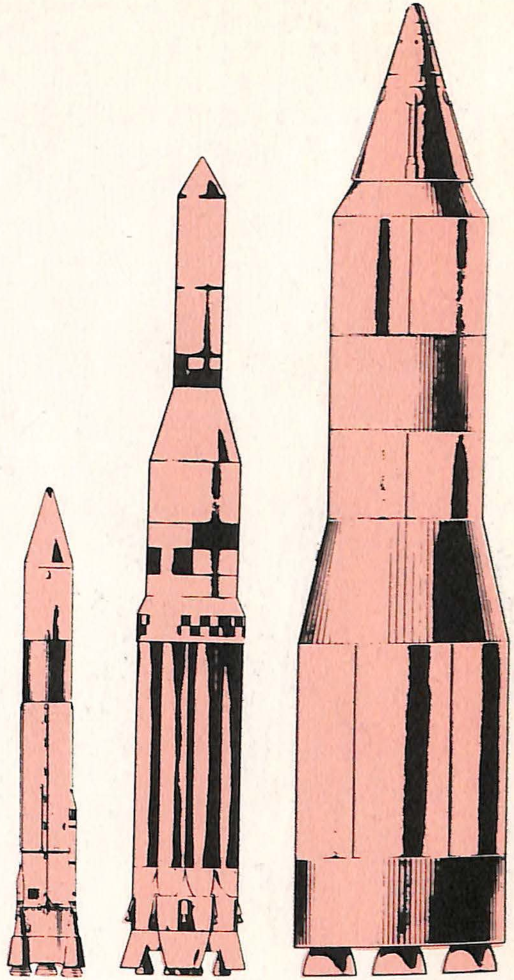
PLANE OF EARTH'S ROTATION
ANGLE OF INCLINATION
SUN
ASTEROIDS
MARS
MERCURY
VENUS
EARTH
500,000,000 MI.
JUPITER
1,000,000,000 MI.
SATURN
1,500,000,000 MI.
2,000,000,000 MI.
URANUS
2,500,000,000 MI.
3,000,000,000 MI.
NEPTUNE
3,500,000,000 MI.
PLUTO

away. And our "next door neighbor," Venus, is a scant 26,000,000 miles distant, but at the best speed yet attained by a rocket vehicle (seven miles a second) it would take three months to reach it.

Consider the technological demands for a manned vehicle capable of journeying to Venus: a propulsion system to sustain the initial speed for a long period; an air-frame far sturdier than any ever built to protect the crew from the disastrous effects of hull puncture by space matter; a guidance system of incredible accuracy; a complete, built-in earth-like environment for the crew; and a degree of reliability which will permit every component of the system to operate for long periods independently of assistance from earth.

Obviously, then, real interplanetary exploration remains for some indefinite future date. It is, however, possible to predict the next immediate steps in space exploration. The National Aeronautics and Space Administration has set forth a "Long-Range Plan" outlining what comes next.

The major requirements for fulfillment of the Long-Range Plan are more powerful rocket boosters to permit undertaking some of the more difficult space missions which cannot be made today. The early American satellites were, for the most part, boosted into space by rockets of about 150,000 pounds thrust. To send up larger payloads and send them farther from earth, more power is needed. The first step, being taken jointly by NASA and its hardware-producing partner, the aerospace industry, is development of a series of high-powered launch vehicles.



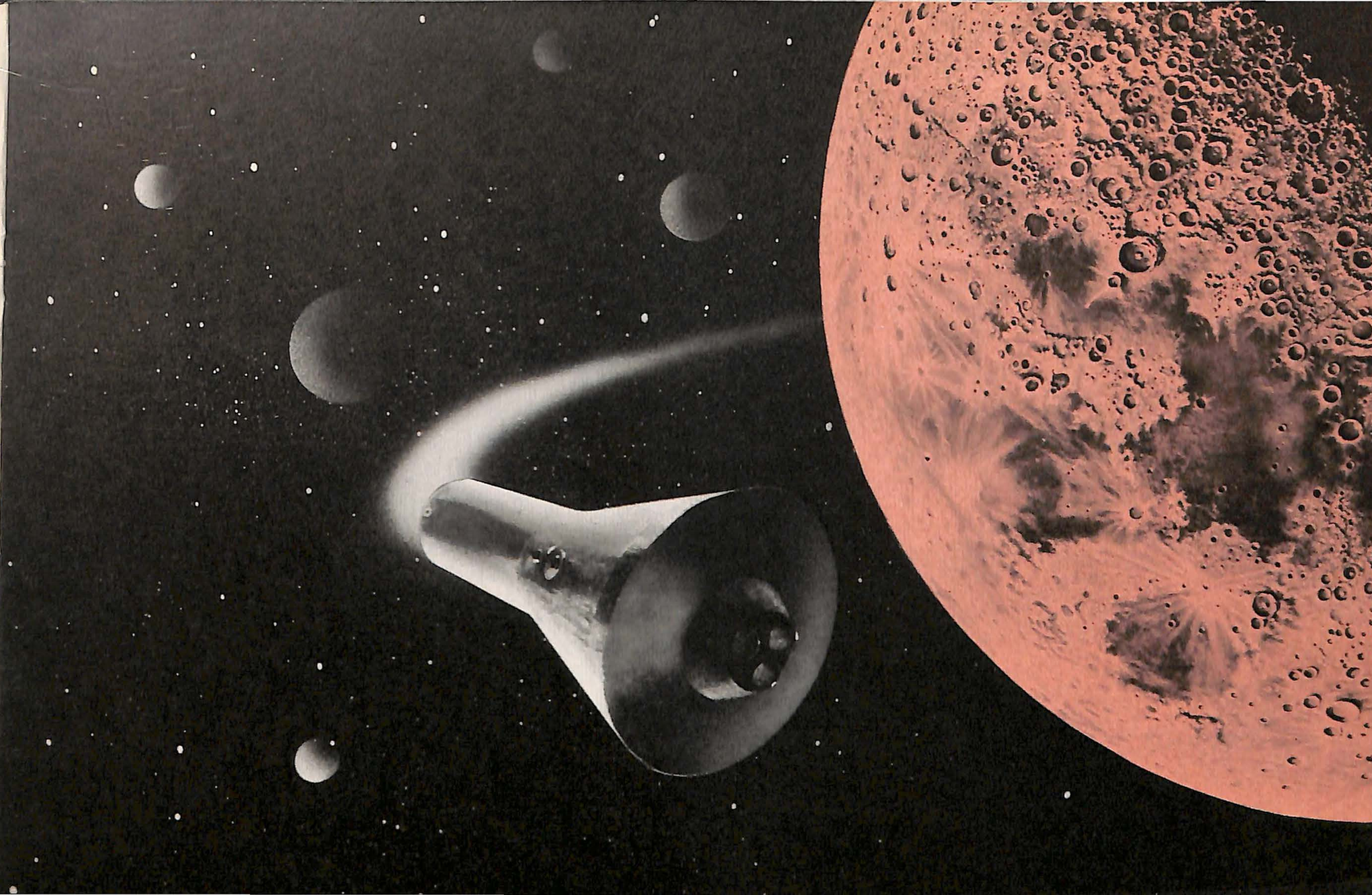
Now coming into use as space boosters are the intercontinental ballistic missiles, which have available more than double the thrust of the early rocket boosters. Even the ICBM's, however, do not have the power for the more advanced missions planned. Under development is a three-stage launch vehicle called Saturn, which will have 1,500,000 pounds of thrust. Already being static-tested, it is scheduled to be operational before the end of 1964.

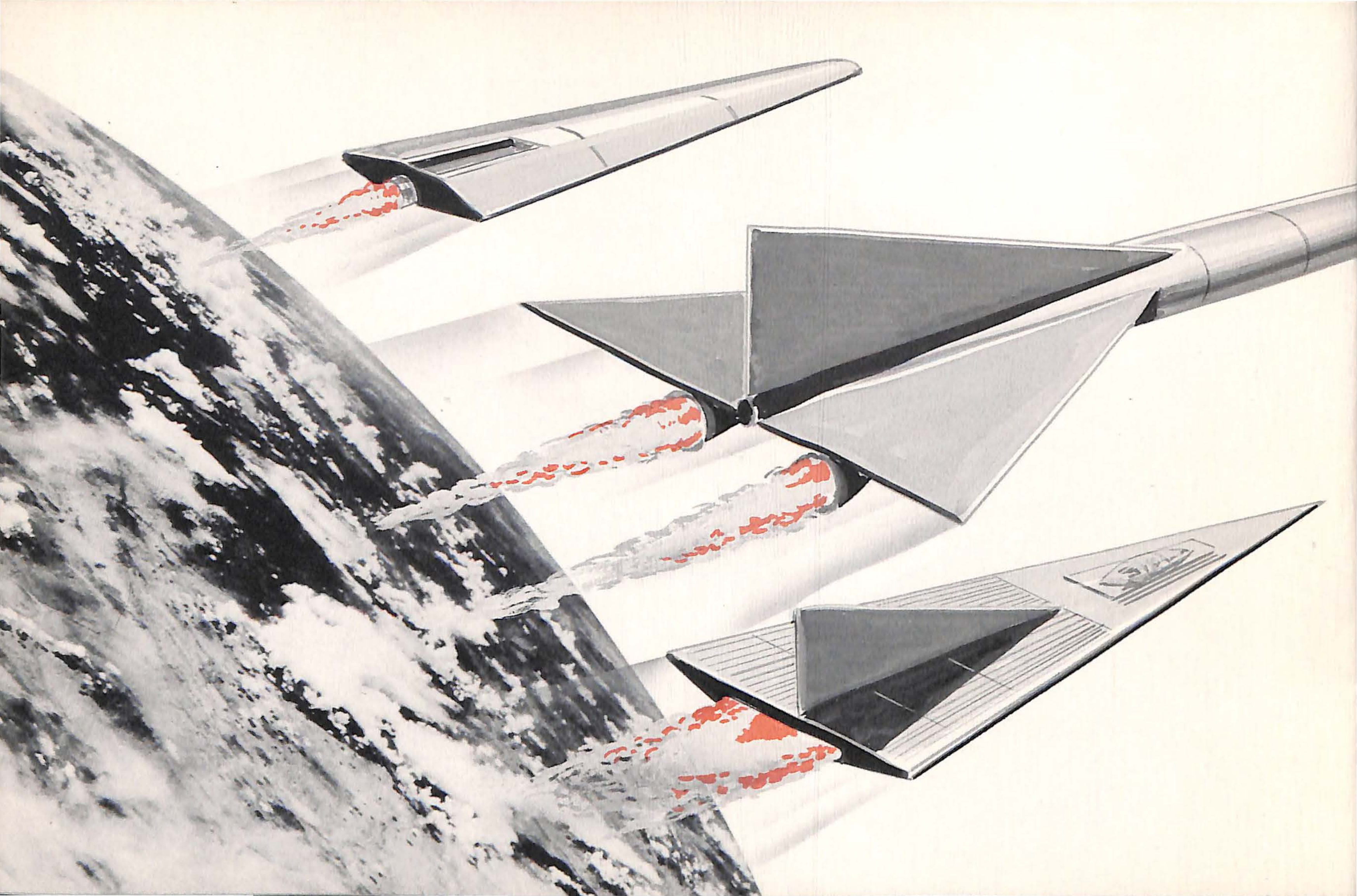
After Saturn, NASA has plans for a tremendous vehicle called Nova. The basic component of a Nova is a single-chamber, 1,500,000 pound thrust engine designated F-1, now under development. Several of these engines will be "clustered" to provide Nova's power—a total thrust of from 9,000,000 to 12,000,000 pounds. Nova is due "sometime after 1965."

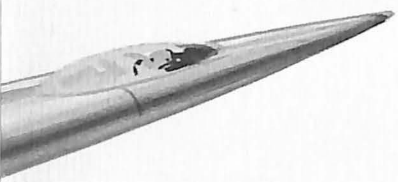
These launch vehicles comprise the keystone of the Long-Range Plan. With them, researchers will be able to conduct a number of advanced missions such as landings on the moon and unmanned probes to some of the planets within our solar system.

The immediate major step in the Long-Range Plan is to put man into space. The first step in that direction contemplates launching a man in a "suborbital" flight, one in which he does not go into orbit around the earth, but follows a ballistic trajectory like a missile. This mission will be of 15 minutes' duration, during which the astronaut will be boosted more than 100 miles into space at speeds up to 4,000 miles per hour.

Later, under NASA's Project Mercury, an astronaut will be launched into orbit around the earth. On the first such mission, the space capsule will make three orbits at a speed close to 18,000 miles per hour and an altitude of 120 miles. The mission





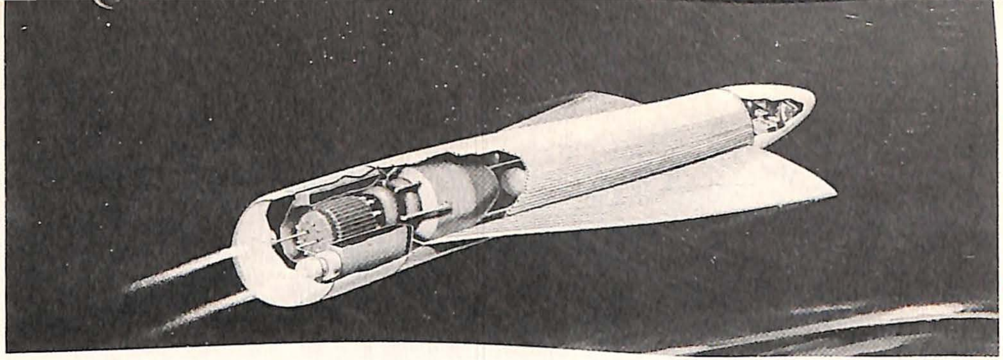


will take four and one-half hours. During 1962 and 1963, about 20 additional testing, training and orbital flights will be made with the manned Mercury capsule.

After Mercury has demonstrated man's capability for space missions, the next step is to launch vehicles capable of carrying more than one man and capable of moving farther from earth. Project Apollo, a multi-man vehicle, is a follow-on to Mercury already under way, and later programs are contemplated. Among the missions planned for multi-man vehicles is the "space laboratory" concept, in which men would orbit earth performing a number of scientific observations which cannot be conducted on the surface. The Saturn vehicle, to be available in 1964, can launch a 25,000-pound laboratory into orbit. With mighty Nova, the United States will be able to launch a 290,000-pound space laboratory occupied by several individuals. This will probably come late in the 1960's.

During the decade, it is also planned to send manned missions around the moon. Finally, some time after 1970, NASA hopes to place man on the moon.

At the same time, research will continue with a variety of unmanned vehicles, aimed primarily at lunar exploration. First attempts will be lunar orbiting satellites,



followed by the so-called "hard" landings of instrument packages which can send back basic data about the moon. After that will come "soft" landings with more fragile and more comprehensive instrumentation. One plan is to send a mobile instrument station, powered by solar batteries, to crawl about the surface of the moon sending back information to earth. Although this would be a very large payload, Nova is theoretically capable of sending 100,000 pounds to the moon.

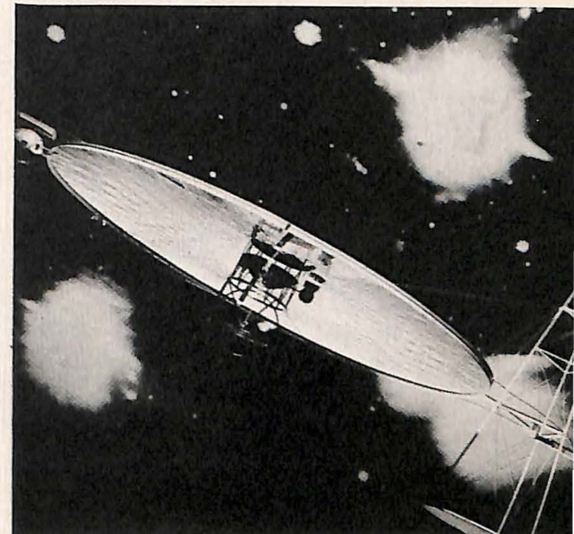
The lunar exploration program will enable NASA to perfect communications, guidance and propulsion systems preparatory to sending probes to other planets. Objectives of these planetary probes include studies of the origin and evolution of the solar system, the nature of the surfaces and atmospheres of other planets, and the most fascinating quest of all, the search for other life within the universe.

While NASA is pursuring the peaceful approach to space exploration during the coming decade, the military services will investigate manned and unmanned space weaponry. Concepts already under study include controlled orbiting hydrogen bombs, manned hypersonic bombers circling the earth every 90 minutes, maneuverable space interceptors which could destroy enemy orbiting bombs or ballistic missiles, and manned reconnaissance satellites.

The prototype of the first manned space weapons system is already in development. Expected to fly in 1964, it is a one-man hypersonic glide bomber called Dyna-Soar which will be rocket-boosted into space to coast several times around the earth on its own momentum at speeds of more than 15,000 miles an hour.

Since little is known, even theoretically, about space warfare, the military space vehicle program is not yet clearly defined. It appears probable, however, that it will progress along lines similar to NASA's vehicle development outline. After the one-man prototype should come larger, multi-man spacecraft and, much later, orbiting "space bases," military versions of the space laboratory.

As space development progresses, NASA and the military services will maintain close coordination to insure maximum gains in both military and peaceful areas of space research. Working in concert with both groups will be the aerospace industry, the manufacturers of aircraft, missiles and spacecraft and their associated equipment.



THE ROLE OF THE AEROSPACE INDUSTRY

The execution of the Long-Range Plan and its military counterpart in space research will require a major national effort. A particular requirement is close and harmonious teamwork between the various groups involved in the program.

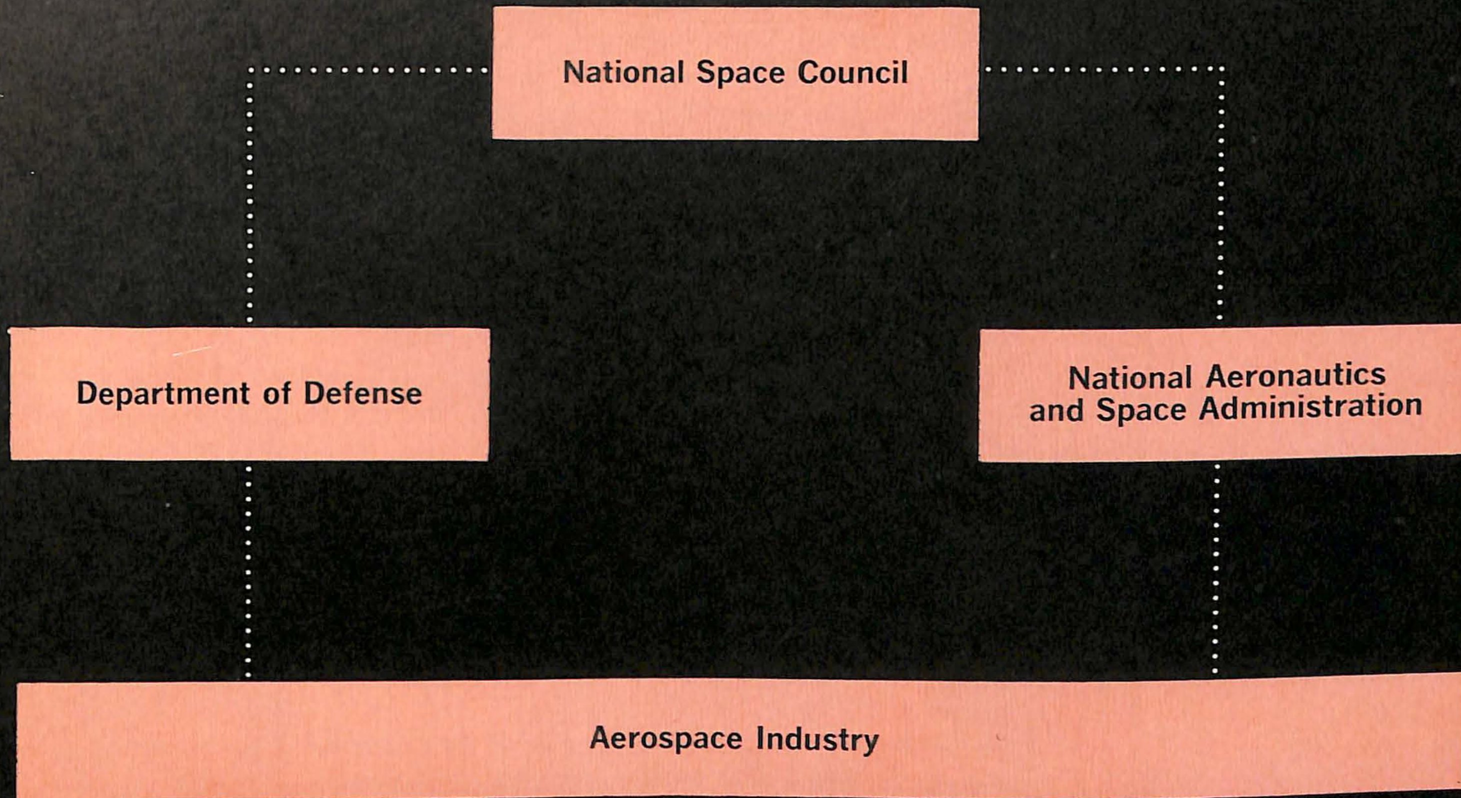
The United States' space exploration team consists of three major members.

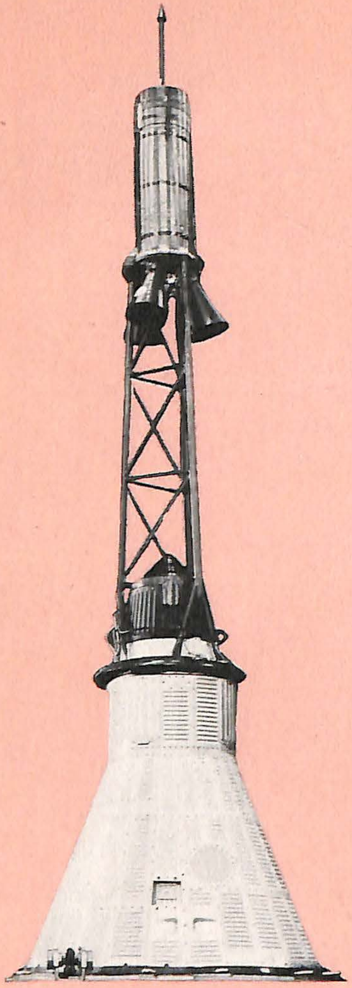
There is the National Aeronautics and Space Administration, whose job it is to plan and direct projects aimed at peaceful exploration of space and reap therefrom the scientific knowledge that will lead to betterment of the national way of life.

There is the Department of Defense, charged with investigating the military potential of space exploration.

The third member of the team, with co-equal status, is the aerospace industry, which has the responsibility for providing the "hardware" for both civil and military space programs. The most perfect organization, planning and direction of the space programs cannot produce the desired results if the equipment is not available.

It was logical that the aerospace industry should inherit the task of turning out space equipment. In more than five decades of building aircraft and missiles, the industry accumulated a tremendous storehouse of knowledge about flight within and out of the atmosphere. Such knowledge provided a base for the development and


National Space Council
Department of Defense
National Aeronautics and Space Administration
Aerospace Industry



construction of vehicles for space exploration.

Today, manufacture of equipment for both the civilian and military space programs is a rapidly growing segment of the aerospace industry's total work load. An example of industry's versatility is found in the fact that the company which has prime responsibility for Dyna-Soar, the manned space weapons system, is also manufacturing jet-powered airliners for commercial use. Dyna-Soar or any of the unmanned space projects would serve as an excellent illustration of the extent to which industry is engaged in the national space exploration program, but, because it is farthest along from the standpoint of hardware deliveries, let us consider the aerospace industry's contribution to the Mercury program.

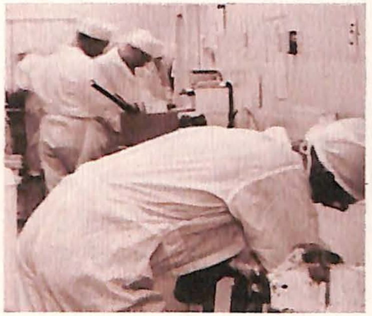
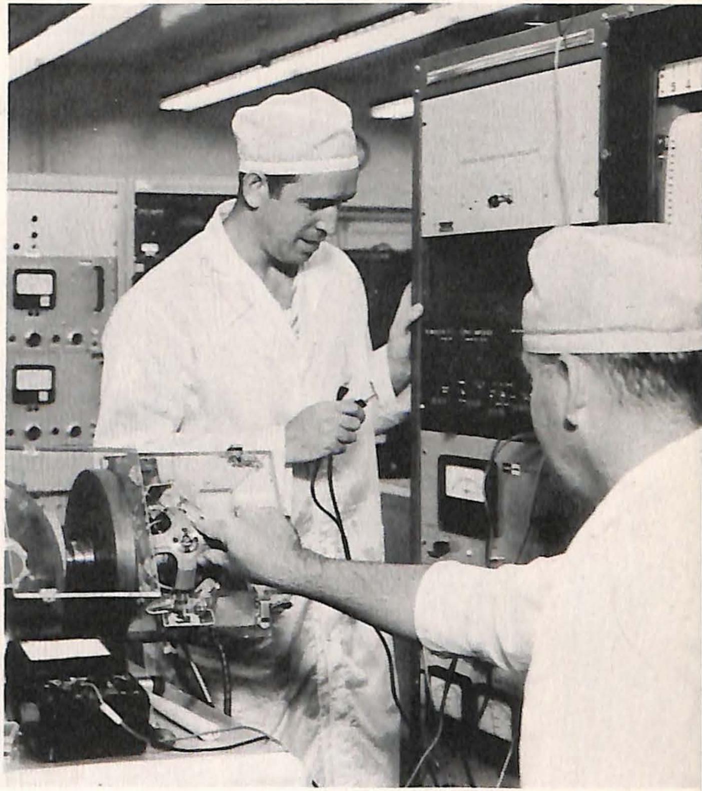
The capsule in which the first American astronaut will soar through space is manufactured by a company known for a long time as a top producer of Navy and Air Force aircraft.

The launching vehicle for Project Mercury is a modified intercontinental ballistic missile, built by one of the leading aerospace companies which has for many years been producing aircraft and missiles.

The mighty rocket power plant which provides the "push" to put the capsule in orbit is manufactured by an old-line aircraft company which has in recent years diversified its product line to include rocket power, guidance systems and other products of the Space Age.

Another company, for years engaged in the production of aircraft systems and components, is responsible for the construction and maintenance of the tracking stations



on the ground, ground-space communications, and the telemetry of data from the capsule back to earth, including the all important biomedical information as to the physical condition of the astronaut.

These are just the major elements of Mercury. Within the capsule, the launch vehicle and on the ground there are thousands of systems and sub-systems turned out by industry. The elaborate testing program for Project Mercury involved hundreds of articles—ground check-out equipment, small boosters, escape mechanisms, parachutes, training devices, etc.—provided by industry. Each major contractor in Mercury has hundreds of suppliers and subcontractors and altogether there are several thousand companies participating in the program. It is estimated that 90 per cent of all the equipment in Project Mercury is industry-supplied.

A further indication of the importance of industry's role in space research is contained in a statement by an official of the National Aeronautics and Space Administration:

"Our intention is to utilize industrial and educational and other non-profit institutions to accomplish the major part of our task. More than 75 per cent of our budget is spent with industry, while we retain 'in-house' only enough research and project activity to enable our people to work at the forefront of the field and thus to be able to manage effectively the technical efforts of our contractors."

To date, manufacture of spacecraft and their associated equipment constitutes only a minor portion of the industry's work load, but it is growing significantly. "Manufacture," as far as the aerospace industry is concerned, is a word whose meaning has changed considerably. It no longer denotes just the construction of a product, because fabrication of an aircraft, missile or a space vehicle is the lesser portion of the total job. More exacting is the expensive and time-consuming research and development of the extraordinarily complex products of modern aerospace technology and the extensive testing and re-testing required to make them completely reliable.

Reliability has always been an important factor in aerospace products, but with each leap in technology it becomes more important. Consider the degree of reliability required for a manned vehicle operating for long periods in the vacuum of space where malfunction of any part can be disastrous.

The need for such reliability in space hardware, coupled with the ever-growing emphasis on research, development and test, places severe demands on the capabilities of the aerospace industry. The industry must maintain large staffs of scientists and engineers to meet the new technological demands, increasing payroll costs. It must continually divert large portions of its meager earnings to the construction of new facilities to keep pace with technological progress. And, at the same time, it must constantly search for new methods of reducing costs to allow the nation to reap the most benefit from the funds available for space research.

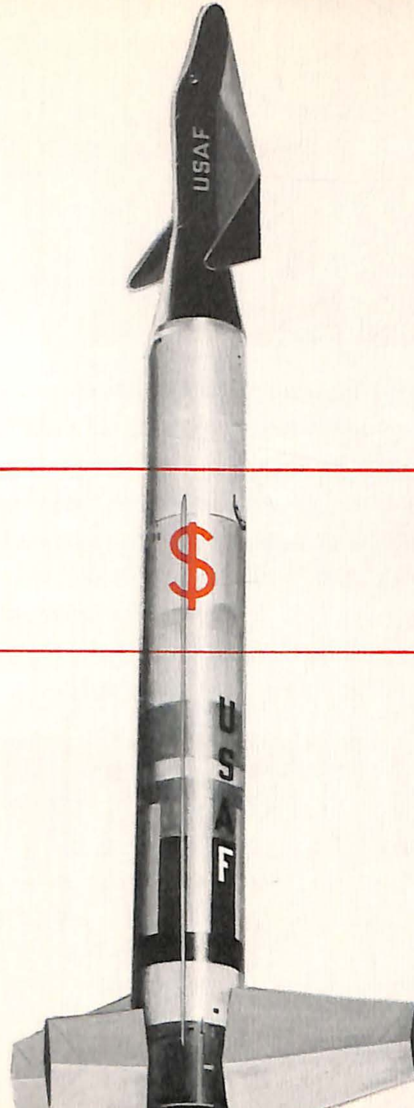
Its role as producing partner of the space exploration team presents a real challenge to the aerospace industry, but it has demonstrated in the past its ability to rise to challenge. The accomplishments of the industry in the early years of space flight indicate its capability to carry out its part in the greater national effort that is to come.

CONCLUSION

Space exploration will be expensive. Of that there is no question. The fantastic projects contemplated for the next decade, and the even more incredible programs which will follow in later years, will require the most complex equipment imaginable, and complexity is a yardstick of cost.

A NASA official estimated that his organization's Long-Range Plan will require funding on the order of $12 to $15 billion dollars. The advanced steps beyond 1970—manned lunar exploration and interplanetary flight—will quite obviously cost even more. At the same time, heavy funding will be required for the military programs. Since the scope of military activity in space is not yet definable, there can be no estimate of costs. Some indication may be found, however, in the fact that the first military prototype program—the hypersonic glide-bomber—is expected to cost about a billion dollars.

Whatever the total cost of a continuing program of military and civil space explo-



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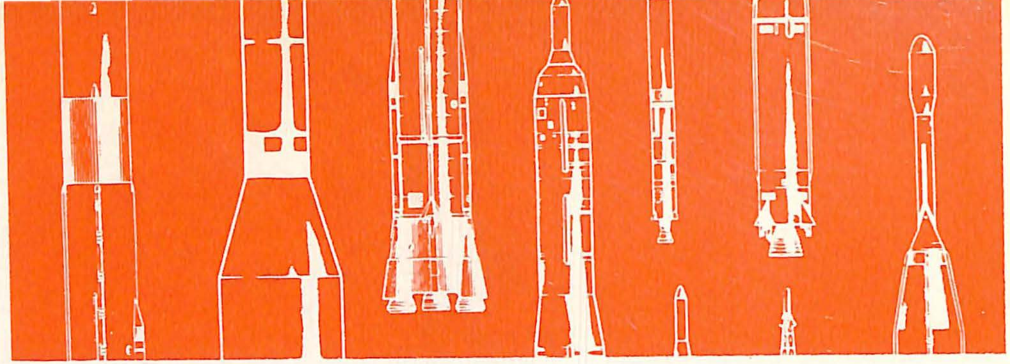
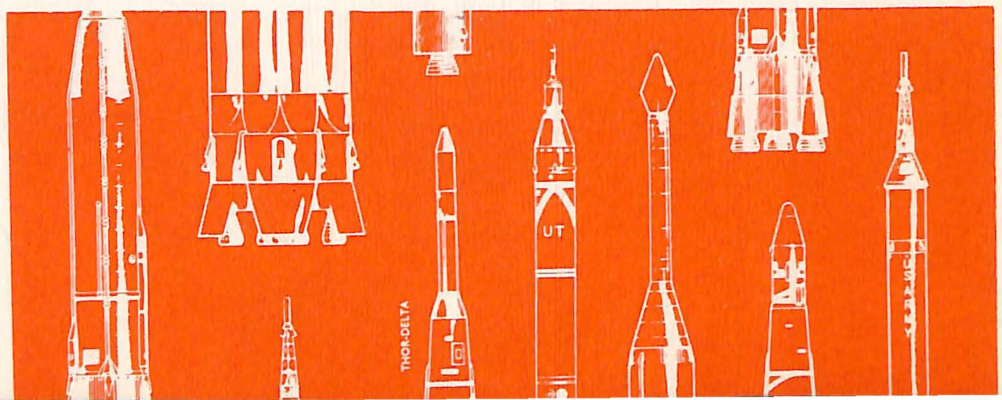
$1 BILLION



LONG-RANGE PLAN $12-15 BILLION

ration, its need cannot be questioned. The potential benefits to mankind are enormous and the requirement to meet the competition, for reasons of defense and national prestige, cannot be measured in dollars.

The members of the space exploration team—the civilian space agency, the military services and the aerospace industry—have the brainpower and the technological know-how to accomplish the current objectives and the nebulous future goals not yet defined. They need behind them an enlightened public, aware of the potential benefit and importance of space research and willing to support it. With such support, the United States need be second to none in space.



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