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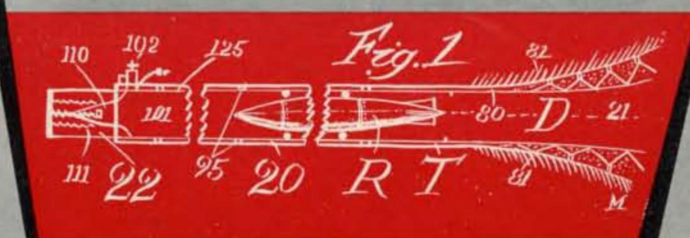

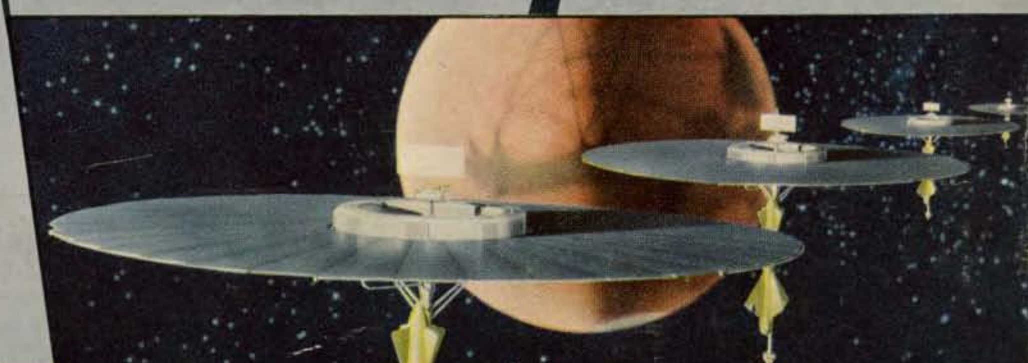

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LANGE


EXPLORERs
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covers

FRONT: Layout and design by Harry Lange. Sketch is space ship mooring patented by Dr. Robert H. Goddard. Photo of Dr. Ernst Stuhlinger's ion space ships orbiting around Mars is from Walt Disney's "Mars and Beyond."

BACK: Oil painting by Lee Moore illustrates die marker dissipation upon impact of first rocket to reach Moon.

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projecting with space journal

By B. Spencer Isbell
editor

SPUTNIKS and now our own Explorer have changed a lot of things by opening the eyes of the public to the fact that space travel has become a reality. As you might guess, the impact of satellite launchings upon this fledgling publication has been very favorable. One news commentator stated, "It (Sputnik) has shot tremendous thrust into what started out as America's first, faltering space magazine called SPACE Journal—dedicated to publicizing factual discussions of interplanetary travel."

The second edition of SPACE Journal was prepared prior to the birth of Explorer; and, therefore, it was impossible to exploit the vast amount of new information for inclosure in this edition. There is little doubt that Explorer will have its effect on expanding the horizon for SPACE Journal.

Volume 1, No. 1 brought many "letters to the editor"; a few are published in this edition's Reaction Department. Among other things, some letters requested predictions of what the future will bring in the realm of space travel, explanations of relativistic aging, and reports on what progress has been made toward developing an "electro-gravitic" propulsion system for space ships.

Forthcoming issues will include articles which will attempt to satisfy these requests. The next issue will include an article on what we have already learned from Explorer.

With due respect for our more imaginative readers, we were more impressed—and should add, quite concerned—by the volume of mail received from our younger fans. Almost invariably they wanted detailed information that would help them to build their own rockets (usually proposed as a basement project). These young people appear resourceful, imaginative, and capable of some startling accomplishments. They will be our next generation of scientists and engineers.

While their quest for knowledge and experience is certainly laudable, the danger to life and property inherent in amateur rocket building and firing often creates a highly undesirable situation. This danger is recognized by the professional engineer and scientist, as well as the organizations actively engaged in rocket and missile work. Dr. Edward H. Seymour, Director of Research at Reaction Motors, Inc., has prepared a special letter to young scientists. We feel that it may help an ever-increasing number of youngsters who are interested in undertaking experiments of this type.

TO THE AMATEUR ROCKET BUILDER

We were happy to receive your recent letter, and to learn of your plans for an experimental rocket. The rocket engine is an intriguing device, and working on its development can be an interesting and satisfying project. As rocket engine manufacturers, we are always encouraged to see young people become enthusiastic about this area of activity, for it is young men like you who will be the engineers and scientists of tomorrow and helping to maintain progress in this vital field.

Although the approach to an experimental unit such as you outlined appears reasonable, we have found that it is not possible for us to determine the feasibility, or even more important, the safety of such a unit without more information. All experimental work must be reviewed carefully to determine how each piece is to be built, and what type of operating procedure is to be used. We use the same approach in our work. Each new design is carefully checked, and tests are run with carefully planned and supervised procedures.

Almost all rocket engine testing, especially new designs, is done behind explosion-proof, reinforced concrete barricades, where all operating personnel are safely separated from the unit under test. To the amateur, without extensive training and costly equipment, this sort of research is extremely hazardous. For your own safety, as well as the safety of others, we cannot emphasize too strongly the dangers inherent in this type of work. Oxygen and propane, for instance, contain more energy per pound than does TNT. If it happens to be released explosively instead of in normal burning, considerable damage and injury can occur.

I am sorry we cannot give you a more direct answer to your question, but experience has shown us that it is not possible to do this without being right on the spot every day, and the importance of avoiding injury and damage is so great that we feel that this must be our policy.

I would urge that you discuss your planned work with your high school science teacher, and investigate the possibility of forming an amateur rocket club. It is far better to share with others the joys and hardships, the successes and failures, (and incidentally, the expenses) of work on such an exciting project. There are a number of such groups throughout the country, many of them affiliated with the American Astronautical Federation, a national organization dedicated to the collection and dissemination of information and the promotion of space flight, or with the American Rocket Society. Whether you form such a group or not, any future work you do should be under the guidance of a responsible adult such as your science teacher.

Should you decide to follow the interest you have already shown in this field, and we certainly hope you do, you will be coming into an exciting profession at the most dramatic time. Throughout the course of history, man has always been intrigued by exploration of this blanket of air that surrounds us. Many of his attempts to pierce it, including some of those currently in progress, have been plagued with failure. Nonetheless, he has persisted with a will to succeed that has put within our grasp the means to accomplish his most fascinating dream—flight into outer space.

Dr. Edward H. Seymour
Director of Research
Reaction Motors, Inc.

stride into space

Reprinted From The New York Times

ALREADY NOW it is clear that October 4, 1957 will go down imperishably in the annals of humanity as the date on which one of man's finest achievements was accomplished. That which was so recently a subject only for theoretical speculation or science fiction has now become reality: a man-made space satellite now revolves, for a time, around our globe. With that feat humanity has taken a giant stride toward space. The dream of the greatest minds among many past generations is now well on the way toward becoming reality. The sphere which now revolves in the heavens above us is the guarantee that man can soon break completely the fetters of gravity which have hitherto bound life to this tiny planet. The long road to the stars is now open.

It was the Soviet scientists and technicians who built and launched this concrete symbol of man's coming liberation from the forces which have hitherto bound him to earth. To them must go the congratulations of all humanity. This is a feat of which all mankind can be proud. The Soviet citizens who accomplished it set the peak on a huge tower which had been raised by men of many nations in the decades and centuries earlier. Newton and Kepler, Galileo and Copernicus, Tsiolkovsky, Goddard and Oberth, all these and many others made their contributions to building the edifice of knowledge which made possible this superlative achievement.

Every great achievement of modern technology opens up two roads before humanity. One is the road of hope and promise, a road made possible if men of all nations and all beliefs will work together for the good of humanity. The other is the road of despair and disaster, the road which is followed if the great achievements of universal science are used for the purposes of aggression, death and destruction.

So it is with the space satellite. The rocket motors which sent it into the upper atmosphere can be harnessed for a great cooperative human assault on the barriers of distance which still separate us from even our nearest neighbors in space. Or they can be incorporated into intercontinental ballistic missiles delivering hydrogen bombs upon defenseless millions. It is for all mankind to decide which of these two roads shall be taken. And the fantastically rapid tempo of modern scientific and technical advance permits no dawdling over reaching the decision.

father of rocketry

By Ralph E. Jennings

(EDITOR'S NOTE: The author is indebted to Esther C. Goddard for making available to him pictures and information which have never before been published. In a letter to Mr. Jennings, Mrs. Goddard stated: 'I am delighted that you plan to dedicate the second issue to my late husband and his work on rockets." SPACE Journal takes pride in presenting to its readers some hitherto unpublished material concerning the life and work of a great American scientist.)

THE FIRST FLIGHT of a liquid oxygen-gasoline rocket was obtained on March 5, 1926, in Auburn, Mass., and was reported to the Smithsonian Institution May 5, 1926. . . . The rocket traveled a distance of 184 feet in 2.5 seconds, as timed by stop watch, making the speed along the trajectory about 60 miles per hour." Thus wrote Robert Hutchings Goddard in his second Smithsonian report, "Liquid-Propellant Rocket Development." What seemed to be an insignificant event actually marked the birth of a new era. For when Robert Goddard's rocket traveled 184 feet, the distance was a step forward in seven-league boots by Man in his long struggle up from darkness toward mastery of his environment.

In the words of Harry F. Guggenheim, president of the Guggenheim Foundation, Dr. Goddard "was just as surely the father of modern rockets as the Wright Brothers were of the airplane." He was certainly the greatest experimental pioneer in this subject—not a mere dabbling inventor, but one who understood the principles involved and was capable also of developing the necessary theories, as was to be expected from a man with his successful academic career.

Born on October 5, 1882, in Worcester, Mass., young Goddard attended school in Boston and then entered Worcester Polytechnic Institute, obtaining a B.S. degree in 1908. He was a physics instructor at Worcester until 1911, during which period he acquired his M.A. and Ph.D. After two years as a research fellow at Princeton University, he went to Clark University where he was successively an instructor, assistant professor, and professor of physics.

While at Clark, Dr. Goddard set down some recollections which began: "Owing to the widespread interest which is certain to arise later regarding space navigation, or

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Dr. Robert H. Goddard making adjustments at the upper end of the rocket combustion chamber. Around the chamber are small coils of copper tubing for vaporizing liquid nitrogen in order to produce pressure for the fuel tanks and for operating controls. Pumps were used for the liquid fuels. Photographed in 1940.

Dr. Goddard stands beside the launching frame before the world's first flight of a liquid-propellant rocket on March 16, 1926.

interplanetary studies, it seems worthwhile to note the development of the writer's ideas and experiments upon the subject. . . ."

Dr. Goddard never published these notes. What he published principally were his patents and two reports to the Smithsonian Institution, the product of years of independent and methodical experimentation. What he did not publish were his speculations on space flight—because he thought more of them, not less of them. At one point, he filed these speculations away in a friend's safe and marked them: "To be opened only by an optimist."

They are now being opened, in the course of preparing Dr. Goddard's biography. Mrs. Goddard is engaged in editing his experimental notes for publication. Scientists and laymen alike will be interested in Dr. Goddard's resume of some of these speculations which he set down between 1904 and 1908 while he was an undergraduate at Worcester. "I bought a number of green-covered notebooks," he wrote, "and started to make a systematic record of suggestions. . . . The suggestions were very diversified, and concerned the possibility of using the magnetic field of the earth; shooting material to a 'space ship' by means of electric, and other, guns; an airplane operated at high speed by the repulsion of charged particles; artificially stimulated radio-activity; artificial atoms of great energy, consisting of moving positive and negative charges; propulsion in space by repulsion of charged particles; reaction against displacement currents in space; re-

The launching tower and observation shelter at the Ward Farm, Auburn, Mass. Photograph taken on July 17, 1929.

pulsion of highly heated material particles at the focus of parabolic mirrors; the use of solar energy, by light devices, on a 'space ship;' the idea of the multiple charge rocket; the use of liquid propellants; and several other plans." A summary of 26 methods was written on December 28, 1909.

Like other men of vision who have made valuable contributions to fundamental and his important work were little known during his lifetime. In the course of his pioneering investigations, Dr. Goddard achieved many "firsts" in rocket research, any one of which would be sufficient to assure him a permanent place in the history of modern science and engineering.

Dr. Goddard in his laboratory at Clark University with the rocket tested on May 4, 1926. This rocket is the second model of a liquid-propellant rocket first flown on March 16, 1926.

Among the principal ones are the following:

1. He developed the basic idea of the bazooka in 1918 during World War I. The weapon was not used until World War II.

2. He developed a rocket motor using liquid fuels and used it in a liquid-fuel propelled rocket in 1926.

3. He was the first to shoot a rocket faster than the speed of sound.

4. He developed a gyroscopic steering apparatus for rockets ten years before it was developed in Europe.

5. He was the first to use vanes in the blast of the rocket motor for steering rockets.

6. He patented the idea of "step-rockets."

7. He developed the mathematical theory of rocket propulsion and flight.

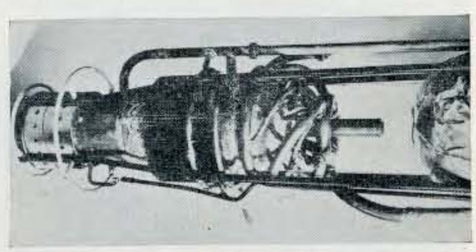
8. He first proved, both mathematically and by actual test, that a rocket will work in a vacuum.

When the United States entered the first World War, Dr. Goddard volunteered his services and was given the task of exploring the military possibilities of rockets. He succeeded in developing a trajectory rocket which fired intermittently, the charges being injected into the combustion chamber by a method similar to that of the repeating rifle. He also developed several types of projectile rockets intended to be fired from a launching tube held in the hands and steadied by two short legs—much like the bazooka of World War II.

These weapons were demonstrated quite successfully at Aberdeen Proving Grounds on November 10, 1918, before representatives of the armed services. However, the armistice on the following day put an end to the war and also to immediate interest in these weapons.

Many a great man owes much of his success to the loyalty, devotion, and encouragement of a woman who is vitally interested in his career. These qualities were brought into Dr. Goddard's life by Esther Kisk whom he married in 1924. She took an active interest in his experiments and served as the official photographer of his tests.

Dr. Goddard's research and experiments during the next two decades were summarized in two papers, "A Method of Reaching Extreme Altitudes" and "Liquid-Propellant Rocket Development." These two famous reports did much to establish on a world-

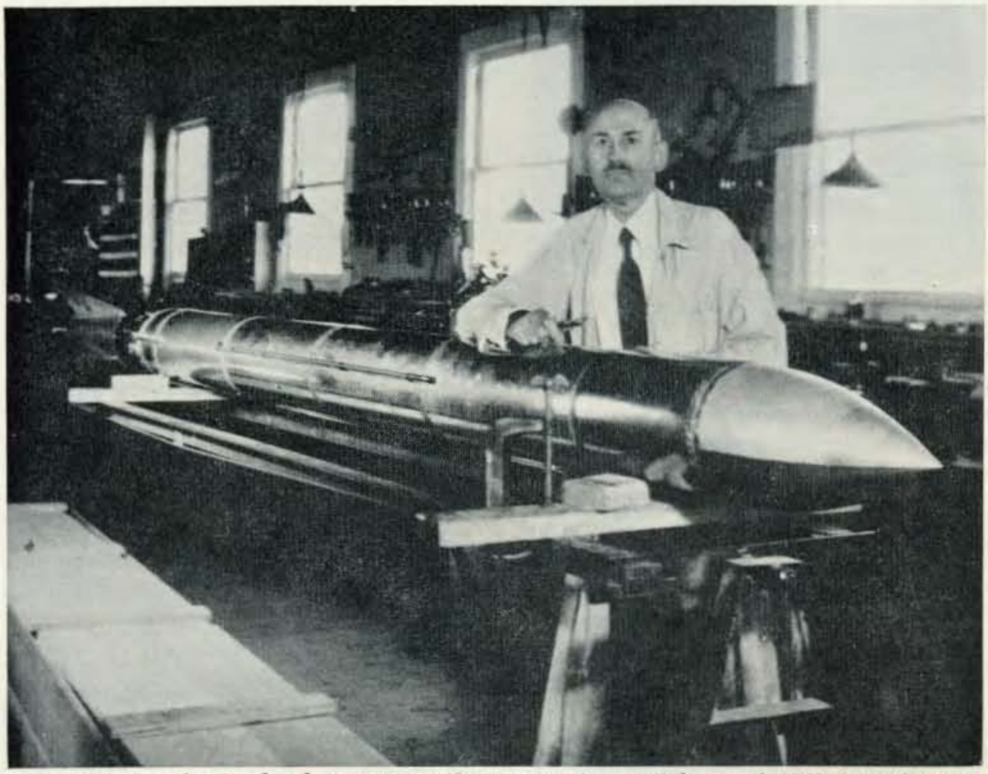


A rocket tested on July 20, 1927. Note the similarity of arrangement to the V-2.

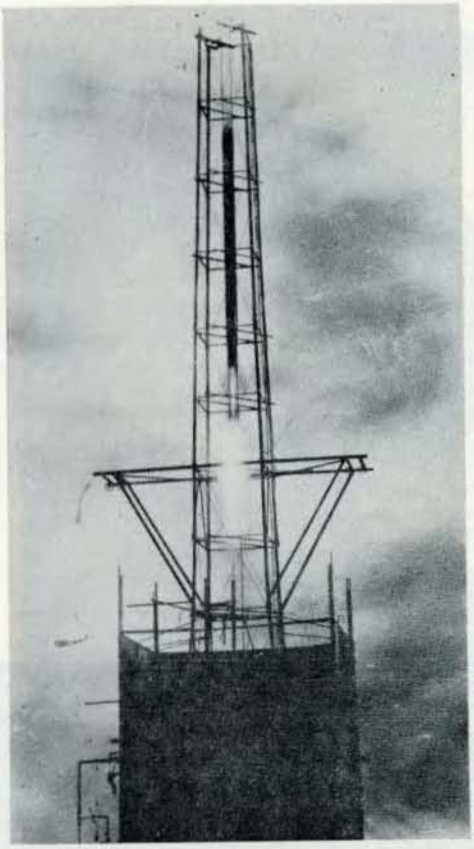
wide basis the scientific and engineering values in rocket and jet propulsion research.

Dr. Goddard even made some tests to find out how much powder would be required to make a flash visible at a distance of 2¼ miles, and from this he calculated that a rocket weighing about 3¼ tons would be required to carry sufficient flash powder to make a visible flash on the moon. He went on to make the further rather vague statement (Goddard's italics): "This plan of sending a mass of flash powder to the surface of the moon, although a matter of much general interest, is not of obvious scientific importance. There are, however, *developments of the general method under discussion, which involve a number of important features not herein mentioned,* which could lead to results of much scientific interest. These developments involve many experimental difficulties, to be sure; but they depend upon nothing that is really impossible." It may be arrived at by conjecture that the unspecified developments might be taken to include manned interplanetary travel.

Dr. Goddard's precocious talents and prophetic writings are analogous to those of Leonardo da Vinci whose original and daring theories might well have revolutionized the thought of his day had they been extracted earlier from his voluminous manuscripts, which remained unpublished until recent times. Dr. Goddard's proposal to explode a load of flash powder on the moon set off a Roman Holiday among newspaper men. The idea of a blinding man-made flash on the moon captured the imagination of the public. And to compound the excitement, this was not the insane proposal of the stereotyped paranoid scientist of comic strip lore who surrounded himself in his slum attic with bubbling caldrons of green mist. It was the idea of a disciplined, psychologically well-adjusted teacher of physics. It was the proposal of a man who



A completed rocket in the shop at Roswell, New Mexico, on February 6, 1940. It used pumps for fuels and was approximately 22 feet long.



The beginning of a flight on March 17, 1938. The launching tower shows a catapult arrangement.

had earned his Ph.D. in his own field and who as a commissioned officer had improved signal rockets for the Navy. In addition, Dr. Goddard's work had the blessings of the Smithsonian Institution.

A few months after Dr. Goddard had been elected to the Board of Directors of the American Rocket Society, he died on August 10, 1945. "The life-work of Goddard," wrote the directors, "both as a scientist and a man, will always remain a brilliant inspiration to those who are privileged to carry on his endeavors, and to every other bold explorer on the frontiers of science. In time to come, his name will be set among the foremost of American technical pioneers."

Fifty years ago, in January, 1907, Goddard as a student at Worcester Tech received rejection letters from three highly esteemed American magazines on an article which presumed to suggest that atomic energy would one day propel a rocket into interplanetary space. One editor replied: "The speculation is interesting, but the impossibility of ever doing it is so certain that it is not practically useful. You have written well and clearly, but not helpfully to science as I see it. . . . I return the paper with thanks."

Speculation on whether our generation will live to see the predictions of Robert Hutchings Goddard become realized facts is not of paramount concern. But whether there is to be an aggressive continuation of fundamental research in a climate of tolerance is the concern of every living American. It is imperative that such a climate include aid, encouragement, and proper recognition for men like Goddard who in spite of technical difficulties, disbelief, and ridicule persist with dogged resolution until they realize their aims. The true fulfillment of our hopes for a peaceful and better world lies in the fruit of their labors.

A Goddard rocket in flight on August 26, 1937.

life on other stars

By Ernst Stuhlinger

director, research projects office
army ballistics missile agency

(Editor's note: This is the first installment of a three-part article. The other two parts will follow in subsequent issues of SPACE Journal).

IN FORMER TIMES there was no question about life on other stars. The common belief followed a literal interpretation of the teachings of the Bible. Our earth was thought to be the center of the universe, the only place inhabited by living beings. At the time of creation all the plants and animals had come into existence as they are now, according to one well-conceived master plan. No change occurred—no development, no expansion. The natural sciences, too much in their infancy, and too strictly limited to a selected few, did not provide enough cogent evidence to the contrary to make a modification of this common belief necessary.

Some few hundred years ago, the human mind entered into a new phase of its evolution. It developed an inquisitive curiosity to know more about the world. Today our earth is no longer accepted as the perfect masterpiece of one six-day creation. It is recognized as a small planet among billions

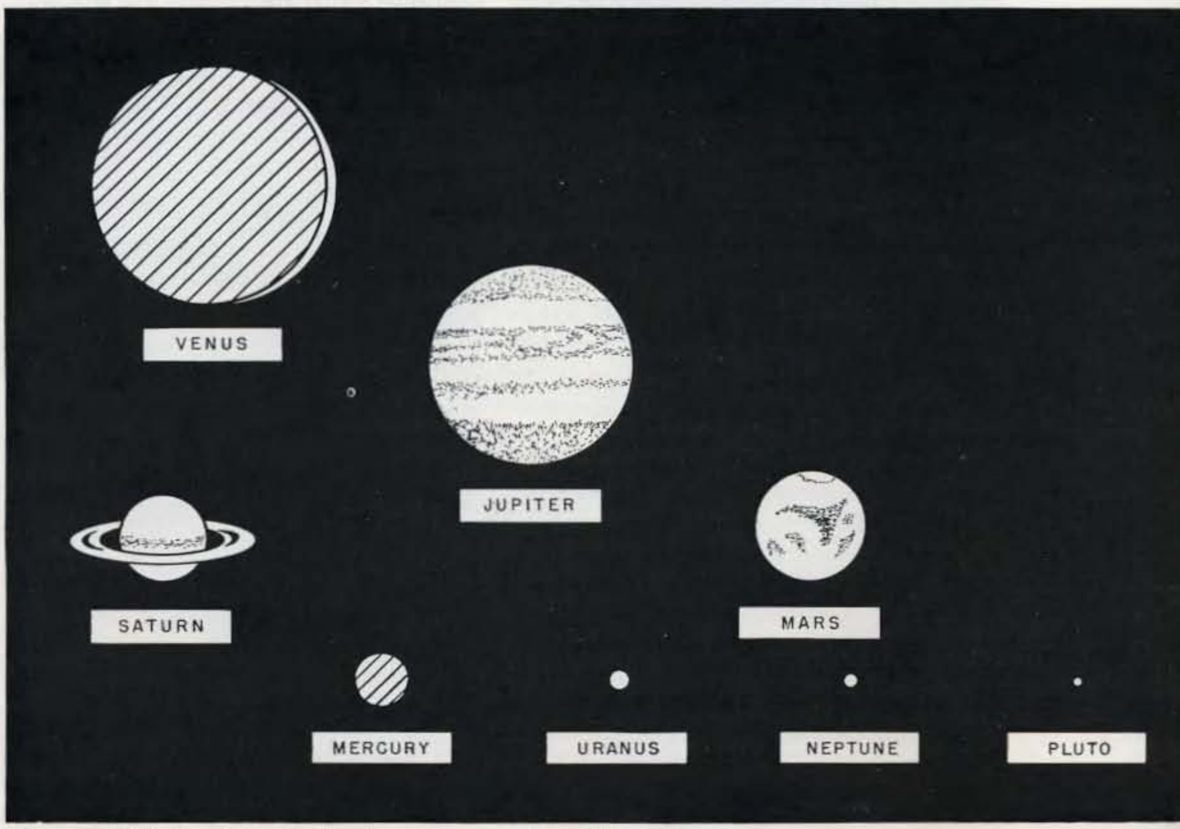


Figure 1. Relative sizes of the planets as seen from the earth.

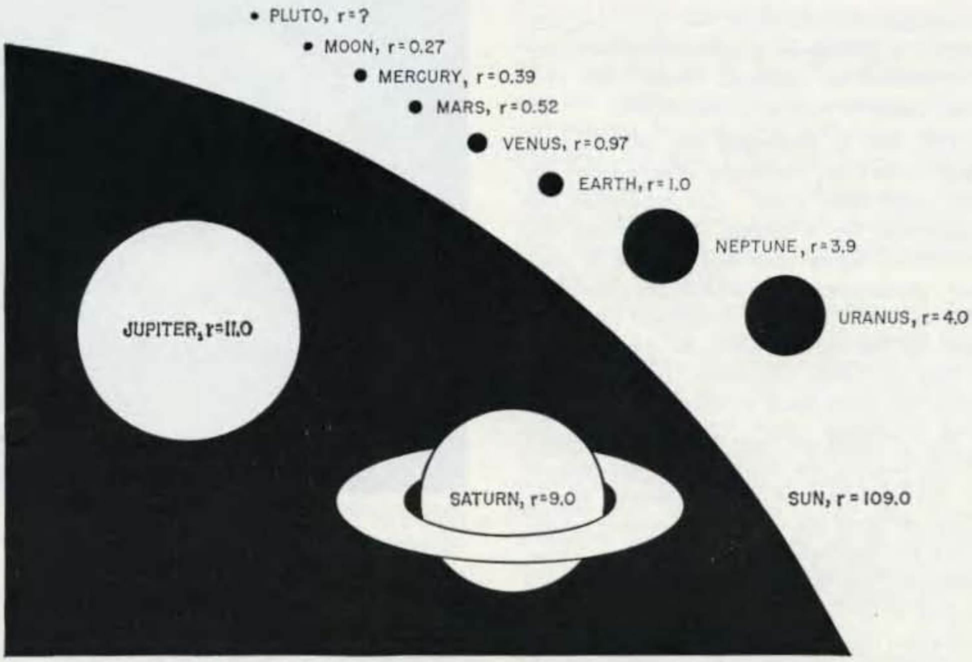


Figure 2. Relative sizes of the planets.

and billions of stars in a boundless universe. Evolution, not perfection, sets the grandiose stage on which we are the actors and the spectators as well. We came to realize that the human mind has the capability of learning and, to a certain degree, of understanding how this world came into being, how it is built, and how it develops. To the visible world around us which was accessible to our forefathers, modern scientists have added new worlds: the world of the atoms, and the world of the stars. We have found that there are universal laws of nature valid equally in these three worlds which help us to understand their interrelations and some of their mysteries. The natural sciences today offer us the foundation for a concept of the world which is not only more correct, but also much greater, and far more magnificent, than any concept our forefathers could develop in their times.

Life on other stars? It would have been a profanity in medieval times to believe that it might have existed. Today this question is one of the most challenging problems of science. There is hardly one great scholar who does not give it his attention, and many of them are rewarded by brilliant new ideas. The remarkable fact is that every branch of natural science bears upon this problem—astronomy, physics, chemistry, biology, geology, meteorology, and all the others. Once we have the answer, its impact will be felt even by sciences as sublime as philosophy and theology.

The question of whether life exists outside the bounds of our earth cannot be answered by a plain yes or no today. If the answer should be positive, it may well be that we will have it as soon as a manned satellite around the earth offers a platform for observations. We certainly will know when our first interplanetary space ship takes us to Mars; and this may possibly happen before the end of our century.

It is another thing if we ask what the *probability* is that life exists on other celestial bodies. We know the external conditions under which life was able to develop and subsist on earth. We know much about the environmental conditions which prevail on other planets in our solar system, and even on other fixed stars. Comparing the necessary conditions for life with the exist-

Figure 4. The Crab Nebula, a leftover of a supernova explosion in 1054 A.D.

ing conditions on stars, we can conclude with a high degree of probability whether life should be expected there, and into what forms it may have developed.

This way of reasoning may seem rather bold. However, countless observations on this earth have shown that whenever the conditions for a certain development are favorable, nature does not hesitate to start this development. Scientists are confident that this rule, so often confirmed on earth, may still be applied when the development is that of living organisms, and when the place is not confined to this earth.

Our original question about the existence of life outside the earth, therefore, reduces to the question of environmental conditions on other stars and of necessary conditions for the development of life. These questions can be answered to a considerable degree today, partially from direct observations and experiments, partially from extrapolations and logical deductions.

Although we usually think of planets only when we discuss the chances of finding life on other celestial bodies, *we should not overlook the possibility of life developing also on the "dark" component of a double star,* where light and heat would be available from the "bright" component. In the present article we restrict our considerations to planet-like bodies which are much smaller than the central star that gives them light and heat.

We will divide our subject from here on into three parts: The astronomical aspects, the physical conditions, and the biological problem. The present article will deal with the astronomical aspects of life on other stars.

When we think of life on other celestial bodies, we are inclined to associate its possible existence with environmental conditions as we have them on our earth. The average temperature should not be above 60°C to 80°C, and not much below the freezing point of water; there should be an atmosphere with at least some oxygen or carbon dioxide; there should be water; and there should be occasional sunshine, or an equivalent starshine. As we will see later, these conditions are mandatory.

That such an accumulation of conditions may well occur in planetary systems is proven by our own earth. The question is then: What is the probability that a planetary system like the solar family occurs among the fixed stars? Before answering this question, we take a short look at the structure and the history of the solar system, of our galaxy, and of the stellar universe.

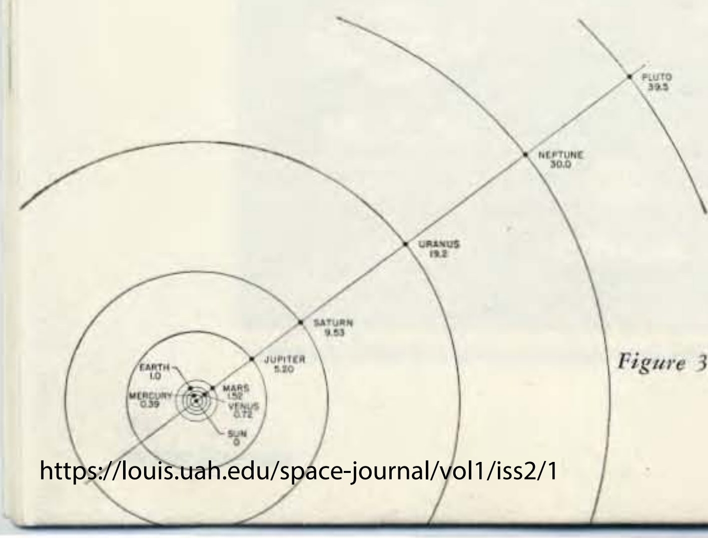


Figure 3. Relative distances of the planets from the sun.

One of the most impressive features of the solar system is the smallness of its components as compared to their distances. If we should build a model of the sun and its planets, and if we chose a sphere of three inches in diameter, for example, an orange for the sun, the planets would have the following diameters and distances: Mercury, 0.01 inches at 10 feet; Venus, 0.026 inches at 20 feet; earth, 0.027 inches at 27 feet; Mars, 0.015 inches at 40 feet; Jupiter, 0.3 inches at 135 feet; Saturn, 0.25 inches at 255 feet; Uranus, 0.12 inches at 525 feet; Neptune, 0.12 inches at 810 feet; Pluto, with as yet unknown diameter, at 1,060 feet (Figs. 1, 2 and 3.) In the same model, the nearest fixed star would have a distance of 1,000 miles from the sun, and the end of our galaxy would be 20 million miles away. Besides the nine planets, we find a belt of many small asteroids between the orbits of Mars and Jupiter; about 1,500 of them have been identified. The mass of the sun comprises about 99.8% of the total mass of the solar system; the planets only 0.2%. On the other hand, the combined angular momentum of the planets is about 98%, and that of the sun 2%, of the total angular momentum of the system. The sun consists of over 90% hydrogen; heavy elements are rare. On the earth, heavy elements are much more abundant. The composition of the planets, disregarding their atmospheres, is very probably similar to that of the earth.

The large angular momentum of the planets is a very strong proof against the assumption that the planets were in former times a part of the sun, or even that the sun and the planets were formed in one process out of a big diffuse nebula. A more satisfactory explanation is possible only if another star, in addition to the sun, is assumed to have participated in the planetogenic process. Theories by Chamberlin and Moulton, and in a very advanced and refined form by Jeans, succeeded in describing many of the detailed features of the solar systems by assuming the close approach of another star. Gravitational

Figure 5. The big spiral nebula in Andromeda.

forces would produce huge tidal waves and would even pull large amounts of matter out of the sun, in the form of a gigantic "filament." This filament would finally break up under its own gravitation and form a number of separate bodies which finally would move around the sun in planetary orbits. Their angular momentum would have been provided by the passing star. The same planet-forming process would also account for the moons of the planets. One conspicuous fact remains unexplained by this theory—the fast rotation of some of the planets. In order to make this rotation understandable, Jeffreys supposes a "grazing collision" between a star and the sun, instead of a close approach. Frictional forces, in addition to gravitational forces, could then account for the rotational motions of the planet.

With this assumption, the observed rotation and the total mass of the planets can be explained satisfactorily. However, the large angular momentum of the planets then remains a mystery.

A new idea was introduced by Russell and developed further by Lyttleton. They pointed out that many of the stars, almost one-half of them, are twin stars, revolving around each other at distances which may count from about a third of a light year down to less than the diameter of one of them. Polaris, our north star, is known to be a quintuplet; Castor is even composed of six individual stars, all orbiting around each other. Russell assumed that our sun had a twin, too, at about the distance of the major planets. This twin was hit and smashed to pieces by another star. Some of the fragments remained in solar orbits; they are our planets now.

This theory is able to explain the rotation, the angular momentum, the distances, and many other features of the planets. Its shortcoming is the extremely small probability for a direct hit between stars. To help this situation, Hoyle made the suggestion that the twin star may not have been hit by another star, but may have gone through the natural cycle of its evolution, which terminated in a cataclysmic explosion. The heavy pieces of this explosion were hurled far out into space; a huge cloud of gases and dust remained in the solar gravitational field, but with the angular momentum which was left over from the twin star. This gas and dust cloud first spread out around the sun in a ring-shaped disk, but later it contracted into discrete blobs because of eddy currents and gravitational instabilities. Most of the mass contained in the gas and dust cloud was finally concentrated in the nine planets.

This theory of planetary origin is part of a comprehensive "New Cosmology" by Hoyle and Lyttleton. Although it is by no means free of controversies, it offers very intriguing descriptions of the life cycles of stars, of their energy balance, and of their compositions. The explosion of the sun's twin star, in the light of this theory, would be a "supernova," the last phase of one specific group of stars called supergiants. Three supernovae were observed within our galaxy in historic times: the first was seen in 1054 by the Chinese; the second in 1572 by Tycho Brahe; and the third in 1604 by Keppler. The first supernova left a gaseous mass, the well-known Crab Nebula (Fig. 4), which has been expanding during the past 900 years with a peripheral velocity of about 600 miles per second.

Supernova explosions are known from other galaxies. Their outburst of light is so tremendous that they can be observed from the earth. Although the final development stage of a supergiant which leads to a supernova may well extend over millions of years, the explosion itself lasts only for a few days. The frequency of supernova explosions, according to Baade and Zwicky, is about once in 400 or 500 years per galaxy, a figure which agrees well with the three supernovae observed within our galaxy during the last 900 years.

Hoyle's theory is well capable of explaining many of the outstanding features of our planetary system. It even explains why we find an abundance of heavy elements on the planets, but not on the sun; heavy nuclei are formed in energy-consuming nuclear processes during the collapsing phase of a supergiant, shortly before its explosion. During this same phase it is likely that a supergiant emits electromagnetic waves which are observed by radio astronomers on earth. The last phase of the entire process, the contraction of the gas and dust cloud into discrete planets, has been studied in great detail by von Weizsaecker. Expanding the laws of fluid dynamics to an astronomical scale, and applying them to the special case of a gas and dust cloud around the sun, he could derive many of the special properties which we observe in the planetary system.

It cannot be said today whether this concept of planetogenesis comes close to the truth. However, it seems to lead to less controversies than older theories, and we may well adopt it until better theories are available. The probabilities for all the individual steps of this planetary history can be estimated from observations and mathematical deductions; we finally can calculate how often a planetary system may have developed within our galaxy since its beginning.

This article is far too short to give an indication of the details of the various theories or of the methods of observation and reasoning which are applied by astronomers to obtain numerical results. The following numbers and figures are therefore only transmitted as facts without further arguments.

Figure 6. A star 'cloud' in Sagittarius. This is only a minute portion of the stars visible in one galaxy. Within the earth's range of observation there are about 100 million galaxies. Each galaxy may contain 100,000 self-sustaining planets.

Published by LOUIS, 1957

Our galaxy has an age of about 4 billion years. With one supernova explosion every 400 years, about 10 million supernovae must have exploded during our galaxy's life span. Every second one of them may have been one component of a twin star, giving rise to a circumstellar gas and dust cloud, and subsequently to a family of planets. Even if it may be too optimistic to assume that each of the resulting 5 million planetary systems contains at least one planet with conditions favorable for the development of life, it is certainly not unrealistic to expect that one planetary family out of 50 includes a member on which conditions similar to those on our earth prevailed at one time or another. *This means that we should expect that life in some form may have developed, during the last 4 billion years, on about 100,000 different planets within our galaxy.*

Our own galaxy shows the structure of a spiral nebula. Its size and shape resembles very closely one of its nearest neighbors in space, the beautiful spiral nebula in Andromeda (Fig. 5), which is "only" 1,500,000 light years away. The diameter of our own galaxy is about 60,000 light years. It contains between 10 and 100 billion stars. Comparing this tremendous number of stars within our galaxy with the 100,000 planets which may possibly bear life, we must conclude that life is, on an absolute scale, a frequent event within the galaxy. Relatively speaking, however, it is extremely rare. Only one in about a million stars is privileged to send its warming sunshine out to a satellite on which living organisms develop.

Figure 7. A cluster of galaxies in the Corona Borealis. All the indistinct blotches in this photograph, about 50, are galaxies approximately the size of our own.

Our most powerful telescope on Mount Palomar is able to discern galaxies as far out as one billion light years. Within this observation range there are about 100 million galaxies (Fig. 6 and 7). Each of them may contain 100,000 life-sustaining planets, *which leads us to a total of ten thousand billion planets, within today's observable universe, which may be inhabited by living beings.* The total number of stars in this volume is ten billion billions.

It is well to remember that this gigantic number is numerically equal to the number of molecules within one cubic centimeter of air.

How long will life continue to prosper on our earth? The heat balance of the earth depends almost entirely on the sun. Solar heat is constantly produced by the fusion of hydrogen nuclei into helium nuclei. This heat production will go on with a slowly increasing rate for about 50 billion years. While the hydrogen supply is gradually consumed, the sun will slowly heat up and, at the same time, swell to a diameter about as large as the orbit of Mars. From then on the sun will start to shrink. It will not explode like a supergiant, but very gradually cool off. At the end, the sun will be a black dwarf. Long before that, life on any of the solar planets will have become impossible because of the heat increase during the hydrogen-helium conversion. But there is a good chance that life will persist on earth for several billions of years—as far as the sun is concerned.

In the next edition of SPACE Journal we will discuss the varying physical conditions which are found on a planet in the course of its life cycle, and we will see in particular whether the earth is prepared to support life for some more billions of years.

rocket mail to the moon

What should the stamp cost, based on current propulsion technology?

By Dr. H. W. Ritchey

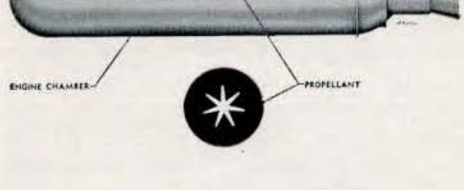
technical director
thiokol chemical corporation
redstone division

MOST ASPECTS of space travel have been covered extensively in a great volume of literature that has appeared on this subject over the last few years. The problems of propulsion and control have received a tremendous amount of attention. Other problems relating to the survival of the human being in space and his psychological and physical reactions to wide variations in gravitational fields have also received considerable attention.

Perhaps the one greatest problem now impeding progress is that of the subconscious inhibitions buried in the minds of those technologists now capable of effecting space travel. This problem may be solved for future generations by the publicity now being released in the semi-technical publications and on television. The younger generation, now in the formative stage, have seen animated cartoons and other demonstrations of the feasibility of space travel to the extent that they now look upon it as an accomplished fact. On the other hand, our present generation of scientists, even those who are able to prove logically by engineering calculations that space travel can be accomplished, have been so subjectively inhibited by their early conditioning that most of them still regard it as impossible in some segment of their mind buried deeply in subconscious. Only within the last few years has it been respectable in scientific circles to discuss seriously the feasibility of space travel.

The actual fact exists that we are now capable of sending an object outside the influence of the earth's gravitational field and, therefore, with an adequate system of guidance could send this object almost anywhere in the solar system. The design characteristics of a rocket system capable of propelling an object outside the earth's gravitational field are so well understood that it is possible to make reasonably accurate calculations of the cost of such a propulsion system. Such a propulsion system could carry rocket-mail letters to the moon or to a planet, and we are then able to estimate to a fair degree of accuracy the cost of a rocket-mail stamp needed to send a rocket-mail letter to outer space.

The problems inherent in the necessary propulsion system have already been solved by progress in the field of solid-propellant rocketry. In the solid-propellant rocket engine, the propellant is properly mixed and "injected" into the combustion cham-



ber at the manufacturing plant. A composite type of solid propellant can be processed as a slurry in the manufacturing plant and cast directly into the pressure vessel. A typical engine of this type is shown above.

The charge burns on all the exposed inside surface of a specially-shaped propellant cavity. Since burning occurs from the inside outward, the flame does not contact the walls of the pressure vessel until near the end of the burning period. If a proper fuel binder is used, the charge can be bonded to the walls of the pressure vessel and penalties in weight are paid for support of the propellant. Although the performance characteristics of present rockets cannot be disclosed, calculations utilizing obvious assumptions concerning propellant densities and densities of the high-strength structural materials can be used to show that it should be relatively easy to make a solid-propellant rocket engine in which 86% of the gross weight would be propellant. Since both this ratio and the propellant specific impulse are related to combustion chamber pressure, it is assumed that this ratio can be attained with a propellant exhibiting a sea-level impulse with an optimum nozzle of 195 lb-sec/lb. If such a rocket is designed to operate somewhere near optimum in the very low-pressure conditions existing at high altitude, this specific impulse figure will rise to a value of about 230.

Many multistage, solid-propellant rocket vehicles have been fired and the capabilities of staging and of high-altitude ignition have already been demonstrated in such missiles as the Lockheed X17 and the multistage, solid-propellant test vehicles fired by NACA. For the purpose of estimating the take-off weight in an "escape velocity" missile, the stage load ratio of 1:4 has been assumed; in other words, each rocket engine weighs four times all the load that it carries. These performance values and design criteria are then used in the following equation for rocket motion:

$$V = I_{sp} \times g \times 2.303 \log \frac{W_1}{W_2}$$

V = velocity, ft/sec
I_{sp} = propellant specific impulse, lb-sec/lb
g = gravitational acceleration, 32.2 ft/sec^2
W_1 = initial weight of system
W_2 = final weight of system

The calculated velocity, uncorrected for drag and gravitational effect, is shown in Table I. This velocity is then corrected for drag and gravitational effect by subtracting an overall gross "loss" figure, converted to equivalent velocity loss.

It has been assumed that each rocket stage is a faithful linear scale reproduction, in which case the following scale relationships obtain:

Burning time of Rocket B = scale factor times burning time of Rocket A

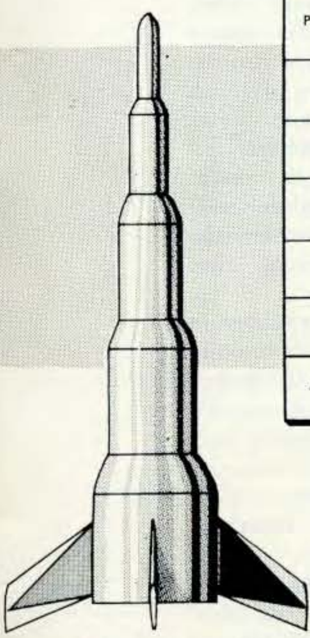
Thrust of Rocket B = scale factor squared times thrust of Rocket A

Gross weight of Rocket B = scale factor cubed times gross weight of Rocket A

Using these relationships it is easy to estimate the time of burning and obtain a correction for the so-called "g" losses of velocity. This correction is also shown in Table I. It is more difficult to arrive at an accurate correction for atmospheric drag, especially since design of the specific aerodynamic configuration is beyond the scope of this article. Based on experience, however, it would seem reasonable and adequate to incorporate a correction of 2,000 ft/sec as the loss to be incurred by atmospheric drag for the smaller, "high-g" rocket, and 1,400 ft/sec for the larger rocket. Thus, as Table I illustrates, it is possible to attain escape velocities with a one-pound payload using a missile having a total take-off weight of less than 3,200 pounds.

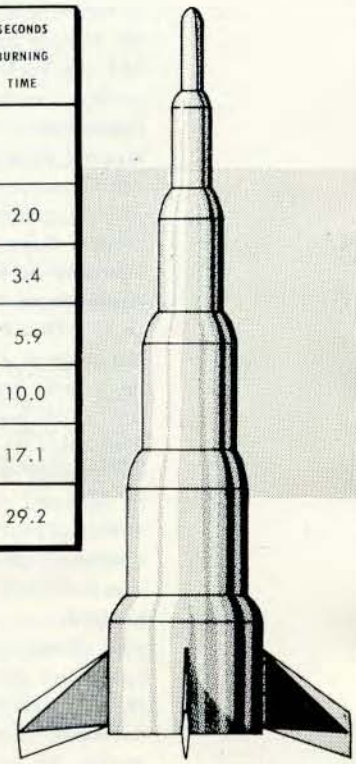
It is also beyond the scope of this article to estimate the production costs of such a missile; however, experience with relatively small numbers of rockets made in research-

TABLE I
MAIL ROCKET TO THE MOON—SPECIFICATIONS



without "retro-rocket"

STAGE	STAGE WEIGHT	ENGINE WEIGHT	PROPELLANT MASS RATIO	PROPELLANT SPECIFIC IMPULSE	THEORETICAL VELOCITY INCREMENT		SECONDS BURNING TIME
					"RETRO-ROCKET"		
					WITHOUT	WITH	
PAYLOAD	1	0					
5	5	4	0.85	230	8400	(—8400)	2.0
4	25	20	0.85	230	8400	8400	3.4
3	125	100	0.85	230	8400	8400	5.9
2	625	500	0.85	230	8400	8400	10.0
1	3125	2500	0.86	230 195	7200	8400	17.1
ADDED	15,625	12,500	0.86	195		7200	29.2
				TOTAL	40,800	40,800	
				"g" LOSS	1,400	2,000	
				DRAG LOSS	2,000	1,400	
				NET	37,400	37,400	



with "retro-rocket"

and-development quantities would indicate that 20 such systems could be assembled at a total cost not exceeding $10.00 per pound of missile weight, amounting to $32,000 per vehicle.

Certain other problems would naturally exist if such a project were to be attempted. For example, there is hardly need to send a rocket-mail letter to the moon unless someone were there to receive it. This problem is normally not related to the cost of the stamp, and, therefore, the cost of placing a recipient in the right location has not been included.

There is also the problem of either hitting the target object with a free-flight ballistic missile or providing some type of terminal guidance. Since the moon subtends a visual angle of about 10 mils, it should not be too difficult a task to launch a rocket in the right direction and with sufficient velocity to hit the moon on a free-flight ballistic trajectory.

The recipient post office on the moon, of course, must bear the cost of finding the rocket at the impact point and recovering it. Here we get into a nebulous area where it might very well be argued that the cost of finding and recovering a rocket would far exceed the cost of the vehicle itself. In fact, the expense of renting one of the conventional launching sites for launching the vehicle might very well fall into the same category. Let's assume, however,

that it requires investment of two man-days time and $2,000 in amortization of equipment in order to launch the rocket. So far as recovery is concerned at the other end of the line, it hardly seems reasonable to permit the rocket to impact on the moon's surface with the incremental velocity equivalent to free-fall in the moon's gravitational field plus what velocity is left at the "turn-over" point. In other words, in order to prevent the rocket from being completely destroyed on impact, it would be necessary to cancel out about 8,500 ft/sec accumulated velocity shortly before impact. This would be done by using the last stage as a "retro-rocket" and by adding on a new first stage weighing four times the 3,125 pounds appearing in Table I. This adds an additional 12,500 pounds to our take-off weight and additional $125,000 to the cost.

The payload will be a one-pound object consisting of a steel shell, a properly constituted dye marker, and the mail will be micro-filmed on 16mm film. Each stamp will allow the sender two pages of correspondence which would be transmitted in the form of two micro-film frames. Since volatility of the dye marker would be a matter of extreme importance, the dye marker will consist of carbon black and a small explosive charge, the total of which weighs four ounces and which will be arranged to explode on impact so that the impact point will be marked by the black powder.

Dye marker rocket impacting on surface of the moon.

The steel shell containing this load will weigh two ounces. The burned-out "retro-rocket" itself will act as a buffer against impact damage, and it is expected that the steel shell containing ten ounces of 16mm micro-filmed correspondence would survive an impact at several hundred feet per second. The cost of recovery and delivery at the receiving end will, in accordance with U. S. Postal policy, be subsidized by the U. S. Government, and, therefore, these costs are not included.

The ten ounces of micro-film will contain 12,800 16mm frames, and will require 6,400 postage stamps to send 6,400 letters. A summary tabulation of the cost of mail service is as follows:

$125,000.00		Added stage
32,000.00		Other rockets
2,000.00		Amortization launching equipment
250.00		Two man-days (consultant rate)
$159,250.00	÷	6,400 = $25.00 per stamp

Dividing by the number of letters that may be transmitted, this leaves us a cost of $25.00 for rocket-mail stamps to the moon.

the remarkable x-craft

By Frederick I. Ordway, III

vice-president

general astronautics corporation

THE UNITED STATES has seen Russia slowly close the wide air-power gap that once separated the two nations. Military experts now agree that in many areas the Soviets are quantitatively ahead of us, and as far as quality goes they are catching up rapidly.

To offset any challenge to our aerial supremacy, the United States has embarked on an ambitious experimental research aircraft program that, it is hoped, will insure the maintenance of leadership in superior quality airplanes and missiles in the years to come.

Many of the exotic spaceships of the science-fiction world were prefixed by the letter X; today many of the astonishing research missiles and planes being developed by American technology have the same introductory letter. The X-series is our preview of tomorrow's aerial weaponry.

The idea for setting up a research series of aircraft began during the course of World War II, but work was not begun seriously until the end of hostilities in 1945. The Air Force, Navy, and National Advisory Committee for Aeronautics (NACA) conceived of, and have continued development on, an advanced series of research vehicles.

Details, from few to rather complete, are available on more than a dozen X-craft. We find that there are three types of vehicles that have been given the X-designation: (1) manned rocket airplanes, (2) manned turbojet airplanes, and (3) unmanned missiles. Rather than try to look at them in numerical order (X-1, X-2, X-3, X-4, etc.) it should be more interesting to think of them by category. Since the most exciting frontiers of flight are usually associated with man as well as speed and altitude, let us look at what has been done with our piloted rocket airplanes.

The Bell X-1 was the first airplane in the world to reach supersonic speeds in level flight, crossing what was known as the "sound barrier" in October of 1947. This was an event of tremendous importance to the aeronautical sciences, and was accomplished by designing and flying a rocket-propelled airplane that was almost literally a manned missile. The plane was

Bell X-1 *Bell X-1a* *Bell X-1b* *Bell X-2*

driven by a powerful Reaction Motors 6000-pound thrust rocket engine operating on liquid oxygen and alcohol. It provided military and industrial aeronautical researchers with invaluable data about the then-virtually-unknown regions of high-speed flight, and data derived from the program were fed into later combat airplane design.

A modification of the early model was the X-1A, five feet longer than its predecessor. After thorough testing in 1952 and 1953, this larger plane amazed the world by travelling at 2½ times the speed of sound, or 1,650 miles per hour, in December of 1953. In another flight it reached a record altitude of 90,000 feet, which literally brought man to the frontiers of space. While the X-1 could only sustain powered flight for 2½ minutes, the X-1A could enjoy four minutes of full power since it carried considerably more fuel.

An X-1B was built and specially instrumented for research on high speed friction heating. As the mysteries of the sound barrier were dispelled, those of the "thermal barrier" were explored. All of these X-1 airplanes were normally air-launched from specially adapted bomber-type four-engine airplanes. This enabled the X-planes to utilize their precious fuel only for the research purposes for which they were designed, without wasting any for take-off and climb to altitude. The planes can and have, however, taken off from the ground under their own power.

It is interesting to know that the X-1A and B planes weigh about 16,000 pounds and are crammed with 1,000 pounds of instrumentation to record the variety of tests that the planes undergo at the outer reaches of the atmosphere and at extreme velocities.

Not all airplanes of the X-1 series were successful. X-1 Number 3 was destroyed during a fuel operation, a modified X-1A exploded in 1955, and a model D of the series also was destroyed.

It is well known that air in motion possesses kinetic energy. Now if we decide to bring to a halt rapidly-moving air, the energy contained in it must be converted somehow, and we find that we end up with heat and pressure energy. A simple equation tells aeronautical-design engineers and aerodynamicists what the temperature rise will be of an object encountering a rapidly-moving air stream. As airplanes and missiles roar through the atmosphere at ever-increasing speeds more and more velocity energy is converted into heat. While some of this heat is conducted through what is called the boundary layer and while, especially at extreme altitude, some is radiated out the air frame, much has to be absorbed.

Specially prepared titanium, stainless steels, and ceramics are used to protect the aircraft from this heat. Moreover, each craft has a certain heat capacity; but aircraft designers knew that sooner or later refrigeration systems would have to be incorporated if man and materials were to survive the "thermal barrier."

It is obvious that the denser the atmosphere the more acute the heat problem becomes. To study the thermal phenomenon properly, great speeds and high-altitude capability are necessary. If we were to fly too low at too high a velocity, we would burn up like a meteor. Man has found that if he wants to go substantially faster than he does today he must get beyond the thick atmospheric blanket and into the rarefied upper levels.

The X-2, another Bell—Air Force—NACA rocket research airplane, was specifically designed to explore this thermal barrier. In July of last year it had reached a top speed of three times the speed of sound or about 2,200 miles per hour. To get this extra performance a Curtiss-Wright liquid-propellant rocket engine, developing 15,000 pounds of thrust, was used. Perhaps even more astounding than the speed produced was the record altitude flight of 126,000 feet, or nearly 24 miles straight up.

The powerful rocket engine allowed data to be gained of airplane performance at high angles of attack. When speeds

of Mach 2 to 3 are reached, the temperature of the skin may rise from 250°F to 650°F at high altitudes. Designers have therefore fitted the X-2 with temperature-resistant glass and a heat-insulated cabin to provide protection for the pilot. Furthermore, special alloys were used in critical parts of the plane. In case of airplane malfunction, the cabin could be ejected and parachute-lowered to an altitude where the pilot could separate and complete the descent with his own parachute.

One of the X-2's exploded and was intentionally jettisoned from its mother launching aircraft in May 1953. The last X-2 crashed because of stability problems, killing the pilot, Capt. M. Apt. So the X-2 program is officially over.

To carry on the work started by the X-1 and X-2 airplanes (as well as the rocket-powered Navy D-558-2, not a part of the X-program), one other manned rocket craft is being developed, the X-15. The Bell X-1E will be used for Mach 2 research until these new planes are ready. Its first flight occurred in June of this year.

Details are shaping up about the North American X-15, which is sponsored by the Air Force, Navy and NACA. It will investigate the unknown velocity regions at five, six, or more times the velocity of sound, and it will probe 100 miles above the surface of our planet. *We can almost consider the X-15 as a manned spaceship, and it will probably be this progression outwards in velocity and "distance from the earth" that will bring us to full-fledged manned space flight.*

We saw that the old X-1 planes produced 6,000 pounds of thrust, while the X-2 built up 2½ times that; as much power as put out by a typical Navy cruiser. The X-15's rocket engine, to be built by Reaction Motors of New Jersey, will release 60,000 pounds of thrust, and will fire from 1 to 3 minutes.

Despite this enormous amount of power, despite the fact that the airplane is designed to explore areas where no man has yet been, and despite the fact that friction heat generated may rise to 1500°F to 2500°F, the plane is considered quite safe. Depending on the circumstances, the pilot, in case of a mishap, will have a 90 to 100 per cent survival chance. The airplane has been carefully designed from the human engineering point of view, with aeromedical scientists of the Air Force and Navy cooperating closely with the manufacturer. It will be heavily instrumented to record conditions of re-entry from space into the earth's atmosphere, heating, stability at high speeds and altitudes, and control. The X-15 will be the first, true hypersonic boosted glider. The initial flight test is expected in 1958.

Although less spectacular, highly important work is being, and has been, accomplished by turbojet-powered research aircraft such as the X-3, X-4, X-5, X-13, X-14 and X-18. All manned, these planes have probed a variety of aeronautical unknowns, and results are rapidly and efficiently being "ploughed back" into industry.

Douglas X-3

The X-3 has often been referred to as the "Flying Pencil" because of its long (nearly 67 feet), thin shape. Powered by two Westinghouse jets, it produces 14,000 pounds of thrust and lands at a brisk 215 miles per hour. The wing loading (a term denoting the gross weight of the airplane divided by the area presented by its wings) is some 200 pounds for each square foot, a very unusual figure.

This mid-wing airplane carries 1,200 pounds of research instrumentation and a refrigeration system for cooling the cockpit and instruments. An interesting fact is that it uses some of its fuel to circulate in the nose area for cooling. The airplane was designed to test out *sustained,* very high speed flight, and was a joint Air Force, Navy and NACA project. Much of the craft was made of titanium.

Northrop X-4

The Northrop X-4 and Bell X-5 represent a different sort of airplane in that they are not primarily designed for speed and altitude testing. The X-4 is characterized by a tailless configuration with swept wings, being patterned after the well-known "flying wing" design. Elevons on the trailing edge of the wing act as ailerons and elevators. It is a small plane, weighing only 7,000 pounds and measuring less than 27 feet long. Much valuable information has been gained on stability and flight characteristics from this airplane in the subsonic speed region.

Meanwhile, the X-5 is a plane featuring a variable sweep wing; that is, the backward slant of the wings can be adjusted *during* flight. While landing and taking off the sweep is about 20 degrees, and in flight it can be positioned back to 60 degrees. The wing-setting mechanism is coupled to an apparatus that immediately compensates for the shift in the center of gravity of the 10,000-pound airplane as the wings are changed. The use of swept-back wings both delays and reduces transonic effects, but the exact degree of sweep is often a problem. Associated with sweep, however, is a number of difficulties such as the thickening of the so-called boundary layer near the tips, flow velocities along the wing, necessity of large angles of attack at high lift, and dynamic stability. The X-5 was designed to investigate the aerodynamic effects of sweepback and change of sweepback. Two airplanes have crashed in the test program.

We now turn to another type of turbojet-powered research airplane known as the VTOL (meaning Vertical Take-off and Landing), represented by the X-13, X-14, and X-18. All three planes have come into

Bell X-5

the news very recently, and all three offer different approaches to the same end.

The X-13 is popularly known as the Vertijet, and its approach to vertical take-off is very direct: set the plane in a tail-downward, nose-upward position, and take off. It is launched from a trailer bed which is hydraulically raised into the vertical position. The plane hangs from a hook on a stretched cable, and when ready to fly builds up power from its Rolls-Royce Avon engine until the thrust exceeds the weight of the airplane. In April the first "transition" flight was made when the plane vertically took off, "converted" to the horizontal position, flew at a respectably high speed, again converted and made a vertical landing. A jet reaction control system is employed during periods of rising, lowering or just hovering; the pilot deflects the jet exhaust by throttle control. Only 24 feet long, the plane has directionally-controlled bleed jets on the wingtips, and excellent performance characteristics (good climb, maneuverability, etc.). The Air Force, Navy, and NACA have all supported the program at one stage or another, although the Air Force supports the X-13 as such.

Ryan Vertijet X-13

A supersonic VTOL fighter has reportedly been designed based on the X-13 which, it is claimed, could climb to 15,000 feet during the time a conventional fighter is becoming airborne. This and other VTOLs will probably revolutionize the concept of aerial warfare in that no elaborate (and vulnerable) landing fields and carriers will be necessary. Give the VTOL a little space in the back yard and that is all it asks.

The shrouds of military secrecy have only just been lifted from the Bell X-14 which might be called a horizontal VTOL. Its two Armstrong-Siddeley ASV. 8 Viper jet engines produce hot discharge gases which are diverted downward during take-off to push the airplane upwards. The total

Bell X-14

thrust is 3,500 pounds. As the plane rises, the exhaust gases are directed by special vanes more and more rearward and horizontal flight can commence. Three compressed air jets are used to control altitude when the plane hovers. The plane has already completed preliminary flight tests both conventionally and under VTOL conditions.

The final X-VTOL plane about which we know something is Hiller Helicopters' tilt-wing X-18, which features four turboprop engines, with two counter-rotating propellers. This approach to the VTOL art relies on tilting the wings from the horizontal to the vertical position and allowing

the turboprops to literally screw the plane up into the air. Small turbojets in the tail provide control during hovering operations. This plane will probably be used to transport troops and supplies to and from areas where no airfields are available. Reports are that it can move along rather rapidly.

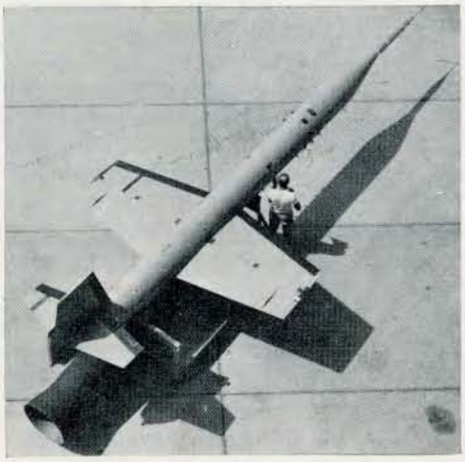
Hiller X-18

We now come to the third and final category in our survey of the X-series, unmanned missiles, the X-7, X-10 and X-17. Each is powered by a different type of engine; each has its own specific research purpose. Lockheed has two, the X-7 and X-17, and North American one, the X-10. All are called test vehicles.

The X-7 is powered by two ramjet engines, being what is called a test bed for the type of power plant that propels the Bomarc intercepter missile. The missile has been under development and test for approximately ten years and will continue at least one more. It is usually air-launched and boosted by a rocket engine to accelerate the missile to the point where the ramjets, which need ram air to sustain their operation, can take over.

Unlike most missiles, X-7 is not expendable, and can be parachute-recovered for continued use and evaluation. It often lands nose first on a nose spike. Data are transmitted to the surface by a radio telemetry system.

The X-17 is a more ambitious rocket, being a three-stage affair, 40 feet long. Normally, the rocket will take off and fly through the atmosphere into space (approximately 200 miles) then tilt and, with motors still firing, enter the earth's atmosphere at fifteen times the speed of sound. All this is done to test re-entry problems



Lockheed X-7

and the vital nose-cone aspect of the forthcoming intercontinental and intermediate-range ballistic missiles. On one flight, when the tilting mechanism did not function, the missile flew to an altitude of more than 600 miles and a range of more than 700 miles. During flights in April and July speeds of 9,000 miles per hour were reported and later confirmed.

More than 20 of the 6-ton, solid-propelled rockets have been fired from the Air Force Missile Test Center, most with good results. While the findings to date have been applied by the Air Force to its Atlas, Titan and Thor ballistic missile projects, the Navy may continue to fly the X-17 as a test vehicle for its submarine-based Polaris IRBM.

Whereas the X-7 and X-17 use ramjets and rockets respectively, the X-10 is provided with two turbojet engines. It is a test vehicle for the recently-cancelled Navaho XSM-64A intercontinental-range cruise

North American Navaho X-10

Lockheed X-17

missile, and it is employed to check out aerodynamic problems, electronic components, and guidance features. Flight testing of the X-10 has been successfully completed according to the Air Force. It has a landing gear and can be recovered after flight for re-use, offering a great saving in money. Navaho, the end product, was to have been powered by ram jets and boosted by three 120,000-pound liquid rockets.

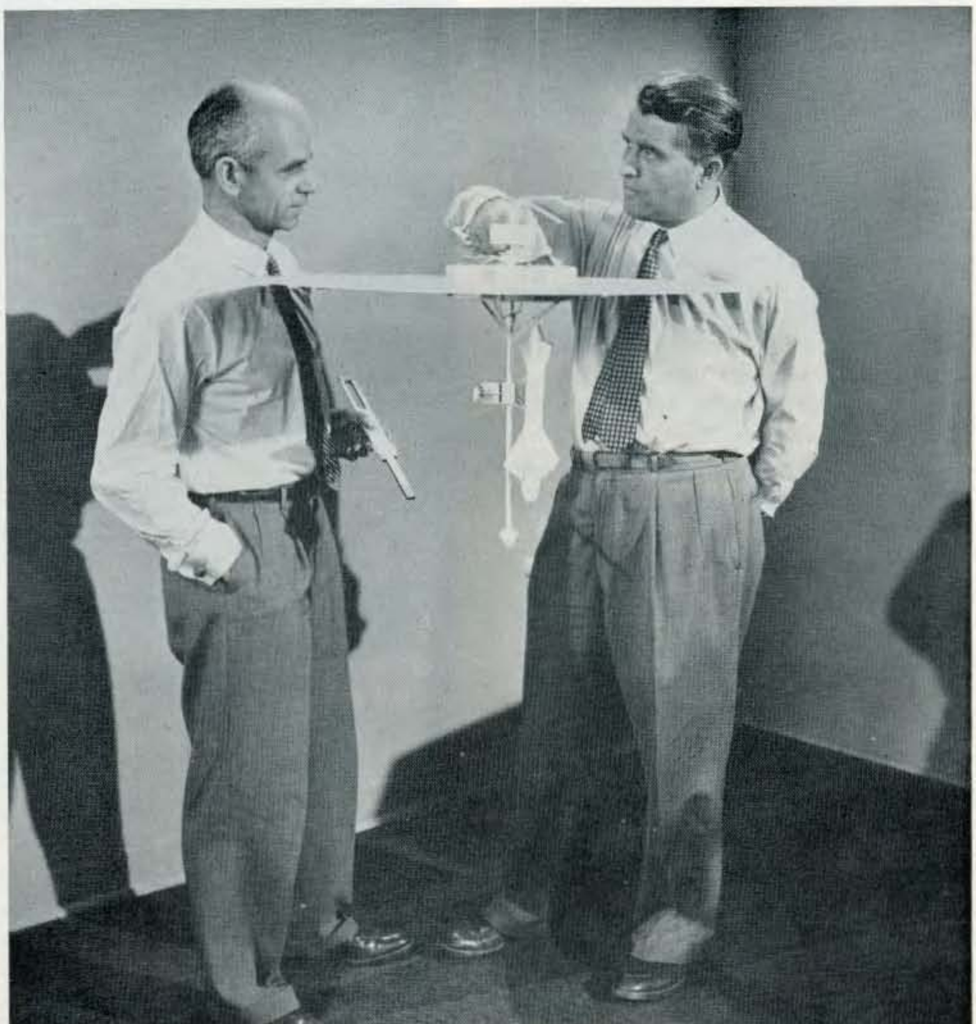
Having briefly looked at these spectacular X-craft, we may ask: "What next? What will happen 10 to 15 years hence?" *The Air Force has already predicted manned rocket aircraft flying at ten times the speed of sound within this time period.* If the X-15 reaches 100 miles, a later X-plane, which may then be called a spaceship, may reach 500 miles, 1,000 miles, or more. The popular distinction between airplanes and missiles may fade as they blend into tomorrow's space vehicles. *Military planners are already thinking of the possibility of wars fought in the space surrounding the earth and its atmospheric blanket.*

At the same time our cruise, interceptor, and ballistic missile programs will become highly sophisticated, and again, if peace continues, techniques evolved could lead to rocket and ramjet-propelled commercial airliners carrying passengers at thousands of miles per hour at the outer fringes of the atmosphere and, of course, spaceships. *There seems little doubt that ballistic missiles and rocket airplanes will be mated and developed into manned vehicles that will one day reach the moon.*

"mars and beyond"

ON DECEMBER 4th of last year, viewers of ABC-TV's "Disneyland" hour watched the third of Walt Disney's *Tomorrowland* space series unfold. *Mars and Beyond*, in the 48-minute documentary "science-factual" format, surpasses its two excellent predecessors, *Man in Space* and *Man and the Moon*.

Now being released in Technicolor for theatrical distribution, *Mars and Beyond* represents the culmination of two years' research, writing and artistic endeavor by



Dr. Ernst Stuhlinger, a leading scientist in the rocket and guided missile field (left,) and Dr. Wernher von Braun, rocket engineer (right), confer on a scale model of the atomic-electric space ship that would make possible the long trip to Mars in this scene from Walt Disney's MARS and BEYOND.

a dozen Disney specialists, under the versatile direction of Ward Kimball. The film assails the enormous subject of life on other worlds, first by a cartoon sequence tracing man's cosmic speculations throughout history, then by a sober view of contemporary scientific hypothesis and conjecture.

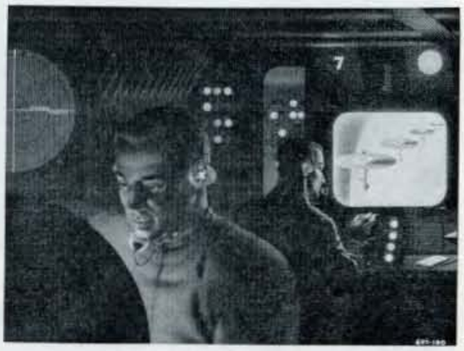
Evolution of the solar system and life, the conditions of man and his environment, and the conditions he may expect on other planets are considerations which form the main thread leading us to the red planet as the only other habitable sphere within our solar family. After a dramatic perusal of facts and speculation on Mars and its mysteries, conducted by Lowell Observatory's Dr. Earl C. Slipher, a method of space flight new to the general public is presented: the ion propulsion system devised by Dr. Ernst Stuhlinger.

In a simulated trip to the fourth planet, the atomic-electric spaceship and its orbit are brought out in animated illustration which captures the imagination. The accurate presentation, careful attention to detail, and concise narration establish Dr. Stuhlinger's hardware as a revolutionary but sound means of extraterrestrial navigation. In telescoping the year-and-a-half voyage into a few minutes on the screen, *Mars and Beyond* achieves the dreamlike reality of a Chesley Bonestell painting brought to life.

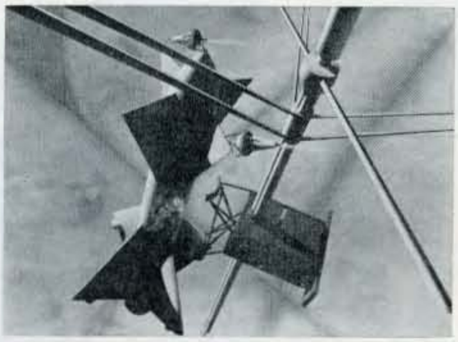
The outstanding virtue of this motion picture is perhaps its success in presenting a difficult subject to so wide an audience. *Time,* in a review of unusual praise, points out, "They did not confuse the popular with the vulgar, avoided the error of talking down to the viewer."

SPACE Journal recommends *Mars and Beyond* to all astronauts who want to introduce their neighbors to the age of space. For those who saw it on television, you will be surprised at the added dimension afforded by a large screen and the superb color for which it was designed.

Its descent slowed by a drag chute, a Martian landing craft nears the surface of Mars.



Crew members of a Martian ship observe on a television screen the progress of the line of the other ships in the first expedition to the planet Mars.



Crew members in bottle suits move the rocket landing craft away from the Martian ship and into position prior to attempting the hazardous 600 mile drop to the Martian surface.

Space Journal, Vol. 1 [1957], No. 2, Art. 1

out-our space

"Good heavens, are you going to build it to the moon?"

"Uh-oh . . ."

THE ADVENTURES OF "LASKA"

vox populi

(EDITOR'S NOTE: The first edition of SPACE Journal brought the following reactions from readers.) . . . .

. . . You may not remember this little story, Professor Oberth, because it is so typical of you that it might have happened many times, but it is as fresh in my memory as if it had occurred yesterday.

It was early in 1943 at Peenemeunde, the German rocket development center on the banks of the Baltic Sea. We test-fired one of the first V2 rockets, and because the art of rocketry was still in its infancy in those days, there was no "pad safety" to hold us back from the launching site. When a missile was fired, we stood under some pine trees not more than 300 feet away from the firing platform, and we were happy to feel the dust and sand, and even the fringe of the hot blast, right in our faces. The V2 missile went off fine that day, and our eyes followed it until it had disappeared in the deep-blue Baltic sky.

When I turned my eyes earthward again, I saw your face close to me. I had never seen you before, but immediately recognized you from photographs. You gazed at a distant point somewhere in the sky, but not at all in the direction in which the big rocket had just disappeared. I felt very happy to stand so close to such an extraordinary man and perhaps to listen to what he might say. But you did not care to talk. After a long silence, I finally said, "It must

certainly be a most gratifying experience for you, Professor Oberth, to see how beautifully your early dreams and concepts of large rockets have now come to life." But you neither answered nor changed your expression. I was convinced that I had said something very stupid, if not offensive.

After a long time, you slowly turned your head, and you kept turning until you looked far out in the opposite direction. After another long pause, you talked, selecting your words as carefully and slowly as only a deep-probing thinker does: "I have the greatest admiration for the engineers and technicians who built this rocket. But beyond that, it does not mean much. We have known before that a rocket will work within and beyond the atmosphere. This rocket is only the first little step toward a much greater project: the exploration of outer space. Out there, there are still so many things which we do not know and which are perhaps far beyond our imagination. There exploration is what really counts. We must not forget this goal in the enthusiasm that a mere technical success may give us."

After this, you continued to look silently into the depth of space which was far away from your eyes but so very close to your heart.

Huntsville, Ala. Ernst Stuhlinger

Dear Editor,

Vol. 1, No. 1, was handed to me for comment. . . . . I have just finished reading it from cover to cover, something I very rarely find time to do with any journal. Please enter my subscription, effective with the first issue if possible. I fear you have established such a high level of achievement with this first issue that you will not be able to sustain it, but the best of luck to you in this endeavor.

Incidentally, regarding Dr. von Braun's contribution (Reaction, p. 39) in which he attributes the "Because it is there" remark to Sir Edmund Hillary; I have not checked any references on this but wasn't this remark actually made by either Mallory or Irvine quite a few years before Hillary's time?

Yours sincerely,
Capt. Edwin R. Archibald USAF
Holloman AFB, New Mexico

Dear Editor,

I have just read your magazine SPACE Journal, and I like it very much. However, I wish to point out an error in the Reaction Department. In his first paragraph, Dr. von Braun refers to the answer "Because it is there" to the question of why anyone should want to climb Mt. Everest. However, this answer was not given by Sir Edmund Hillary, but by George Leigh-Mallory, who disappeared on Mt. Everest in 1924. On this, his third attempt to conquer Mt. Everest, he and his companion, Andrew Irvine, were last seen by N. E. Odell, high up the mountain. I'm sure that Sir Edmund was motivated by the drive to which Dr. von Braun refers, but he did not make the remark attributed to him.

Yours truly,
Eugene Edelstein
New York, N. Y.

Readers Archibald and Edelstein are correct in saying that the statement was first made by George Leigh-Mallory. Dr. von Braun is also correct in attributing the remark to Sir Edmund. In the film documenting the expedition, Sir Edmund used the phrase, giving Leigh-Mallory credit, and said that he was motivated by the same reason. Editor.

Dear Editor,

I want a one-year subscription to SPACE Journal. Start me with the winter issue. . . .

Each issue of SPACE Journal costs 50 cents and it is published quarterly. Why does it cost $2.25 for a one-year subscription? Why the extra 25 cents?

Yours truly,
Leo Bigos

In the rush to get the first issue out, a good many things became confused—among them the price on the cover of the

second printing of the first edition. The correct price per copy is 50 cents; yearly subscription price is $2.00. Growing pains of a fledgling publication were also the cause of this delayed second edition. The schedule is now stabilized. Editor.

Dear Editor,

I am enrolled in a teacher training program at the local university and am now studying the development of a unit in the upper elementary level. With the emphasis placed on man and science in the world today, we have chosen the *Study of Man* as the theme of our initial unit development; its relation to his environment; its effects at different altitudes and depths; and the compensations that are necessary to enable him to go beyond the stratosphere (and into space, if ever).

Do you have any pamphlets or information that we could have in relation to our topic? A bibliography and a list of sources of information would also help greatly.

Ewa, Oahu, Hawaii Masako Kiyabu

A list is on the way. Editor.

Dear Editor,

You've started a publication which is most welcome, and I can't conceive of a better group to handle it. The SPACE Journal certainly needed to counteract some of the poorly written "space articles" now appearing in almost every newspaper and magazine on the newsstands.

But my first reaction, when I saw your first issue at the local magazine shop, was disgust. It's not bad enough that we're behind the Russians on this thing, I thought —now here's another sensation-happy publisher trying to make a fast buck on it. . . .

So I bothered to pick up your first issue and glance down the list of contributors on the cover. Well, it looked rather good —so then, finally, I searched inside for the small print telling who *did* publish this magazine. And I bought it.

Consequently, my first suggestion would be that you incorporate some of that small print somewhere on the front cover, giving due credit to the Rocket City Astronomical Association of Huntsville, Alabama.

Secondly, I would suggest that you skip the poetry. . . . But the most serious request I have to make is that you omit any science fiction, at least until the magazine reaches a sufficient size to spare a few pages on a short story. Instead, I would much rather have some good biographical studies of such men as Newton, Copernicus, and Fermi, as well as Goddard and Lowell—or even H. G. Wells or Daedalus. . . .

Chicago, Illinois Joe Gibson

Thanks for the ideas, Joe. And as a start, see the current issue for an article on Prof. Goddard. Editor.

Dear Editor,

I have read several articles in your first issue of SPACE Journal, and find myself particularly intrigued with Dr. von Braun's "Where Are We Going?" and Mr. Whipple's "Why Conquer Space." I find that the inspiration expressed by these could use some backing in SPACE Journal in other forms than technical articles. . . . .

I call to mind particularly the appeal to youth. And I can say from my own experience that my present interest in astronomy has its foundations not only in the popular books so readily available on the subject, but also in an active participation in some astronomical experiment. I am sure that had I not observed an eclipse of the moon in 1943 or 1944, or looked at the sky with binoculars and later a telescope (homemade), I would not have shown much enthusiasm for the stars. For many people the reading of books and articles is adequate, but I feel that experiencing the feel of looking through a telescope on a cold night or developing the first negative of an attempted moon photograph adds an essential ingredient to the flourishing of an interest.

Somehow, I feel that such an ingredient should be put into SPACE Journal. As an example you might supply information on the frequencies and nature of the signals to be used by the various satellites' transmitters so that amateurs with limited equipment can enjoy some of this "active participation." That the Russian Sputnik had one signal so conveniently located in the

spectrum as to be available to inexpensive short wave receivers was well suited to this. The satellite could be easily heard and, for example, its pulse rate established (counting pulses) and its signal strength could be graphed. And though no useful data may be recorded in such a fashion, what is there lost, if this helps boost someone's interest in the conquest of space?

I do not particularly have in mind that another Moonwatch be established. Just something that can put the amateur in direct contact with the activities, not through reading alone, but by "active participation." What would be lost?

Berkeley, Calif. William E. Kunkel

Absolutely nothing would be lost, and it is one of the aims of the SPACE Journal to stimulate just such interest among amateurs. We plan to do just that in forthcoming issues. Editor.

Dear Editor,

It is with considerable enthusiasm that I discovered your journal, not in the sedate and musty atmosphere of the public library of Los Angeles, but deep in the skidrow section of Main Street. There in a bookstall famous for its girly magazines, foreign car publications, art studies, and pin-ups, my eye fell on your exciting effort to interpret space technology for the world.

Particularly of interest are the philosophical remarks or intellectual justification for your activity. This I believe is important for Americans, as we do not often understand anything which is devoid of economic motive. Thus far there has been no mention of oil wells, uranium deposits, or diamond mines on Mars. . . . Just the pure possibility of discovery. I approve of this. The technical side of this is of interest to me as I have a small part in the technics of space travel: I work for a company that manufactures vibrotrons, the vibrating wire type of transducer which measures pressures with great accuracy. . . .

Let me compliment your staff on its rare human approach to one of the greatest technological efforts of all time. Dr. von Braun, for a European, has considerable insight into the thinking of Texas. Evidently they, too, have been conditioned by "space" limitations.

Yours sincerely,
V. E. Jenkins

Tustin, Calif.

Los Angeles, it appears, possesses one of the more discriminating skidrows in the country. SPACE Journal, it also appears, enjoys even a wider audience than we had at first supposed. While the first issue contained no "mention of oil wells, uranium deposits, or diamond mines on Mars," succeeding issues will include articles on all phases of the many facets of space exploration. . . including the commercial possibilities of establishing industry on Mars, if such be feasible. SPACE Journal is concerned with all problems and possibilities involved in space travel, and in the future it will print articles accordingly. Editor.

THE ROCKET CITY ASTRONOMICAL ASSOCIATION re-elected four officers and three board members to their posts for 1958. Re-elected were: Dr. Wernher von Braun, who on January 29 received the Space Flight Plaque of the American Astronomical Society, president; Mr. Conrad Swanson, vice president; Mr. George Farrell, secretary; and Mr. Quincy Love, treasurer.

Also re-elected as board members of the association were Mr. Wilhelm Angele, Mr. B. Spencer Isbell, and Mr. Gerhard Heller. Associate board members elected were Miss Susanne Hilten and Mr. Hartmut Schilling to fill the positions vacated by Mr. Gerd Schilling and Mr. Gerald Swanson.

beyond this star

By James L. Daniels, Jr.

BRAD PRESSED THE BUTTON beside the buoyant cushion on which he lay. The seamless fabric covering slid down from his body and disappeared into the footboard. He stretched to loosen his dormant muscles. So this was the *laska* of the attempt. *Laska,* day; he was even using their words now. So far, so far—from that blue-green Earth with its young green hills and azure sky, with its sun-warm days and rhinestone nights. More than six months now, earth time, he had been here on this dead moon so far from Earth. Now, if the escape attempt worked, he must go back with the disappointing answers—the few that he had. The only reward for the whole long-heralded expedition was the proof of the Animate Progression theory the Palomar Group had championed so long. The regimentation, the stagnant state of humanity here, the whole cramped and stuffy, tomb-like existence of a dead-souled people in these Domes on this airless icy world—even with its everlasting automation, it was all so dead, like these undecorated metal walls around him.

Brad rolled up to sit on the side of the bed. The warmth of his feet touching the cool floor actuated the silent weathertron somewhere in the center of the building. The close air stirred and freshened in the room.

Across the narrow room the blank door in the wall by the View-screen broke silently open. The liquid blonde girl who entered came toward him, smiling—flowed as if without feet under her glistening leg-clinging skirt. Kay-bar! She alone could make him think of the folly of the attempt. He held out his arms for her. She glided into them.

"You sleep so long, my One." Her voice was warm alto.

"Am I such a fool to go?" Brad held her out from him. Her face saddened.

"Is the time so soon, Brad?"

The answer hurt within him. "I suppose I knew that you would know, Kay-bar, but I couldn't tell you." He stood up, sliding her hands from his arms, and turned away. The skylight had folded back, and the perpetual sodium light cast pale yellow on the walls of the room. Up beyond the mile-high crystal dome the awful sputtering giant, Jupiter, was almost directly overhead. "I guess no lover in your eons of history, nor in the short time of man on earth, ever faced a parting any differently. How does a man tell his woman, 'I am going—and without you.' Even when he is going to leave her, not just hundreds of miles or thousands, but millions, behind him."

"I, like your Earth-poets' lovers, would say, 'Take me with you.'" She touched his shoulder gently. Her breath was warm against his back. He clasped the hands she folded around his waist. "But I will not so ask. I know that you have to, darling; that it is not for your people or mine; not for your world or mine, but even for all our kind, that you go. Goodbye, Brad, and may you live to see your green hills of Earth again." Brad's breath ached in his throat as she slipped away and out of the room.

"With how sad steps we leave the love-dream couch, to which I wandered from afar." He finished the line with his own words, for truly his coming had been from afar.

A long time afterward, in the Sani-closet, with the cleansing sonic waves tingling his skin like a needle shower, he closed his eyes to dream of Earth.

. . . .

He had been tingling with needles of excitement when he had first climbed those long stone stairs up to the oak-panel door of the Observatory.

It was ten years later before he was ready, before they even told him that he would be one of the three out of the thirty in the organization, the Palomar Group, who would take that long jump beyond the pale blue Earth into dark space—to find those ancient answers.

Since the mid-century war the basic question had been simple: "Can man endure in the face of continued fratricide, with weapons in hand that can obliterate life?" But the simplicity of the question had belied the complexity of the answer. Neither Science nor Philosophy had been able to begin to answer. The pondering of the question had been belated, pessimistic, and negative.

In desperation, Drs. Wherry, Carl, and others of the first Palomar Group in the sixties had turned to the discarded theory of Animate Progression, which was simply that solar system life had begun in eons past on the outermost planet when proper conditions had evolved; then as that planet with its own cooling, the diminishing heat of the sun, and its own outward drifting from the sun, had lost its atmosphere and died, the life of the planet had moved on, or had been moved by unknown cosmic forces, to the next planet nearer the Sun. The process had repeated itself until our own Earth had evolved life and populated itself. Most scientific and research groups, influenced by such limited theories as Wildt's atmospheric composition theory—which would preclude existence of earth-

form life on the other planets—had disclaimed the Animate theory and scoffed at the Palomar Group. But the group continued its astronomical research. While the world sciences devoted research toward greater weapons and man rushed madly toward annihilation, the Palomar Group devoted itself to the Animate Progression research, turning its spectroscopic studies to each planet in turn, constructing an accurate space Atlas, and preparing men for space travel.

Confident that the guided missile and manned rocket programs would inevitably overcome the technological barriers to space travel, the Group directed research toward selecting the best possibility among the solar system planets for surviving life. They reasoned that if the Animate theory were correct there would be a strong possibility that life had survived on at least one of the older planets in the progression, and if such life had survived then the inhabitants by virtue of the very eons of their existence should be far wiser than earth's man. The proper presentation of the question of man's survival would be to such "Old Ones," if they existed.

Manned satellites in the late sixties had helped to make possible the technological breakthrough. The Moon Observatory had been completed in 1971 and the Palomar Group, now reclaimed by science and the government, moved in there in time for unobscured observations of Mars during its close approach in August of that year. Mars proved to be a rusty dried-up planet, but, during the next year, electro-spectroscopic studies, without Earth's vapor lines to interfere, revealed that Venus actually did have water vapor in its atmosphere. Furthermore, that atmosphere was actually evolving into a composition that would support life forms such as found on Earth. Heartened by their discoveries, the Group searched with renewed zeal for some sign of surviving life on the outer planets.

It was only when they began their study of the satellites that a real possibility was found, Europa, the third moon of Jupiter. Only slightly smaller than and twice as far from its parent as Earth's moon, it fascinated the Group because of its high reflectivity, so high that from the Moon its albedo proved to be twenty times that of Earth. There seemed no way to explain it other than that it must be due to something artificial. And artifice in the Universe could only mean life.

Not long after the early chemical space drives had taken man to the Moon, Dr. Reinhold, working with Neutronics Electric, had developed his G-Null Converter. Reinhold had simply coupled Stuhlinger's Ion drive experiments with the Force-field Transmitter developed in 1970 by Hochberger at M.I.T. and had come up with a device for transmitting a positive force field to a prescribed area ahead of the ship and simultaneously polarizing the entire ship to negative. It would simply draw the ship forward by attraction, with its speed regulated by the strength of the field. By reversing the direction of the field from front to rear and adjusting the strength, the ship could be eased downward against a gravitational pull at a controlled speed, thus simplifying landings on any planetary body. The legendary Paragravity Device was a fact.

* * * *

Hence, the destination was determined, the course charted, and a feasible ship under construction when Brad Hudson, Myron Drake and Steve Amhearst were selected to form the crew of the *STARFIRE*. The *STARFIRE* had launched from the moon in the spring of ninety-three.

For the entire nine months there had not been a single major malfunction—just the vast darkness and the monotonous hum of the G-Null Converter in the compartment next to his bunk. At times it had not been easy to hold back the shrill voice inside that kept trying to shriek out against the hum and the weightlessness that even the magnetic soles had not been sufficient to overcome. They still left one with the feeling of hanging from the ceiling by the shoes.

Another ninety hours would bring the ship into the Jupiter gravitational field.

Then would come the real test of Reinhold's Converter. If it could build up sufficient braking power to hold against the Jupiter field, at least until they could get into an orbit around the tiny Europa! Reinhold had been confident, but then he was the father of the thing and was not the one having to test it. Brad was somewhat apprehensive. His rigid stomach muscles assured him of that.

Forward, in the bulbous nose of the ship, the short squat Amhearst amid dials and panels hunched suddenly forward with his eyes glued to the electroscope, scanning the now basketball-sized Jupiter and the rapid elliptic swing of Europa around it.

"Better get up here, you two," Amhearst's hoarse voice blasted suddenly loud over the helmet intercom. Brad sat up as the lanky Drake brushed past him with his robot-like waddle. After two years of training and nine months out, Drake still hadn't learned to coordinate his movements with the alternate left-right, on-off, automatic switching of the magnetic soles for walking. Brad followed the long man to the front. Beyond the forward port, Jupiter was ballooning at a terrific rate.

"What?" Drake's calm rationality came through, even in his voice. The cool-headed bean pole had been the stabilizing factor throughout the long voyage. Amhearst, in answer, motioned toward the forward port.

"Europa's the little mite to the right now. You can see it with the naked eye." And there it was, a tiny bright light, sliding across the red flurry of Jupiter's south tropical disturbance. "Now check the electroscope!" Amhearst slid back from the face piece. Brad pressed his own helmet to the scope. The enlarged scope image brought the little moon a thousand times closer. It was ice white with crystal-like specks dotting the face of it.

"There's life—or was!" Brad forced himself to relax against his childish desire to jump up and down. He enriched his oxygen supply and breathed deliberately slow and long.

Within ten hours the crystal spots had resolved into clear domelike structures on the ice-covered moon, spaced geometrically over the surface. Thus, the high albedo was accounted for. In another five hours city-like arrays of structures could be seen in each of the giant Domes.

During his third ten-hour watch since the observations had begun Brad could make out cylindrical and hemispherical buildings, glinting brightly metallic in the artificial yellow glow inside the Domes. By now the apprehension had again replaced the excitement: Would the life that had created this human-like architecture still exist inside those bubbles that had no doubt enabled them to survive after the death of their world? The apprehension doubled into cold sweat when Brad called the others to stations for the field reversal. For now would be the test—hurtling inward toward Jupiter at one hundred thousand miles per hour. Drake and Amhearst strapped in and checked. Brad glanced over the panels and dials.

"Now!" he said. He locked the Landing Control into the orbit of Europa. He sucked in his breath and held it, flashed the red panel alert, and cut the Converter to Zero. He pressed the Field Reversal lever to Automatic. The Field-Dial needle snapped across the face of the dial and locked on Reverse. Now, would it hold? Brad breathed again, leaned back and adjusted his body straps. The slowing body-tugging deceleration began. Five hours of this and then landing. Quite suddenly the blackness came, and he knew no more.

When the inward flow of returning consciousness ebbed, Brad was aware of an aching white light. It seemed to have no source. He was not on the ship! He must have miscalculated the deceleration rate. So the Automatic had landed them. He lay on a dais of some kind in the center of a rather bare and cold hemispherical room. On one side of the room were ten white-cloaked figures seated behind a panel of desks. After a moment Brad realized that he was the object of their attention. He blinked again, for the ten were identical—straight coal-black hair, pale skinned and heavy browed. As Brad studied the cold

impassive faces, the one in the center spoke.

"You, Space Comer, are in the presence of Primesters. I am Ko-Pall, the Judge Superior of this world. We have ascertained that you are the Prime One of the comers." *What of the others?* Brad could not speak. "To know you and your race we have kept you unconscious as we found you, for our psycho-physio examinations. Now, we must examine you in a conscious state. You will touch the protrusion under your right hand, please." The bass voice flowed out with a hypnotic resonance. The man's face remained expressionless, but there was a sinister hardness around the dark glinting eyes.

Brad fingered the knob under his palm and pressed. The dais resolved itself into an easy chair shape, leaving him in a comfortable upright position. So smooth was the transformation that Brad's reflex tensing had not time to brace his body against it. Now the tenseness went out. The tautness in his head told him that his body's relaxed condition was still part of the effect of whatever narcoleptic inducing agent they had used on him.

"You have of course been thoroughly examined by our Psycho-Physiological people and our Bio-Zoological staffs while you were narcothized, as have the others of your people." *Drake, Amhearst—where are they?* Brad strained to speak.

"In a moment," Ko-Pall said, "you will be able to speak. As for your friends, if that is your concern, they are safe. They, too, are being studied. We will not harm you. I assure you that our interest is purely scientific and rational. Idle curiosity has no place in our world. You will, of course, observe that we converse in your language. This we know will not surprise you, as you people had on your vehicle primitive electronic translators and deciphering devices; hence, you are aware of the simple process of defining and reproducing a language. You know that the next step is a device for imposing the mechanics on the brain of the learner. An extension of mnemonics does it."

Of course, Brad thought, *So we Earthmen have gone so far with technology that we forgot the simple little human elements. Thirty days hath September—.*

"If you are wondering about the Primesters you see here, we are the government. The Primesters' special interest in you is political not clinical or scientific. Our Science and Tech-Councils have those areas. Our examination need not be feared. Now, you are advanced as a life form, otherwise you would not have ventured through space. You are advanced as a race, otherwise you could not. Naturally we must determine whether you are a threat to our world. Our Tech-Councils, after their examination of your ship and other equipment, have all assured us that you can be such a threat. Now, we must ascertain your political intentions and potential for we know that it is political and commercial ambition, not scientific potential, that initiates conflict."

Ko-Pall clasped white bony hands before him on the black metallic desk top. "We are, of course, amazed that your life form, even though more primitive in its evolutionary state, is similar to ours, for our research has proven compatibility of many and radically different life forms with the universe. We have determined that you are of Planet Three of our Solar system?" The cold man paused as if waiting for an answer.

Brad's voice came now, but hoarsely. "Yes, we are from Earth."

"We had detected life there but thought it more primitive." Ko-Pall's face displayed some slight signs of interest now. "Why did you come here?"

Brad's voice came easier. He explained the Animate theory, the question of man's survival, and the natural curiosity of Earthlings. When he had finished, the Primester Council filed solemnly out, like a panel of robed English judges.

They let him sleep eight hours in a cubicle off the central room—then back for questions. Question eight, sleep eight—methodically they continued the examination, covering every facet of earth life. Society and government, they probed until

there was nothing in his mind in those areas they did not know. The food concentrates they brought him were tasteless. He grew weary. Ko-Pall grew more persistent, almost sadistic, until the cold hard face and methods fused into a brittle sinister personality. And Brad knew the man was dangerous. He became so cruelly human —the racket boss, the dictator. In his nearly numbed state, Brad saw the possibility of answer to Earthman's dilemma fade and die in the face of this self-centered man. So here, after eons of existence, was man. Surviving, yes, but still the same selfish, power-mad creature that was the younger Earth kind.

Then, abruptly, the examinations ceased with Ko-Pall's pronouncement that the Earthmen were truly a threat to Europa. Brad knew that here would be Ko-Pall's stepping stone to more power, the elimination of the threat.

They had sent him to Mu-bar then—Mu-bar the Director of Bio-Sciences for Europa. It was to this wizened little man with crinkly cornered eyes and gentle mouth, and to his daughter Kay-bar, that Brad owed his survival these six months since the Primester's inquisition. Ko-Pall had conceded to Mu-bars' demand and had granted a six-month observation period.

Under this guise Mu-bar had taken Brad into his own apartment. There, with Kay-bar's daily company, Brad had learned the comforts of this hermetic world—the sonic shower, where now he stood tingling; the electronic appliances with no wires; the television and telepathic scanners, projectors, and monitors, even to control sleep and rest; the diseaseless cities; the algae and plankton food production; the artificial sunlight and power harnessed to Jupiter's ceaseless hydrogen eruptive activity, that was the great Red Spot. And with Kay-bar he learned the love he had not had time for in his Earth years of intense study and training.

With Mu-bar Brad learned the horrors—regimentation and hollow communal living, controlled genes that reproduced each human type needed for specific slots in the economy, which explained the similarity of the Primesters. He learned of the incessant and ancient migration of the race. He learned how Mu-bar, in revolt against the order, had altered the state prescribed genetic structure for his own daughter so that she had been born a throwback, an individual, unordered, unpatterned, quite human—and very female.

Now in his dark cubicle shower, Brad tried to bring it into focus—the cold vindictive Ko-Pall, the rational but dying world, his own lonely years of fierce objectivity, his own self-sufficient Earthkind. Eyes closed, he leaned against the close metallic shower wall, trying to reclaim some direction from the swirling weariness, while the whole universe coalesced, and all the outward flow of sense and life from the center of his being reversed and whorled inward to compress within the boundaries of consciousness. And he was aware of the buffeting flow—the baffling recoil and wildly richocheting outflowing force of self. For one bright moment, poised on the precipice of vast incomprehensible knowing, he knew the basic flaw of the man animal: that rational out-flowing, that centering in self of all that is knowledge, all that is being in time and space, all that is life—the misconception that humanity is in itself complete, the center of the cosmos, and that man is in control. Then in a moment it was gone and Brad was there again in the shower, just a scared little man in an alien land five hundred million miles from home.

—To be continued in the next issue of SPACE Journal—

IT IS OF GREAT IMPORTANCE that the general public be given an opportunity to experience—consciously and intelligently—the efforts and results of scientific research. It is not sufficient that each result be taken up, elaborated, and applied by a few specialists in the field. Restricting the body of knowledge to a small group deadens the philosophical spirit of a people and leads to spiritual poverty.
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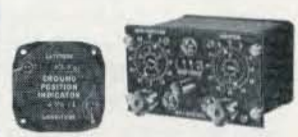

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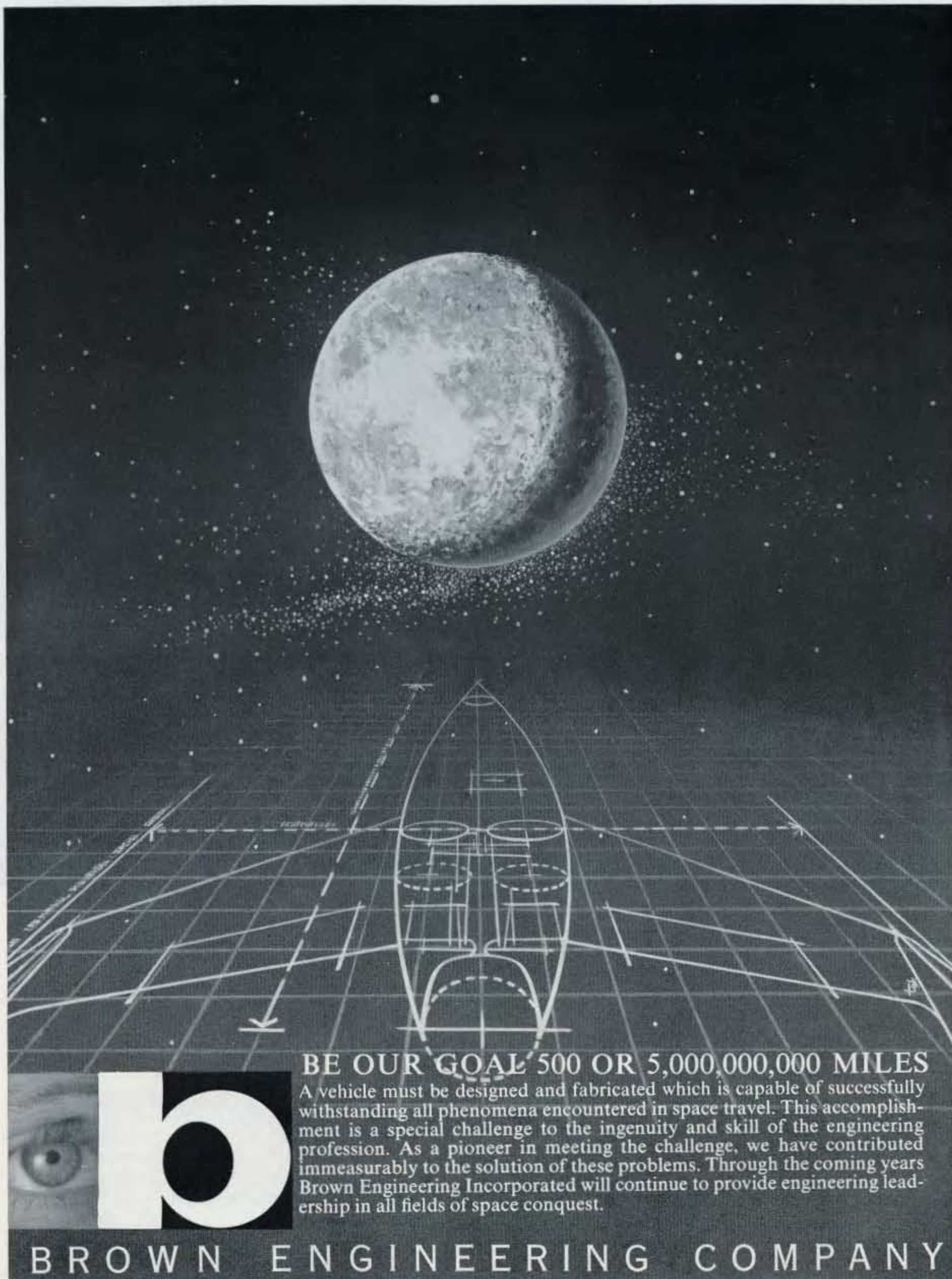
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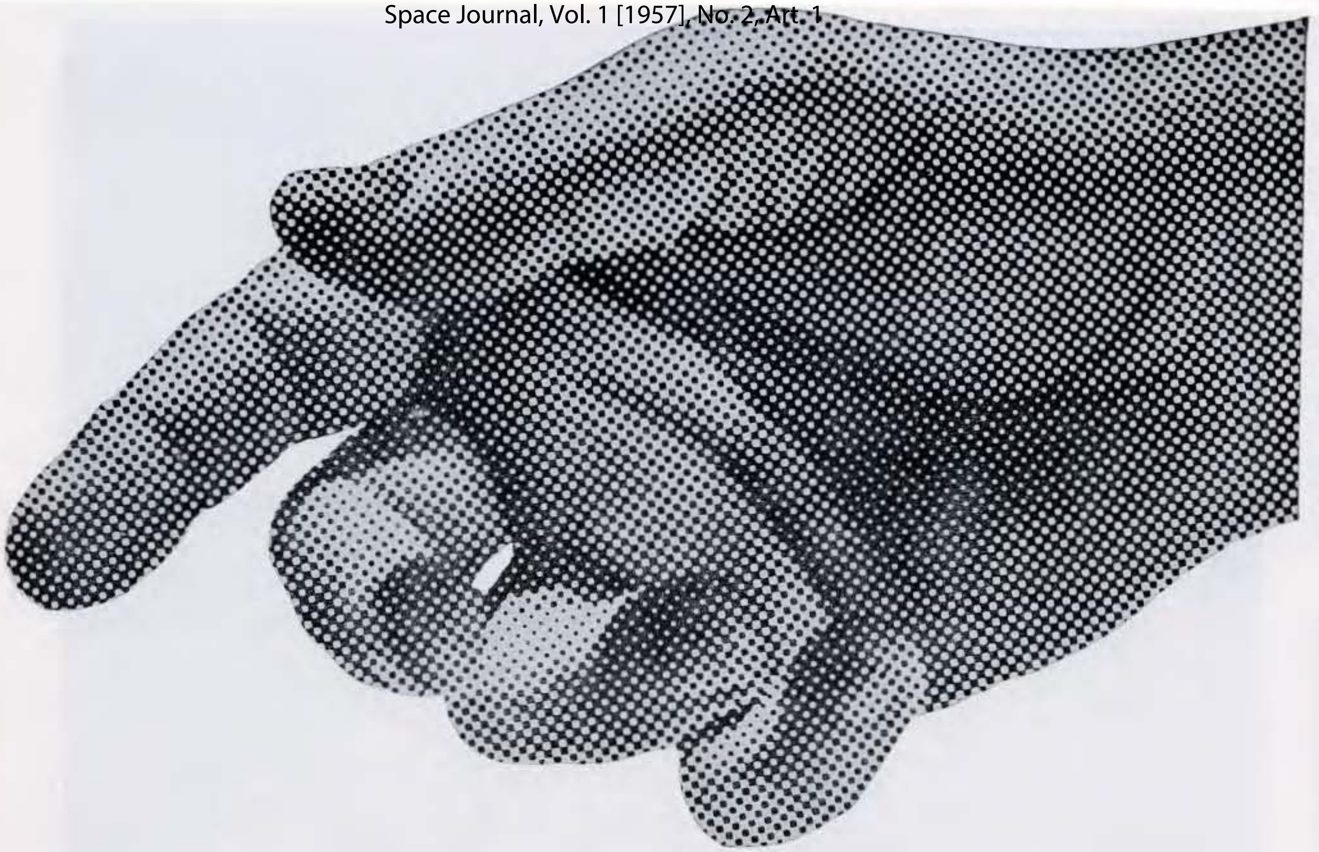

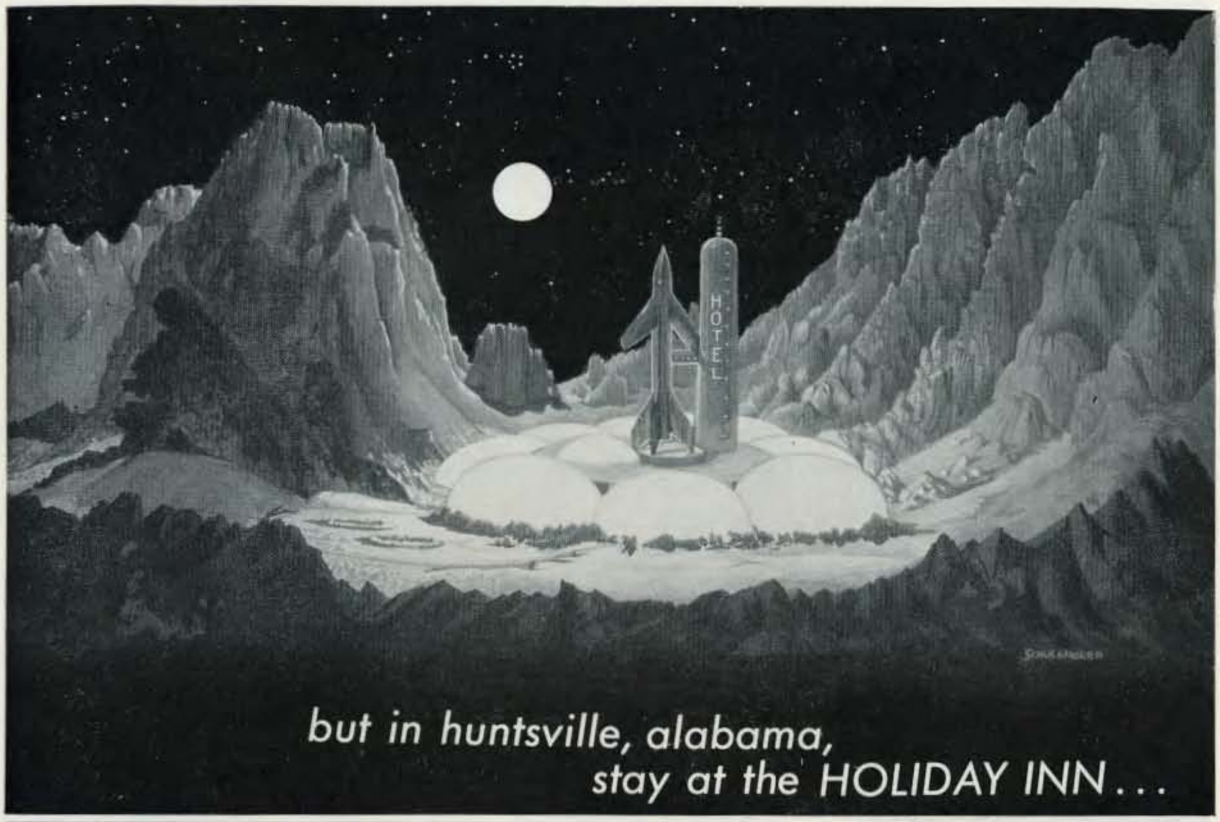

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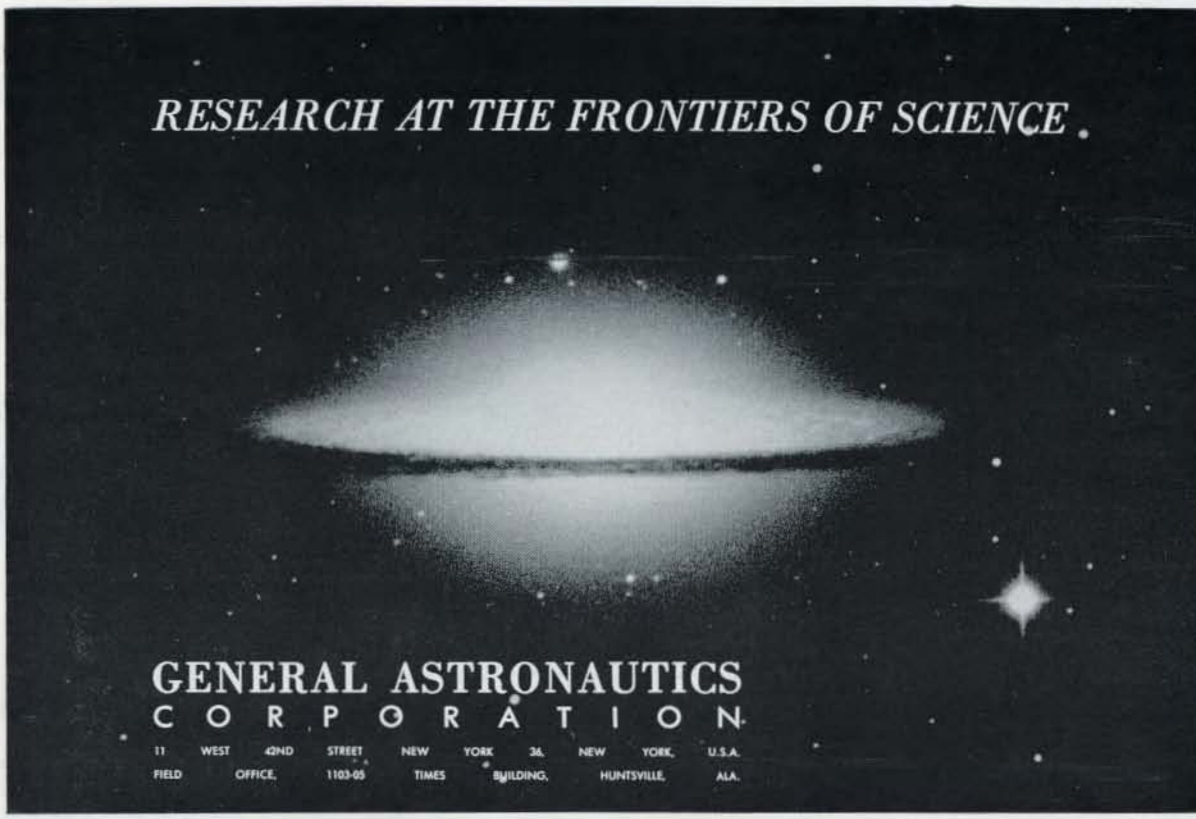
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