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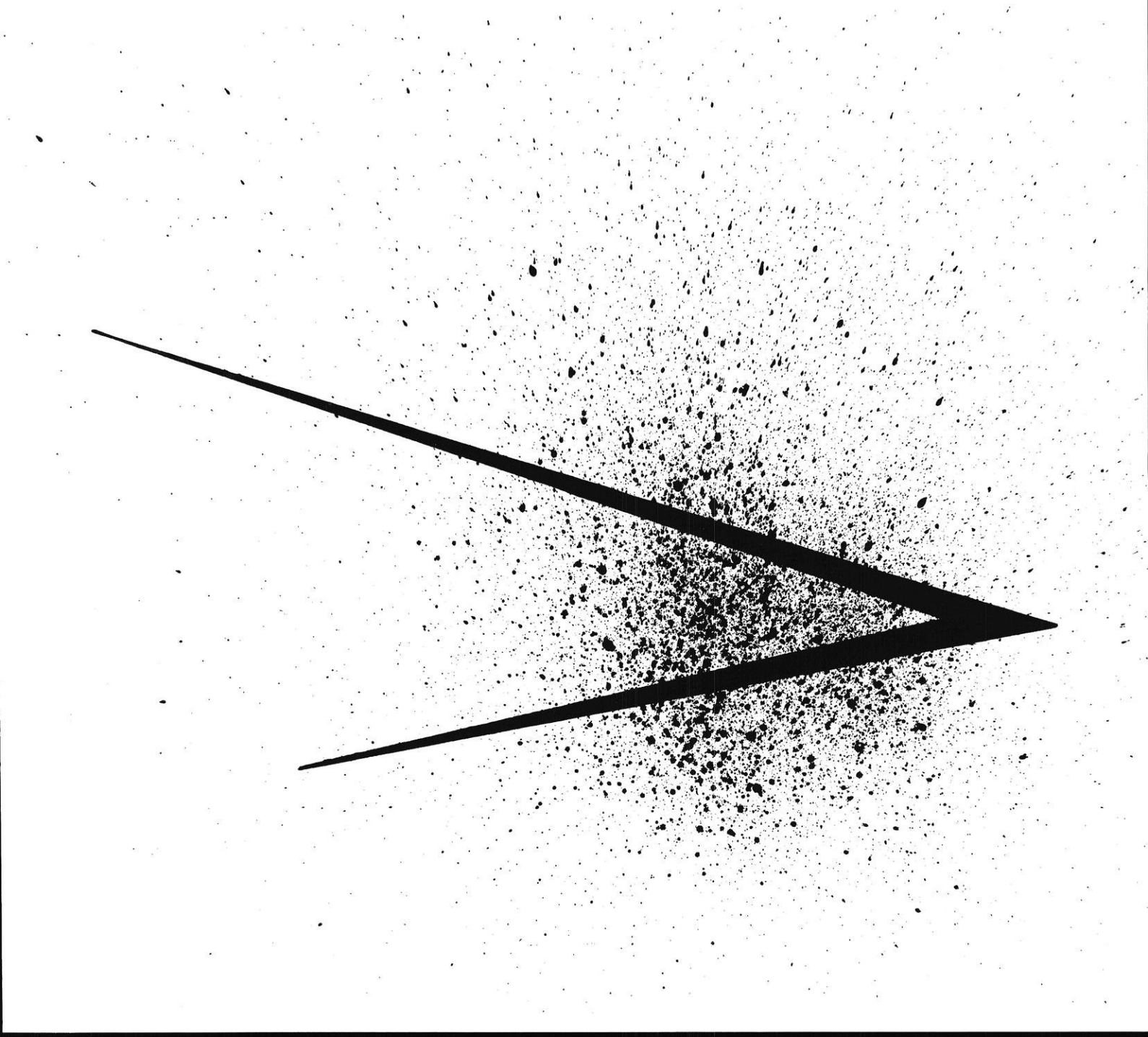
NOVEMBER, 1961 • 25 CENTS
MEMBER E. C. M. A.

THE WISCONSIN ENGINEER



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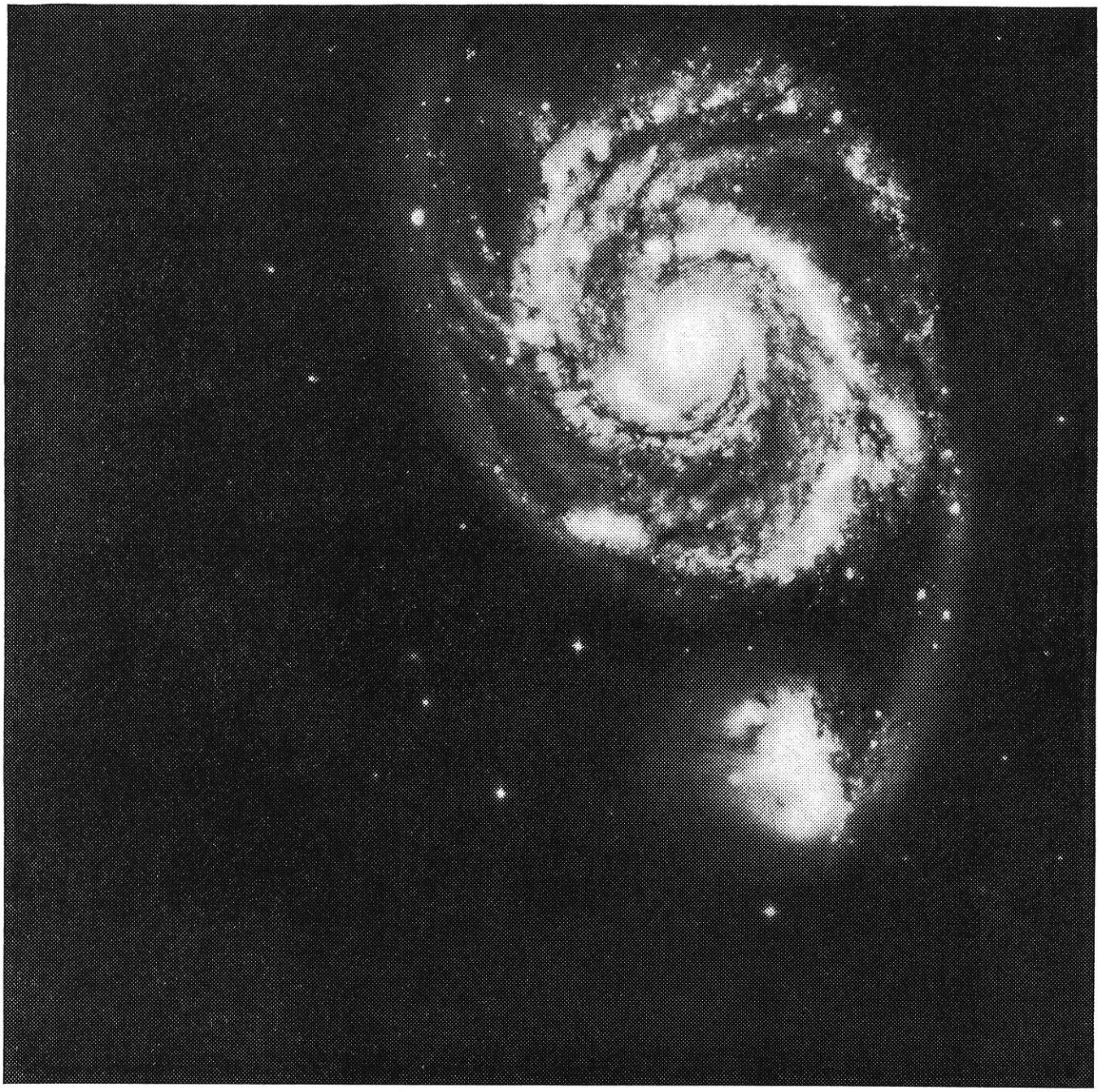

How cold is up? We know that outer space can never be colder than minus 459.72° Fahrenheit—that's absolute zero, the point at which all molecular motion ceases. We don't know what coldness like this will do to materials, but we're finding out. Scientists are using a heat exchanger to produce temperatures as low as minus 443° Fahrenheit. They test materials in this extreme cold and see how they perform. Out of such testing have already come special grades of USS steels that retain much of their strength and toughness at –50° or below; steels like USS "T-1" Constructional Alloy Steel, TRI-TEN High Strength Steel, and our new 9% Nickel Steel for Cryogenics applications. And the heat exchanger to produce the –443° Fahrenheit is Stainless Steel! No other material could do the job as well. Look around. You'll see steel in a lot of places—getting ready for the future. ■ For information about the many career opportunities, including financial analysis or sales, write U. S. Steel Personnel Division, Room 6085, 525 William Penn Place, Pittsburgh 30, Pa. U. S. Steel is an Equal Opportunity Employer. USS, "T-1" and TRI-TEN are registered trademarks.

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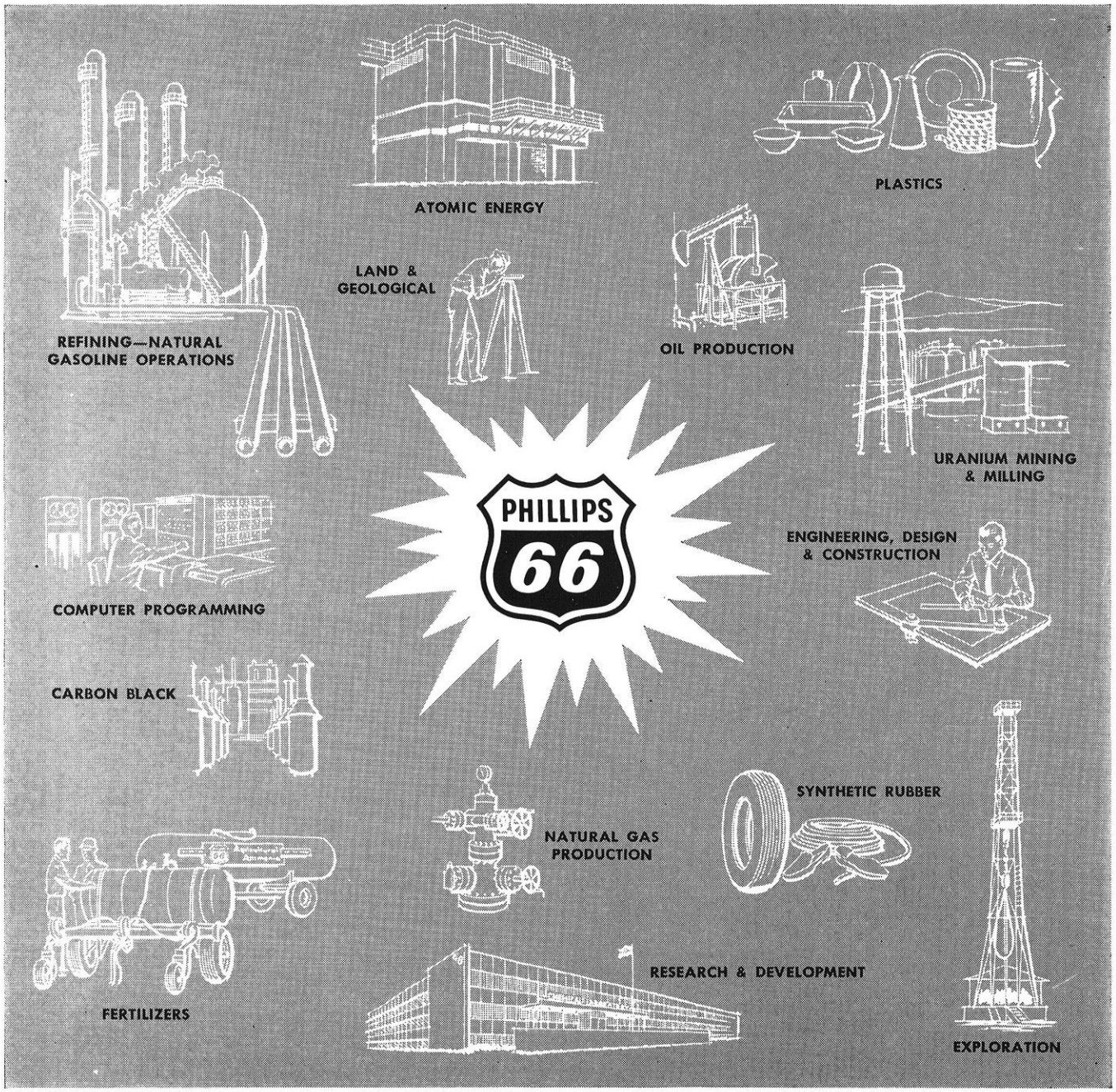

NOSTRAE VIRES IN DIVERSITATE POSITAE SUNT

Freely translated—"Variety is our forte". And for over 25,000 Phillips employees this variety adds extra spice to the job of earning a living and building a career. Hardly a day goes by without new and significant events—important research discoveries in the labs, new oil and gas fields, new plants, additional marketing areas . . . and, of course, personal promotions to meet the demands of company growth.

Because of its diversification, Phillips is, financially speaking, often compared to a mutual investment fund. It is strongly engaged in three basic industries—oil, natural gas, and chemicals. Products and services from these industries are used by nearly every other industry as well as by the consuming public. This broad participation gives Phillips unusual stability.

Phillips leads the petroleum industry as a (1) producer of natural gas liquids, most versatile of hydrocarbons, (2) seller of natural gas, (3) producer-marketer of liquefied petroleum gas, (4) manufacturer of nitrogen fertilizers, (5) supplier of raw materials to the rubber industry, and (6) in atomic energy activities. Phillips is also a major supplier of plastics and raw and intermediate materials for plastics, of carbon black, synthetic fiber ingredients, and many specialty chemicals. The company is among the leading oil companies in research, patents, and chemicals production.

Growth, stability, and diversification are significant aspects of Phillips Petroleum Company.

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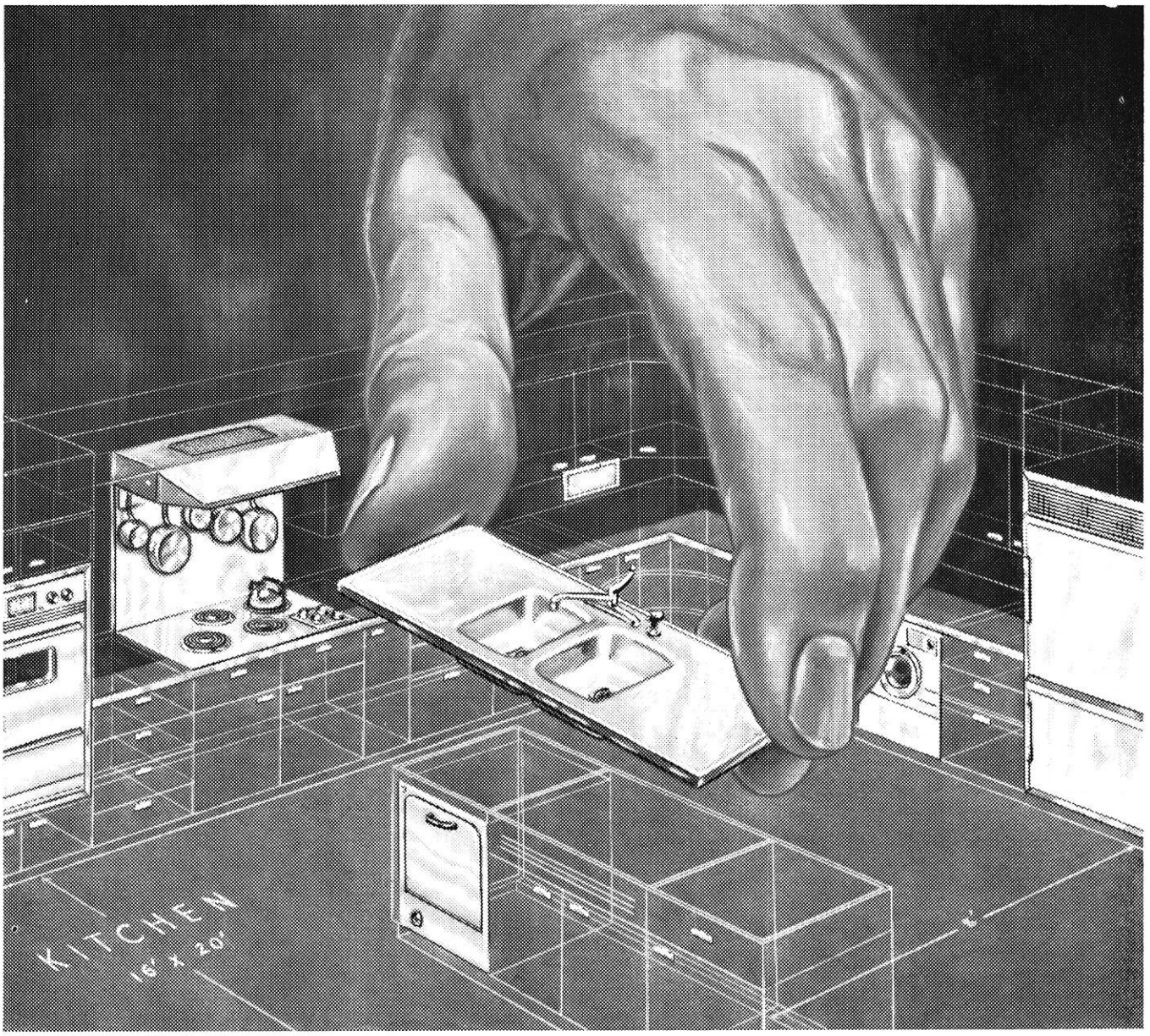
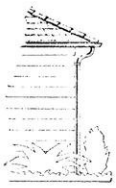
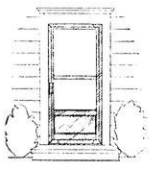


Build with the carefree beauty of stainless steel

Handsome appliances and gleaming counter tops that stay bright and are so easy to wipe clean...even the kitchen sink becomes a thing of beauty when it is made of shining stainless steel —the useful metal that was developed after years of research.



Whether you're building or remodeling, stainless steel gives a lifetime of value . . . saves many dollars in upkeep. You can now have gutters and downspouts that are almost indestructible because they won't rust or rot. And the strength of stainless makes possible door and window screening so fine you hardly know it's there.



The secret of stainless steel lies in chromium—one of many indispensable alloying metals developed by Union Carbide. They are typical of the hundreds of basic materials created through research by the people of Union Carbide in metals, as well as carbons, chemicals, gases, plastics and nuclear energy.

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ARTICLES

THE WISCONSIN ENGINEER

The Student Engineer's Magazine Founded in 1896

DEPARTMENTS

THIS MONTH'S COVER

This Month's Cover is from a sketch drawn by L. Quist. His theme is taken from his article on the hypersonic plasma barrier.

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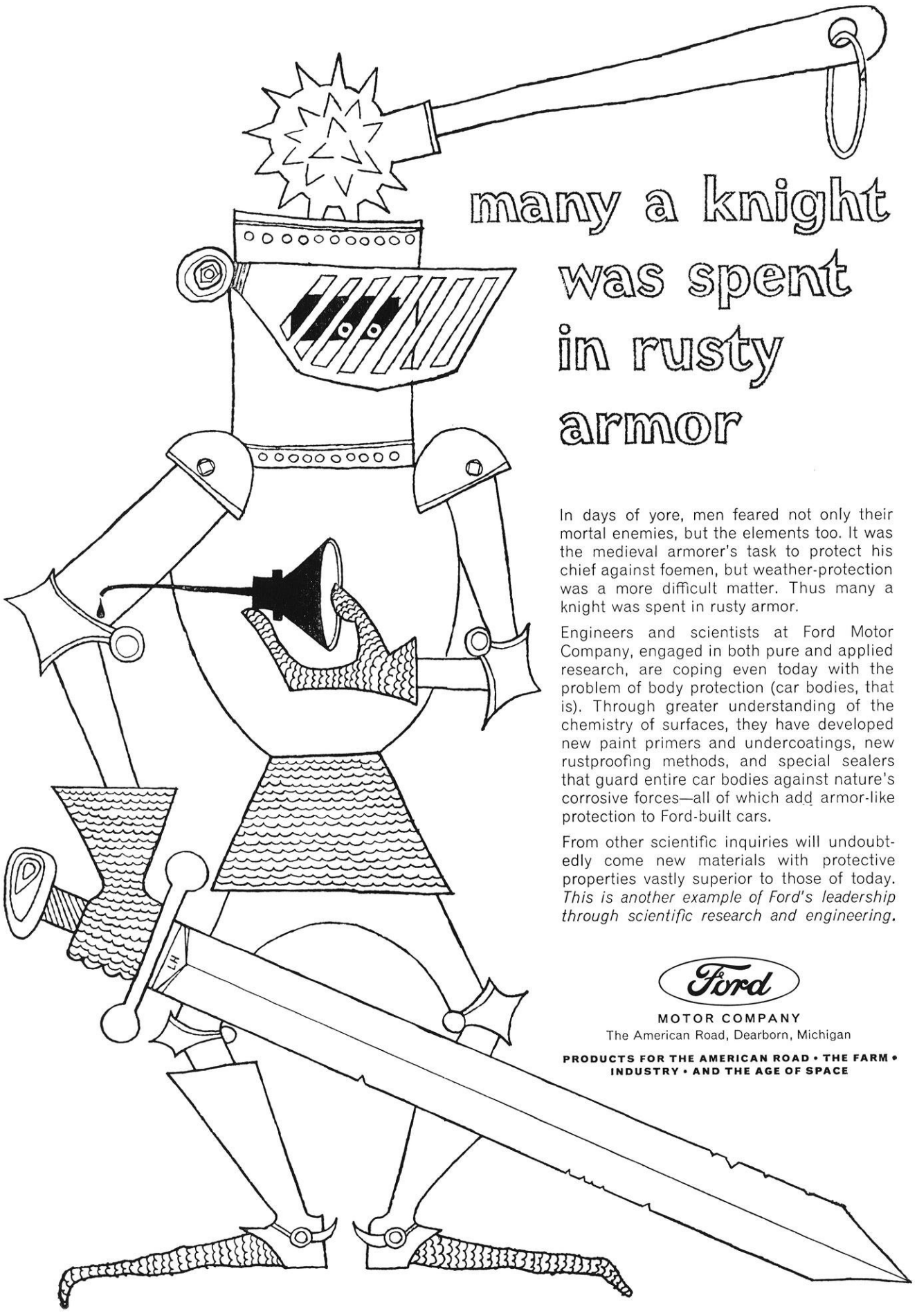

many a knight was spent in rusty armor

In days of yore, men feared not only their mortal enemies, but the elements too. It was the medieval armorer's task to protect his chief against foemen, but weather-protection was a more difficult matter. Thus many a knight was spent in rusty armor.

Engineers and scientists at Ford Motor Company, engaged in both pure and applied research, are coping even today with the problem of body protection (car bodies, that is). Through greater understanding of the chemistry of surfaces, they have developed new paint primers and undercoatings, new rustproofing methods, and special sealers that guard entire car bodies against nature's corrosive forces—all of which add armor-like protection to Ford-built cars.

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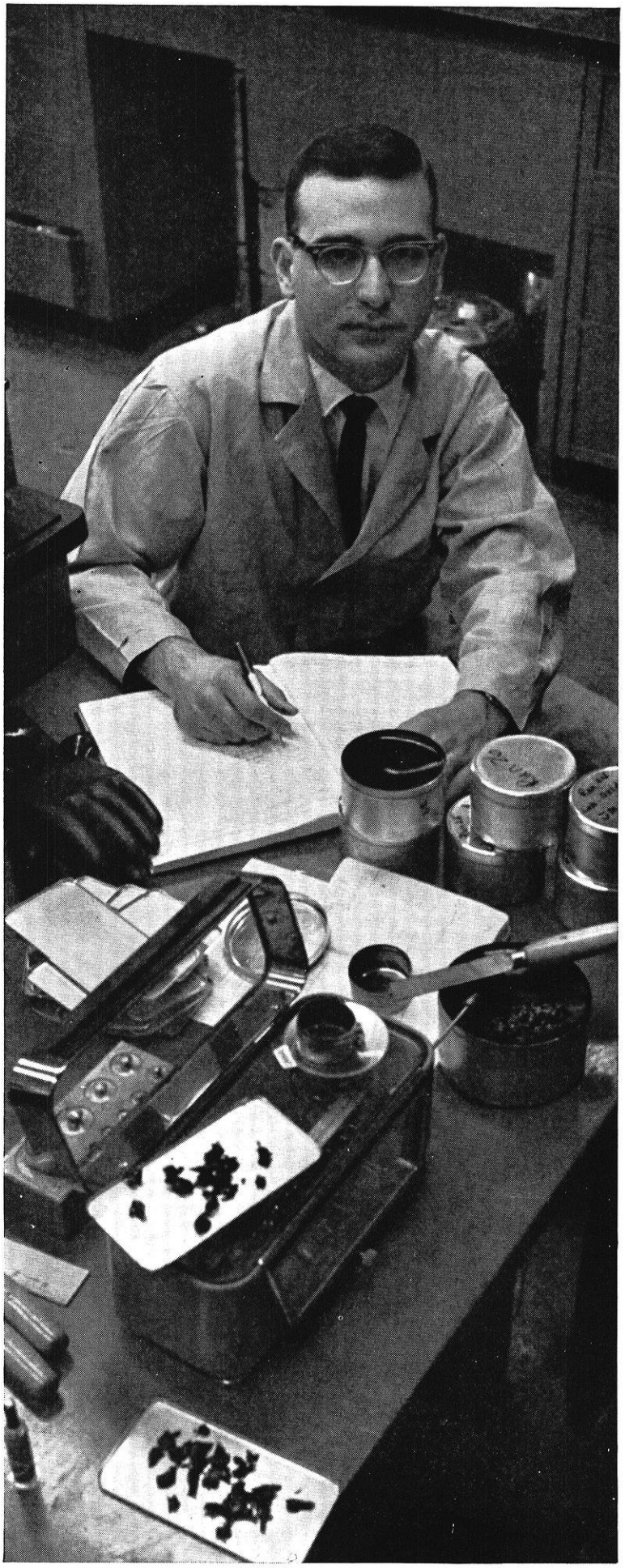

I chose a career, not a job!

by Pete Vossos

"I found a satisfying job right from the beginning —and more important, American Oil is diversified enough to offer varied opportunities for the future."

Peter Vossos earned his Master of Science degree at Iowa State, '58. As a physical chemist, Pete's immediate project is studying fundamental properties of asphalts with the objective of improving their performance in roofing and industrial applications. About his 2½ years at American Oil, Pete adds, "This is a company that's big enough and dynamic enough to be doing important work, but not so mammoth that you get lost in the crowd."

Many ambitious and talented young scientists and engineers like Peter Vossos have found challenging careers at American Oil. Their choice could have special meaning to you. American Oil offers a wide range of research opportunities for graduate chemists, chemical engineers, mechanical engineers, physicists, mathematicians and metallurgists.

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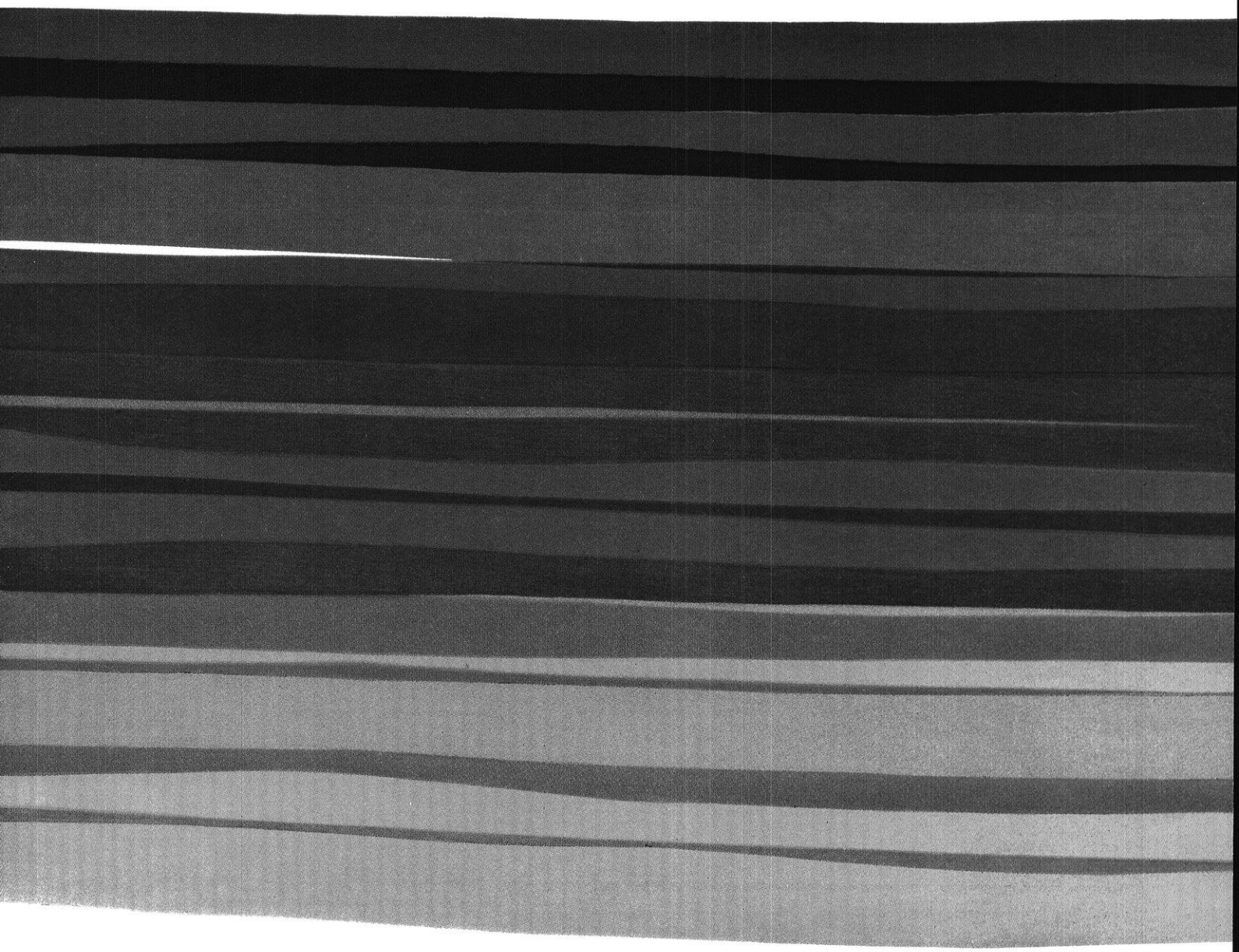

FRESH WATER FROM THE SEA

"If we can develop low-cost means of bringing water to thirsty lands and people of the world, we shall bring a boon to mankind that is even more meaningful than the conquest of outer space . . ."—U. S. Senate Report.

In the desert sheikdom of Kuwait, a Westinghouse plant is now extracting nearly 17 million gallons of fresh water every week from the extra-salty Persian Gulf. In San Diego, another Westinghouse plant will soon be producing drinking water from Pacific Ocean water—seven million gallons a week.

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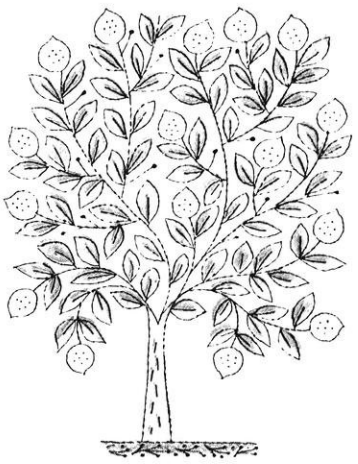

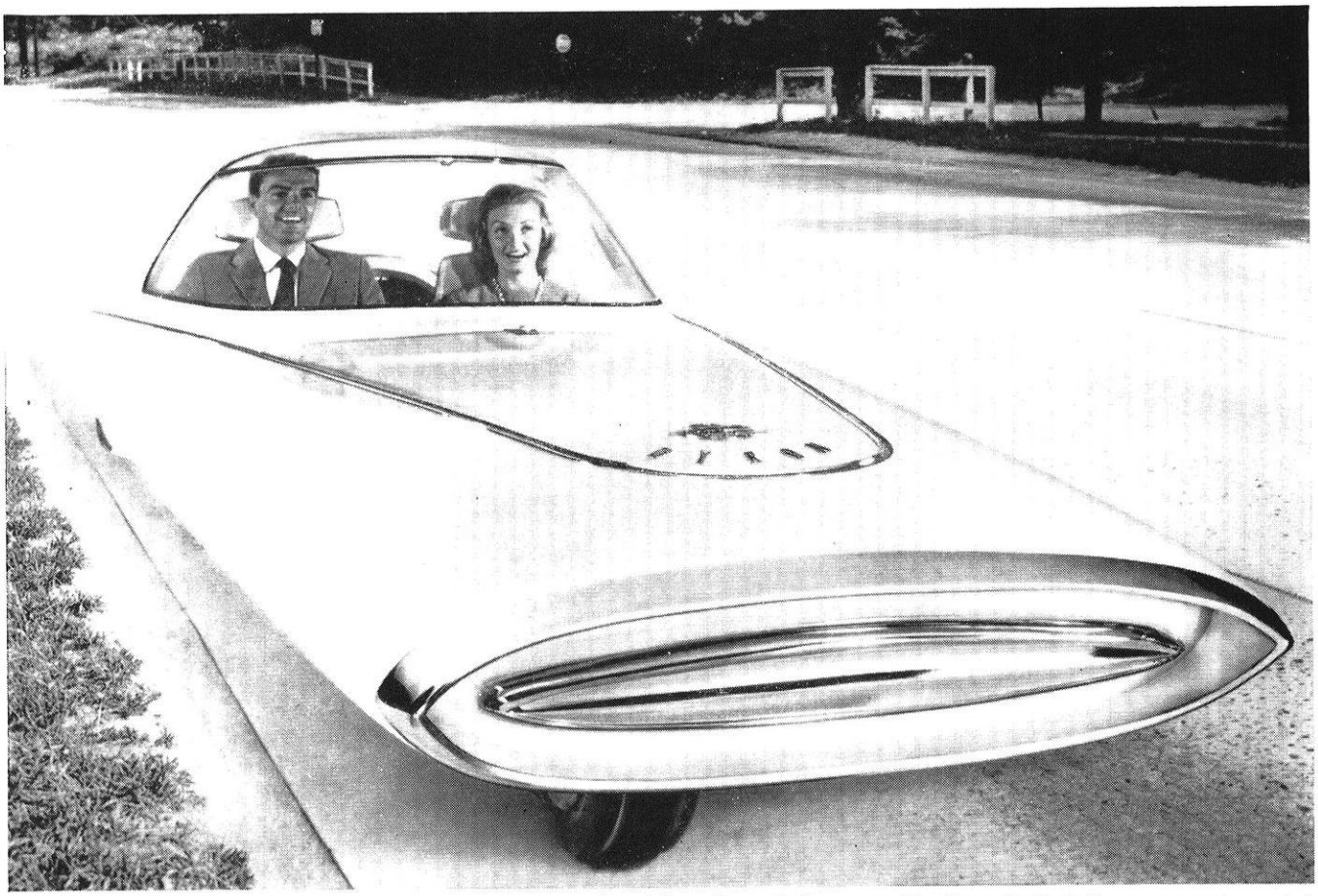

Gyron—dream car that drives itself. This two-wheeled vehicle of the future envisions automatic speed and steering control for relaxed "hands-off" driving. Designed by the advanced stylists of one of America's leading automotive companies, the delta-shaped Gyron would feature a computer that permits motorists to "program" their journey—distance, speed, arrival time—on a non-stop expressway. A gyroscope would stabilize the car in motion. Setting off the Gyron's sleek lines are parts coated with bright, corrosion-resistant nickel plating. The front bumper, exhaust ports, taillight bezel, control console, all get solid beauty-protection with this durable nickel coating system.

How Inco Nickel helps engineers make new designs possible and practical

The engineer is vitally concerned with design—inside and outside—whether it's an advanced new car or a nuclear-powered ship. With Nickel, or one of the many metals containing Nickel, he has a material that can meet the demands of a wide range of service conditions—providing an excellent choice for the equipment of today and the designs of the future.

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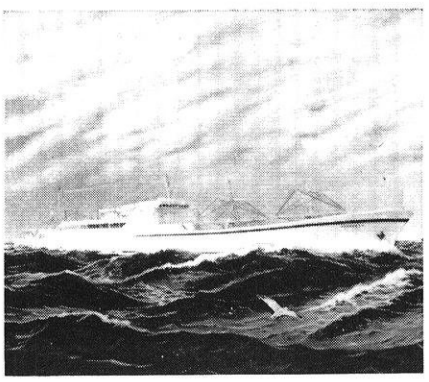
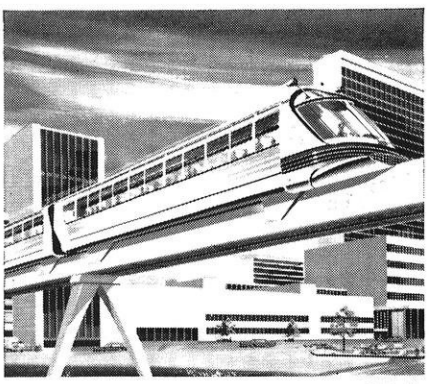


The Nuclear Ship Savannah is capable of sailing 350,000 nautical miles without refueling. Her uranium oxide fuel is packaged in tubes of Nickel Stainless Steel, more than 5,000 of them. Engineers specified 200,000 pounds of Nickel Stainless Steel for use in the ship's reactor to meet critical service demands.



Monorail "Airtrain"—a compact, high-speed transportation system that will be automatic, almost noiseless. Development is being explored by leading U.S. cities. Lightweight Monorail design demands strong weight-saving metals. Logical choice: Nickel alloys to take advantage of newest engineering concepts.

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Recently we asked some of them what factors influenced them to decide for Du Pont. They cited more than half a dozen reasons. Here are some they almost all agreed upon:

OPPORTUNITY AND RECOGNITION

They were aware that college-trained beginners go right to work with men who have achieved. For example, research chemists work with individuals who've done successful research. New engineers work with pros, some of whom have designed new plants, or devised new manufacturing methods, or distinguished themselves in some other way. And other graduates, with B.A. or M.B.A. degrees, go to work with leaders who've been successful in Sales or Advertising or Treasurer's, or another of Du Pont's many departments.

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Here are but a few since World War II: "Orlon"* acrylic fiber followed nylon (soon after the war). Then came "Dacron"* polyester fiber, "Mylar"* polyester film, "Lucite"* acrylic lacquer and "Delrin"* acetal resin. These, and many others, have created thousands of new jobs . . . in research, manufacturing, sales . . . in fact, in *all* Du Pont departments.

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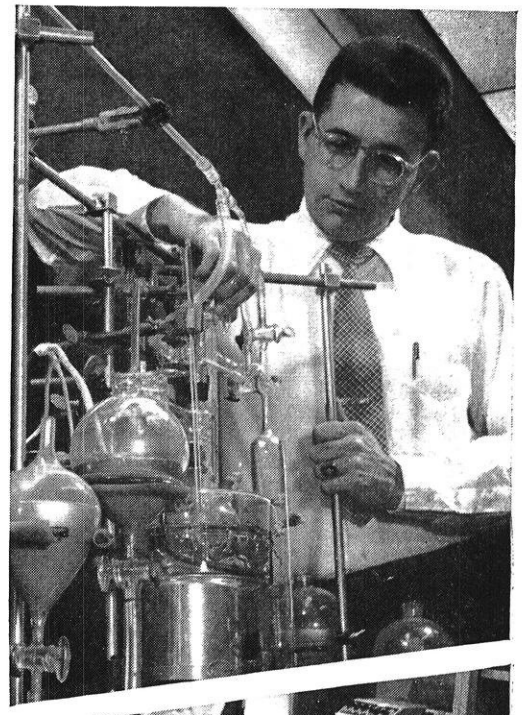
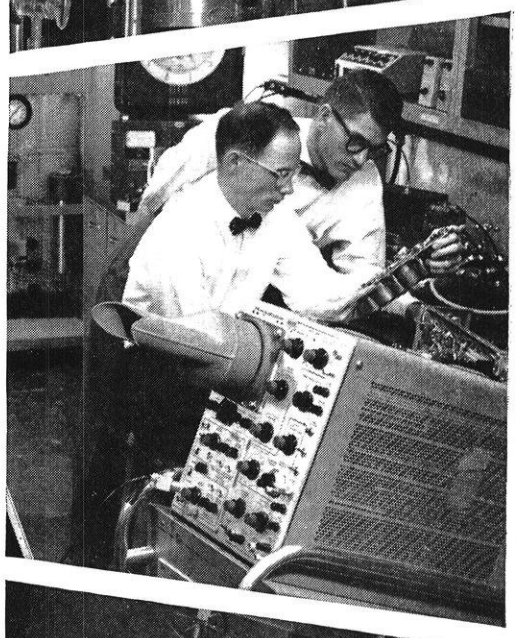
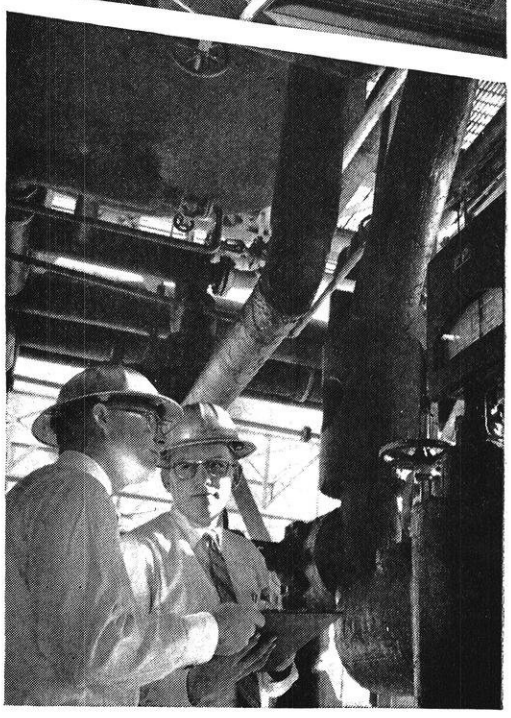
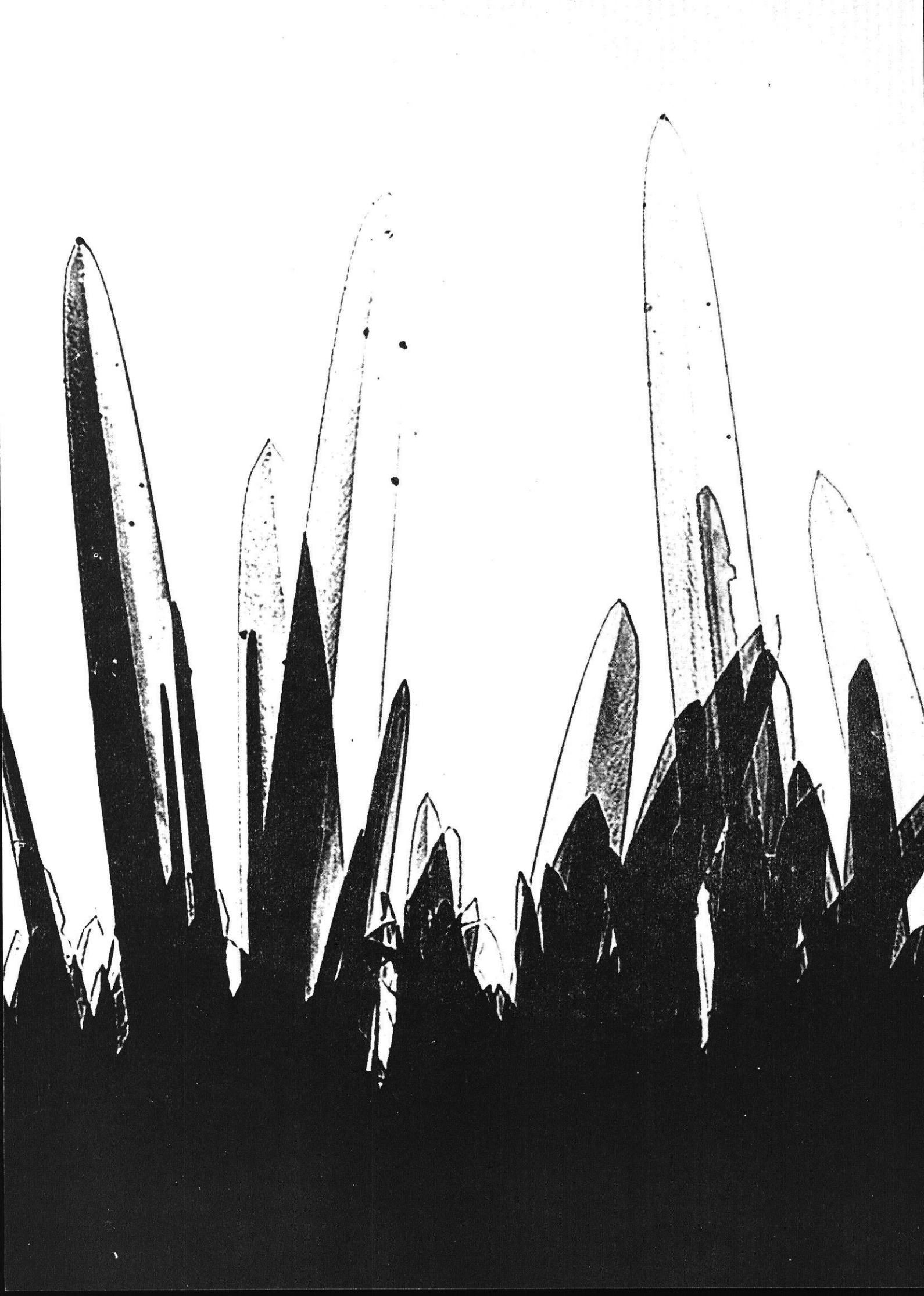








Rambling With The Editor

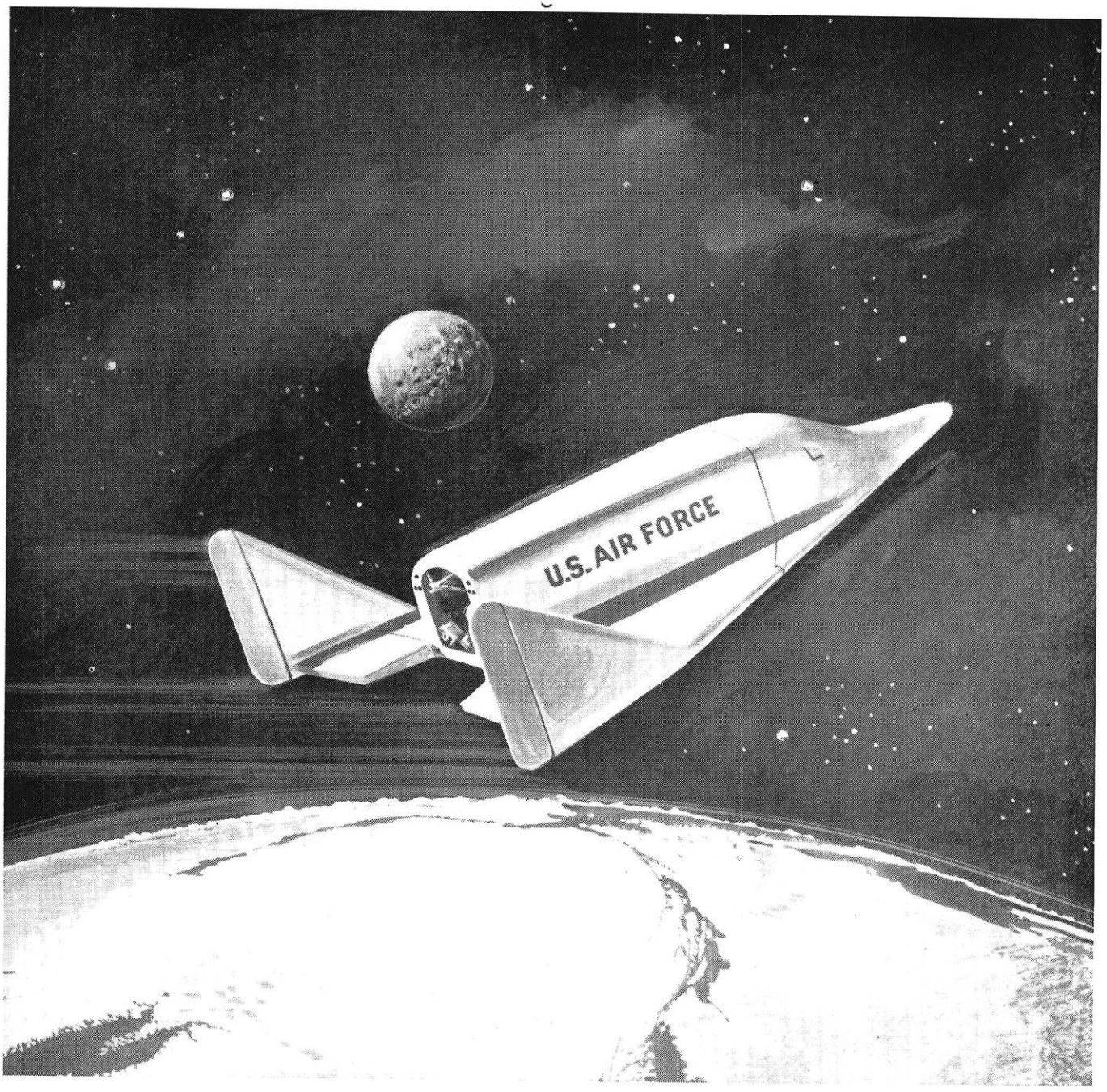
What Price Security?

In the past 20 years much legislation has been passed, and great sums of money spent, to make the lives of American people secure from the ravages of poverity, ignorance, and starvation. The schemes advanced by government planners to wipe out these horrible conditions are too numerous to list here. These plans are presented to the citizens with the comment that, "The cost of this is little enough to pay for the lessening of human suffering."

What is the price of this lessening? Most of us realize that these plans cost the government X billion dollars per year and many of us realize that the government's money is our taxes pooled in a common pot, but few of us stop to think about the losses of personal freedom that go hand in hand with more security. For instance, the government now decides the minimum amount of retirement insurance which you must carry, and then has the premium removed before you receive your pay. This is done even though you need the money for school expenses now, and will probably be in a much better position to save for the future after you have graduated. This is really about as sensible as making a starving man, with a good pair of shoes, buy another pair just because someday his present shoes will wear out. The simple fact of life is that we purchase our economic security with our political and economic freedom. I think you will agree that this is too high a price to pay.

I therefore suggest that as you go through school and through life you actively seek opportunity. For if you take advantage of life's opportunities you will have more security than you need without buying it with your freedom.

This photograph, taken through an electron microscope at the Westinghouse research laboratories, dramatically demonstrates the effect of water vapor upon the rusting of iron. In a dry oxygen atmosphere the iron forms a protective oxide coating thickly populated with tiny whiskers about 30-millionths of an inch high, each one growing from a specific site on the metal surface. But in an atmosphere of pure water vapor, the surface erupts into thin, blade-shaped oxide crystals, which reach a density of nearly one billion per square inch. As the blades of oxide grow in size, they spread across the surface of the iron causing it to corrode destructively. Less than one percent of water vapor in the dry oxygen atmosphere causes the destructive crystals to form.



Cooling space pilots from launch to landing

New concepts in airborne cooling have become vital to the progress of America's space program. For example, Garrett is now developing an advanced system for the Boeing Dyna-Soar manned space glider. It will use the liquid hydrogen fuel for the vehicle's own accessory power system to control the temperature of the pilot and equipment throughout the flight. This is another of the many systems in development by Garrett to further the conquest of space.

Project areas at Garrett with which you might wish to become identified include space life support systems, solar and nuclear power systems, electronic systems, air conditioning and pressurization systems, computer systems and small gas turbines for both military and industrial uses.

Available to newly graduated engineers is a several month orientation program to help you determine your future.

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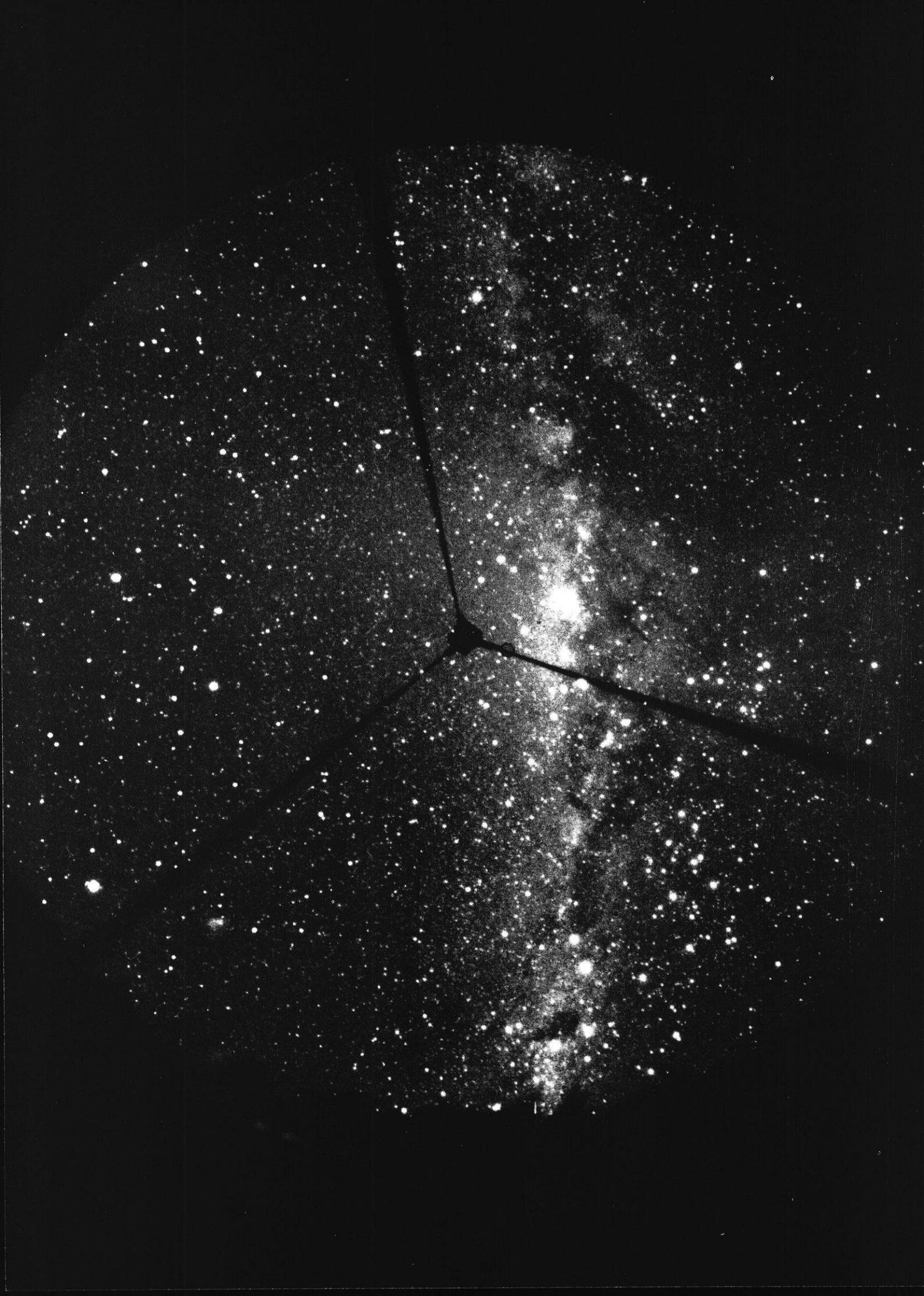


The Major Theories Concerning The Origin of The Solar System

by J. Nauman me'62

OF THE many fields of astronomy, perhaps the most fascinating and also the most difficult is cosmogony, the study of the evolution and origin of the Solar System.

The field of cosmogony has gradually been divided into two basic categories—one that the Solar System is the result of a gradual evolutionary process, and the other that some violent action associated with the interaction of a star with our Sun is the cause of the origin of our Solar System.

The major theories concerning the origin of the Solar System are pure speculation based on logical, observational, deductions. Since these theories do not depart from the scientific method, of attempting to arrive at a given result—the origin of our Solar System—from an assumed set of events, modern science has accepted them to be reasonably correct.

The major theories are : (1) Nebular Theory of Laplace. (2) Tidal Theory. (3) Collision Theory. (4) Binary Star Hypothesis. (5) Cepheid Theory. (6) Electromagnetic Theory.

The Nebular Theory of Laplace

A nebula is one of a large class of celestial structures, greatly extended and extremely slender, composed of matter in a gaseous or finely divided state.

This theory is based on two considerations: the existence of a nebula or nebulae in the Universe, and the well-known ring system of Saturn.

The two types of nebulae are extra-galactic or spiral nebulae, and diffuse gaseous nebulae. Since Laplace had no idea of the existence of spiral nebulae, his theory concerns the diffuse gaseous type.

Laplace theorized that very long ago the Sun was a gaseous globe, or nebula, consisting of a dense nucleus beyond which extended an immense atmosphere reaching to a distance in the vicinity of Neptune.

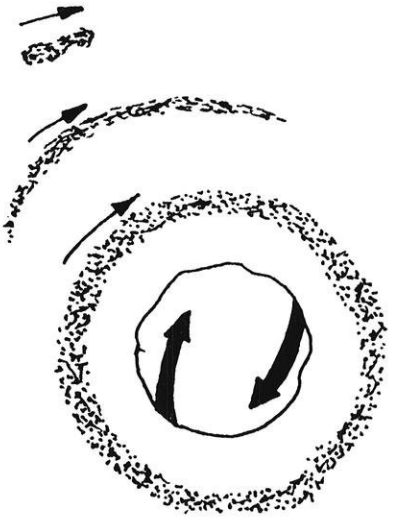
He further theorized that this nebula was originally rotating. Under gravitational attraction, the nebula would slowly contract, and by the laws of dynamics, its rotational velocity would increase.

We know from dynamics, that when a body rotates, a centrifugal force acts upon it, tending to pull it apart. Laplace supposed that when the centrifugal force in the outer layers of the nebula exceeded the gravitational force, gaseous matter was thrown off. This gaseous matter formed a ring similar to Saturn's which revolved in the same direction as the nebula, and in it's equatorial plane, (see fig. 1)

While revolving, this ring began and continued to contract, causing the matter in the ring to slowly collect into a single deposit of gaseous matter. Upon condensation and cooling, this matter developed into a planet which revolved around the nucleus of the nebula in an approximately circular orbit.

As this process continued, the nebula continued to contract, and

Fig. 1



THE SOUTHERN MILKY WAY

Photographed with the Greenstein-Henyey Wide-Angle camera at Bloemfontein, South Africa. Field of view 140°. The center of our galaxy lies slightly to the right of the intersection of the shadow of the camera struts.

threw off six more rings similar to the first ring. These six additional rings became six more plants by the same process, and the highly condensed core became the Sun.

One of the questions you may be asking yourself is what happened to the other two planets? The Nebular Theory only accounts for seven. During Laplace's time the other two planets had not been discovered.

Todays Laplace's theory is considered a poor approximation for the formation of a planet's satellites, as well as the planets.

An astronomer named Jeffreys, has calculated that if a satellite has a present diameter of less than 2,500 miles, it could not be formed through the condensation of gaseous mass. Since most satellites have diameters much less than 2,500 miles, the majority of the satellites could not be formed by Laplace's theoretical process.

Another serious objection to the theory is that the Sun once extended beyond our outermost planet. Immense giant stars do exist, but they are small in comparison with Laplace's theoretical diameter of six billion miles.

Astronomers are reasonably sure that the Sun's age is only around ten billion years, which would mean it is a young star. In that period of time the Sun's mass could not have diminished to what it is today. It seems unlikely that the Sun has changed much at all during its lifetime.

If the Sun were its present size during the origin of the Solar System, the planets could have been pushed away from the Sun to the tremendous distances they are today.

One of the most serious objections to this theory is that the composition of nebular material is different from the planets in our Solar System. Apart from hydrogen and helium, all other elements, in the Sun, are extremely rare. Yet in the Earth and the other planets, hydrogen and helium are rare in comparison with the abundance of iron, calcium, silicon, magnesium, and aluminum. Due to this objection, the Nebular Theory has been ruled out.

Tidal Theory

Because of the weaknesses of the Nebular Theory, cosmogonists have turned to the alternative idea of some violent action associated with the interaction of a star with our Sun as the cause of the origin of the Solar System.

Just as the Moon causes tides on our oceans, by gravitational attraction, a star, assumed much more massive than our Sun, raised immense gaseous tides on our Sun as it started to pass by. As the star continued past the Sun, the tides on the Sun distorted into a huge filament, (see fig. 2). This filament soon broke away from the Sun with a rotary motion about it.

After this filament broke away from the Sun, it broke up into sections, each forming a distinct aggregation of matter. Later these sections cooled and contracted into a planet in a highly elongated orbit.

Since the orbits of the planets were highly elongated, after one or more revolutions they again came close enough to the Sun for tidal action to partially disrupt them. The result of this disruption was to cause small filaments to break off from the different planets. Upon cooling and contraction of these filaments, the planet's satellites were formed.

The question arises as to what caused the orbits of the planets to change from the elongated orbits to the approximately circular orbits of today? The change in character of the orbits is attributed to Solar matter dispersed about the Sun in addition to the filament. While in the elongated orbits, the planets collided with the Solar matter, causing the eccentricity of the orbits to be reduced to the circular orbits of today.

One of the main faults in the Tidal Theory is it's inability to explain the revolution of the planets about the Sun. All the theory states is that the filament broke up, and cooled and contracted into planets with highly elongated orbits. But how did the planet get the highly elongated orbit? What gave the planet it's original motion? This is not explained.

The other main fault is the difference in composition between the Sun and the planets. If the theory had stated that the Sun broke up the star it would be more reliable because you could assume a star with the same composition as our plants.

If it would not be for the difference in composition of our Sun and the planets, this theory would be a fair approximation for the origin of the Solar System. But due to this difference, the Tidal Theory has been ruled out.

The Collision Theory

The failure of the Tidal Theory to give a satisfactory explanation of

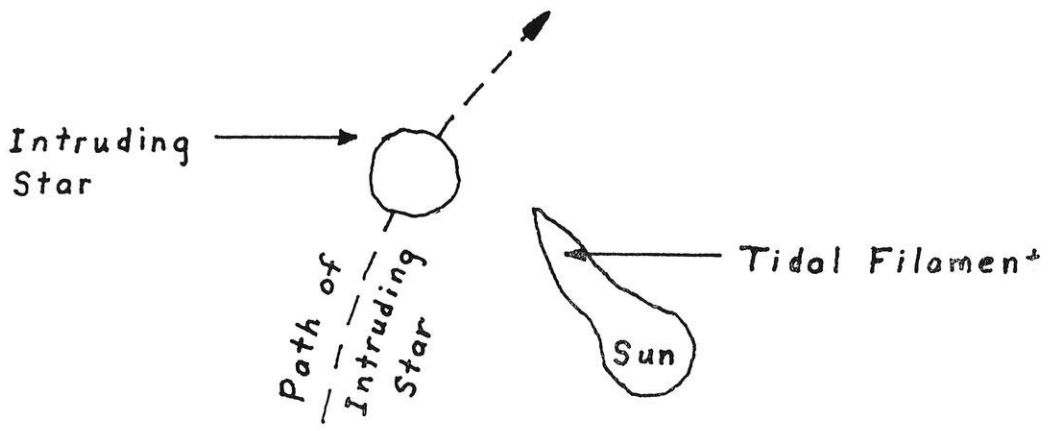


Fig. 2

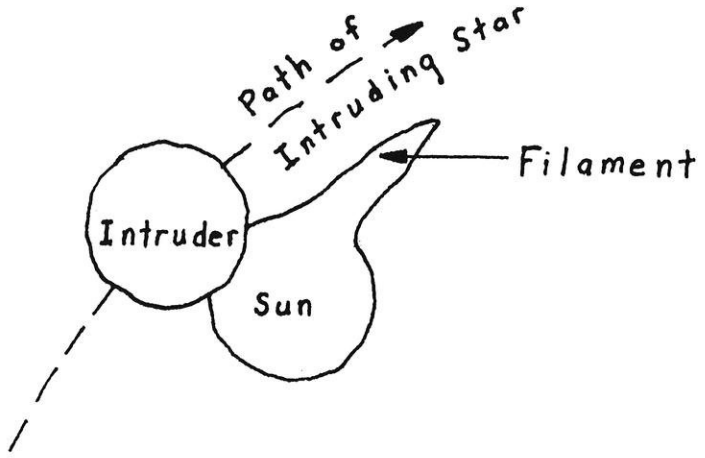


Fig. 3

the rotations of the planets caused a man named Jeffreys to modify the Tidal Theory. He theorized that the encounter of the star with the Sun was a collision, though the collision was not exactly head-on, as shown in Fig. 3.

It is extremely hard to submit this theory to any type of mathematical proof, so Jeffreys' arguments were strictly on a qualitative basis.

Despite the use of a qualitative scale, this theory does have some success, particularly regarding planetary orbits and rotations.

After collision with our Sun, the star still carried enough momentum to escape the Sun's gravitational attraction. The filament was supposed to break up and follow the same Tidal Theory process.

What caused the planets to revolve about the Sun at their great present distances? Jeffreys argued on a qualitative basis, so he could not explain this. Today we know that it could not be caused by the angular momentum of the colliding star because in such a collision, between two gaseous bodies, momentum would not be conserved.

The other fault in this theory lies in the probability of a star colliding with our Sun. It has been mathematically derived that the probability of such an event is one in 13 billion-billion.

If we were able to find some way to account for the gain in angular momentum of the filament, after the star has collided with the Sun, this theory could be the answer. Although the probability against it is still great, there is a chance. Therefore we cannot rule out this theory, but must place it on a "ready line" until we are able to account for the gain in angular momentum.

The Binary Star Hypothesis

One of the chief faults with the last three theories has been the impossibility of explaining a reasonable process by which the planetary matter ejected from the Sun is moved to the great distances of today and set in motion in circular orbits. This difficulty would be reduced if the matter from which the planets formed were originally as far away as a planet such as Saturn. In this case the planets would not be a product of the Sun.

Professor H. N. Russell theorized that if the Sun was once a binary star (a twin-star system) and if another star made a close approach to the Sun's companion star, producing the same effects as in the Tidal Theory, the angular momentum and Tidal Theory problems would be reduced.

It would be correct to assume that the Sun was once a binary star because they are common in our Galaxy. Since this assumption is correct, the Binary Star Hypothesis is another modification of the Tidal Theory. The only difference is that the passing star acted upon the Sun's companion causing the same Tidal Theory process to occur on it. The Sun was not affected.

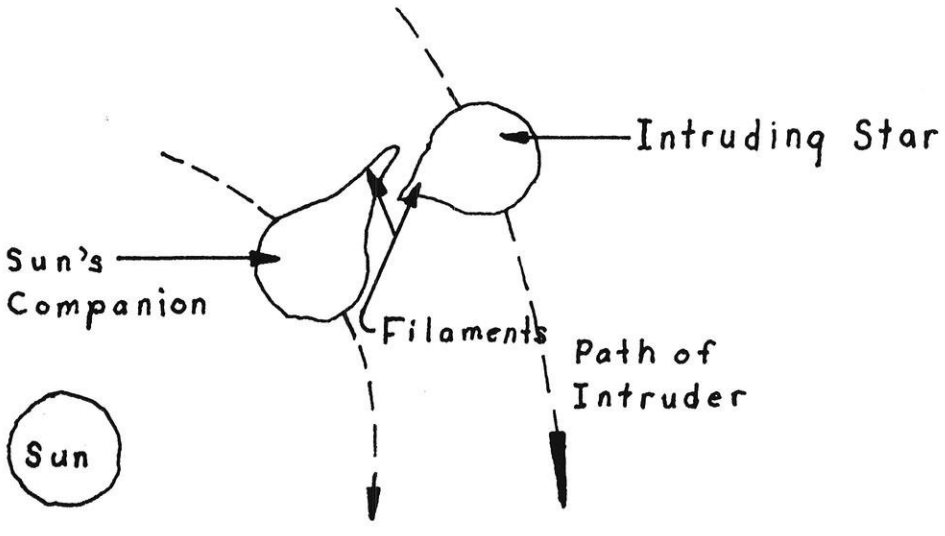
This suggestion of an encounter of a passing star with the Sun's companion raises the problem of explaining how the Sun's companion was removed from the Sun's control, and how the tidal filament stayed in the Sun's control later breaking up and condensing into planets. Dr. R. A. Lyttleton found a solution to this problem in 1936.

Suppose that the orbital radius of the Sun's companion was 1700 million miles, so that if the mass of the companion is equal to the Sun's mass, the period of the companion is about 50 years, and the orbital speed is about 6 miles per second. The path of the intruding star is not necessarily in the plane of the binary (see fig. 4), and its speed relative to the Sun is at least 20 miles per second.

In order to produce great enough tidal forces on the companion, the intruding star must be three to four million miles away from it. Since the companion star is so far away from Sun, the tidal effect on the Sun, due to the intruder, would be negligible.

If the mass of the intruder is

Fig. 4



about equal to the mass of the companion star, it is probable that the intruder will eject a tidal filament. Lyttleton has proven mathematically that if this occurs, the filaments will stay in the Sun's control, and the intruding star and it's companion will disappear into galactic space.

This theory accounts for the angular momentum associated with the planets as it was designed to do. But this theory is open to one serious objection; what process produced the immense changes in distances of the planets from the Sun? This remains unexplained.

Because the changes in distances of the planets are unexplained, we must conclude that although this hypothesis clears up the angular momentum problem. It is no better an answer to the origin of the Solar System than it's three predecessors.

The Cepheid Theory

The Cepheid Theory is a fairly recent theory on the origin of the Solar System, advanced by Professor A. G. Banerji in 1942. The basic idea in his theory has not been used by many scientists.

He began his theory by using a Cepheid variable such as Delta Cephei, a bright star in the constellation of Cepheus. A star of this type pulsates, and if not disturbed, will continue to pulsate without causing any harmful effects to itself. But an intruding star will change this situation; the extent of the pulsations will increase under the gravitational attraction of the intruding star. As the pulsations continue, the Cepheid will become unstable and will throw off vast quantities of matter. These vast quantities of matter condensed into the Sun and it's planets.

If the ejection velocity is great, the Sun and planets will leave the parent Cepheid. The orbital motions of the planets around the Sun are supposed to be due to the lateral attraction of the parent Cepheid. Later the Cepheid disappears into space. This theory is excellent because it explains the uniformities of the Solar System, such as angular momentum, and orbits of the planets.

Although all the implications in this theory have not been fully worked out, it is already an excellent theory. Once the composition argument, and how the planets got their satellites is worked out, it will be one of our best theories.

The Electromagnetic Theory

In all the previous theories, only mechanical forces such as gravitational attraction and friction have been used to try to explain the origin of our Solar System. In 1942, Dr. Hannes Alfven used electromagnetic forces.

Like the Earth, the Sun also has magnetic properties associated with it. These properties are referred to as the Sun's "magnetic field."

To illustrate the importance of electromagnetic forces, Alfven calculated the ratio of electromagnetic force to gravitational force on a proton in Pluto's orbit, our farthest planet. The ratio is 250 to 1. He concluded that if the Sun is surrounded by electrons and an ionized cloud of the elements, the influence of electromagnetic forces on positively changed atoms is predominant.

First Alfven had to explain how the Sun could become immersed in a cloud of ionized atoms. He assumed that the Sun was rotating more rapidly at one time, and passed into a gaseous nebula in which the atoms are initially unionized, electrically neutral. These atoms were gravitationally attracted toward the Sun, acquiring energy of motion in the process. At some critical distance from the Sun, this energy is great enough to tear away one or more outer electrons from other atoms. By this process, he said the Sun could be surrounded by an immense envelope of ionized atoms which extend to planetary distances.

Alfven then applied the laws of motion for changed particles in a magnetic field, and showed that this envelope will accumulate around the Sun's equatorial plane. This accumulation would take place at distances comparable with Jupiter and Saturn from the Sun, and would be set into rotation by solar energy.

Most of the atoms would condense into planets, by this rotatary effect and the remainder of the atoms, because of the new planet's magnetic field, would be condensed into satellites.

This theory has one main difficulty, it must be modified to account for the formation of Mercury, Venus, Mars, and Earth. At present, this has not been done, and is still in the development stage. Once it has been developed, we will have gained another very excellent theory.

Conclusion

In conclusion, we can be reasonably sure that the Solar System originated from a single activity on a large scale very long ago.

Scientists are still not certain whether the Sun or some star was the parent of our Solar System. Perhaps we are even on the wrong track. Only the development of better scientific equipment and more complex mathematics and physics can tell us this. All theories proposed at present fail to have any proof.

The task is difficult; present mathematics is unable to cope with the complexities in some of our theories, our present laws of physics cannot be considered unchangeable, and new discoveries in mathematics and physics add new problems.

Perhaps we will never really know, or we may know by next year. This has caused the mystery of the origin of our Solar System to be a great challenge.

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A canny Scot was engaged in an argument with the conductor as to whether the fare was to be five cents or ten cents. Finally the disgusted conductor picked up the Scot's suitcase and threw it out the window just as the train was crossing a long bridge. It landed with a mighty splash.

"Hoot, mon," screamed the Scot. "First you try to rob me and now you've drowned my little boy!"

THE HYPERSONIC PLASMA BARRIER

by L. K. Quist, ee'62

CRAFT entering the lower portion of the earth's atmosphere at extremely high velocities encounter a multitude of problems. one of the specific problems has been the transmission and reception of information during the time interval in which an ionized plasma region is formed when the high velocity craft hits the lower denser portions of the atmosphere.

Some proposed solutions to this problem along with the economic factors in each case are presented in this paper.

The Nature of The Plasma Barrier

Present radio communications encountered a great difficulty in trying to reach vehicles entering the lower, denser portions of the earth's atmosphere when these vehicles are in the velocity range of 3600 to 15,000 miles per hour. This may be attributed to the fact that at these tremendous velocities the kinetic energy of the decelerating vehicle is transformed into internal energy of the vehicle's surroundings. This energy is sufficient to cause the ionization-dissociation reactions between nitrogen and oxygen.

With the formation of high density nitric oxide ions and electrons, a sheath is completely wrapped around the vehicle; the high density ions adhere close to the vehicle while the electrons tend to move toward the outer portions of what may now be termed the plasma region. The shock front is actually a cone which extends back into the regions of turbulance.

When an electromagnetic radio wave is incident upon the plasma, the individual electron receives the entire energy absorbing and re-radiating it so that the actual wave is absorbed, reflected, and refracted in the plasma. The air breakdown properties, atmospheric intrinsic impedance, wave phase velocity, and noise levels are all modified by this action.

It can easily be seen that the stage of re-entery when the plasma region is formed, and thus the stage when radio communications are blocked out, will become a rather critical period of time in the landing of craft from outer space. Any very small error in the computations will multiply itself many times at such velocities. At this point, constant radio communications must be kept with high speed computers to compensate for any small deviations. Thus the importance of solving the problem of communications to these vehicles is realized.

Proposed Chemical Solutions

Three methods of solution by chemical means have been put forth. The first of these involves the use of a refrigeration system that will transfer the heat generated at the nose to the rear of the vehicle where it may be put to positive use. This system will require an extensive amount of heavy refrigeration and will probably not be used considering the very high fuel per pound ratio now required to leave the earth.

The second proposed chemical solution is to inject chemicals into the region of the plasma so as to combine with the electron formations. Fluorine and oxygen are some of the better possibilities, since their outer shell configurations enable them to react strongly with high electron concentrations. Here, again, an additional—perhaps unnecessary—payload is going to mean added fuel costs.

Finally a flow of supercooled gas such as helium or hydrogen over the nose cone will reduce the increase of internal energy of the vehicle's surroundings, but it has essentially the same drawbacks as the others.

Electrical Solutions

A high intensity field may be produced of sufficient strength to reduce the conductivity of the plasma to a level where the incident wave may pass through. This, however, is little more than a brute force method and the massive machinery that would be required in this case prohibits this method.

By using the derived formula for the index of refraction:

$$n = \sqrt{1 \quad \frac{-Ne^2}{E_0 m W^2}}$$

where: W = modulated wave frequency
e = charge of the electron
N = number of electrons per meter squared
E_o = permitivity of free space
m = mass of an electron
n = index of optical refraction

(Continued on page 22)

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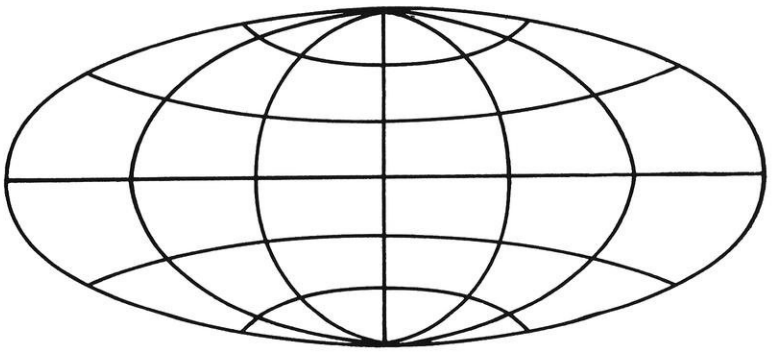

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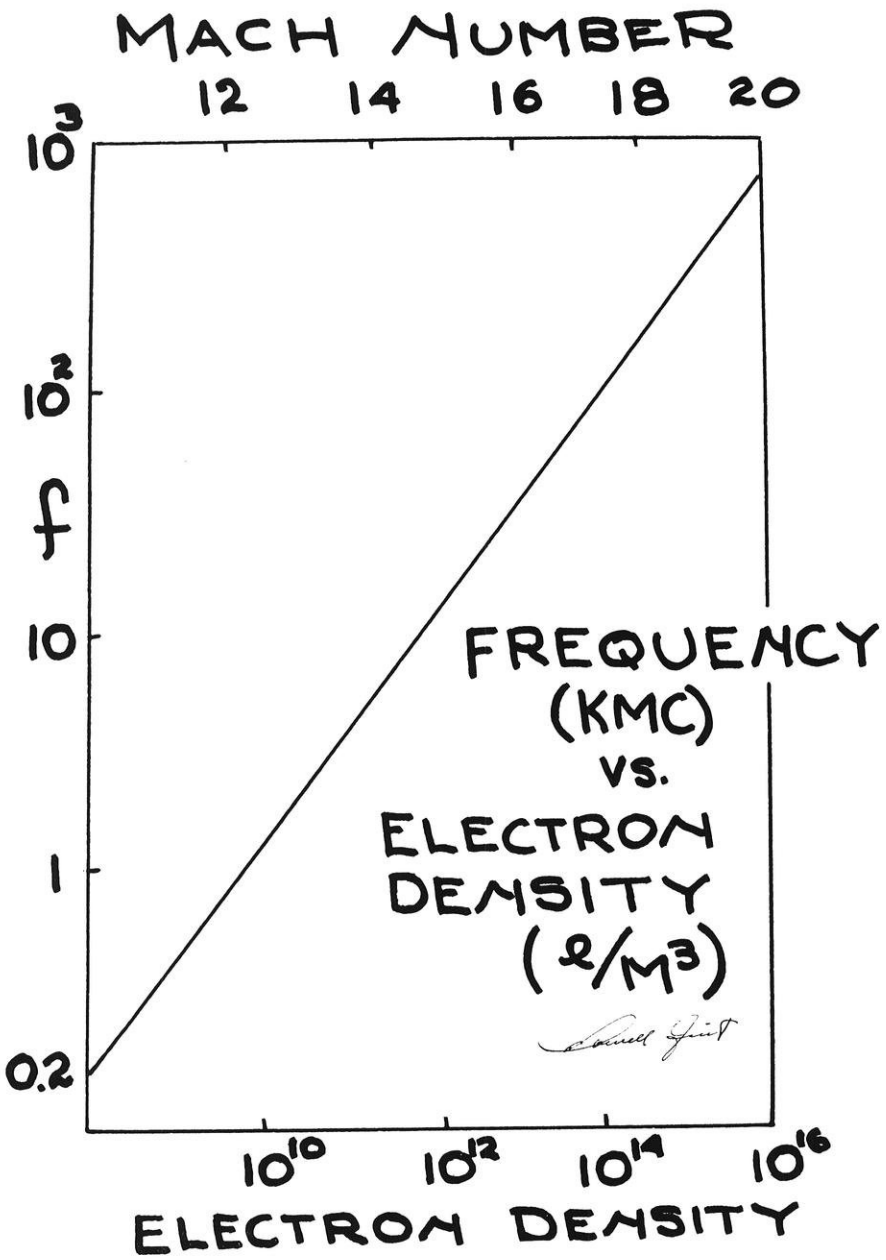

At the point where n = o the frequency is called the critical frequency. It can easily be shown that the critical frequency

$$W_{cr} = \sqrt{\frac{Ne^2}{mE_o}}$$

When m is a real number, the wave will pass through the plasma region. When n is zero the wave is reflected. When n is imaginary, the wave does not travel in the plasma region. Figure 1 shows that for increased velocities or increased electron densities, modulation frequencies of over 100 kilomegacycles must be utilized in order to make the wave travel in the plasma region. From this, the need to make the wave travel the plasma region for n imaginary or complex is appreciated.

Figure 2 shows the attenuation for various critical plasma frequencies as plotted against the modulated wave frequency. From this curve it may appear that the answer would lie in the usage of either very-low or super-high-frequencies. Let us first consider the use of v-l-f. Their long wavelength makes them unpractical because of the reflective properties the ionosphere exhibits toward them.

The use of super-high-frequencies also presents problems. In this range of frequencies the atmosphere tends to attenuate. In the case of either v-l-f or s-h-f the problem exists of having to convert all of our conventional communications equipment over from the very-high and ultra-high-frequencies, and to do this would require a prohibitive expenditure.

In the past few years experiments have been conducted in the lab, with new research aircraft, and with our missles. As of now, the most rewarding research has come from the plasmas studied in the lab, since most of our present-day aircraft and missles do not reach velocities required to give an electron density much over the lower limit of that required to produce a plasma region.

The work that has been done in the lab has indicated that there may be a fairly practical method of passing a traveling wave through the regions of high electron density.

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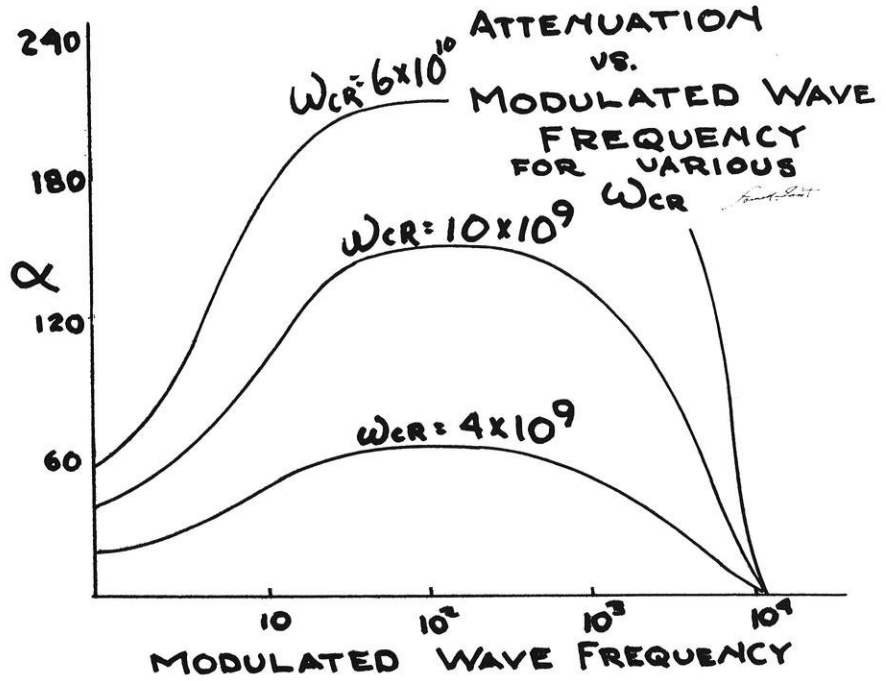

Flight Stabilization and the Adaptive Concept

by James D. Carlson, ee'62

THE increasingly evident fact that present aircraft flight requirements are causing open-loop control systems to be tremendously and unjustifiably complex, has created a great need for adaptive control systems. The greater heights and faster speeds, that todays' aircraft are capable of achieving, are responsible for the response of the vehicle varying over a much wider range; the range and nature of the response depending on the change in environment. It is just this change in environment which must be compensated for. To illustrate, a jet pilot acquires the habit of continually injecting a minute, low frequency test signal to the control stick such that he may become accustomed to the behavior of the vehicle as the environment changes, something that the pilot of a conventional aircraft does not do. The above mentioned complexity of open-loop systems not only means higher cost for building the control unit itself, it also means that the unreliability of the system could result in failure and destruction of an entire test vehicle. What is needed is a system which is more precise and reliable.

The answer to the problem can be found in an entirely new class of controls; adaptive control systems. Referring back to the jet pilot; he adapted his behavior, by testing the response of the vehicle, to a changing environment. It is exactly this trait of the human being, adapting to environmental changes, which is imitated in adaptive controls. The primary purpose of an adaptive system is to automatically change, or adapt, its own system parameters in order to obtain optimum dynamic performance of the vehicle.

The word adaptive has an origin which is biological. It is referred to as a process of self-modification in an organism in accordance with a changing environment or structure. Various definitions and classifications and classifications arise due to the manner in which the concept is applied to control processes. Figure 1 gives a description of the characteristics of a control process and its environment that are subject to change.

This block diagram indicates the areas in which variations in the control process might occur. Variations might appear in the process parameters, input command, or as disturbances. The disturbances, although shown as being injected at only one point in the network, may appear at the input—as random noise, or at the output—an example being wind acting on a radar antenna.

The process parameters are capable of changing with respect to time, physical environment, or signal level. For example:

1. The mass and moment of inertia of the vehicle changes with fuel consumption.
2. The control surfaces of an aircraft exert less turning torque as the atmosphere becomes less dense with altitude, and are more effective with increasing speed.
3. The gain of an amplifier is lowered if it is saturated by an excessively high signal level.
4. The gain of an amplifier may change with temperature, radiation, or power supply variations.
5. The rate of a chemical process increases with temperature and pressure.
6. The response of an aircraft may not be known with any exactness until it is built and in flight.

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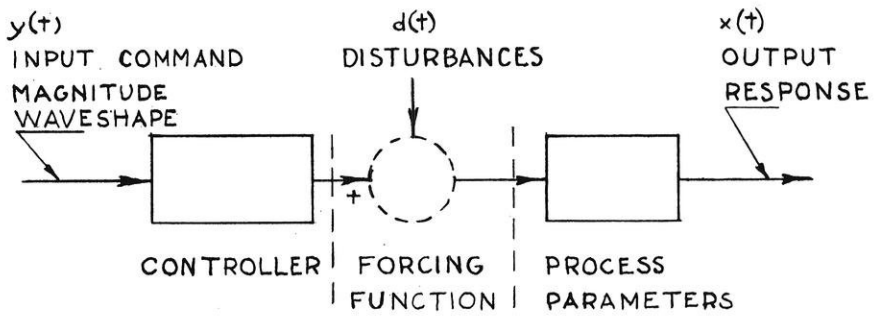

Fig. 1.

The input can vary in two ways over a wide range. The magnitude of the waveform may vary, and the nature of the signal itself may vary. It may be required of a servo to follow a slowly moving input in the presence of noise, and at the same time, be able to move to a new target in a minimum of time, two requirements that could conflict. If the input signal or the disturbances vary over a wide range, application of an adaptive feature is highly desirable.

Having discussed an adaptive system in a general manner, it might be beneficial to present a broad, working definition of the concept. To be considered adaptive, a system must, due to a change in environment, change its internal parameters in order that a predetermined criteria for good performance is fulfilled. In order to sense the environmental changes, the system monitors its own performance or accepts outside inputs which carry the desired environment changing information.

To illustrate the application of the adaptive concept, servomechanisms from the Inertial Reference Servo developed by Sperry Gyroscope Corporation for the X-15 research aircraft will be presented. The entire system consists of a gimbaled stable platform whose gyros and accelerometers are interconnected to an analogue computer to provide continuous measurement of vehicle orientation and inertial velocity components.

Some of the system servos are purposely designed to be nonlinear. They sense that a change in environment has occurred, and automatically switch to a new mode of operation having different parameters, thereby yielding improved operating conditions.

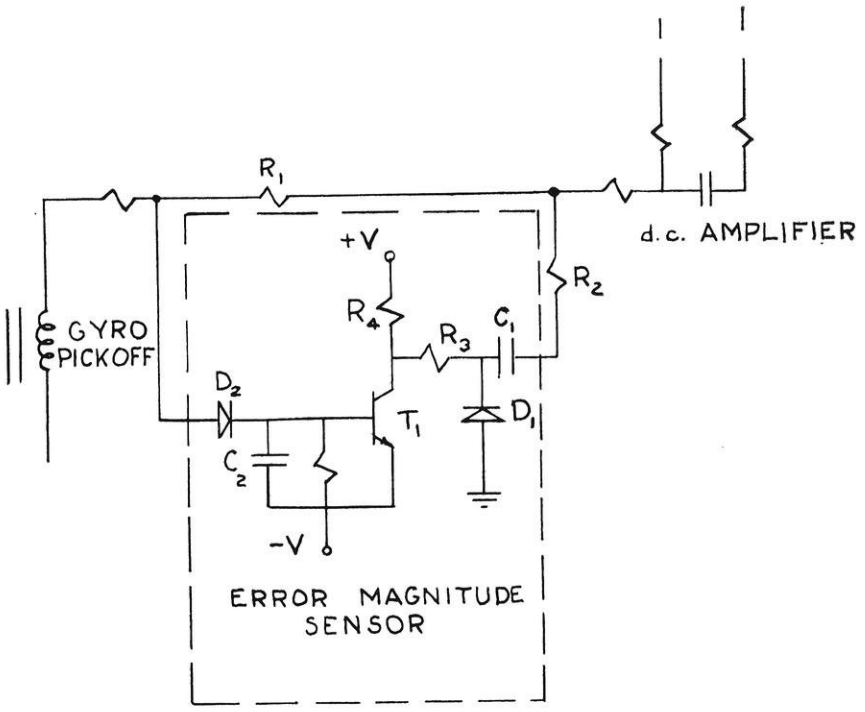

Fig. 3.

The first application of an adaptive feature is in the gimbal stabilization loop, shown in Figure 2. The function of this loop is to detect disturbances other than those encountered in linear operation. When an abnormal disturbance is detected, the gain of the loop is caused to change. The gimbal moves until it establishes the gyro case in a predetermined space referenced position.

Under normal operation, any error signal is detected by the gyro and amplified by gains A1 and A3. The amplified signal is applied to the motor, which drives the gimbal, which in turn positions the gyro case. New signals are generated by amplifier A3. They are derivatives of the error signal. The purpose of the new signals is to damp the servo response in order that stable operation will result. Normal disturbance torques are well within the capabilities of the motor.

It is possible that a severe transient signal may appear in the loop. The non-adaptive servo, when subjected to this excessive signal, would become violently unstable. The derivative damping signals would be completely swamped out.

Inclusion of an adaptive feature prevents harmful oscillations from occurring by detecting the disturbance and automatically cutting the loop gain by one-third. This new value of gain is maintained until the transient signal has completely died out.

The heart of the adaptive feature in this loop is the error magnitude sensor, shown in Figure 3. Its function is to compare the error signal from the gyroscope with a fixed reference voltage. The reference voltage is that voltage which causes the diodes and transistor to simultaneously begin conducting. The combination of T1 and D1 in a conducting state provides a low a-c impedance path to ground. The

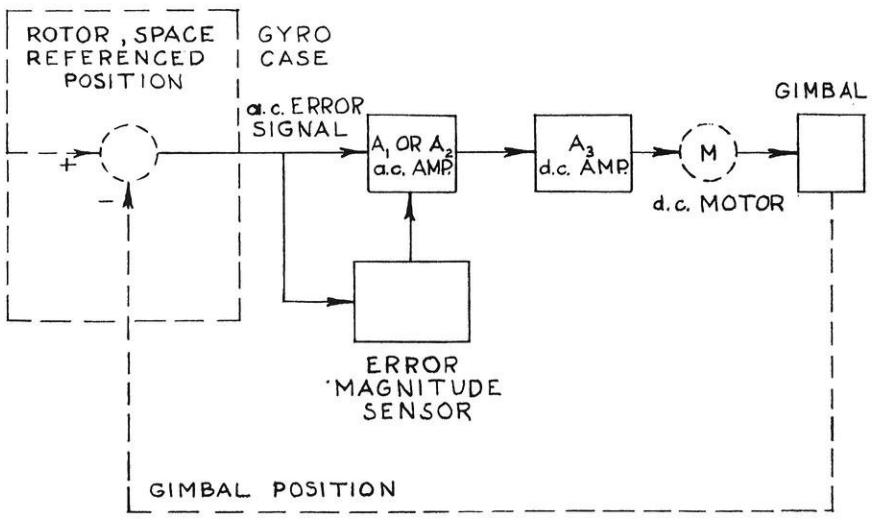

Fig. 2.

transient, therefore, bypasses the amplifier and is returned to ground. This action causes reduction of the gain in the amplifier, remaining in this state throughout the duration of the transient signal. When the transient has disappeared, the firing switch of the transistor-diode combination then cuts off. The firing level of this switch is just past the saturation level of the amplifier and does not interfere with the normal operation of the servo.

Application of the adaptive feature permits an increase in servo gain of 300%, a bandwidth increase of 70%, a reduction in position errors to one-third of those in the non-adaptive case, and probably most important, the servo loop is unconditionally stable.

The second servo incorporating the adaptive concept is the Computer Velocity Servo. The basic function of this loop is to track aircraft velocity on the inertial velocity potentiometer, illustrated in Figure 4. During a velocity change of the aircraft, it is required that the potentiometer be driven to a new position in a relatively short period of time. However, the potentiometer must be driven slowly so as to minimize overshooting, and to minimize oscillations about its null position. For normal operation, the loop response is completely linear for all possible flight conditions. The loop is virtually a first order system, because the amplifier time constants are small compared to normal servo rise time. The tachometers tend to improve the response of the amplifiers. The input resistors provide isolation for the various inputs, thus insuring that no interaction among inputs occurs.

If the aircraft undergroes a large change in velocity, the servo loop takes too long in responding to this large change. The problem can be solved by increasing the gain of the amplifiers. As this is done, however, the time constants of the amplifiers become significant when compared to the servo response time. The operation of the loop becomes nonlinear, and violent instability results.

The undesirable performance of the loop suggests an adaptive application. Two modes of operation result from the application. The adaptive feature, the error magnitude sensor, is bypassed in the normal mode due to the biasing of the diodes. When the aircraft undergoes a large velocity change, a large error voltage results which exceeds the diode cut-off bias, thus causing the diodes to conduct. The diode circuit then serves as the input to the amplifier A1, replacing the 300K resistor. The ratio of the 300K resistor to the 10K resistor shows that the gain of the amplifier increases by a factor of 30 during adaptive operation. This gain increase produces a mode of operation whch enables motor speed to reach a maximum. The shaft of the motor, therefore, drives the potentiometer pointer at a faster rate of speed. As the distance between the pointer and its null position decreases, the magnitude of the error voltage decreases correspondingly. The error voltage falls below the diode cut-off bias, and is applied to the amplifier through the 300K resistor, resulting in normal operation. The potentiometer slows down as a result of this action, and approaches its new position at the desired rate of speed. The operation of this servo can be looked upon as an "on-off" switching between an adaptive mode and a normal mode.

The two examples presented here illustrate the application of adaptive controls in fulfilling flight stabilization requirements. Open-loop systems are too complex to fulfill these requirements, and are too complex to provide the necessary precision and reliability. An adaptive system and an open-loop system used under normal flight conditions, do not differ greatly in cost. The difference in the circuitry is only a matter of two diodes, a transistor, and numerous resistors and capacitors. The complexity required of open-loop systems in order to obtain desired performance, however, is very costly. The unreliability of the open-loop system greatly increases the possibility of vehicle destruction during testing. The cost of this eventuality would run into the millions of dollars. It is clearly evident, therefore, that the amount of monetary saving involved with the utilization of an adaptive control system is quite substantial. The adaptive concept provides an effective, practical solution to any problem which may be encountered in air travel.

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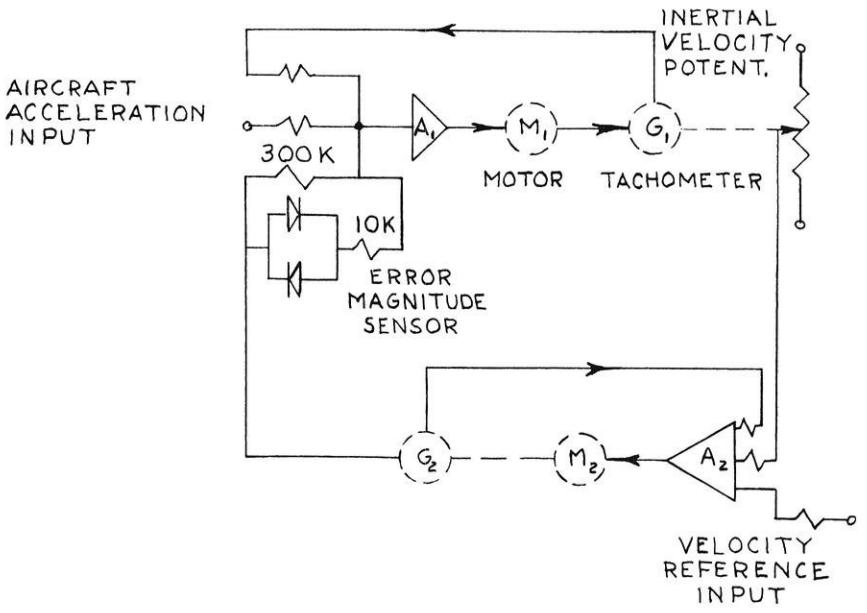


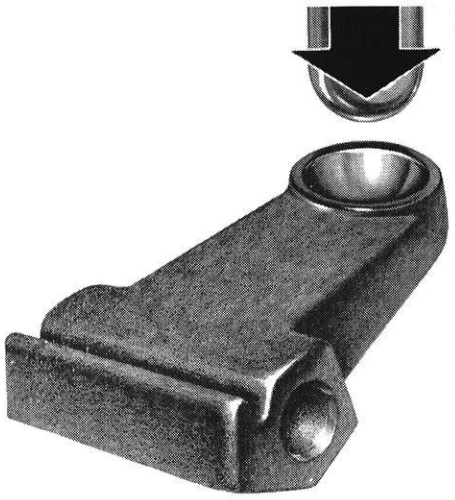
Fig. 4.

Did You Know That Malleable Castings Can Be Stamped, Rolled, Punched, Spun?

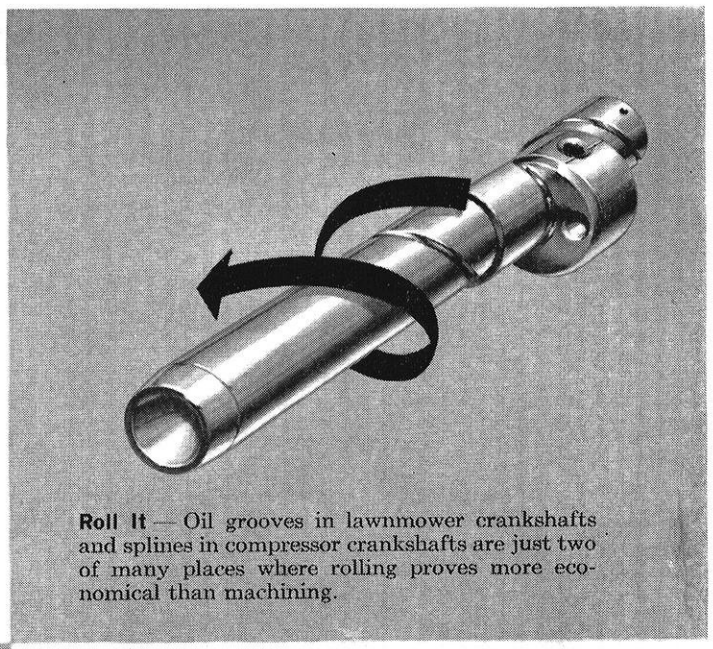
Many people are unaware that castings can be finished by any method except cutting or grinding. But the ductility of Malleable iron castings permits use of a wide variety of high-speed forming techniques that can eliminate operations, cut finished costs or even lead to new designs. These examples illustrate the versatility you get only with ferritic and pearlitic Malleable castings. For a fuller understanding of how Malleable can help you, call any producer that displays this symbol —

Free Folder describing these techniques is available for your use. Just ask any member of the Malleable Castings Council for Data Unit No. 116, or write to Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

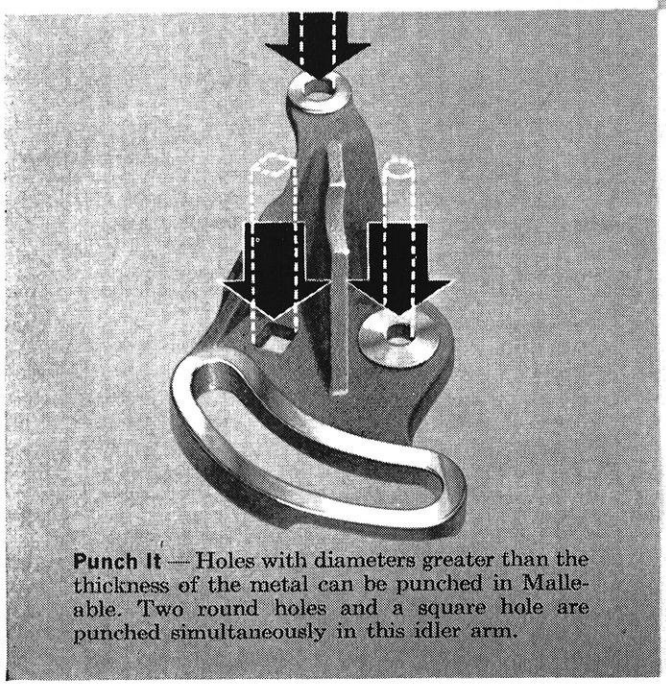
MEMBER
MALLEABLE
CASTINGS COUNCIL



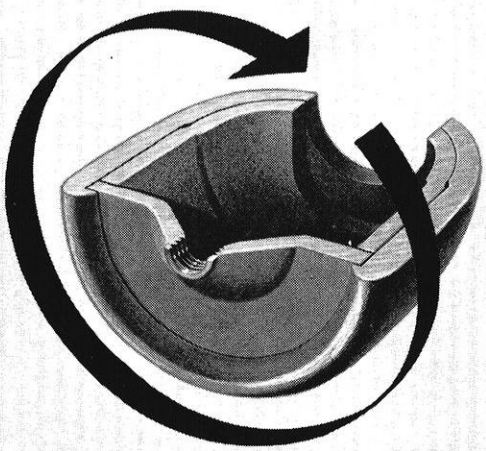
Hot Form It Hot coining this Malleable transmission part reduces finished cost . . . eliminates three cutting operations required by the previously used steel part.



Roll It — Oil grooves in lawnmower crankshafts and splines in compressor crankshafts are just two of many places where rolling proves more economical than machining.



Punch It — Holes with diameters greater than the thickness of the metal can be punched in Malleable. Two round holes and a square hole are punched simultaneously in this idler arm.



Spin It — Malleable's ductility permits the sleeve and end disc in this ball joint to be held in place by spinning the Malleable housing into a strong, permanent flange.

WHO is at work on a satellite system for global telephone and TV transmission?

WHO provides the communications channels for America's missile defenses?

WHO is girdling the globe with communications for America's first man into space?

WHO tapped the sun for electric power by inventing the Solar Battery?

WHO used the moon for two-way conversations across the country?

who?

WHO guided Tiros and Echo into accurate orbit?

WHO made your pocket radio possible by inventing the Transistor?

WHO maintains the world's largest, finest industrial research facilities?

WHO supplies the most and the best telephone service in the world?

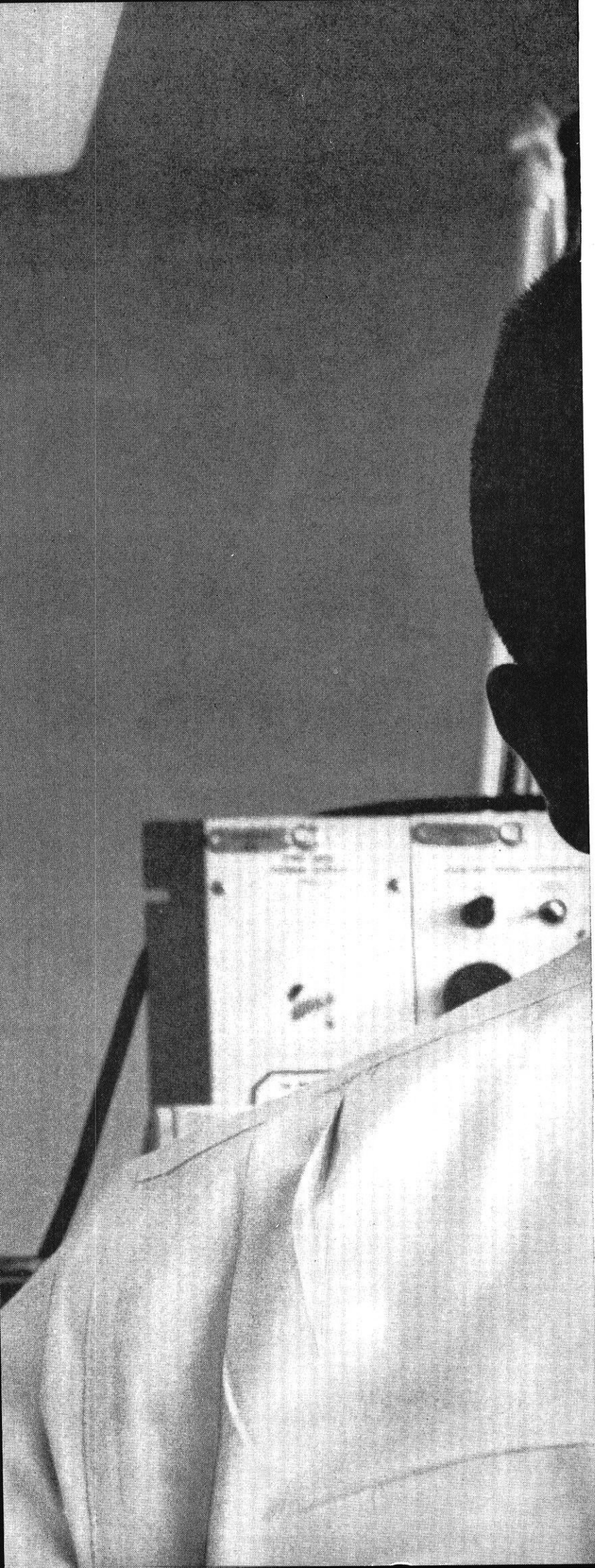
WHO has the UNIVERSAL communications organization?

THERE'S ONLY ONE ANSWER TO ALL TEN QUESTIONS

BELL TELEPHONE SYSTEM

Pioneering in outer space to improve communications on earth


DO NOT DISTURB
ON TEST



Harley A. Cloud (B.S.E.E., Penn State '58) is a group leader in the development of simulation testing equipment for a new airborne computer which IBM is building for the Air Force.

TRIPS THROUGH THE STRATOSPHERE WITHOUT LEAVING THE GROUND

A computer will be the heart of the navigation and control systems for future aircraft designed to operate in the stratosphere.

Such a computer is now being built by IBM for an advanced aircraft under development for the Air Force. Harley Cloud, an IBM engineer, is developing simulation equipment which will put the computer through its paces. His equipment will simulate the systems functions encountered by the 250-ton aircraft at Mach 3, fourteen miles up, with potential adversaries in wait.

Without the airplane leaving the ground, his testing equipment will simulate such inputs to the computer as acceleration in the inertial system, velocity in the doppler radar, and air pressure in the air data subsystem. These simulation techniques will help protect lead time for the entire project.

Responsibilities Are Large. As a group leader, he is directing the design, laboratory breadboarding, electrical drafting, testing and evaluation of this ingenious equipment. It's a very responsible job for a man out of school less than four years.

But age is no barrier to advancement in IBM. In the fast-moving world of data systems, it is ideas and the ability to do the job that count. And fresh new ideas and abilities are always welcomed at IBM—whether in development, research, manufacturing, or programming.

If you feel you might be interested in one of these fields associated with data systems at IBM, you might discuss it with the IBM representative. Your placement office can make an appointment. All qualified applicants will be considered for employment without regard to race, creed, color or national origin. Or you may write, outlining your background and interests, to:

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You naturally have a better chance to grow with a growth company.

• One in a series of messages on how to plan your career

What kind of engineers make steel?

The answer is mechanical engineers, chemical engineers, electrical engineers, mining engineers, industrial engineers, civil engineers, and, of course, metallurgical engineers. There are others, too, but our listing covers the ones most frequently encountered.

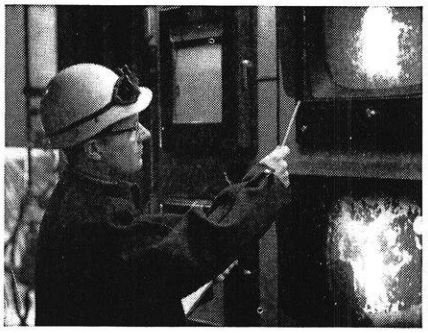
It's a common misconception that college-trained metallurgists dominate the steel industry. Not so. *Every* major engineering degree is represented within the management ranks of a steel company.

It makes sense. The mining and processing of minerals obviously suggests the need for Mining Engineers. Then come the chemical processes of coke-making, smelting, refining. Fuels are consumed, valuable by-products are made. Is it any wonder steelmaking calls for Chemical Engineers?

And how about the machinery, the mills, the furnaces, the instrumentation that make up a modern steel plant? Mechanical Engineers design them, and frequently supervise installation. Civil Engineers design and put up the buildings to house them, and the feed lines to keep them supplied.

Power? Steel is the biggest industrial consumer of electric power. You cannot conceive of a greater concentration of electrical equipment than in a modern steel mill. And many steel plants *generate* electric power, too. Electrical Engineers are busy fellows in the steel industry.

Steelmaking calls for volume production, complex and scientific, often highly automated. Steel companies make numerous finished products, too, from nuts and bolts to nuclear-powered cruisers. The Industrial Engineer finds



plenty to do around steel.

What's more, the above comments fail to make perhaps the most important point—interchangeability. We have found that there are endless opportunities for men with any one of the engineering degrees we have mentioned to handle jobs entailing great responsibility. The supervisor of a huge open-hearth department, or a giant rolling mill, might well be an M.E., a Ch. E., a Met. E., an I.E., or C.E.

Sales Engineers—Because of the nature of our products, Bethlehem salesmen are best equipped when they, too, are engineers. For a man with a technical background and a "sales personality," there are splendid opportunities with Bethlehem Steel.

Shipbuilding—As the world's largest privately owned shipbuilding and ship repair organization, Bethlehem offers careers to Marine Engineers and Naval Architects, as well as to engineers in many other categories.

The Loop Course—This program was established some 40 years ago, to select and train well-qualified college graduates for careers in the Bethlehem organization. It was so named because of an observational circuit (or "loop") of a steel plant. After a five weeks' basic training period, which is held once a year at company headquarters, in Bethlehem, Pa., loopers receive their first assignments, which call for specialized training that may last for a few weeks or for as long as a year. Next comes on-the-job training, and the looper is on his way.

Big and Diversified—Because of its size and diversity, Bethlehem Steel offers unlimited opportunities to "get ahead." One of the nation's largest industrial corporations, with over 140,000 employees, we are engaged in raw materials mining and processing; basic steelmaking and the production of a wide range of steel products; manufacturing; structural-steel fabricating and erecting; and shipbuilding and ship repair. A new centralized research facility, the Bethlehem Steel Company-Homer Research Laboratories, costing in excess of $25 million, located in Bethlehem, Pa., rivals the finest in any industry.

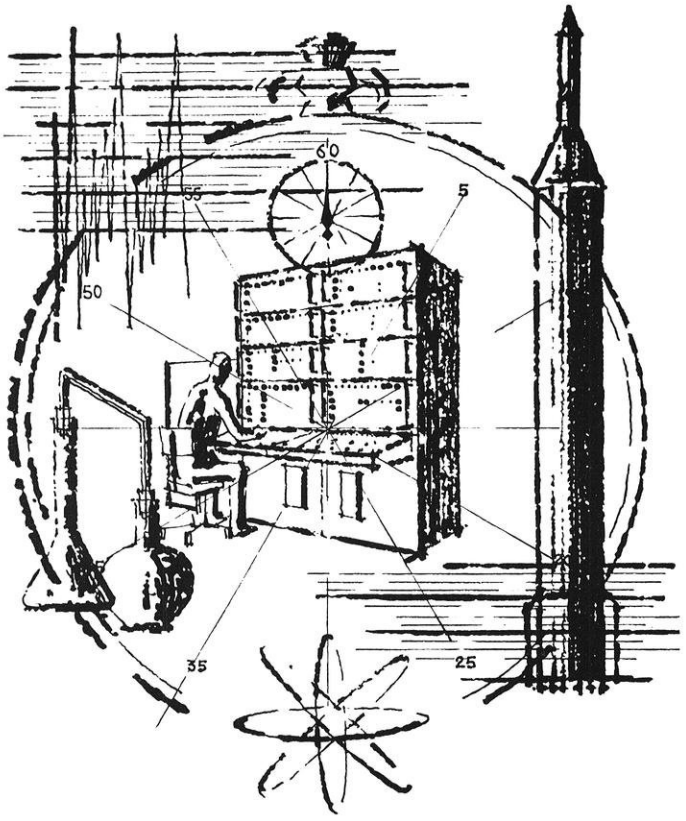
Read our Booklet—The eligibility requirements for the Loop Course, as well as a description of the way it operates, are more fully covered in our booklet, "Careers with Bethlehem Steel and the Loop Course." It will answer most of your questions. Copies are available in most college placement offices, or may be obtained by writing to Manager of Personnel, Bethlehem Steel Company, Bethlehem, Pa.

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

Steel

BETHLEHEM STEEL

BETHLEHEM STEEL



SCIENCE HIGHLIGHTS

by John C. Ebsen ee'65

Lunar Capsule Progress Report

SINCE the day in 1609 when Galileo, with his newly invented telescope, became the first human to look at the moon through magnifying lenses, man has studied the moon's craters and mountains and wondered about its true makeup.

In 1962, a U. S. rocket will streak nearly a quarter of a million miles into space and land a small ball-shaped capsule on the moon's surface. Scientific data about the lunar structure will be radioed back to earth by the capsule.

Aeronutronic, under contract to the National Aeronautics and Space Administration's Jet Propulsion Laboratory (JPL), is developing the capsule that will impact on the moon after a 240,000-mile journey aboard a Ranger spacecraft being built by JPL.

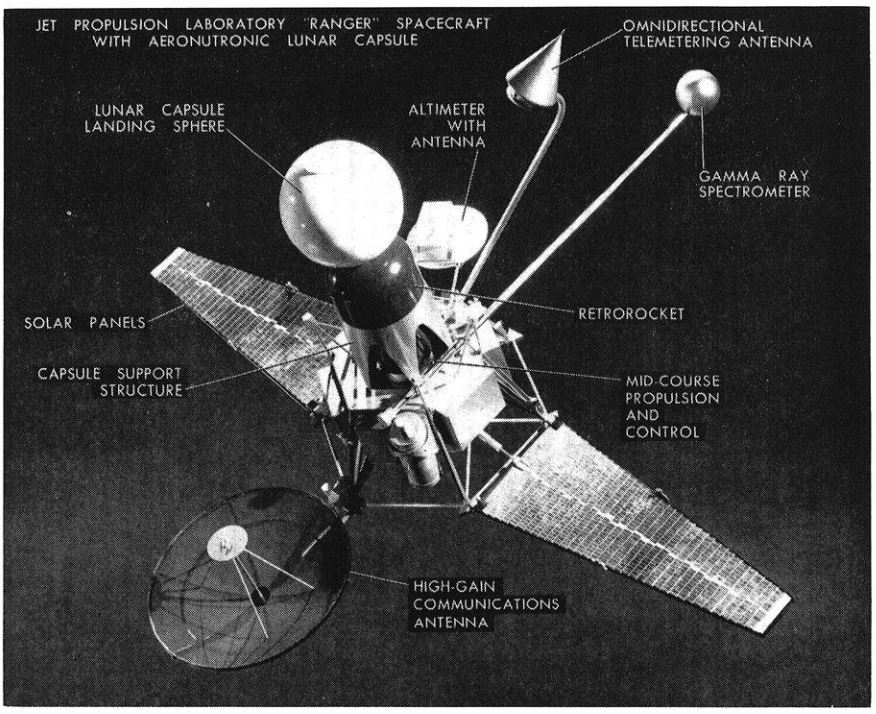
Project Ranger Progress

A progress report on the lunar capsule was given to news representatives at a press conference held at the Newport Beach Engineering and Research Center.

The lunar mission, which will provide man with another major step into space and increase his knowledge of the universe, was explained by Frank G. Denison, Manager of Lunar Systems.

Denison described the capsule as a "300-pound talking ball," containing a seismometer to record moon quakes, temperature recording devices, and other instruments. It will ride aboard the Ranger spacecraft, and both of them will be boosted on their 60–70-hour flight to the moon by an Atlas-Agena B.

At a distance of about 20–25



miles from the surface of the moon, Denison explained to the newsmen, the capsule will be detached from the Ranger spacecraft and a retrorocket will slow its speed to impact the surface of the moon at less than 150 miles an hour. Ranger will continue its high speed, 5,000 mile an hour, journey directly into the moon's surface and be obliterated by the impact.

Once the lunar sphere lands on the moon's surface it will immediately begin its data-gathering mission and transmit vital scientific data back to earth receiving stations. Data from the seismometer will be relayed to earth for an extensive period of time up to several months.

Balsa Wood Shell

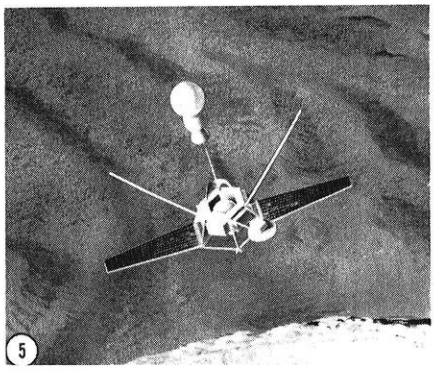
The capsule—in total—measures 25 inches in diameter, and consists of a thick outer shell of balsa wood. Inside this outer covering is a 12 inch diameter survival sphere containing the critically important scientific instruments. The sphere inside the balsa wood shell is surrounded by a flotation fluid, or liquid, to help distribute the structural loads of the lunar impact. This also permits the sphere to right itself to a vertical position by moon-gravity after the assembly comes to rest, so that the sensitive axis of the seismometer is in correct position to transmit its scientific data back to earth scientists.

A near-constant or even temperature for the survival equipment is provided by the use of cryogenic-type vacuum insulation and a small quantity of water ballast which keeps the temperature essentially constant whether the capsule is being heated or cooled by the lunar environment.

The capsule must withstand the rugged environment of the moon where the surface temperature drops to minus 250 degrees Fahrenheit at night and rises to as much as 220 degrees Fahrenheit during the lunar day.

"Hospital Clean"

Aeronutronic and JPL space scientists are concerned that when they land their instruments on the moon that they do not transport earth-bound germs to the lunar surface. To prevent contamination of



About 25 miles from the moon's surface the spacecraft and lunar capsule separate.

the moon, everything possible is being done to insure that the entire capsule is "hospital clean" externally and sterile in all respects. Internal instruments will be biologically sealed to further insure sterilization requirements which will become most important for later planetary flights.

Under sub-contract to Aeronutronic, Hercules Powder Company is developing the high performance solid propellant retrorocket at its Bacchus, Utah, facility. The motor weights 195.9 pounds, and is dynamically balanced to minimize alignment errors when the capsule is spin stabilized. The spin rocket system is being developed by Aeronutronic and will be installed in the cone of the retrorocket nozzle. This spin unit is jettisoned when the retrorocket ignites above the surface of the moon.

Terminal phase of the Ranger journey will be initiated by a five point altimeter being developed under an Aeronutronic subcontract, by Wiley Electronics Company, of Phoenix, Arizona, a subsidiary of Giannini Scientific Corporation. The altimeter will give the lunar capsule the "go" signal to separate from the Ranger spacecraft as it approaches the moon. Denison explained that the altimeter plays a critical role in the lunar mission and will provide additional knowledge as to the exact position of the moon.

"We know the approximate distance to the moon, which varies several thousands of miles at different times of the year. But we do not know the mileage precisely enough to preset the time of separation of the capsule," Denison said.

As the spacecraft nears the moon, a radio signal from the earth will activate the altimeter. The altimeter reflects radar pulses from the moon, a switch on the altimeter will close, the capsule is separated from the Ranger spacecraft, the spin rockets fire and finally the retrorocket is ignited.

TV Camera

Main body of the Ranger spacecraft will carry a gamma-ray spectrometer and a television camera system for photographing the moon as it approaches on the high speed mission.

"Astronomers and space scientists have long speculated about the make-up of the moon," Denison said. "The Project Ranger capsule should answer many questions about its subsurface structure."

All flights of the Ranger will be carried out from the Atlantic Missile Range at Cape Canaveral, Florida, with flights of the lunar landing sphere conducted in 1962.

SEWER TV

Closed circuit TV is turning up everywhere—even in the sewers, Electronics, McGraw-Hill publication, reports. A floating T.V. camera can spot hard-to-find sewer leaks, saving municipalities hundreds of thousands of dollars in maintenance costs.

ONE-INCH FALL FATAL

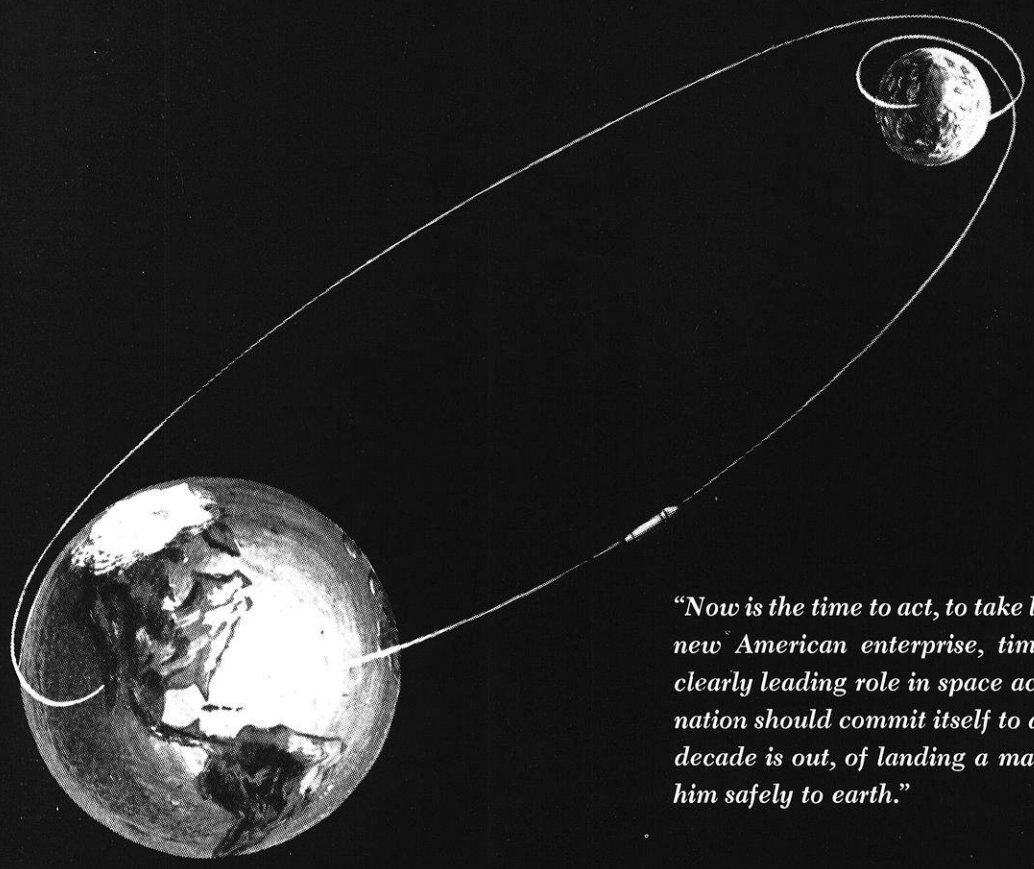
A missile may fail in its mission because a worker on the assembly line let a part drop one inch on a workbench, American Machinist/Metalworking Manufacturing, McGraw-Hill publication, reports. Tests show that when instruments fall one-to-three inches, forces up to 20 times those of gravity strike them, and the results are sometimes disastrous.

WAVES MAKE ELECTRICITY

The Indian Ocean island of Mauritius plans using the force of its customary four- to 12-foot waves to generate electricity, Power, McGraw-Hill publication, reports. A lagoon would be dammed and natural wave action allowed to fill it. Then, when the tide goes out, water would be run back into the ocean through turbines, generating electricity.

(Continued on page 37)

National Aeronautics and Space Administration



"Now is the time to act, to take longer strides, time for a great new American enterprise, time for this Nation to take a clearly leading role in space achievement. I believe that the nation should commit itself to achieving the goal, before the decade is out, of landing a man on the moon and returning him safely to earth."

The President
of the United States
May 25, 1961

The nation has committed itself to accelerate greatly the development of space science and technology, accepting as a national goal, the achievement of manned lunar landing and return before the end of the decade. This space program will require spending many billions of dollars during the next ten years.

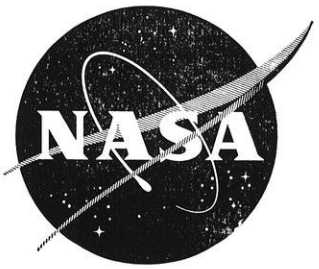
NASA directs and implements the nation's research and development efforts in the exploration of space. The accelerated national space program calls for the greatest single technological effort our country has thus far undertaken. Manned space flight is the most challenging assignment ever given to mankind.

NASA has urgent need for large numbers of scientists and engineers in the fields of aerospace technology who hold degrees in physical science, engineering, or other appropriate fields.

NASA career opportunities are as unlimited as the scope of our organization. You can be sure to play an important role in the United States' space effort when you join NASA.

NASA positions are available for those with degrees or experience in appropriate fields for work in one of the following areas: Fluid and Flight Mechanics; Materials and Structures; Propulsion and Power; Data Systems; Flight Systems; Measurement and Instrumentation Systems; Experimental Facilities and Equipment; Space Sciences; Life Sciences; Project Management.

NASA invites you to address your inquiry to the Personnel Director of any of the following NASA Centers: NASA Space Task Group, Hampton, Virginia; NASA Goddard Space Flight Center, Greenbelt, Maryland; NASA Marshall Space Flight Center, Huntsville, Alabama; NASA Ames Research Center, Mountain View, California; NASA Flight Research Center, Edwards, California; NASA Langley Research Center, Hampton, Virginia; NASA Wallops Station, Wallops Island, Virginia; NASA Lewis Research Center, Cleveland, Ohio.



Positions are filled in accordance with Aero-Space Technology Announcement 252B.

All qualified applicants will receive consideration for employment without regard to race, creed or color, or national origin.

The Hypersonic Plasma Barrier

(Continued from page 22)

It has been found that when a field is aligned with the transverse axis of the vehicle, and the incident wave is also aligned along this axis, there exists a set of drift currents which actually provide amplification to the incident wave. This corresponds to a value of n which is neither zero nor imaginary, but complex. In this manner the incident wave may not only be passed through the plasma, but it may also go through a stage of preamplification before reaching the vehicle.

It must be remembered, of course, that the experiments carried out so far with the plasmas have been with plasma produced in the lab which are homogeneous, isotropic, liear, and constant, and that in the turbulant region surrounding the re-entering vehicle, plasmas such as this are quite unlikely. However, among all the methods proposed so far, this fact represents an important breakthrough and may be the key to an economical method of solving the problem of wave attenuation in these high electron density plasmas.

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A fellow walked into a doctor's office and said, "Doctor, I feel terrible, I want you to give me a thorough examination."

The doctor said, 'Fine. First let me ask you a few questions."

"Go right ahead," said the man.

"First, do you drink much liquor?"

"I have never touched the vile potion."

"Uhuh. Do you smoke?"

"I have never touched the filthy weed."

"Do you run around much nights?"

"I am in bed every night by nine o'clock for a fine night's rest!"

"How about women?"

"They have no fascination for me."

"Uhuh. Tell me, do you have sharp pains in the head?"

"That's just it! I have terribly sharp pains in the head."

"That's your trouble. Your halo's on too tight."

* * *

A young engineer took his girl to an open-air opera one beautiful warm summer evening. During the first act he found it necessary to excuse himself. He asked the usher where the men's room might be found.

"Turn to your left, and walk down to the big oak tree, and there it is."

The young engineer did as he was told and in due time returned to his seat.

"Is the second act over yet?" he asked his girl.

"You ought to know," she replied.

* * *

Soon after Janice and Montie were married, Janice decided to cook her first chicken. When Montie started to carve it, he said, "What did you stuff it with, dear?"

"It didn't need stuffing, darling," she replied. "It wasn't hollow."

* * *

An engineer who came to a dentist's office for a tooth extraction was so frightened at the prospect, that the dentist sympathetically offerred him a shot of whiskey. Then the engineer asked for another shot, and gulped it down. The dentist then asked kindly:

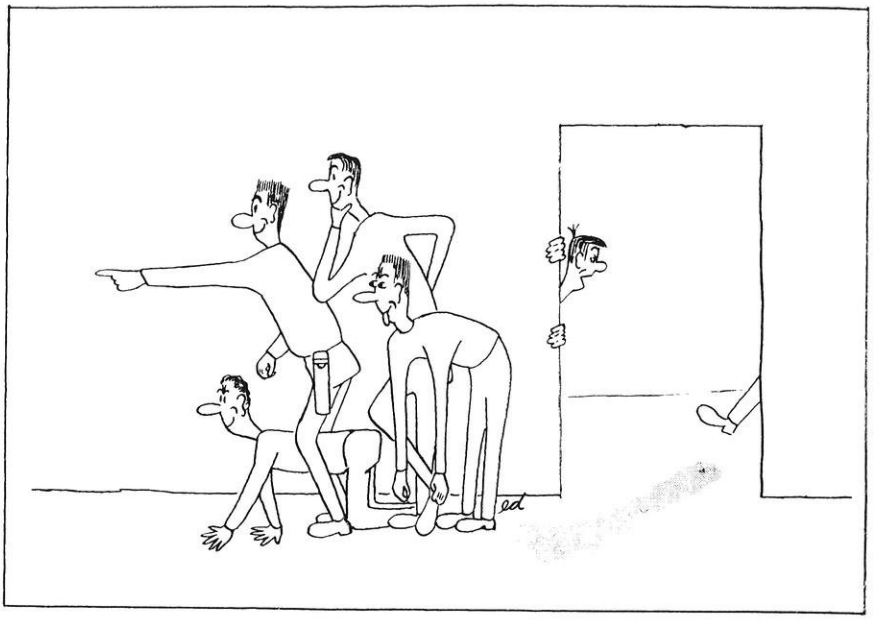
"There, young man. Do you feel any braver? Got your courage back?"

"Yeah," snarled the engineer. "And brother, I'd like to see anybody touch my teeth!"

* * *

Then there is the story of what one strawberry said to another:

"If we hadn't been in the same bed, we wouldn't be in the same jam."



"Hey Fellas—Guess What Just Went By?"

Science Highlights

(Continued from page 33)

XENON HIGH BRIGHTNESS LAMP

A new product in the field of xenon high brightness, long-range illumination has been developed by the Duro-Test Corporation and the United States Army Engineer Research and Development Laboratories.

Xenon high pressure, high brightness bulbs are a new type of lamp for military use, searchlights, projectors and space applications. The rays of the xenon lamp can be projected for a distance of 50 miles.

In one "envelope," the bulb has three arc discharges spaced approximately one-quarter of an inch from the other, differing in this way from one-arc conventional lamps. The availability of the three closely spaced arcs, which can be switched and regulated independently, makes the lamp particularly useful for military and space applications, as well as commercially.

Some of the advantages of the xenon bulb over carbon lamps are the clean, maintenance-free operation; no open flame; no carbon fumes; perfect daylight color of light, and long-life of up to one thousand hours. This compares with the present necessity of replacing carbons in carbon arc lamps at much shorter intervals.

"The reason," according to Mr. Simson, president of Duro-Test Corp. "for the extreme brilliance of the xenon high pressure, high brightness bulbs is due to the high concentration arc of the 'rare gas' xenon which is found in the atmosphere and is extremely expensive due to the fact that 10,000,000 cubic feet of air must be processed in order to produce one cubic foot of pure xenon gas."

The shells of xenon bulbs must be made of fused quartz, the only suitable transparent material with a softening point as high as 3500° F. These highly heat-resistant bulbs are filled with more than 10 times atmospheric pressure of xenon (more than 140 lbs. per sq. inch).

The lamp was developed with the cooperation of the United States Army Engineer Research and Development Laboratories, Fort Belvoir, Va., by Dr. Wolfgang E. Thouret and Herbert S. Strauss, physicists of Duro-Test Corporation. Stanley M. Segal of the Army Engineers was responsible for initiating and guiding the work of the Duro-Test scientists.

ULTRASONIC WATER METER

Scientists in Rhode Island have developed a device that measures the velocity of rivers with ultrasonic sound waves, Electronics, McGraw-Hill publication, reports. The device sends waves down and across the river to a receiving apparatus which can measure the extra speed added to the waves by the river flow.

ELECTRIC ANESTHETIC

Surgeons at the University of Mississippi recently used a 700 CPS electric current to anesthetize a woman for an operation, according to Electronics, McGraw-Hill publication. The current was connected to the patient's temples by electrodes. She awoke with no after-effects or reactions, within a minute after the current was turned off.

WIRES ELIMINATE FURNACE

Engineers have found another use for the wire-mesh reinforcement used in concrete floors—they're made it double as a heating element by connecting it to a power source, reports Engineering News-Record, McGraw-Hill publication. Working on the resistance heating principle common in electric toasters, the builders of a North Dakota warehouse were able to eliminate the furnace room and the furnace.

PAMPERED FISH TEST WATER

Pennsylvania is using pampered fish to check on pollution in streams, Engineering News-Record, McGraw-Hill publication, reports. Sunfish and trout are kept in tanks, where they thrive on clean water and the finest fish foods. When suspect water is received by the health department, the fish are placed in it. Officials say the finicky fish can detect bad water that defies chemical tests.

SPRAY-ON UPHOLSTERY

Upholstery on cars soon may be put on with a spray gun, Chemical Week, McGraw-Hill publication states. In the process, soon to be used in Canada, fabric is chopped up and put in a special gun. It is then sprayed on a car's doors or roof, previously treated with an adhesive.

NEW LEAD FOR OLD

Lead can be salvaged 99.75 per cent pure from automobile storage batteries by means of a new Hungarian process, according to Chemical Engineering, McGraw-Hill publication. The key to the new process is the addition of sodium hydroxide and sodium sulfide during a two-step refining smelt operation.

Professor: "You, in the back of the room, what was the date of the Declaration of Independence?"

"I dunno."

"You don't eh. Well, what do you know about the composition of our Constitution?"

"Nuttin!"

"Anything about the Battle of Bull Pen?"

"Nope."

"You can't! I assigned this study last week. What were you doing last night?"

"I was out drinking beer with a bunch of buddies."

"You can't! How dare you stand there and tell me a thing like that! How do you expect to pass the course?"

"Wal, I don't mister. Ye see, I just come in to fixe the radiator."

* * *

Some dog, a sort of relative to Lassie I believe, used to walk with his master to and from school every day. But lately, I've noticed, they've separated.

I think the dog graduated.

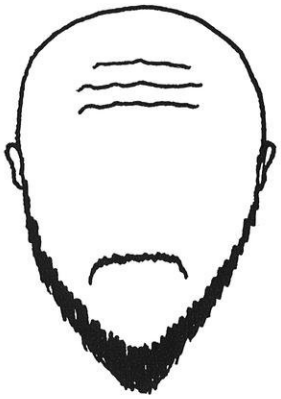
* * *

Mixed emotions: A man watching his mother-in-law backing over a cliff in his brand new Cadillac.

* * *

Thought of the Month

Engineers — Mind
Lawyers — Matter



BRAIN BUSTER

by L. L. Chambers

Mr. Smith, giving a cocktail party, fills two bowls full of cigarettes. He then observes that, at bowl one, Mr. Jones smoked half of the cigarettes plus one, Mrs. Jones smoked a third of the remaining cigarettes plus one, and Mr. Robinson smoked a fifth of the remaining cirgarettes plus one. At bowl two, Mrs. Robinson smoked a fourth of the cigarettes plus one, Mr. Green smoked half of the remaining cigarettes plus one, and Miss Fox smoked a third of the remaining cigarettes plus one. He further noticed that he originally had 140 cigarettes, thirty-two at the end of the party, and that the difference between the number of cigarettes in the two bowls was somewhere between five and ten. How many cigarettes were in each bowl originally?

* * *

This problem can be solved with or without calculus.

Three boxes each contain two marbles. One box holds two white marbles, another holds two black marbles, while the third holds one of each. The boxes are labeled as to their contents, but unfortunately, all the labels are wrong. Nevertheless, you should be able to figure out which marbles are in which box by picking out one marble from one of the boxes.

In a certain locale there are two tribes of natives, Aragomacs and Melogomacs. The Aragomacs always tell the truth, but the Melogomacs always lie. A traveler met a group of three natives and asked what tribe they belong to. The first said something the traveler didn't hear. The second explained, "He said that he was an Aragomac." The third exclaimed, "You're a liar!"

To what tribe did the third man belong?

* * *

An ancient mathematician once punished a thievish slave, whom he had caught redhanded, by ordering him to walk up and down, past the seven columns of the temple of Diana, counting them until he reached the one-thousandth column. The columns were in one line and the slave was supposed to count them by walking from the left to right. When he reached the seventh he was to turn and count the sixth as the eighth, moving from the right to the left. When he again reached the first column, he was to turn and count by moving left to right again. After finishing his march, he was to report to the mathematician which column had been the one-thousandth. The mathematician, however, had easily calculated the answer. He just sat back and waited for the slave to finish. Can you figure out which column was one-thousandth?

There are four homing missiles located originally in the vertices of a square twenty by twenty miles in size. Each missile homes on another missile with a velocity of 5,280 feet per second. Each of the missiles will turn to the right immediately after launch. If they are lanuched simultaneously, they will ultimately collide in the middle of the square. How long will it take for the collision to occur?

* * *

A small boat is carrying some bricks across a small lake. The boat capsizes and the bricks drop to the bottom of the lake. The boat has now been turned up and is now floating. The boat now being lighter will displace less water than when fully loaded. The question is: Will the water level of the lake drop or rise because of the bricks on the bottom? Why?

* * *

If you are one of the many clock-watching students, this problem should be relatively easy.

Jack and Ed were to meet at the railroad station to make the eight o'clock train. Jack thinks his watch is twenty-five minutes fast, while in fact it is ten minutes slow. Ed thinks his watch is ten minutes slow, while in reality it has gained five minutes. Now what is going to happen if both, relying on their watches, try to be at the station five minutes before the train leaves?

At AC-Milwaukee, the moon, planets and stars beyond are constantly in the thoughts of our engineers and scientists.

We're in the navigation business and have been since 1948. We are now developing & manufacturing Inertial Guidance Systems for the TITAN II, THOR and MACE missiles, and a modified Bombing Navigation System (ASQ-48) for the B-52C&D. Research and development programs include navigation systems for mobile ICBMs, space vehicles, supersonic aircraft and ocean vessels. AC-Milwaukee is also now producing the AChieverfone mobile radiotelephone.

You will find AC-Milwaukee an excellent place to begin your professional career. If you have a BS or MS degree in E.E., M.E. or Physics, contact your College Placement Office for a General Motors-AC campus interview or write to Mr. G. F. Raasch, Director of Scientific and Professional Employment, Dept. 5753, 7929 South Howell, Milwaukee 1, Wisconsin. (Advanced positions are also available for men completing their doctorates with specialization in guidance and navigation.)

To provide a transition from academic learning to practical career development AC offers the following training programs: **MILWAUKEE**—Career Acceleration Program—A twelve-month program with formalized classroom instruction given in conjunction with rotating job assignments in Manufacturing, Reliability and Engineering. Courses include: **Ballistic and Cruise Missile Laboratory Sessions, Advanced Servomechanisms, Principles of Airborne Digital Computers, Basic Principles of Inertial Guidance, Semi-conductor Technology, Probability and Statistics, Philosophy of Reliability.** Field Service Program—Two- to four-month classroom and laboratory training on inertial guidance systems or bombing navigation systems. Domestic and foreign assignments follow completion of program. **BOSTON**—Advanced Concepts Research and Development On-the-Job Training Program—AC's Boston Laboratory is engaged in developing advanced inertial guidance equipment primarily for application in earth-bound vehicles. **LOS ANGELES**—Advanced Concepts Research and Development On-the-Job Training Program—AC's Los Angeles Laboratory is occupied with advanced guidance research for space vehicles and ballistic missiles, plus advanced research in special purpose digital computers.

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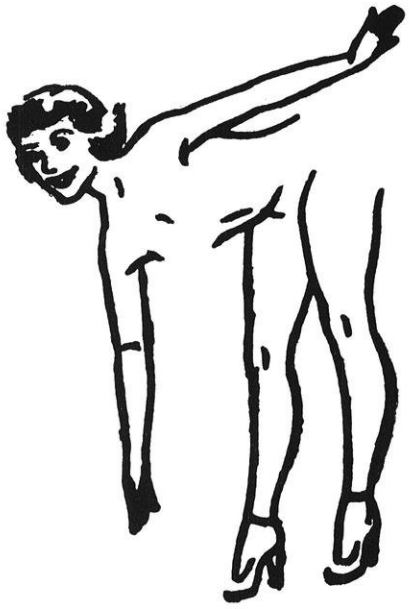


Fill in your Own Lines

by Ron Neder ce'64

Freshman: "Why do janitors here wear uniforms?"

Senior: "So we can tell them from the faculty."

* * *

An elderly U. of W. professor was walking through a busy intersection when a large St. Bernard knocked him down. A moment later, a Corvette skidded around the corner and inflected further damage. A bystander helped him to his feet and asked if the dog hurt him.

"Well," he answered, "the dog didn't hurt me very much, but that tin can tied to his tail damn near killed me."

* * *

The legend is told that in the days of ancient Rome an officer, called away to the wars, locked his beautiful young wife in armor and gave the key to his best friend, with the admonition: "If I don't return in six months, use this key. To you, my dear friend, I entrust it."

Ten miles away from home, he saw a cloud of dust approaching and waited.

His friend, on horseback, galloped up saying: "You gave me the wrong key."

* * *

Definition of a redhead: A communist outhouse.

The scene is a train compartment in Romania. The characters: A Russian officer, a Romanian, an old lady, and an attractive girl.

The train enters a tunnel. The passengers hear first a kiss, then a vigorous slap.

The old lady thinks: "What a good girl she is, such good manners, such fine moral character!"

..The girl thinks: "Isn't it odd that the Russian tried to kiss the old lady and not me?"

The Russian thinks: "That Romanian is a smart fellow: he steals a kiss and I get slapped."

..The Romanian thinks: "Am I a smart fellow! I kiss the back of my hand, hit a Russian officer, and get away with it."

* * *

When a man is twenty and a young lady smiles at him when passing on the street he looks himself over to see what makes him so attractive. When he is forty and a lady smiles at him, he looks around to see who is following him or what is unzipped.

* * *

Have you heard of the new college game. Button, button, here comes the housemother.

Dick: "How many drinks does it take to make you dizzy?"

Carol: "Three, and don't call me dizzy."

* * *

Funeral director to aged mourner: "How old are you?"

"I'm 97; be 98 next month."

"Hardly worth going home, is it?"

* * *

The doctor went up to visit the sick woman but came down in a few minutes to ask her husband for a screw driver. A few minutes later he was down again and asked for a can opener. Still later he was back for a chisel and a hammer. The worried husband couldn't stand it any longer.

"Please tell me what's wrong with my wife doc," he cried.

"Don't know yet," replied the doctor. "I can't get the lock of my bag open."

* * *

Prof: "Well, what did you think of the course?"

C.E.: "I thought it was very well covered. Everything that wasn't covered during the semester was covered on the final."

Kodak beyond the snapshot...

(random notes)

A little x-ray news

More precious than rubies is confidence in the importance of what one does for a living. One thing we do for a living is to manufacture x-ray film. Unkind words are rarely spoken about society's need for x-ray film. Now we have news about x-ray film and need to make it seem important. Easy.

The first piece of news has it that Kodak x-ray film of high contrast and fine grain is now obtainable with emulsion on one side only. Ties in to the current push for great structural strength in small mass. Load-bearing members are now getting so thin that putative flaws on their radiographs have to be checked out with a microscope. Since a microscope can focus on only one side of the film at a time, it's better to have the other side blank. Simple, yes; trivial, no. Manufacturing and distribution problems on our scale are rarely trivial.

The second piece of news much exceeds the first in importance. You have been given estimates by various authorities of how much radiation you and your children can expect to soak up, barring disaster. You have been told how much to figure for medical and dental radiological examination over a lifetime. Meanwhile we have been quietly goofing up the statistics! We have been upping the response of the films. With the latest step, the same amount of examination requires half or a third as much radiation as before. Just privately rejoice a little at how the deal has been sweetened a bit for you, statistically.

To John!

We are not alone in polypropylene. Seven other large and reputable companies are known to be playing in the game against each other and us. All we players must be very brave, hide our nervousness, and raise our glasses high in a toast to the memory of Senator John Sherman, who believed in the great public good that comes of free and untrammeled competition.

(Other nations have ambitious polypropylene plans of their own and are outproducing the U.S. in polypropylene right now in the aggregate. The peoples of the earth had better start making their artifacts out of polypropylene—and fast!)

As the game gets under way, we hold certain strong cards. Our Tenite polypropylene

- Can be polymerized from propylene by two completely different processes of our own devising, both free and clear of the U.S. patents of others.
- Comes in many flow rates.
- Comes in the widest variety of reproducible colors.
- Is exceedingly well fortified by our own antioxidants against oxidative deterioration.
- Has "built-in hinge," i.e. tremendous fatigue resistance under flexure.
- Weathers very well when extruded in monofilament for webbing and cordage, because of our own ultraviolet inhibitors.
- Has high-enough softening temperature so that when it is extruded as sheet you can cook in it and yet on a yield basis it costs less than cellophane.

A familiar force

Here is a picture of the basic amplifier

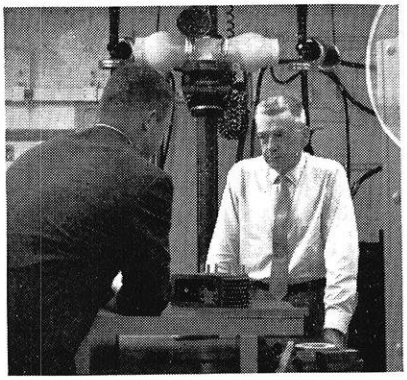
used in photography. This amplifier can provide a gain of 10^9. There is a genie in the bottle. Familiarity with him breeds not contempt but admiration.

Once upon a time, it was customary to summon the genie by retiring to a little darkroom and pouring him out of his bottle into a white enameled tray. No longer does he demand such ceremonious treatment.

Our wet friend now works unseen inside a box, responding to push buttons. His very fluidity has been replaced by a kind of viscosity which need little concern the client, who merely inserts a probe into a disposable cartridge. When the work is done, the genie uses his private exit to the sewer.

This newly announced Eastman Viscomat Processor does 36 feet of 16mm film per minute. Not entirely by coincidence, this happens to be the rate at which film runs through a projector. The film spends about one minute in the processor. It emerges processed to standard commercial quality, ready to project. It can be stopped for seconds or days and restarted without loss of quality. Were we not so touchy about processing quality, the gadget would have been on the market long before.

Note: Whether you work for us or not, photography in some form will probably have a part in your work as years go on. Now or later, feel free to ask for Kodak literature or help on anything photographic.



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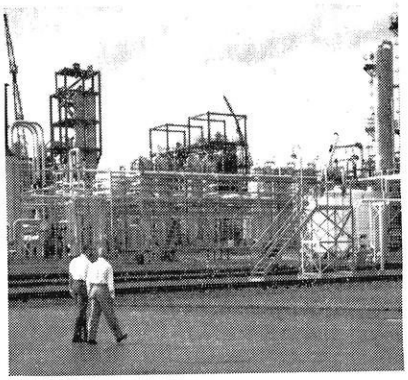

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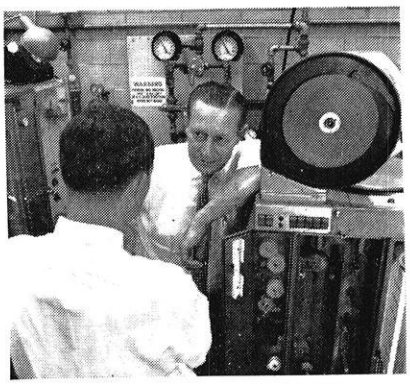

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Interview with General Electric's Dr. J. H. Hollomon

Manager—General Engineering Laboratory

Society Has New Needs and Wants—Plan Your Career Accordingly

DR. HOLLOMON is responsible for General Electric's centralized, advanced engineering activities. He is also an adjunct professor of metallurgy at RPI, serves in advisory posts for four universities, and is a member of the Technical Assistance panel of President Kennedy's Scientific Advisory Committee. Long interested in emphasizing new areas of opportunity for engineers and scientists, the following highlights some of Dr. Hollomon's opinions.

Q. Dr. Hollomon, what characterizes the new needs and wants of society?

A. There are four significant changes in recent times that characterize these needs and wants.

1. The increases in the number of people who live in cities: the accompanying need is for adequate control of air pollution, elimination of transportation bottlenecks, slum clearance, and adequate water resources.

2. The shift in our economy from agriculture and manufacturing to "services": today less than half our working population produces the food and goods for the remainder. Education, health, and recreation are new needs. They require a new information technology to eliminate the drudgery of routine mental tasks as our electrical technology eliminated routine physical drudgery.

3. The continued need for national defense and for arms reduction: the majority of our technical resources is concerned with research and development for military purposes. But increasingly, we must look to new technical means for detection and control.

4. The arising expectations of the peoples of the newly developing nations: here the "haves" of our society must provide the industry and the tools for the "have-nots" of the new countries if they are to share the advantages of modern technology. It is now clearly recognized by all that Western technology is capable of furnishing the material goods of modern life to the billions of people of the world rather than only to the millions in the West.

We see in these new wants, prospects for General Electric's future growth and contribution.

Q. Could you give us some examples?

A. We are investigating techniques for the control and measurement of air and water pollution which will be applicable not only to cities, but to individual households. We have developed, for example, new methods of purifying salt water and specific techniques for determining impurities in polluted air. General Electric is increasing its international business by furnishing power generating and transportation equipment for Africa, South America, and Southern Asia.

We are looking for other products that would be helpful to these areas to develop their economy and to improve their way of life. We can develop new information systems, new ways of storing and retrieving information, or handling it in computers. We can design new devices that do some of the thinking functions of men, that will make education more effective and perhaps contribute substantially to reducing the cost of medical treatment. We can design new devices for more efficient "paper handling" in the service industries.

Q. If I want to be a part of this new activity, how should I plan my career?

A. First of all, recognize that the meeting of needs and wants of society with products and services is most important and satisfying work. Today this activity requires not only knowledge of science and technology but also of economics, sociology and the best of the past as learned from the liberal arts. To do the engineering involved requires, at least for young men, the most varied experience possible. This means working at a number of different jobs involving different science and technology and different products. This kind of experience for engineers is one of the best means of learning how to conceive and design —how to be able to meet the changing requirements of the times.

For scientists, look to those new fields in biology, biophysics, information, and power generation that afford the most challenge in understanding the world in which we live.

But above all else, the science explosion of the last several decades means that the tools you will use as an engineer or as a scientist and the knowledge involved will change during your lifetime. Thus, you must be in a position to continue your education, either on your own or in courses at universities or in special courses sponsored by the company for which you work.

Q. Does General Electric offer these advantages to a young scientist or engineer?

A. General Electric is a large diversified company in which young men have the opportunity of working on a variety of problems with experienced people at the forefront of science and technology. There are a number of laboratories where research and advanced development is and has been traditional. The Company offers incentives for graduate studies, as well as a number of educational programs with expert and experienced teachers. Talk to your placement officers and members of your faculty. I hope you will plan to meet our representative when he visits the campus.

A recent address by Dr. Hollomon entitled "Engineering's Great Challenge — the 1960's," will be of interest to most Juniors, Seniors, and Graduate Students. It's available by addressing your request to: Dr. J. H. Hollomon, Section 699-2, General Electric Company, Schenectady 5, N.Y.

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All applicants will receive consideration for employment without regard to race, creed, color, or national origin.