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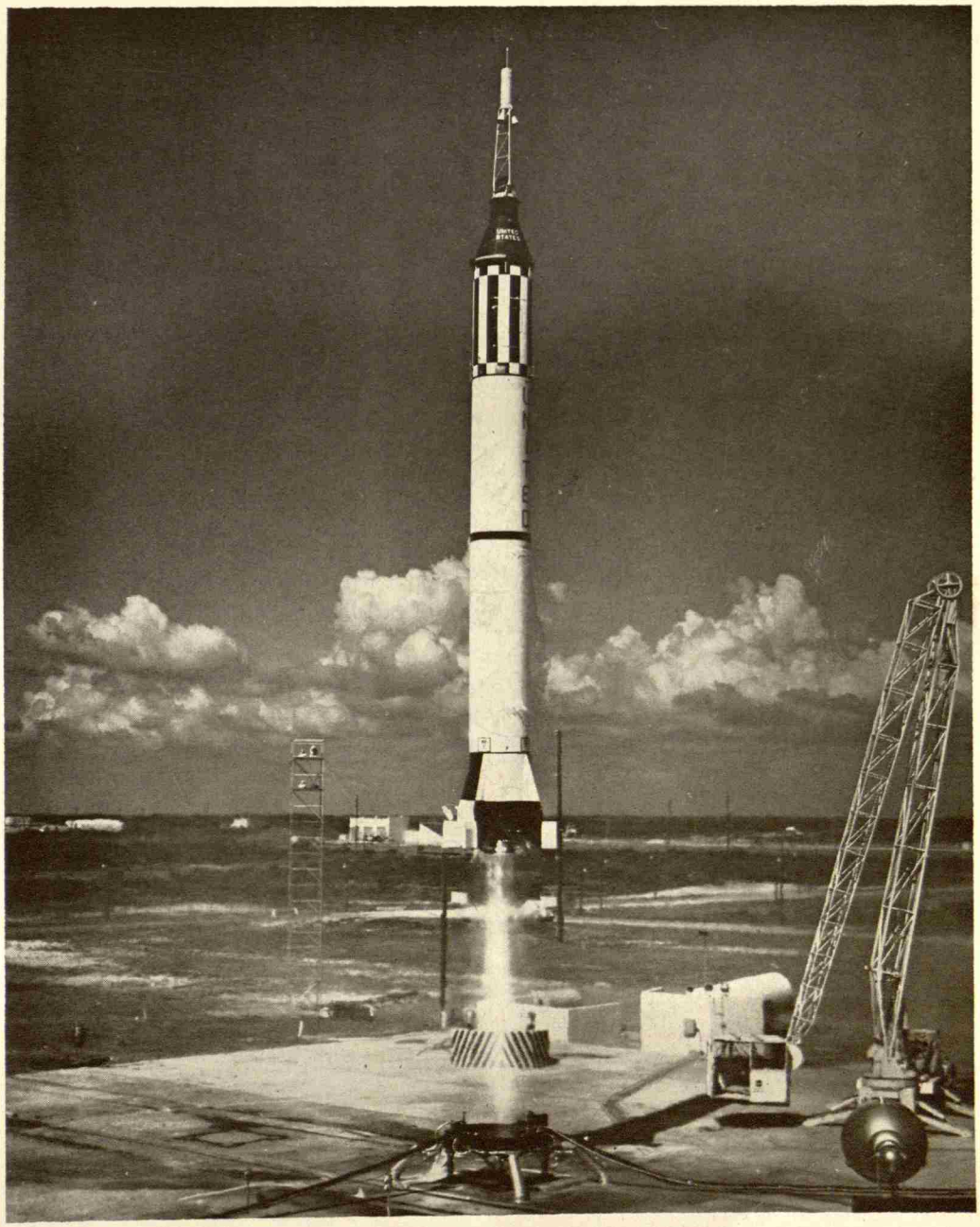
Spartan

ENGINEER

may 1962

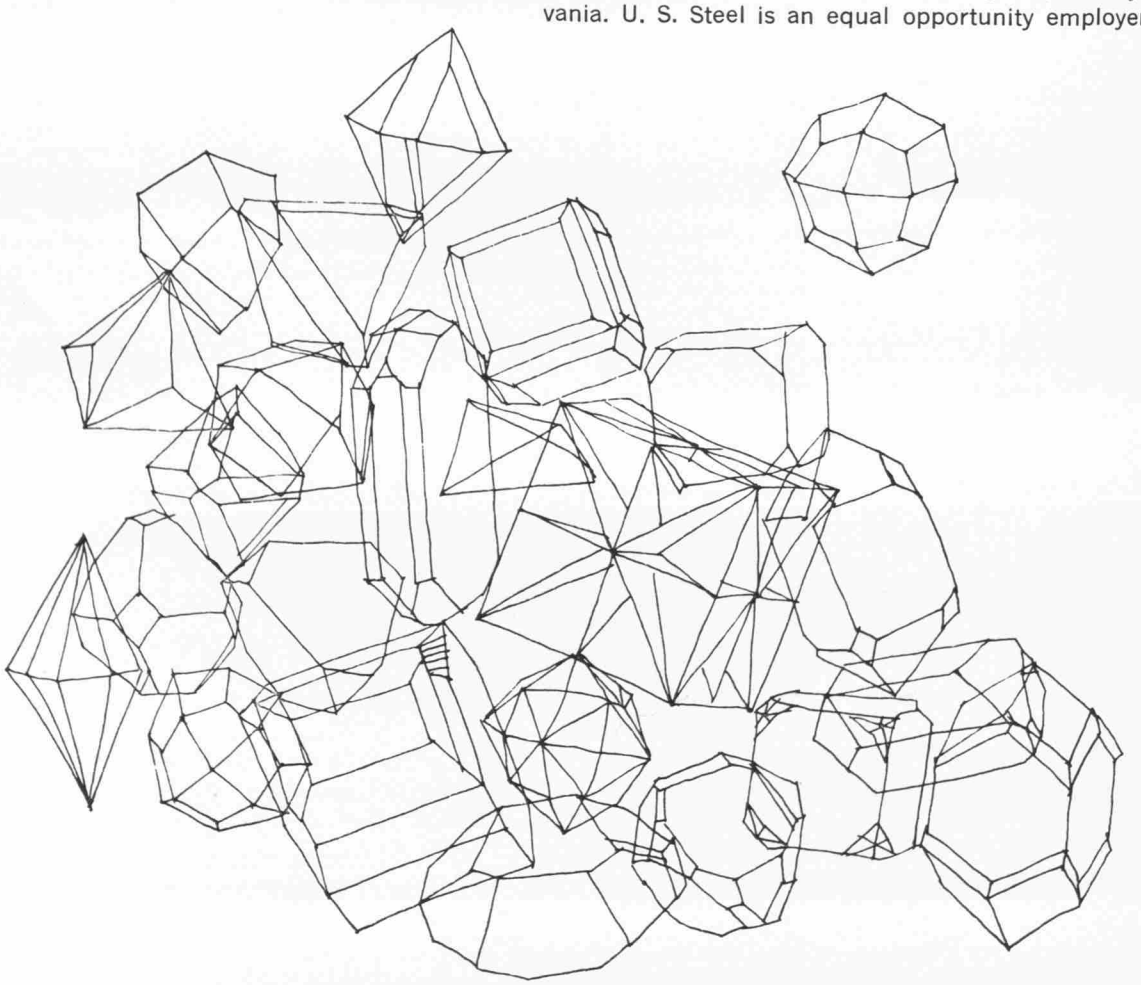


A cure for uncommon cold

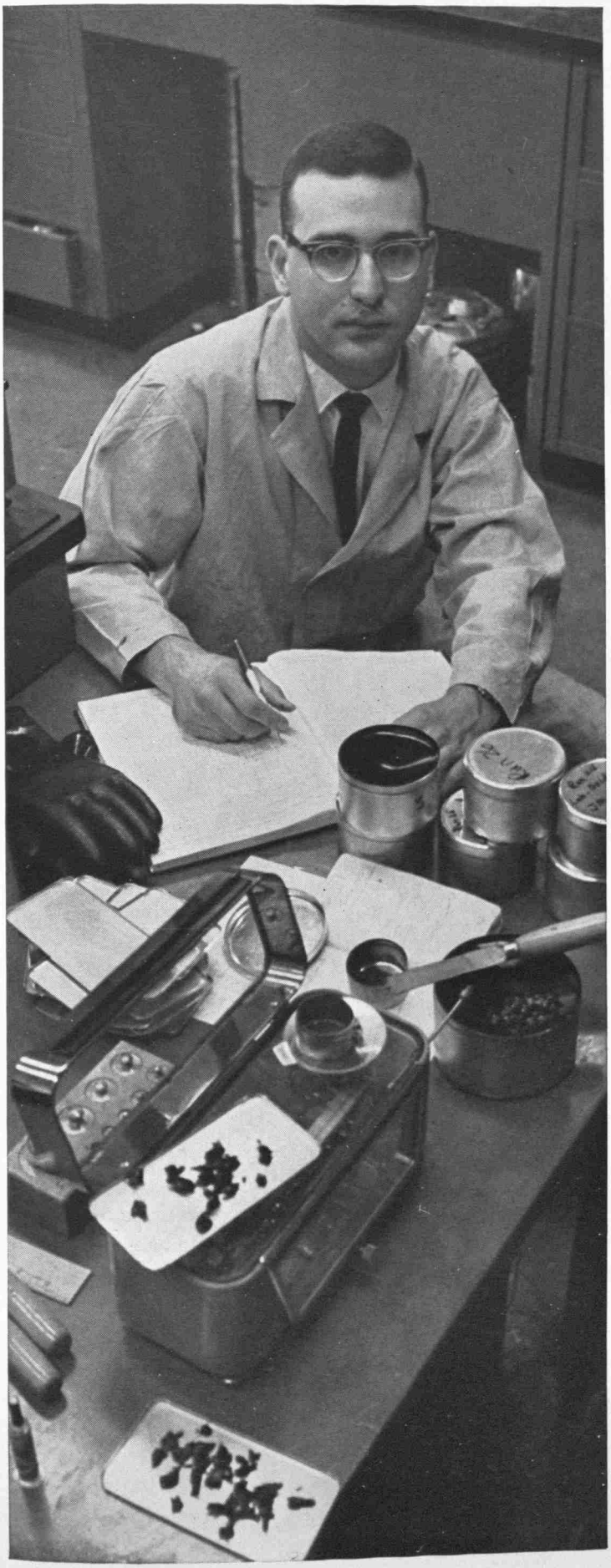
Dunk an orange into liquid oxygen, then drop it on the floor and it will shatter like glass. A vital component of missile propulsion, liquid oxygen is so cold that it crystallizes many materials on contact, and weakens some metals used for normal liquid storage vessels.

But because industry and national defense are using more and more liquefied gases at hundreds of degrees below zero, there was need for a constructional alloy steel that would stay strong and tough at extremely low temperatures. United States Steel helped determine the suitability of a remarkable steel for such application. It's called 9% Nickel Steel and it can be used for pressure vessels that hold liquefied gas as cold as −320°F. The unique combination of properties of this alloy steel makes it particularly suitable for cryogenic use.

This is just one example of U. S. Steel's continuing program to develop new and better steels—that's what makes the work of U. S. Steel engineers so stimulating. Be sure to register with your placement director. For information about the many career opportunities at United States Steel, including financial analysis and sales, write to U. S. Steel Personnel Division, Room 2301, 525 William Penn Place, Pittsburgh 30, Pennsylvania. U. S. Steel is an equal opportunity employer.



United States Steel USS TRADEMARK



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.

If you are interested in a career with the Research and Development Department of American Oil Company, write to: D. G. Schroeter, American Oil Company, P. O. Box 431, Whiting, Indiana.

IN ADDITION TO FAR-REACHING PROGRAMS INVOLVING FUELS, LUBRICANTS AND PETROCHEMICALS, AMERICAN OIL AND ITS ASSOCIATE COMPANY, AMOCO CHEMICALS, ARE ENGAGED IN SUCH DIVERSIFIED RESEARCH AND DEVELOPMENT PROJECTS AS:

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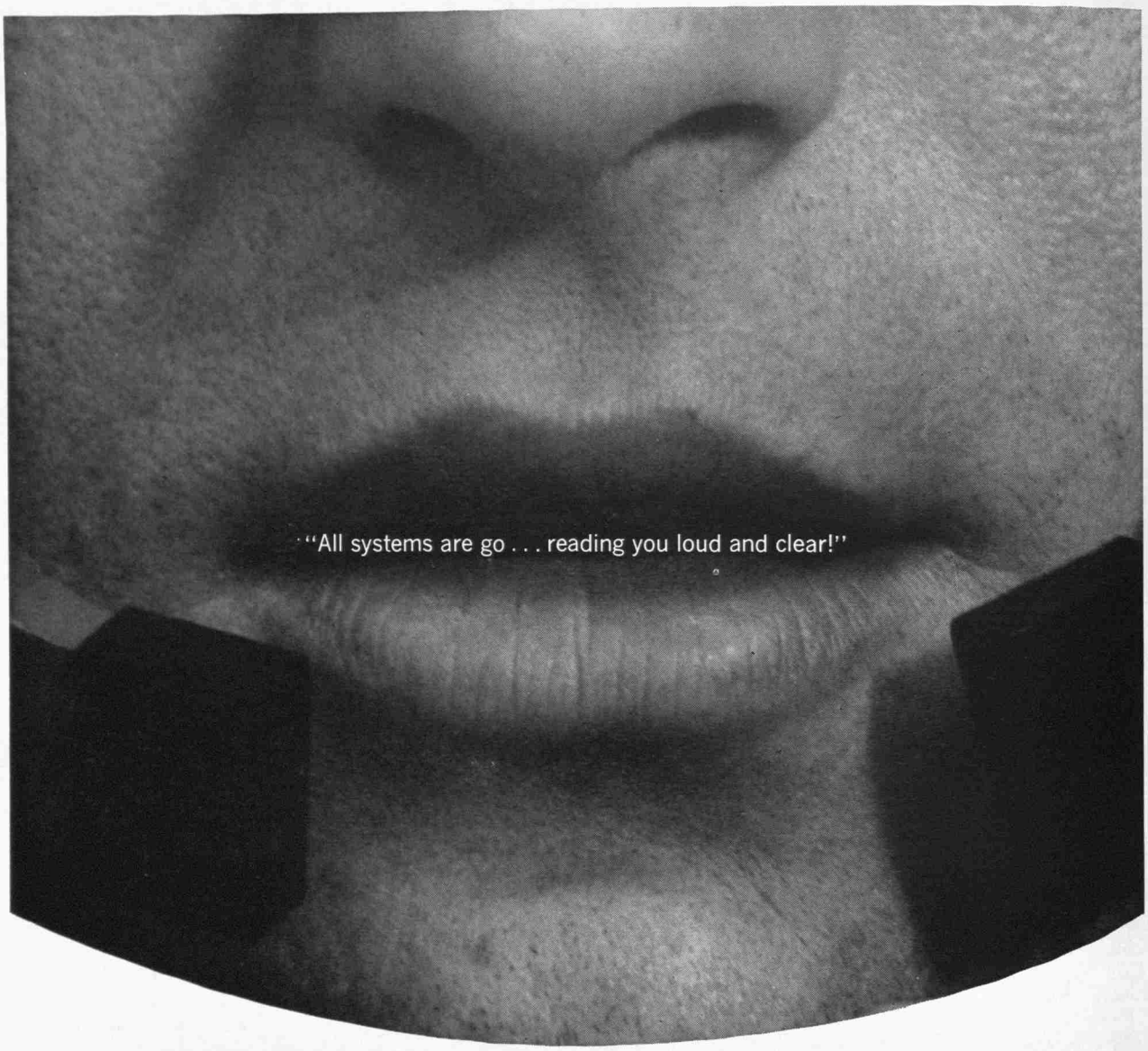

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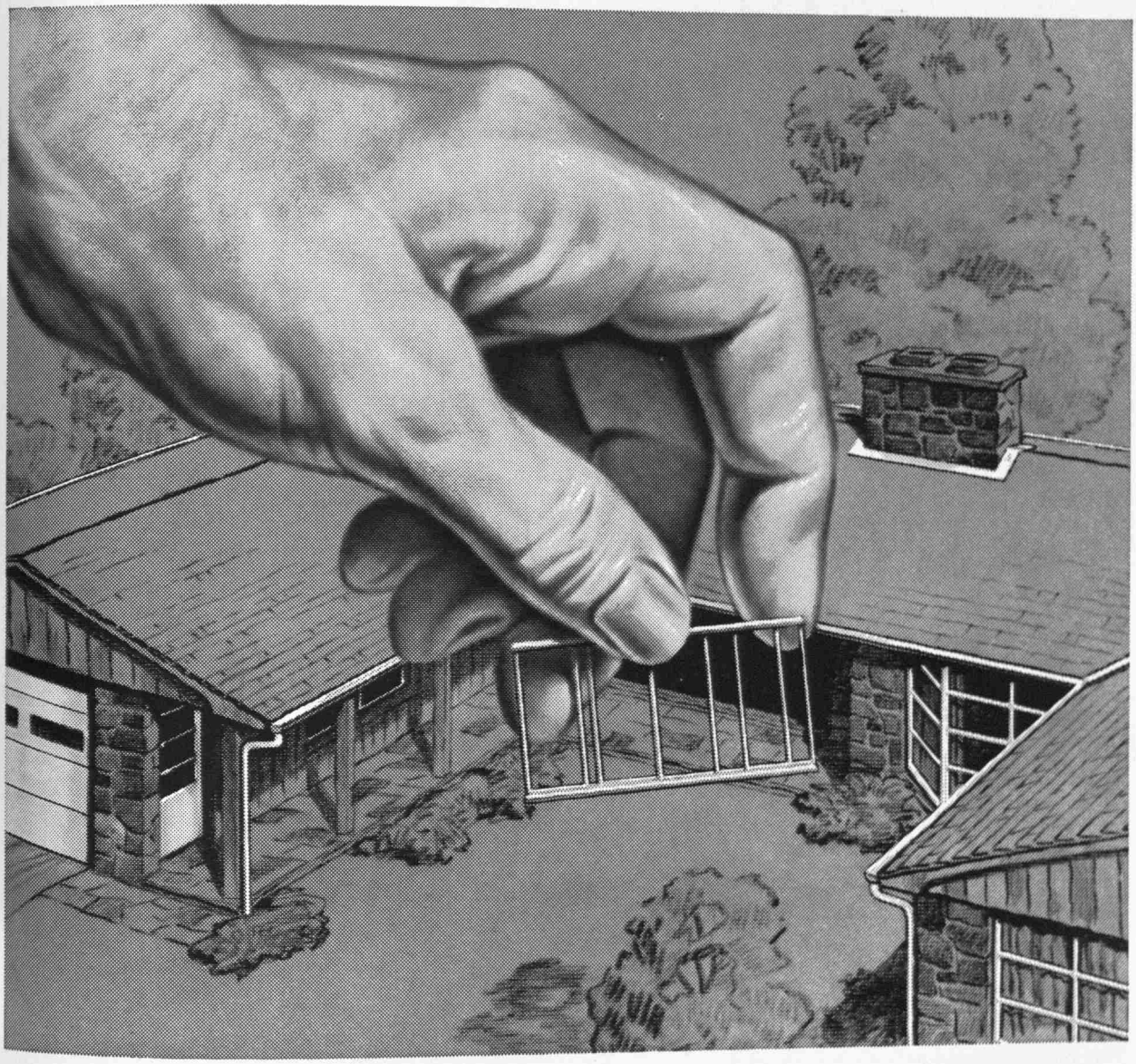

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Now the new look of any dream house can be protected . . . if stainless steel is used in the right places. Gutters, downspouts and flashing will never cause ugly corrosion stains. Doors and windows won't dent, warp, stick or rust. And the strength of stainless steel makes possible screening so fine you hardly know it's there.

Many other things stand up against the weather too—such as lawn furniture, barbecues and garden tools. And inside the house, stainless steel brings the same carefree beauty to kitchens.

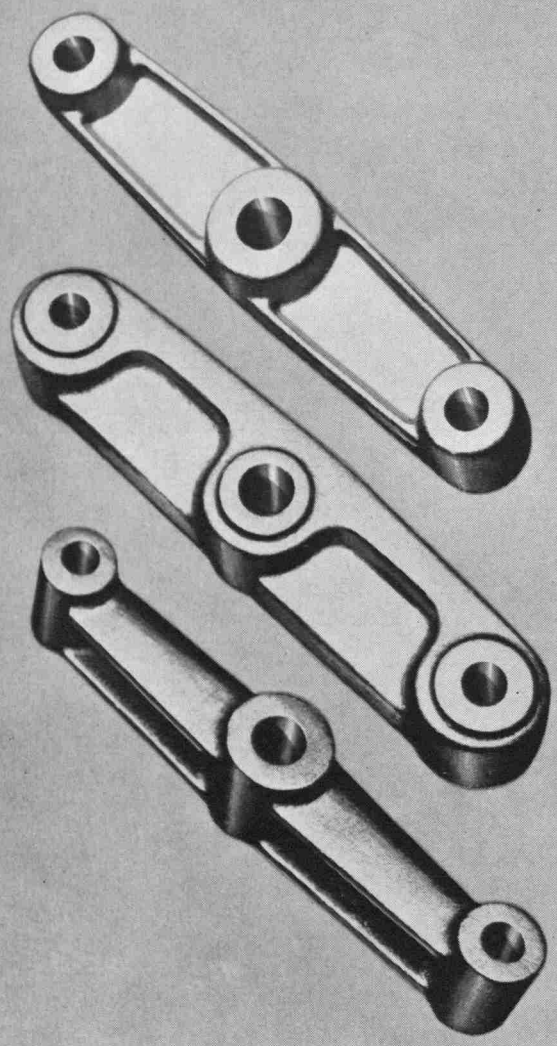
The lifetime quality of stainless steel comes from chromium—one of many essential alloying metals developed by Union Carbide. In the basic fields of metals, as well as carbons, chemicals, gases, plastics and nuclear energy, research by the people of Union Carbide will continue to help bring forth more useful products for today's living.

You will be interested in the career opportunities available with Union Carbide in carbons, chemicals, gases, metals, plastics, and nuclear energy. Why not look over our literature in your placement office? For further information write for Booklet VV, Union Carbide Corporation, 270 Park Avenue, New York 17, New York. (Please mention your career field.)

UNION CARBIDE

...a hand in things to come

Combine Modern Design With Malleable Iron For Lighter, Stronger Parts

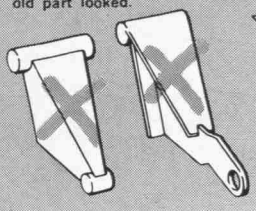


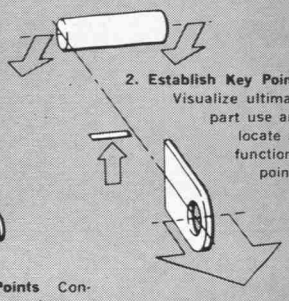
Maximum utilization of different metals is classically illustrated by these three designs for an equalizer bar for tandem trailer springs. This part evolved through several design changes as the user sought the best combination of low cost, high strength, minimum weight. The two parts at the top performed satisfactorily and were well designed for their respective production methods. A Malleable castings designer, taking advantage of the high tensile strength of pearlitic Malleable, originated the "U" section design, shown at the bottom, which results in least weight, lowest cost and greatest strength.

Six Steps In Designing Minimum Weight Malleable Castings

By following these basic steps, designers can take advantage of Malleable's high strength and excellent thin-section castability to produce rugged, lightweight Malleable castings. Early consultation with your Malleable producer can be of real assistance.

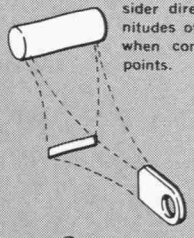
1. Start Fresh Forget how the old part looked.

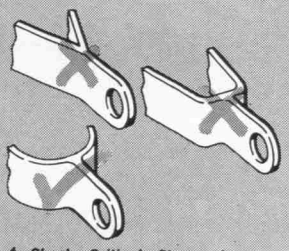




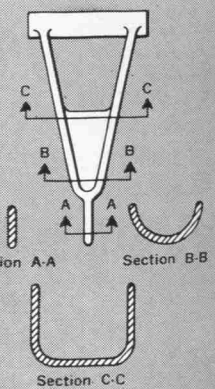
2. Establish Key Points Visualize ultimate part use and locate all functional points.

3. Connect Key Points Consider directions and magnitudes of service stresses when connecting terminal points.

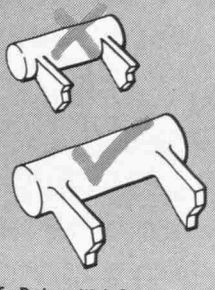




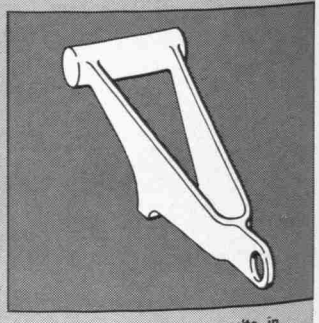
4. Check Critical Stress Areas Your Malleable supplier can assist with design suggestions and experimental stress analysis techniques.



5. Make Sections Uniform Sections should be designed to promote directional solidification toward the feeding head. This insures proper cooling and heat transfer.



6. Reduce High Stress Points Add ribs, corrugations, fillets and radii as needed.



Following these steps results in a good final design.

Free Malleable Engineering Data File is available for your use. Just write to Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio...or ask any company that displays this symbol...

MEMBER
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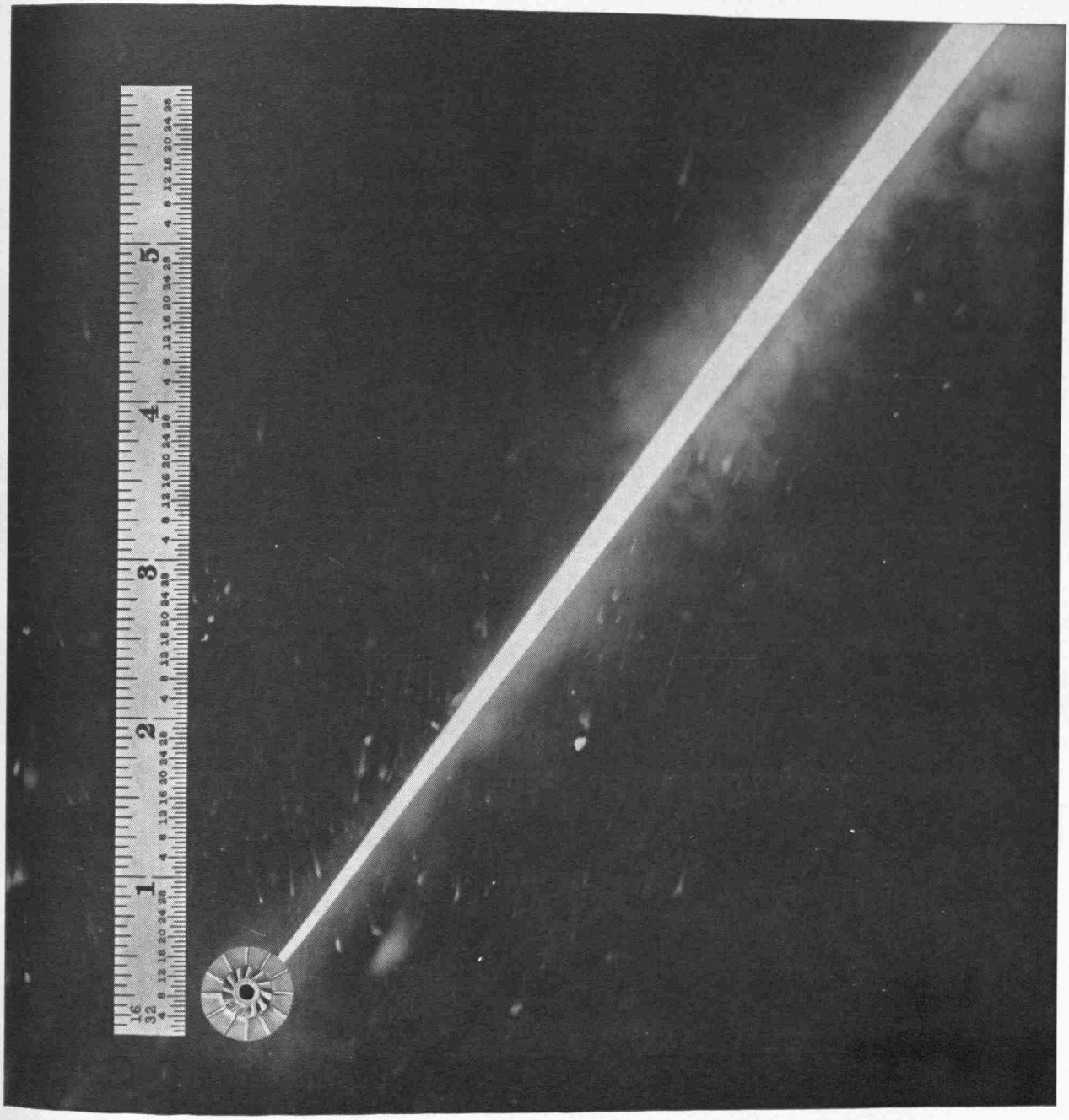
CASTINGS COUNCIL



250,000 rpm/-452° F

Miniature turboexpander permits major breakthrough in cryogenics ... Temperatures ranging from −200°F to −452°F are achieved by converting gases such as helium and nitrogen into a liquid state.

When cryogenic liquids circulate over an object, the moving molecules within come virtually to a stop. This abnormal condition makes some metals superconductive and extraordinarily sensitive to any form of electrical energy.

Military and commercial applications include increasing the effectiveness of ground and airborne detection, navigation and communication systems, shrinking the size of computers and solving specialized space cooling problems.

A leader in cryogenic cooling and lightweight turbomachinery, Garrett-AiResearch is now developing a closed cycle cryogenic system to compress and then expand (boil off) the low temperature gas into its supercold liquid state.

The tiny turbines within the system run on air bearings and eliminate all rubbing surfaces. Much greater system reliability and long life is the result ... another major advance by Garrett in the exciting new science of cryogenics.

For information about other interesting projects and the many career opportunities with The Garrett Corporation, write to Mr. G. D. Bradley in Los Angeles.

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Spartan Engineer

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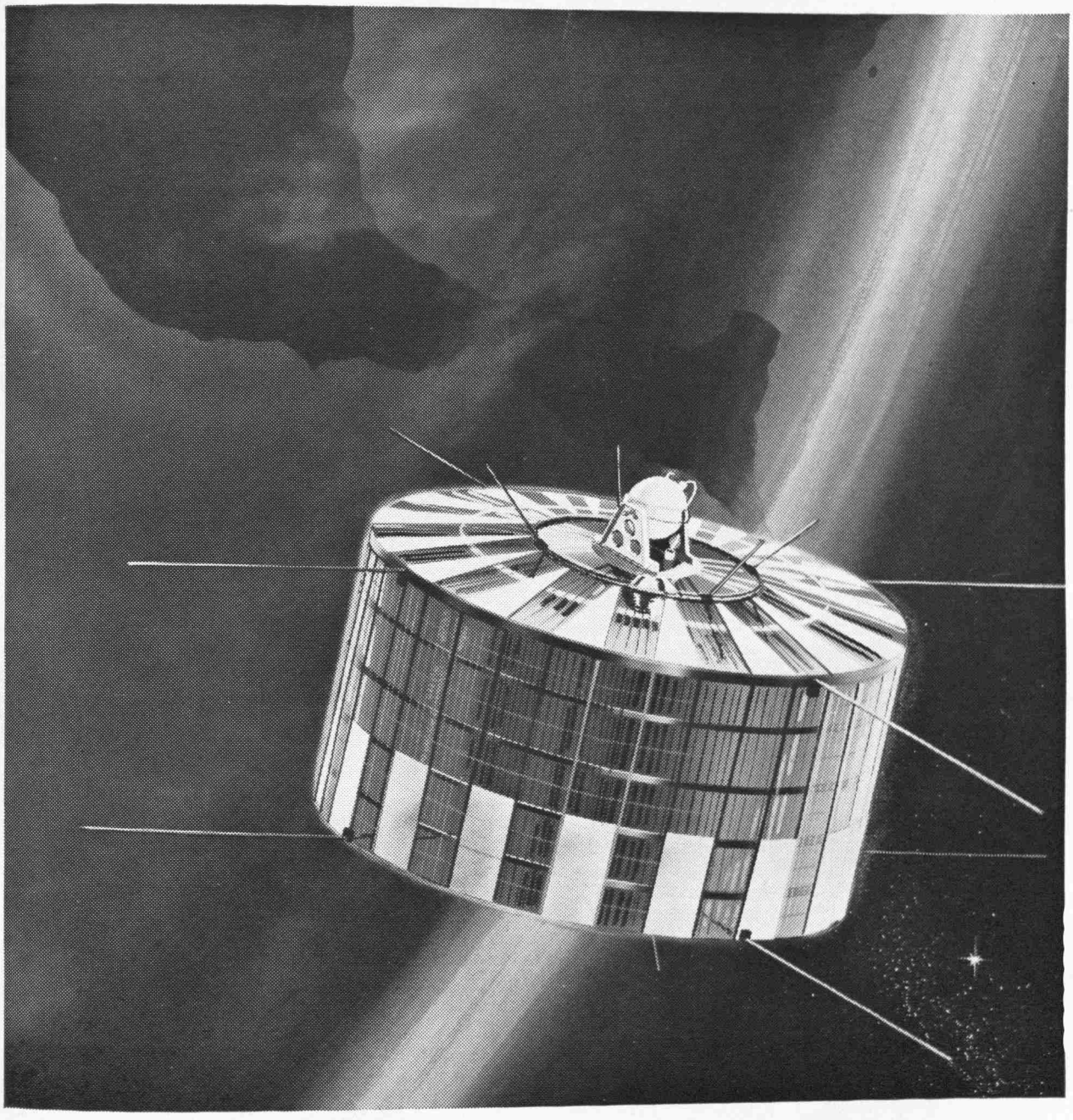

Illustration Courtesy The Martin Company

Atomic power for outer space

Monsanto . . . a world leader in chemicals, plastics and petroleum products . . . has also taken a giant step into the atomic space age. Now broadcasting signals from space is a *Transit* satellite transmitter, powered by an "atomic generator." This long-lived power source is fueled with plutonium 238 processed and encapsulated at Mound Laboratory, which Monsanto Research Corporation, a wholly owned subsidiary of Monsanto, operates for the Atomic Energy Commission.

This achievement is important to *you* because it suggests the kind of future the Monsanto family offers the young engineer of exceptional promise. You'll be joining a company that's ready and able to move vigorously into new fields. And that means plenty of growing room for *you* . . . ever-expanding opportunity as your professional interests broaden.

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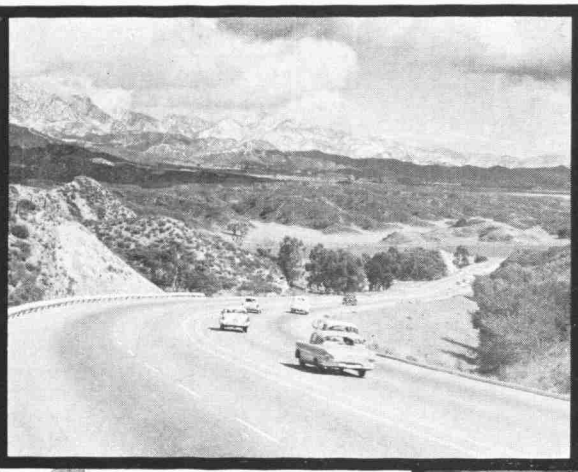
CHALLENGE IN CALIFORNIA

IN ALL PHASES OF CIVIL ENGINEERING



highways

bridges

structural

sanitary

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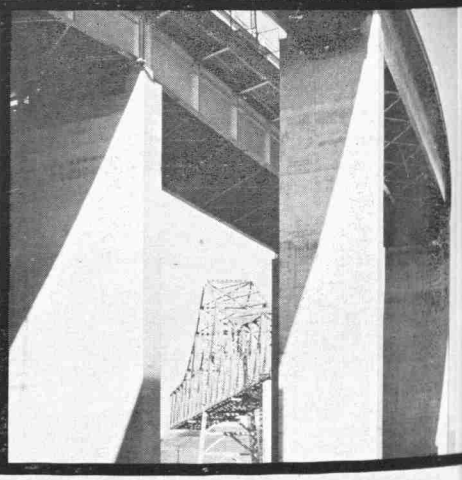
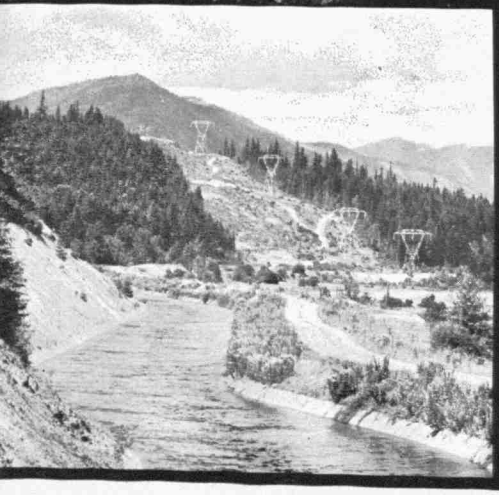
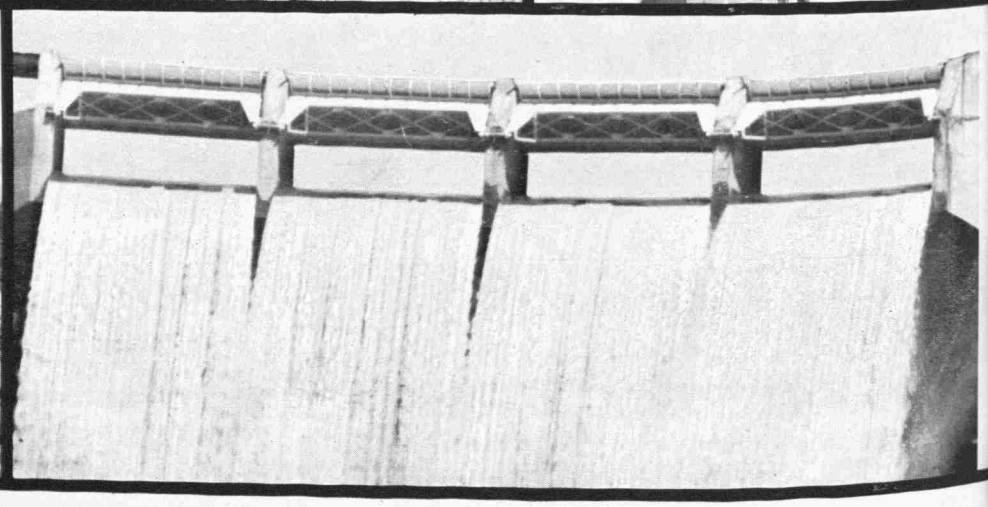






CIVIL ENGINEERING JUNIORS: A few months from now, when you return to school as a Senior, we will have an announcement for you in this space which could launch you on your way to rapid advancement. It will tell you when we will be on your campus to talk with you about well-paying jobs in California's long-range state projects in highway, bridge, structural, sanitary, and hydraulic engineering. Watch for this announcement: CHALLENGE IN CALIFORNIA!

Dean's Letter

The Profession of Engineering

The work of the engineer is often described as a profession, although the work of individual engineers is highly diverse. The field of medicine is considered a profession, and here too, the knowledge required and the functions served may differ widely. The common factor which binds the men of medicine together is the Hippocratic oath—an allegiance to an ideal. So, too, do we engineers have an objective and an allegiance—albeit not so formalized—*a fervent desire to reshape the world as each finds it, in the hope of aiding in improvement of the lot of the human race.*

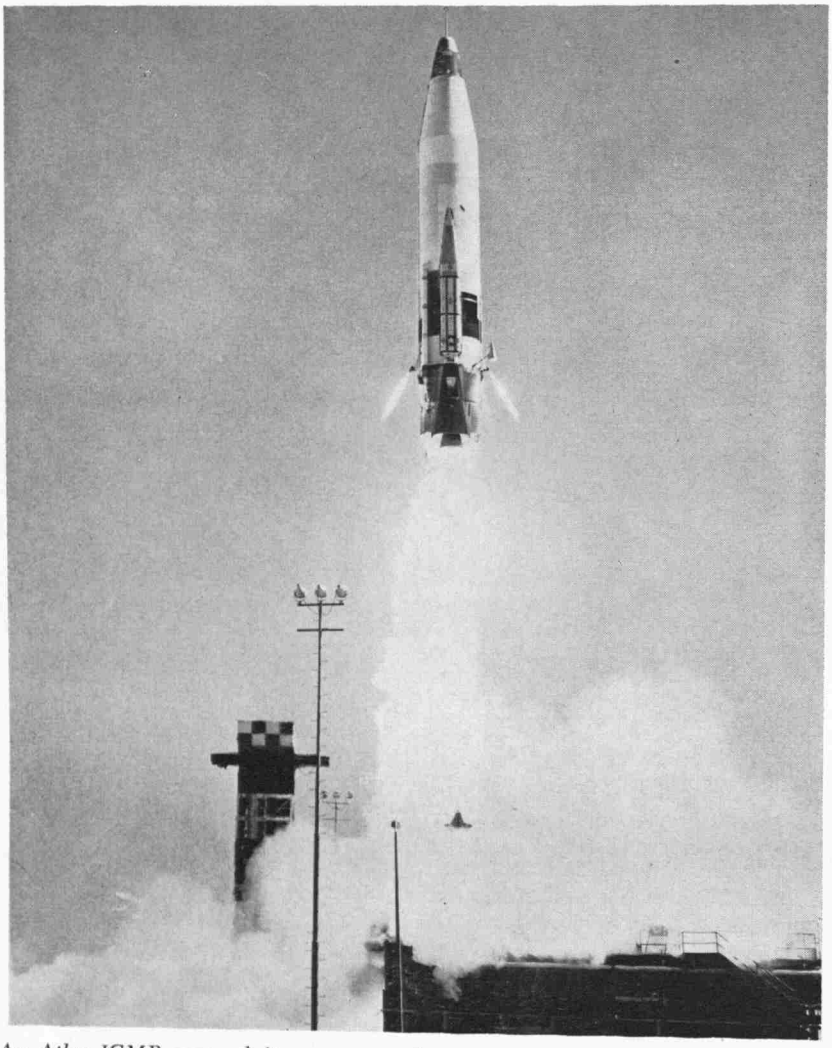
The work of the engineer lies in the physical and mathematical world, but with extensions into biology, psychology, sociology, and many other areas of the social and life sciences. From the rigorous application of thermodynamics by the rocket engineer or the use of electromagnetic theory by the microwave component designer to the technical arts employed by the construction or production engineers—from the mathematical analysis of the researcher to the economic analysis of the consulting engineer—there is one great spectrum of knowledge. Each engineer, in his technical field and in his functional assignment, utilizes a portion of that spectrum, differing in field or function from the portion used by other engineers.

Only in the colleges do we seem able to neatly divide this spectrum into concise packages—Civil Engineering, Mechanical Engineering, Chemical Engineering and the like. Industry drops these labels for individuals rapidly, and one notes in reading the "Engineer-Wanted" advertisements that the need is for microwave engineers, system analysts, heat transfer specialists, or pollution control engineers. While our society bastions—the ASCE, ASME, and other professional societies—retain the label of a field in their names, we note that the AIEE, ASME, and the IRE all have groups or committees on automatic control, that both the ASME and ASCE are concerned with mechanics of fluids, that there is joint membership possible in the ASME, AIEE, and the IRE, and that the AIEE and IRE are deciding that division of electrical engineering into electrical power and radio fields is no longer necessary and are taking steps to merge.

Our neat campus packages of specific engineering knowledge also seem to be coming unglued. Established to meet the conditions of the last century, these curriculums were built around a need for knowledge of particular types of equipment. Today, we give attention to the scientific base for system design, to development of concepts and ideas as much as to laboratory models, and the apparatus distinctions have become less important.

We will always have divisions of the field—the spectrum of knowledge is too broad for coverage by any person—but future distinctions between divisions will rest only on broad areas of knowledge—not on hardware. And even so, we will still have only one profession—if we continue to try to improve, to make more efficient, to apply new knowledge to the needs of man on this earth and beyond.

J. D. Ryder



An Atlas ICMB soars aloft on a research mission at Cape Canaveral (Convair)

Orbiting Space Vehicles Provide Danger to Mankind . . .

by John Thornton, E.E. '62

SPACE DEBRIS

Less than three hours after Col. John Glenn's historic orbital flight, the remains of the giant Atlas booster that had lofted him into space reentered the earth's atmosphere over the Union of South Africa. As the booster slammed into the upper atmosphere, air resistance caused great chunks of the Atlas to break off and burst into flame as the heat vaporized metal.

Several observers on the ground reported fireballs as the booster disintegrated. Later that night a farmer, Jan Snyman, heard several loud explosions and a roar. Not knowing the cause of the noise, he returned to bed.

Several days later while inspecting his farm, Snyman came across a thin piece of sheet metal measuring three feet by four feet. Though still unconfirmed, there are rumors hinting that a second chunk of metal weighing 45 pounds was also found. The metal fragment was turned over to U. S. diplomats at Pretoria.

Later the chunk was flown to Cape Canaveral for inspection. Engineers of General Dynamics Corporation, the builder of the Atlas, positively identified the metal sheet as part of the booster. Through markings that survived the terrific heat of reentry, the engineers were able to determine the fragment's location on the Atlas.

The fate of the mysterious second fragment is not yet determined. The chunk is supposedly on its way to Cape Canaveral. But the U. S. Government hasn't officially announced the existence of the fragment as yet.

Although many satellites have been deliberately recovered from orbit, this is the first time a man-made object has managed to survive the plunge through the atmosphere without special protection. Scientists of the National Aeronautics and Space Administration were surprised that the piece survived.

An object to be recovered from orbit is protected by a heat shield. According to theory, any unprotected object will be burned to a crisp upon reentry. But scientists say that they have several theories that account for the freak recovery.

(Continued from page 31)

SOME IMPORTANT NEW JOBS WERE CREATED BY DU PONT TODAY

The development of new products always leads to challenging new opportunities at Du Pont. Products like time-honored neoprene synthetic rubber, for example. Or more recently, "Delrin"* acetal resin for a wide range of plastic applications, and "Cronaflex"* engineering reproduction films.

Products like these have created thousands and thousands of jobs at Du Pont over the years. Good jobs that not only contribute to the growth of the company, but assure Du Pont's employees of steady employment and the chance to progress. To keep these jobs coming in the future, Du Pont's annual investment in research exceeds $90 million.

Right now, there are opportunities at Du Pont for qualified engineers (chemical, mechanical, electrical, metallurgical and industrial) and for chemists and physicists, sales and marketing men. If you expect to receive your bachelor's, master's, or Ph.D. degree this year, talk with your placement director about Du Pont. For more information about opportunities here, clip and mail the coupon below.

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PLASMA PHYSICS

SUBMITTED BY A GRADUATE STUDENT

In recent years, thanks to the efforts of astrophysicists, plasma physics has become one of the most widely investigated of all technical fields. This is due in part to the great many facets of the subject itself. Originally of interest only to the astrophysicist because of its applicability to space and solar phenomena, it has been found useful in nuclear research, communications, space propulsion systems, electric power generation, thermionic power conversion, and many other fields.

Plasma itself is a fourth state of matter—neither gas, liquid, or solid but a state in which free electrons and positively charged ions exist together. Many natural phenomena have been found to be plasma phenomena. Among these are Aurora Borealis or "Northern Lights," lightning or electrical discharges which cause ionization in the atmosphere, and even open flames or fire which consist of hot ionized gases rising from the combustion region. The Hydrogen bomb is an excellent example of a plasma reaction —one in which the tremendous heat generated by the triggering fission reaction induces the combination of lighter hydrogen atoms to form helium. The sun, from which the earth derives the light and heat by which it sustains life, is an excellent example of a thermonuclear plasma or a plasma in which a controlled thermonuclear reaction is taking place. The ionosphere, which surrounds the earth at a height of 70 to 300 kilometers, is generated by a reaction of the thin atmosphere at that altitude with the incoming radiation from space. In fact, it has been estimated that 99.9% of all matter in the universe is plasma.

Plasma Theory

Several problems are inherent to any study of plasma and its properties. First, the conditions under which plasmas exist are far different from those found in our environmental conditions on earth. Second, the techniques for measuring the various parameters are at present crude. A great deal has yet to be done in basic plasma research so that many of the presently known plasma phenomena may be better understood.

A. Heating

Among the practical problems which are first encountered is that of how to heat the plasma to the desired temperature. Several methods have been developed, some of which are mechanical while others are electrical.

The most obvious method is to pass a current through the plasma since it is ionized and is a good conductor. This method is called Joule Heating. It may be accomplished by using a closed tube filled with gas which serves as the secondary of a pulse transformer. The current induced in the secondary gas column serves to heat the gas. In straight or linear columns the gas is made to conduct by means of electrodes placed at opposite ends of the column and a voltage difference is impressed upon them. The highest temperature attained by Joule Heating is approximately 5,000,000°K.

A second method by which plasma can be heated is by adiabatic or magnetic compression. When a magnetic field is made to vary slowly with time in the radial direction, the volume to temperature relationship is of the same form as the expression for the reversible adiabatic compression or expansion of an ideal gas. As a result of the varying magnetic field, energy is added to the transverse component of the total energy while the axial component remains constant. This increase in energy appears as a rise in the temperature of the plasma.

B. Confining

The second major obstacle in plasma research is confinement of the plasma after it has been heated. Again the magnetic field has proven most valuable for this function.

The most common method of confining is called the "pinch effect." If a current is passed through the plasma, a constricting magnetic field is created which forces the particle toward the axis of the current flow. To eliminate losses at the ends of a linear pinch, the tube which confines the plasma is closed on itself in the shape of a torus and the current is induced by transformer action.

A second common method of confinement is by "magnetic mirrors." Coils are wound about the tube containing the plasma in such a manner as to produce strong repelling fields at each end of the container but a weak field in the center. As particles approach either end of the tube, they are pushed back into the plasma by these fields.

A third system is called the Stellerator system. In this method, the toroidal tube is twisted into a figure-eight shape and an external solenodial coil of wire is wound around the tube. The plasma thus produced is much more stable than either pinches or magnetic mirror confinement.

C. Diagnostics

Plasma research calls for not only creating plasmas, but also examining them. This field is called plasma diagnostics. Many devices are in use today which have been used in other fields but are now finding applications in the area of plasma diagnostics.

A fluorescent screen is used in plasma diagnostics to locate the plasma, give information about the ion orbit size, and determine the density of the

plasma. Fast shutter photography will give the same information. Streak photography gives a time history of the position and light intensity of the plasma.

The use of spectrographic techniques yields information about ion velocity distribution. It is also used to identify the plasma species and impurities and to determine the electron temperatures.

Direct current probes, although they perturb plasma greatly, will give information about the electron temperature, the ion and electron densities, and their distribution. These are generally not too reliable due to the degree to which they disturb the plasma.

Radio frequency techniques are often used to obtain information about the electron density of the plasma. Measurement of radio frequency energy emitted from a plasma will reveal information concerning the kinetic electron temperature.

As yet, infrared measuring techniques have proven too slow to be of any advantage. However, as the detectors necessary to infrared research improve, it is expected that this type of test will become useful. At present infrared techniques may be used for observation of plasma fields.

D. Thermonuclear Plasma

When the first hydrogen bomb was exploded, the age of thermonuclear research was officially born. As stated before, the hydrogen bomb is an uncontrolled thermonuclear reaction. It is this sort of reaction which scientists someday hope to control so that the tremendous power generated may be tapped and used.

Atomic reactors are of two basic types: first, a fission reaction where atoms of very heavy elements (uranium and plutonium) are split in smaller and lighter atoms with the liberation of energy; second, a fussion reactor where atoms of very light elements (hydrogen, deuterium, and tritium) are forced to combine into atoms of heavier elements (helium), again with the release of energy. It is the second of these two types in which we are interested.

In order for fussion reactions to occur, it is necessary that the nuclei of the interacting atoms be close enough to allow the very short range, nuclear attractive forces to act. However, to approach one another this closely, the atoms must have sufficient energy to overcome the long range Coulomb repulsion forces. It has been shown both experimentally and theoretically that the energy required for this to occur involves temperature in the range of 10^{8}°C.

There are three thermonuclear reactions which are of particular interest because they show the great promise. All involve the heavier isotopes of hydrogen because the rate of fussion of hydrogen is too slow. The first isotope of hydrogen is deuterium or hydrogen with a neutron in its nucleus and the second is tritium or hydrogen with two neutrons in its nucleus.

The three significant reactions are:

1) $D + D \rightarrow He^3 + n + 3.2$ mev
2) $D + D \rightarrow T + p + 4.0$ mev
3) $D + T \rightarrow He + n + 17.6$ mev

Where **D** equals deuterium, **T** equals tritium, **He** equals helium, **n** equals neutron, and **p** equals proton. It can be seen that the third reaction is the most desirable because it produces the most energy.

Fussion reactions have the advantage over fission reactions because their fuels are abundant and inexpensive. The energy per unit mass of fuel is higher for fussion, and there is no "runaway" with the reaction. Finally, since fussion products and by-products are non-radioactive, they present no disposal problems.

Probably the largest factor in favor of the fussion reaction is that it offers the advantage of direct conversion of heat into electricity. This would eliminate the very inefficient and costly heat cycle now in use for most electric power generation.

As an illustration of the power producing capabilities of thermonuclear reactions, it is estimated that if all the deuterium was extracted from the ocean and surface water, a total of 10 tons could be collected. If this amount was used in a fussion process, a total of 10^{21} kilowatt years of power could be produced. Since deuterium is present in one part in 6,500 about one gram of deuterium could be extracted from 8 gallons of sea water. This one gram would yield 8×10^{10} calories—about the same as yielded by the combustion of 2,700 gallons of gasoline.

Since cost is usually a major factor in power generation, fussion again meets the requirements by being economical. At present, one pound of deuterium costs about $140. This amount could produce 4×10^{7} kilowatt-hours of power. This is an average cost of 0.00035 cents per kilowatt hour. For nuclear fission fuels, the average cost is about 0.08 cents per kilowatt hour and for combustible fossil fuels, about 0.2 to 0.3 cents per kilowatt hour. It can be seen, therefore, that nuclear fussion reactions are much more economical than other types of fuel.

Engineering Applications of Plasma Physics

Many devices which we take for granted are either plasma devices or utilize plasma processes. Among the most common of these is the ordinary fluorescent lamp. The mercury vapor rectifier and the gas filled voltage regulator tube are other examples. Laboratory equipment for the generation of audio and radio frequency noise is still another application. Two more recent and progressive applications will now be discussed.

A. Plasma Propulsion Systems

Plasma propulsion systems are of interest because they offer a means of low thrust, high specific impulse transportation through outer space. In the absence of gravitational forces, high thrust engines are not necessary. However, high specific impulse engines are necessary because interplanetary and deep space probes require engines with specific inpulses of 7,500 to 20,000 seconds. The highest achieveable by chemical means is 500 to 1,000 seconds. (Specific impulse is defined as thrust in weight units per unit propellant mass flow rate and has the units of seconds.)

Several schemes have been derived for plasma propulsion. All operate on the principle of expulsion of hot plasma from a shaped chamber as do conventional engines.

The first method is electrostatic or ion propulsion. In this system, a beam of high velocity ions is accelerated by means of a high voltage potential difference. A source of ions and an accelerator are all that is necessary for this type of propulsion. However, this type of engine would lose thrust due to the accumulation, behind the vehicle, of space charge which would inhibit the expulsion of ions. This problem

(Continued on page 42)

An Important Step in an Engineer's Career Is . . . .

THE JOB INTERVIEW

by Fred Saari and Jeffrey C. Adams

The Western College Placement Association recently released some information based upon a survey which they conducted. The study was industry oriented and was entitled, "What We Look For In A College Graduate." The ensuing report listed twenty-seven qualities ranging from integrity to marital status. These items could be organized under five main categories: (1) Academics; (2) Extra-curricular activities; (3) Past Experience; (4) Personal Qualities; and (5) Instructor's Recommendation—although they are not necessarily in this order of importance.

A business recruiter is basically looking for potential in a college graduate. He uses the five sources of information listed, as well as such intangible guides as his own intuition in judging a future employee. But what is potential and how is it measured? Potential is a very nebulous term and hard to pinpoint because it depends on so many variables. A company looking for a research chemical engineer and another looking for a salesman will place differential importance on the personal qualities and academic achievement which they desire in an applicant. To one employer the ability to handle people and win confidence is more important than it is to the other. In trying to pinpoint the variables it is necessary to keep in mind what the company's needs are and use this to explain why they would rate one item indicating potential above another.

In looking at an applicant's transcript probably the first things that the eye catches is the grade point average or "indication of academic achievement." Industry considers grade point a very important item, but this is not the whole story. Other considerations must be taken into account such as the married student who had worked thirty hours a week to put himself through school and still support his family. In one part of the day he might be studying hard for a dynamics test while at night he could be working at a clothing store or a factory. This applicant as compared with an unmarried person who had his nights free to study seems to be in a more strenuous position. As a consequence he might get lower grades even though he has the same potential. This is taken into account by the interviewing personnel and in most cases given considerable weight.

It is in the interview that many of the personal qualities of a person are brought out. According to Mr. Gordon L. Dolbee of Upjohn Company, "the interview serves two purposes: first of all they want to find out if they are interested enough in the applicant to invite him to the home office; and secondly, they want to increase the applicant's interest in the company." This is very important since all applicants want to look into their company before hand and find out such things as its location, size, and products.

If the applicant is invited to the home office he meets the various department heads and it is upon mutual decision of these men whether he is hired. A company looking for an electrical engineer to do computer development will probably hire one who is stronger in this line of work as compared to one whose speciality is transmission lines. Of course such things as personal appearance, manners, poise, and other signs of a college graduate are considered important, but the interviewer looks beneath the surface to get evidence of motivation and drive of the person. Does he fill the bill as to the qualities we are looking for? Will he advance in our corporation?

The applicant's past employment is also brought out in the interview and could have some bearing on his chances for the job. This in many cases, along with personal qualities, sway an employer to more consideration if the competition for a job is keen. A case in point as mentioned by Mr. Edwin Fitzpatrick of the placement bureau at Michigan State University would be two people applying for the same job, one who has worked his summers as a student engineer or draftsman and another who has worked in a grocery store or as a life guard. Other things being equal, the first would be given more consideration because his past experience pertains to his profession and could better help the company. However, even if the past experience does not pertain to the major, industries like to see a variety of jobs held during the summers because they believe varied experience could again help both employer and employee.

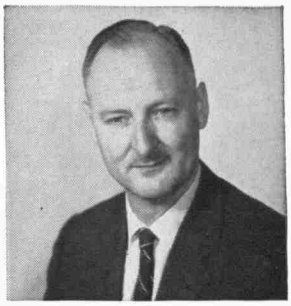
Closely aligned with experience are the extracurricular activities both on campus and off. According to Mr. Jack Kinney of the placement bureau of Michigan State University, "it is not so important to say you belong to an organization as it is to say you took an active role in the organization, such as an officer in which capacity there is a chance to lead." It is a further evidence of accepting responsibility and developing leadership traits. Especially in the field of sales work employers like to see signs in which handling

(Continued on page 31)

A MESSAGE FROM KEARFOTT TO DOCTORAL CANDIDATES WHO WILL BE RECEIVING THEIR DOCTORATES FOR STUDIES EITHER IN ENGINEERING OR SCIENCE DISCIPLINES WITHIN THE NEXT FEW YEARS.

ANNOUNCING A NEW RESEARCH CENTER FOR THE AEROSPACE SCIENCES

Under the Direction of Dr. Robert C. Langford



Dr. R. C. Langford, Director of the new Kearfott Research Center, has joined Kearfott after 18 years as R&D Director in a major electronics corporation. He was graduated with a Doctorate as a Swan Research Fellow from the University of London. He is senior member of IRE, a founder member of the American Nuclear Society and a member of the American Rocket Society. An author of technical articles and lecturer, he has also been a member of a U.S. Government committee analyzing Russian accomplishments in the electronic and solid state fields.

Your interest is enlisted in a new scientific community entirely concerned with scientific and technical investigations; totally divorced from administrative or development duties.

Studies will be related as closely as possible to urgent needs of government agencies, determined through personal consultation with their representatives. Particular (but not exclusive) emphasis will be placed on problems bearing on navigation, guidance and control of upper atmosphere, space and undersea vehicles, areas where Kearfott has long held a leadership position in the development of systems and components.

Recent doctoral candidates are sought who are interested in pursuing research programs under the technical guidance of eminent scientists in the following areas:

Oceanography – to investigate natural phenomena, in order to arrive at a more perfect understanding of the effect of earth sciences on systems required by government. (A vessel will be provided.)

Radiation Sciences – to increase understanding of plasmas, wave propagation; to fully explore energy conversion, infrared technologies.

Astrospace Environments – to study natural phenomena in order to provide a more perfect understanding of environmental boundaries of space systems.

Hydraulics & Pneumatics – to provide a fuller understanding of fluid technology in dynamic systems.

Guidance & Navigation – terrestrial and celestial – to develop a broader comprehension of the needs of future systems.

Physics – specialists in modern materials research pertaining to solid state, fluid, magnetic and dielectric materials.

Chemistry – to develop and extend range and application of organic materials. Activity will be in both materials and processes.

Metallurgy – to serve as authority on metallurgical properties of modern materials – function-wear, defect propagation and anelasticity.

▶ *Please write Dr. Langford at length about your interests and past work. Copies of thesis or papers will be appreciated – and returned, if desired.*

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RADIO FREQUENCY INTERFERENCE

A Growing Problem in Modern Communications

by Charles W. McAfee

Recently, engineers and technicians of the Air Force Missile Test Center at Cape Canaveral watched the intermittently erratic behavior of their test missile as it streaked across the Atlantic. There was no immediate explanation for the behavior, but similar irregularities had previously been traced to an increasingly common source—radio frequency interference, known commonly as rfi. Such was again found to be the case. A taxi-cab dispatcher in Miami was transmitting a signal that interferred with the missile guidance system, causing the missile to stray from its pre-planned trajectory while the dispatcher was transmitting.

Instances such as this are occurring more and more frequently. As the quantity of electrical apparatus being operated increases, more and more stray signals are radiated into the atmosphere. These signals interfere with reception of desired signals by a receiving set. Besides receiving the desired signal, a device may receive many unwanted signals, some of which are sufficiently strong to cover the desired signal and foul the system.

Any electrical apparatus is a potential source of rfi. A light switch, an automobile starter, or even a length of wire that is subjected to a signal of its resonant frequency may become a source of radiation.

These sources can be broken down into four classes: (1) switching, (2) discharges, (3) radio-frequency leakage; and (4) harmonic generation.

Interference radiation due to switching may occur at any switching device, such as a common electric stove or a heating pad. Rfi caused by switching results when arcing occurs across the switch terminals when the switch is operated. The radiated signal is very complex and contains many harmonics.

Discharge interference is a product of such apparatus as fluorescent and neon lamps. Signals containing harmonic components are radiated from the glow discharge tube four times during each a-c cycle, which means that 240 new signals are emitted each second from a tube operating on a 60-cps line. Carona discharge is emitted from high-voltage transmission lines. Discharge interference is often apparent when an automobile radio passes near neon signs or transmission lines.

Radio-frequency leakage is a result of inadequate shielding of generators such as induction heaters and oscillators operating in the radio-frequency range.

Harmonic interference is caused by generators which produce non-sinusoidal wave forms. Every non-sinusoidal wave contains harmonic components, and these harmonics are emitted as interference. Since no generator produces a perfect sinusoid, every transmitter and oscillator is a source of rfi.

The problem posed by rfi has been recognized since the advent of radio. However, suppression techniques were not developed until automobiles began to be equipped with receiving sets. It was then necessary to reduce the interference due to the generator, ignition system, and front-wheel bearing friction. Rfi caused no great concern, however, until the numerous complex electronic defense systems came into use. These systems greatly increased the number of rfi generators, and at the same time the increased sensitivity of the equipment caused it to be more susceptible to interference. Even though the seriousness of the problem was recognized during the war, few attempts were made to do anything about it because of the urgent need for rapid development and production of new electronic equipment.

Since the war build-up, the complexity of rfi has increased much more rapidly than have the methods and techniques of suppressing it. Every day more incidents directly attributable to rfi occur in communications and guidance systems.

For instance, interference in airline communication systems has been traced directly to passenger-carried apparatus such as battery-driven dicta-phones and electric shavers. The question remains unanswered as to whether or not the recent airline collisions occurred because of similar interference.

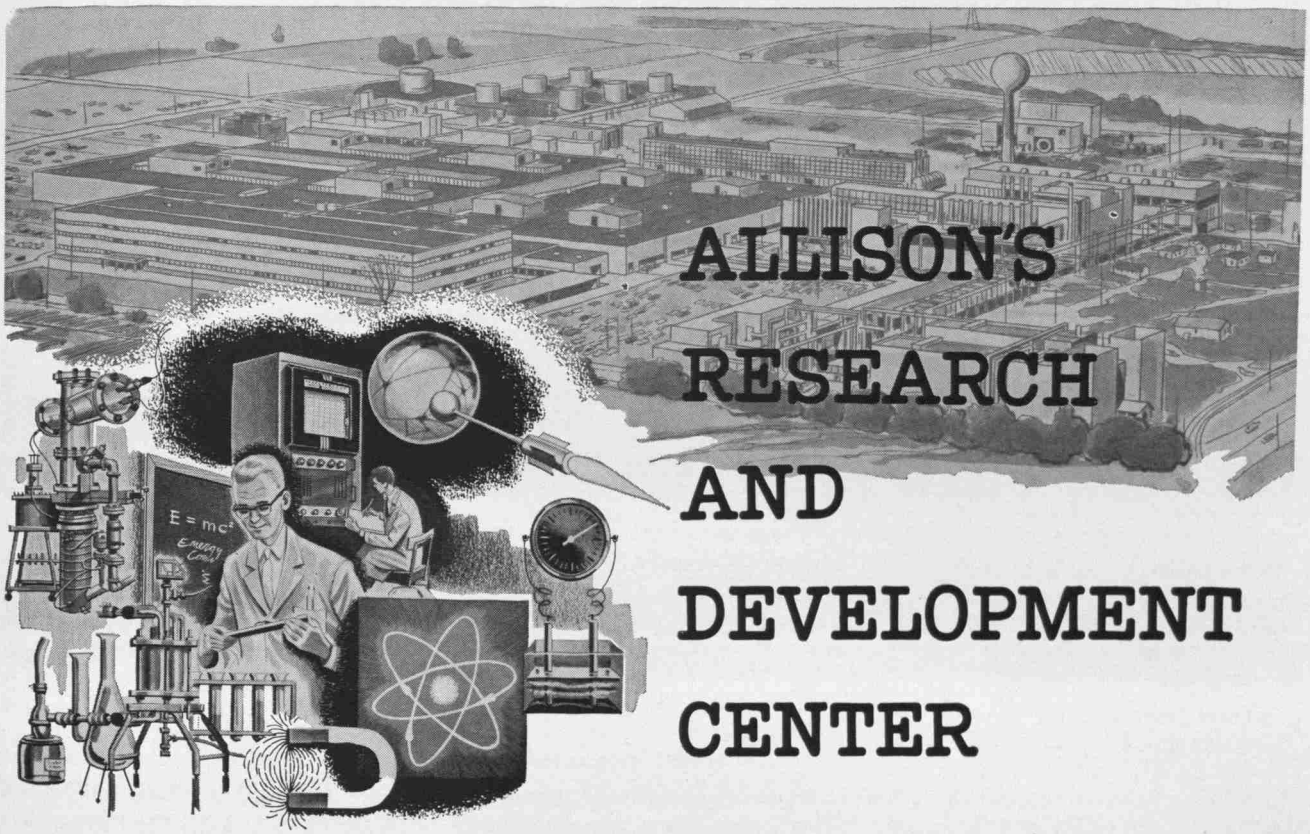
Another example is the increasing incompatibility between radar and microwave communications. Microwave receivers pick up extensive interference in the form of harmonics and spurious emissions from ardar transmitters.

Many other incidents occur, ranging in seriousness from the mysterious opening of a radio-operated garage door to the premature destruction of a missile.

Attempts are being made, especially by the military, to curtail the rfi problem. The Army signal corps is establishing a multi-million dollar installation to study equipment compatibility under simulated field conditions. The data obtained in this study will be analyzed and used to develop new manufacturing and operational techniques. The Federal Communications Commission maintains a network of long-range detection stations, a means by which the FCC can track the interference to its source.

The military, in conjunction with civilian concerns, has established design and operational standards. These

(Continued on page 29)



ALLISON'S RESEARCH AND DEVELOPMENT CENTER

● This vast, 217-acre complex of test cells and modern laboratories is the Allison Division, Research and Development Center in Indianapolis.

Here, Allison scientists and engineers are pursuing numerous challenging and exciting research projects involving power and propulsion systems of the next generation.

Facilities at Allison's R&D Center include a high altitude chamber capable of simulating altitudes up to nearly 200 miles. Presently the chamber is a prime data source for studies relating to magneto-fluiddynamics and the environmental simulation of space radiators.

Allison's Rocket Propulsion Facility includes laboratories for rocket motor and nozzle testing. An 18 x 64-foot rocket propulsion chamber is capable of testing up to 1000 pounds of either solid or liquid propellant at 25,000 pounds thrust.

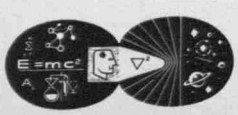
Rocket propulsion nozzles can be tested over a thrust range of 100 to 25,000 pounds in the nozzle test facility. In the nearby combustion laboratory, engineers can study the internal characteristics of gas turbine nozzles. Here compressed air can be supplied at pressures up to 270 psia, with exhaust pressures simulating altitudes from sea level to 75,000 feet—an available pressure ratio of more than 500 to one.

Latest addition to this phase of our research program is the solid fuel rocket static test firing pad in a remote section of the R&D Center. Designed and built by Allison to accommodate rocket thrusts up to 12,750 pounds, this new facility is being used for evaluation and perfection of such current projects as space vehicle and attitude control systems, and advanced rocket nozzles. Provisions are incorporated to apply varying degrees of yaw, pitch and roll—conditions that are corrected by the attitude control system to demonstrate its ability to keep a missile or space vehicle on its programmed course.

Of course, these are only a few of the facilities and research projects at Allison. There's a laboratory for virtually any requirement—physical optics, radio-isotope, infra-red, solid state physics, physical chemistry, direct conversion, heat transfer, fluid dynamics, to name a few.

And the story doesn't end here. The Allison Scientific Advisory Board, American and European consultants, and the vast resources of the entire General Motors organization also support Allison's efforts.

These extensive facilities plus research work underway and nearly half a century of experience in energy conversion represent the capabilities which Allison is harnessing in its contribution to the aerospace needs of the future.

Energy Conversion  *is Our Business*

ALLISON DIVISION GENERAL MOTORS CORPORATION

the laser - a coherent light source

by ROBERTA HUFFMASTER

Telephone conversations carried by light waves? A single light beam that carries all the messages that now go across country on regular communication channels? Optical radar utilizing antenna only inches across?

These and many other exciting possibilities have been anticipated due to the recent discovery of a device that generates a beam of coherent light. It is known as a LASER, an acronym for Light Amplification by Stimulated Emission of Radiation.

It is coherence of radio waves, for example, that enables them to be modulated, amplified, and detected, the basis for communication by telegraph, telephone and television. By providing a source of coherent light, the laser indicates the possibility of extending present communication methods to the optical frequencies.

It is also possible to obtain light from a laser that is at a single monochromatic frequency, with highly parallel light rays. This collimated beam of infrared light from the laser can be focused to produce intense heat. In an experiment at Bell Laboratories, a laser beam was directed at a carbon block and focused with a simple lens. A spot on the target was heated to 8,000° C in only .5 milliseconds.

Laser operation requires an active material that will produce stimulated emission of radiation, an excitation source that pumps power into the active material and a resonant structure.

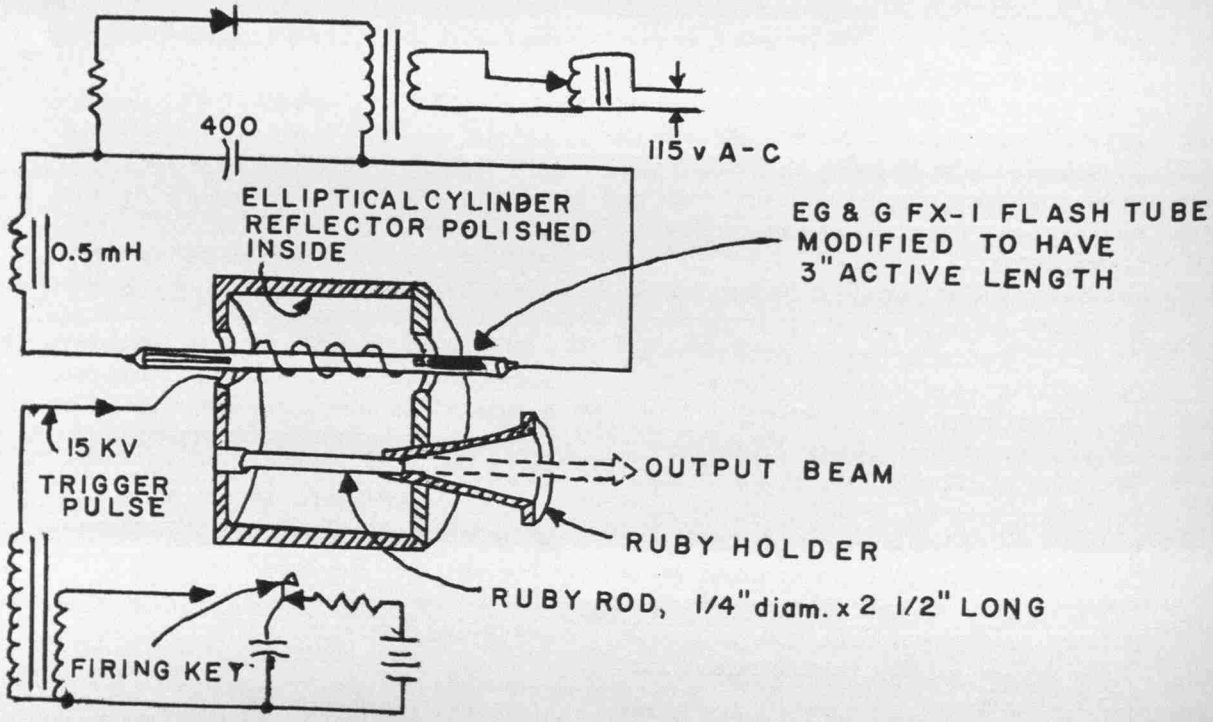


FIG. 1--Flashtube excites Cr^{+++} atoms in ruby to higher energy state. In dropping back to ground state, Cr^{+++} atoms emit coherent light. (Raytheon)

The construction of a ruby laser is shown in figure 1. The active material is ruby, the excitation source a xenon flashtube, and the resonant structure is formed by the ruby rod, whose ends are reflecting mirrors. One end of the rod has a heavy silver coat that makes it an opaque mirror and the other end has a silver coat that makes it a 92-percent-reflecting mirror.

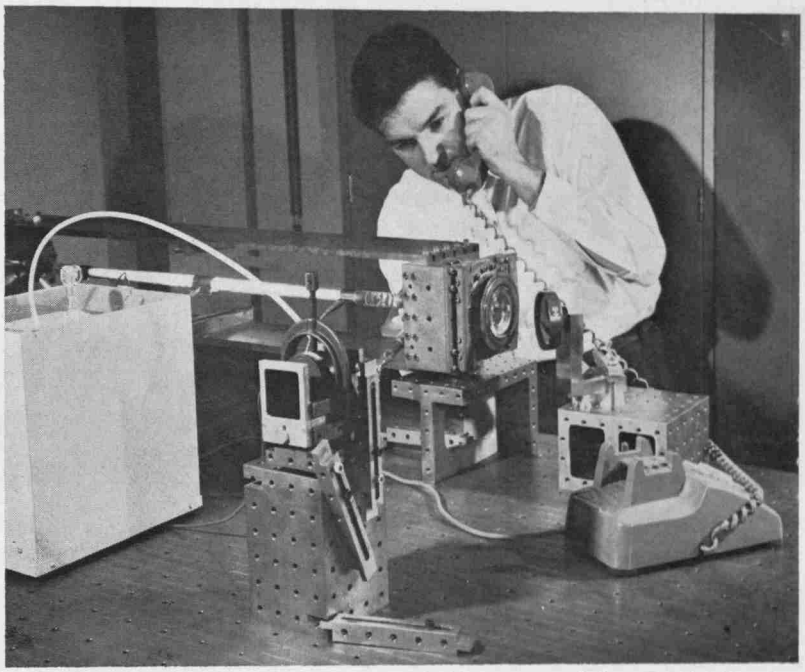
It is possible to get a picture of laser action by relating this action to the energy-level diagram of the lasing material. Figure 2 shows a simplified energy-level diagram for Cr+++ (chromium ion) doped pink-ruby crystal (Cr_2O_3:Al_2O_3).

The heights of black bars 1 and 2 and of the area shown in cross hatching (3) indicate the possible energies that a Cr+++ ion can have; energy is in units of 10^3 wavelengths per cm; 1 wavelength per cm is equivalent to 1.9858×10^{-16} ergs. In their normal condition (the ground state), the Cr+++ ions have zero energy; this condition is indicated by level 1.

If light photons having a wavelength of 5,6000 A irradiate the ruby crystal, they will raise the energies of some Cr+++ ions to various energy levels lying in the absorption band of energies indicated by 3. Flashtubes supply this irradiating light, along with light comprising many other wavelengths. The left-hand arrow (W_{13}—see legend) going from level 1 to band 3 indicates the increase in energy acquired by a Cr+++ ion when it absorbs a 5,6000-A light photon; the use of light excitation to raise the energy level of atoms to a higher level(s) is called optical pumping.

After short, but finite times elapse, some of the Cr+++ ions in band 3 drop back to level 1 (shown by A_{31}) and some drop to level 2 (S_{32}). The rate at which Cr+++ ions drop to level 2 is greater than the rate they drop to level 1. The Cr+++ ions in energy level 2 hold their energy for a short time before they drop to level 1.

The rate that ions go from level 2 to level 1 (A_{21}) is less than the rate Cr+++ ions go from level 1 to level 3. Thus, optical pumping builds up the number of ions having level-2 energies to a greater number than the number of ions having level-1 energies; In other words, the Cr+++ populations of levels 1 and 2 are inverted from their normal relation. This population inversion is essential for producing stimulated emission of light.



Telephone conversation by optical maser demonstrated by D. R. Merriott (Bell Labs)

In dropping from level 2 to level 1, Cr+++ ions radiate light. Level 2 (^2E) actually comprises two levels, levels E and 2A, which emit radiation lines R_1 and R_2, respectively. If conditions were not completely correct for achieving laser action—for example, if an insufficient amount of excitation were applied—R_1 radiation would be spontaneous radiation rather than stimulated radiation and would comprise a much broader band of wavelengths than the stimulated emission.

In both cases, the center frequency of the R_1 and R_2 energy radiated when ions drop from level 2 to level 1 is calculated from $v = (E_2\text{-}E_1)/h$ where v is frequency, E_2 is the energy at the center of level E (for R_1) or level 2A (for R_2), $E_1 = 0$, and h is Planck's constant.

The resonating character of laser action enhances radiation at the central wavelength of R_1 and diminishes other radiation. Arrow A_{21} in Fig. 2 indicates the spontaneous radiation of R_1 and spontaneous (incoherent) radiation at R_1 and R_2.

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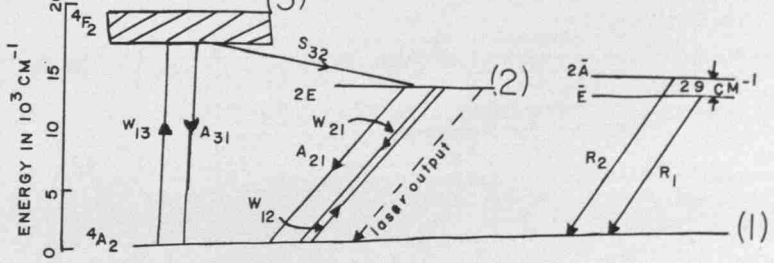

Fig. 2-- Energy-level diagram for ruby and explanation of terms in Legend. (Electronics)

Legend:

W_{ab}	Energy-change-probability rate due to exciting radiation of of frequency v_{ab}. $W_{12} = W_{21}$
ab	Level number a to level number b
A_{ab}	Energy-change-probability rate with accompanying radiation
S_{32}	Energy-change-probability rate without radiation
$^4A_2$	Ground state (0 energy) of Cr^{+++} ions
$^4F_2$	Absorption band of energy levels of Cr^{+++} ions
^2E	Energy level comprises sublevels $2\bar{A}$ and $\bar{E}$

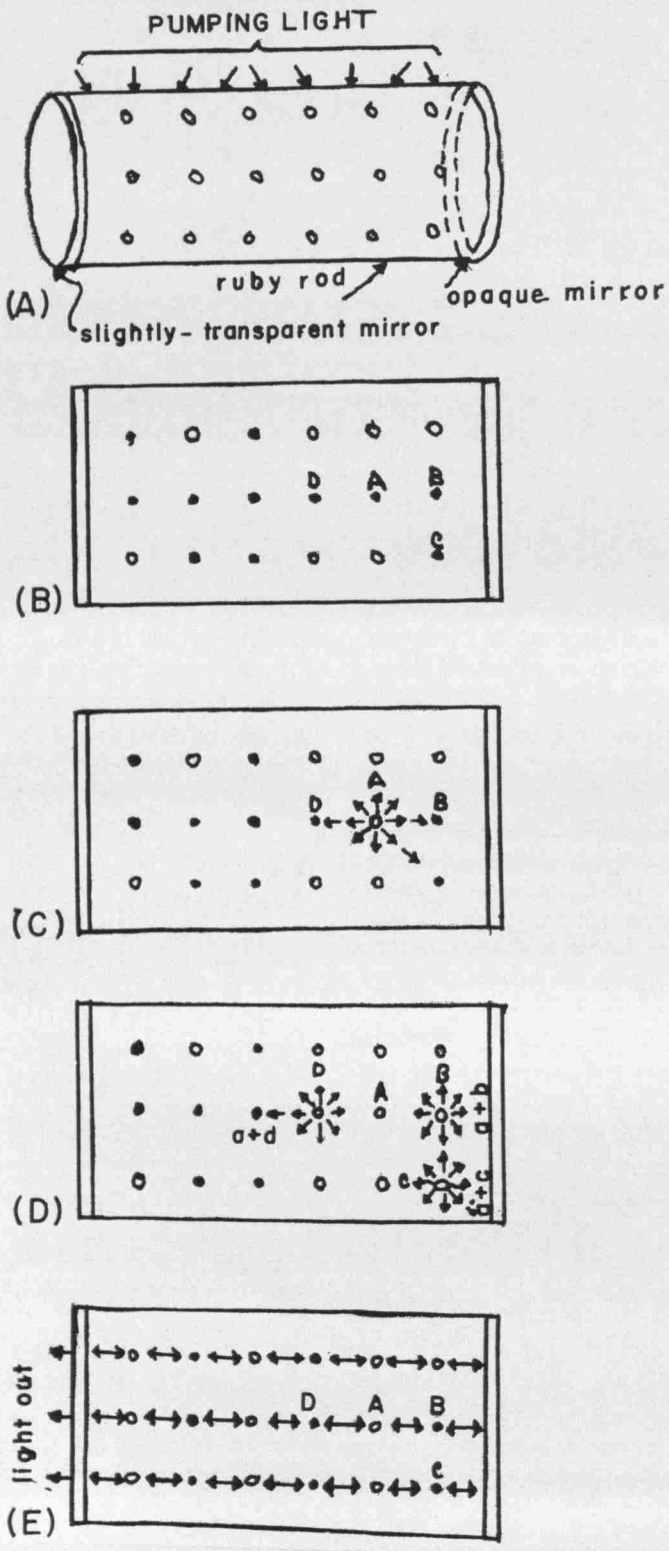

FIG. 3--Sketches (A) to (D) depict the sequence in which ion A spontaneously emits radiation that triggers the stimulated emission in the laser beam (E). (Electronics)

The simplified sketches shown in Fig. 3A to 3E illustrate sequences of laser action. At the instant that pumping light is applied (Fig. 3A), all Cr^{+++} ions are in the ground state; the unshaded circles indicate this state.

Optical pumping raises some Cr^{+++} ions to level E (Fig. 2). The black circles in Fig. 3B indicates ions that have been pumped up to level E; for simplicity, ions pumped to level 2A are not indicated. Some Cr^{+++} ions drop to level 1, radiating photons that have various wavelengths centered about the central wavelength of R_1.

Figure 3C shows one ion, ion A, dropping to level 1 and spontaneously emitting radiation; in these simplified sketches, ion A is the first ion (and the only one that is shown) to emit R_1 radiation spontaneously, that is, without being stimulated by R_1 radiation. The radiated photon tends to stimulate radiation of the same wavelength from other Cr^{+++} ions of level E that are in its path. This is indicated in Fig. 3C and 3D.

Assume that incident radiation a from ion A has the wavelength of the strongest R_1 emission. Incident photon a is reinforced by stimulated photons b, c and d in a precise phase relationship, as indicated by light rays a + b, a + c and a + d in Fig. 3D. The opaque mirror reflects a + b back into the ruby cavity, but a + c passes through the side wall and is lost.

Thus, the cavity enhances radiation propagated parallel to the axis of the ruby rod and minimizes radiation going in other directions.

Due to the amplification caused by photons stimulating the emission of other photons of the same wavelength; rays comprising photons of the center wavelength of the R_1 line, which is the strongest (that is, most prevalent) wavelength, become predominant over other R_1-wavelength rays. This action makes the laser output highly, but not completely monochromatic.

Since photons traversing other paths than in the direction of the long axis of the crystal escape from the sides of the rod (Fig. 3D), the laser output beam is highly directional. Photon streams reflect back and forth between the end mirrors and emerge from the end mirror that is slightly transparent. Figure 3E indicated the cohering effect of the light field in the cavity in stimulating emission by the ions.

(Continued on page 38)

THE BELL TELEPHONE COMPANIES SALUTE: MARTIN CAWLEY

When Martin Cawley joined Illinois Bell Telephone Company a year and a half ago, he immediately was assigned to a job in the Building Engineer's Group. This work involved preparing plans and specifications for remodeling several floors of an important telephone office building, and following details of the field work until the job was completed. A lot of responsibility, but he handled it well and earned an assignment as Project Engineer. Now he handles still more complex building projects, each contributing to better telephone service for Chicago.

Martin Cawley and other young engineers like him in Bell Telephone Companies throughout the country help bring the finest communications service in the world to the homes and businesses of a growing America.

BELL TELEPHONE COMPANIES

Physiological Research In Project Mercury

Research in Space Medicine Paves the Way for Manned Lunar and Interplanetary Flights

by John Thornton, E.E. '62

One of the major objectives of Project Mercury is to study an astronaut's physiological responses under space conditions such as would be encountered on a trip to the moon. Such conditions include rapidly changing ambient pressures, noise, vibration, acceleration, a 100% oxygen environment and thermal stress.

The first manned suborbital flight took place May 5, 1961, when a Redstone rocket carried astronaut Alan Shepard on a fifteen minute flight. The maximum altitude attained during the flight was 116½ statute miles. The Mercury capsule made its final landing in the ocean 300 miles downrange from Cape Canaveral.

During the flight, Commander Shepard's responses were monitored continuously. His suit was instrumented for two channels of electrocardiogram, respiration rate, and body temperature. The data was transmitted to ground stations by the telemetry system. Identical recordings were made in the capsule.

Commander Shepard is recovered at sea by Marine rescue helicopter (NASA)

Downrange stations and aircraft kept telemetry and voice contact during the flight. A continuous inflight conversation between the capsule and the ground was maintained during the flight.

Most of the instrumentation and telemetry equipment had been tested in earlier Redstone animal-carrying flights. The chimpanzee Ham which rode in the earlier MR-3 flight, was fitted with a system similar to the one used by Shepard. Several post-flight changes were made before the instrumentation was suitable for a manned suborbital flight attempt.

The recording of body temperature was one of the most important measurements made during the flight. Experiments with the early Man High balloon flights indicated that body temperature was a critical aspect in future manned space flight.

Usually, large rectal catheters or probes are used in medical research for the measurement of deep body temperatures. Since these probes would be uncomfortable during periods of high or sustained acceleration, a new method had to be found.

Engineers at McDonnell Aircraft Corporation developed a new type of rectal body probe using thermistors. The probe, which is less than an inch

in length, is unnoticed by the astronaut during flight.

Respiration rate was measured by a microphone mounted thermistor. Since a face mask could not be used in a pressure suit, another method had to be found to obtain constant measurements of nasal and oral breathing.

A thermistor was mounted on the pilot's microphone. The thermistor was held at a constant temperature of 200° F. Air movement caused by breathing cooled the thermistor, producing a change in resistance. The rate could then be detected. This type of instrumentation allowed the pilot to move his head during flight.

In order to record the electrocardiogram, certain specifications had to be met. The instrument had to have a low impedance in order to match it to the capsule amplifiers. In addition, it had to operate over a 24-hour period.

The small fluid electrode was glued to the skin with a non-irritating paste. The changing potential was detected by a small wire mesh imbedded in the paste. The detector was then sealed to prevent the paste from drying out.

Placement of the electrode on the astronaut's body was critical. In order to reduce interference, electrodes were placed at various points on the pilot's chest in the region of the heart.

Additional sources of interference which affected the electrocardiogram were the batteries which formed the main power supply for the capsule. After a great deal of research, a type of amplifier was found which gave good results.

Several auxiliary sources of information were used in the capsule. A motion-picture camera operating at six frames a second gave a visual indication of the pilot's reactions under high-G forces and weightlessness. Voice transmissions were used to give an indication of the astronaut's mental state.

From a physiological standpoint, scientists divided the flight into two phases—the countdown and the actual suborbital flight itself. This was primarily due to the different environments encountered during the two phases.

Shepard entered the capsule approximately four hours and fifteen minutes before liftoff. During this time, the pulse and respiration rate were monitored. The pulse rate was sampled at five minute intervals during the countdown. As liftoff time approached, the sampling rate was increased to 15 second intervals of ten second duration each. Shepard's pulse rate remained at approximately 80 beats per minute except for brief intervals during which it rose as high as 95. At thirty seconds

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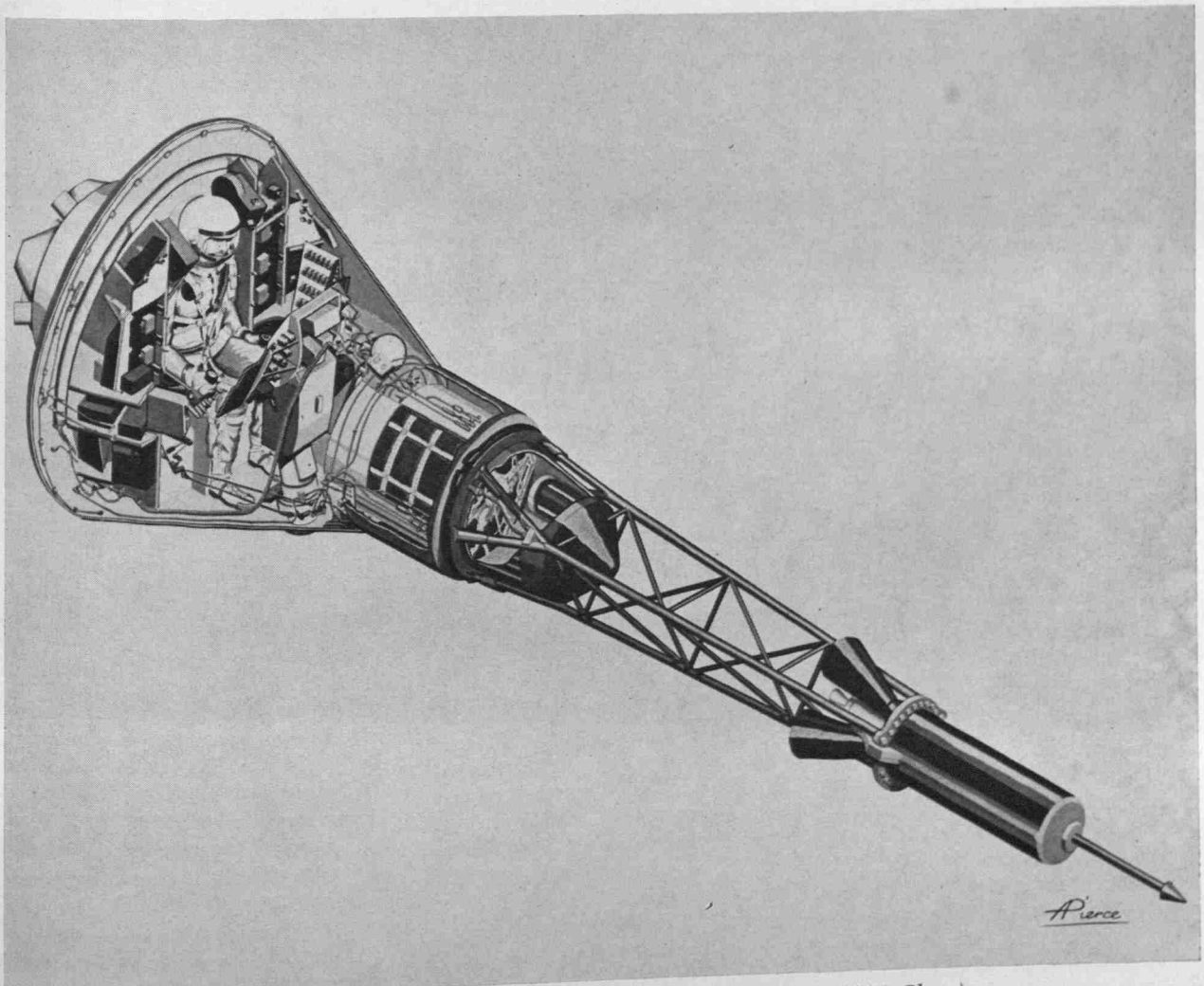


Cutaway view showing environment system and instrumentation for Freedom 7. (NASA Photo)

MSU'S NEW COMPUTER

Research in Science and Engineering Aided by World's Newest Electronic System

by David G. Thaler, E.E. '62

Michigan State will soon have the newest and best electronic system currently in production.

The Board of Trustees voted (April 13, 1962) to purchase the newly designed gigantic 3600 Computer System from the Control Data Corporation in Minneapolis. In fact, this system is so new that it was not even proposed to the University until April 6, 1962. Final details of the proposal were not received until April 12, 1962 the day before the board was to make its decision as to which of the computers under consideration would be purchased.

In addition, the information contained in the proposal was to be held confidential as the computer was just starting to be produced and details concerning this fabulous computing system were not released to the general public until after the first of May.

"We know of no other computing system in this price class with this capability," Richard Kinsman, sales engineer for Control Data said. He further added that the installation of this system ". . . would give Michigan State University the finest computing system installed in any university in the United States, except for possibly one or two installations in the multi-million dollar class."

Delivery of the nation's first assembly of the 3600 Computing System will be made to Michigan State on, or about, March 31, 1963. The newly purchased system includes a computer with a storage capacity of 32,768 words on magnetic cores, and a console containing an electric typewriter. Also incorporated in the system are two bi-lateral channels, a magnetic tape control, six model 606 tape units, a 1000 line printer, a slow speed card punch, a medium speed card reader, and the model 160-A computer.

An educational discount of $910,200 reduced the list price of $2,298,000 to private industry, to a net price for the University of only $1,387,000. This reduction is a result of the Data Control Corporation's decision to provide free computing time on their own large computer and to lend Michigan State an interim computer until delivery of the 3600 System.

The interim computing system is being provided by the Data Control Corporation to help alleviate the present overload on MISTIC. After installation about the first of June, this system will be capable of running FORTRAN problems immediately.

The complete interim system consists of a basic computer, a line printer, a card reader, a card punch, and two magnetic tape units. The basic 160-A computer is housed in a standard size office desk and includes a memory module of 8,192 words on magnetic cores, a paper tape reader and punch, and a control console. Normally, the computer is used with 7-level paper tape, but it appears quite feasible that the tape equipment already available for MISTIC can be used by adapting the tape reader to accommodate 5-level tape.

The 160-A computer will become part of the 3600 Computing System next March, with the other components being returned to the Control Data Corporation at that time. This system normally rents for $4,990 per month, but is being provided at no cost to the University until the complete 3600 System is installed and operating. This means about $50,000 worth of free computing for Michigan State.

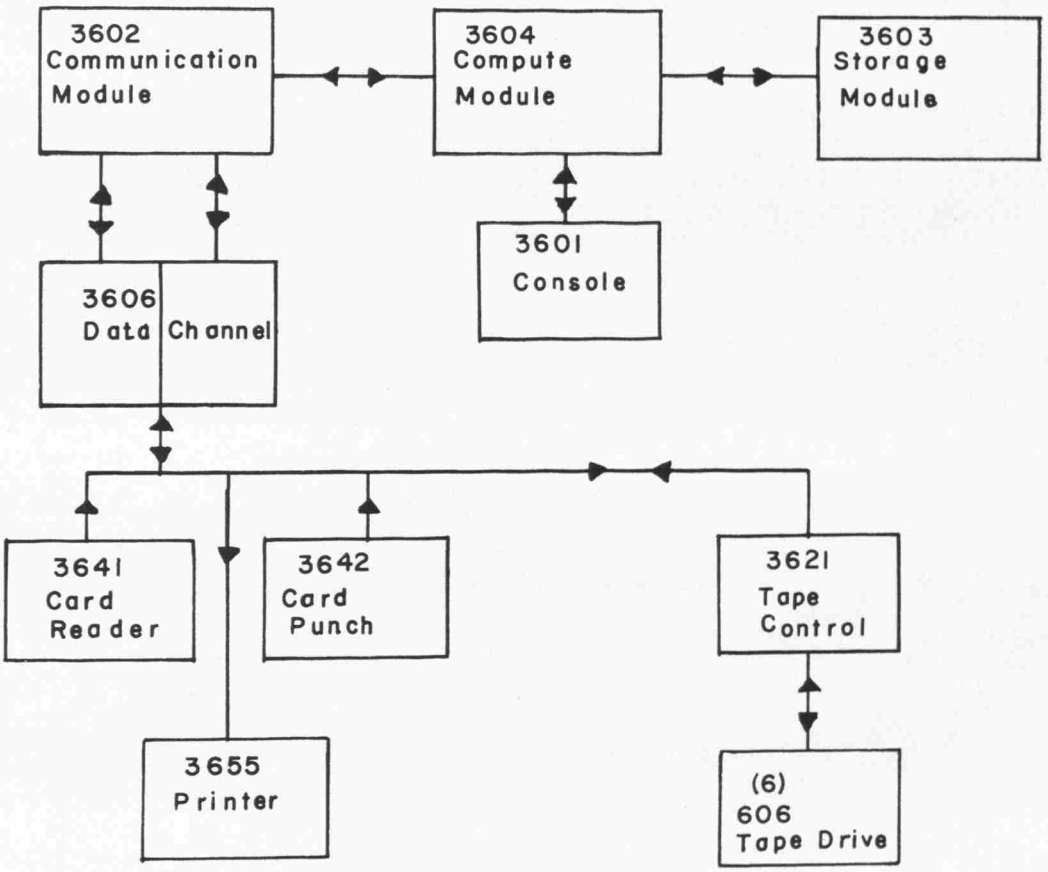
Control Data is providing 200 hours of free computing time on their huge Minneapolis facility, valued at $400 per hour, to accommodate problems too large to be conducted on either MISTIC of the 160-A interim computing system.

The University is considering the installation of a data-phone communication system to permit direct communication via long distance telephone line with the Minneapolis computer. This constitutes an additional $80,000 worth of computing time, which makes a total value of $130,000 worth of free time being donated to Michigan State University by the Control Data Corporation.

The selection of the Control Data Corporation's computing system climaxed an intensive study that began in October of last year. The various machines that the University was considering included the best computers offered by the Burroughs Corporation of Detroit, International Business Machines, and the Control Data Corporation.

According to Dean Milton E. Muelder, vice president in charge of research, the Data Control 3600 system is considered to be three to four times as fast as the IBM 7090 and twice as fast as the IBM 7094, which is a newer version of the IBM 7090. Bearing in mind that the speeds of the different computers vary with the problems being computed, the IBM 7090 is considered to be anywhere from 2½ to six times as fast as the B-5000 computer produced by the Burroughs Corporation.

The general configuration of the 3600 system is shown below:



Upon arrival at Michigan State next March, the new computing system will undergo 30 days of acceptance tests before it replaces the MISTIC. The technically out-dated MISTIC is currently being used by over 40 different departments with the University and is operating constantly 24 hours a day, five days a week.

The MISTIC was built in 1957 for under $250,000 including parts and technicians' salaries. Most of the actual construction was done by juniors and seniors in the undergraduate EE labs under the supervision of computer staff members and professors.

MSU's present computer was originally modeled after the University of Illinois' famous Illiac computer which at the time was the leader in its field. It too had inevitably become obsolete and is being retired shortly.

Much controversy still exists as to the origin of the name given to the present computer. There are many who feel that "MISTIC" stands for "MIchigan State Integral Computer." Others advocate just as strongly that "MIchigan State Illiac Computer," in honor of the computer after which it was modeled, is the true meaning of the MSU-coined word.

Speed is the biggest advantage of the new computing system, which according to Dr. Reid, assistant professor of the computer laboratory and electrical engineer, should prove to be one to two thousand times as fast as MISTIC. Currently MISTIC is being heavily overloaded by the forty departments using its facilities. Many other users are being turned down because of the necessity to select those programs which most deserve to be run on the computer. Due to the long waiting period to get problems computed, many departments are having computer work done in New York City, or at the University of Michigan.

With the 3600 Computing System possessing the tremendous capability of co-ordinated, simultaneous, high-speed operations, even a few idle seconds become painfully obvious and extremely costly. During the normal 10 to 30 seconds delay now encountered with the MISTIC in manual insertion of a program tape and sign-off the previous tape, a good size problem could have been completed.

Furthermore, the computer itself can accurately perform its own accounting, maintain its own log, and even grade student problems. As a result, the computer operation will be

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THE ROLE OF THE ENGINEER TODAY

How College Recruiters Look For Future Executives

by Mr. John A. Overhouse
Training Engineer
Mich. State Highway Dept.

The engineer is being called on more and more to assume the role of coordinator and supervisor of the Technician specialists. In selecting engineers to be supervisors the question comes up: Will he assume the responsibility to plan, anticipate, organize and supervise the work in his area? How do we identify the potential supervisor? How can we indentify the engineer who will assume the responsibility to communicate? Actually, it appears at this time that one of the most accurate indications of supervisory aptitude is the ability and willingness to communicate.

The future executive must have the motivation to keep up with things. At this time management is trying to keep up with developments in the area of data processing, so that they may be able to utilize data processing in assembling facts into obvious patterns. The modern manager then makes decisions which are based on facts that he knows to be fact.

Therefore, as a supervisor, manager, or executive, the engineer has to have a strong base in words and numbers (Reading, Writing and Arithmetic) on which to acquire the fundamentals of engineering and the specialized skills for his job. The present government project in retraining people is proving once again that this sequence of fundamentals first and job skills later cannot be reversed.

As Engineer-Designer

As an Engineer-Designer, the engineer should have a strong base in math and English and a knowledge of graphic arts so that he has confidence in abstract thinking and the ability to convey his ideas to the technician. How does the company identify special aptitudes and skills in Engineering Design? A written test usually shows ability in numbers and words, inasmuch as it requires comprehension to understand the problem and ability in communications skills or math to indicate a solution.

As a Researcher

As an Engineer in Research, the company or the recruiter would have to depend a good deal on the engineer's ability to communicate by writing reports and specifications on his findings. To identify an aptitude for research would again involve the engineer's ability with words and numbers.

The Usual Factors in Evaluating Engineering Graduates

The grade-point average is probably the most accurate of all the factors, in that it represents consistent effort over a four-year period. The grade-point position in the class is apt to indicate the position in a professional group later on.

Extra curricular activities might indicate a special interest relevant to the job, as well as social adjustment and ability to work in a group.

Part-time work while going to school is commendable and may sometimes account for a lower grade-point average. The work experience may help the new engineer adjust to a job in industry. However, this factor is outweighed by differences in motivation which crop up in professional life.

Motivation Key Factor

Motivation is probably the key factor which determines the progress in the professional development of the engineer. Success for the individual in a company depends more on consistent motivation than any other factor, if we can assume that most engineers belong to a select group and that they all have somewhat the same mental equipment and academic background. To compete in industry and to assume a leadership role requires a continual effort to improve and develop professionally. Life is like driving a car, each moment we have to drive safely as of that moment, our yesterday's good record will not carry us through today.

Motivation in people changes from time to time just like everything else. There are many things which come into our lives which can and do influence our motivation. Parent, sweetheart, wife, children, health, can affect our motivation. It is obvious that motivation and what causes the changes can cover a lot of ground and yet we can safely say that motivation accounts for the biggest difference in people. Engineering grads start out with much the same chance and opportunity these days, but it isn't long after graduation before the men and the boys begin to get separated due mainly to difference in motivation.

It is difficult to predict motivation, because it can vary as the engineer comes to grips with life and some of its anxieties and adversities. With some types, motivation is rather steady and they keep plugging right along, come rain or shine. Others are finely tuned in on one wave length and are greatly affected by outside influences which tend to disrupt their ideal environment. Their motivation may vary from enthusiasm to downright depression over seemingly trivial and irrelevant things.

No doubt it would take a ticker tape to keep track of these amplitudes in motivation and the attitudes reflected toward colleagues, the job, the company, the boss and toward the engineering profession. It takes a very stable and determined person with long-range goals to be able to main-

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how quiet is quiet?

Cats are notoriously silent in their singularly feline way. But even the most stealthily treading tomcat could take lessons from the men at Ford Motor Company whose job it is to track down and suppress unwanted noise in vehicles.

At our Ford Research and Engineering Center in Dearborn, engineers have created a unique room without echoes, virtually duplicating the perfect stillness that exists miles above the earth's surface.

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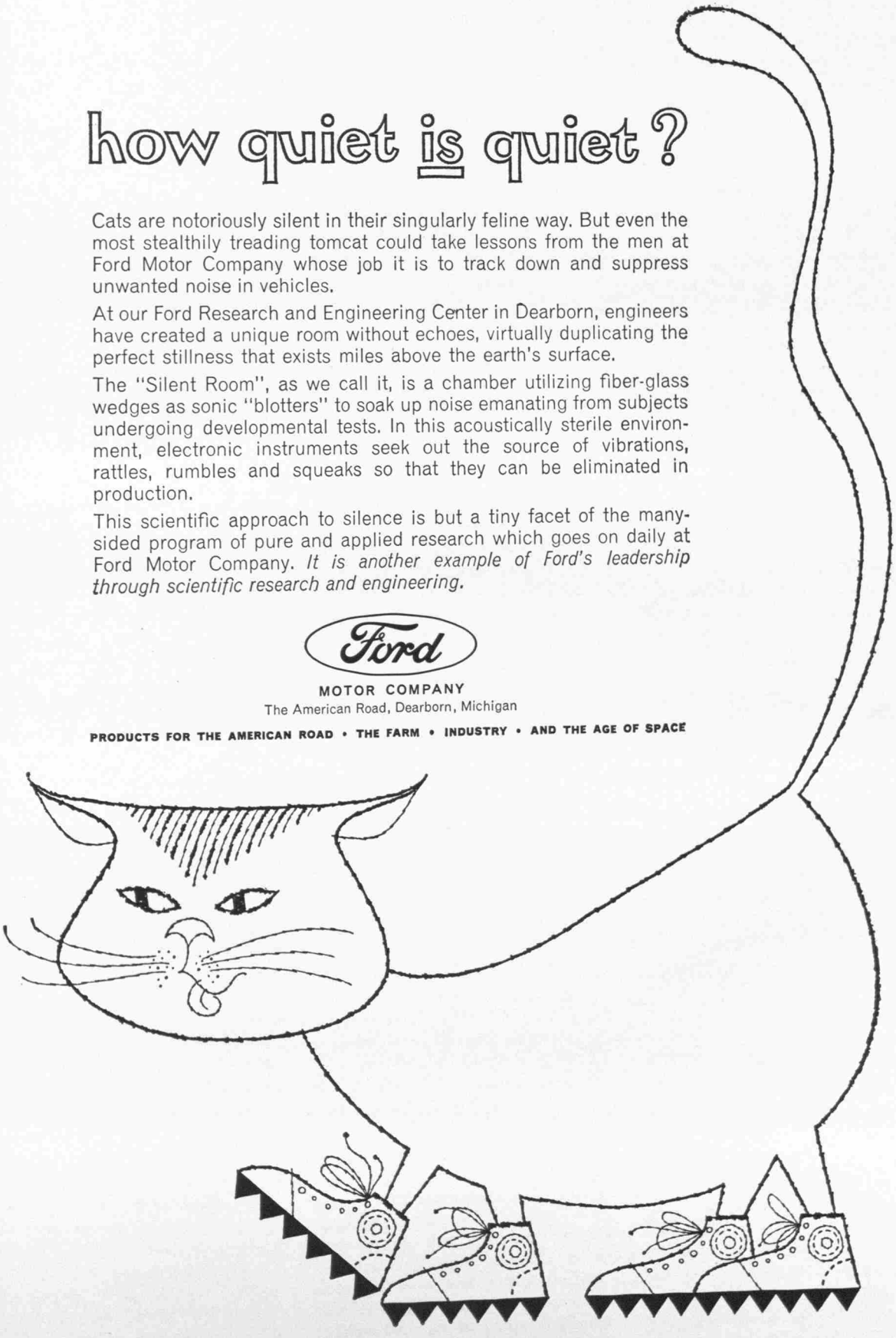

THERMOELECTRICITY

Compact, Efficient and Versatile Power Source Offers Many Advantages to Consumer Goods

by Charles Stout

Thermoelectricity is a method for the direct conversion of heat into electricity. It permits the direct generation of electricity from a coal fire, nuclear reactor, or other heat source without the need for intermediate apparatus. Inversely, it makes possible refrigeration directly from the flow of an electric current.

Thermoelectricity is especially attractive as a method of generating electricity in those applications where simplicity, reliability, ruggedness, long life, lightweight, quietness of operation and freedom from service worries are important considerations. Or, it might supplement conventional methods of power generation by taking advantage of heat energy now wasted.

Essentially, a thermoelectric generator is an electron pump which uses heat energy as its driving force. Heating one end of a piece of thermoelectric material causes the electrons within it to crowd to the cool end, where they build up as an electric charge, or voltage. Joining together two materials which differ in the magnitude of this effect, and heating their junction, causes a continuous flow of electrons through an electrical device connected to the cool ends of the pair of materials.

Modern practice improves the effectiveness of the thermoelectric process by joining two materials in which the effect differs not in magnitude, but in direction. Heating one of the materials (n-type) causes electrons to flow away from the source of heat in the usual manner; but heating the other material (p-type) causes so-called "holes" (locations void of electrons) to flow away from the heat source, which effect is equivalent to the flow of electrons toward it. Both legs thus add to the over-all flow of charge carriers through the circuit. Modern thermoelectric devices are composed of such n-type, p-type thermoelectric junctions, with each leg composed of one or more thermoelectric materials.

The attractiveness of the thermoelectric process goes beyond its usefulness for power generation. The process is reversible. Instead of using a difference in temperature in thermoelectric materials to maintain a flow of electricity, a flow of electricity can be used to maintain a difference in temperature. Whereas the thermoelectric power generator is an electron pump driven by heat energy, the thermoelectric refrigerator is a heat pump driven by electrical energy.

As electrons flow through the circuit, they increase their concentration in one leg of the junction. Therefore, as they flow across the junction they "expand." The additional energy required for this expansion is extracted from the heat energy in the region of the junction and the junction cools. If the direction of the current is reversed, the reverse effect occurs and the junction will heat instead of cool.

Successful thermoelectric materials depend upon a delicate balance between their thermal conductivity, their electrical resistance and a property called their thermoelectric power. Three general classes of materials are used.

Metals were the original thermoelectric materials and still are employed in the form of intermetallic compounds. Zinc antimonide (ZnSb) is a typical example. The most widely used thermoelectric materials are semiconductors, a class of materials from which transistors and other solid state devices are made. Bismuth telluride (Bi_2Te_3) and lead telluride (PbTe) are typical. The third class of thermoelectric materials, discovered in 1956, are known as mixed valence compounds.

The phenomenon of thermoelectricity dates back to what is known as the Seebeck effect, discovered in Germany in 1821. Thomas Seebeck found that an electric current flows continuously in a closed circuit composed of two dissimilar metals as long as the junctions of the metals are maintained at different temperatures. Such a device is called a thermocouple.

In 1834 the French physicist Jean Peltier, gave a partial explanation of the phenomenon and observed the opposite effect: heat energy is absorbed at one junction and is liberated at the other whenever an electric current flows in such a circuit. This discovery is commonly referred to as the Peltier effect. Twenty years later the English physicist, Lord Kevin, advanced the first detailed theoretical explanation for the phenomena by Seebeck and Peltier.

Until recently however no known pair of metals permitted efficiencies beyond the order of one percent—too low to offer promise for widespread applications. Some limited commercial uses for the process were found and applied; for example, the automatic safety pilot control on home gas furnaces and hot water tanks. But no large-scale commercial applications were in prospect or appeared to be theoretically feasible.

A departure from the all-metal thermocouple, and a significant increase in the efficiency of the thermoelectric process, came in 1937 with the work of Dr. Maria Telkes at the Westinghouse Research Laboratories. By use of a zinc-antimony and lead sulfide pair she was able to observe experi-

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ENGINEER'S ROLE

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tain motivation in spite of frustrations on the job.

While it is obvious that motivation is the biggest difference in people, it is also the factor which can be improved the most by good company policy and management. Good management will bring out that which is best in employees and it is a function of management to be aware of what is frustrating good employees.

Complexity of Demands

Engineers and scientists have put people on the spot by developing a technical world which is becoming too complex to comprehend in one lifetime. Yet the increasing depth of our world of knowledge allows more opportunity for those who can maintain motivation.

Each generation starts from scratch and attempts to review the record. It takes a lifetime to get caught up with the detail in one specialty. Once in a while we get an Einstein who has the time during his life's span not only to review the record but to add a little that is new as well. The ability to organize, retrieve and apply information is critical in engineering. Here again, man's capacity to retain information is limited and he has to extend his senses by utilizing data processing equipment and other mechanical means of retrieving. It takes motivation for the engineer to familiarize himself with these necessary aids for advancement.

How to Measure Motivation in the Graduating Engineer

How can we measure this factor of motivation which in some people is so subject to change? Motivation toward a specific professional goal may not even exist at graduation. A young engineer may become enthused and truly motivated only after he lands on the job and becomes aware of definite objectives for the first time. He may not be motivated until he has family responsibilities and can decide just what sort of a life he wants and, even more important, when he discovers that he can.

No doubt it is a blessing for most of us that this most important factor is not always measurable and predictable,—this gives people new chances every day. There is always another chance to take a new look at our lives and where we are going, always a chance to take a new direction.

Importance of Skill in Communication

This factor can be measured and predicted. While ability to communicate is probably not as decisive a career factor as motivation—it is important.

Communication skills are measured continually as industry resorts more and more to testing people for professional development and promotion. While a written test may be designed to identify special skills and aptitudes, the score usually indicates confidence and fluency in words or numbers. So the moral is that we can justify strength in communication skills just to pass these tests, which are sure to come in the professional development of an engineer.

There is a strong correlation between communications skills and ability to supervise. The ability and willingness to communicate and keep both management and employees informed can determine success as a supervisor. Usually management's evaluation of an engineer reflects the engineer's evaluation of himself. If the engineer-supervisor lacks confidence in use of words and numbers, no doubt management will think so, too.

The engineer-supervisor knows by intuition or by training that in any organization it is people who have the vitality and who respond to communication. Materials and equipment are lifeless things. It is people who have the spirit and motivation that is awakened through communication.

Organization charts which show the chain of command and authority actually emphasize the importance of orderly communication along prescribed channels.

Adequate communication and exchange of information can create an atmosphere of trust and confidence which can provide the spark which makes a dynamic organization.

These skills in supervision and communication are hard to come by and have to be acquired over a long period of maturing and development. The student should concentrate on skill with words through continual practice on articles, reports, speeches and reading. The new emphasis on speed reading is further evidence of the importance of keeping in touch. Motivation to communicate must come from within the individual. Apparently we have to learn this responsibility to communicate and at times it takes some trying experiences before we accept this discipline. A procedural manual may not be enough to move the individual to communicate if he fails to accept the responsibility.

Of the many factors which may appear on the employment interview form under extra curricular activities, the most important could be in the area of communications skills. Contributions to the campus Engineering Magazine and student news would indicate confidence in words and the student's interest in improving the ability to use words. The ability to communicate is one of the best indicators in identifying a potential engineer supervisor.

In conclusion we can say with some certainty that the academic record of the engineer indicates the strong academic base in fundamentals which must always precede the special skills to be developed on the job. We can also say that the greatest single factor which affects the professional career of the engineer is motivation which can vary according to the individual and his environment. Also a willingness and ability to communicate is probably the most important factor which can determine whether an engineer can become a good supervisor and manager.

R.F. INTERFERENCE

(Continued from page 16)

standards define band width limits, frequency stability, radiation levels, and susceptibility limits for equipment to be used by the armed forces.

However, much work toward eliminating rfi remains to be done. The military and civilian effort should be correlated in order that information gained from tests can be more effectively distributed. Every electrical engineer and technician should familiarize himself with interference suppression techniques. Our laws should be such that the FCC would have the authority to enjoin the use of interference-generating equipment, and to force designers and manufacturers to conform to proven control methods.

Until large-scale preventive procedures are taken, rfi will pose an ever-increasing threat to our civilian and defense communications systems.

THERMOELECTRICITY

(Continued from page 28)

mentally an efficiency of seven percent in the temperature range of 70-800 degree Fahrenheit. This marked the advent of semi-conductor-type materials for thermoelectric purposes.

Recent research has also been made on the utilization of the Peltier effect for thermoelectric refrigeration. The materials usually employed are semiconductors such as bismuth telluride. The earliest reports of practical success in thermoelectric refrigeration have come from Russia, with the development of household-type refrigerators and a variety of specialized small-scale devices.

In 1958 Westinghouse demonstrated several potential home appliances using thermoelectric cooling and heating. These included a device to both heat and cool a baby's bottle automatically, a mobile hostess cart with both refrigeration and oven compartments, a full-scale household refrigeration of ten cubic foot capacity, and a "hot-cold light" panel that combines thermoelectric heating and cooling with electroluminescent lighting. The panel demonstrates the advanced concept of cooling a home in summer, heating it in winter and lighting it the year around, all by solid state devices having no moving parts and under the control of a single set of dials.

In a remarkably short time, the power output of practical thermoelectric devices has risen from a fraction of a watt to 5000 watts, the largest unit yet constructed. New materials have raised efficiencies from one-half of one percent up to the order of 6 to 8 percent for some devices operating at practical temperatures.

Unlike conventional heat engines, the efficiency of a thermoelectric generator is independent of its size. Small thermoelectric power generators fill a gap in available power sources, either because it is impractical to scale a conventional source down to a small size or because thermoelectric generators already are more efficient than the scaled-down conventional device. The same principle holds for thermoelectric refrigeration. For the first time a technique is available for cooling and freezing small, independent, isolated regions.

The first widespread applications for thermoelectric devices will be for small, specialized units which make maximum use of the unique advantages of thermoelectric refrigeration and power generation. Laboratory apparatus, medical equipment, cathodic protection for pipelines, power sources for electronic equipment in remote areas—these are typical applications which have been explored.

In the consumer field, small appliances designed to utilize the compactness, versatility and convenience of thermoelectricity will no doubt precede such major appliances as refrigerators and air conditioners. In both industrial and consumer applications, however, it is felt that thermoelectricity will have its greatest impact in making possible new and different products, rather than in replacing existing items already well established in the factory, business establishment, or home. For example, thermoelectricity could bring the era of separate independently controlled refrigerated storage compartments throughout the home as contrasted to the single, all-purpose home refrigerator of today. Widespread consumer applications, however, are generally not foreseen until processing costs are reduced.

Although thermoelectricity has made rapid progress, it is not likely to deeply affect conventional large-scale methods of generating the world's electric power needs. Small thermoelectric generators could not economically supply the electrical requirements of individual homes. Also, there is no reason to believe that it will ever be practical on a scale large enough and inexpensive enough to furnish electric power comparable to that from a typical electric power station. Rather, thermoelectricity should be regarded primarily as an important new method of energy conversion, which fills a gap in existing methods of power generation and promises increasingly widespread applications in the future.

PROJECT MERCURY

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before liftoff, the pulse rate rose to 108 beats per minute, later increasing to 126.

Respiration rate was sampled at five minute intervals during countdown. Although recordings were made, some of the results were unintelligible. The respiration rate remained at 15 to 20 breaths per minute until liftoff. At this point, the rate increased significantly.

During the flight, Shepard's pulse rate reached 138 beats per minute. This occurred when the main engine cut off and the capsule separated from the booster and continued for about 45 seconds. While under a weightless condition, Shepard was more active than at any other point in his flight. Upon re-entry, the pulse rate increased and then dropped off to about 111 beats per minute at impact.

Shepard's respiration rate increased to a peak of 40 breaths per minute during the powered portion of the flight. During weightlessness, the rate dropped off to about 20, but increased again upon re-entry.

The electrocardiogram indicated normal responses throughout the flight. At the same time, the deep body temperature recorded by the probe increased slightly from 99° F at liftoff to 99.2° F near the end of the flight.

Throughout the flight, Commander Shepard kept in constant voice contact with ground stations. During the complete flight, the astronaut made normal reports concerning the cockpit instrumentation. When compared with telemetered data, the pilot's reports agreed closely.

The major conclusions concerning the astronaut's physiological responses during the flight as stated by the National Aeronautics and Space Administration are:

1. Shepard was conscious of his performance throughout the flight.
2. A five minute period of weightlessness did not affect physiological responses to any great extent.
3. Transition periods of acceleration-weightlessness produced responses well within tolerable human limits.
4. Special senses, such as vision or hearing, were not affected by the flight.

In addition to the physiological instrumentation, the camera film, capsule attitude control records and voice communications indicated that the astronaut fulfilled all specified mission requirements. During flight, he made various attitude maneuvers with the manual control system. Shepard frequently observed the earth's surface and cloud conditions.

The success of the Mercury-Redstone 3 flight in proving man's capability to

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INTERVIEW

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people was important. They look for extroverts capable of mingling and selling, and this type of out of class participation is important.

In the laboratory and in submitting reports the instructor gets a more complete picture of the student's ability. Applying what is learned in class is imperative, for without this adaption from class to lab the education is far from complete if not lost. Industry realizes this and turns to the instructors' evaluations. They are the indication of the student's competence in the classroom and lab.

The engineer must be aware that more and more is expected from him in the field of communications. Research papers, project reports, and financial statement must be formulated in a coherent manner such that he can communicate to others. In many cases they must be generalized clearly enough so as to be understood by the layman. He is often called upon in civic functions to lead and express himself. This responsibility must be met. In conjunction, an employer expects the graduate to have varied interests in which to release tensions and relax. He has been exposed to many interests and should have wider and varied tastes. It all adds up to the benefit of the company and the individual.

Perhaps the most crucial question considered in judging potential is "Will this person advance in his field?" All advancement is based on achievement. The person must do the job. If the job requires much social interaction he must be able to get along with people. If the job requires research he must gather information and formulate it into a useable form. Such firms as General Motors, IBM, and Upjohn have stated that a stronger technological basis is desirable in all engineering fields. In some cases business or economics courses are beneficial, but the stronger the basic scientific knowledge the better.

Perhaps a bigger fallacy than overestimating grades is underestimating them. This is true not only in engineering curriculum but also in other fields of study. Industry likes the applicant with the high grade point and the sooner this is realized the better. In many cases it is used as a crutch in the final analysis. The employer can stack two prospects side by side and the grade point can make the difference. Mr. Ron McDuff of International Business Machines said it indicates two things, "ability and motivation." "The individual has set a pattern which will stay with him through life." Also important are grades during the last two years and the comparison of the engineering to all college grades, as stated by Mr. Jack Kinney.

Potential, then, is an intricate combination of the specified and implied qualities. It is a function of the companies' needs and the applicant's qualifications joining forces to point toward the future. The employer is looking for competence, and the employee is looking toward fulfillment. A company basically uses these five sources of information and it is up to the applicant to measure up to them. The young graduate will advance from Michigan State University to greater things only through integrated combination of development and growth. The format of this advance is production and that is industries' goal.

ACKNOWLEDGMENTS: interviews with representatives from General Motors Corporation, International Business Machines, and Upjohn Corporation.

PROJECT MERCURY

(Continued from page 30)

withstand the unique environment of space has speeded up the U. S. space program considerably. The subsequent flights made by Captain Grissom and Col. Glenn added much significant data to that collected by MR-3.

Information gathered during these pioneering suborbital and orbital flights will some day enable man to travel to the moon or planets. The Apollo program, designed to land three men on the surface of the moon, is using data from Project Mercury for preliminary design.

Soon more astronauts and more sophisticated space vehicles will replace those of Project Mercury. But the pioneering efforts of Shepard, Grissom and Glenn as well as those of many engineers and scientists will never be forgotten.

NASA

(Continued from page 10)

The main theory suggests that the metal sheet fell edgewise through the atmosphere. Scientists think that the thin edge didn't heat up due to friction as would a thicker missile warhead. Because of the large surface area of the sheet, enough heat might have been radiated into space so that the temperature was kept below the melting point of the metal.

NASA officials are trying to find a solution to the problem before the next orbital flight is attempted. Mainly they would like to prevent any damage to foreign countries. South Africa has bombarded NASA with questions on the settlement of any future claims due to damage from falling space debris.

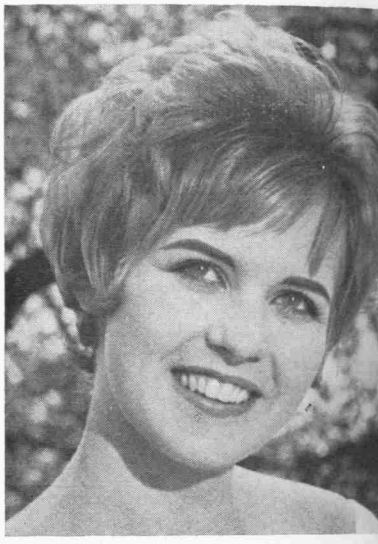
A similar situation occurred when a Thor-Able-Star rocket was fired from the Cape. A short time after liftoff, the rocket had to be destroyed. A falling fragment hit a cow in Cuba. The fuss caused by Fidel Castro is still remembered by the U. S. Department of State.

Although the danger of getting hit by a piece of space junk is small, NASA scientists are trying to find an answer. A complete study of the flight path is under way. But the second astronaut, Lt. Cmdr. M. Scott Carpenter, is expected to make his orbital attempt as scheduled during May.

Three possible solutions are being considered by NASA. The first is to fire anyway, since the probability of causing damage is small. A second solution under consideration is some type of recovery system for the boosters. The main drawback with this system is the extra weight which is a critical factor in a booster of Atlas size. Although NASA scientists have been working on this problem, they aren't far enough along to use it yet.

The third method would be to place explosive charges on the booster unit. When detonated upon reentry, the booster would disintegrate into pieces small enough so that complete destruction would be insured.

MISS ENGINEER



Miss Engineer this month is Judy Lamparter.

This lovely 5′ 6″ blue eyed blond is from Detroit, Michigan.

Judy is a freshman and an Alpha Phi pledge. She is majoring in Elementa Education. After getting her education, Judy plans to teach art.

Photos by T. S. Crockett

WHAT'S NEW?

Kueffel & Easer Co., world's leading manufacturer of slide rules, has introduced DECI-LON—a new rule with expanded computing capacity.

Major features of the instrument are: 1) a unique choice and arrangement of 26 scales, 2) greater consistency and logic, 3) convenience and speed in operation, and 4) lifetime construction.

DECI-LON is built on the principle of the DECI-GRIG, which was developed by K & E two decades ago, and is today the most widely used slide rule in the field of engineering.

"The DECI-LON marks an important advance in slide rule evolution," a K & E spokesman said. He pointed out that the new rule was developed to provide students and professionals with the familiar scales of the slide rule for basic calculations, plus new ingeniously arranged scales for more advanced mathematical calculations.

To provide greater consistency and logic, the DECI-LON has new scale groupings, an augmented use of color, functional scale names, and extended calibrations.

To enable users to make readings faster and more conveniently, the DECI-LON incorporates a new proximity grouping of scales, additional calibrations, the extended use of color coding, and a redesigned indicator that is easier to manipulate. Besides a wider field of view, the new indicator also has a red hairline to contrast vividly against the rule's black graduations.

In a new scale arrangement, the Lon scales are now on the front face of the rule and all of the Lon Minus scales are now on the reverse face. With these powerful scales appearing in unbroken sequence and referring consistently to the C and D scales which now appear on both faces of the rule, roots and powers of numbers from 1.001 to 30,000, and decimal fractions from 0.00003 to 0.999 can be found speedily and directly *without reversing the rule.*

The addition of LnO and Ln-O scales on DECI-LON brings the lower limit of the Lon scales and the upper limit of the Lon Minus scales ten times closer to unity than on previous K & E rules. Moreover, the positioning of these scales adjacent to the D scale creates, in effect, an infinite series of Lon scales capable of bridging the gap between scale limits and unity to whatever degree of closeness may be required.

On DECI-LON, the use of color has been extended to a new, more consistent level. The prevailing color meanings of the DECI-LON may be translated as follows:

BLACK: Lon Scales,
positive readings,
standard left-to-right
reading direction,
front face of the rule.

RED: Lon Minus scales,
negative readings,
reverse right-to-left
reading direction,
back face of the rule.

This color consistency is evident in the positioning of the black Lon scales on the front face and the red Lon Minus scales on the back face; and in the development of the trigonometric scales where black is forward reading and slanted to the right, red is reverse reading and slanted to the left. Another aid to rapid orientation is the use of color coding at the ends of the sliding member. Again, black is used to indicate the front face of the rule; red the back face.

The two most used scales, C and D, are located on both the front and back faces of the DECI-LON. No matter how the rule is picked up or what scales are being used in relation to them, C and D are always available for direct reference. And extending the K & E principle of full consistency, all DECI-LON scales of calculation, including the new LnO and Ln-O, relate to the basic D scale.

DECI-LON offers *two* sets of scales for squares and square roots. In accordance with the principle of consistency, the A & B scales are provided as scales of *calculation* for continuous operations. In addition, the Sq1 and Sq2 scales are available as scales of *reference* for use when all that is required is the determination of square root values.

The Sq scales provide two further advantages: not only are squares of numbers found directly on the D scale, but *fourth powers* are conveniently found on the A scale, with *fourth roots* available by reverse of this reading process. This is further evidence of DECI-LON'S orientation to the needs of modern engineering-science as fourth powers and roots are particularly useful in the important area of thermal radiation, with fourth roots particularly being encountered in heat transfer problems in both radiation and convection.

In naming the newer scales on DECI-LON, K & E has chosen symbols closely associated with the function of those scales. Thus *all* the modern scales on DECI-LON bear names which immediately suggest their functions: natural logarithms are obtained by using the Ln scales, square roots by using the Sq scales, sines by using the S scale. The name of all the traditional scales, such as A, B, C, CI, L, & K, remain unchanged.

Related scales have been grouped adjacent to one another to facilitate fast readings. For example, the Sq scales have been positioned next to the CF and DF scales for quick area of circle calculations.

Another refinement which will appeal particularly to frequent users of the trigonometrical scales is the addition of sub-numbers on the lower range of the SRT scale, and the inclusion of certain basic constants on the C and D scales on the reverse face of the rule.

DECI-LON is equipped with an improved indicator, the frame of which has been designed for increased ease of manipulation with wider field of view. The window material is unbreakable, and carries a red hairline on both sides to contrast vividly with the rule's black graduations.

While all of the DECI-LON scales of calculation relate to the basic C & D scales, certain scales—such as the LON, Sq, folded and trigonometric scales—have graduations opposite the C and D indexes which do not correspond to specific numbers. Such scales are "extended" so that their end values represent specific numbers, thus giving the user rapid orientation to the index values of these scales.

DECI-LON looks different because it is different. The choice and arrangement of its 26 vital scales led to a bold innovation in modern slide rule design. By family-grouping the Lon scales for maximum effectiveness, "form followed function" and a new slide rule look was born—with the lower member of the rule slightly

(Continued on page 36)

COMPUTER

(Continued from page 25)

vastly different from MISTIC operations with the 3600 System.

The Computer Laboratory personnel will carry out all actual computer operation. Input to the computing system will be by punched cards, prepared by the user and transferred to magnetic tape by means of the 160-A computer and the Communication Module. It will then be ready for immediate use by the Compute Module upon clearing itself of the previous calculations.

The 3604 Compute Module performs the arithmetic and logical operations required for executing instructions, generates control commands for sequencing those operations, and translates commands for other sections. The Compute Module can handle 51 bit words as the 3600 System is based on a word length of 48 bits, plus three parity bits. It also contains several registers for arithmetic and control operation of which are the single length A and Q registers; a single length auxiliary register D; six, 15-bit index registers; two "bounds registers" which are used to lock out indicated portions of memory from writing; and an interrupt and interrupt mark registers. The arithmetic that is built into the compute module includes fixed point, as well as both normalized and unnormalized single and double precision floating points.

Instructional formats for the 3600 System are varied. There is a class of 24-bit single address instructions, which contains all of the orders of the 1604 except for three input-output and interrupt orders.

A second class of 24-bit single address orders exists that is totally different from the 1604 orders. In addition, there are also two more classes, both being 48-bit two-address orders. In all classes of orders, direct, relative, and indirect addressing are permitted.

As an indication of the speed of the 3600 System, the following effective times are presented. These times include securing and executing the instruction, and are all in floating point:

Single Precision	Time (in microseconds)
Add/Subtract	4.0
Multiply	2.6
Divide	2-14
Double Precision	
Add/Subtract	5.0
Multiply	2-26
Divide	2-26

In comparison MISTIC requires 100 microseconds in fixed point addition while multiplication takes 1000 microseconds.

A core storage of 32,768 51-bit words is provided by the 3603 Storage Module and is divided into two halves for more rapid access time, which may vary from .7 microseconds to 1.5 microseconds per word.

The three parity bits are generated and checked each time a word is read or written in memory. A parity failure will cause an interrupt, and the master program can take appropriate action.

The 3602 Communication Module is one of the most attractive features of the 3600 System. It provides the link between all peripheral equipment, including the satellite 160-A and the remaining portions of the computing system. In addition, there are two 3606 Data Channels under the control of the Communication Module to which will be attached, through their appropriate control units, six CDC 606 magnetic tape units.

Although the Communication Module operates largely independently of the Compute Module, it can transfer from memory to the Communication Module a 48-bit control word, specifying which Data Channel and unit on the channel is to be activated.

The control word also indicates a beginning word address in memory and the number of words that are to be transferred. The kind of action to be initiated, (read, write, re-wind, etc.) is also indicated by the control word. Then, making use of its own arithmetic and control section, the Communication Module transfers data while the 3604 Compute Module calculates independently.

The 3600 Computing System possesses a wide range of expansibility. Up to eight 3603 Storage Modules can be added to give a total capacity of 262,144 51-bit words. A maximum of 32 possible Data Channels can be achieved by attaching four 3602 Communication Modules. With this system, auxiliary disc storage and remote units consisting of keyboard entry devices may be used. The 606 tape units have a maximum storage transfer rate of 83,400 characters per second, with transfer completely parity checked.

Operating control of the system will reside with the 3600 CO-OP Monitor, which is a three level control system. The first level, called the Master Control System (MCS), is independent of the second or third level programs used. The MCS provides for:

1. Automatic sequencing of jobs, including full accounting for each job
2. Memory allocation
3. Loading of program cards and library routines
4. Operator-machine communication
5. Assignment of I-O equipment
6. Linkage to second level control systems
7. Recovery procedures in case of failure

Any second level system can be used since the first level program is independent of the second or lower levels. Provided with the CO-OP Monitor is a second level system called the CO-OP Control System. This second level system provides linkage with the third level system, of which it is largely independent. However, the third level system provided includes an assembly system comprised of FORTRAN (the latest modification), COCOL, and COMPASS.

A self-modifying language that will allow a program in its own language to modify the language is being developed.

More languages can be added to the system as they become available. The MCS is constructed in such a manner as to allow any routine on the library tape to be called and used as a second level system. A new third level language translator could furthermore be written in an existing language, such as FORTRAN, translated to machine language, and then used as the new third level system.

A minimum amount of storage space is permanently assigned to the resident portion of the program which is the bare minimum of Monitor orders sufficient to keep the Monitor under control. Only one tape unit is assigned to the Monitor, with all the rest available for the user. Although the entire Monitor system is independent of the kind of input-output equipment available, it can still supervise the activity of the satellite computer.

The system will appear familiar to the user as the programming is done

(Continued on page 36)

COMPUTER

(Continued from page 35)

in FORTRAN or COBOL. The program and data deck will be headed with control cards specifying name, account number, the language of the program (COBOL, FORTRAN, etc.), and the logical I/O units. These cards will be followed by cards with instructions as to maximum running time for the problem, maximum number of lines of standard output medium, and other pertinent data and comments. The deck is then combined with other decks and fed into the 3600 System via the card reader.

Each problem is the compiled, run, and the results transferred to a print out magnetic tape. The tape is then used in an off-line fashion to print out on the line printer. Meanwhile, the Monitor logs each problem in, and then compiles and runs it. If running time happens to exceed the maximum amount requested, the Monitor shuts off the problem and produces a minimum of information. It will then start another problem and print out accounting data on the console typewriter. In event that a problem being code-checked fails, post-mortem information as requested on the control card is sent to the print tape.

The Monitor also supervises all interrupts, no matter where they originate, and services them in order of acquisition. Furthermore, in event of minor computer failure, the Monitor executes various conservative recovery measures. Thus manual intervention will only be necessary in the event of some major loss of program control, and it is hoped that the system will be able to operate full time without intervention.

The general policy of the Computer Laboratory will undoubtedly remain the same as in the past, with the Laboratory extending as much assistance as possible in the programming area. It will also offer short, non-credit courses on the 3600 System and 160-A computing system along with separate courses on FORTRAN and COBOL.

The 160-A will be installed on the fifth floor of the Electrical Engineering Building in the computer room along with MISTIC. When the new 3600 System Computing arrives, it will be installed on the north side of the second floor of the Electrical Engineering Building.

The Electrical Engineering Department will have moved into their new quarters in the new Engineering Building, leaving the first two floors to be taken over by the Computer Laboratory. Ample space will be provided for both programming and data preparation.

"No single facility is as important to the entire University as the computer facility," emphasizes Dr. Muelder. He states that the University would like to encourage all its colleges to develop and promote the use of the computer by their departments. This is what is known as the "university approach to computers."

WHAT'S NEW

(Continued from page 34)

wider than the others. The DECI-LON is slim, trim, well-balanced, and easy to manipulate.

DECI-LON is made of a special shatterproof synthetic exclusive with K & E. Humidity variations have no effect on its operation. The DECI-LON will not warp, crack, or stick. Precision molding and new four-bolt end plates insure accuracy, rigidity, and permanence of alignment. Thus DECI-LON, including its unbreakable indicator, is capable of a lifetime of service and is guaranteed to give it.

★ ★ ★

A new process to make fresh, drinkable water from any contaminated supply, even sea water, was announced recently by General Electric's General Engineering Laboratory in Schenectady, N. Y.

The laboratory has reviewed the method with the Interior Department's Office of Saline Water, the agency in charge of all saline water demineralization research and development activities of the Federal Government.

Called "diffusion distillation," the method is promising for homes or small commercial establishments. It might eventually be built as an automatic appliance the size of a refrigerator.

An experimental device employing the process has been operating for some time at the laboratory. It produces pure, soft water from otherwise unusable sources at the rate of 200 gallons per day.

The device has several advantages over other distillation methods for low-capacity applications: it works at normal air pressure and below the boiling point of water; it needs no operator, and there is only one moving part.

The experimental unit is a cylinder three feet long and two feet in diameter. Inside is a horizontal shaft with a number of discs mounted on it. A motor turns the shaft and discs at about one revolution per second. Bottom half of each disc is immersed in a pool of hot, incoming water. Top half of the disc passes between hollow, cooled condenser plates. The rotating disc picks up a film from the pool, and water molecules evaporate from the film and diffuse across the short air gap to the cool stationary plate. There they condense into droplets of pure water and run by gravity into collecting troughs.

Incoming water circulates through the condenser plates first and is warmed by the still's own heat of condensation up to about 200 degrees. Fuel burners or electric heaters are needed only to boost the temperature to 210 degrees.

Power requirements are low: about 1/50th of one horsepower to turn the disc and drive a circulating pump. A fist-size electric motor would suffice.

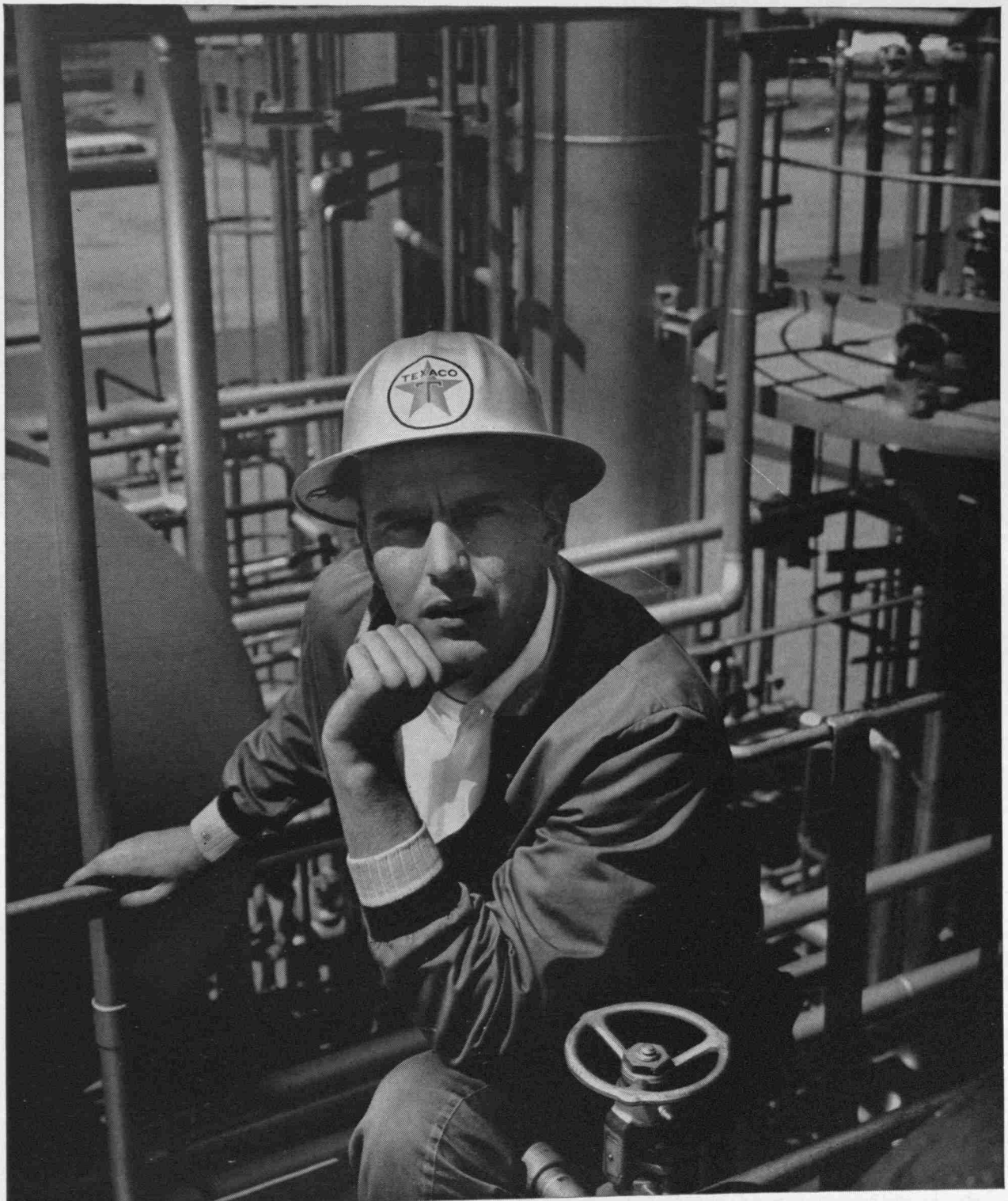
A typical unit for home use would operate around the clock, laboratory engineers said, shutting off automatically when the storage tank is filled, starting up again at any predetermined tank level.

Scale formation does not affect the still's efficiency because the heat transfer takes place between the water vapor and the clean condenser plates. Only after a long period, when the scale has nearly filled the space between disc and plate will the unit need cleaning or disc replacement.

The diffusion still may have much wider usage than simply for seashore or island sites where natural fresh water is scarce. It can handle water that is brackish, heavily mineralized, or polluted by organic matter. The water is pasteurized and softened as well as purified. Its purity is not affected by varying amounts of solids in the salty or contaminated supply.

In addition to home use, the diffusion still may have great potential for self-service laundries, motels, restaurants, hospitals, military field units, and small boats.

The new G-E diffusion still, like other distillation systems, should remove radio-active particles from contaminated water.



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LASER

(Continued from page 20)

To maintain the stimulated-emission process, losses such as those due to radiation escaping from the crystal and losses due to mirror reflection must be overcome by photon amplification. Beam angle of the ruby laser is in the order of 0.01 radian.

Although vast numbers of ions within the ruby crystal are individual radiators of photons, laser action causes them to radiate their energy in step, that is coherently.

The key action of the lasing process that produces in-step radiation is that of an incident photon triggering an ion to emit a photon in phase with the incident photon. If it were not for this action, each excited ion would spontaneously emit a photon, that is, emit a photon at any time within the relaxation-time range that is characteristic of Cr^{+++} in Al_2O_3.

Since the individual radiators radiate (nearly) in step, and since these radiators produce radiation of (approximately) the same wavelength, the laser's output beam has space and time coherence.

In this form, the laser emits light in a closely-spaced short burst. Each burst is less than a millionth of a second long, and the bursts are spaced only a few millionths of a second apart.

One way in which this behavior might be explained is as follows. The intensity of the light confined within the rod may tend to build up to the point where it stimulates emission. It begins to depopulate the metastable state (2) so rapidly that the optical pump is no longer able to maintain a sufficient population of atoms in that state for the cooperative action of the atoms to continue.

Then the radiation abruptly dies down, until the exciting flashtube can restore that population. The extremely rapid pulsing of the light thus results from the alternating depletion and restoration of the active population of atoms.

A modified gas laser, suing a mixture of helium and neon gases for its active medium, has been found to produce a continuously operating laser.

It receives its power from a low-powered electrical discharge within the gas and has an output power of about 0.01 watts.

Many peaceful and military uses for the laser have been discussed.

University of Michigan physicists are planning to test the fundamental assumption that light and radio waves travel at the same speed in a vacuum by beaming both light and radio signals simultaneously at a satellite equipped with a corner reflector and then measuring the times for their returns.

They also have considered using the laser beam as a "match" to touch off a brief thermonuclear fusion reaction for laboratory purposes. A laser power density of some 10^{13} watts/cm^2 can be obtained as compared with about 10^6 watts/cm^2 on the sun's surface.

Vast areas have been swept by speculation on military uses of lasers.

Because of the laser's ability to generate intense heat, it has been proposed that a laser be included in antimissiles. The means of destroying a missile might depend on burning a hole through an important support part of the missile frame.

There are locations on an airframe where severe vibrations will develop if a guiding vane is fractured. One could depend on the disintegration of the major sensitive portions of the missile in this way.

It has been suggested that a liquid laser operating in the near infrared range is possible in theory, using the action of two chemicals and nothing else—to produce coherent light output.

This has raised speculation about a "squirt-gun" like device to be used as a side arm by individuals. It might include a chamber containing one of the chemicals, with a lens ahead of the output area of this chamber. A second chemical would be pumped into the first chamber by trigger operation of a miniature pump. When the two liquids combine, an output focused to a fine point on the target by the lens would develop the heat required for use as a weapon.

The discovery of a coherent light source has opened up a whole new spectrum of ideas, experiments and uses for man's most important aid, light.

Jan: I baked two kinds of biscuits today. Would you like to take your pick?

Jon: No thank you. I'll use my hammer.

WHAT'S NEW?

Several ductile alloys have been discovered to remain superconducting in extremely magnetic fields (up to 100,000 gauss). These alloys may greatly simplify the problem of making superconducting electromagnetic coils.

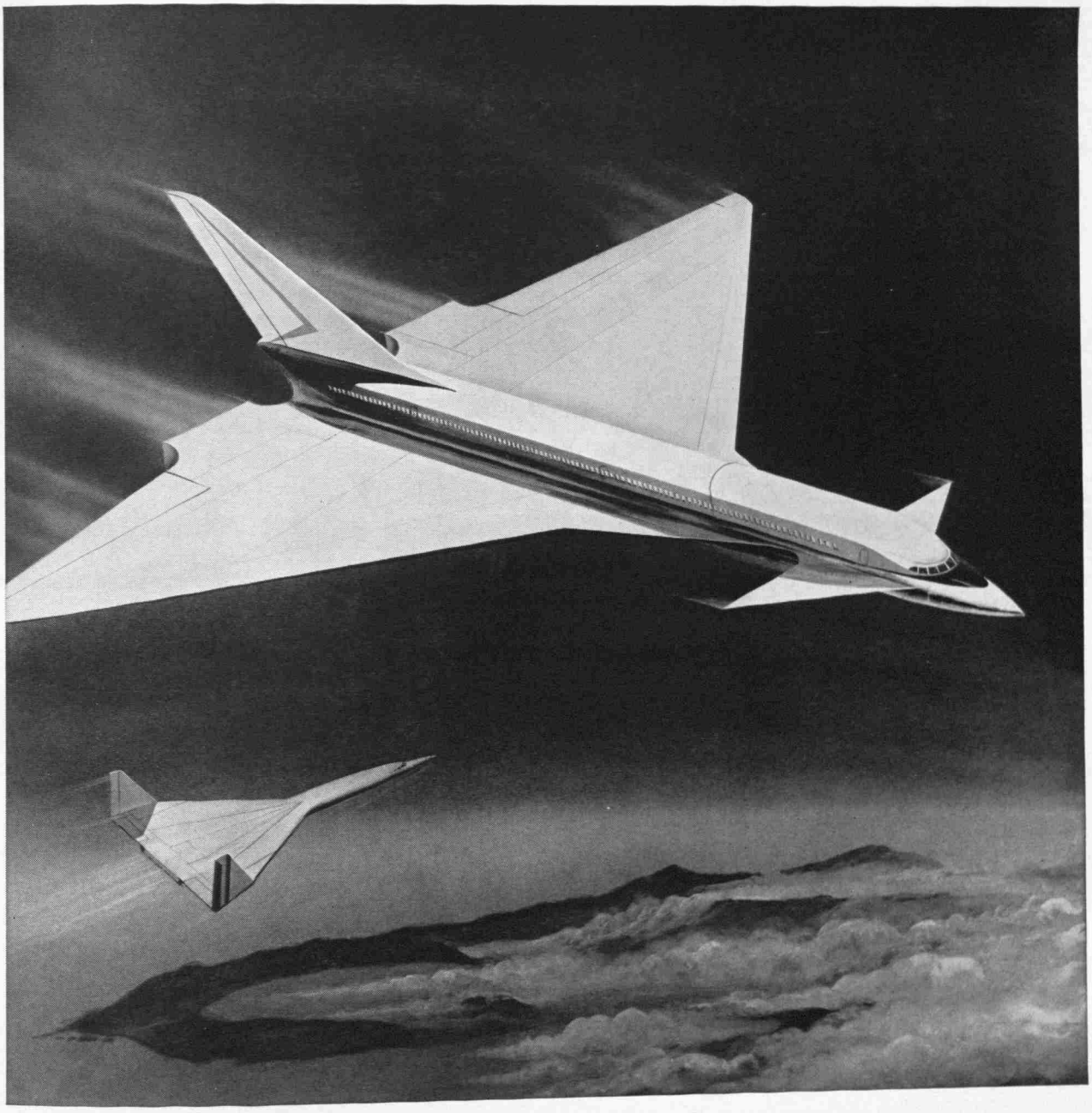
An alloy of niobium and zirconium has been found to remain superconducting in a field of 80,000 gauss while carrying 10,000 amp/cm^2. Other alloys, nobium-titanium and vanadium-titanium have been found to be useful superconducting materials at liquid helium temperatures.

Bell Laboratories scientists have reported that a compound of niobium and tin (Nb_3Sn), at 4.2 degrees K, remained superconducting in fields as large as 88,000 gauss while carrying a current of 150,000 amps/cm^2. It has the highest transition temperature of any known superconductor. However, Nb_3Sn is very brittle and special metallurgical techniques are required to form magnet coils that can withstand the mechanical forces produced by very high magnetic fields.

These ductile superconducting alloys give promise of simplifying the problem and will compliment the application of Nb_3Sn. These experiments indicate that an electromagnet with about a three-inch layer of windings of the niobium-zirconium alloy will produce a magnetic field of 80,000 gauss at 1.5°K. By extrapolation of the data to lower temperatures, it was estimated that Nb_3Sn will remain superconducting at temperatures around 4°K. in fields of 200,000 guass and possibly higher. Therefore, it is still one of the most promising material for magnets having field strengths well above 100,000 gauss.

The successful construction of a superconducting electromagnet will have important implications in many scientific fields. The availability of large magnetic fields will extend the operation of many electronic communication devices to higher frequencies, thus providing increased bandwidth for use in radio-relay communication systems.

Another attractive application is in the field of thermonuclear fusion for the production of electric power. High magnetic fields are needed to provide "magnetic bottles" to contain high temperature gas plasmas.



2000 mph airliner...another engineering challenge!

On the drawing boards of aircraft engineers, plans are taking shape for a supersonic passenger jet – one that will fly from New York to London in just over 2 hours, at Mach-3 speeds of 2000 m.p.h. or more. The delta-shaped transport, flying at altitudes up to 80,000 feet, would make today's fastest airliners seem as pokey as stagecoaches. And what size! Perhaps two hundred feet from nose to tail. Three stories tall.

Through the intensive research of the metallurgical engineer will come a metal for the skin of this mighty airliner. One that will be able to withstand critically high temperatures – up to 630°F – caused by supersonic speeds.

Challenging? An engineering career, such as metallurgy, is full of challenges. Whether it's exciting, new designs for a supersonic airliner, a gas-turbined car, a nuclear-powered ship, you'll be at work in a stimulating profession – one with room for advancement – one that promotes progress and economic growth.

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The Thermodynamics Finals

Free energy and entropy were whirling in his brain,
With partial differentials and Greek letters in their train;
For delta, sigma, gamma, theta, epsilon and pi
Were driving him distracted as they danced before his eye.

Heat content and fugacity revolved within his mind,
Like molecules and atoms that you never have to wind,
With logarithmic functions doing cake-walks in his dreams
And partial molal quantities devouring chocolate creams.

They asked him, on the final, if a mole of any gas
In a vessel with a membrane through which hydrogen could pass
Were compressed to half its volume, what the entropy would be
If two-thirds delta sigma equalled half of delta P.

He said he guessed the entropy would have to equal four,
Unless the second law would bring it up a couple more.
But then it might be seven, if the thermostat were good,
Or it might be almost zero if once rightly understood.

The professor read his paper with a corrugated brow,
For he knew he'd have to grade it, but he didn't quite know how
Till a sudden inspiration on his cerebellum smote,
And he seized his trusty fountain pen and this is what he wrote:

"Just as you guessed the entropy, I'll have to guess your grade,
But the second law won't raise it to the mark you might have made,
For it might have been a hundred if your guesses had been good,
But I think it must be zero till they're rightly understood."

—Author Unknown

PLASMA PHYSICS

(Continued from page 13)

could be solved by stationing electron sources at the perimeter of the beam. The electrons injected into the beam would neutralize the space charge before it could accumulate.

A second type of engine is the plasma jet. In the system a cold gas is allowed to flow between the cathode and anode of a shaped chamber where a large voltage causes the gas to break down and ionize. A current then flows through the gas heating it even more. It is then allowed to expand out of the nozzle of the shaped chamber. Republic Aviation Corporation reports development of an engine of this type which they call a pulsed plasma pinch engine. A 3 kilowatt, 300 microfarad capacitor and anode producing specific impulse of 5,000 to 12,000 seconds.

A third system under investigation involves the use of a preheated gas. A gas which has been preheated to about 3,000°K. is forced into a chamber and subjected to a potential difference. This difference causes the gas to break down and a conduction of current to flow in the gas which is now a plasma. Coils wrapped around the chamber create a magnetic field which forces the gas particle out of the chamber, through a nozzle thus supplying the thrust.

B. Electric Power Generation

From the study of magnetohydrodynamics (referred to as M H D), it has been found that a plasma moving through a magnetic field will exhibit a potential difference in a direction normal to the magnetic field and the direction of flow. If electrodes are inserted into the plasma across this potential difference and connected to some external load a current will flow through the plasma and through the load. This is the principle of the direct current M H D generator. One of its several advantages is that it has no moving parts and only a moving fluid. It can produce alternating current by using a pulsed magnetic field. Remaining obstacles include finding a method of achieving adequate fluid flow velocity, developing fluids with the proper ionization and disassociation potentials and heat transfer characteristics, and finding proper geometric configurations for the device. Contamination and corrosion are also of great concern.

Conclusion

The survey of plasma physics has no conclusion. In the beginning will come great advancements in the basic knowledge necessary to understand plasma. Later will come astonishing new applications undreamed of even in our time. And finally, plasma physics may someday answer the questions which men have asked for centuries concerning the nature of the universe. The survey of plasma physics has only begun.

★ ★ ★

WHAT'S NEW?

The world's largest robot, an 85-ton giant that walks on tank treads, yet can pick up an egg with the touch of a child, was recently demonstrated in Cincinnati.

Called the "Beetle," the huge vehicle was built for the Air Force by General Electric. With a man inside to drive it and operate its hands and arms, the Beetle can move in close to a radioactive nuclear rocket or reactor to make adjustments or perform emergency operations.

Though its arms are 16 feet long, and brawny enough to punch a hole through a concrete wall, the Beetle's hands perform extremely delicate operations. They can put nuts and bolts together or manipulate hand tools. (A special plug on the wrist also permits the use of power tools for nuclear do-it-yourself projects).

The operator sits inside a 100,000-pound cab, protected from harmful radiation by foot-thick lead shielding. The whole cab, to which the arms are attached, rises on four hydraulic stanchions to a height of 25 feet above ground level, and rotates as required. Protecting the operator from above is a lead hatch that weighs seven and a half tons. The five windows of his cab are two-foot-thick panes of specially leaded glass.

The Beetle can also "see" around corners and inside hot reactors and powerplants with a closed-circuit TV camera. With one of its hands, it simply plucks the camera from a special "breast pocket" and points it at the object of interest. The picture appears on a screen inside the cab.

Though the cockpit is no place for those inclined toward claustrophobia, everything possible has been done to make the operator comfortable. He has a six-position powered seat, a two-way radio, a thermos jug for long "missions" and even a cigarette lighter. He has three different ways to raise his hatch, should any sort of malfunction occur.

The Beetle's mechanical arms were designed and built by General Electric. Each arm consists of a shoulder, upper arm, elbow, forearm, wrist assembly and hand or remotely interchangeable hook.

A 500 horsepower Continental gasoline engine powers the vehicle. The six-cylinder, horizontally-opposed engine is equipped with a supercharger, and is air cooled. A four-cylinder, 110 horsepower auxiliary engine drives the main hydraulic pump and an a-c generator for systems operation.

An electrical creep drive system is provided for close vehicle positioning and can be used to move the vehicle out of a radiation field. The Beetle can also rescue another vehicle by towing it.

The operator stays comfortable inside his cab, thanks to a three-ton air-conditioning unit which maintains a humidity controlled temperature of 72 to 76° F whether the temperature outside is 130 in the shade or 25 below zero.

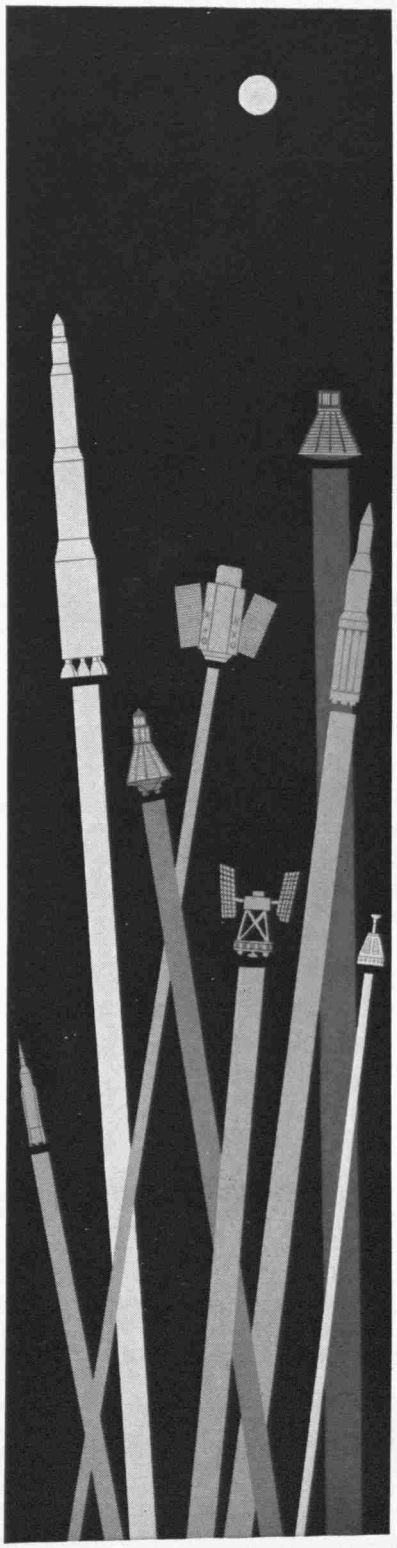
A periscope supplements the operator's field of vision. It can scan through 180 degrees horizontally and 170 degrees vertically with magnification of 1.5 and 6 power. The lenses of the periscope and surfaces of the leaded cab windows are electrically defrosted, and constantly washed with dry nitrogen to prevent fogging.

As long as the Beetle is operating, a radiation detector is at work. The operator is safe even when radiation levels outside the Beetle would be fatal.

The Beetle's many different systems are interconnected by some 400 miles of wiring. Two microphones allow the operator to listen to the sound of his engines, and a public address system lets him talk to personnel outside. or sound an alarm siren.

Development of the Beetle was begun during the aircraft nuclear propulsion program. It was originally conceived as a vehicle that could work close to nuclear-powered aircraft to

(Continued on page 48)



GROWTH CLIMATE

People . . . and ideas . . . do best in a favorable environment.

At NASA, scientists and engineers are favored by many "climatic" advantages, for the vigor, the importance, the scope and urgency of America's space program demands the best environment the nation can provide.

For professional employees NASA offers a graduate study program second to none. While on full salary, you can take graduate courses for credit during work hours at nearby universities, tuition-free. In-house seminars led by world-famous scientists and engineers are offered. In addition, NASA scientists and engineers benefit by early professional recognition, a wide choice of work areas, unmatched facilities, and participation in history-making projects.

Truly this is growth climate, where career opportunities are as unlimited as the scope of NASA's many aeronautical and space exploration activities. Here, the harvest of your ideas and discoveries may contribute to the benefit and enrichment of all mankind.

NASA has urgent need now for large numbers of qualified scientists and engineers. Positions are available in nearly all scientific and engineering disciplines, for men and women with B.S., M.S., or Ph.D. degrees.

NASA invites your inquiry to the personnel director of any of the following NASA centers:

NASA Manned Spacecraft Center, *Houston, Texas*

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*

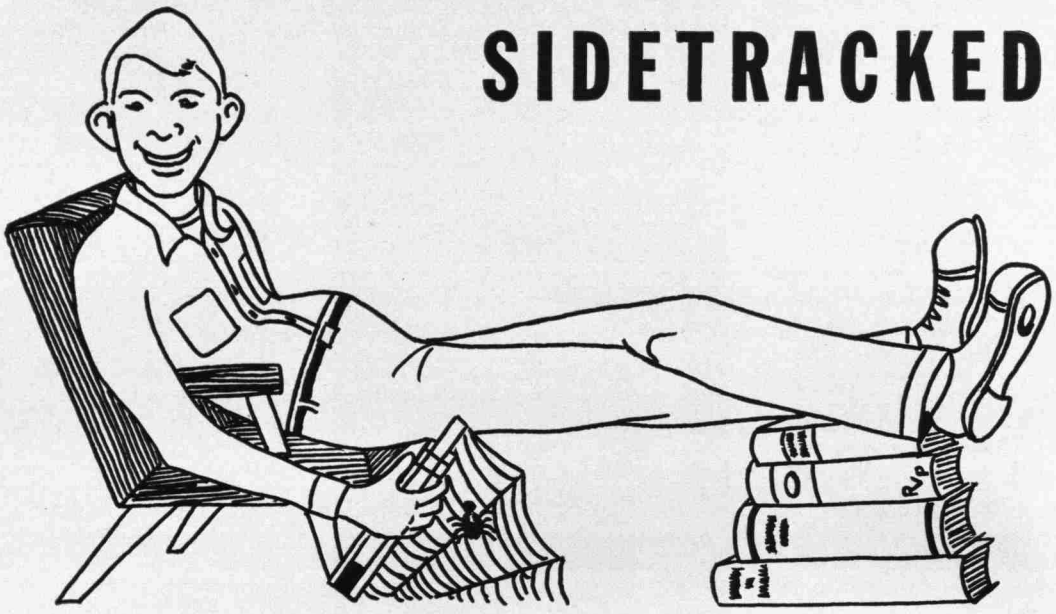
NASA HEADQUARTERS, *Washington 25, D. C.*

POSITIONS FILLED IN ACCORDANCE WITH AERO-SPACE TECHNOLOGY ANNOUNCEMENT 252-B.

ALL QUALIFIED APPLICANTS WILL RECEIVE CONSIDERATION FOR EMPLOYMENT WITHOUT REGARD TO RACE, CREED OR COLOR, OR NATIONAL ORIGIN.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SIDETRACKED



Chemical Analysis of a Kiss

Properties: Ethereal in nature. Taste, sweet; color, colorless to deep red. Is not affected by water, but reacts strongly to alcohol.

Occurence: Cars, porches, parlors, and parks. In most cases the compound has only a transitory existence, but it may exist for a considerable period of time.

Chemical Behavior: It quickly breaks up when exposed to a bright light, but it seems more stable by moonlight. It frequently plays the part of catalyst producing bonds of a more permanent nature. The appearance of the parent compound produces a quick and violent displacement of the individual members of the compound.

Future Developments: Although it is not new, it is constantly being rediscovered. Very little is known about the nature of the compound, in spite of the fact that many heads are busily engaged on the problem until late every night.

"Is there a difference between affection and love?" asked the freshman.

"Of course, child," said the senior, "they are as different as day and night."

An EE caught in a snowdrift looked up and saw a St. Bernard coming toward him, with the usual keg of brandy under the dog's chin. "Well," exclaimed the EE, "here comes man's best friend—and look at the big dog, too."

The new recruit didn't salute the colonel. "Do you realize who I am?" asked the officer, "I run this entire camp. I'm in charge of twenty-five thousand soldiers."

"You got a good job," said the private, "don't louse it up."

"How are the children getting along?"

"Oh fine. Tony wants to be a racketeer and Molly wants to be a chorus girl."

"But what happened to Al?"

"Oh, we had to shoot him. He wanted to be an engineer."

"It's not just the work I enjoy," confided the cab driver. "It's the people I run into."

"O.K., Moses, take out your tablet and number from one to ten, we're going to have a little quiz."

If it's funny enough to tell, it's been told; if it hasn't been told it's too clean; and if it's dirty enough to interest an engineer, the editor gets kicked out of school.

The engineer just back from a hunting trip was describing the trip. "Well, there was that big black bear hiding behind a tree. I realized that I had only one shot and that had to be bounced off the canyon wall. Well, I calculated the angle of approach, the windage, and how much the bullet would deflect due to the flattening after hitting the canyon wall!"

"Did you kill the bear?" asked his friends.

Replied the engineer, "No, I missed the wall."

It's tough to find
For love or money
A joke that's clean
And also funny.

There was the little boy who had just gotten a pen pal from Holland. He was so happy about it, that when he came home that night he said cheerfully, "Guess what, Mom? I got a girl in Dutch."

Engineers' Creed

As a Professional Engineer, I dedicate my professional knowledge and skill to the advancement and betterment of human welfare.

I pledge:

To give the utmost of performance;

To participate in none but honest enterprise;

To live and work according to the laws of man and the highest standards of professional conduct;

To place service before profit, the honor and standing of the profession before personal advantage, and the public welfare above all other considerations.

In humility and with need for Divine Guidance, I make this pledge.

Adopted by
National Society of Professional Engineers
June, 1954

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

Are you "taking a job" or "beginning a career"?

There's a mighty big difference between the two

As we see it, "taking a job" can be much like taking a single, tentative step in the dark. It may serve your purposes temporarily, but where do you go from there?

Young men who snap up tempting job offers often regret their decisions as time goes by. The plain fact is that glittering inducements sometimes cover up the lack of a future. But the man who thinks in terms of a *career* is not easily fooled; he sees his first job as a beginning, not as an end in itself.

Careers with Bethlehem Steel—A doorway to careers with Bethlehem Steel is the Loop Course—its members make an observational circuit (or "loop") of a steel plant during their initial training program. Through the Loop Course, Bethlehem seeks *only* men who are interested in career opportunities. We do not accept men who are "just looking for a job"; and, by the same token, we do not assign loopers to "dead-end" jobs.

Promotion from Within—It is important to bear in mind the fact that, aside from the need for an occasional specialist, we fill management positions from within the organization. The Loop Course, through its 40 years of operation, has provided about 2,000 selected and trained men, capable of advancing to positions of increased responsibility.

Loopers are Thoroughly Trained—New loopers report to our general headquarters, in Bethlehem, Pa., usually early in July. They attend a basic course of five weeks, including lectures, classroom discussions, educational films, and daily plant visits. The Loop Course is *not* a probationary period. After completion of the course, every looper receives his first assignment. Then, after reporting to a plant, yard, or home office division, he receives further orientation before beginning on-the-job training. Bethlehem loopers embark on their careers with thorough training behind them.

Big and Diversified—Because of its size and diversity of its operations, 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. We operate steelmaking plants on the Eastern Seaboard and the Pacific Coast; shipyards on the Atlantic, Pacific, and Gulf Coasts; manufacturing units and fabricating works in twelve states; and sales offices in most leading cities. 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

THE ADVERTISER'S INDEX

WHAT'S NEW

(Continued from page 42)

perform maintenance and emergency operations. Jered Industries, Inc., of Birmingham, Michigan contributed to the design and fabrication as major sub-contractor.

When the ANP program was discontinued, the Air Force decided to carry this project through to completion so the vehicle could be available for work on other nuclear programs.

The Beetle has now been shipped to the Atomic Energy Commission national nuclear rocket test site in Nevada for a six-month testing and check-out program by the Air Force Special Weapons Center.

The Air Force expects to use information gained from this program for the design of second generation air-transportable handling vehicles for its nuclear power programs.

Kodak beyond the snapshot...

(random notes)

Densitometry in Lilliput

Photography is art, photography is amusement, and more and more photography is a way of packing information and electronic circuitry. The packing calls for thinking very, very small about photography.

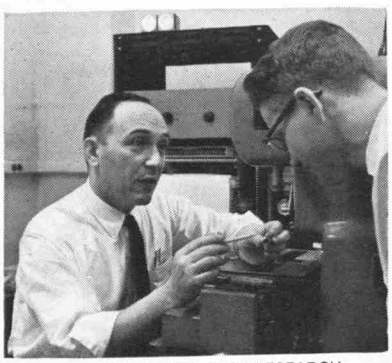
We cannot be blamed for feeling a little wistful as we cheer photography's progress in Lilliput. A remarkably small number of dollars worth of KODAK High-Resolution Plates and KODAK KPR Photo Resist are used up in producing a remarkably large number of solid-state microcircuits.

Fear not for us. We'll make out.

Nowhere will you catch us claiming that this "micro" business is as easy as falling off a log. Indeed, an appreciation of the relationship between the logs of exposure and reciprocal transmittance makes scarcely more than a good beginning toward controlling them on a micro scale. Here the frequency response of a photographic emulsion must be cascaded with the frequency response of the other components in the total picture-handling system.

The game is widely believed to be worth the candle. To shed light on what is really going on, one needs to be able to measure density reliably over an area less than ½ micron wide, scanned in synchronism with a recorder that responds logarithmically.

Not only do we use such instruments, but we build them and sell them for money to others. This benefits science and cheers us up.



GOOD PACKING NEEDS GOOD RESEARCH

From edible lubricants to erasable copying films, plenty of lively careers to be made with Kodak in research, engineering, production, marketing.

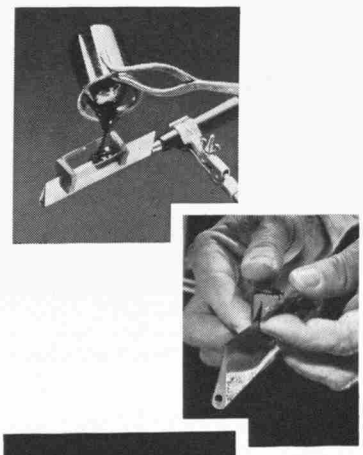
And whether you work for us or not, photography in some form will probably have a part in your work as years go on. Now or later, feel free to ask for Kodak literature or help on anything photographic.

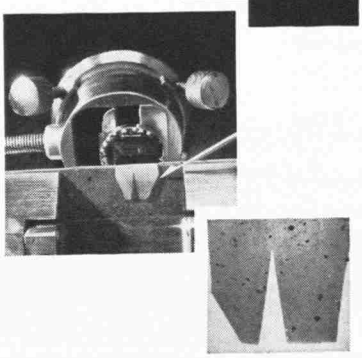
Faithful but flexible

We find the trick shown below helpful in microscopic studies of profile sections along objects like knives. The casting material is our *Epolene C-10* Polyethylene Resin. You pour it at only 100°C. Yet at room temperature the little casting "remembers" its shape so accurately that despite the twist of unpeeling, profile details as small as 0.00009-in. radius are preserved in the sliced sections, and measurements are repeatable to ± 0.00001". Then, if overheating is avoided, you can remelt and reuse the resin for more castings.

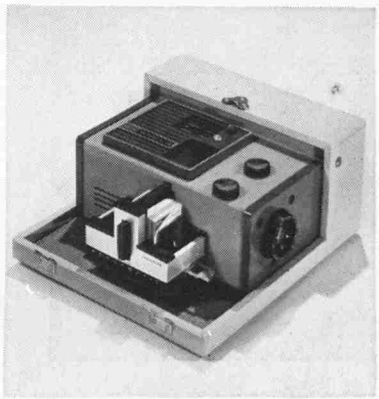
The man who came up with this trick is on our payroll to ward off trouble from micro-organisms in making film and paper. He is a microbiologist and has never been asked to contribute to machine shop practice in order to impress the plastics-molding trade.

Life can be devious instead of tedious.





It projects slides!



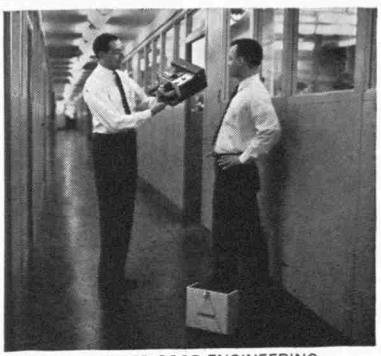
Learned and scientific as we are, we have not lost interest in simple consumer goods.

If you really want to know the truth, consumers are enjoying a simplicity kick at present. We even suspect you of being the type yourself. Otherwise we wouldn't be advertising the KODAK READYMATIC 500 Slide Projector to you.

It doesn't just scream "latest design!" but quietly is.

If you buy like that, you will pay less than $70 for a 500-watt 2x2 projector, complete with case and 4-inch lens, while sacrificing neither optical performance nor ease of slide-changing nor ruggedness of construction.

If you engineer like that, you will have a prosperous career with a manufacturing organization that values its reputation.



GOOD BUYS NEED GOOD ENGINEERING

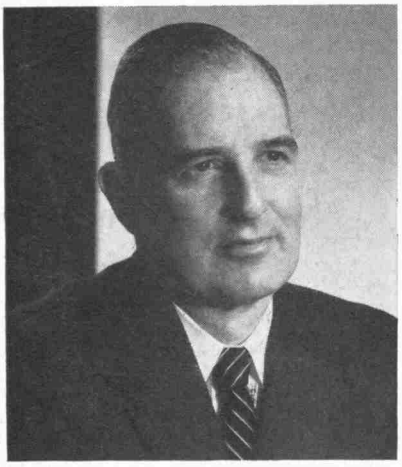
EASTMAN KODAK COMPANY
Rochester 4, N.Y.

Price subject to change without notice.

Kodak
TRADE MARK

An interview with General Electric's W. Scott Hill

One of a series...



Manager—Engineering Recruiting

How to Make the Most of Your First Five Years

MR. HILL has managerial responsibility for General Electric's college recruiting activities for engineers, scientists, PhD's and technicians for the engineering function of the Company. Long active in technical personnel development within General Electric, he also serves as vice president of the Engineers' Council for Professional Development, board member of the Engineering Manpower Commission, director of the Engineering Societies Personnel Service and as an officer or member of a variety of technical societies.

Q. Mr. Hill, I've heard that my first five years in industry may be the most critical of my career. Do you agree?

A. Definitely. It is during this stage that you'll be sharpening your career objectives, broadening your knowledge and experience, finding your place in professional practice and developing work and study habits that you may follow throughout your career. It's a period fraught with challenge and opportunity—and possible pitfalls.

Recognizing the importance of this period, the Engineers' Council for Professional Development has published an excellent kit of material for young engineers. It is titled "Your First 5 Years." I would strongly recommend you obtain a copy.*

Q. What can I do to make best use of these important years?

A. First of all, be sure that the company you join provides ample opportunity for professional development during this critical phase of your career.

Then, develop a planned, organized personal development program—tailored to your own strengths, weaknesses and aspirations—to make the most of these opportunities. This, of course, calls for a critical self appraisal, and periodic reappraisals. You will find an extremely useful guide for this purpose in the "First 5 Years" kit I just mentioned.

Q. How does General Electric encourage self development during this period?

A. In many ways. Because we recognize professional self-development as a never-ending process, we encourage technical employees to continue their education not only during their early years but throughout their careers.

We do this through a variety of programs and incentives. General Electric's Tuition Refund Program, for example, provides up to 100% reimbursement for tuition and fees incurred for graduate study. Another enables the selected graduate with proper qualifications to obtain a master's degree, tuition free, while earning up to 75% of his full-time salary. These programs are supplemented by a wide range of technical and nontechnical in-plant courses conducted at the graduate level by recognized Company experts.

Frequent personal appraisals and encouragement for participation in professional societies are still other ways in which G.E. assists professional employees to develop their full potential.

Q. What about training programs? Just how valuable are they to the young engineer?

A. Quite valuable, generally. But there are exceptions. Many seniors and graduate students, for example, already have clearly defined career goals and professional interests and demonstrated abilities in a specific field. In such cases, direct placement in a specific position may be the better alternative.

Training programs, on the other hand, provide the opportunity to gain valuable on-the-job experience in several fields while broadening your base of knowledge through related course study. This kind of training enables you to bring your career objectives into sharp focus and provides a solid foundation for your development, whether your interests tend toward specialization or management. This is particularly true in a highly diversified company like General Electric where young technical graduates are exposed to many facets of engineering and to a variety of product areas.

Q. What types of training programs does your company offer, Mr. Hill?

A. General Electric conducts a number of them. Those attracting the majority of technical graduates are the Engineering and Science, Technical Marketing and Manufacturing Training Programs. Each includes on-the-job experience on full-time rotating assignments supplemented by a formal study curriculum.

Q. You mentioned professional societies. Do you feel there is any advantage in joining early in your career?

A. I do indeed. In fact, I would recommend you join a student chapter on your campus now if you haven't already done so.

Professional societies offer the young engineer many opportunities to expand his fund of knowledge through association with leaders in his profession, to gain recognition in his field, and to make a real contribution to his profession. Because General Electric benefits directly, the Company often helps defray expenses incurred by professional employees engaged in the activities of these organizations.

Q. Is there anything I can do now to better prepare myself for the transition from college campus to industry?

A. There are many things, naturally, most of which you are already doing in the course of your education.

But there is one important area you may be overlooking. I would suggest you recognize now that your job—whatever it is—is going to be made easier by the ability to communicate . . . effectively. Learn to sell yourself and your ideas. Our own experience at General Electric—and industry-wide surveys as well—indicates that the lack of this ability can be one of the major shortcomings of young technical graduates.

**The kit "Your First 5 Years," published by the Engineers' Council for Professional Development, normally sells for $2.00. While our limited supply lasts, however, you may obtain a copy by simply writing General Electric Company, Section 699-04, Schenectady, New York.*

(An equal opportunity employer.)

Progress Is Our Most Important Product

GENERAL ELECTRIC