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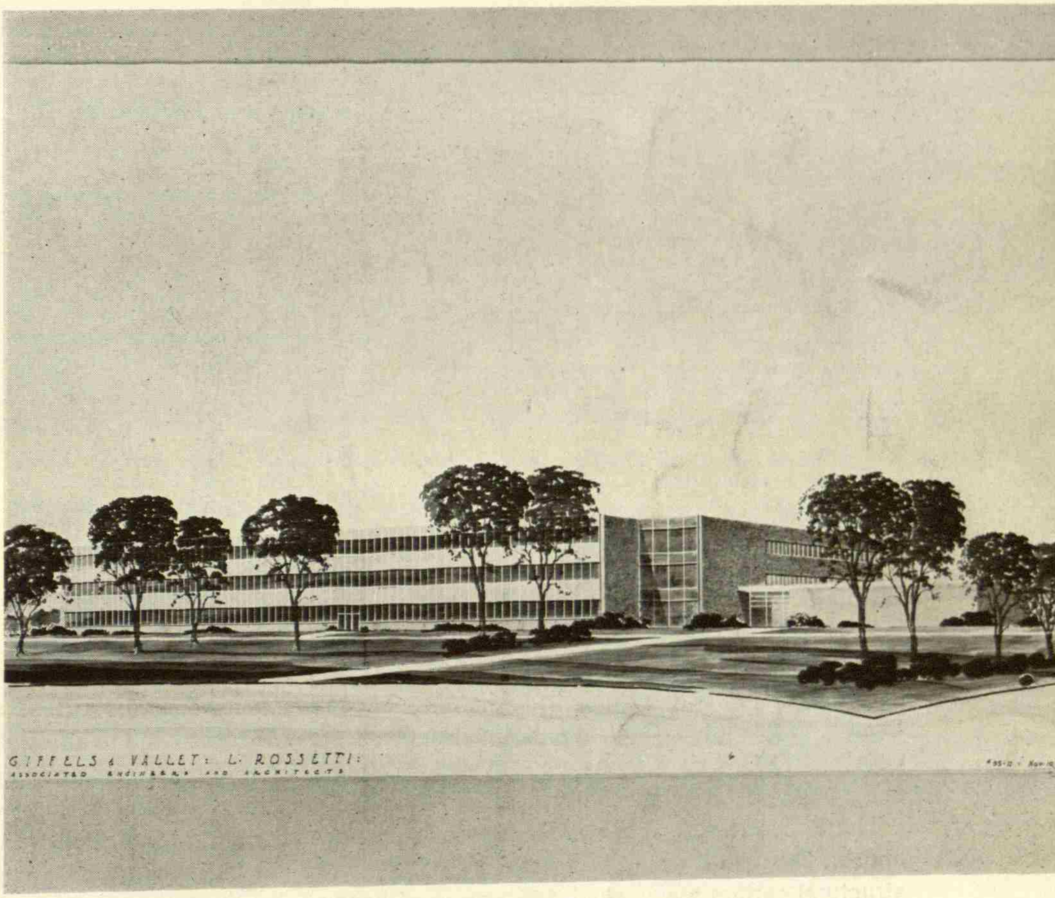
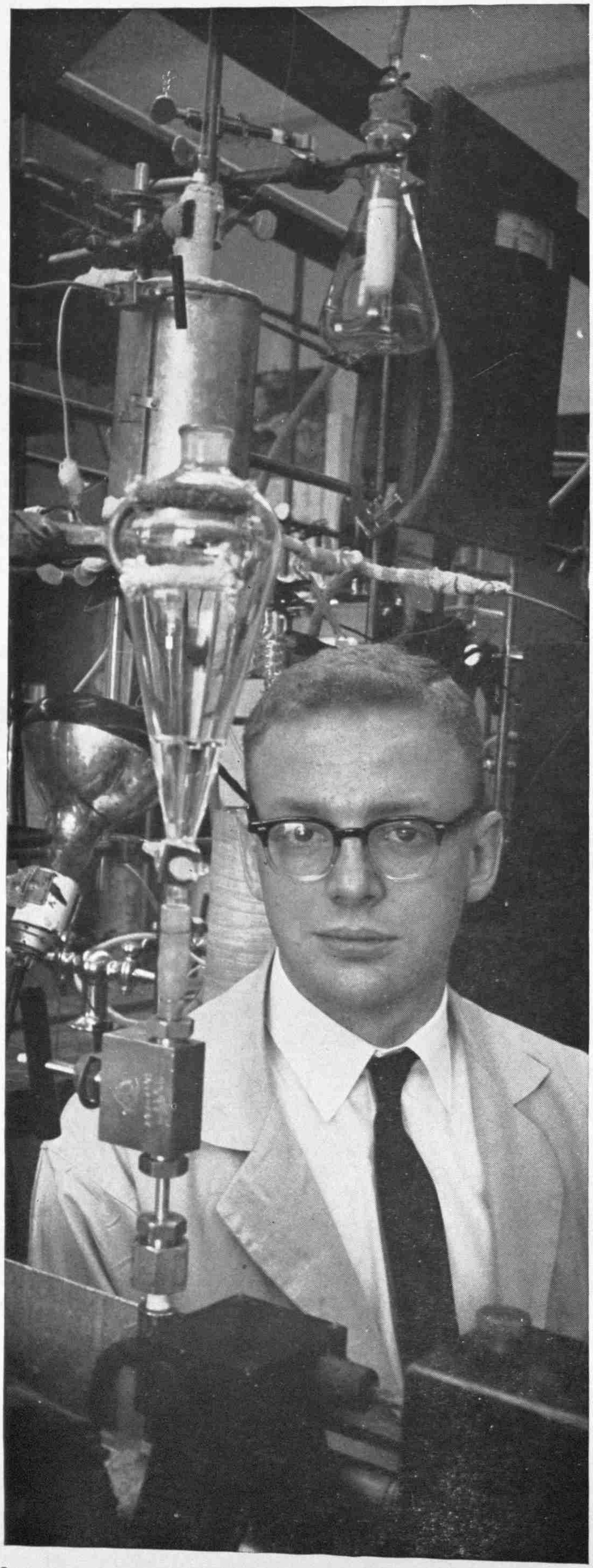
spartan ENGINEER

march 1962



....Our New Engineering Building



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What kinds of engineers are needed most?

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What is Air Force Officer Training School?

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Does the Air Force offer career opportunities?

Yes. Technically trained officers have a particularly bright career outlook. They have good opportunities for graduate study.

How can further information be obtained?

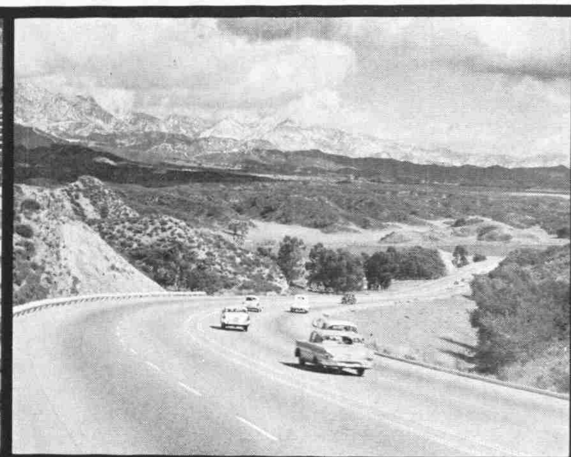
Write to OTS Information, Box 7608, Washington 4, D.C., or inquire at any Air Force Recruiting Office, listed in the telephone directory under "U.S. Government—Air Force."

Civilian Career Opportunities

The Air Force also offers challenging jobs for engineers as civilians. Write to Directorate of Civilian Personnel, Hq. Air Force Systems Command, Andrews Air Force Base, Washington 25, D. C., concerning opportunities for individuals with degrees in aeronautical, electrical, electronic, and mechanical engineering. Write to Directorate of Civilian Personnel, Hq. Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio, concerning opportunities for individuals with degrees in industrial engineering.

CHALLENGE IN CALIFORNIA

IN ALL PHASES OF CIVIL ENGINEERING



highways
bridges
structural
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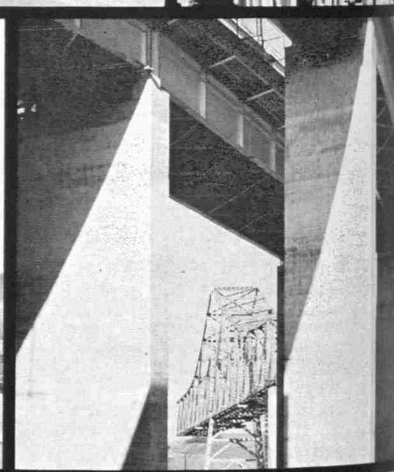

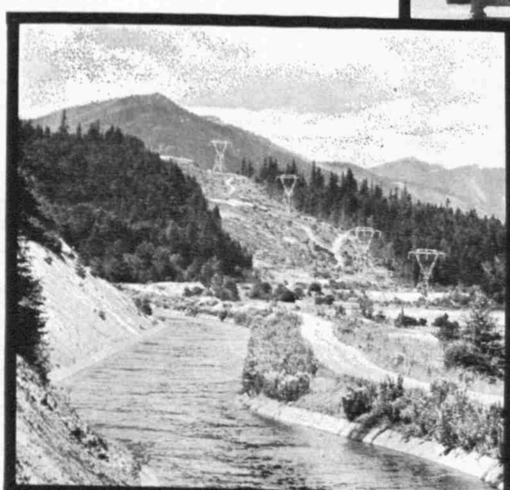

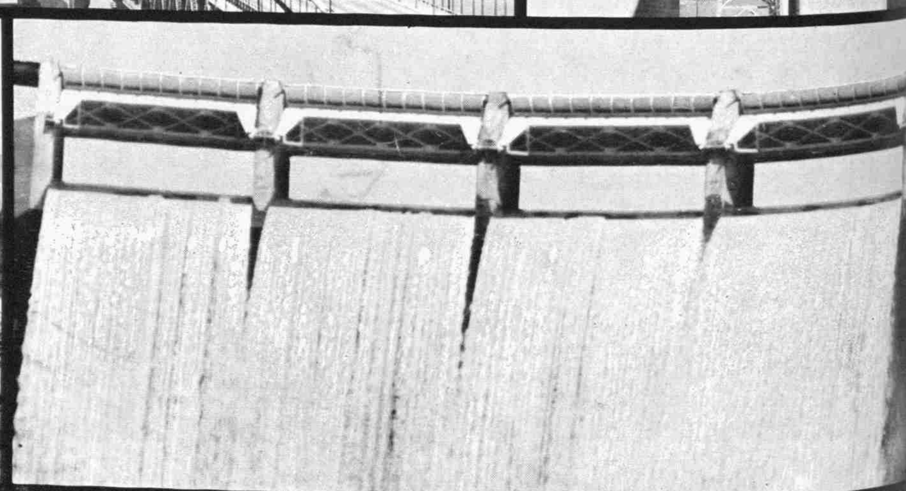

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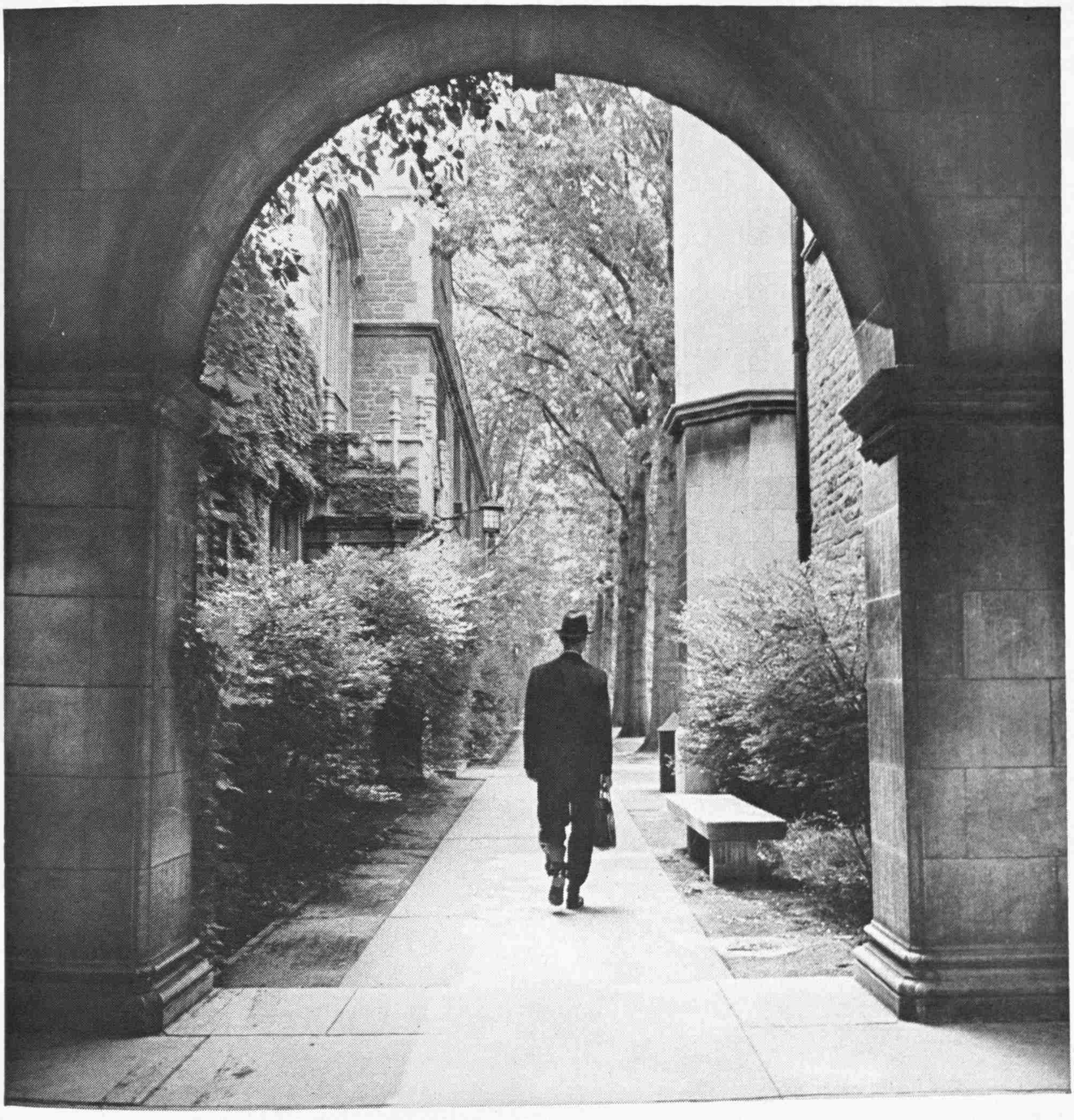

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Spartan Engineer

VOLUME 15 NO. 3 MARCH 1962

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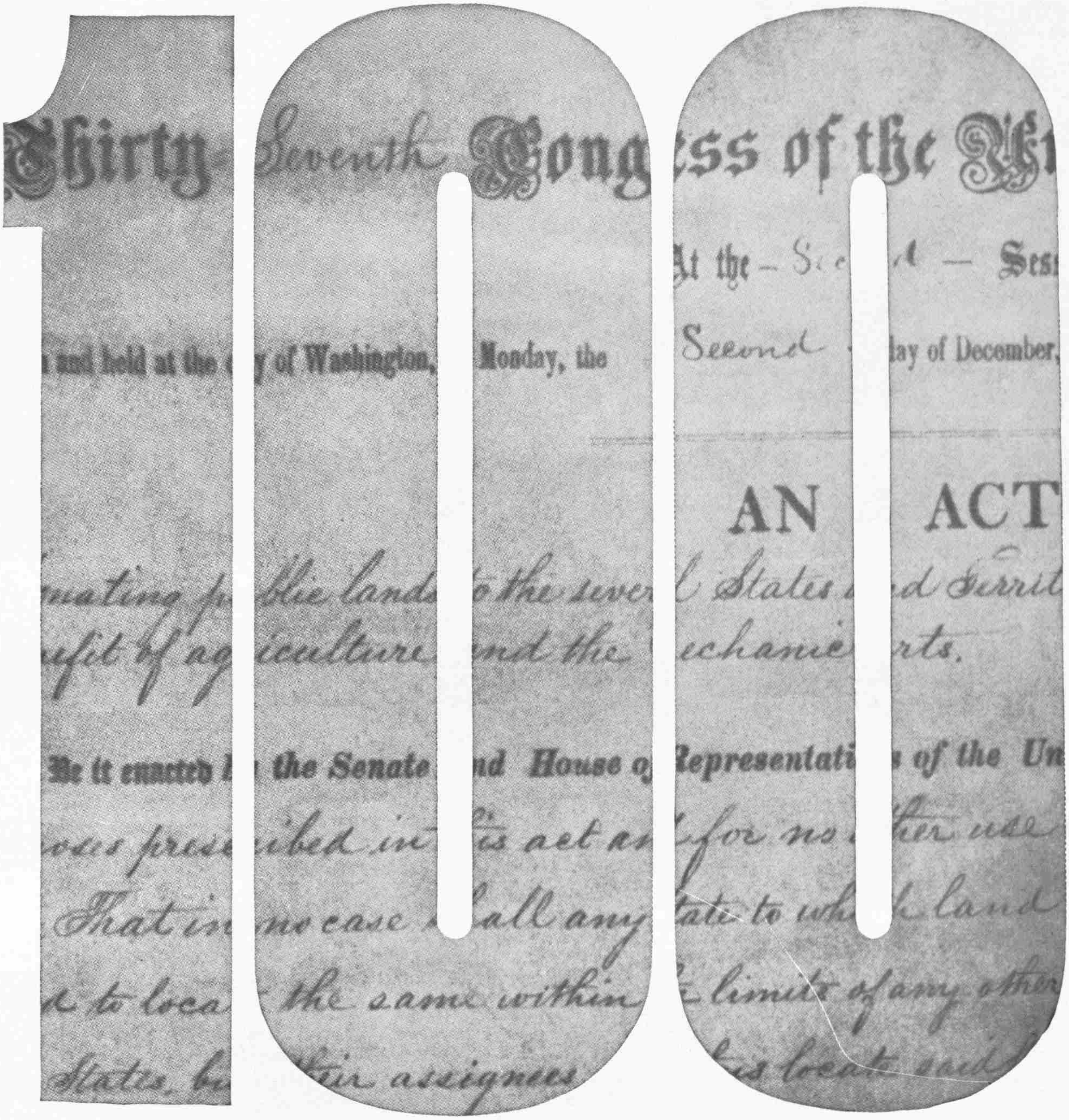

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Dean's Corner

The target for moving to our new building is the month of May. There will then follow a summer of activity, settling into new offices, assembling old and new equipment in laboratories, learning where people and classes are located. Disruptions and difficulties, it is true, but they will place a great big period at the end of an era—one in which this College was divided in six buildings, with almost no laboratory space designed for its present purpose—a situation not conducive to development of cooperative effort as one College.

The new building was designed to achieve the maximum from cooperation and effort toward a common goal—the betterment of our educational program and our research, in engineering and in the application of physical science and mathematics. Because of the continual change in programs of engineering education the building has been designed for flexibility—for change in usage of areas, or for expansion or contraction of areas as needs and demands change. An addition which will more adequately house the Chemical engineering work is under contract, and the building was designed with further construction in view. Thus we hope to be able to fit our facilities to the future.

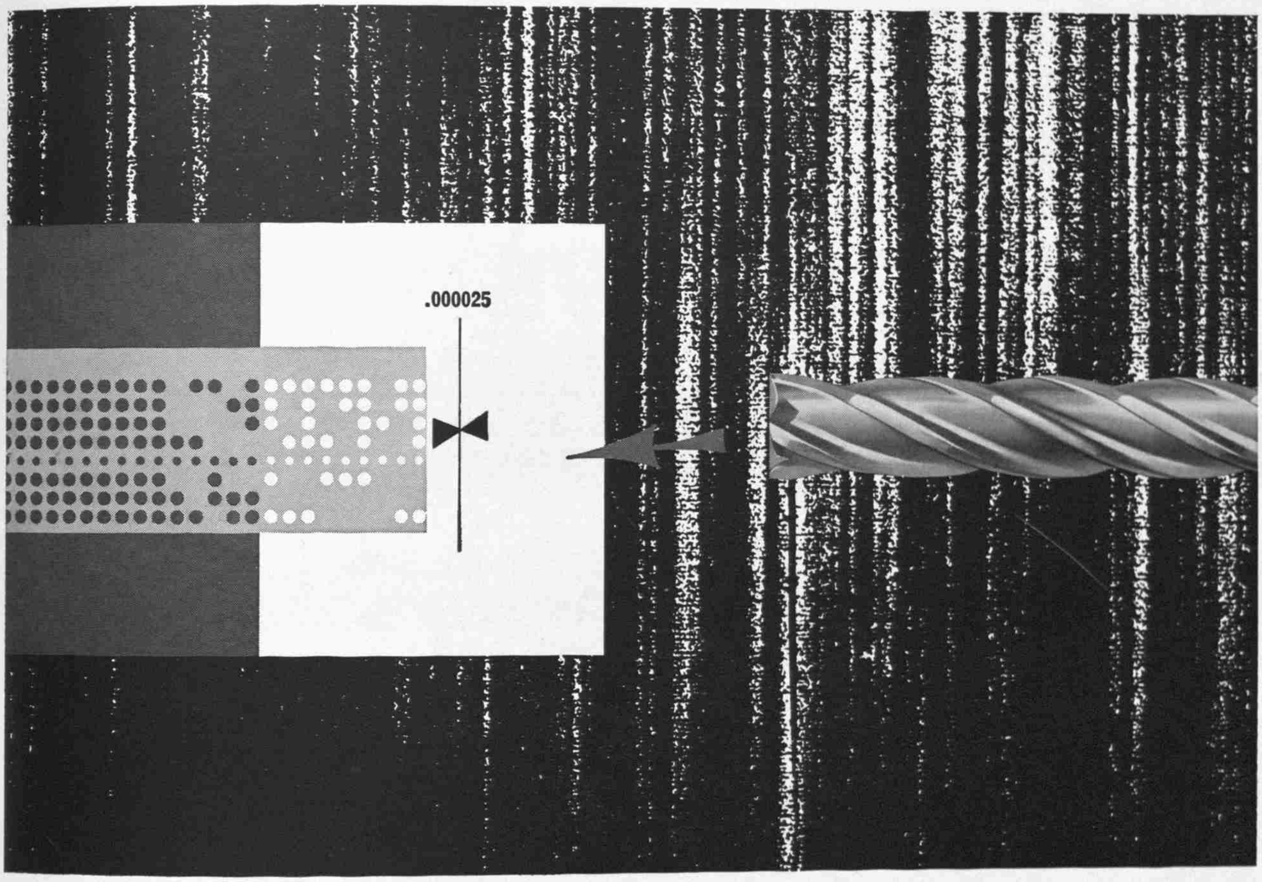
The building is arranged to foster cooperation of departments, faculty, and students, to improve coordination in the use of facilities, and to garner the maximum from a situation in which all of our departments, faculty, and facilities will be located under one roof. It will also provide many of the amenities of modern campus life—a college library, a student lounge for reading and study, an auditorium for our seminars and meetings, adequate conference space for faculty committees or meetings with off-campus visitors, and a faculty seminar room for between-class conversation. In the past we have been able to provide none of these facilities—and our esprit de corps has suffered correspondingly.

The new building is big—but as with all new buildings—it is not big enough. It has been felt that having the entire College in the building was of great value and worth a little crowding, especially in view of modern trends to become more fundamental in our educational process, thereby giving lesser meaning to our traditional departmental organization and pointing out difficulties of whole buildings dedicated to existing disciplines. This "togetherness" will create opportunity for interesting experiments in teaching of the experimental process—otherwise laboratory. As two examples, there will be a common fluids laboratory in which four departments cooperate instead of each having its own partial laboratory facility and teaching its own version of Bernoulli, a common analog laboratory in which five of our areas pool their equipment, courses—and of major importance—their faculty competence.

Thus MSU moves into its new day in Engineering.

March, 1962

J. D. Ryder



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Letter from the Editor

Today Michigan State University is producing better-qualified engineers by setting higher academic standards.

When I came to Michigan State one year ago, Dean Ryder told us that sixty-seven per-cent of the men starting then would not obtain their degrees as engineers. Now I'm a sophomore and there are about one-half of these men left as engineers.

Industry, today is demanding more and more of engineers. When I say demanding more I do not necessarily mean a skill in handling an equation or a slide rule, which is very essential. But, an engineer must learn to write technical reports, business letters, and instructional reports. Writing is the only way an engineer can make himself understood to non-engineering workers. An engineer also has to be able to speak well, which will enable him to give clearer directions on the use of the products he designs.

The **Spartan Engineer** was originated for these very reasons. Last issue three graduate students submitted articles about their projects. By doing this they were giving industry a truer cross-section of themselves which can not be brought out in a job interview. I feel that every engineering student should work in some phase of an extra-curricular such as the **Spartan Engineer** if possible. It is the hope of the faculty of the College of Engineering that all the students will take advantage of these opportunities.

Vic D. Humm

The Periodic Table lists all the known elements of the world we live in . . . more than half of them used by Union Carbide

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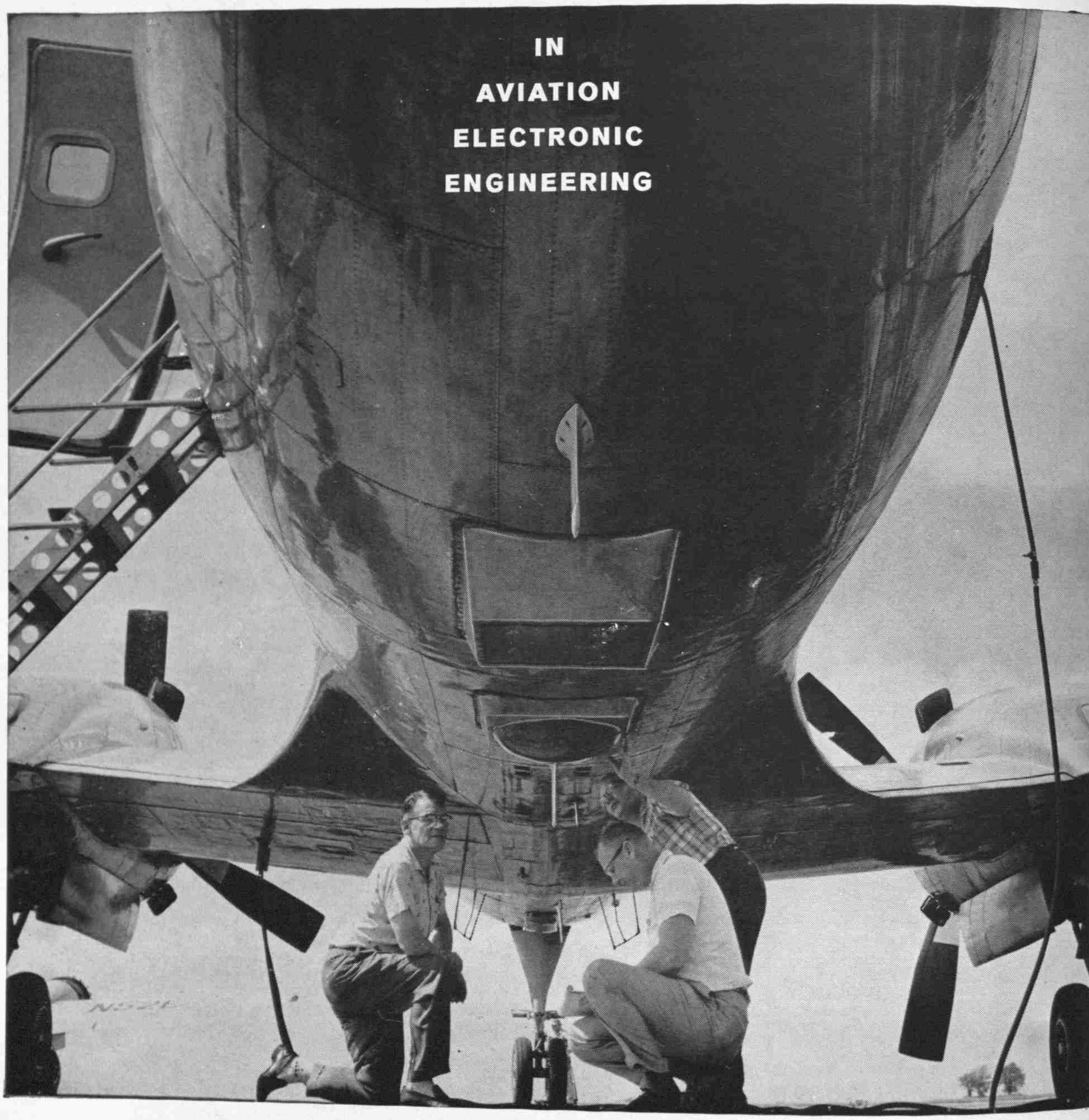

IN
AVIATION
ELECTRONIC
ENGINEERING

. . . . Our New Engineering Building

by Roberta Huffmaster

The new engineering building is another step forward in the history of engineering at MSU. The 4.25 million dollar building, housing soil analysis, bacteriology, and nuclear labs is distinctly different from the first attempt at teaching mechanics, as the course was called at MAC in 1885.

The capital L-shaped building, as yet without a name, will encompass all the engineering departments and permit interdisciplinary togetherness, somewhat like the first course in mechanics. It will be complete with classrooms, labs, offices and a 360-seat auditorium.

The size of the building itself is impressive. The east wing is 400 feet long, the west one is 135, and the north one is 300 feet long plus another 100 feet for the lobby and auditorium. It is 3 stories tall, has a basement in the north wing, and a penthouse on the roof that contains the heating system. This occupies an area of 150,000 sq. feet. Air conditioning is now provided for the auditorium.

There will be labs in the fields of thermodynamics, fatigue, soils, heat treatment, combustion, fluids, and many others. In the structural labs the floor loading is 500 lbs. per sq. ft., and compared to 100-150 lbs. per sq. ft. loadings in the other labs. One lab will contain a graphite moderated subcritical reactor which will be used for a presentation course in the fields of Radiological Health, and Nuclear Engineering. It can also be used for low level radiation research. The reactor will have a 5 curie plutonium-beryllium neutron source.

The west wing of the building will house the Central Engineering Administration, and on the third floor, provide a 50 by 100 foot separate engineering library.

An interesting feature of the building is that it is completely sectioned off into free-standing parts. Even the plaster will not connect the walls. Expanding joints were used to make certain that cracking will not occur.

The practical, however, has not overshadowed the aesthetic. The interior walls of the corridors vary in color from peach to blue to buff and the halls will have a light-color mosaic flooring.

The freshman engineering student of 1962 will proceed along a far different course from that of the entering freshman of 1885. In that year 35 students enrolled in mechanics. The course emphasized, as did agriculture, practical and general scientific knowledge. The engineering students had to spend their afternoons working in the shop, mainly making tools for the shop. They had to take 40 credits of math through calculus, 30 of physics and chemistry, 30 in composition, oratory and literature, and a year of German. Between 1885 and 1895, 52 students graduated in mechanics.

The construction of an engineering building in 1907, two years before a new agriculture building was built, signified a change in engineering's status at the college. In 1895 the ratio of engineering to agricultural students was 1-to-2. But by 1907 the ratio had reversed to 2-to-1. The present Olds Hall is a replica of this first building.

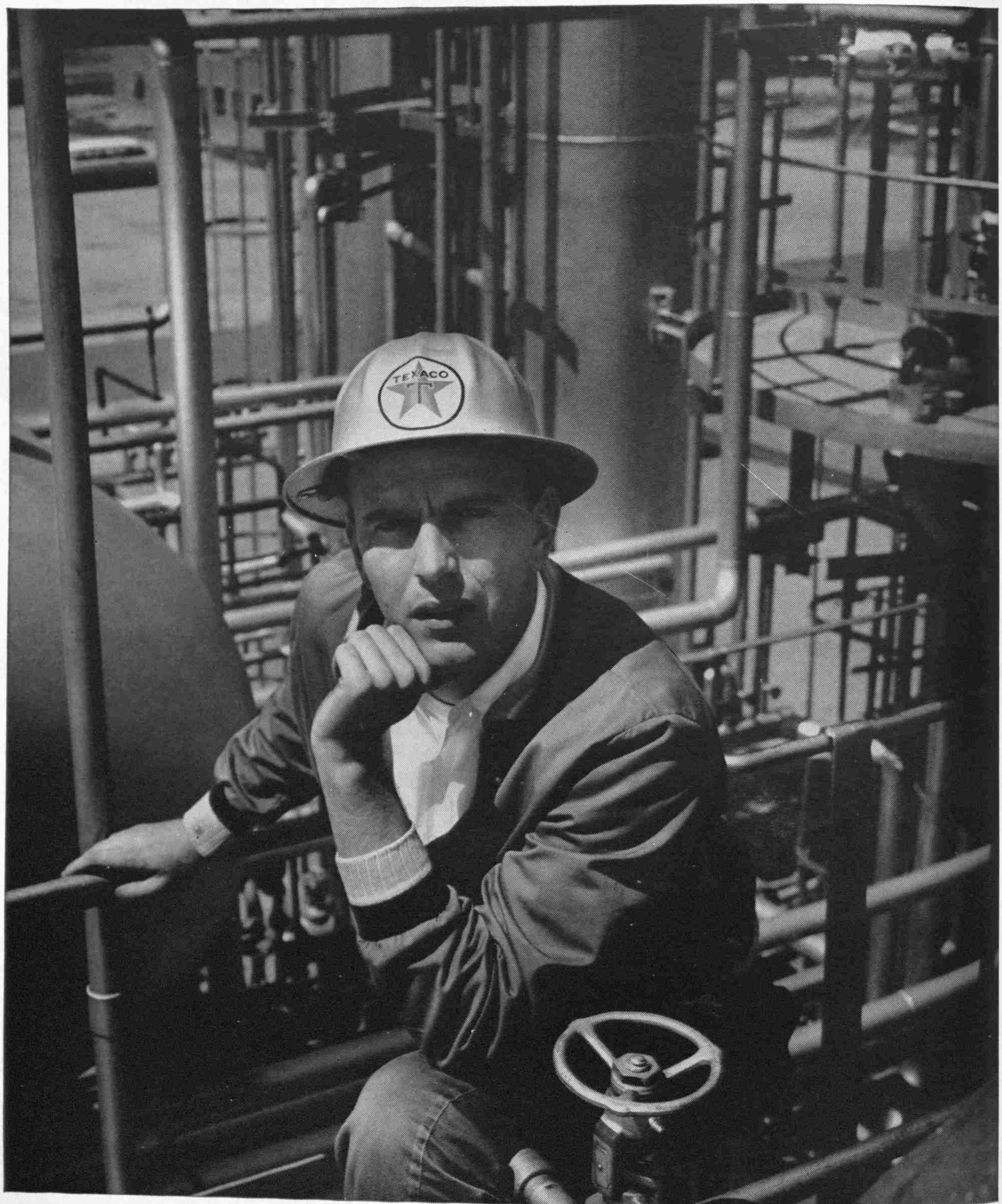
A fire in March 1916 destroyed the engineering building and the shops, and almost ended the department's existence in East Lansing. A few thousand dollars worth of electrical equipment and a couple of lathes were all that could be saved. The destruction of facilities strengthened rumors that the whole department should be transferred to U of M and merged with its department.

The president of the college Dr. Kedzie however, had other ideas. He called the faculty together, and enough classrooms were volunteered to take care of the homeless classes. When the year's studies were finished, Professor V. T. Wilson concluded that "equipment does not make a college; it is teachers and a condition of intelligent understanding between students and teachers."

The fight to move the engineering department to Ann Arbor was ended with R. E. Olds' gift of $100,000, plus other money that enabled the construction of Olds Hall.

Olds Hall made engineering permanent at MSU, but the new building with its increased facilities will make it prominent.

Original Engineering Building



STATICS . . .

"Basic To An Engineer's Education"

by Dr. Lawerence E. Malvern
Professor, Applied Mechanics
Michigan State University

"Almost every instructor believes that his subject is the most important one in the curriculum. The only difference with me is that I don't just *believe* that Statics is the most important course you will take; I *know* it is!" These incautious words spoken to my Statics class on the first day of Winter Term brought me a challenge from *Spartan Engineer* editor Vic Humm to back up my assertion. With the escape-hatch explanation that I was talking to a class of sophomore Civil and Mechanical Engineering students about technical education and not contesting the eternal values of the humanities, I will attempt to explain my conviction that the first course in Engineering Mechanics is basic in the education of an engineer.

This conviction has grown in me mainly during the last six years, although I have been teaching mechanics twice that long. Because most of the examples in the Statics books dealt either with rather unexciting things like ladders leaning against walls or with some old-fashioned looking structures, I had not realized quite how important the ideas and methods taught there still are in the space age. An aeronautical engineer in the missile division at the Boeing Airplane Co. first opened my eyes by showing me how important the free-body methods of analysis are in advanced design research on complicated missile control mechanisms. Since then I have questioned a number of engineers working on advanced projects in the aero-space field. Some of them did complain that their own first introduction to mechanics had over-emphasized statics as compared to dynamics and had given too little attention to three-dimensional analysis, shortcomings still to be found in Engineering Mechanics textbooks. But despite the shortcomings these engineers were all agreed on the great importance of the foundation course in mechanics.

Since the time of Archimedes the science of mechanics has been closely associated with engineering. You can hardly find a Mechanical or Civil Engineering problem not concerned with the effects of forces acting on bodies, either in producing acceleration as in a missile or in producing deformation as in a structure. These effects of forces on bodies are precisely what is studied in the science of mechanics. To be sure, most students will already have encountered the principles of Newtonian mechanics in a physics course, and they will learn a great deal more about mechanics and how to apply it to real engineering situations in later more advanced courses in mechanics or in engineering design theory. Why then do I single out the first course in Engineering Mechanics as so important? It is certainly not because of the new scientific principles taught there. It has been said that the principles covered in the first course could all be written on one three-by-five card. There are, however, two great things to be learned from this first course in engineering analysis about bringing abstract scientific principles to bear on concrete problems with the aim of bringing about changes in the material environment.

This is the engineering student's first opportunity to use the physical principles and the mathematics he has studied in situations resembling, somewhat, engineering problems. And the first thing to be learned is that the mathematics can never be applied to nature as it really is. A mathematical model must be constructed representing in every case some idealized or approximate version of nature. In the first course in mechanics the first step in constructing the mathematical model is usually accomplished by making an idealized physical model of the situation, using such ideal concepts as concentrated forces, point masses, and rigid or linearly elastic bodies. The second thing to be learned is free-body analysis in order to be able to write down the equations applying the principles of mechanics to each part of the idealized physical model.

The free-body method is the most characteristic analytical tool of Engineering Mechanics. Introduced in the traditional Statics course, it is applied over and over again in later mechanics courses such as Strength of Materials and Dynamics and in Structural and Machine Design courses. By means of free-body diagrams we display clearly just what forces act on what bodies and are able to apply the principles of mechanics unambiguously to the physical model. A similar isolation of a part of a system is accomplished by the "control surface" in thermodynamics problems. In advanced courses in Structures or Systems Analysis, more sophisticated mathematical methods may be employed for complex structures or systems, and possibly more realistic physical models, but it is yet to be demonstrated that any other method is as simple and effective as the free-body method introduced in sophomore mechanics for arriving at the correct mathematical description of a component in a mechanical system.

(Continued on page 32)

Sediment Transportation

Civil Engineers Offered New Challenge

by John Adams
Graduate Student
Department of Civil Engineering

In school, in design, and in research, the specific, detailed problem is often sufficiently engrossing to cause one to completely lose sense of the overall problem. In school, material is studied to pass a test. On the job, all effort is expended toward the design of one bridge. In a research project, the seemingly perfect agreement between experiment and analysis may obscure the niche this one fact holds in an imperfect theory. To avoid this narrowness, the problem of sediment transportation in streams will be traced from its place in geology to a specific experiment being conducted at Michigan State University.

The geologic cycle is one of constant change; new mountains are raised only to be reduced to plains. Climate plays a vital part in the destructive portion of the cycle. Water, the universal solvent, constantly falls on the mountains, steadily rushes over the plains, and relentlessly seeps beneath the ground surface. The winds add their dry, eroding breath, and temperature hastens the destruction by freezing or boiling the water on and within the rock. As storm water runs off on the surface, it forms rils, brooks, creeks, streams, and rivers on its way to the sea whence, by evaporation, it shall return again to torture the land. As the water flows on its way it carries along the fine sands and silts that are the product of its destructive power. Over the ages of geologic time, rivers form their beds in the same material that they carry. These rivers, and man-made canals in erodible material, may be lumped under the title of alluvial channels, and constitute the problem under consideration.

The hydraulic engineer leaves the meterologist the problem of determining the temperature and precipitation variations, and concerns himself with the flow of sediment-laden water in alluvial channels. This is the first simplification of the problem. Though how and when the precipitation gets to the stream, and the temperature of the water itself, are important, their determination is not the concern of the hydraulic engineer.

The subject is still extremely complex. A quick glance at a map will convince anyone that natural rivers just do not flow in straight, uniform channels. The alluvial stream often forms series of loops, and encompasses islands, bars, rapids, and pools. Yet even these are not stable or fixed, but are continually being re-formed by the force of the stream. The loops, or

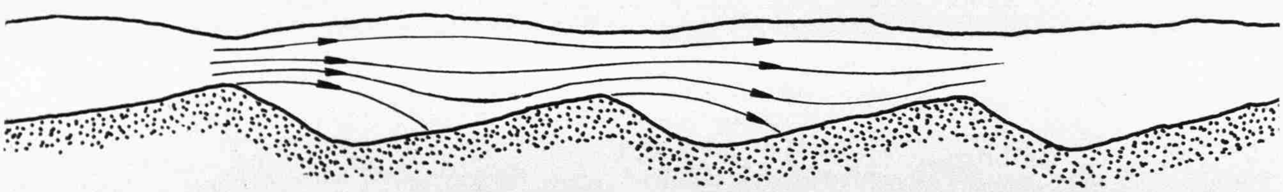


Fig. I. Flow over a Dune Bed.

meanders, tend to move downstream virtually intact. Islands and bars come and go with the years or seasons. All these changes are the result of erosion and deposition of its bed and banks by the stream.

Man often wants to control the rivers. However, he must first learn why they act as they do before he can expect to effectively control them. Even then this control may be effective in the minute lifespan of man, but be of only minor irritation to the powers of nature as they pursue their divinely ordained purpose.

It is apparent from the failure of many river-control projects that man does not understand the mechanics of sediment transportation by streams, as he must to succeed in such endeavors. In fact theoretical analysis of steady, uniform flow in simple conduits is by no means complete. But the complexity of river flow makes theoretical analysis impossible. Thus, the solution must be approached by experimental research.

At first it might seem best to study rivers directly. Unfortunately they do not lend themselves to observation. Frequently the measurements should be made during the spring thaw or in stormy weather. Besides, field measurement is expensive, time consuming, and extremely difficult to perform accurately. Consequently laboratory experimentation has been undertaken. Empirical formulae for sediment transportation have been developed from the results of experiments using flumes with sand beds in them and with systems to recirculate the water-sediment mixture. However, correlation between flume data and field measurements has not been entirely satisfactory. This may be because the experiments have not faced up to the real question: what forces acting on a particle on the bed of a channel, will make the particle move? The tests have at least clearly shown that the evaluation of the forces on a stream bed and the relation between these forces and the movement of sediment particles is of vital importance to the development of a practical theory.

The flow pattern in an alluvial channel has been observed taking any of several forms. The bed may be plane, may be composed of ripples or larger dunes, or may be in the form of large, irregular bars. The flow pattern for the case of regular dunes is shown in Fig. 1. The natural dunes are not congruent, but are quite similar and tend to move downstream while remaining surprisingly intact. Because of the regularity, and the nature of the flow, it is expected, at least intuitively, that there is some relation between sediment motion and dune formation.

Note that the flow expands beyond the crest of each dune, and then contracts on the back of the next dune. On the bed surfaces there is a static pressure due to the weight of the water above and a dynamic pressure from the impinging flow. There is also a shear or drag force caused by friction of the flow along the boundary. Due to the dynamic effects, the pressure is highest where the expanding flow strikes the next dune. The shear is very small in the trough where a fairly stable eddy forms, but increases approximately linearly with distance along the back of the dune, reaching its maximum value at the crest. It is suspected that the crest of the dune may occur at the point where the shear becomes large enough to move most of the sediment particles from the surface, for once a particle has entered the flow, it will be held in suspension by turbulent mixing.

Perhaps it would seem that the selection of the dune bed as the easiest bed form to study would permit the use of moveable-bed flumes to solve the problem. But there are too many irregularities in any naturally formed bed of sand, and measurement on moveable beds is virtually impossible as a scour hole is formed around any instrument placed near the bed. Thus a fixed bed is being used in the experiment here at Michigan State. All the dunes are the same, idealized shape with perfectly plane surfaces and sharp corners, as shown in Fig. 2. To eliminate the problems caused by the free surface in an open channel, a closed conduit has been selected. The dunes are reflected in the top of the conduit to provide a centerline of symmetry which can be considered analogous to the free surface, with only minor discrepancies in velocity distribution, and these discrepancies do not extend to the dune surface.

Now the complex phenomenon has been reduced to manageable terms. Measurement of the velocities, shears, and dune pressures should produce answers to the question of what forces act on the dunes.

Yet there remain other things to consider before actual measurement begins. How long should the conduit be? In open sediment studies the answer has always been: longer. But space, one of the researcher's facts of life, dictated the length as 44 ft. As

(Continued on page 38)

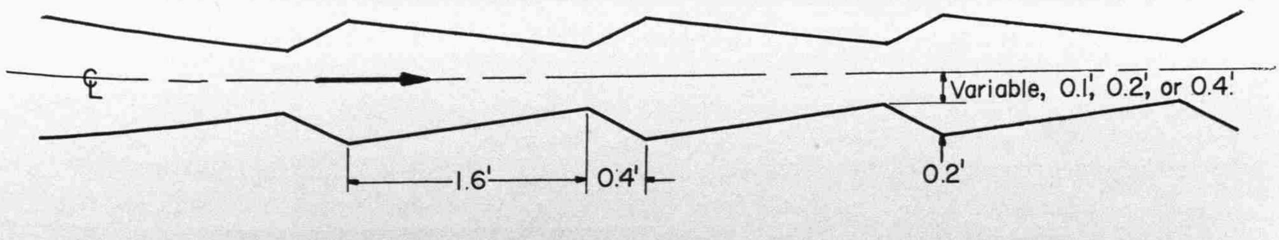
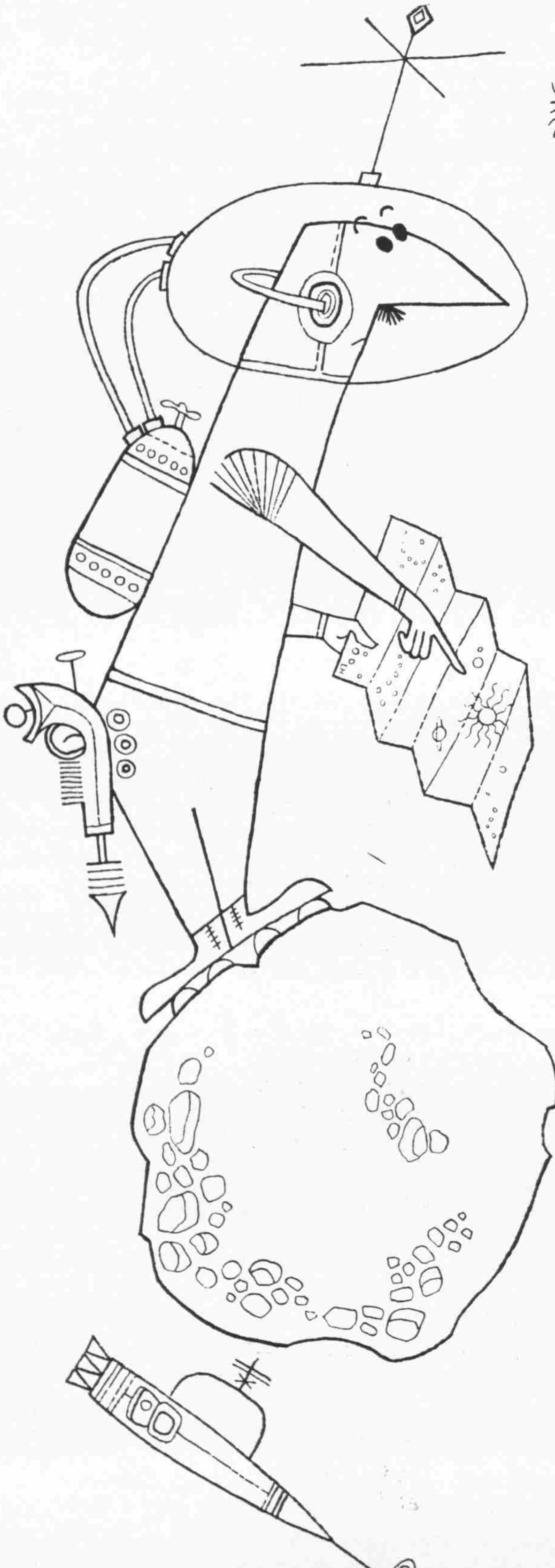
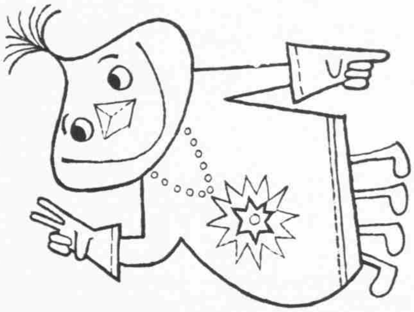


Fig. 2. Dune Model.





how far is "way out"?

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THE VERSATILE PLASTICS

An Expanding Field Finds Many Applications

by Loren Nelson
ME '63

Many engineering students are not aware that plastic is one of the leading engineering materials used today. Almost every engineer has used plastics or has encountered a situation in which plastics could have been used to do the job cheaper and better than the material used. All phases of engineering are concerned with plastics. The chemical engineer is concerned with the development and the production of plastics. The electrical engineer uses them for wire insulation, recording tapes, connectors, and many other things. The mechanical engineer uses them for gears, gaskets, tools and jigs, automotive parts, industrial moldings, valves and fittings, and the list is almost endless. Even the civil engineer uses plastics for structural members, paints and coatings, translucent roofs for buildings and even on roads as a non-skid protective coating.

Plastics have been defined as any one of a large and varied group of materials consisting wholly or in part of combinations of carbon with oxygen, hydrogen, nitrogen and other organic and inorganic elements which, while solid in the finished state, at some stage in its manufacture is made liquid, and thus capable of being formed into various shapes, most usually through the application, either singly or together, of heat and pressure. Plastics can be divided into two groups. Thermoplastics are those plastics which become soft when exposed to sufficient heat and harden when cooled, no matter how often the process is repeated. Thermosetting plastics are set into permanent shape when heat and pressure are applied to them during forming. Reheating will not soften these materials.

One type of plastic that is of special interest because of its high mechanical strength and resistance properties is the epoxy family. Epoxies have a strong adhesive characteristic and are the most adaptable bonding agent known. Epoxy base paints and coatings show excellent wear and corrosion resistance and are waterproof. They are especially adapted to use on concrete and masonry. One potential use for epoxies is as an adhesive for applying high-friction aggregate to roads.

Due to their high mechanical strength epoxies are being used in the tooling trade. Ren Plastics, Inc., one of the major producers of tooling plastics, is located here in Lansing. The founder and president of Ren Plastics is Mr. Harold Renaud. Mr. Renaud, seeing the bright future for plastic tools after 25 years experience as a patternmaker, entered the plastic tooling business in 1941. After working with the primitive plastics then available he entered the formulating business and began to produce special plastics for tooling.

The growth of plastic tools was so rapid that his company was unable to build all the tools that industry demanded. To cope with this problem he provided instructions in his own plant and sent technicians out to show others how to use plastics for tools. Then, in 1952, Ren Plastics, Inc., was organized as a formulator of tooling plastics and the actual tool making work was discontinued.

Ren produces a wide variety of tooling plastics. They make REN-wood, a plastic replacement for mahogany, fillers and pastes for filling and repairing models, laminating materials, casting materials, tubing and other related products.

There are several reasons for using plastics for tooling. The primary reason is cost. Plastic equipment will cost only approximately 1/5 as much as metal equipment. However, plastic will last only from 20 to 25 percent as long as metal. It is plain to see that plastic is much cheaper for the short run or for light service. Plastics are also very easy and fast to repair or change. This is an advantage in model making as well as in production. Plastic tools may often be repaired without removal from the production area and in a fraction of the time it takes to repair metal tools. When a change in shape of a pattern or tool is required a simple casting technique is used. Another advantage of plastic, when time is a factor, is that a job can be taken from the drawing boards and put into production with plastic in a fraction of the time it takes for metal.

One example of the savings from the use of plastic is the corebox inserts used in the foundry at Buick Motor Division, General Motors Corp. Metal inserts were being used at points of excessive wear in manifold coreboxes. It took a skilled machinist from 40 to 120 hours to make a single insert which had a maximum service life of 40 hours. The inserts are now cast from plastic. It takes 30 minutes to set up four inserts in a mold and 7 hours

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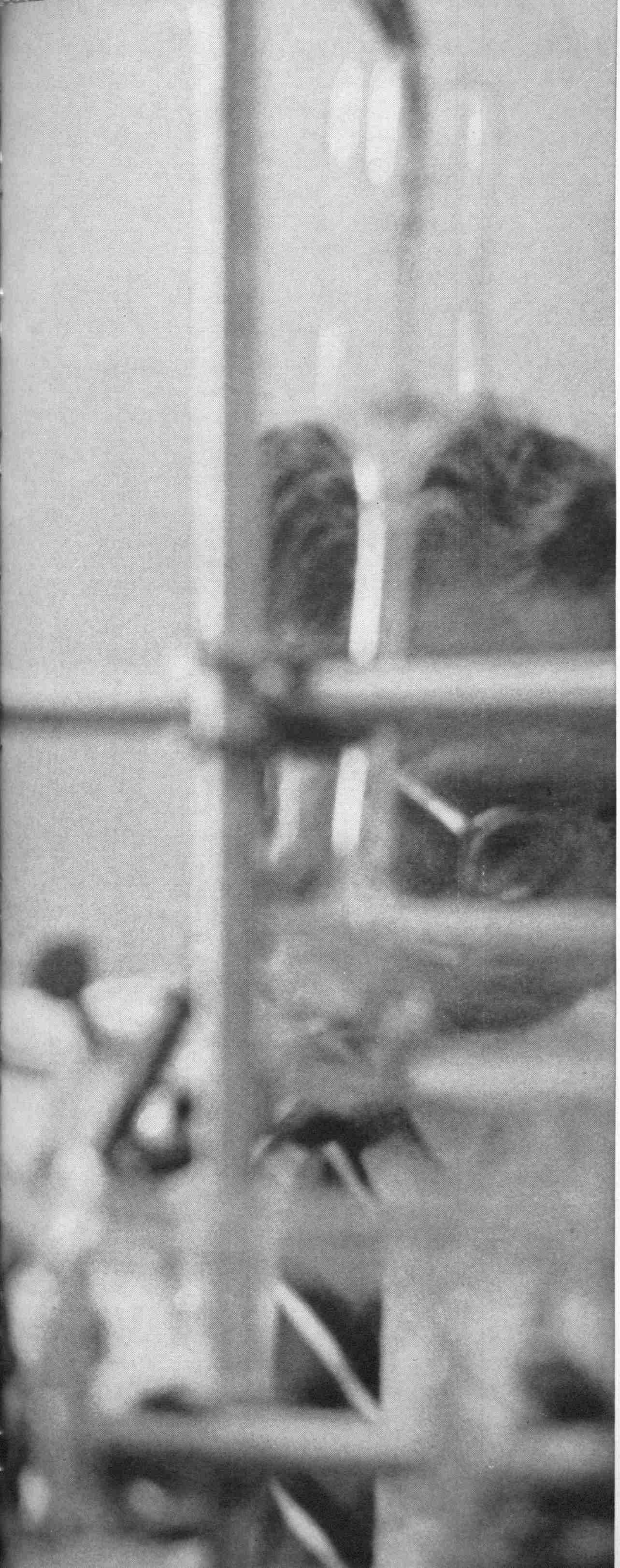

Edward M. Davis, Jr. (B.S.E.E., Carnegie Tech '55; M.S., Cal Tech '56; Ph.D., Stanford '58) is directing micro-electronic device development at IBM's Poughkeepsie, New York Laboratories.

DR. DAVIS AND MICRO-DEVICES

When Dr. Edward M. Davis was working for his bachelor's degree, miniaturization was a novelty. Today, with the transistor and the printed circuit commonplace, micro-miniaturization is one of the newest challenges in electronics. Ed Davis is helping to meet that challenge.

Today's computer operations take only millionths of a second; tomorrow's may accelerate to billionths. In a billionth of a second, however, even light can travel only about a foot, and the physical size of an electronic circuit may slow its operation critically. The answer is in micro-electronics where complete circuits are packaged on minuscule substrates, and each transistor may occupy less than a thousandth of a square inch.

Since early in 1961, Ed Davis has been in charge of an IBM engineering project exploring the parameters of advanced micro-devices. His work may very well help establish the technology of future computers. Equally important, he and his colleagues are already gathering significant knowledge in the advanced study of solid state electronics.

A basic approach is encouraged at IBM. Whether in research, development, manufacturing, or programming, the IBM scientist and engineer are encouraged to go to the heart of the problem. The IBM representative interviewing on your campus will be glad to discuss with you the opportunities in any one of these fields. All applicants will receive consideration for employment without regard to race, creed, color or national origin. Your placement office can make an appointment, or you may write, outlining your background and interests, to:

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N. S. SAVANNAH

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More than 140 years ago, on May 22, 1819, a 320-ton ship started an epoch-making voyage from Savannah, Georgia, to Liverpool, England. She was the S. S. Savannah, the first vessel to use steam on a transatlantic crossing. The 29-day, 11-hour voyage was successful even though the little craft could carry only enough coal and wood to permit about 89 hours of actual steam propulsion.

As the Savannah ushered in the Steam Age in ocean travel, it is fitting that another Savannah should usher in the Atomic Age of merchant shipping. This is the 22,000-ton N. S. (for Nuclear Ship) Savannah, the world's first nuclear-powered cargo-passenger ship. The new Savannah is another first as important as was its namesake, the tiny vessel which opened the era of steam navigation almost a century and a half ago.

Construction of the N. S. Savannah was undertaken in accordance with the policy of the President and the Congress to foster and develop the American Merchant Marine. The vessel is intended to demonstrate to the world (1) the intent of the United States to employ the power of the atom for peaceful, productive purposes and (2) the feasibility of using nuclear energy to power merchant ships.

It is not expected that the Savannah, as the first ship of its kind, will be economic, since costs of such a prototype are necessarily high. It is expected, however, that the Savannah will pioneer the way to construction of other nuclear-merchant vessels which eventually will prove to be economically competitive with those powered by conventional means.

The development of the Savannah has been the joint responsibility of the U. S. Atomic Energy Commission and of the Maritime Administration of the U. S. Department of Commerce. Design and construction of the ship was carried out under the direction of a Joint Group comprised of personnel from both the Maritime Administration and the AEC. The vessel was designed by George G. Sharp, Inc., of New York, and was built by the New York Shipbuilding Corporation, of Camden, New Jersey. The Babcock & Wilcox Company, of New York, designed and built the Savannah's 69 thermal megawatt pressurized water reactor. States Marine Lines, of New York, was chosen to operate the Savannah as general agent for the Maritime Administration. States Marine has supplied the ship's crew, including deck officers and highly-trained reactor engineers.

Building of a nuclear-powered merchant vessel was first proposed by former President Dwight D. Eisenhower in a speech in New York on April 25, 1955. Construction was authorized by Congress on July 20, 1956.

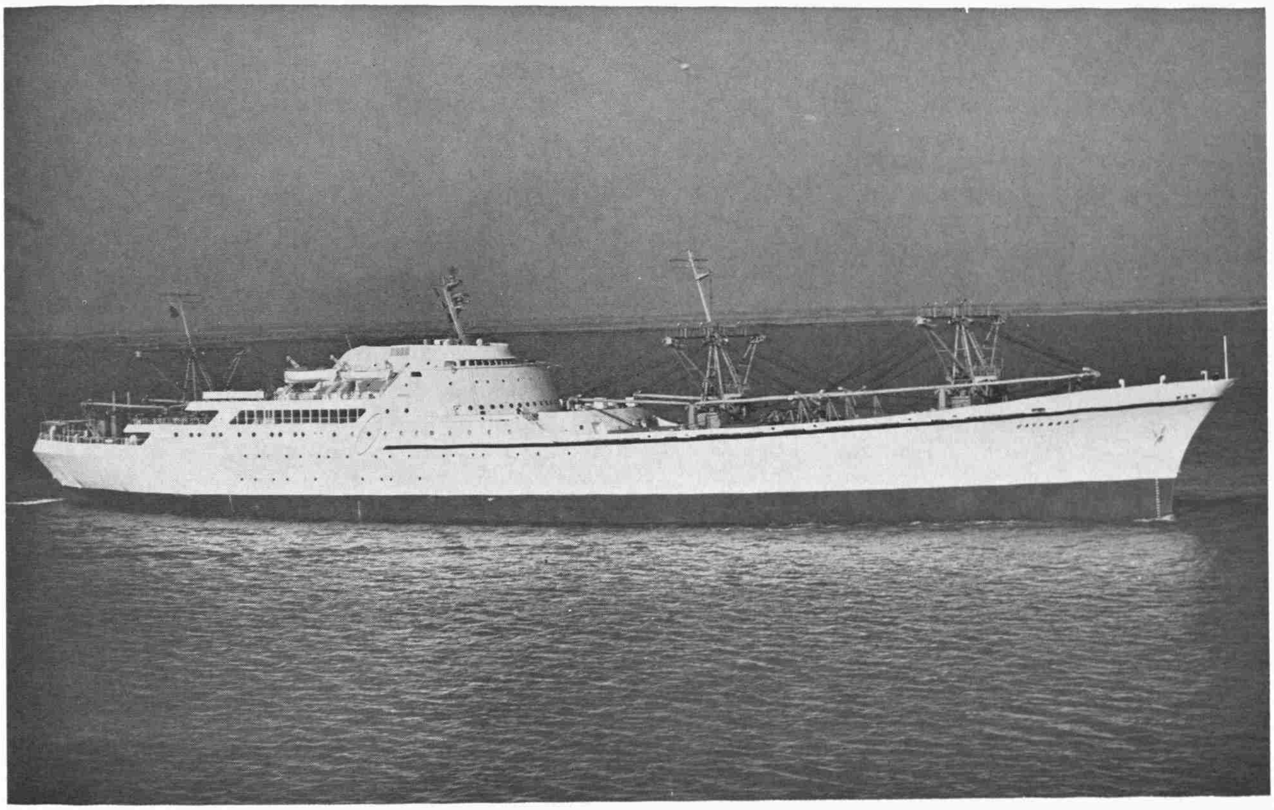
The contract with The Babcock & Wilcox Company for development and fabrication of the nuclear propulsion system was awarded in April, 1957. The contract for construction of the Savannah was signed with the New York Shipbuilding Corporation in December, 1957. The keel for the ship was laid by Mrs. Richard Nixon on National Maritime Day, May 22, 1958, and the vessel was launched on July 21, 1959, with Mrs. Dwight D. Eisenhower as sponsor. Construction of the Savannah was essentially completed in the spring of 1961.

After public hearings on the safety of the ship's nuclear system in March and April, 1961, and following extensive tests of the reactor and the propulsion plant, the Savannah's reactor was loaded with uranium oxide fuel on November 27 and 28, 1961.

Criticality, or a sustained nuclear chain reaction, occurred December 21, 1961, and was followed by zero and low power tests of the reactor at the New York Shipbuilding Corporation yard at Camden up to a level of 10 per cent of the reactor's design power.

The ship then was moved under auxiliary power from temporary boilers to Yorktown, Va., for full power reactor operation and for her initial sea trials.

Since the Savannah is a prototype ship, many special features, such as provision for extensive remote operation of components and the possibility of rapid maneuvering rates, have been incorporated into the vessel's construction and equipment for evaluation in future ship design. Components, and



even entire plant systems, will be changed when it is indicated that significant technical advancements can be made by doing so.

To sum up, the Savannah has five important missions:

(1) To demonstrate to the world the employment of nuclear power as an instrument of peace for the benefit of mankind.

(2) To bring the power of the atom into the market places of the world in peaceful trade and commerce.

(3) To demonstrate that nuclear-powered merchant ships are dependable and safe.

(4) To stimulate early solutions to such problems as international liability and indemnification and to achieve acceptance for nuclear ships in world ports.

(5) To give the Atomic Energy Commission and the Maritime Administration the opportunity for assessing the contributions of atomic power to the progress of the American Merchant Marine.

The reactor of a nuclear-powered vessel performs the same function as does the oil-burning equipment in a conventionally-powered vessel. This function is to produce heat with which to generate the steam needed to turn the ship's turbines and propellor shaft.

A reactor is, simply, an atomic furnace. Heat is produced in this furnace by continued, chain-reaction splitting, or fissioning, of the atoms of the nuclear fuel.

In the type of reactor installed in the Savannah, water is circulated under pressure through the heart, or core, of the reactor as the fissioning process takes place. The water removes the intense heat created in the reactor core by the splitting of the fuel atoms and transfers this heat to a secondary system of piping located in a device called a "heat exchanger."

Water in this secondary system is changed to steam for propulsion of the vessel.

The nuclear fuel in the Savannah's reactor comprises approximately 17,000 pounds of enriched uranium oxide. A single core of the fuel is expected to supply enough energy to operate the ship for 3½ years without replacement. Approximately 90,000 tons of fuel oil would be needed to produce an equivalent amount of energy in a conventionally-powered vessel.

There are a number of reasons why nuclear-powered merchant ships are expected to have distinct advantages over conventionally-driven craft.

Two significant reasons may be summarized briefly as follows:

...On long voyages, nuclear ships will be able to carry larger cargoes because their reactors will require less space than conventional oil-burning equipment and fuel tanks.

...Nuclear ships will be able to operate on longer runs at higher sustained speeds than conventional ships.

The Savannah is a single propeller ship with an overall length of 595 feet, 6 inches. She has a molded beam of 78 feet and her design draft is 29 feet, 6 inches when fully loaded. Her normal cruising speed is 20 knots developed with an output of 20,000 shaft horsepower from her nuclear reactor. She is a vessel of advanced design with a raked stem and a modified cruiser stern. The ship will carry 60 passengers, a crew of about 110 and about 10,000 tons of dry cargo.

The Savannah is fitted with six complete decks. Ten main transverse, watertight bulkheads divide the ship into eleven thwart-ship compartments.

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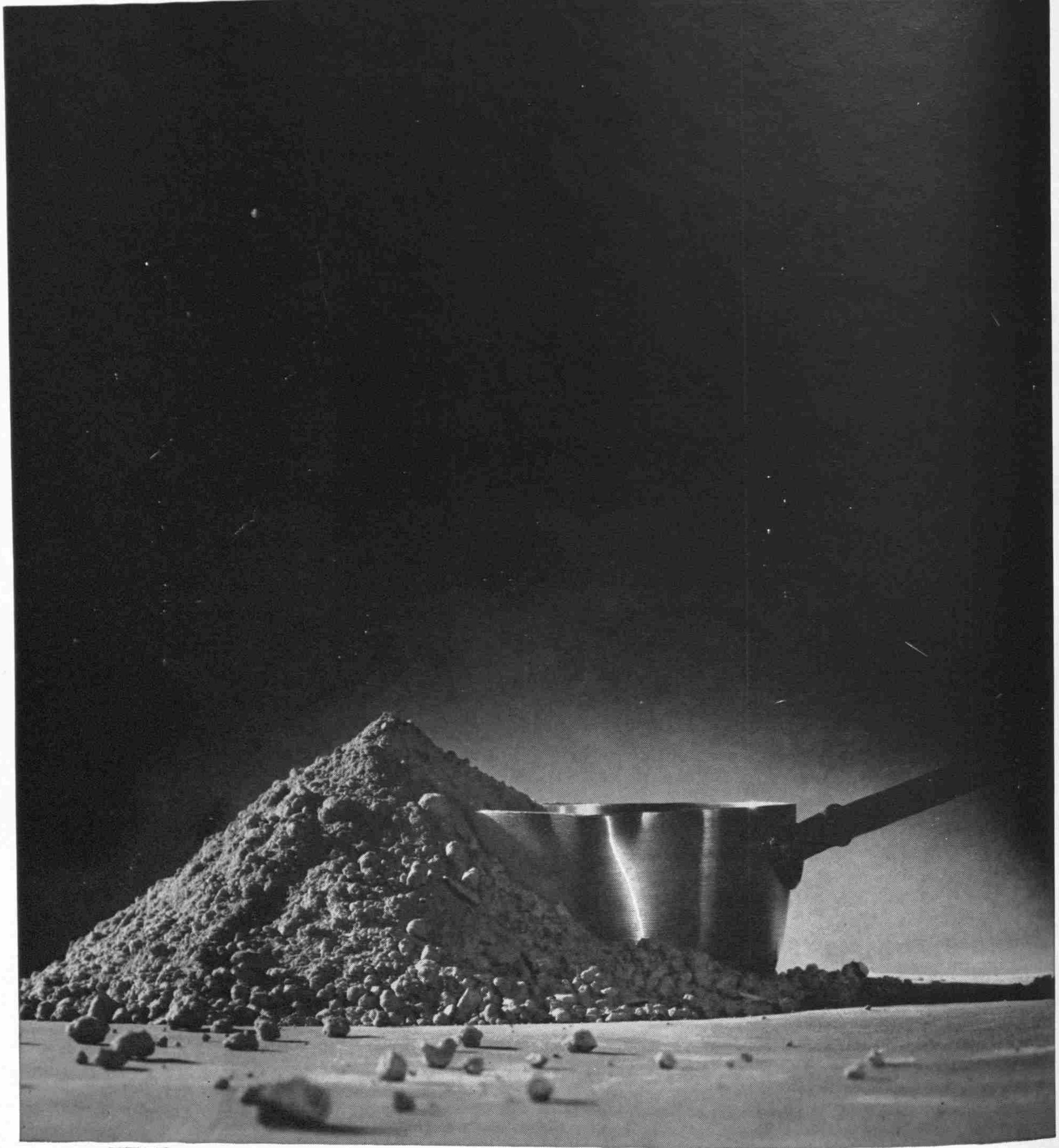

N. S. SAVANNAH

(Continued from page 25)

Navigating Bridge Deck: This, the uppermost deck, serves a dual purpose. The forward end is given over to the pilot house, with the radio room on the starboard side and chart room on the port side, outboard of the gyro and radar equipment room. The balance of the navigating bridge deck includes living quarters for three radio operators and two cadets as well as space for the fan rooms, a battery room and the emergency generator room.

The pilot house is completely outfitted with the latest navigation and communication equipment. Dominating the area is the wheelhouse control console, housing all conventional wheelhouse instrumentation. The magnetic compass is of the reflecting type, the first to be manufactured in this country. On either side of the steering stand are the latest type of navigational radars, the first to use "true motion" presentation of data. Another important unit in the wheelhouse is the control console for the anti-roll stabilizers which are located on the port and starboard sides amidship. The stabilizer fins are operated hydraulically by a gyro system capable of sensing sea conditions and providing the countermeasure for reduction of the roll. Each fin has a lift of approximately 70 tons at 20 knots. Meterological instruments for recording sea water temperature, atmospheric pressure, wind direction and velocity, humidity and air temperature are incorporated into the vessel, making her a veritable floating weather station. A special radio facsimile receiver is designed to receive world-wide weather map transmissions at sea from weather transmission stations throughout the world.

Boat Deck: This, the next uppermost deck, is devoted entirely to officers' accommodations. A specious officers' lounge, located in the after-end, affords observation on either side of the ship as well as aft overlooking the passenger recreation area.

Promenade Deck: This deck is devoted exclusively to public rooms and spaces. A "walk around," the full width of the deck, features a series of high windows permitting an unobstructed, yet sheltered, forward view of the sea. Just behind the promenade deck "walk around" is the main lounge which can be closed off from the adjacent writing room, library and card room by folding screens. A novelty shop is also located on this deck.

The main lounge is equipped with projection machinery for motion pictures as well as for closed circuit television viewing of the reactor space.

The after end of the promenade deck structure includes the veranda and cocktail bar, which, through sliding glass doors, opens onto a swimming pool and an open deck area for the recreational use of passengers.

The dance floor is outlined by tables whose illuminated tops glow by means of "panelescence" lighting.

"A" Deck: Within the hull structure, "A" deck level is assigned to the main lobby, passenger staterooms and accommodations for the purser, steward, doctor and nurse. The ship's hospital and dispensary are also located on this level, as is the health physics laboratory.

Thirty staterooms, each with private bath, accommodate one, two or three passengers each. Some adjoining rooms open up to form suites.

"B" Deck: The dining room on "B" deck will seat approximately 75 people. A huge, parabolic sculptured mural provides a dramatic background at the aft end of the room for the captain's table. Opposite, at the entrance foyer, a small golden model of the original Savannah is suspended in a glass panel.

"C" Deck: A viewing gallery on "C" deck allows visitors to observe the engine room from three sides and to look through the large windows separating the main engine and reactor control room.

The interior design and appointments of the Savannah reflect the finest products of modern American materials, craftsmanship and technology.

Bulkheads or, in less nautical language, the interior walls of the vessel, are surfaced with a variety of maintenance-free materials.

Furniture, incombustible beyond the requirements of the U. S. Coastguard, features steel, aluminum and plastic construction.

Carpets, draperies and upholstery use a maximum of man-made fibers.

All public spaces, living accommodations, medical areas, passages, offices and shops aboard the Savannah are air conditioned.

The vessel is equipped with five elevators—one passenger elevator which operates between the boat deck and "C" deck; two cargo elevators and two stores elevators.

The Savannah has four aluminum lifeboats hung from steel gravity davits. One has a hand-operated propeller, another is motor-propelled and two are oar-propelled. The boats have a capacity of 190 persons.

The ship is equipped with two 12,000-pound Danforth cast-steel bow anchors and one 12,000-pound Danforth cast-steel spare bow anchor. Each bow anchor is furnished with 165 fathoms of 2.5-inch cast-steel stud link chain.

The steering gear is a four-cylinder, electrohydraulic ram type driving the crosshead through a Rapson slide. Two independent power plants are capable of handling the rudder with a maximum torque requirement of about 7,000,000-inch-pounds. The rudder is a balanced, streamline spade type capable of turning 38 degrees port and starboard.

A complete refrigeration system is provided to serve the ship's cooling system of approximately 9,000 cubic feet. Two refrigeration units are provided, each capable of handling the normal sea load.

The Savannah has some of the latest cargo handling gear available. In lieu of the normal kingposts, a tubular rigid frame structure is used for the 10-ton booms. This is the lightest structure yet designed for Ebel-rigged booms. The Ebel rig is a modern method for fast cargo handling. The rig makes it possible for one or two deckhands to unstow and position all booms on the ship for cargo operations in less than an hour; and the shifting of booms from inshore to offshore operation during loading can be accomplished in one or two minutes by the winch operator without moving from his station. An inherent safety condition in this system makes the rig refuse to lift a load if tension in the falls tends to exceed a safe limit.

The Savannah's hull is built on a conventional transverse framing system, except for the inner bottom.

(Continued on page 30)

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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N. S. SAVANNAH

(Continued from page 28)

This inner bottom is "egg crated" below the reactor compartment with transverse floors running crosswise of the ship at every frame, or rib, of the vessel and with a deep vertical keel and many keelsons running in the fore and aft directions.

The great strength thereby provided in the inner bottom assures very high resistance to damage to both ship and reactor in the unlikely event of grounding.

The reactor compartment itself is located amidship between two upright, longitudinal collision bulkheads, or partitions, made of heavy steel. The bulkheads protect each side of the reactor. Between the bulkheads and the hull of the ship, three decks of the vessel offer additional protection from collision. The flooring of each of the decks—B, C, and D—has special, heavier-than-normal steel plating welded to the deck beams for added strength. Inboard of the bulkheads are collision mats made up of alternate layers of inch-thick steel and three-inch redwood for a total mat thickness of 24 inches.

Thus, in the event of a broadside collision opposite the reactor space, the ramming ship would have to penetrate a total of 17 feet of stiffened ship structure, the heavy collision bulkheads and two feet of collision mat before reaching the heavy reactor containment shell, or vessel. This steel containment shell rests in a cradle of steel where its bottom half is surrounded by a four-foot thickness of reinforced concrete. The steel cradle, the concrete and the containment shell itself would also have to be pierced before the actual reactor plant could be damaged.

Protection of the containment complex from ship accidents was studied in detail in establishing the Savannah's design criteria. In particular, ship collisions were carefully reviewed and methods were developed to predict structural damage to vessels struck in collision. On the basis of these studies, the Savannah was designed and constructed to withstand, without damage to the nuclear reactor compartment, any collision with any of the ships making up 99 per cent of the world's merchant fleet.

In case of sinking, provision has been made to allow for automatic flooding of the containment shell of the reactor to prevent its collapse in deep waters. The flooding valves are designed to close upon pressure equalization so that containment integrity will be maintained even after sinking. Salvage connections have been installed to allow containment purging or filling with concrete in case of sinking in shallow water where recovery or immobilization of the reactor plant seems advisable.

Primary radiation shielding around the Savannah reactor consists of a 17-foot high tank of high strength carbon steel located within the containment shell and covered with a layer of lead from two to four inches thick. The tank extends from a point well below the core of the reactor to a point well above it. The tank will permit a wall of water 33 inches thick to surround the reactor and, when filled, constitutes the first line of resistance to radiation from within the reactor.

Surrounding this primary shielding is the heavy steel containment shell already mentioned. The top half of the shell is covered by a six-inch layer of lead plus a six-inch layer of polyethylene, each of which acts as additional radiation protection. The bottom half of the vessel, as indicated above, is surrounded by four feet of concrete shielding which protects against radiation as well as collision.

The containment shell is designed to withstand the greatest possible pressure surge in the event of a "maximum credible accident"—a hypothetical accident postulated in the study of reactor safety. In no credible reactor accident can there be any hazardous release of radioactivity to the surroundings.

Power plant liquid and solid radioactive wastes are collected in tanks for disposal into a specially designed barge in port. The liquid waste collection tanks are equipped with monitoring devices.

Gaseous wastes will normally be disposed of at sea through the radio mast, which contains two detectors for monitoring purposes. The detectors are an air particle monitor and a radio-gas monitor. Both are designed to operate whenever gas is vented to the atmosphere. If radioactivity rises above specified tolerance limits, the gas will be retained until it can be diluted and discharged below established tolerance limits.

All monitors on the N. S. Savannah are intended to operate through a system of channels, with each channel covering a certain range of activity. All detectors are designed to relay their readings to the main control panel in the control room where automatic recording and visual observation instruments are located.

Portable monitoring equipment, similar to conventional health physics survey equipment, is provided for access, survey and maintenance monitoring.

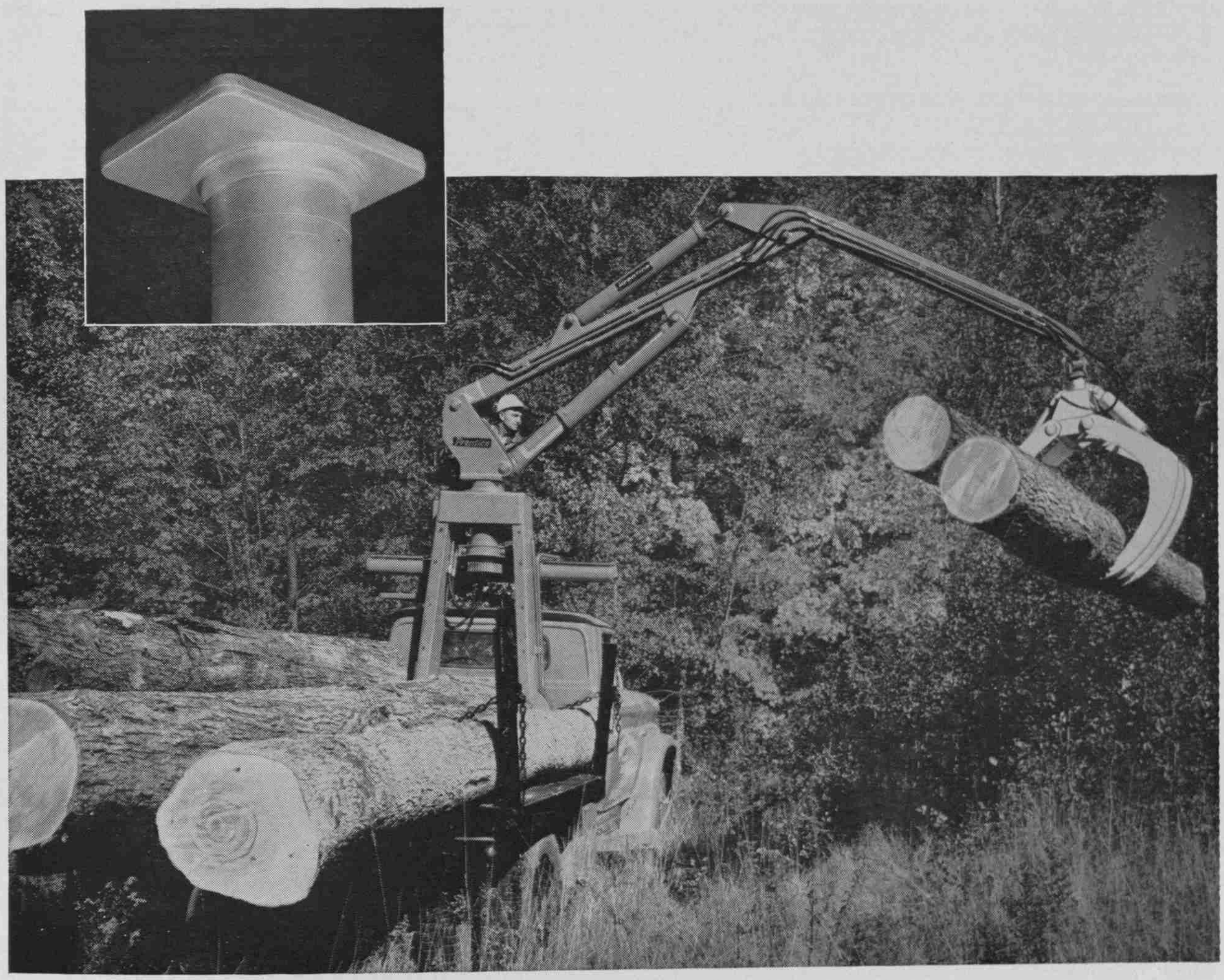
From the standpoint of ship safety, assurance of sufficient power to maintain steerage and maneuverability is the principal requirement of the propulsion plant. To this end, duplication of machinery and power sources on the Savannah has been carried out to the fullest practicable degree.

Two auxiliary 750-kw diesel generator sets are on standby to provide the following: (1) Power to the main bus for operating those loads needed to supply cooling for decay-heat removal after an emergency reactor shutdown; (2) emergency "take-home" power designed to enable the ship to reach port should the nuclear power plant become inoperative; (3) power for reactor startup, and (4) spare generating capacity for normal operation should a turbine generator become inoperative.

In the event of a reactor shutdown these generators will automatically start and synchronize on the main bus bar to supply and distribute power to the components used for reactor cooling.

The 300-kw emergency diesel generator is also available to supply power to the 450-volt emergency switchboard. This source will operate in case both the main turbine generators and auxiliary diesel generators do not. Loads connected to the emergency switchboard include lighting, low speed windings of the primary coolant pumps and power for the emergency cooling system.

A battery protected source will also provide power to those loads that require an especially dependable power source with no interruption due to loss or switching of auxiliary power.



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Why did the designer look to forgings for superior strength and reliability? Because forged parts start with refined metals, uniform throughout. By hot-working this superior stock between precision dies in forging hammers or presses, the structure of the metal is improved even further. That's why forgings offer unique opportunities to improve strength-weight ratios and reduce production costs.

Forged parts withstand the landing impact of jet aircraft, yet are light and strong. They help restrain the tremendous temperatures and pressures involved in modern missile technology; improve the performance of vital automotive parts. Forgings enhance the safety factor of our high-speed world.

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When it's a vital part, design it to be

FORGED

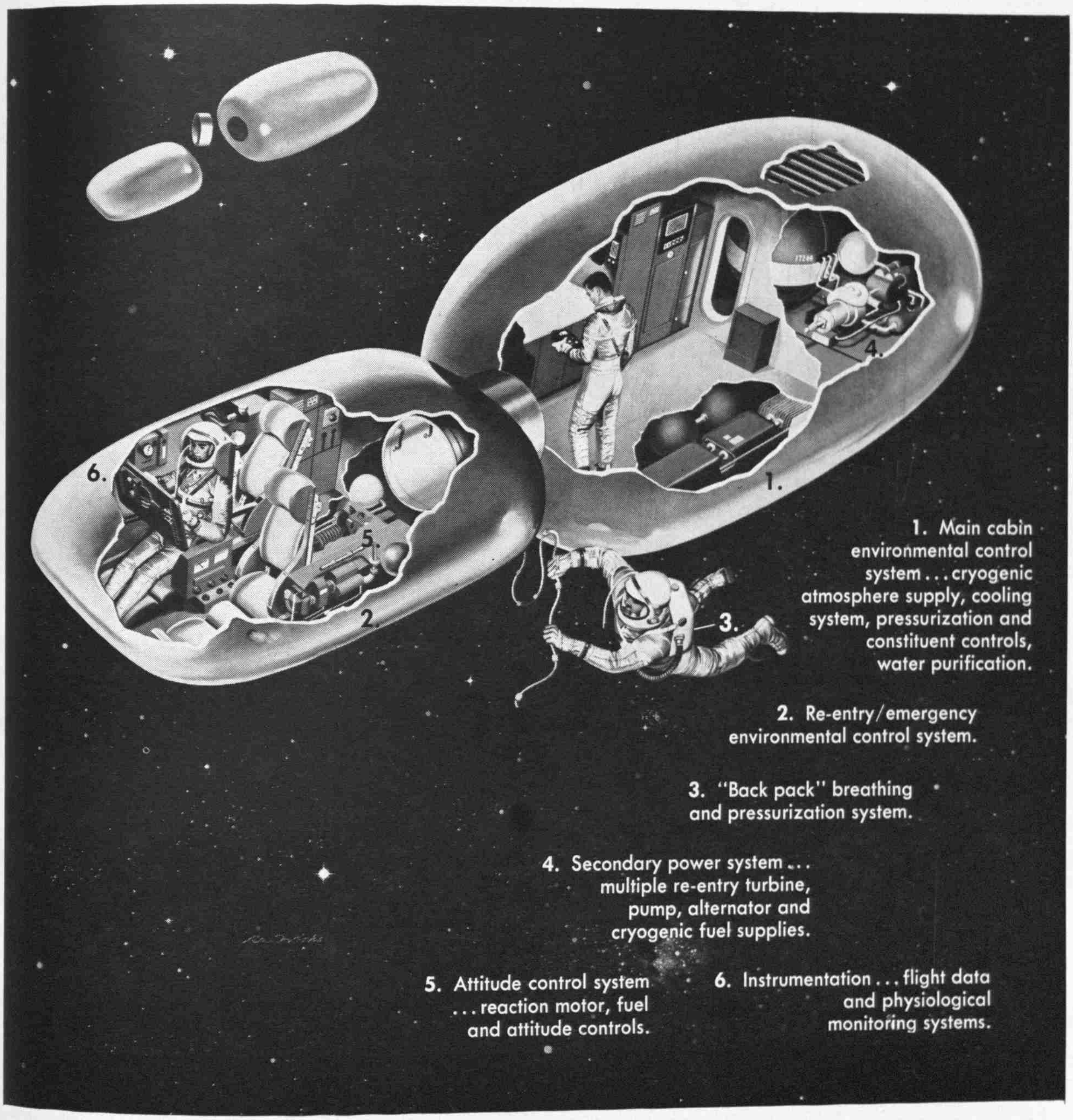
STATICS . . .

(Continued from page 15)

The word "correct" in that last statement means of course correct with respect to the physical model being employed and the mechanics principles assumed to apply. The pragmatic test of these assumptions is the degree to which the engineering analysis based on them is successful in producing usable answers to challenging modern engineering problems. We all know that there are some practically important physical situations where Newtonian mechanics does not apply with sufficient accuracy. For very small particles quantum mechanics must be used. At high velocities, approaching the speed of light, the relativistic corrections of Einstein's Special Theory must be used. When we get into Einstein's General Theory of Relativity we find that the concept of force is not even included. The specialist in mechanics and the advanced engineering student will need to learn something about these theories, but he will still find that Newtonian mechanics is the basis of almost all mechanical problems in engineering even in such exciting new ventures as man's first steps into space.

Does this mean that the first course in mechanics should not change with the times? Not at all. It is already changing, belatedly, I think, in the direction of more emphasis on three dimensions and the use of vector algebra. I believe that the next change should be in the direction of making Engineering Mechanics I, a dynamics course, with statics included only as a special case. This will have the advantage of leading the student to think of Newtonian mechanics as essentially dynamics and will facilitate early allusions to the limitations of Newtonian mechanics. Objections to the change are mainly on the grounds that statics should come first because it is simpler and requires less prerequisite mathematics. For this reason suitable textbooks beginning with dynamics are hard to find. I do not doubt, however, that the change will come, and soon.

These changes, reflecting as they do the greater mathematical maturity of today's engineering student and the greater demands to be placed on the engineering graduate, still leave in the first course in Engineering Mechanics its two most important characteristics, the emphasis on the construction of a physical model and the free-body method. These attributes have earned it praise in the past, and continue to make it the most important foundation course in engineering analysis.



Manned space flight requires reliable and efficient thermal and atmospheric systems plus secondary power equipment. Complete, integrated systems (such as those pictured above) are under study at Garrett's AiResearch Manufacturing Divisions. Their design reflects 20 years of leadership in airborne and space systems, including NASA's Project Mercury life support system.

Other project areas at Garrett include: solar and nuclear power systems for space applications; electronic systems, including centralized flight data computer systems; and small gas turbines for both military and industrial use.

An orientation program lasting several months in diversified areas is available to every newly-graduated engineer to aid in his placement. It includes working on assignment with experienced engineers in laboratory, preliminary design and development projects.

For further information about a career with The Garrett Corporation, write to Mr. G. D. Bradley in Los Angeles.

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Marry not an engineer

Verily I say unto you, marry not an engineer; for the engineer is a strange being possessed by many devices; yea, he speaketh in parables which he calleth formulae, and he wieldeth a big stick which he calleth a slide rule; he hath but one bible — a handbook.

He talketh away of stresses and strains and of no end of thermodynamics; he showeth always a serious aspect and seemeth not to know how to smile; and he picketh his seat on the car by the number of springs therein and not by the damsel thereon. Neither does he know a waterfall except for its power, nor a sunset but for its specific heat.

Always he carrieth books with him, and he entertaineth his maiden with steam tables. Verily, though the damsel expecteth chocolates, when he calleth, he opens the package to reveal samples of a new alloy.

Yea, he holdeth a damsel's hand, but only to measure the friction, and he kisseth only to test viscosity. For in his eye shineth a faraway look which is neither love nor longing, but a vain attempt to remember an equation.

Even as a little boy, he pulleth a girl's hair, but to test its elasticity, and as a man he discovereth different devices, for he would hold a maiden to his bosom only to count the palpitations of her heart, and to reckon the strength of her material.

Alas! His marriage is a simultaneous equation, involving two unknowns and yielding a periodic function.

Anonymous

WHAT'S NEW?

SPEECH BY A DIGITAL COMPUTER

Edited by Dianne Caccamise

A method of producing synthetic speech in response to the typing of phonetic symbols on a keyboard was disclosed at a meeting of the Acoustical Society of America by Doctors John L. Kelly, Jr. and Louis J. Gerstman of Bell Telephone Laboratories.

Dr. Kelly explained that he and Gerstman had recently proposed a "speaking machine" of the tandem resonant type in which novel principles are used. Before actually building it, however, they used a high-speed, general-purpose computer to simulate it.

The computer is programmed to accept in sequence on punched cards the names of the phonetic speech sounds which make up an English sentence. The computer then processes this information the way an actual speaking machine would, and produces an output like the output of the speaking machine.

The program has two parts. One simulates the speaking machine; the other consists of rules for combining the individual speech sounds into connected speech and producing control signals for driving the speaking machine.

Nine control signals corresponding to voice pitch, buzz intensity, hiss intensity, plus the counter frequencies and bandwidths of three speech formats, are continuously generated.

The speech of the simulated talking machine comes out of the computer on digital magnetic tape. It is then converted to a variable magnetic sound track suitable for playing on an ordinary tape recorder.

Dr. Gerstman played tape recordings of the computer "saying" simple sentences in a measured monotone voice. Then he demonstrated more natural inflection and phrasing. This was obtained, he said, by specifying on each punched card, the changes in pitch and timing.

By specifying the pitch of the sounds, he was also able to make the computer sing. He played tape recordings of synthesized singing.

The samples presented are early results of a research project begun by Kelly and Gerstman to obtain a better understanding of the nature of speech. Ultimately this knowledge may be useful in devising new ways of transmitting speech efficiently over communications systems.

For example, a person may, in the near future, be able to sit at a keyboard and by typing, cause a talking machine thousands of miles away to speak for him.

There is also the possibility that talking machines, like the one simulated in the computer, could be built for use by people who are unable to speak.

Also, in the future, a blind person may be able to have a speaking machine read to him from books which have been previously encoded on a punched tape.

Solar radiation beyond the earth's atmosphere can be precisely simulated in environmental space chambers bathed in both visible and invisible light from a bank of carbon arcs. Such chambers should prove invaluable research tools in the earth-bound evaluation of space vehicles and equipment.

The visible light of the carbon arc has long been regarded as man's closest approximation of sunlight, and is widely used in motion picture projection and studio lighting, and in the graphic arts fields of photoengraving and photolithography.

Scientists had assumed that the sun and the carbon arc had identical outputs over the entire range of the spectrum, and this significant correlation has just been confirmed in a series of measurements made in the development laboratories of National Carbon Company, Division of Union Carbide Corporation.

Using a Perkin-Elmer recording spectrophotometer, National Carbon engineers measured the spectral energy distribution of radiation from the carbon arc all the way out to 150,000 angstroms. Data were then plotted on a curve showing the spectral energy distribution of the sun outside the earth's atmosphere from 2,500 to 60,000 angstroms, which includes from 98 to 99 percent of the sun's energy output, and the two curves were found to follow each other very closely over the entire range.

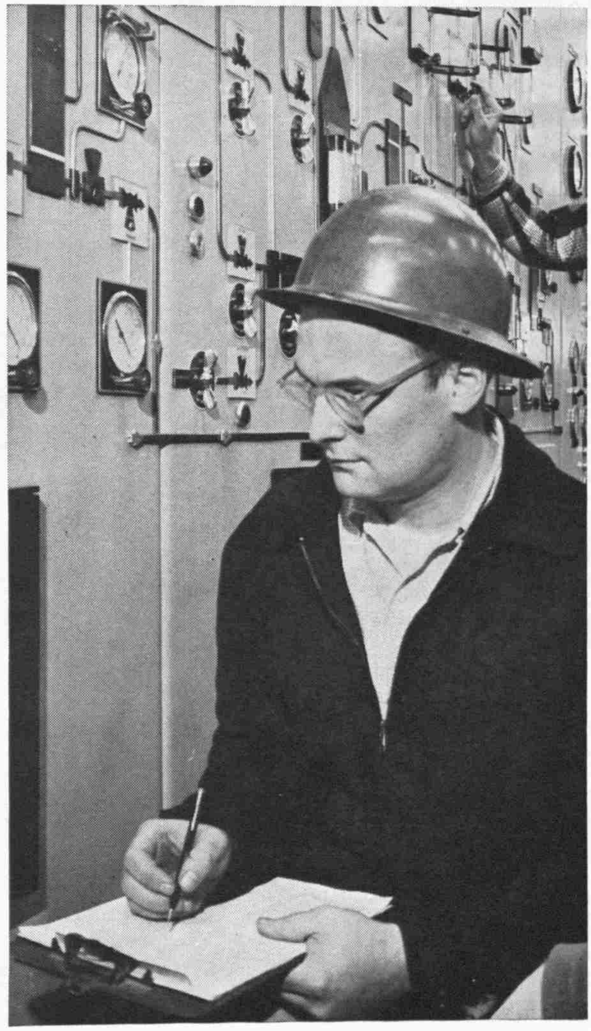
Armed with this scientific confirmation, space equipment designers can now use banks of carbon arcs with no filters or added energy in test chambers to simulate conditions of solar radiation in outer space. Much of the sun's energy is absorbed by the atmosphere, and never reaches the earth. Once space vehicles are above an altitude of approximately 300 miles, however, the atmosphere is so rarified as to absorb none of the sun's energy, and solar radiation becomes a critical factor in the operation of the vehicle, component parts and such devices as solar cells that are used to convert the sun's energy into electrical power for the vehicle.

Solar cell evaluation will be conducted according to specifications developed by the American Institute of Electrical Engineers. The energy standards for such tests are based on Johnson's spectral energy distribution of the sun outside the earth's atmosphere. It is this same curve that National Carbon used as a basis of comparison in determining that the crabon arc matches solar radiation so closely.

According to National Carbon, special techniques have been developed for the continuous operation of the high-intensity arc carbons it manufactures, thus assuring uninterrupted performance in space chamber tests. The space chambers already in operation use carbon arcs, and large chambers now under consideration will undoubtedly also use this high-intensity energy source to simulate solar radiation.

(Continued on page 38)

WHAT? MECHANICAL ENGINEERS IN A CHEMICAL COMPANY?



True, we do employ a number of chemists and chemical engineers at Du Pont. But our need for mechanical engineers is just as urgent. In fact, the ratio of MEs to CHEs at Du Pont is 10:17.

Why? Well, we need mechanical engineers to build new plants, equip and operate them. We need them, too, to design and build equipment and to develop new processes.

Just as important, we need mechanical engineers to help us improve our present manufacturing processes, which are constantly under study. How can we operate more efficiently, more economically? How can we better our products? Mechanical engineers play an important role in supplying the answers.

In a company the size of Du Pont—with annual sales of $2,000,000,000, investment in plant and equipment of another $2,000,000,000 and research expenditures of $90,000,000 a year—there's a wealth of opportunity for the mechanical engineer. Just as there is for engineers of almost every specialty—and for chemists, physicists and mathematicians, too.

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BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

PLASTICS

(Continued from page 21)

for them to cure at room temperature. The savings from using plastic is 91 percent of the previous cost and the plastic has the same service life (40 hours) as the metal had.

Another example of savings by the use of epoxies was reported by Motorola Inc.'s Military Electronics Div. They are casting a pocket size transceiver case from epoxy in an epoxy mold. They saved $1300 over machining from aluminum and the case was produced in half the time required by other methods.

It should be noted that tooling is just one of the many hundreds of uses for plastic and epoxies are but one of the many different kinds of plastics. New and better plastics are being produced and more uses for plastics are being discovered all the time. The efficient engineer should keep abreast of new developments in plastics as well as the other engineering materials and consider plastics carefully when specifying materials. However, the engineer should not let the low initial cost of plastic influence his decision to use them until he has looked at the whole picture for in the long run some other material may be better.

SEDIMENT TRANSPORTATION

(Continued from page 17)

an economy move air was selected as the fluid instead of water. Water requires much heavier construction and a recirculation system.

In order to simulate the roughness of a sand bed, sandpaper is glued on the plastic dunes. But this poses a serious problem: shear measurement techniques on smooth walls are not highly developed, and measurement on rough boundaries is much more difficult. Here questions of this nature arise: "What is the local flow pattern?"; "Where is the instrument?"; or even "Where is the boundary?"! This problem has been handled by extending the surface pitot tube method, the simplest of those in use on smooth walls, to rough boundaries.

A differential manometer, using alcohol (Old Crow) as the gage fluid, and permitting direct readings accurate to 0.001 ft. is used to measure all the pertinent quantities. Pressures measured every foot along the conduit determine the pressure drop, and static pressure distribution on the dune surface is measured through piezometers drilled in the plastic walls. The velocity is determined by use of stagnation and static pitot tubes made from hypodermic needles obtained from the good neighbors over in Giltner Hall. A traverse mechanism has been designed and built to permit accurate probing of an entire dune section by the pitot tubes. The shear forces are determined from stagnation pressures recorded with the tube in contact with the wall and the static pressure on the wall. Noteworthy here is the concept of indirect measurement. Only pressure is measured, and that by the deflection of a column of fluid, yet velocity and shear as well as pressure are determined.

In closing, the overall picture must be brought into focus again. Though the force distribution on one shape of dune may be determined, and may perhaps aid in the development of a deep insight into the movement of sediment, many of the variables were fixed or varied only slightly, and many dune shapes, not to mention other bed forms, remain to be studied. The present investigation is adding to the knowledge of the details of sediment transportation, but how it can help solve the practical problems is not readily apparent. The techniques developed and the knowledge gained should, however, be useful in the next phase which will probably utilize artificially fixed but naturally formed dunes.

The project described in this article is being conducted by Dr. E. M. Laursen, associate professor of Civil Engineering, with the assistance of J. R. Adams and Li-San Hwang, and with the support of the National Science Foundation and the Division of Engineering Research at Michigan State University.

WHAT'S NEW?

(Continued from page 36)

The art of earthmoving is to be greatly improved with the development of a new K-W-Dart tractor and trailer. This "truck" can haul 70 tons of material at speeds up to 30 miles per hour. This is accomplished by using a 12 cylinder, 600 HP turbodiesel engine with a 1468 cu. inch displacement producing 1638 ft. lbs. of torque at 1500 RPM; coupled with a twin torque convertor automatic transmission. A triple reduction rear end is also used for further speed reduction.

This earthmoving giant has a combined tractor trailer weight of 89,000 lbs. To hold up this weight and the weight of the 70 ton payload, 10 tires with 32 ply ratings are used, each holding 85 psi of air.

To turn this "monster" it takes a 3¼ inch hydraulic booster with a 15 inch stroke. It will make a U turn in just 42 feet. As can be seen, this is another advancement in the long line of advancements achieved by the engineers of the earthmoving industry.

HUGE SPACE STRUCTURES

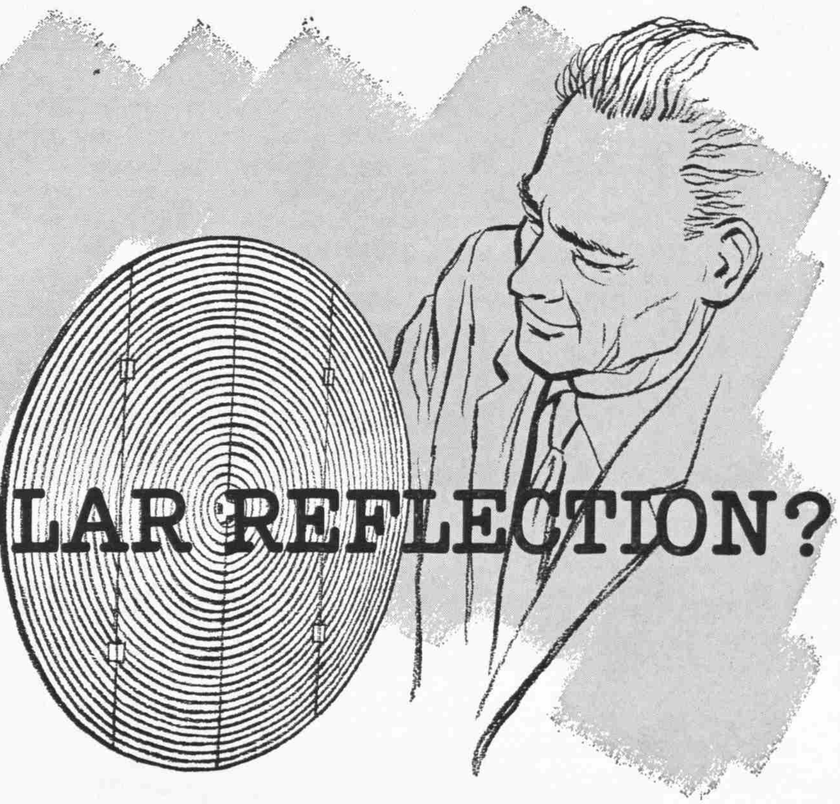
Special "rigidizing" characteristics are being built into fabrics to make them suitable for satellite duty under the extreme conditions of a space environment.

Scientists believe that materials with these tailor-made properties will greatly facilitate the use of giant solar reflectors and balloon-like communications structures—objects which promise to play an important role in the space technology of the future.

Their aim is to create a substance that will remain flexible during the missile trip into orbit, and yet retain the capability of rigidizing automatically when subjected to the space environment.

(Continued on page 40)

Take a new direction in SOLAR REFLECTION?



● That's just what we did at Allison.

Studies indicated that the Fresnel principle could be adapted to an extremely lightweight, foldable solar collector for operation of power systems.

Our researchers went to work, aided by Allison's extensive resources—our physical optics and metallurgical laboratories, American and European consultants, our Scientific Advisory Board and every resource General Motors possesses.

Results—a Fresnel mirror which can collect and concentrate solar energy to run direct conversion systems, Stirling cycle engines, Rankine cycle mercury turbines, solar regenerated fuel cells and numerous other devices which will provide electric power for space missions.

Allison's solar reflector utilizes such significant design characteristics as:

70% less weight than other solar reflectors capable of withstanding the rigors of space for extended periods of time . . .

Strong enough to withstand the severe stresses encountered in rocket blast-off and boost . . .

Can be folded to fit a rocket case during launch, automatically unfolded once orbit is attained . . .

And this is but one example of Allison technology at work. Current research investigations encompass four basic energy conversion systems: open and closed cycle gas turbines, Stirling-cycle engines, direct energy conversion devices and rockets. From this research into solar and nuclear as well as chemical energy will develop many of the primary and auxiliary power systems of the future.

But concepts are constantly changing, and Allison is ever probing new forms of energy conversion in the search for improved forms of propulsion and power. And as the research devices of today become the power systems of the future, Allison will continue its history of pioneering and progress in power.

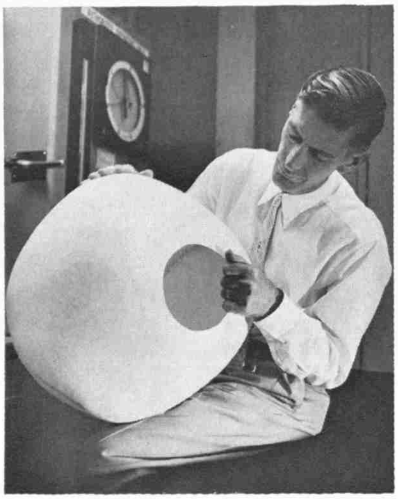
Energy Conversion is Our Business

ALLISON DIVISION GENERAL MOTORS CORPORATION

WHAT'S NEW?

(Continued from page 38)

A large space structure composed of such a material, they reason, could be delivered into orbit in a packaged state with a minimum of bulk and weight —two prime considerations in terms of missile payload.



Once aloft and inflated, the object would soon rigidize and maintain its shape even though it was punctured by meteors, punished by temperature extremes, and exposed to ultraviolet radiation and other cosmic forces. These coatings are applied to the fabrics to impart a "rigidizing" capability and to form a film or barrier in the porous surface of the material so that it can be inflated when used in space structures.

"If all of this liquid is permitted to evaporate from the material, the remaining composition of the coating rigidizes providing the material with structural strength. To investigate these processes, small spheres approximately two feet in diameter have been constructed with our experimental materials and tested under simulated space conditions in a vacuum chamber."

This eventuality, would greatly enhance our capabilities for long-range communications and power generation in space.

CRYOGENIC MAGNET SYSTEM

A cryogenic magnet system, capable of developing a field of 50 kilogauss at —269 degrees C opens an entirely new area of high-field magnet research with possible application in magnetohydrodynamics, thermonuclear fusion, cryogenic devices and other related fields has been marketed by the Westinghouse Electric Corporation.

Development of the superconducting magnet was first announced by Westinghouse in September, 1961. The magnetic field created by the one-pound magnet was twice as strong as that of a conventional iron-core electromagnet weighing 20 tons. In less than three months, scientists have increased the magnetic strength of the magnets from 43 to 60 kilogauss. In addition, the company developed a cryogenic system which is now available to industrial, governmental, and academic laboratories engaged in research in cryogenics, superconductivity, magnetics, plasmas, etc.

The superconducting system consists of coil and its support, a special power supply, gaussmeter, Dewar assembly, helium liquid level indicator and helium transfer tube.

The superconducting magnet contains two miles of wire about the diameter of a sewing thread. The wire is a niobium-zirconium alloy of these two metals. Special techniques were developed to prepare the alloy and take it through the complicated metal processing.

The wire is available in a variety of compositions. It is produced with from 10 to 65 percent zirconium, in standard sizes from 20 to 7½ mil diameters, and several thousand-foot lengths. The wire can be purchased bare or insulated.

The commercially available superconducting coil, or solenoid, is approximately three inches in diameter, three inches long, and produces a 50,000 gauss magnetic field within the ½ inch inside diameter.

The coil is then immersed in a vessel of liquid helium which keeps it at a temperature near 269 degrees C below zero. The energy required to cool the coil is only a small fraction of that needed to create a comparable magnetic field with a standard electromagnet. Essentially, therefore, the magnet produces almost all of its super-magnetism "for free."

A transistorized power supply furnishes constant current, low ripple d.c. power for use with superconducting magnetic coils. The portable unit is designed for less than 0.1 percent regulation from no-load to full-load with an input voltage variation from 105 to 125 volts a.c.

Unique protective features are incorporated to prevent damage to the power supply or to the superconducting magnet.

For example, if the load current increases at a rate greater than 4 amperes per second, or if the output voltage increases at a rate greater than 0.1 volts per second, the power output current is reduced to zero.

Furthermore, provision is made to reduce the output current to zero when the liquid helium reaches a predetermined low level. A dumping circuit is provided in the power supply to dissipate a portion of the energy stored in the magnet in the event it goes into normal conduction range. In addition, a thermal detector and a time-delay relay are used to prevent internal damage to the power supply.

Another feature is that the power supply is programmed to increase or decrease the output current linearly to any preselected current up to 25 amperes maximum in a finite time.

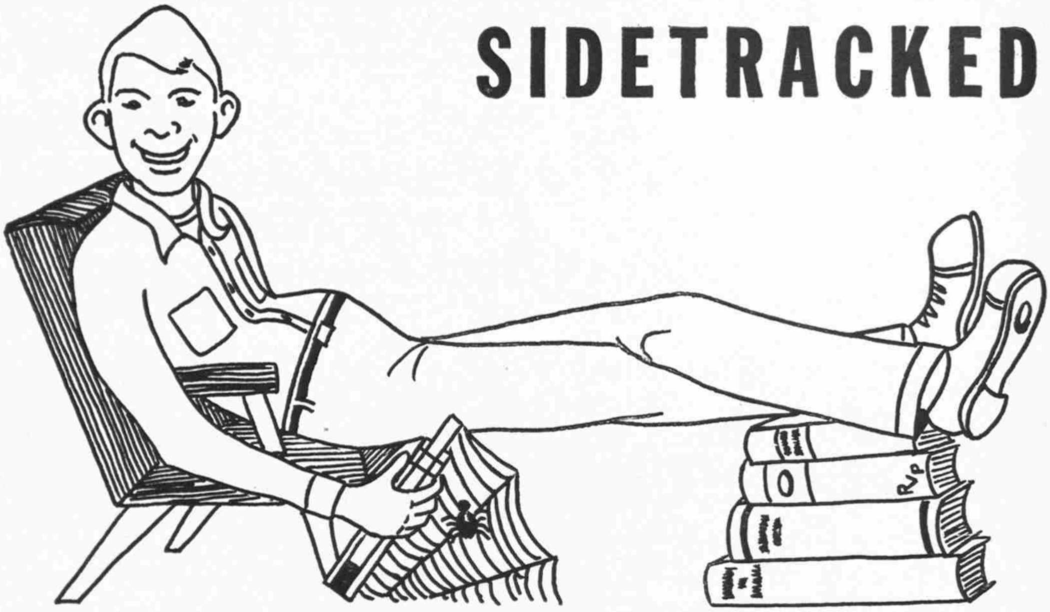
A single power supply can be used as a "master" supply to program simultaneously up to 10 other similar power supplies in parallel by a simple connection. The result, a versatile power supply package that can be applied to the more complicated segmented magnet coil designs. Such an arrangement is necessary to provide the optimum coil design for the user.

The Dewar (cold retaining bottle) was developed to maintain the cryogenic environment necessary to operate the superconducting magnet. The vessel container consists of two concentric cylinders with the helium contained in the inner space. The air space between the two cylinders is evacuated, and then the entire unit is immersed in liquid nitrogen in a thermally jacketed container. The liquid nitrogen maintains the temperature around the double-walled helium container at —196 degrees C. A final stainless steel jacket surrounds the liquid nitrogen container which is evacuated and sealed at the factory. This outer vacuum chamber contains activated charcoal at the base to collect residual gases that might accumulate. The helium chamber is provided with a pump-down fitting. Both the nitrogen and helium chambers can be vented to the atmosphere.

The efficiency of this container, which is more than fifteen times better

(Continued on page 44)

SIDETRACKED



The car sped off the highway, went through the guard rail, rolled down a cliff, bounced off a tree, and finally shuddered to a stop.

A passing motorist who had witnessed the entire accident helped the miraculously unharmed driver out of the wreck.

"Good Lord, mister," he gasped, "are you drunk?"

"Of course," replied the man. "What do you think I am—a stunt driver?"

The Russian school teacher asked a pupil who the first humans were.

"Adam and Eve," the kid replied.

"And what nationality were they?"

"Russian, of course," said the kid.

"And how do you know?" asked the teacher.

"Easy," the kid replied. "They had no roof over their heads, no clothes to wear, and only one apple between the two of them—and they called it Paradise!"

A German was the guest of a Frenchman who asked him how they distinguish between an optimist and a pessimist in Germany.

"It's very simple," replied the German. "The optimists are learning English and the pessimists are learning Russian."

Two producers were watching the star of a Broadway play. "I wonder who made her dress," said one of them admiringly.

"It's hard to say," answered the other, "probably the police."

"How did you puncture that tire?"

"Ran over a milk bottle."

"Didn't you see it?"

"Naw, the kid had it under his coat."

Frosh: "A woman's greatest attraction is her hair."

Soph: "I say it's her eyes."

Jr.: "It's unquestionably her teeth."

Sr.: "What's the use of sitting around lying to each other?"

Professor (rapping on desk during class): "Order."

Student: "Bourbon and Soda."

Jim: "Do you neck?"

Mary Ann: "That's my business."

Jim: "Ah, at last—a professional."

Customer: "Your dog seems very fond of watching you cut hair."

Barber: "Naw, it's just that once in a while I snip off part of the customer's ear."

"Now," said the professor cheerfully, "please pass all your test papers to the side of the room and kindly insert a carbon sheet under each paper so that I can correct all the errors at once."

A husband answering the phone: "How do I know? Why don't you call the weather bureau?"

"Who was that?" asked his wife.

"Some fool wanted to know if the coast was clear."

Two men and a young lady on the pullman going to New York decided they had better get acquainted.

One man said: "My name is Peter, but I'm not a saint."

The other man said: "My name is Paul, but I'm not an apostle."

The girl muttered: "My name is Mary and I don't know what to say."

And then there was the inebriated EE who was arrested for feeding the squirrels in the park. He was feeding them to the lions.

I never kiss, I never neck.
I never say Hell, I never say heck.
I'm always good, I'm always nice.
I play no poker, I play no dice.
I never drink, I never flirt.
I never gossip or spread the dirt.
I have no lines or funny tricks,
But what THE HELL . . .
I'm only six.

Found on fall registration card of freshman engineering student: NAME OF PARENTS—Mommy and Daddy.

A bosom companion sometimes turns out to be a false friend.

WHAT'S NEW?

(Continued from page 40)

than conventional containers, resulted from a detailed analysis of the factors involved in the flow of heat into liquid helium containing vessels. The present container holds 7½ litters (approximately two gallons).

Input power to the liquid helium level gauge is 115 volts, 60 cycles. This gauge continuously measures the liquid level in a helium Dewar from 5 to 23 inches. The level is indicated on a six-inch scale meter. The sensing element is connected by a coaxial cable to the control cabinet containing a meter and limit relay.

To warn of low helium level and to turn off heat-producing apparatus, a signal limit contact at zero reading may be used. After setting, the zero and full-scale indications remain accurate to plus and minus 1/32 inch of helium level.

The gaussmeter is part of the superconducting system. It is an instrument to provide accurate magnetic intensity measurements.

Ever hear a speech or music in an auditorium that didn't exist?

At Bell Telephone Laboratories, the head of an acoustics research group, Dr. M. R. Schroeder, has been doing just that.

He's been using an electronic computer to simulate what happens to sound waves when they bounce back and forth in imaginary rooms.

With his method, a room can be evalued, modifications studied, and a final satisfactory architectural plan adopted, all before construction is actually started.

Beginning with an architectural plan drawing of a proposed concert hall, a point on the stage is selected and then major paths that sound waves would take between this source and a typical seat in the audience is drawn. Both one-bounce and multi-bounce reflections from the walls and ceiling, as well as a direct path is drawn.

The time it takes a sound impulse to travel over these various paths from source to listener is calculated and reverberation time of the hall is computed. Reverberation time is the time it takes a sound in bouncing back and forth between the walls to be absorbed and fade away to one millionth of its original intensity.

The information is stored in the computer, along with a program which instructs the computer to treat any sound which is put into the computer the same way the auditorium would treat the sound on its way between the source on the stage and the listener's ears. Then a sample of speech or music is recorded on digital magnetic tape.

The computer acts on these sounds just as the floor, walls, ceiling, etc., of the auditorium would and produces an output tape, also in digital form. The output tape is then fed to another machine which converts the digital information into an analog multitrack sound tape suitable for playing on a multichannel tape recorder playback. This tape is played over several loudspeakers in a free-space room which doesn't add echoes and reverberations of its own. The sound has the necessary echo delay amplitude variations and directionality to give a good stereophonic resemblance to an actual hall.

The listener decides, on the basis of what he hears, whether the simulated room has good or bad acoustics. By changing the computer program the acoustic characteristics of the simulated hall can be modified.

In addition to designing new concert halls, computer simulation can be used to improve the acoustics of existing halls. The computer can be programmed to simulate the effect of minor architectural changes on the acoustic characteristics of the hall. The tape from the computer is played over loudspeakers set up in the hall and the proposed changes evaluated before renovations are begun.

ADVERTISER'S INDEX

Kodak beyond the snapshot...

(random notes)

Deep in lacquer

That our name is never seen on a can of lacquer doesn't mean we aren't in it pretty deep.

Our newest cellulose ester for the lacquer formulators has the butyrylated, acetylated cellulose chains running much shorter than heretofore. This results in higher solubility, which means less solvent needed. It also means poorer film strength, but that's OK. A butylated urea-formaldehyde resin, included at the right proportions in the formulation along with the proper catalyst, will cross-link to the cellulose acetate butyrate during the drying of the coating. To provide a point of attachment on the cellulose chain, we restore one out of 12 of its hydroxyls. This condenses with the butoxy groups of the butylated urea-formaldehyde polymer to split out butyl alcohol.

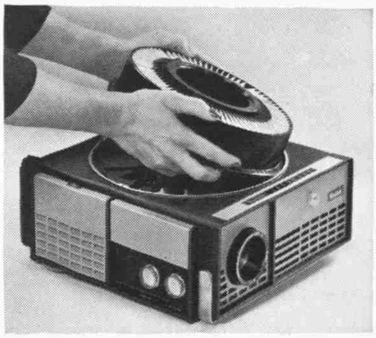
Thus the short chains that are more soluble in the can become very much less soluble in the finish of a table on which some gay dog has set down the cup that cheers. No longer need a drop of lotion spilled on the dresser trouble the conscience of a good woman.

In these days of epoxies, silicones, methacrylates, polyesters, etc., why do we monkey with cellulose? What a silly question!

For one thing, we have shown how admixture of cellulose acetate butyrate can improve them all.

For another, cellulose is by far the world's most abundant high polymer. It is formed by sunshine.

The happy eye



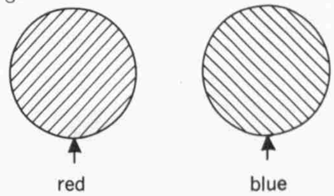
This is the *Kodak Carousel projector.* It projects slides. Carousels symbolize carefree abandon. Care lest slides jam can be abandoned. Gravity feeds them. Gentle gravity. Slides are automatically lifted back to 80-slide storage tray. Pushbuttons at end of long cord advance slides, reverse, even refocus. (Latter is largely for kicks. Slides get prewarmed not to pop out of focus.) See Kodak dealer for exact price.

First, though, consider the picture below. It's an experimental viewing device. An image is projected on a translucent screen. No matter how sharp the original picture, the simple machinery behind the screen can *always* improve the sharpness. It integrates out optical noise. It also makes the screen more pleasant to stare at. Some very purposeful staring is being done today.

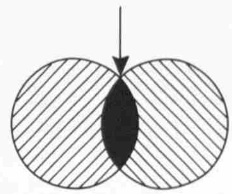
Our long research on human vision has more than happy-time slides in mind.

Overlap in black

What would you say to a photographic paper that comes out red or blue—depending on the color of the exposing light.



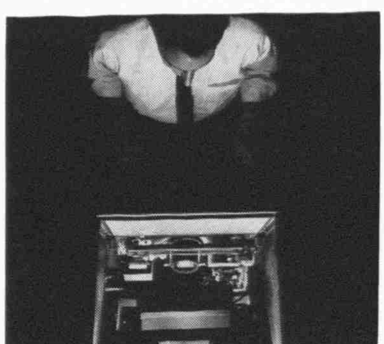
and black where they overlap?



We are currently advertising around in various technical journals like *Geophysics, Materials Research and Standards,* etc. to ask if anybody would be interested in buying some rolls of paper like that for experimentation. It might be useful in interpreting the readings of certain kinds of instruments. You never know till you ask.

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

CELLULOSE TECHNOLOGY NEEDS GOOD PEOPLE



VISUAL ENGINEERING NEEDS GOOD PEOPLE

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TRADEMARK

One of a series . . .

Interview with General Electric's Dr. J. H. Hollomon
Manager—General Engineering Laboratory

Society Has New Needs and Wants—Plan Your Career Accordingly

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

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

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

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

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

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

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

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

Q. Could you give us some examples?

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

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

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

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

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

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

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

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

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

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