Spartan Engineer

What Makes the MANIAC Tick?

Engineers Can Write Better Technical Reports

A Building Full of Knowledge

MSU Hosts Tau Beta Pi

The Roots of Automation

OLUME 9 NUMBER 1 NOVEMBER, 1955 PRICE 25c

John W. Hirt, Class of '49
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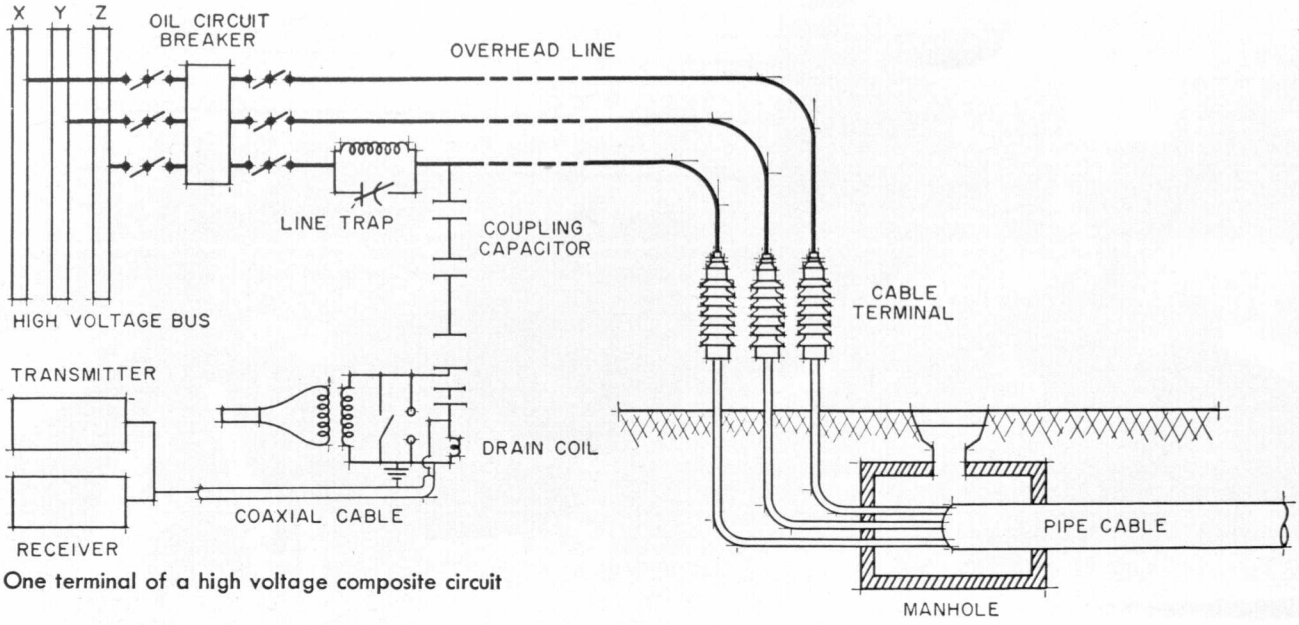

One terminal of a high voltage composite circuit

HERE'S A PROBLEM FOR ELECTRICAL ENGINEERS

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Spartan Engineer

of michigan state university

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ARCHITECT'S DRAWING OF M.S.U.'s NEW LIBRARY
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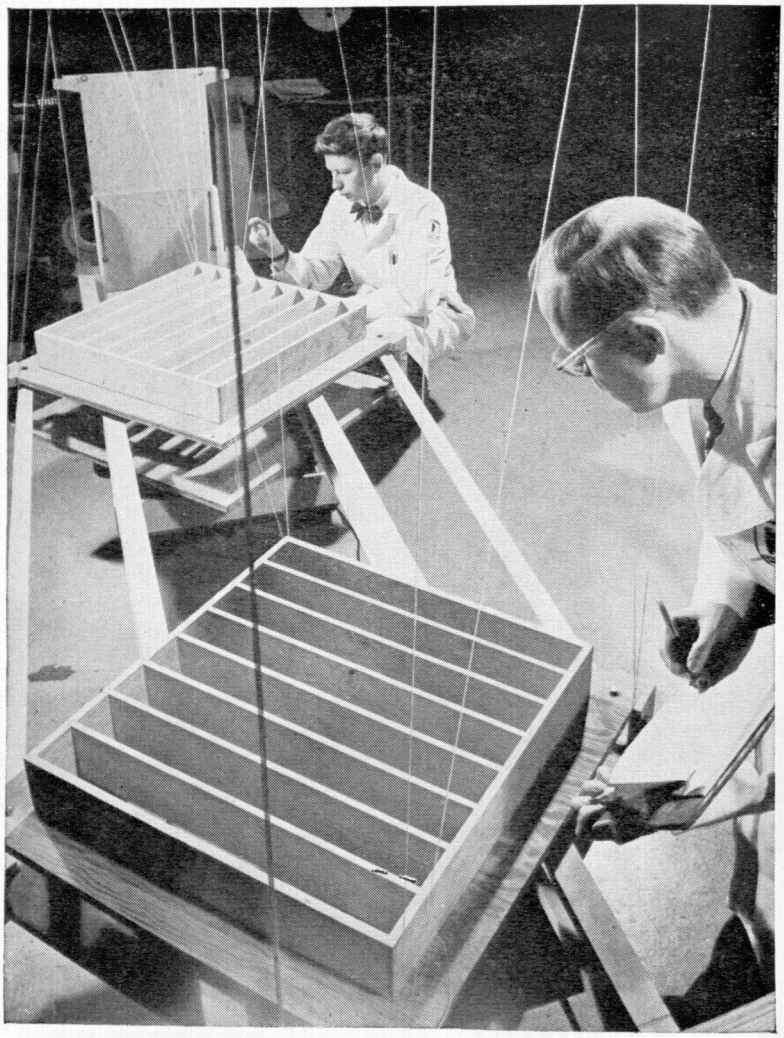
A highly unusual application of industrial mathematics. This string-suspended structure is a mechanical analogue of a differential equation illustrating a theory of why automobile brakes squeal. The engineers are observing the period of oscillation set up by an air stream blowing up through the vaned members to obtain values for substituting in the equation.



GM engineers in action

LOTS OF TIMES an engineer must interpret an ordinary problem in an unusual way to get the best results—as these General Motors engineers are doing.

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GENERAL MOTORS

Personnel Staff, Detroit 2, Michigan

Editorial

Symbolism is a peculiar but powerful entity. We identify and respect large corporations by their trademarks. That trademark becomes more than just a material design itself. It grows to the point that to sever it from the company would inflict great damage to that company.

Colleges also become symbolized in accordance with what they stand for. A football team, or the high intellect in some special field of endeavor displayed by its graduates becomes symbolic of that school. The latter is the case of many famed engineering schools.

Yours truly had the opportunity to attend a conference of the Engineering College Magazines Association at the University of Nebraska this fall at which time the Spartan Engineer became a member of this unique journalistic association. Only the finest belong. It becomes, then, an honorable symbol of our school.

Of the thirty-five schools represented, nearly every well known engineering school in the country was included. They all had one characteristic in common. A fine engineering journal published on campus. The best magazines came from the most respected schools. It demonstrated the students there had the stuff to earn the reputation they held. An outsider knows the students can apply themselves to prove their worth and that of the school. Every student has an interest and many spend long hours proving their concern. The students must supplement the work of the college to earn their reputation.

The Spartan Engineer and Michigan State University have been thrown in with this lot to compete. The nature of our reputation can be partly determined from your effort toward the betterment of your magazine.

WHAT MAKES TANIAC TICK ?

by R. L. Reaser, R. W. Lenhardt

Computers of all types are in extensive use today. They are becoming almost a necessity in business as well as Engineering work. Business machines start with the everyday adding machine, run through comptometers and up to the automatic billing and other large and complex accounting machines. Engineering machines range from the simple though invaluable slide rule, through the automatic fire control system, to the very large and expensive machines such as the Harvard Mark I Calculater.

The Electrical Engineering Department here at Michigan State recently purchased a Boeing Electronic Analog Computer which, with accessories, is valued at almost $10,000.00.

The purpose of this article is to give a general discussion of computers, and a more detailed presentation of a particular example to show the operation. By way of introduction for the newcomer, into the field of computing devices the history and classification of these devices is discussed.

To introduce more detailed concepts of analog computation, a discussion will follow of the basic elements of the operational amplifier analog computer. The Electrical Engineering Department's computer, which you have probably seen at the Engineering Exposition, is of this type.

In 1925 Network analyzers were produced which could simulate large power systems. These machines, which were built mostly by the General Electric and Westinghouse Companies, were the first of the modern electronic analog computers. During the second world war Harvard University, in cooperation with IBM, built the Harvard Mark I Calculator. This machine was capable of memory in solving problems by using the familiar system of punched cards. Rapidly following the Mark I were the completely electronic digital computers such as ENIAC, the SWAC, the MANIAC, etc.

Also, almost at the time of the Second World War, Philbrick and Lovell independently discovered the operational amplifier. The introduction of the operational amplifier has made possible the newest class of general purpose analog computer. Some of this type are the BOEING, EASE, GEDA and REAC.

In the previous discussion there are several types of computers mentioned. Generally they can be classified in two groups. These are, the digital computer and the analog computer.

The digital computer deals exclusively with numbers. It is essentially a summer and solves more complex problems, such as solution to differential equations, by repeated refining of an approximation. They may be further subdivided into mechanical, electrical and combinations of the two. The mechanical uses gear teeth as digits, while the electronic uses electrical pulses. A hybrid class uses a combination of the two, generally employing relays.

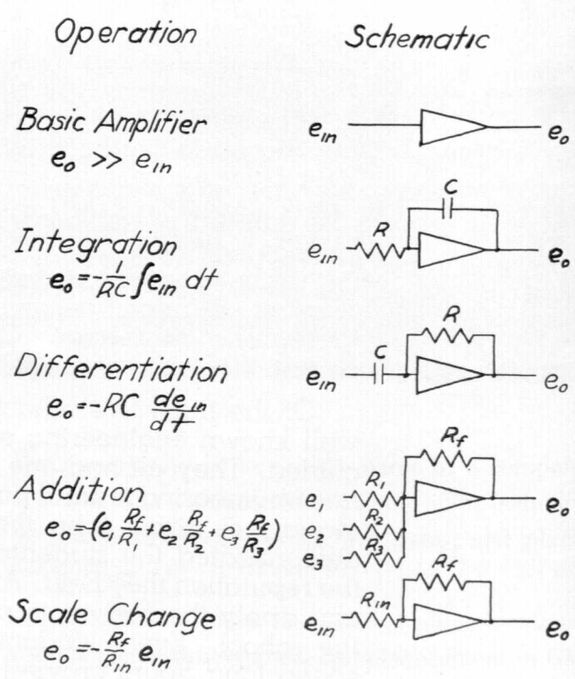

Fig. One

Analog computers deal with continuous physical variables using shaft rotations in the mechanical devices and voltage fluctuations in electrical devices to represent the variables. They may be broken down into the direct and the indirect types. The direct types represent the system itself, such as scale models or equivalent circuits, while the indirect type solves the equations of the system under study.

The indirect type is the one which we will be dealing with from this point on. The more exact name for the computer of which we will talk is the Operational Amplifier Type Differential Analyzer

As mentioned before, the analog computer deals with continuous physical variables. In our case, it will be voltages. These voltages can be made to respond according to various mathematical operations by the nature of the circuit in which they are used. It is through the use of this property that differential equations can be solved.

Before it can be shown how equations are solved it will be necessary to explain the basic component of the machine, the operational amplifier. With proper feed back connections this unit can be made to add, integrate, differentiate or change the sign of the voltage impressed upon it.

There are three properties of the amplifier which account for its unusual ability. First, it is a D.C. amplifier. Second, it has a very high gain. Third, it operates class A. It will be represented by the symbol in Figure 1-a (where K equals the gain). Figure 1-b is the connection used for integration. Applying Kirchoff's current law to the node number I we obtain.

$$\frac{e_{in}-e_g}{R} = \frac{-Cd(e_o-e_g)}{dt}$$

This assumes class A operation in which no grid current flows. But,

$$e_g = \frac{e_o}{K}$$

and because

$$K >> e_o,\ e_g \doteq 0$$

Hence,

$$\frac{e_{in}}{R} = -C\frac{de_o}{dt} \quad \text{or} \quad e_o = \frac{-1}{RC}\int e_{in}\,dt$$

Figures 1-c, 1-d and 1-e show the circuits used to differentiate, add, and multiply by a constant (scale change). The equations for these circuits are derived in a manner similar to the integrator just done. Note that the output of all these circuits is the negative of the input. This is because an odd number of stages was used in the amplifier. Sometimes it is necessary to change the sign of a voltage. A Scale with a unity ratio is used for this purpose. Some times more than one of these operations can be combined into one amplifier.

For simplicity, from now on I'll use a box symbol and put on it the operations it performs, now we will demonstrate how a simple problem can be represented and solved by the computer. The differential equation of a system is:

$$My'' = F(t) - K_{11}y$$

Where M is the mass, K.. is the spring constant and F(t) is some forcing function applied. This equation states that the summation of terms on the right hand side of the equation should equal the mass times the second derivative of y. Thus, if these terms are available at the input of an adder then the output will be My. This output may then be integrated twice to obtain y, and with the correct scaling factors the appropriate inputs for the adder will be obtained. The forcing function F(t) may be a perfectly arbitrary function of time so long as it is possible to generate it as an electrical voltage.

We can get a more complicated problem if we consider torsion in a spring. When it is elongated there will also be a slight resultant twist. By the same reasoning there will also be an elongation due to an applied torque.

There will now be two equations for this system: On translational and the other torsional. They are:

$$My'' = F(t) - (K''y \quad K1_2\Theta)$$

$$I\Theta \doteq T(t) - (K_{21}y \quad K_{22}\Theta)$$

Where $K_{12} = K_{21}$ = mutual spring constant. Notice the similarity between the first equation and that which was just worked out. All that is missing is a $-K_{12}$ O to be added to the summer.

The second system is similar to the first except that a different variable is used. We say they are analogous. Now we need to relate the two systems. This is done in the equation through the mutual constants. We now have the complete solution to the system and can find out the value of any one of these quantities at any time T by measuring the appropriate voltage at that time.

(Continued on page 40)

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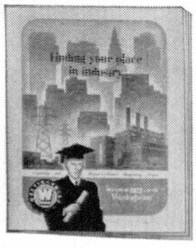

ENGINEERS . . .

can write better technical reports

by JOHN KENT, Chief,
Editorial Bureau, Consolidated Engineering Corp.,
Pasadena, California

Editor's Note: We have reprinted this article from Chemical and Engineering News, January 31, 1955, in the belief that it may aid some of our readers in preparing technical reports.

You, as a chemist or engineer, can improve your technical reports by adopting methods used by professional writers. Failure to do so may result in injustice to yourself and to your career.

Since your writing is judged by the same criteria as that of the professional writer, you must use the same methods to get comparable results. Some of these methods are really the writers' "tricks of the trade." One is the use of short sentences.

The short sentence is probably the greatest help to understandable writing. It permits spacing of ideas. Ideally, each sentence should be limited to one thought. Very often, however, simple sentences are incapable of communicating complete thoughts. Sentences become longer as modifying and qualifying words are introduced and as relationships between subject and thought are developed.

As sentences become longer. relationships between words become less clear. Such sentences are harder to understand and may require rereading. They often lead to errors in grammar. Consequently, long sentences must be watched.

During recent years researchers have come up with a "readibilty formula" or criterion. The formula shows that when average length of sentences runs over 20 words, thoughts become difficult to understand.

Here is a standard in terms of words per average sentence:

Under 10—East to read
15—Fairly easy
20—Standard
25—Difficult
Over 30—Very difficult

Here is how you can measure the readability of your writing. Pick several blocks of seven sentences at random throughout your manuscript. Average the sentence lenghts of each block of seven; then average the average of each block.

Remember this: A sentence of over 25 words generally can be cut into two short ones. After several long sentences, insert a short one to act as a "rest" for the mind. Aim to get more sentences into the easily grasped 10-to 15-word length.

There's another reason why technical people in particular should write short sentences. In ordinary writing, shorter words can be substituted to help the reader understand. Generally, technical words cannot be simplified. Short sentences can compensate for this limitation.

Here's an example:

Technical sentence:

"Corrosion damage was not distributed uniformly on the tube surface but was concentrated at random locations."

Newspaper sentence:

"A 14-year old boy was arrested last night while he was robbing a jewelry store."

Both sentences have 16 words. But the technical sentence has 92 letters in its 16 words, the newspaper sentence only 63 letters. Short common words will help keep the letter-count down. Some technical people have trouble here.

Because of misplaced deference to convention, many empty, bookish, formalistic, and legalistic words and phrases creep into our speech and writing. Most of them can be called "non-working" words. Cull them and substitute "action" words. Here are a few examples:

Avoid	*Use instead*
with respect to	for, about
effectuate	carry out
ascertain	find out, learn
for the purpose of	for
in the nature of	like
in view of the fact of	because, since
presently	now
along the lines of	like
subsequent to	for, after
avail yourself	use

Many technical people are troubled over paragraphing. What should a paragraph include? When do you begin a new paragraph? In modern usage, paragraphs are becoming shorter. In newspapers, for example, almost every sentence is a paragraph.

In technical reports, paragraphs should be well constructed. The first sentence of a good paragraph

(Continued on page 32)

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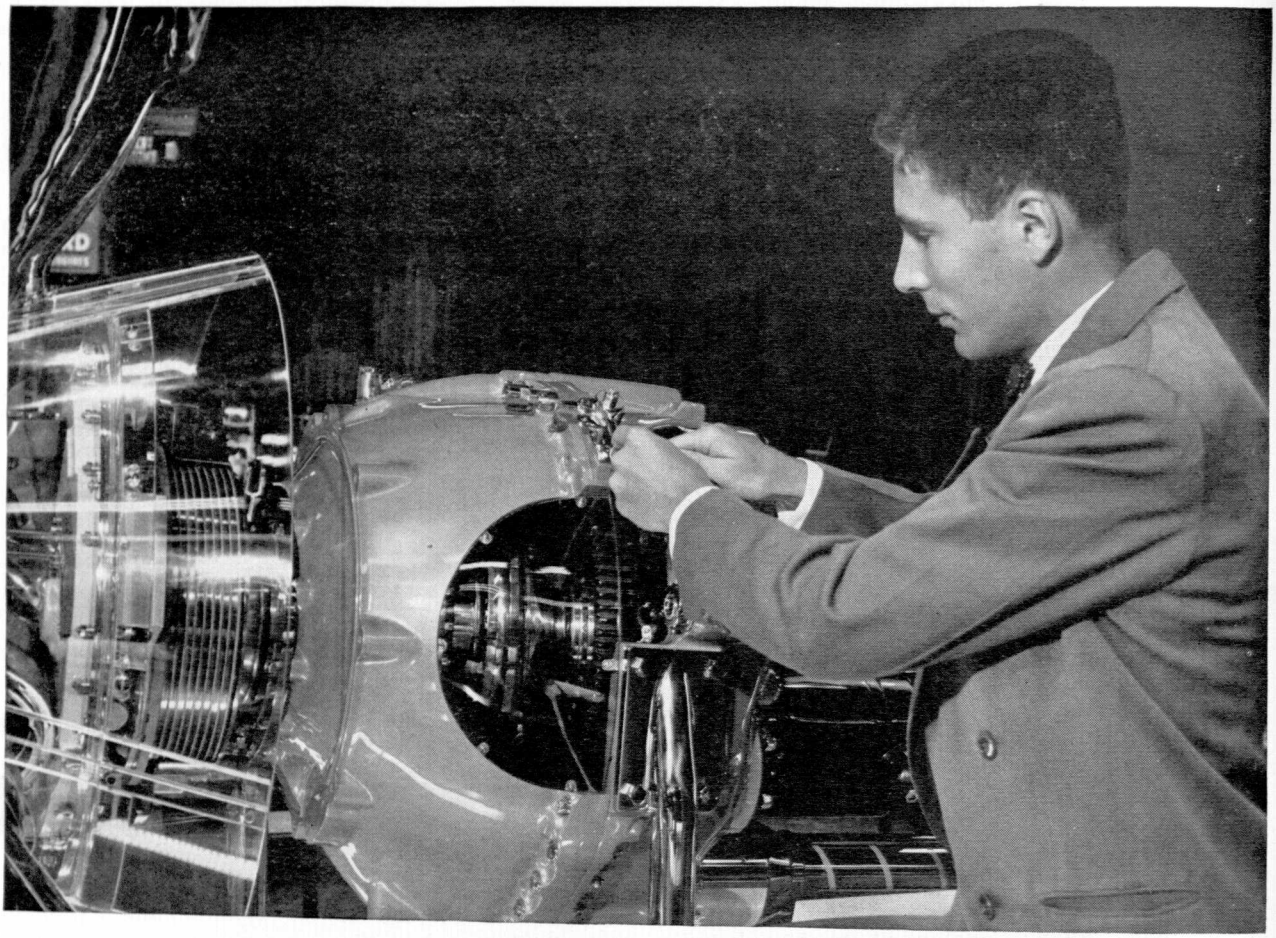


DIVERSITY of technical skills required by Allison in the design, development and production of turbo-jet and turbo-prop engines offers a wide range of opportunities to young graduate engineers.

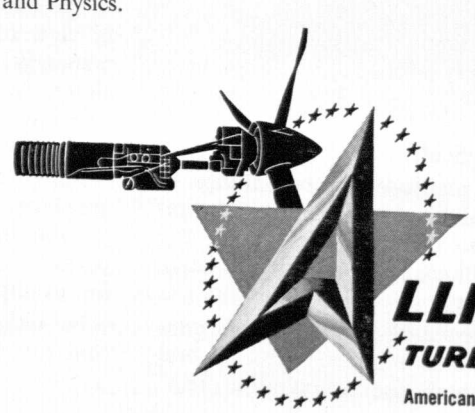
And, the Advanced Educational Facilities help the young graduate find the work best suited to his academic training and liking.

For instance, there's Wayne McIntire (above) Mechanical Engineer, Purdue University, who came to Allison upon graduation in 1950. After completing the training program, Wayne now is doing the kind of work he wanted, and is technically qualified to handle. He is Project Engineer, mechanical design of gea r boxes. He is shown making an adjustment on the propeller linkage control on the cutaway model of the Allison T56 aircraft engine. This, incidentally, is America's first production turbo-prop engine, and is used in the Lockheed C-130 Hercules, a 54-ton transport. The Allison Model 501, which is the commercial version of the military T56, is the powerful turbo-prop engine proposed for commercial airline use.

In his present job, Wayne works on initial design . . . helps decide what components—such as propeller brakes, accessory drives, oil pumps, etc.—are needed for the specific project.

The nature of Allison business continually presents a variety of interesting and challenging problems to the engineering staff, which—along with the Mechanical, Aeronautical, Electrical, Metallurgical, Chemical and Industrial Engineers—includes majors in Mathematics and Physics.

We'll welcome the opportunity of telling you more about the Allison Advanced Educational Facilities, and the benefits and advantages which can be yours at Allison. Arrange for an early interview with our representative when he visits your campus, or write for information about the possibilities of YOUR engineering career at Allison: R. G. GREENWOOD, Engineering College Contact, Allison Division, General Motors Corporation, Indianapolis 6, Ind.



ALLISON

TURBO-PROP ENGINES

American built for the new era in air travel

M. S. U.'s new library . . .

A BUILDING FULL OF KNOWLEDGE

Surely no one last spring considered the site of the new library an attractive part of our campus. Rather, it was a thorn on our flowery campus. There were some changes made, however, during our absence this summer. The building has taken on much beauty, and a look at the cover of this magazine indicates it will blossom considerably more.

The building is of interest to all those who visit the campus but is of particular interest to an engineer. For behind that beauty lies many interesting engineering problems and feats.

No one would want to hear of all the engineering complications involved in a building of that size, but mention of a few unique features will give insight into a project of such as this. Of interest to a construction engineer and a heating and ventilating engineer is the peculiar use of the supports. In this building, rather than use conventional column supports with "H" beams, a dual use was made of the supports. Square beams were used with a hollow interior. These shafts were used to conduct heat ventilation from the lower floors to the upper floors. This suggests problems in insulation. Surely, expansion and contraction of a supporting column would be detrimental.

More noticeable and of interest to the general public, if not to an electrical or maintenance engineer, is the method of lighting used throughout the library.

This problem has several ramifications. First, the fact that the building contains 5,698 fluorescent tubes and 761 incandescent lamps indicates problems in electrical hum must have been encountered. All these lights can be controlled by individual rooms and also by a central master switch. To rid the building of hum, permanent magnets are used in the switches rather than electro magnets. An electromagnet is used only to actuate a switch. It is held in place by a permanent magnet.

The second complication ties in the ceiling. The fluorescent tubes are spaced two feet apart and cover the entire ceiling. This is then covered from below by sheets of corregated plastic, which incidentally are seven thousandths of an inch thick. The corregations and supports keep the ceiling from buckling. Now the interesting implications appear when a light burns out. As one can see from the plastic that has already been put up in the basement, it is susceptible to dirt and black spots caused by dead insects. A lesson has been learned and the remainder of the plastic will not go up until the dust caused by construction has subsided. Now, after all the ceiling has been erected, what happens when a tube burns out. If it is replaced singly, the laborer will leave finger marks on the soiled plastic. If the plastic is washed it will show up as one bright white spot in a ceiling tinted gray. A group replacement plan is therefore being used. When eighty-five percent of the average life of the tubes has elapsed, all the tubes will be replaced at once and the entire ceiling taken down and washed. This will occur approximately every three years. The percent of life that has elapsed can be determined from the number of lights which have already burned out. These never reach the average lifetime while other would burn on much longer than the average. Of strange interest is that the mortality rate for these fluorescent lamps follows the same pattern as that for the United States male.

Shown here is a view of the ceiling in the assigned reading room of the new library. A portion can be seen where the plastic ceiling has been installed in contrast to that section that has been left bare. This is an illustration of one problem encountered by engineers working on the building.

The only conclusion one can come to is: look around, fellow engineer, it might prove interesting not to mention the possibility of picking up some practical information.

NEW DEVELOPMENTS

Edited by Bob Fredericks

New Wire Insulation Developed

A major step toward smaller, longer-lived, and more efficient electrical equipment has been made by scientists through the development of a new insulating enamel for copper wire.

Laboratory tests on electric motors insulated with the new enamel show that the motors can operate continuously for 10 years at a temperature of 325 degrees Fahrenheit without damage to the insulation. This length of time is equivalent to the normal operation of a refrigerator motor for 30 years, or a washing machine motor for about a century.

This new enamel is a modified polyester-type resin containing about 20 percent silicon and represents the culmination of 10 years research and development of polyester-type wire coatings. By incorporating silicones into these materials, an insulation is now produced which can withstand higher temperatures for longer periods of time than any wire enamel which does not contain silicones.

Scientists declare that raising the limiting temperature of an electric motor to 325 degrees Fahrenheit will mean a reduction in the size of present motors.

Using this new enamel to replace the glass insulation normally required for high temperature motor winding would reduce the thickness of insulation by 50 percent. The enamel has been successfully applied to all sizes of copper wire from gauge 40 to gauge 10.

The new enamel also has unusual resistance to flow under pressure, which occurs when enameled wire is tightly wound and wedged into the slots of an electric motor. This pressure causes the wire to eventually cut through less resistant insulation and "short out."

Transistorized Automobile Radio

An experimental transistorized automobile radio that operates directly from a 6-volt car battery and requires only about one-tenth of the power used by a conventional car radio has been developed by R.C.A.

The new radio, employing nine transistors in place of electron tubes, is equal in performance to standard car radios. Emphasizing its low power consumption, it was pointed out that more than half the small amount of current required by the radio is used to light the two small pilot lights that illuminate its dial. A radio of this type would create so little drain on a car battery that it could eliminate many cases of battery failure that now occur when a driver forgets to turn off the radio when he parks his car.

The radio has been tested with a 6-volt battery as its power source. It is also adaptable to installation in automobiles with 12-volt batteries. With a 12-volt power supply the power output of the radio would be more than doubled, since it is not limited by the capabilities of the transistors.

While the experimental radio resembles present car radios in its external appearance, it requires no vibrator, power transformers, or rectifier—elements needed in vacuum-tube car radios to increase and control the power level.

The transistorized radio maintains a high level of performance over the widest range of temperatures likely to be encountered in automobile service. In laboratory tests, it has performed satisfactorily at temperatures as low as —40° F. and as high as 176° F.

BUBBLES AID METAL DEVELOPMENT

Study of soap bubbles by scientists may aid in the development of metals that are stronger than those now in use and that have other improved properties. Such bubbles are helping to explain fundamental data on the behavior of metals.

The soap bubbles resemble in many respects the crystals or grains of which all metals are made. In particular the way that little bubbles grow into big ones is closely analogous to the growth of metallic grains.

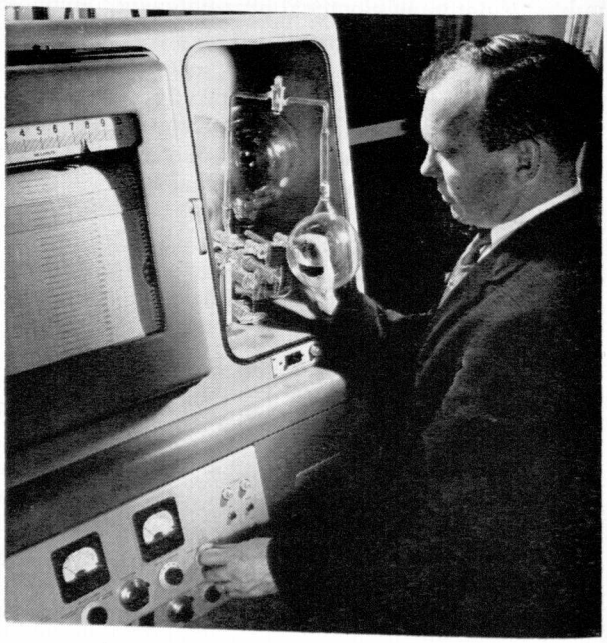
Neither the bubbles nor the grains ever grow by the coalescence of two smaller units into a larger one. Instead, when a bubble or grain gets bigger, its boundaries expand at the expense of adjacent ones which contract and finally disappear.

The bubbles are not blown in the open air, but in special glass cells, about five inches in diameter and

(Continued on next page)

A NEW MASS SPECTROMETER analyzes gases and vapors by smashing their molecules into fragments and weighing the resulting atoms and radicals. In the illustration, a research scientist has the spectrometer set for process monitoring. The graph shows a tracing and retracing of a peak of one given mass.

This is the first instrument of its kinds to be used in the steel industry.



half an inch thick. Each cell is half-filled with a special soap solution. It consists of a liquid sold in toy stores for making bubbles, to which other chemicals have been added to improve the performance. Then the air is pumped out of the cell and the space above the liquid becomes filled mainly with water vapor. The tube to the vacuum pump is sealed off, so the exhausted cell may be handled.

When the cell is shaken vigorously and then laid on a flat surface, thousands of tiny bubbles appear above the liquid. After it has been allowed to stand a little while (ten or fifteen minutes) the bubbles are larger and fewer. At this stage their continued growth may easily be observed. Lapse-time motion pictures which show the movements speeded up considerably have been made.

The bubbles have varying number of sides, but when there are only three sides on a bubble, it starts to disappear. The three sides shrink, while the vapor inside migrates through the walls into adjacent bubbles, which are enlarged accordingly.

In a single metal grain the atoms are lined up like bricks in a wall. So are the atoms in a grain next-door, but the rows in one grain do not line up with those in the other. The line of discontinuity is the boundary between the grains.

When a metal is heated, some of the grains enlarge, while others shrink and disappear, just as in the soap bubbles. As the boundary of a grain passes an atom, the atom shifts its position a little to get into line with the rows in the expanding crystal.

Many metallurgical applications, such as the steel used in electrical transformers, depend on accurate knowledge and control of metal grains. Hence, studies of their behavior, by the bubble technique and other means, is expected to lead to new knowledge which may greatly improve the performance of metallic structures.

Triode for UHF-TV

A radical concept in receiving tube design in the form of a tiny "micro-miniature" ceramic triode for UHF television sets was announced by General Electric.

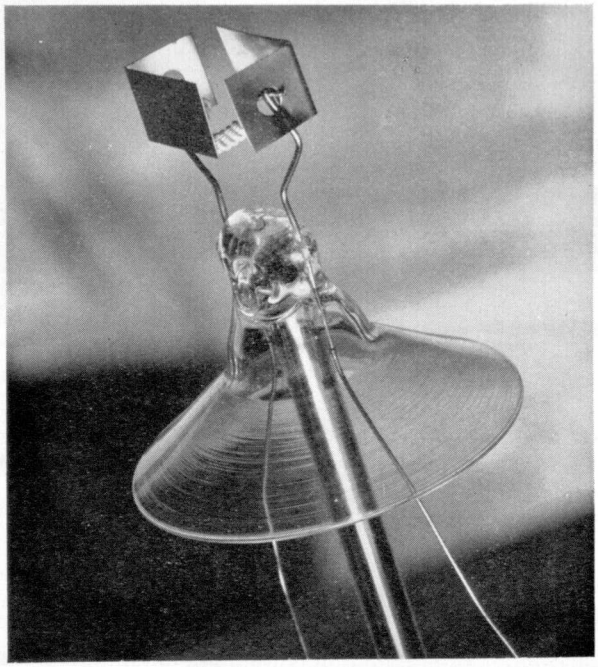
This micro-miniature triode—6BY4—is an all metal and ceramic tube about three-eights of an inch long and five-sixteenths of an inch in diameter. The production models will soon be available with a noise factor of approximately eight decibals, and a power gain of 15 db. when operating at a frequency of 900 megacycles with a bandwidth of 10 megacycles.

This radical new receiving tube design brings into focus new horizons in standards for noise figures, UHF amplification, ruggedization, miniaturization and extreme operating temperature specifications.

G-E engineers see the possibility of a complete line of these tiny electronic tubes from diodes to complex multi-element tubes. Possible applications include mobile and industrial communications, airborne and mobile radar, industrial controls, guided missile controls, nuclear power controls—possibly even man-made satellites.

A Martian Hat?

Though it may look like a Maritan hat, this strange device is actually an inside working part from an every-day fluorescent lamp. Lamp engineers call it a filament assembly, and each of its parts, however odd looking, serves an important purpose.



The hollow glass stem, before being sealed and discarded, will be used to draw air from the assembled lamp and replace the air with the rare gases argon and krypton. The two wires will be connected to metal pins in the base to conduct electricity, and the funnel-shaped flare will be sealed to the tubular glass bulb to form an air-tight joint.

The upper wires carry current to heat the tungsten filament to provide the electrons necessary to the lamp's operation. The metal "bumpers" help keep the outer glass tube clean, and are but one of the improvements developed to assure fluorescent lamps that are brighter throughout their 7,500-hour lifetime.

SIMULATED BOMB BLASTS

The largest laboratory device yet developed for simulating the blasts from bombs has been designed. The instrument—called a "shock tube"—allows engineers to study the effects of blasts without actually exploding a bomb.

The new shock tube, which has a 6-foot diameter, is considerably larger than any others developed in the country.

The new tube's significance lies in the fact it enables scientists to study blast effects on larger-scale models of buildings which might be exposed to blasts.

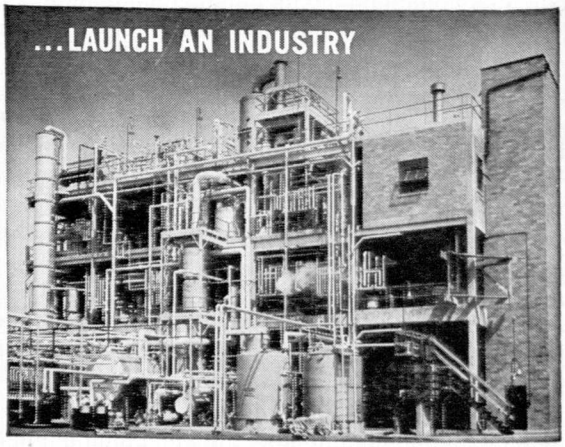
The tube has an over-all length of 150 feet. It

(Continued on page 26)

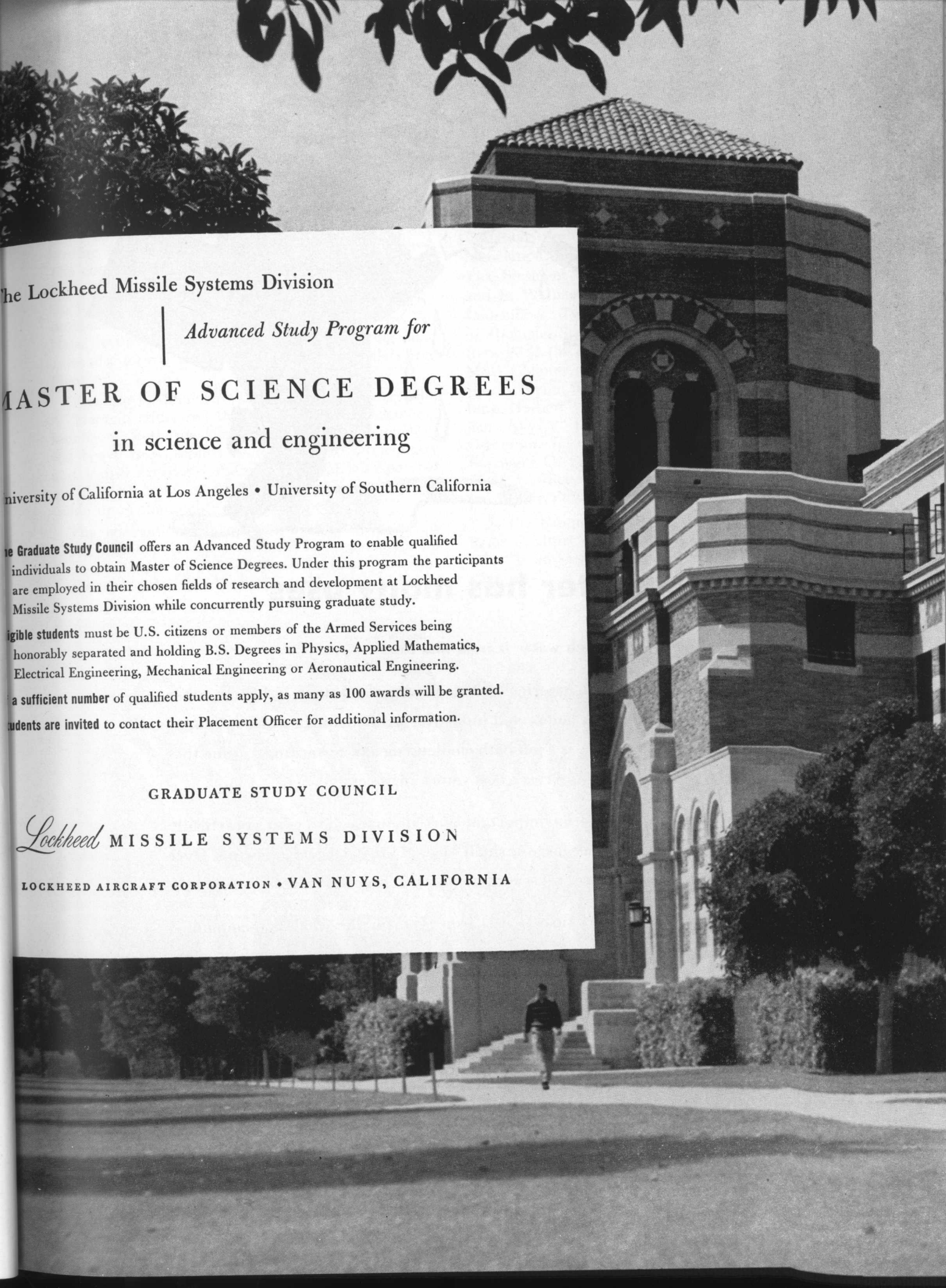
HOW HERCULES HELPS...

EXCITING NEW DISHES AND CUTLERY, both molded with a new Hercules plastic, Hercocel® W, are as durable as they are beautiful. A product of Hercules research, Hercocel W is a low-cost thermoplastic combining high heat resistance and good dimensional stability with exceptional toughness and impact strength. (Tranquil ware dishes by Byrd Plastics, Inc.; cutlery by Royal Brand Cutlery Company, a Division of National Silver Company, Brooklyn, New York.)

HANDY CONTAINERS and display rack for Hercules smokeless powders work two ways—they make it easier for the sportsmen who do their own loading to select the right powder, and convenient for the dealer to arrange an eye-catching display. Hercules powders have long been the favorite with handloaders who want accuracy and economy.



A MILLION POUND A MONTH PLANT is now producing dimethyl terephthalate at Burlington, N. J. Largest single user: Canadian Industries (1954) Ltd., in the synthetic fiber 'Terylene'. Hercules' plant, first to make DMT by air oxidation, is designed to expand as markets grow.



he Lockheed Missile Systems Division

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igible students must be U.S. citizens or members of the Armed Services being honorably separated and holding B.S. Degrees in Physics, Applied Mathematics, Electrical Engineering, Mechanical Engineering or Aeronautical Engineering.

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udents are invited to contact their Placement Officer for additional information.

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MSU HOSTS TAU BETA PI

by Marvin Van der Ploeg

Tau Beta Pi, National Engineering Honor Society, held its 50th National Convention at Kellogg Center on the campus of Michigan State University on Oct. 2, 3, 4, and 5. The 170 delegates to the convention included about 150 student members from 95 of the leading Engineering schools throughout the country. The convention, which is the governing body of Tau Beta Pi, had five business meetings on its schedule. On the lighter side was an evening of entertainment, provided by the MSU men's glee club and by Jim Hays, lecturer extraordinary. The hardworking delegates also took time out to tour the Oldsmobile Forge Plant.

Governor G. Mennen Williams and President John A. Hannah addressed the delegates at a welcoming luncheon. Both speakers reminded the delegates of the heavy responsibility of engineers to our country and World Freedom. President Hannah also pointed out that what this country lacks in quantity must be made up in the quality of its engineers.

The convention paused also to honor two of its oldest members and past officers. In appreciation for his contribution, a fellowship was originated in the name of "Uncle" Charlie Spencer, who was president of the Society for eleven years and who claims MAC as his school. Special acclaim was also given "Red" Matthews, Sec.-Treas. of Tau Beta Pi for many years.

Another highlight of the Convention was the Formal Initiation conducted by the National Officers of the Association. These officers are: President H. M. King; Vice-President W. C. Voss; Sec.-Treas. R. E. Nagle; and L. W. Bass, C. F. Muckenhoupt, H. K. Brown, Councillors. Twenty of the top Engineering students of Michigan State University were initiated into Tau Beta Pi at this ceremony. The new members of the MSU Chapter are: Don Beuerle, Alger B. Colthorp, Jim Germain, William Donald Glauz, Richard Hartung, Herbert W. Kirby, Earl Knott, Robert E. Kurkjian, Kay V. Lask, Gordon Rex Morin, Lester V. Ostrander, Jr., Franklin D. Owen, Thomas Payette, Raymond G. Piereson, Donald Pollakowski, William James W. Rice, Criag Alan Sterling, John Allen Swanson, Harry Edward Tomaschke, James Keith Iverson.

At the banquet following the initiation ceremony, Peter F. Hurst delivered an address on some aspects of a "good engineer" in deference to "just another engineer."

M.S.U.'s twenty new members of Tau Beta Pi, National Engineering Honor Society.

Saran Wrap is stretched by injecting compressed air to form a bubble ½ mil in thickness which is then compressed and wound.

Bubble, bubble, toil and brainwork . . .

Dow engineers create modern new plant for Saran Wrap production

Demand was multiplying for Saran Wrap. Housewives across the nation wanted more and *more* of this clear, moistureproof plastic wrap for foods. A new plant was needed . . . and needed fast.

Dow's engineering and technical staff went to work. Production processes were checked and improved. Mechanical engineers designed new machinery. Electrical engineers introduced new fluorescent lighting (shielded by an entire ceiling of corrugated plastic) eliminating glare from Saran Wrap which would have tired the eyes. Modern plant innovations were widely apparent as the blueprints came in from engineer after engineer.

Then the job was done. Hard work and brainwork had produced an enviable new plant ready to produce in excess of 5,000,000 Saran Wrap rolls a month. Dow-engineered from start to finish, it stands as a testimonial to the depth and talent of Dow engineering and planning.

Dow is interested in all types of engineers and scientists who are considering a Dow future. And for the Dow sales program, in addition to engineers and scientists, those with partial engineering and scientific training are also needed.

Whether you choose research, production or sales, you can find a challenging career with Dow. Write to Technical Employment Department, THE DOW CHEMICAL COMPANY, Midland, Michigan or Freeport, Texas, for the booklet "Opportunities with The Dow Chemical Company"—you'll find it interesting.

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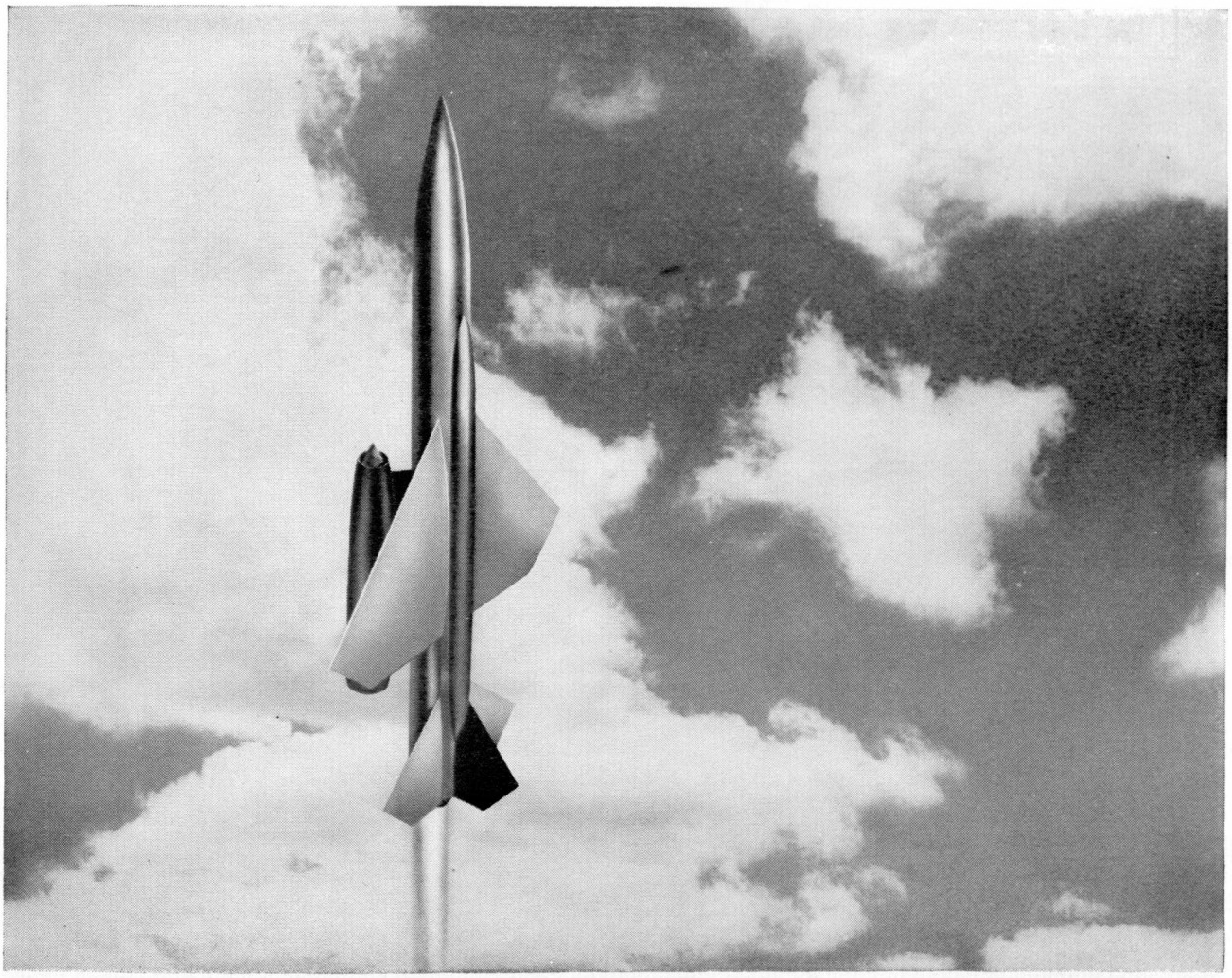
DOW

Spartan Engineer



Boeing engineers have a date with the future

Guided missiles like this Boeing Bomarc IM-99 are increasingly important in America's defense planning. Many kinds of engineers—electrical, mechanical, civil and aeronautical—play vital roles in developing it. The knowledge they are gaining will be priceless in producing the supersonic airplanes and guided missiles of the future. These men explore the frontiers of engineering knowledge in rocket and nuclear propulsion, in extremes of vibration, temperature and pressure and in many other fields.

Boeing engineers are members of aviation's top creative team. The aircraft they help develop will maintain the leadership and prestige established by the Boeing B-47, the present "backbone" of Strategic Air Command . . . the B-52, our giant new global bomber . . . the Bomarc IM-99 . . . and, most recently, the 707 and KC-135, America's first jet transport and tanker.

At Boeing, engineers' professional achievements are recognized by regular merit reviews and in other ways. The Boeing policy is to promote from within the organization. And Boeing is known as an "engineers' company." One out of every seven employees is an engineer! Among top management, the proportion is even higher.

Equipment at Boeing is superb: the latest electronic computers, a chamber that simulates altitudes up to 100,000 feet, splendidly equipped laboratories, and the new multi-million-dollar Flight Test Center. The world's most versatile privately owned wind tunnel, at Boeing, is soon to be supplemented by a new tunnel capable of velocities up to Mach 4.

Do you want a career with one of America's most solidly growing companies? Do you want a chance to grow, and to share in the challenging future of flight? Then plan your career as a member of one of Boeing's engineering teams in design, research or production.

For further Boeing career information consult your Placement Office or write:

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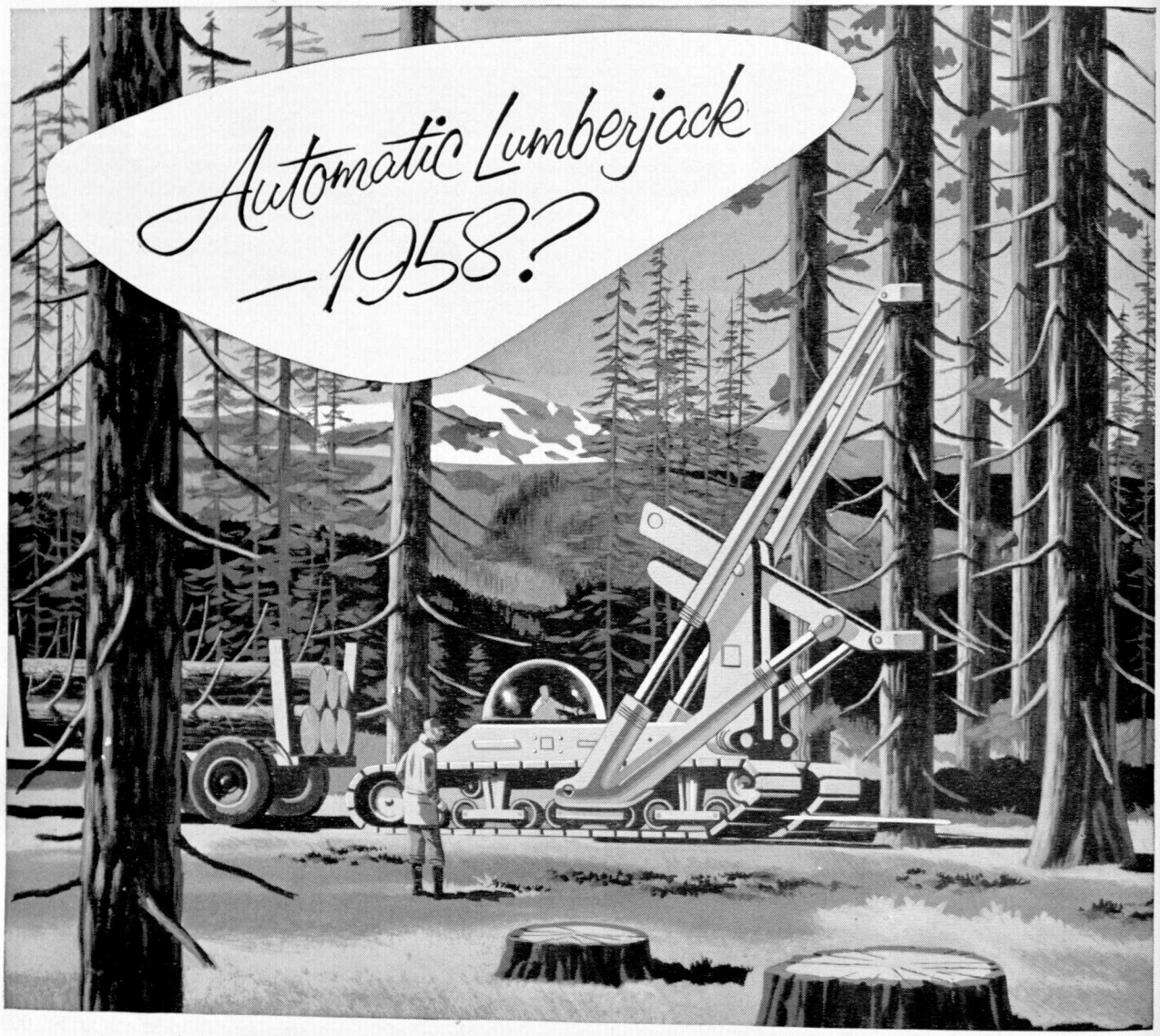
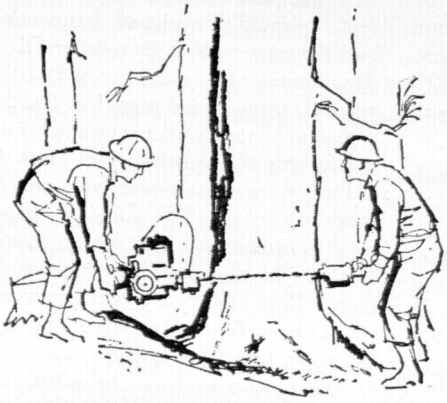
NEW **DEPARTURES OF TOMORROW**





Cool-running chain saw, like every type of power saw in use today, uses New Departure ball bearings for longer life at peak efficiency.

Even Paul Bunyan couldn't match the pace of this "automatic lumberjack" of the future. It fells, sections and loads trees—all at the push of a button!

The company that launches this wonder will probably look to New Departure for ball bearings. For New Departures have proved their ability to hold moving parts in perfect alignment, cut wear and friction, and work long hours without letup—or upkeep. Above all, New Departure has lived up to its name—being *first* with ball bearing advancements.

So, when improving or designing a product, count on New Departure for the finest ball bearings.

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NEW DEPARTURE
BALL BEARINGS

NOTHING ROLLS LIKE A BALL

CLUBS AND SOCIETIES

Of the many clubs on campus, none are more important to the engineer than those pertaining to his own field. These clubs are organized to enhance the engineer's future. So that the student may get a better perspective of his particular option, guest speakers and an array of field trips are made available to the students.

At the meetings, the student may express his ideas on different projects that he may be interested in, and work on them with other engineers, thus getting the benefit of working with others and developing his knowledge of the field.

Although each club has its special interest, all clubs work harmoniously with one another in many events. A product of this effort can be seen in the annual Engineering Exposition held during the spring term.

Your interest in clubs will build a better future for you. The importance of your membership in one or more of these organizations is emphatically stressed.

ASME

At the first fall meeting of the American Society of Mechanical Engineers, Chairman Tony Burdo introduced the coming year's officers and events. Vice Chairman Roger Preuss, Secretary Dick Hartung, Treasurer Bill Flynn, and Honorary Chairman Jerry Hemmye, together with Tony, dedicated themselves to a bigger and better year for ASME.

Bigger, by hosting the Regional Student Conference on our campus next spring with representatives coming from nearly twenty mid-western universities, and also by sponsoring events in cooperation with other engineering societies. Better, by inviting nationally known speakers to meetings; and inciting higher student interest in ASME activities.

Tops on the agenda were prospects for field trips to engineering firms. The first of these took place October 10 at a combined meeting with the Central Michigan Sub-section, starting with a dinner at the Famous Grill in Lansing, and finishing with a tour through world-famous Abram's Aerial Survey Corporation. Future plans include visiting the Oldsmobile assembly plant, General Motor's Flint body plant, Howell Electric Motor Works, and a plastics manufacturing firm.

The remainder of the evening included a series of short talks by members who highlighted their summer engineering experiences to the group. Perhaps one of the most unique features of ASME is the opportunity it offers students to develop their communica-

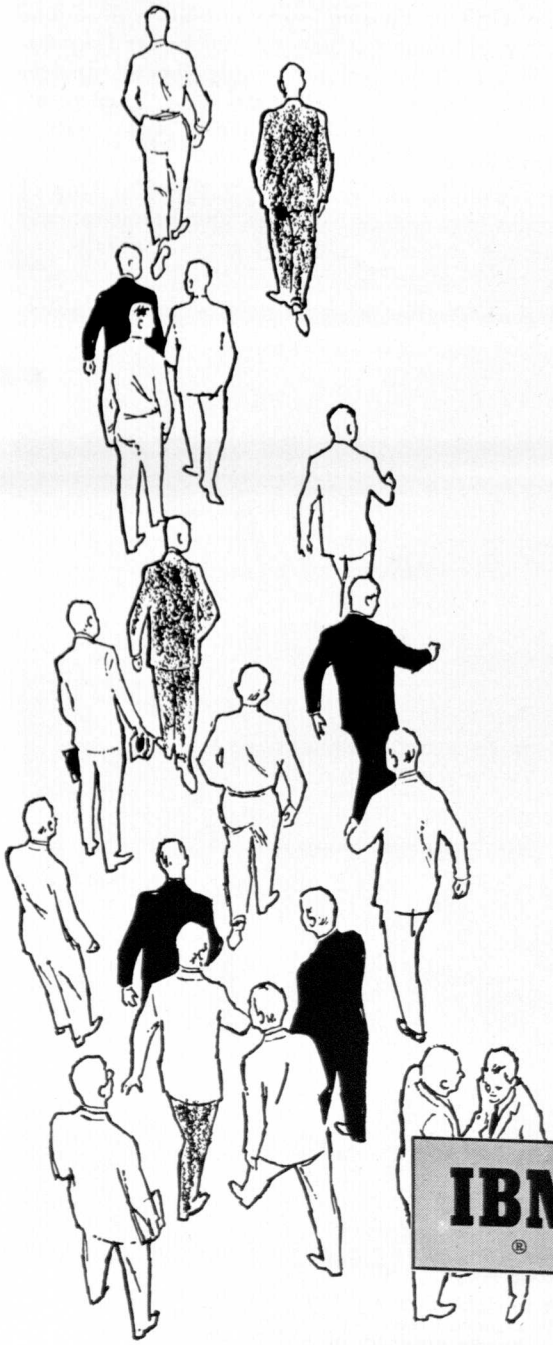
(Continued on page 34)

Students working for Boeing Airplane Company in Seattle, Washington, this summer are shown here in front of the B-52, which they worked on.

Left to right, they are Jerry Linton, president of AFS; George Clute, Dee McDonald, Roger Shultz, Tony Burdo, president of ASME; and Jim Leigh.

(A message from **IBM***—where progress is engineered)*

Pioneer or "Routineer"?



In simplest possible terms, there are two basic courses open to you when you apply your engineering degree in the business world . . . you can "routineer" or pioneer. As a routineer you will fill in the details of other men's concepts. As a pioneer you will operate on the frontiers of your chosen field—helping *originate new concepts.*

Which course *you* follow depends largely on the field you select and the company you join.

There is underway today, in business, science, and government, a quiet but far-reaching revolution in the automation of office equipment and procedures. The use of electronic data processing machines—for performing complex scientific computations . . . for handling huge volumes of business data—is still in its infancy. For engineers in data processing, new horizons unfold in endless succession.

IBM's leadership in the field of data processing is due largely to our reliance on pioneer engineering. Many years ago IBM deliberately set out to build the kind of engineering climate . . . the facilities, the freedom, the associations . . . that would attract and stimulate the pioneer.

If *you* want to pioneer in a dynamic new field, IBM offers an unusual opportunity to make important and rewarding contributions.

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the roots of automation

Excerpts from a speech given by D. C. Burnham, Vice President of Manufacturing for Westinghouse, at the 19th Annual Machine Tool Electrification Forum.

Few words have engendered as widespread discussion as has the term "automation." Many questions have also arisen, both as to the reasons for automation and its effects. In a talk at the 19th Annual Machine Tool Electrification Forum earlier this year, D. C. Burnham, Vice President of Manufacturing, answered many of these questions. Below are a few excerpts.

AUTOMATION naturally has its roots in today's manufacturing history. It is no revolutionary concept, but rather a next logical step in a slow evolution. In our plants today are examples of the various phases or steps through which we have progressed on our way to automation. There are four of these: (1) *job shop,* the lowest volume, highest cost method of production; (2) *progressive-line* manufacturing, where machines are arranged according to the work that must be done on the product; (3) *conveyorized-line* manufacture, in which conveyors are used to carry parts from one machine to the other; and finally (4) *automation,* with its high degree of automatic handling and control. The roots of automation can be clearly traced through these four phases back to the beginning of manufacturing.

The job shop is undoubtedly the oldest method of manufacturing still in existence today. Parts are individually handled, individually machined, and assembled by hand. At the turn of the century, with few exceptions, this was the only method of manufacturing in existence for most industries.

Your automobile, for which you pay $3000 today, would cost approximately $100,000 if manufactured by job show methods at present labor rates! Obviously, the automotive industry would be very small if such were the case.

Then someone conceived the idea of arranging equipment so that the part to be produced progressed in a straight line from machine to machine. This cut down on handling costs, raised productivity. The next step up the scale from straight-line manufacturing was as inevitable as automation is today.

The assembly line or conveyorized method was to mark America as a nation unparalleled in producing high-quality, low-cost goods. Although Henry Ford was not the originator of the conveyorized method of manufacture, he can be credited as being its greatest scholar. Ford announced in 1909 that he would "build a motor car for the great multitude" and that he proposed to do it by building 1000 cars a day! What it did for America is written in almost every minute of our present-day life. The words "United States" and "mass production" were to become complimentary. The techniques of mass production have fitted in so well with the young, ambitious, and democratic American way that it has not only made us the strongest nation in the world but has also played a major role in preserving the democracy that made mass production possible in the first place.

The step from conveyorized manufacture to what is called automation involves the use of more automatic machines and controls as well as automatic handling between machines. It is most certainly the next logical step in industrial progress—and undoubtedly not the last one.

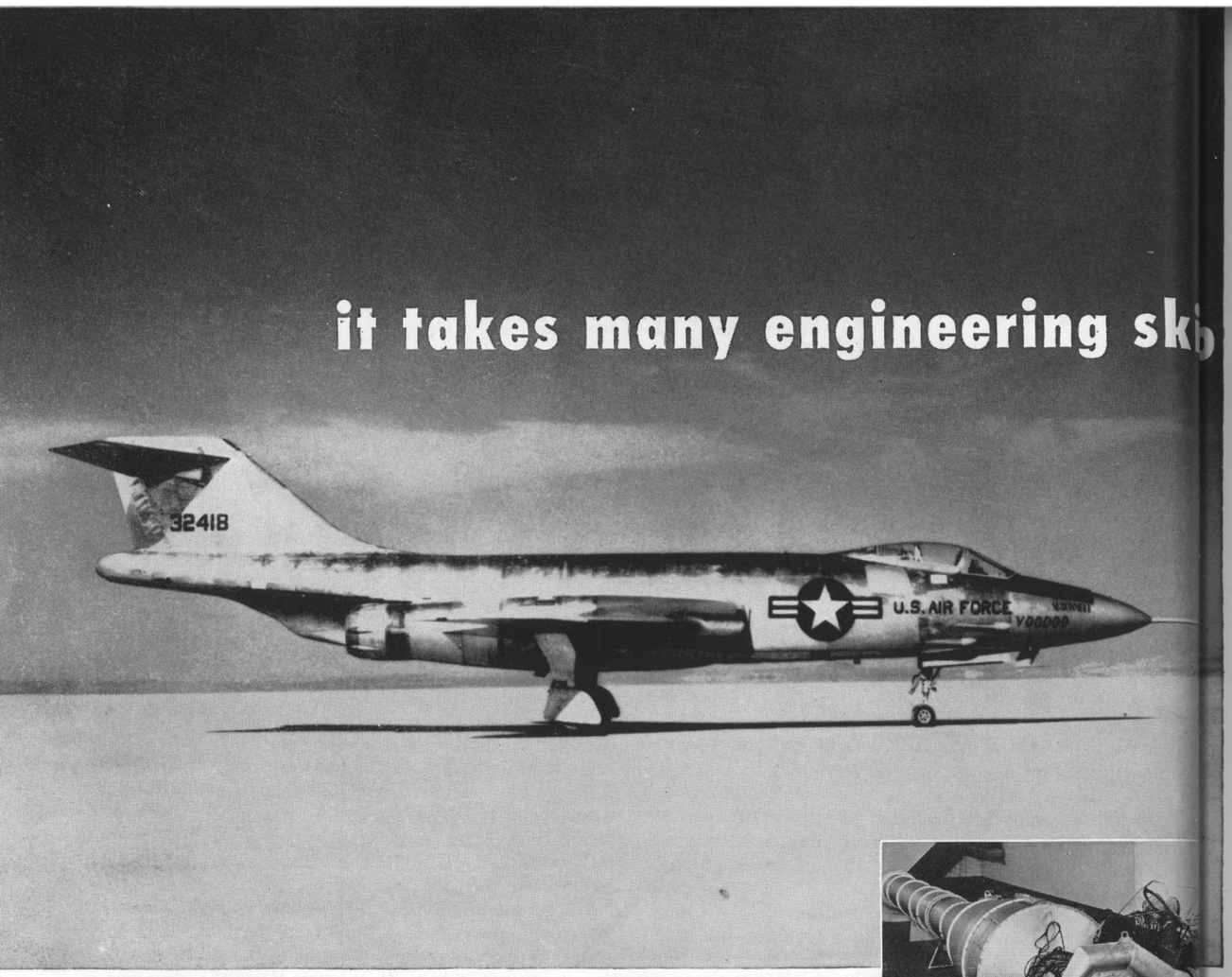
Perhaps we will never see the advent of the completely automatic factory, but if we do, it will be because we are ready for it. It will not upset our balance. It will come simply as another step in the long evolution, as an economic necessity.

How can we go about attaining automation? Let me quote a specific case. Westinghouse has in its organization examples of each of the four types of manufacturing mentioned. Not all of any one plant is in one specific stage, but certain products demand certain types of manufacturing, either because of the nature of the product or of the process. Large, single-design steam turbines, for example, would be difficult to conveyorize.

It is not realistic to expect to automate the job shop.

(Continued on page 40)

it takes many engineering skills to create the top aircraft engines



McDonnell "Voodoo", *the most powerful jet fighter ever built in America.*

An aircraft powerplant is such a complex machine that its design and development require the greatest variety of engineering skills. Pratt & Whitney Aircraft's engineering team has consistently produced the world's best aircraft engines.

The best planes are always designed around the best engines. Eight of the most important new military planes are powered by Pratt & Whitney Aircraft J-57 turbojets. The first two jet transports in the United States will use J-57s. Further, no less than 76 percent of the world's commercial air transports are powered by other Pratt & Whitney Aircraft powerplants.

Such an enviable record can only be built on a policy which encourages, recognizes and rewards individual engineering achievement.

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Boeing 707

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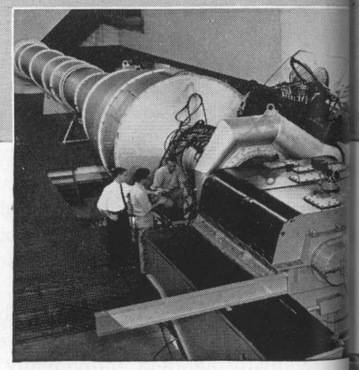
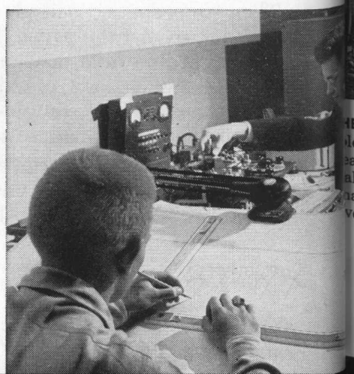


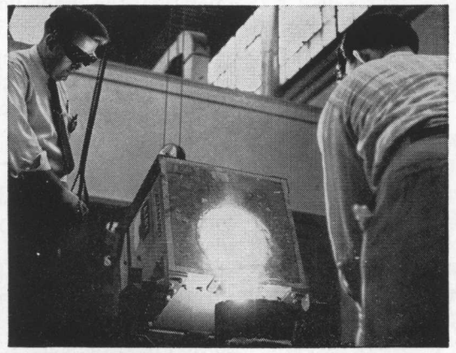
MECHANICAL ENGINEERS are concerned with many phases including experimental testing and development, mechanical design, stress and vibration analysis, combustion research, heat transfer and nuclear reactor development.

AERONAUTICAL ENGINEERS work on innumerable internal and external airflow problems concerned with design, development and testing of aircraft powerplants. Some who specialize in analytical engineering forecast engine-airplane combinations a decade in advance of design.

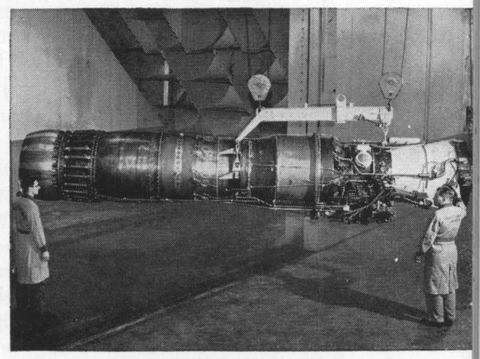


ELECTRICAL ENGINEERS directly contr their specialized skills to the analysis development of controls, systems and s instrumentation. An example is the "p mat" which automatically integrates and pressures, temperatures and air angl performance testing.

EMICAL ENGINEERS, too, play an important le. They investigate the chemical aspects of eat-producing and heat-transferring mate- ials. This includes the determination of hase and equilibrium diagrams and exten- ve analytical studies.



METALLURGISTS investigate and develop high temperature materials to provide greater strength at elevated temperatures and higher strength-weight ratios. Development of superior materials with greater corrosion resistance is of major importance, especially in nuclear reactors.



WORLD'S MOST POWERFUL production aircraft engine. This J-57 turbojet is in the 10,000-pound thrust class with considerably more power with afterburner.

New Developments

(Continued from page 13)

already has been tested and is being put into use for model testing.

In order to get different shock wave pressures and durations, the tube was provided with interchangeable sections of varying lengths.

To absorb the maximum recoil force of 600,000 pounds, the foundation of the tube was designed as a slab of reinforced concrete 10 feet wide, 3 to 4 feet thick, and 100 feet long with keys 10 feet wide and 6 feet deep spaced 20 feet apart.

Here's how a shock tube is used as a laboratory instrument for generating controlled shock waves.

A certain amount of combustible gas is introduced into one section of the tube and is confined by a light diaphragm. The diaphragm is shattered when the gas is ignited, and the released pressure wave travels down the tube to the test section, where a building model has been placed. The resulting forces are recorded with electronic equipment.

Development of shock tubes stems from the fact that actual bomb tests are expensive, and it also is difficult to control the conditions under which they are conducted. Laboratory tests can be performed much more efficiently and over a much wider range of target items.

The testing of structures is aimed at answering two questions. First, what forces on a building result from the bomb explosion? Second, how does the building react to the forces?

A building is not a simple item. To illustrate, a shock wave might crumble a brick wall or shift it as a unit—results which may cause large differences in building damage.

Irradiation Machine

EAST LANSING—A machine that has been termed one of the biggest advances in research equipment in recent years has been installed at Michigan State University.

It's a G.E. electron beam generator—also called a cathode ray machine—which can pasteurize food without heating. Here are a few of the already-known things the million-volt generator can do:

It can kill grain storage insects or make them sterile at a cost of about a cent and a half per ton for electric current. Scientists hope the machine could be used to help save the millions of bushels of grain stored in this country under the government price support program.

Besides controlling insects scientists believe the machine can prevent mold on wheat. That would mean grain could be stored at a higher moisture content and that the machine may be practical for use by elevators.

Bread treated with this machine can be kept at room temperature for many months without molding.

It can increase the shelf life of beans and other products. The ray device can be used by the plant breeder to change the chromosome arrangement in seed. This can speed up research toward new varieties of plants.

Most of the departments in the school of Agriculture have set up research projects on which the machine is to be used. Investigations slated include use of the machine on:

Sugar beets to increase production of sugar, on milk and other dairy products for pasteurization, on potatoes to prevent sprouting. Plant breeders plan to use the generator in their search for better varieties of crops.

The powerful device has been installed behind two-foot-thick concrete walls in the agricultural engineering building. This is to protect workers from the rays. A heavy woven wire fence also prevents people from getting too close.

The electron beam generator, however, is less hazardous than an atomic radiation machine. The electron machine uses electricity for its irradiation energy. The atomic machine, more expensive to use, gets its energy from radioactive material. The atomic radiation is more penetrating, but also much slower in action.

'Copter Boots

An all-weather helicopter that overcomes the threat of freezing temperatures and hazardous ice formation can now perform its life-saving missions in sub-zero conditions that used to keep the "whirlybirds" grounded.

The helicopter uses a set of new electrically heated rubber "boots" to warm its rotor blades and prevent icing. With the new heating device, helicopters may now fly in weather and regions they never could before.

The rubber boots are fitted snugly along practically the entire length of the rotor blades to keep ice from depositing its dangerous weight. Resembling the operation of an electric heating pad, the boots have tiny resistance wires imbedded in rubber and connected with the ship's electrical supply. When in operation, the wires heat up and the heat keeps the whirling rotors free of ice.

Heating pads for airplane exterior surfaces can be made in any shape or size to fit such parts as antenna masts, propellers, air scoops, spinner domes and cowl rings.

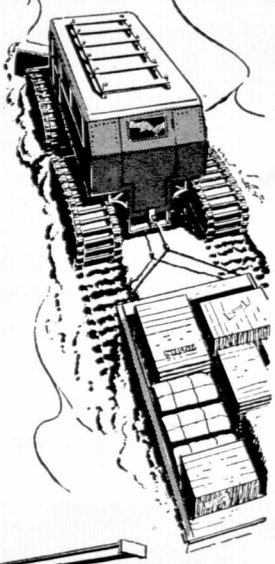
An old gentleman riding the top of a Fifth Avenue bus noticed that every few minutes the conductor would come from the back and dangle a piece of string down in front of the driver underneath. Whereupon the driver would utter profanity terrible to hear. Finally, the old gentleman could stand it no longer, so he asked the conductor why he dangled the string and why the driver swore.

"Oh," the conductor answered naively, "his father is being hanged tomorrow, and I'm just kidding him a little."

CREATIVE ENGINEERING

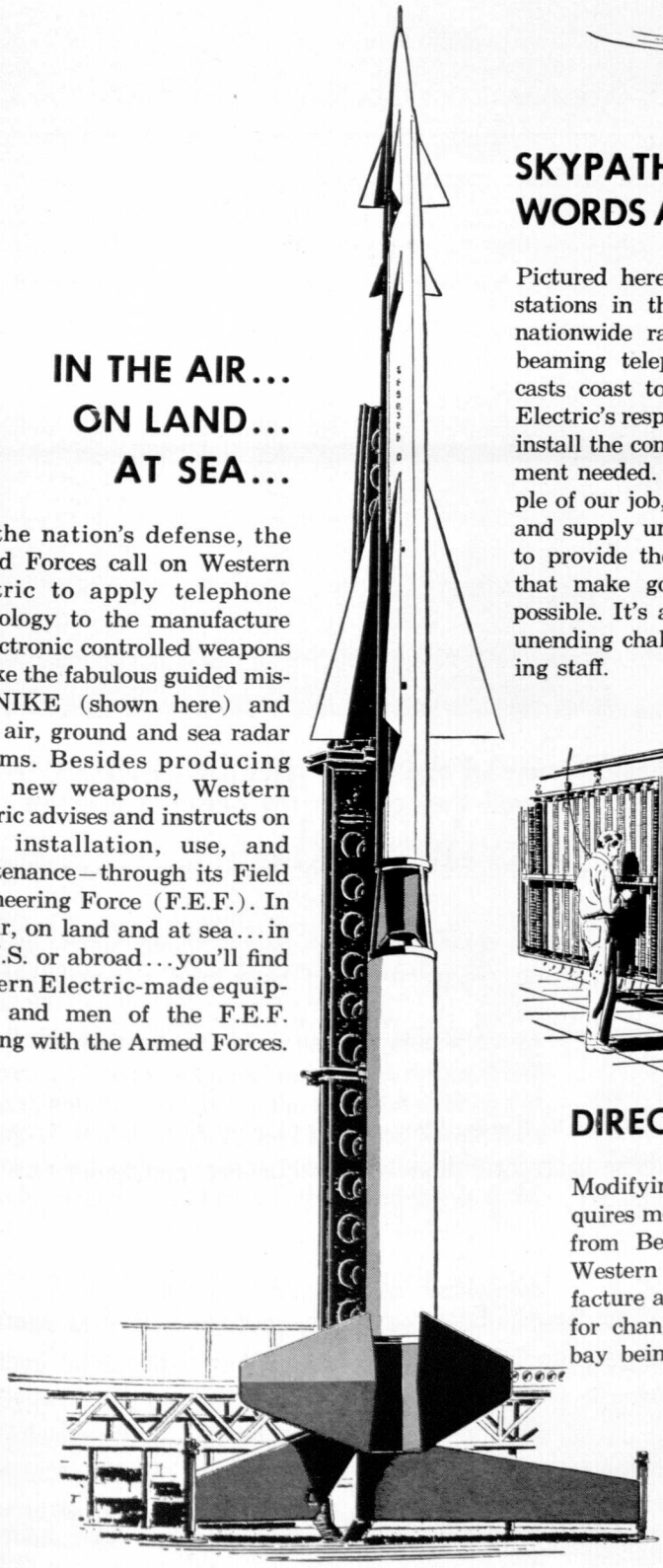
SKYPATH FOR WORDS AND PICTURES

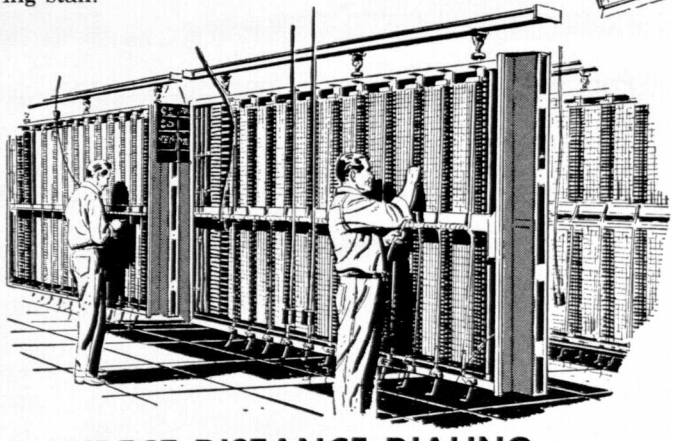
Pictured here is one of the many stations in the Bell System's new nationwide radio relay system for beaming telephone calls and telecasts coast to coast. It is Western Electric's responsibility to make and install the complex electronic equipment needed. This is another example of our job, as the manufacturing and supply unit of the Bell System, to provide the thousands of things that make good telephone service possible. It's a job that presents an unending challenge to our engineering staff.



IN THE AIR... ON LAND... AT SEA...

For the nation's defense, the Armed Forces call on Western Electric to apply telephone technology to the manufacture of electronic controlled weapons ... like the fabulous guided missile NIKE (shown here) and other air, ground and sea radar systems. Besides producing these new weapons, Western Electric advises and instructs on their installation, use, and maintenance—through its Field Engineering Force (F.E.F.). In the air, on land and at sea... in the U.S. or abroad... you'll find Western Electric-made equipment and men of the F.E.F. working with the Armed Forces.





DIRECT DISTANCE DIALING

Modifying telephone systems for nation-wide dialing requires months of make-ready. Working with technical men from Bell Laboratories and Bell telephone companies, Western Electric engineers develop and plan the manufacture and installation of the intricate equipment needed for change-overs. Shown here is an automatic switching bay being manufactured in one of Western's 16 plants.

Western Electric

MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

Whereas, much grief and disappointment — yea, even bloodshed, hath been needlessly endured for lack of true guidance, a saddened sage of the Kingdom of Ye Olde Sliding Ruler hath assembled the following

Ten Commandments of Ye Studente Engineers

I. Verily, I say unto you, bring ye volumes of manuscript as tribute unto the master of the Laboratory of Power, lest he unleash upon you his mighty fury. Remember well that he withholdeth the "A" as a mighty jewel, but lavish the "F" without mercy.

II. Be ye not present at the Place of the Gable; neither be ye found at the Inn of the Deerhead on the eve of the great inquisition, lest thou appear for interrogation with fogged mind and blurred vision. Such appearance extracts not sympathy from the department head — neither will his staff comfort thee.

III. Thou shall diligently burn thine candle in the evening — yea, even unto the crowing of the cock, lest thy master be displeased with thine efforts.

IV. Make thy comma and thine semicolon trusted friends unto thee. May they assist thee in traversing the province of Harris the Blackhearted unscathed.

V. When thine master uttereth the big joke, be ye filled with mirth; when he smileth not, make thy countenance like unto stone.

VI. Park not thine carriage in the stables of the Lords and Nobles — lest the constabulary confiscate thy silver and thine property — yea, even will they curtain thy personal liberties.

VII. Be ye not tardy in returning thy fair damsel to the Hall of Abbot; may thou never experience the wrath of the Keeper of the Harem.

VIII. Beware of the "Blind Date," she accepteth thine cigarettes and beer and squandereth thine shekels and promiseth unto thee mighty things that she will giveth to thee — yet she giveth only her thanks.

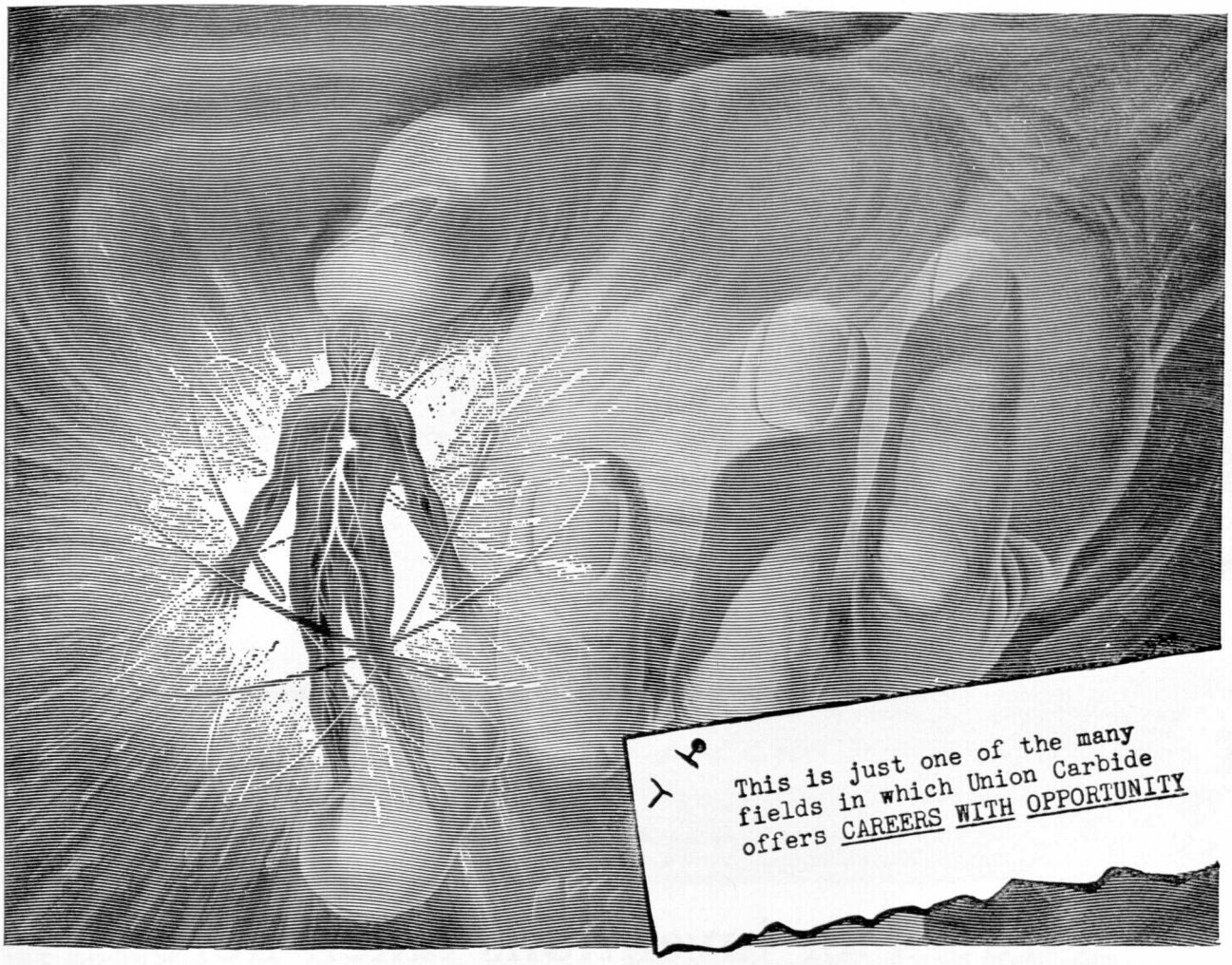
IX. Be not first — nay, be thou not even early unto thine class; neither be ye the last to leave — nor may thee engageth in discourse with thine instructor lest thou incur the condemnation of thy fellow peons.

X. Prepare thee well for thine day of judgment; know ye that thy masters punish with impunity.

My children, endear these maxims to thine heart. Enter upon thy journey with the opened eye and closed mouth; tread with light step and neverending vigilance. Keep thy sliding rule ever ready to fend off the attacks of the inquisition. May it please Allah that thou may succeed. Godspeed!

Yuben Haad Furshur

(From the Colorado Engineer)



Your health will be better since doctors can now use

the voice of the atom

DOCTORS have long wanted to learn more about the human bloodstream—how it supplies nourishment . . . defends against disease . . . becomes diseased, itself.

THAT WISH IS REALITY today, because atomic energy has given a voice to certain of nature's elements. When these elements are exposed to the powerful radiation of splitting atoms, they become radioactive, themselves, and are called *radioisotopes*. The radiation they give off can be detected and heard with special instruments.

Now doctors introduce isotopes of iodine, iron, sodium, or other elements into the bloodstream. Their course can then be followed to determine the location and nature of the trouble. Isotopes are also becoming increasingly important in actually treating ailments.

ISOTOPES are being used in similar fashion by industry and agriculture to analyze materials, measure wear, control processes, and to help answer mysteries of how plants absorb nourishment from the soil and how it affects their growth and health.

THE PEOPLE OF UNION CARBIDE operate, under Government contract, the Oak Ridge National Laboratory, the Nation's chief source of radioisotopes, as well as the huge atomic materials plants at Oak Ridge and Paducah.

STUDENTS AND STUDENT ADVISERS: *Learn more about career opportunities with Union Carbide in* ALLOYS, CARBONS, CHEMICALS, GASES, *and* PLASTICS. *Write for booklet 5E-2.*

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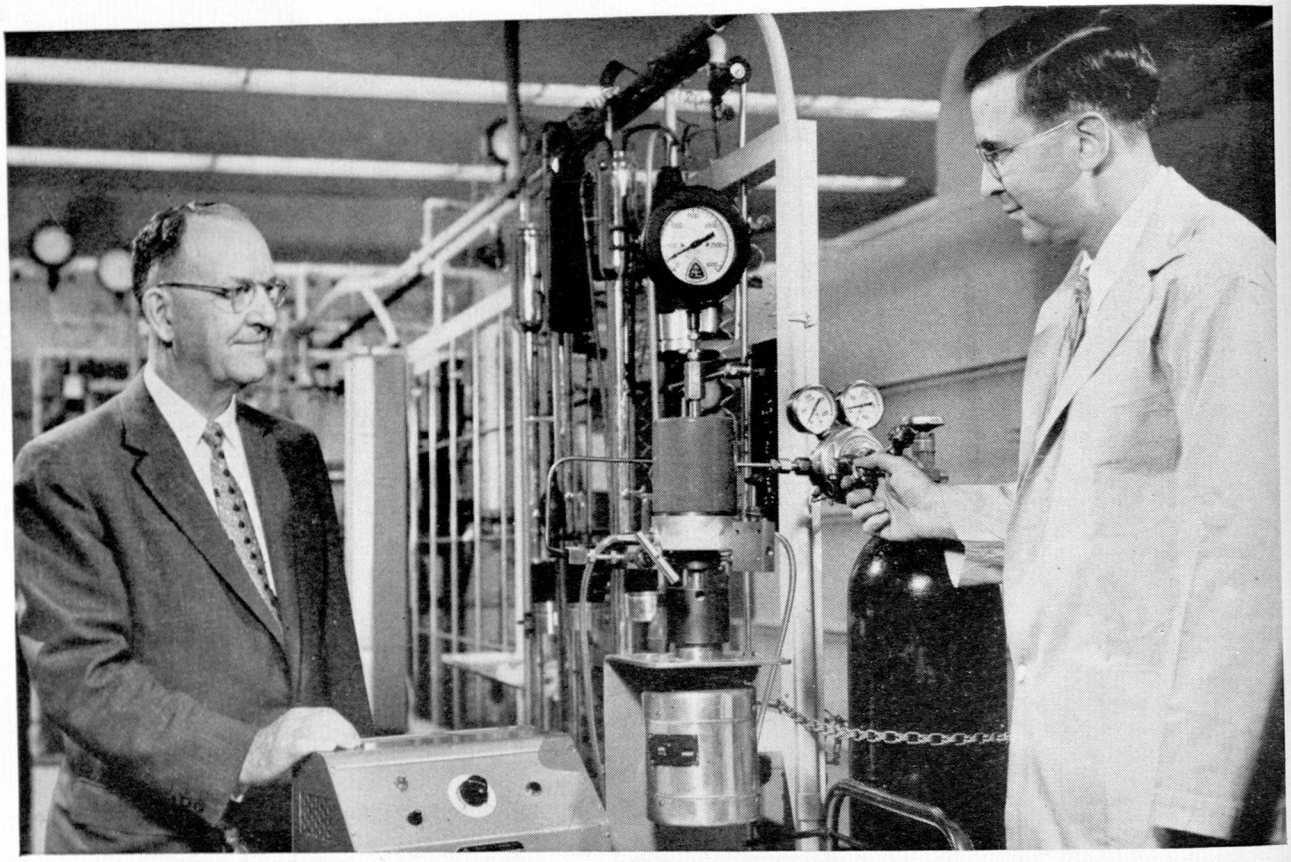

Dr. Ward Kuentzel and Dr. Edmund Field, co-inventors, observe operation of the new Magne-Dash autoclave in Standard Oil's Whiting research laboratory.

Orders for inventions taken here

MODERN RESEARCH creates a need for brand-new types of equipment. In petroleum laboratories, mixing up some stuff in a beaker usually isn't the answer. The research pioneer may have to use high temperatures and high pressures. If he must stir his mixture, he has a tough job. How can he prevent leakage past the shaft of the stirrer?

To meet this and other difficult situations, Standard Oil has set up a "Special Devices Program". A group of scientists creates the apparatus needed to solve today's problems.

An example is the Magne-Dash* autoclave. It has a magnetically operated agitator, and no external moving parts. Leaks cannot occur. Research men now use freely the high pressures that lead to new plastics and other new products.

Like many other inventions made by Standard Oil scientists to solve our own problems, the Magne-Dash is licensed for production and sale by a maker of scientific equipment.

The Special Devices Program is just one of the creative activities at Standard Oil. Young scientists find it stimulating to work in such an atmosphere.

*Manufactured under Standard Oil license by Autoclave Engineers, Inc., Erie, Pa.

Standard Oil Company

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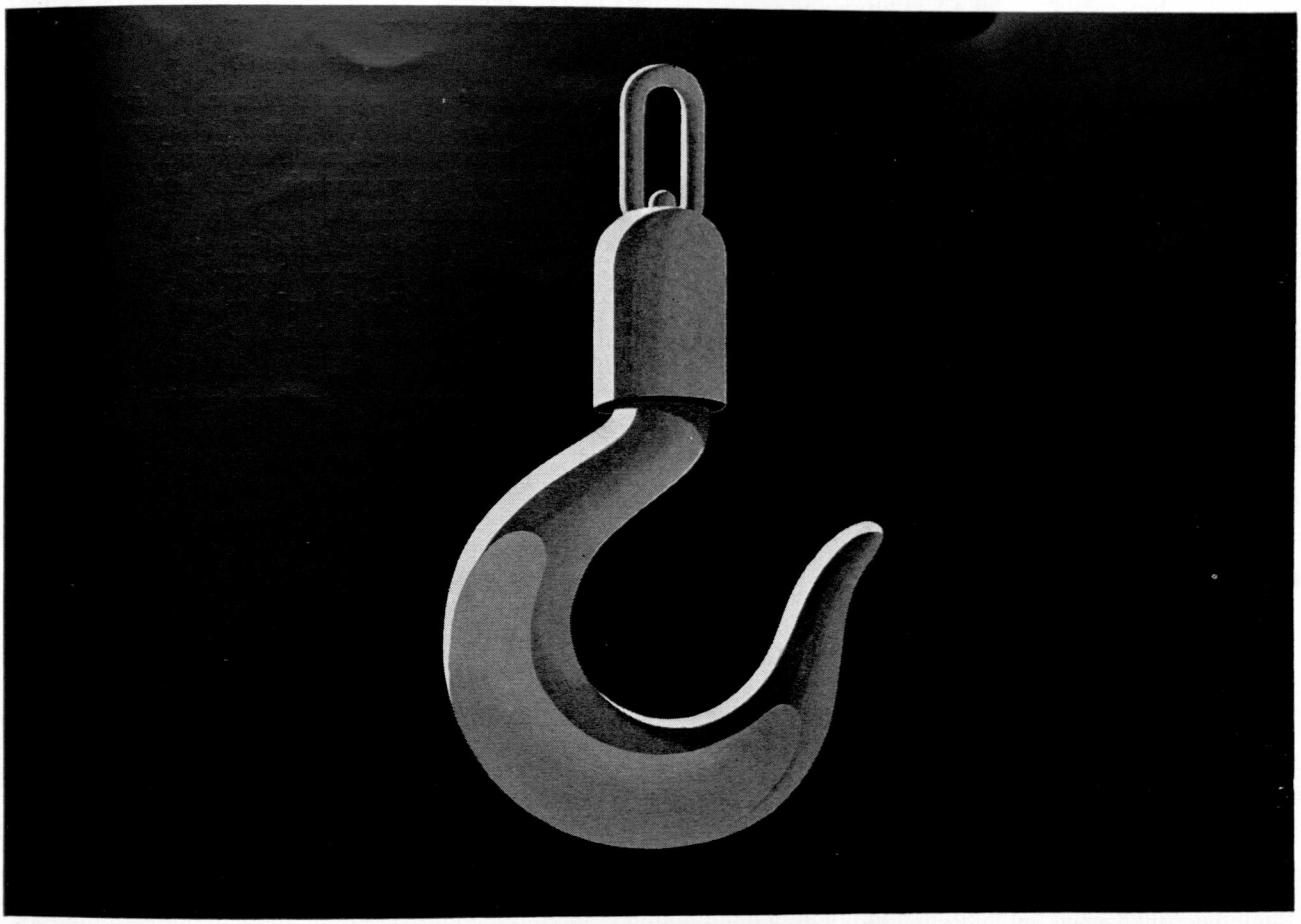
STANDARD



SKY HOOK . . .

Here is a hook for a hoist—mankind's sinew-sparing servant . . . as industrially indispensable as its load-lifting applications are limitless.

Hoists lift steel beams for buildings and bridges, raise and lower drills and casing for deep-driven oil wells, lift a bucket of cold water from a country well or a ladle of molten metal in a mill . . . lighten load-lifting chores for machinists and miners, loggers and longshoremen, farmers and factory workers.

HOW MANY KINDS?

Consider the many kinds of hoists in use today . . . reeved with rope, cable, chain . . . powered pneumatically, manually, electrically . . . engineered with gears, pulleys, pistons, ratchets.

Think how many millions of plans, sketches, models and mock-ups have contributed to their evolution. The eyes of a myriad of inventors, engineers and draftsmen have appraised them. The hands of countless pattern-makers, tool and die makers, machinists and other craftsmen have shaped them.

Pulling together is a work method uniquely American. And, America can work like that because it has an all-seeing, all-hearing and reporting Inter-Communications System.

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Technical Reports

(Continued from page 9)

should be the topic of the sentence. It should tell the reader what's going to be said in the paragraph. It should aiso provide a transition (if such is needed) from the preceding paragraph. This topic sentence should be short and direct.

A good paragraph should also have a summarizing sentence which should warn the reader—"this is the end; prepare for another thought or another subject."

The length of a paragraph depends on two things: subject matter and consideration for the reader.

The rule of composition on paragraphing is clear. When the thonght or subject promised in the topic sentence is exhausted, start a new paragraph. Consideration for the reader may modify this rule somewhat. Written with the reader in mind, paragraphs should do several things:

- Give the reader visual evidence of a break in thought.
- Provide just enough material on each thought, or facet of a subject, not to tire his mind.
- Provide a "hook" for the reader's attention.

There are three major pitfalls to paragraphing:

- Lack of topic sentence.
- Lack of unity.
- Improper development of central thought.

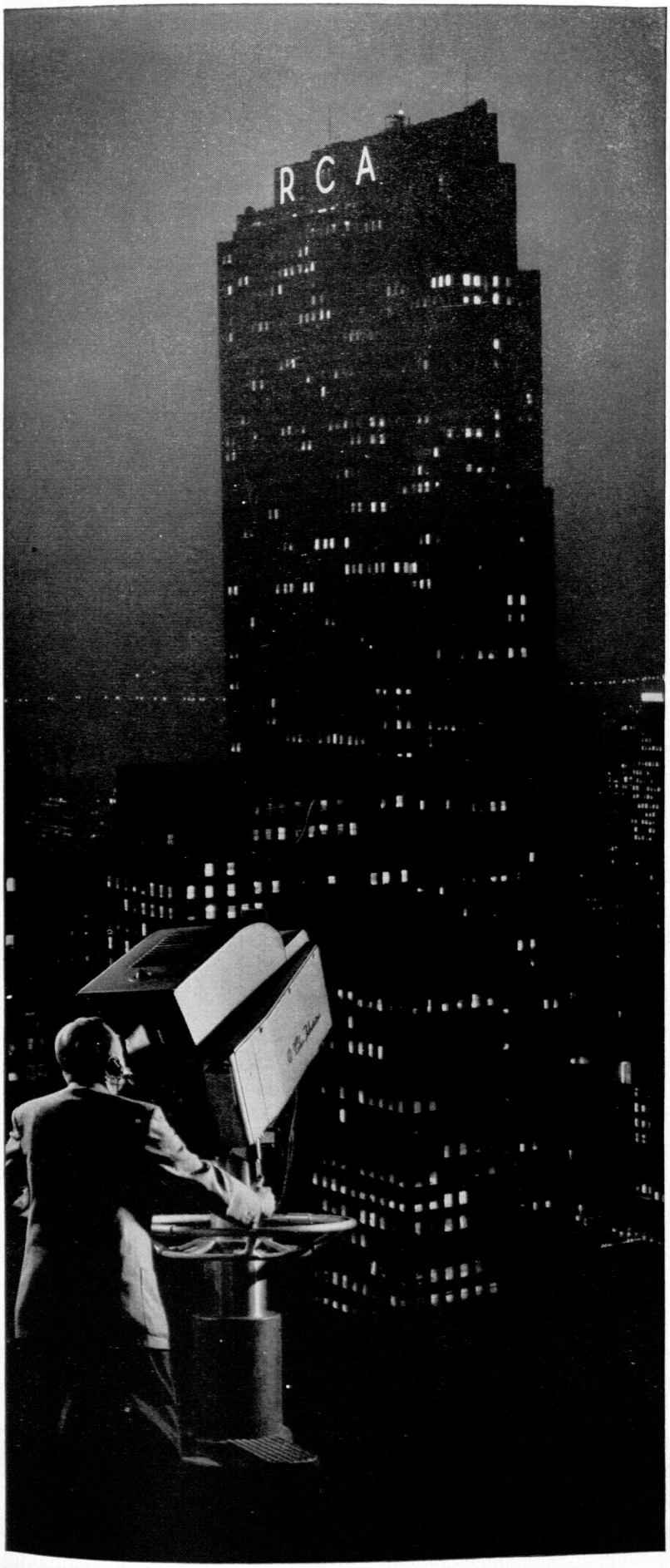
To see if you have observed the rules of good paragraphing, check your paragraphs against these questions:

1. Is the topic sentence concise?
2. Does the paragraph need a transition sentence?
3. Does the paragraph contain more than one central thought? (Yes? Then split the paragraph.)
4. Can the paragraph be broken into two by regrouping information? (This is desirable and worth the effort.)
5. Does material in the paragraph cover what was promised in the topic sentence?
6. Is a summarizing sentence needed?

Read your manuscript several times. First read over the entire draft to get the "feel" of it. Does it tell a story simply and concisely? Cut and shorten where possible.

Read it over a second time, looking for bad sentences, lack of topic sentences, and errors in grammar. If time permits, put the manuscript out of sight for a day or two. Then read it a third time before letting it out of your hands.

Paying attention to rules of composition and grammar is not enough. The professional writer soon learns many things that are not taught in college composition courses. You, as a report writer, should practice them too. For example, have confidence in your writing. You cannot do anything well unless you have confidence in your ability. Also, you must show interest in your writing. A good report is the result of a lot of hard work—and enthusiasm. But most of all, you've got to write if you want to be a good report writer. Writing is something than can be learned only through practice.



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RCA's 36 years' experience is yours to share in TV—black-and-white or color

To pioneer and develop television, in color as well as in black-and-white, called for a special combination of practical experience, great resources and research facilities in the fields of communications and electronics.

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EXPERIENCE: RCA has been the recognized leader in radio communications since its formation thirty-six years ago. Its world-wide wireless circuits, established in 1919, and its development of electron tubes, laid the groundwork for radio broadcasting in 1920 . . . and the first nationwide radio network in 1926.

Radio broadcasting led to television—and in 1939 RCA made history by introducing black-and-white TV as a service to the public.

Dr. V. K. Zworykin of RCA invented the Iconoscope, or television camera tube, and he developed the Kinescope, now universally used as the picture tube.

RESOURCES: Pioneering and development of color TV has been one of the most challenging and expensive projects ever undertaken by private industry. To date, RCA has spent $50,000,000 on color TV research and development, in addition to the $50,000,000 previously spent in getting black-and-white TV "off the ground" and into service.

RESEARCH FACILITIES: RCA has one of the most complete, up-to-date laboratories in the world—the David Sarnoff Research Center at Princeton, N. J. It is the birthplace of compatible color television and many other notable electronic developments.

No wonder that you can turn to RCA to find all of the essentials of quality and dependability born only of experience.

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RADIO CORPORATION OF AMERICA

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Clubs and Societies

(Continued from page 21)

tion with other engineers through spontaneous discussions, talks, speeches, and essays.

At the close of the meeting, several discussion groups gathered to talk over hobbies and engineering interests while new members were enrolled. ASME will continue to accept new members throughout the year at meetings, or by contacting Mr. Hemmye in Room 15, Olds Hall.

AFS

Michigan State's chapter of the American Foundrymen's Society is one of the most active societies in the engineering school. Last year the society presented a television skit demonstrating the fundamental principles of foundry technology (using live molten metal) and the wide applications of the casting industry.

Members of the chapter also participate in a number of meetings held at the Union and Kellogg Center where men from the cast metals industry present their problems and advice. Each year the chapter holds a student industry banquet at which student members can acquaint themselves with men in the cast metals field.

Each term the chapter sponsors one or two field trips to leading foundries in the state. The first trip this term was to the foundry and assembly plants of the Cadillac Motor Company Division of General Motors Corporation. These trips are open to all students in the engineering school—you are welcome ot go on these trips and a wealth of knowledge can be gained from them.

You are urged to join this active, beneficial, and informative society.

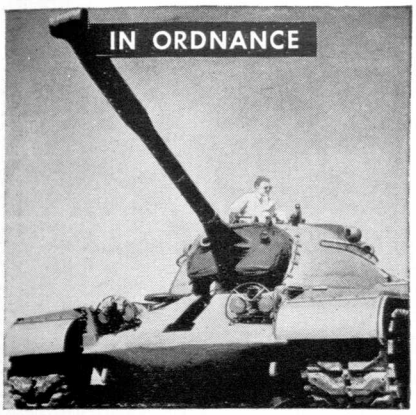
ASAE

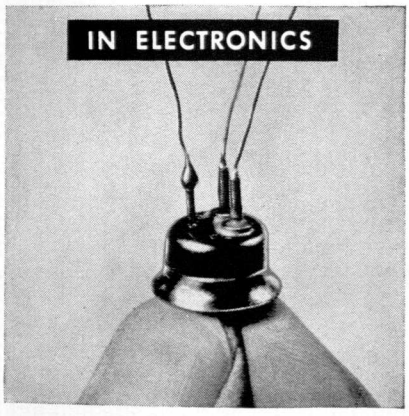
The Student Branch of the ASAE held their first meeting of the 1955-56 school year on September 27. Our president, Earl Terpstra, resigned to take the position of president of the Engineering Council. Vice-president Bob Muirhead then moved to president. Our second meeting of the term will be a special Open House for freshman and faculty members.

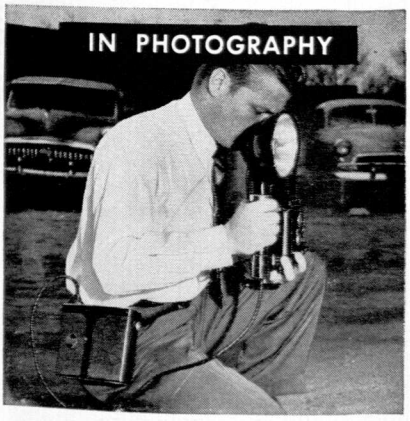
The Club had a booth at the Activities Carnival displaying the race car which won the race last year and a small electric bulldozer. Other activities for Fall term include the meeting of the Michigan Section of the ASAE on October 22. On November 8 the faculty has invited the students to a home-cooked dinner and program.

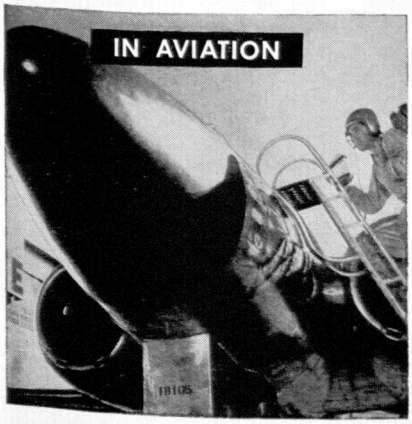
Farmer's Week will be the main event of the Winter term, during which the Club will help with exhibits and the program.

The major event for Spring term will be the Engineering Exposition which will follow its usual course with the Agricultural Engineers displaying machinery and other agricultural engineering displays. A Student-Faculty picnic, featuring all you can eat and a baseball game, will close the year's activities.









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THE opportunities for engineers in the automatic control field are unique in their variety and in the insight provided into all of the industries of today's modern world.

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These are a few of the fields in which Honeywell's several divisions are engaged, providing automatic controls for industry and the home.

These controls are made possible by the creative imagination of highly trained engineers working with the very latest research and test facilities.

With twelve separate divisions located throughout the United States and with factories in Canada, England and Europe, Honeywell offers unlimited opportunities in a variety of challenging fields. Based on diversification and balance between normal industry and defense activities, Honeywell will continue to grow and expand because automatic control and instrumentation are so important to the world's progress.

That is why we are always looking for men with ideas and imagination and the ambition to grow with us. In addition to full time engineering and research employment we offer a Cooperative Work Study program, a Summer Student Work Study program and Graduate Fellowships. If you are interested in a career in a vital, varied and diversified industry, send the coupon for more information.

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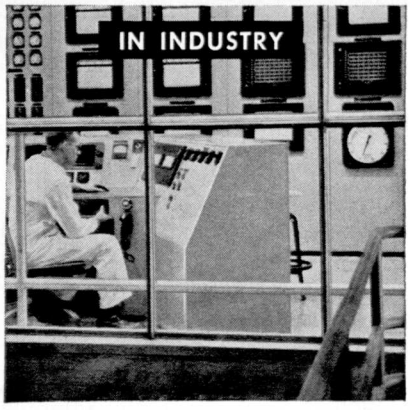

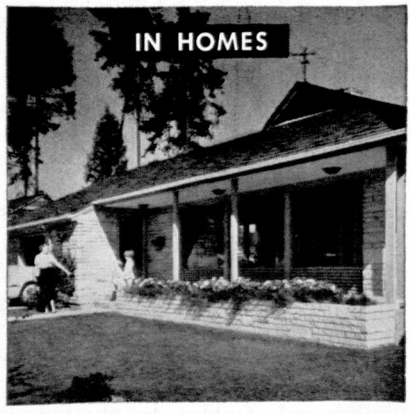

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Gentlemen: Please send me your booklet, "Emphasis on Research", which tells more about engineering opportunities at Honeywell.

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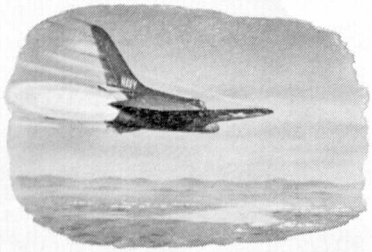
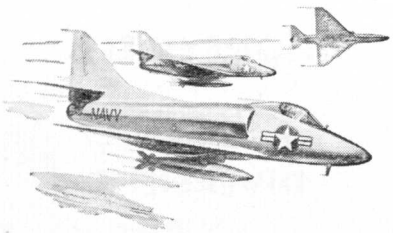
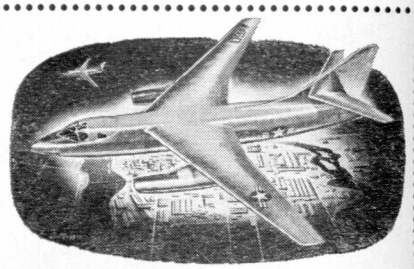


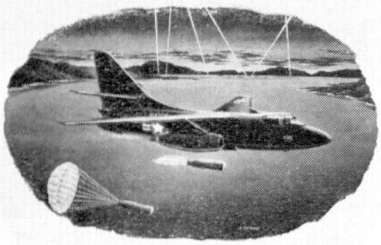
F4D, "SKYRAY"— only carrier plane to hold official world's speed record



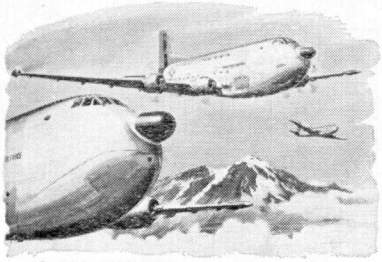
A4D, "SKYHAWK"— smallest, lightest atom-bomb carrier



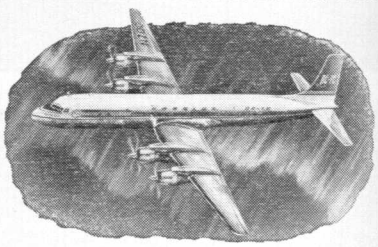
RB-66 — speedy, versatile jet bomber



A3D, "SKYWARRIOR"— largest carrier-based bomber



C-124, "GLOBEMASTER"— world's largest production transport



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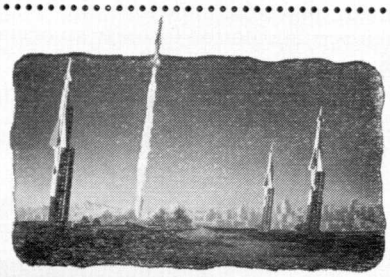
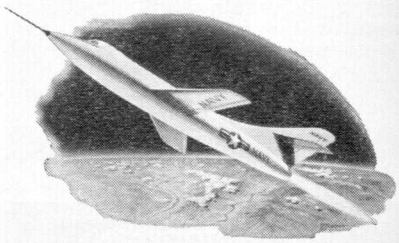


"NIKE"— supersonic missile selected to protect our cities



D558-2, "SKYROCKET"— first airplane to fly twice the speed of sound

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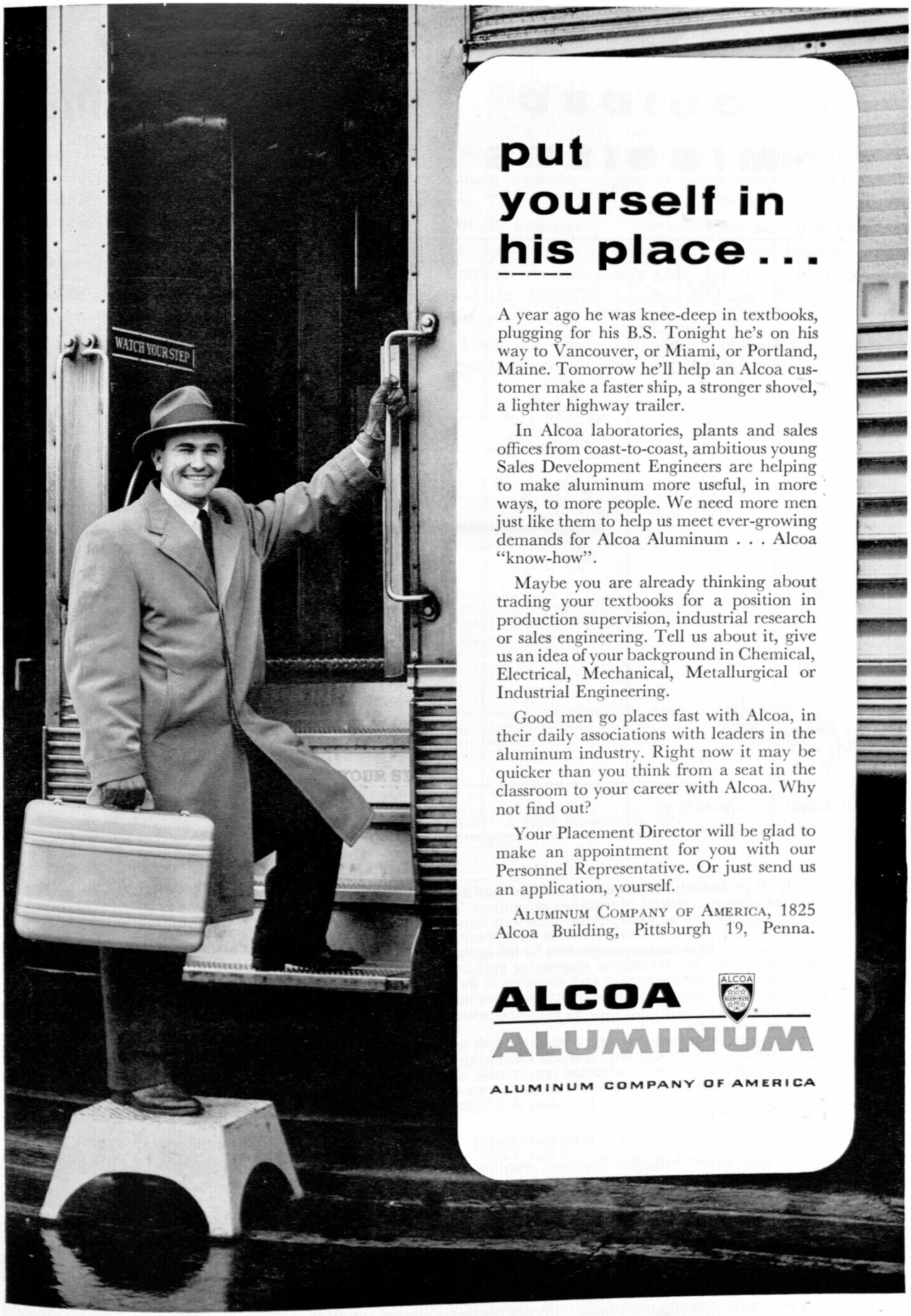

put yourself in his place . . .

A year ago he was knee-deep in textbooks, plugging for his B.S. Tonight he's on his way to Vancouver, or Miami, or Portland, Maine. Tomorrow he'll help an Alcoa customer make a faster ship, a stronger shovel, a lighter highway trailer.

In Alcoa laboratories, plants and sales offices from coast-to-coast, ambitious young Sales Development Engineers are helping to make aluminum more useful, in more ways, to more people. We need more men just like them to help us meet ever-growing demands for Alcoa Aluminum . . . Alcoa "know-how".

Maybe you are already thinking about trading your textbooks for a position in production supervision, industrial research or sales engineering. Tell us about it, give us an idea of your background in Chemical, Electrical, Mechanical, Metallurgical or Industrial Engineering.

Good men go places fast with Alcoa, in their daily associations with leaders in the aluminum industry. Right now it may be quicker than you think from a seat in the classroom to your career with Alcoa. Why not find out?

Your Placement Director will be glad to make an appointment for you with our Personnel Representative. Or just send us an application, yourself.

ALUMINUM COMPANY OF AMERICA, 1825 Alcoa Building, Pittsburgh 19, Penna.

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

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*Inside front cover

**Inside back cover

***Back cover

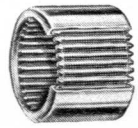
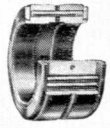
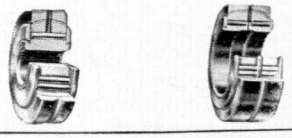
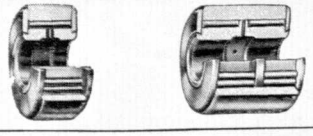
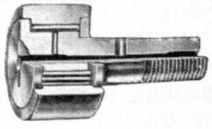
The Torrington Needle Bearing... many types for many needs

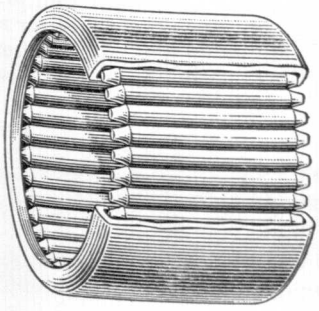
In previous advertisements in this series, the many advantages of the Torrington Needle Bearing and the proper procedure for its installation and maintenance have been discussed. The DC unit type bearing was used in these discussions because it is the Needle Bearing with by far the greatest variety of applications throughout industry.

From the basic Needle Bearing design, however, many modifications have been made. The result is a complete line of Needle Bearings suitable for specific applications. Although these bearings are all different, each offers the advantages which have made the DC unit type so popular. They give the highest possible radial load capacity in a minimum of space; they are light in weight, easy to install and simple to lubricate.

The following chart shows many types of Torrington Needle Bearings, gives their design features and general applications for which they are designed.

The new Torrington Needle Bearing catalog will be sent on request.

TYPE	SERIES	BEARINGS	DESIGN FEATURES	APPLICATIONS
DC	B		Thin, drawn shell, retaining full complement of small diameter rollers. Inner races are furnished when shafts are not hardened.	Wherever high load capacity is needed and space is at a premium.
HEAVY DUTY			The outer race is made in one channel-shaped piece, hardened and ground to precision limits. Heavy inner race.	For heavy-duty applications where split housings occur or where press fit of bearing into housing is not possible.
AIR-CRAFT	NBC		Heavy inner and outer races, with end washers securely fastened to inner race.	Aircraft applications involving oscillating motion only.
	NBE *(left)* NBK *(right)*		Similar to NBC except have self-aligning outer races.	Aircraft applications where alignment is difficult or deflection is severe.
	NBF *(left)* NBL *(right)*		Similar to NBC except have heavy outer races to carry rolling loads.	For use as rollers under heavy loads at low speeds.
CR	CR		Heavy solid-sectioned outer race and rollers made from high-quality bearing steel. Portion of stud which serves as inner race is hardened. Threaded end left soft to avoid brittleness.	Cam follower applications where maximum load capacity and shock resistance are required.



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TORRINGTON NEEDLE BEARINGS

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • BALL • NEEDLE ROLLERS

Automation

(Continued from page 23)

But we can expect to raise it to the next higher level of manufacturing. With additional investments in machinery and perhaps in floor area, any one of the manufacturing types can usually be raised one notch up the scale. This should be the goal of industry. With such an approach, economic automation may be achieved. Also, with this approach, when automation is accomplished in any operation, the change will come about naturally, slowly.

But the most important question to the confused man on the street is: What will automation do for me? It will provide a higher standard of living, but there's more to it than that.

The defense of America, now as in the past, depends on our ability to produce. In time of a major defense effort, our national production facilities are strained to the last man-hour. Automation then assumes the role of a vital defense mechanism. We can ill afford to neglect the excellent opportunities it presents.

Another facet of America makes automation a necessity. The working population and the total purchasing power of this nation are naturally closely allied. The gross national product is increasing at the rate of 3½ percent a year. However, the American working population is increasing at the rate of only 1.8 percent a year. Something, somehow has to take up the slack if we are to continue to be able to produce to the level required to improve our current standard of living. Automation is that something. We need automation just to maintain the present rate of improvement in our country's standard of living.

Maniac

(Continued from page 7)

In conclusion, I'd like to point out a few of the advantages of these computers. In the example which was just worked out there were two degrees of freedom. In many cases, problems arise which involve several more degrees.

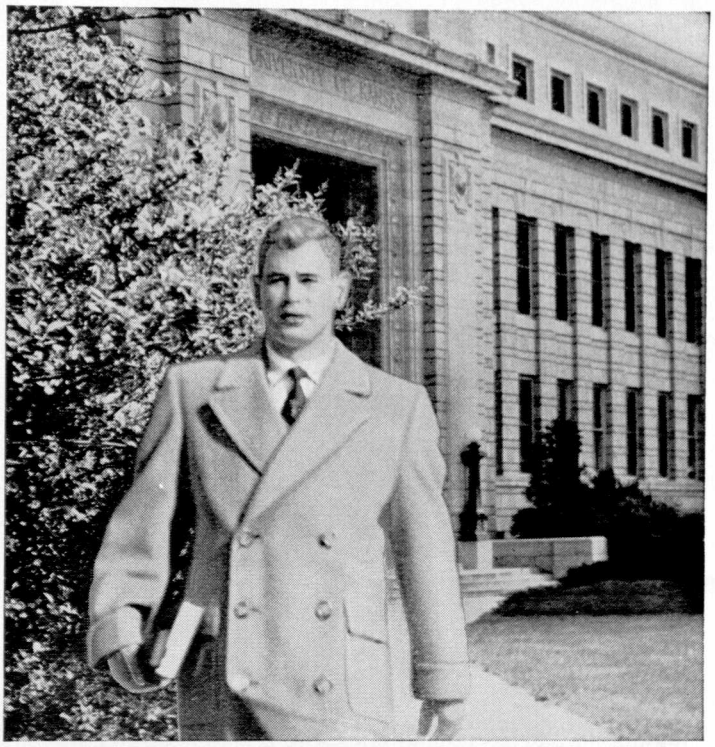
An example of this is in the design of an airplane. Here there are the three moment freedoms of pitch, yaw, and roll; and the three displacement freedoms, longitudinal, vertical and transverse.

Problems like these are the reason that analog computers have become so prominent. Because they operate at quite high speeds, they are especially useful in experimental work. The effect of changing a particular parameter on a system can be found immediately by changing the appropriate dial setting.

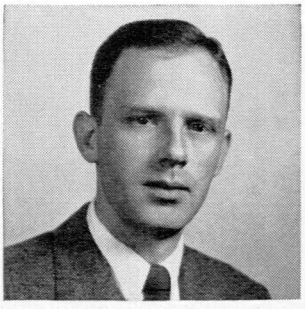
Now that systems in all fields are becoming increasingly complex, analog computers should be of equal interest to all engineers.

Dave Johnson asks:

What's involved in production work at Du Pont?



DAVID L. JOHNSON, JR., expects to receive his B.S.Ch.E. from the University of Kansas in 1956. He is very active in campus affairs, president of Alpha Chi Sigma and a member of several honorary engineering fraternities. Dave is interested in learning more about production work in the chemical industry.



JAMES L. HAMILTON is one of the many young engineers who have been employed by Du Pont since the end of the war. After service in the Navy, Jim got his B.S.Ch.E. from the University of West Virginia in June 1948, and immediately joined Du Pont's Repauno Plant at Gibbstown, N. J. Today, he is Assistant Superintendent of the dimethyl terephthalate area at this plant.

Jim Hamilton answers:

Well, Dave, I've been doing production work at Du Pont for about seven years now, and I'm still getting involved in new things. That's what makes the work so interesting—new and challenging problems arise all the time.

To generalize, though, the duties are largely administrative. That's why effectiveness in working with others is one of the prime requirements. Teamwork is important in research and development work, for sure. But it's even more important in production, because you work each day with people having widely different skills and backgrounds.

A production supervisor needs a good understanding of engineering and scientific principles, too. He has to have that to get the best results from complicated equipment—but he doesn't necessarily need the specialized training that goes with research and development work. A real interest in engineering economics and administration is usually more helpful to him here than advanced technical training. The dollar sign's especially important in production work.

It all adds up to this, Dave. If you enjoy teamwork, and have a flair for large-scale, technical equipment, then you'll find production work mighty rewarding.

A MORE COMPLETE ANSWER to Dave Johnson's question about production work is given in "The Du Pont Company and the College Graduate." This booklet describes in detail the training, opportunities and responsibilities of engineers who take up this kind of work at Du Pont. Write for your free copy to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington, Delaware.

DU PONT

REG. U. S. PAT. OFF.

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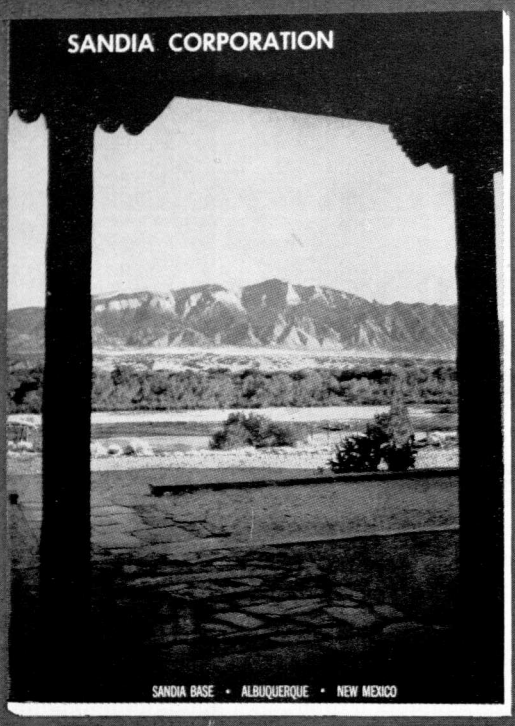

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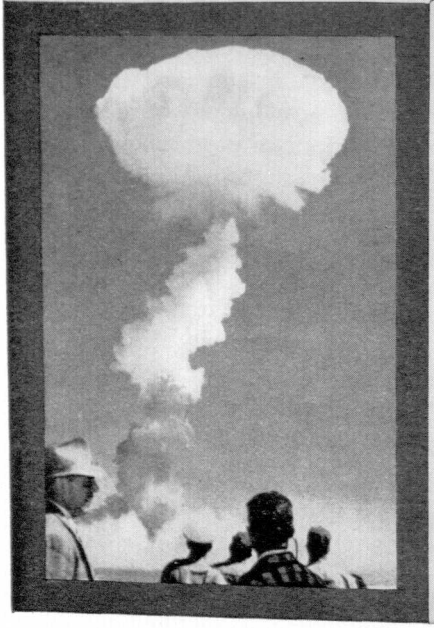
in the field of
NUCLEAR WEAPONS DEVELOPMENT



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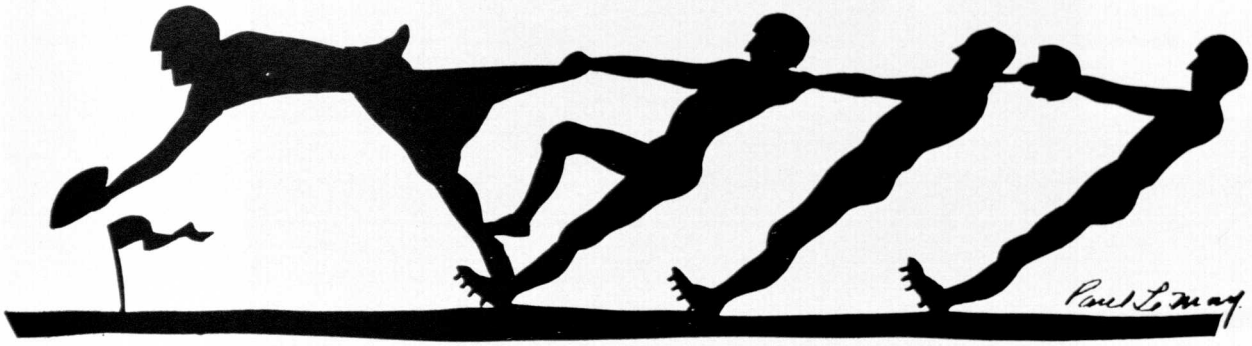
Or Write Mr. F. E. Bell, Professional Employment Division, Sandia Corporation

SANDIA *Corporation*

Albuquerque, New Mexico

Determine NOW To Reach Your Goal



The choice of your career association means much to you in realizing your ambition. CONVAIR-FORT WORTH offers exceptionally attractive career opportunities worthy of investigation and consideration by every Engineering Graduate.

As a division of General Dynamics Corporation, CONVAIR of Fort Worth occupies an important place in the long-range development of the Nation's military and commercial aviation. CONVAIR'S scope of activity offers interesting career opportunities for men with engineering talents.

At CONVAIR-FORT WORTH you work in ideal, air-conditioned surroundings. A company-sponsored, in-plant program enables candidates to earn graduate degrees in Engineering. CONVAIR has paid vacations, excellent insurance and retirement programs. Advancement is entirely on merit.

Fort Worth in the Great Southwest has an abundance of community life of interest to college graduates — Southwest Conference athletics, excellent musical and theatrical bookings, seven large lakes in nearby area, year-around climate conducive to outdoor living and recreation.

Write now for information about CONVAIR'S interest in Engineering Graduates.

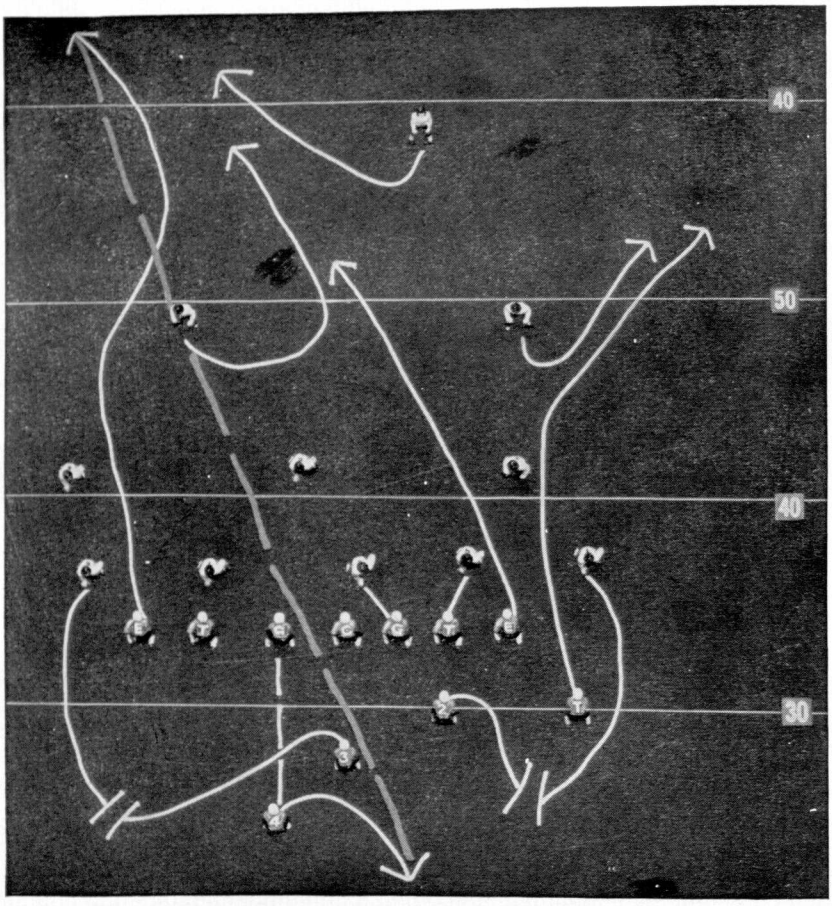
Address . . . H. A. BODLEY
CONVAIR Engineering Personnel Dept.
Fort Worth, Texas

CONVAIR

A DIVISION OF GENERAL DYNAMICS CORPORATION

FORT WORTH, TEXAS

An enlarged reprint of the above cut-out silhouette, suitable for framing or pinning up, will be sent free to any engineering student on request.



aerial attack

Q: What has *this* to do with the aircraft industry —and you?

A: It may have plenty to do with both. Here's how:

Football teams are judged by scoring ability in top competition—teamwork, form, ability, strategy, class. So, too, are aircraft companies.

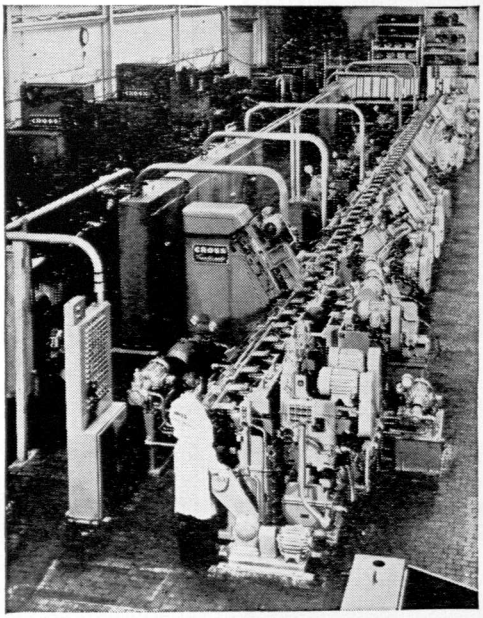
Martin has created one of the finest engineering teams in the whole world of aviation. And under the new Martin concept of design and development by team operation, every engineering problem—from today's experimental contract to the frontier problems of the future—is the target for a coordinated "aerial attack" by a top-flight team of specialists.

Result: Martin's team operation technique has opened up important opportunities for young creative engineers.

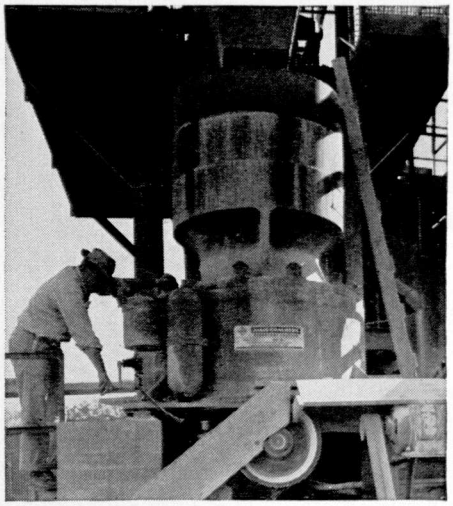
Contact your placement officer or J. M. Hollyday, The Martin Company, Baltimore 3, Maryland.

MARTIN
BALTIMORE

Build your future on these 3 Growth Industries...



MANUFACTURING — There are 51 Allis-Chalmers motors in this lineup of machine tools designed for high automobile production.



CONSTRUCTION—Crushers like these from Allis-Chalmers process the enormous quantities of aggregate for the booming construction industry.

THERE IS much talk today about growth companies. Allis-Chalmers is one of them, supplying machinery for three basic industries—manufacturing, construction and power.

Therein lies an opportunity for you, since Allis-Chalmers builds many types of equipment.

. . . for a manufacturing industry that must increase output $3.5 billions by this time next year.

. . . for the construction industry that is destined to spend many billions of dollars on highways in the next ten years.

. . . for the electric power industry that will double its capacity by 1956.

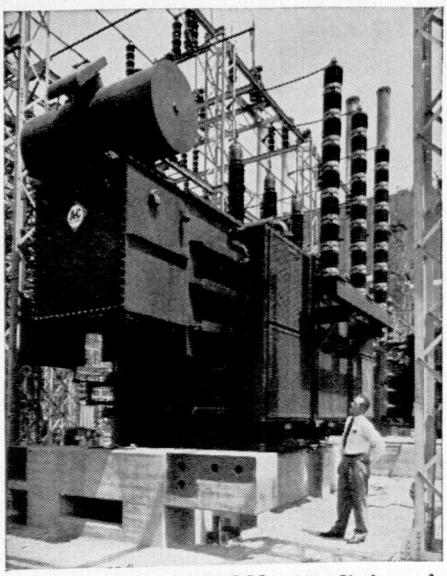
Here's what Allis-Chalmers offers to Young Engineers:

A graduate training course that has been a model for industry since 1904. You have access to many fields of engineering: Electric power, hydraulics, atomic energy, ore processing.

There are many *kinds* of work to try: Design engineering, application, research, manufacturing, sales. Over 90 training stations are available with expert guidance when you want it. Your future is as big as your ability can make it.

Or, if you have decided your field of interest and are well qualified, opportunities exist for direct assignments on our engineering staff.

In any case—learn more about Allis-Chalmers. Ask the A-C manager in your territory, or write direct to Allis-Chalmers, Graduate Training Section, Milwaukee 1, Wisconsin.



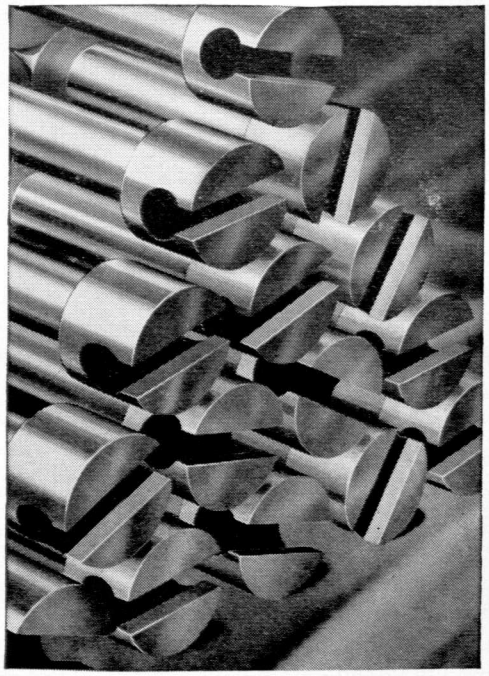
POWER GENERATION—Allis-Chalmers is helping meet growing power demand with equipment such as this 150,000 kva transformer.

A-4684 **ALLIS-CHALMERS**

Plants and Sales Offices all over the World

Another page for **YOUR STEEL NOTEBOOK**

The steel that could take anything but a bath



In steel mills and warehouses, a roller leveler straightens wide sheets and heavy plates between powerful steel rolls.

Stress on the rolls is tremendous. To make them strong and tough enough, one manufacturer used an alloy steel, 52100. Then, to make the rolls *hard* enough, they were heated to a high temperature and quenched in a liquid bath. But the severe quench was causing many of the rolls to warp.

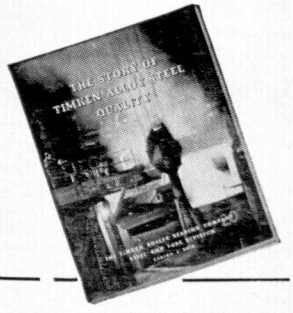
The roll maker took his problem to Timken Company metallurgists, asked if he could make rolls from 52100 steel that wouldn't distort in quenching. They said yes—if the steel were uniform from lot to lot in analysis and hardenability.

TIMKEN® steel quality control solved the distortion problem

The roll maker switched to 52100 steel made by the Timken Company. He found the steel was uniform from lot to lot, heat to heat, year in and year out. Result: he was able to standardize heat-treating practice. Distortion was practically eliminated.

The Timken Company constantly solves steel problems like this one by furnishing steels to the most exacting specifications. Timken Company metallurgists are specialists in fine alloy steels. And they use the most modern quality control methods to assure uniformity, time after time after time.

Want to learn more about steel or job opportunities?



Some of the engineering problems you'll face after graduation will involve steel applications. For help in learning more about steel, write for your free copy of "The Story of Timken Alloy Steel Quality." And for more information about the excellent job opportunities at the Timken Company, send for a copy of "This is Timken". Address: The Timken Roller Bearing Company, Canton 6, Ohio.

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

SIDETRACKED

A passenger in an airplane was far up in the sky when the pilot began to laugh hysterically.

"What's the joke," asked the passenger.

"I'm thinking what they'll say at the asylum when they find out I escaped."

A Texan, newly arrived in England, was playing poker with a couple of the natives. He was pleasantly surprised upon picking up an early hand to see four aces in it.

"I'll wager a pound," said the Britisher on his right.

"Ah don't know how y'all measure your money," drawled the Texan, "but Ah reckon Ah'll have to raise you about a ton."

A bricklayer working on top of a building accidentally dropped a brick squarely on the head of a civil engineering student walking below.

"You'd better be careful up there," said the student. "You just made me bite my tongue."

The girl was through with her bath and was stepping onto the scale to weigh herself. Her husband happened to return home at the time and entered through the back door. Seeing what his wife was doing as he passed the bathroom door, he exclaimed, "Well, dear, how many pounds today?"

Without turning her head, she replied, "I'll take fifty pounds today, and don't you dare pinch me with those tongs."

Brainteaser

M.E. PROBLEM, TEST # 2.

A crosseyed woodpecker with a cork leg and synthetic rubber bill required ½ hour to peck ¼ of the distance through a cypress log 53 years old. Shingles cost 79 cents per hundred and weigh 8 pounds apiece. The log being pecked upon is 34 feet long and weighs 46 pounds per foot. Assuming that the coefficient of friction between the woodpecker's bill and the cypress log is 0.097 and there is negligible resistance to diffusion, how many units of vitamin B_1 will the woodpecker require in pecking out enough shingles for a $75,000 barn with detachable chicken house? The woodpecker has an efficiency of 97 percent, and gets time and half for overtime.

FREE—Lifetime subscription to bearer of correct answer. Contact S.E. office—Union Building.

One day a little mouse was hurrying across a wheat field when suddenly it was scooped up by a big reaping machine; the poor little mouse was tossed from side to side, and was finally thrown back on the field. Another little mouse came upon his friend lying on the ground, bruised and beaten, and asked him what happened.

"I've been reaped," came the reply.

ME: "How did you puncture that tire?"

EE: "Ran over a milk bottle."

ME: "Didn't you see it?"

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

During the holidays, two students from the same town met back in the old home burg.

"Say," said the first, "aren't you working your way through college?"

"Yes," replied the second, "I'm editing the *Spartan*, but don't tell my mother. She thinks I'm bootlegging gin and peddling marajuana cigarettes."

A Chem. E. we know broke his arm fighting for a woman's honor. It seemed that she wanted to keep it.

"Heard you were moving a piano, so I came over to help."

"Thanks, but I've already got it upstairs."

"Alone?"

"Nope, hitched a cat to it and drug it up."

"You mean your cat hauled that piano up two flights of stairs? How could a cat pull a heavy piano?"

"Used a whip!"

The doctor gave his 80 year old patient a very curious look.

"I've been practicing for two decades, and I'll be darned if I ever heard of such a complaint as yours. What do you mean, your virility's too high?"

"It's all up in my head," replied the old man, sighing gently.

Try reading the rest of the magazine—it's good, too!