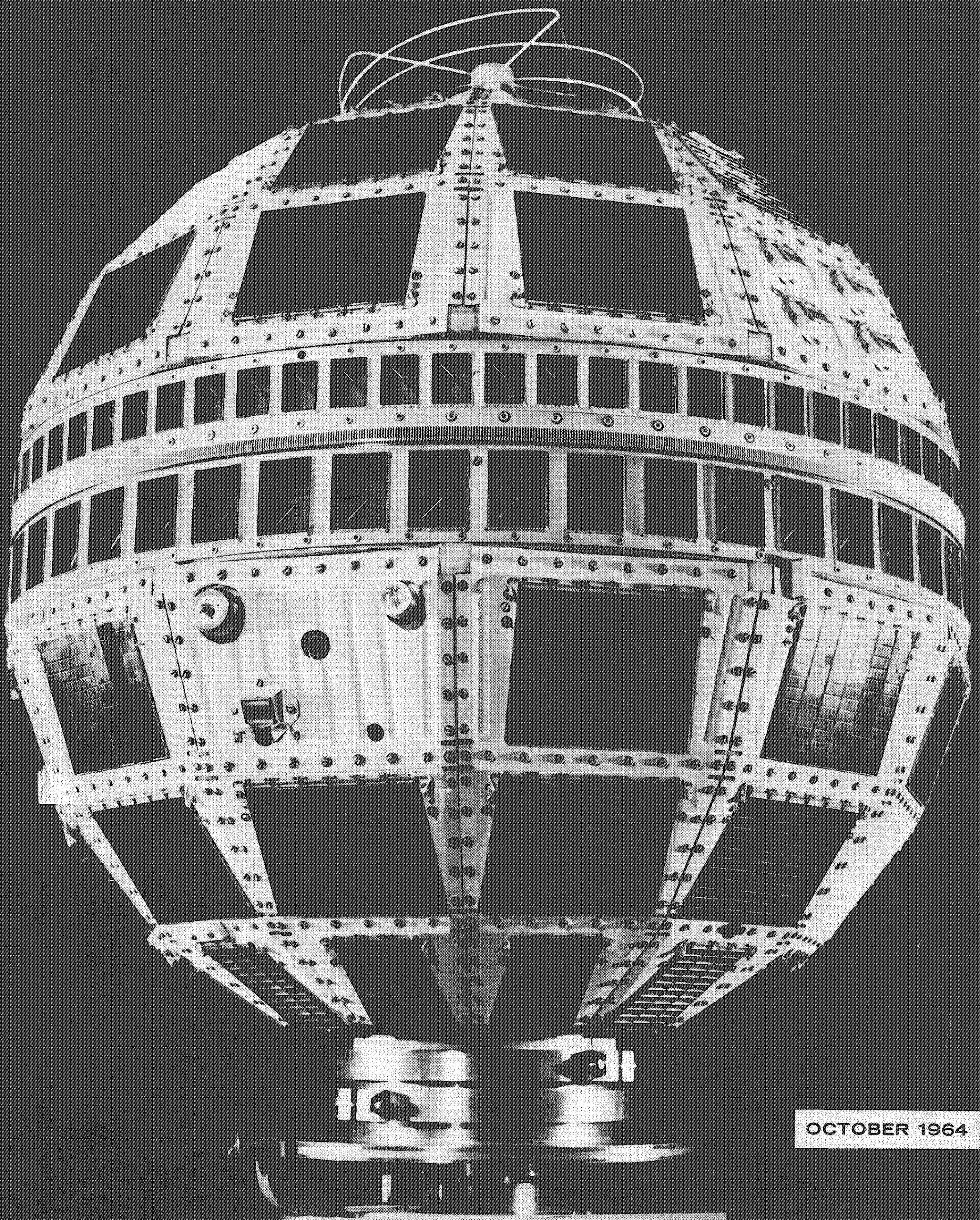
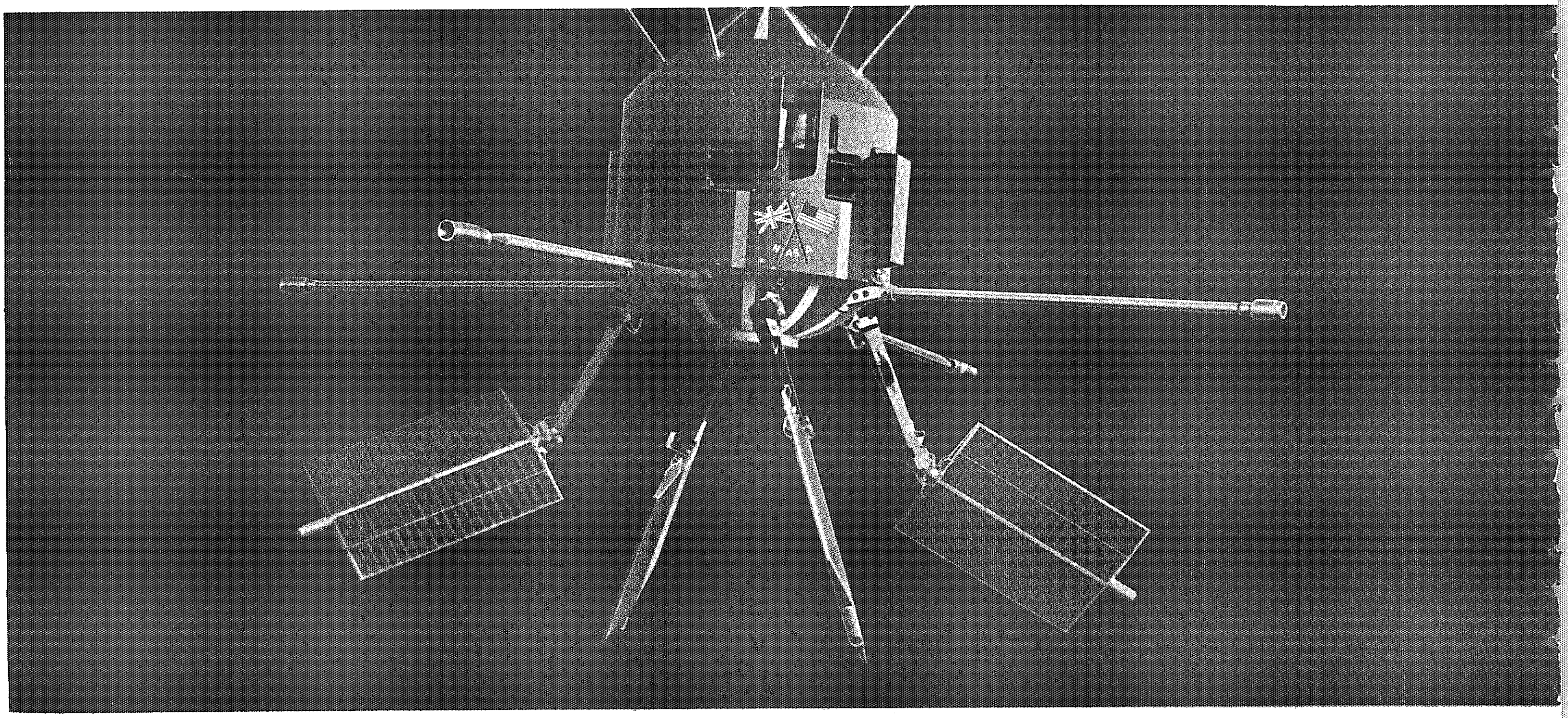
Minnesota TECHNOLOG



OCTOBER 1964

Scientists are listening to sounds from the stars



through a satellite built by Westinghouse

Almost all we know about deep space we learned by studying light . . . the faint, flickering light from distant stars. Now, suddenly, a whole new universe is opening up to us through *sound* from the stars. It comes via a satellite in which the British Government, NASA's Goddard Space Flight Center and Westinghouse each had a share.

This sound comes from millions of stars which we never knew before, because they emit no light. We couldn't hear them, either, because the earth's atmosphere shut off these noises, but now we can. The satellite, Ariel II, also tells us how the earth's heat balance affects weather and how micrometeoroids erode space ships.

The British developed the scientific experiments. Westinghouse built the satellite and integrated the system. NASA launched it.

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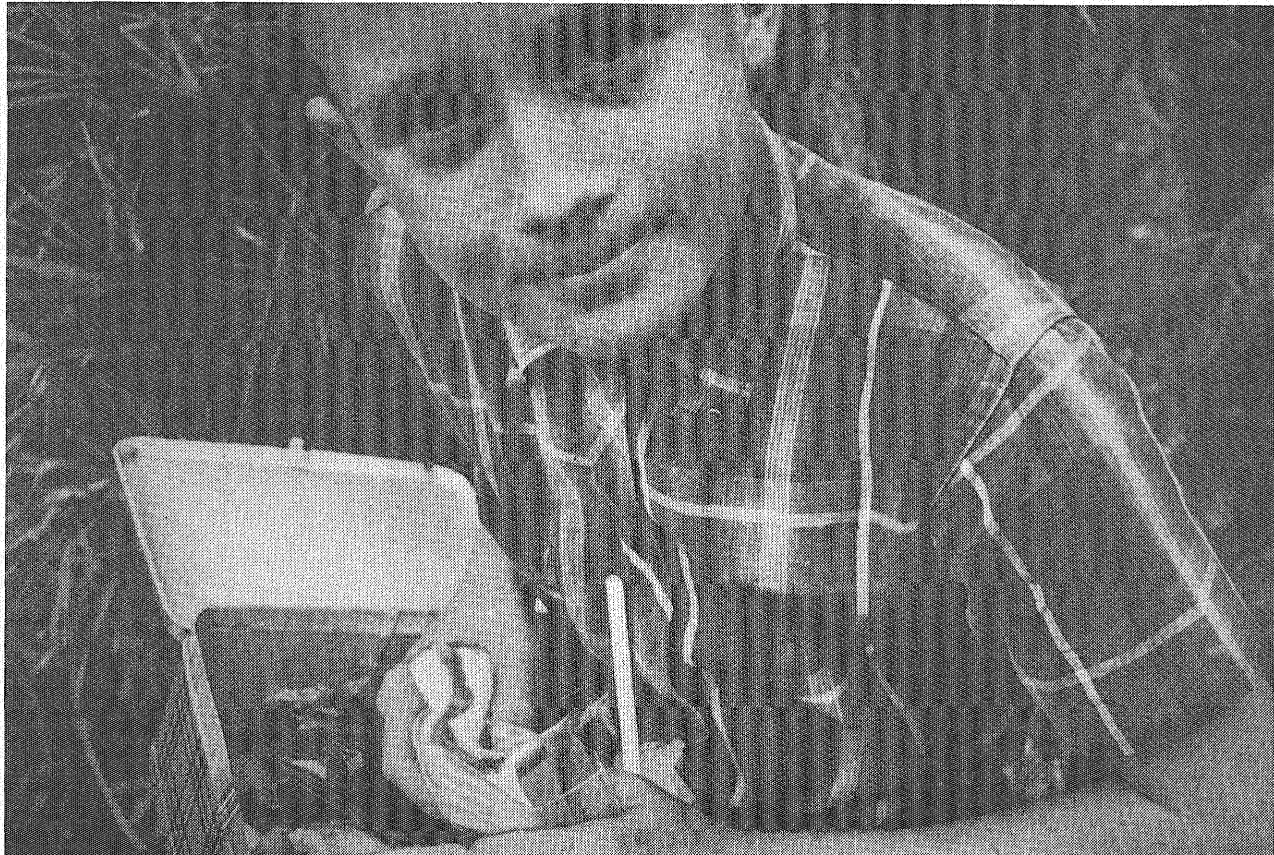

Is it possible that a leading maker of jet engine turbine blades had a hand in giving Pat Deegan a fresh sandwich today that was made last night?

It's perfectly logical to assume that the nation's leading producer of alloying metals like chromium, manganese, tungsten, and vanadium could become an expert on their use in new forms of steel. One result is the development of a new kind of stronger stainless steel.

Nor would it be surprising that the nation's pioneer and leading producer of plastic raw materials would be selling plastic food bags with a new kind of fold-lock top that locks in freshness. They're called "Glad" Bags, and they keep Pat Deegan's lunch fresh even though it was packed the night before.

But you'd have every reason to doubt that two such unlike activities could come from the same company. Provided you didn't know about Union Carbide.

In fact, you'll come across lots of diversifications at Union Carbide. It's one of the world's largest producers of chemicals, and it makes ingredients for textiles, paint, and urethane foam for cushioning. It is one of the most diversified private enterprises in the field of atomic energy. As a world authority in super-cold fluids, it produces tons of liquefied hydrogen, oxygen, and nitrogen for fueling space vehicles. It's a leader in carbon products and makes exhaust nozzle liners for rockets, brushes for electric motors, and electrodes for electric arc furnaces. And its consumer products include world-leading "Prestone" anti-freeze.

In fact, few other corporations are so deeply involved in so many different skills and activities that will affect the technical and production capabilities of our next century.

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Cover: Telstar, Bell Telephone Company's middle-range communication satellite is this month's cover subject. Picture courtesy of Bell Telephone Company.

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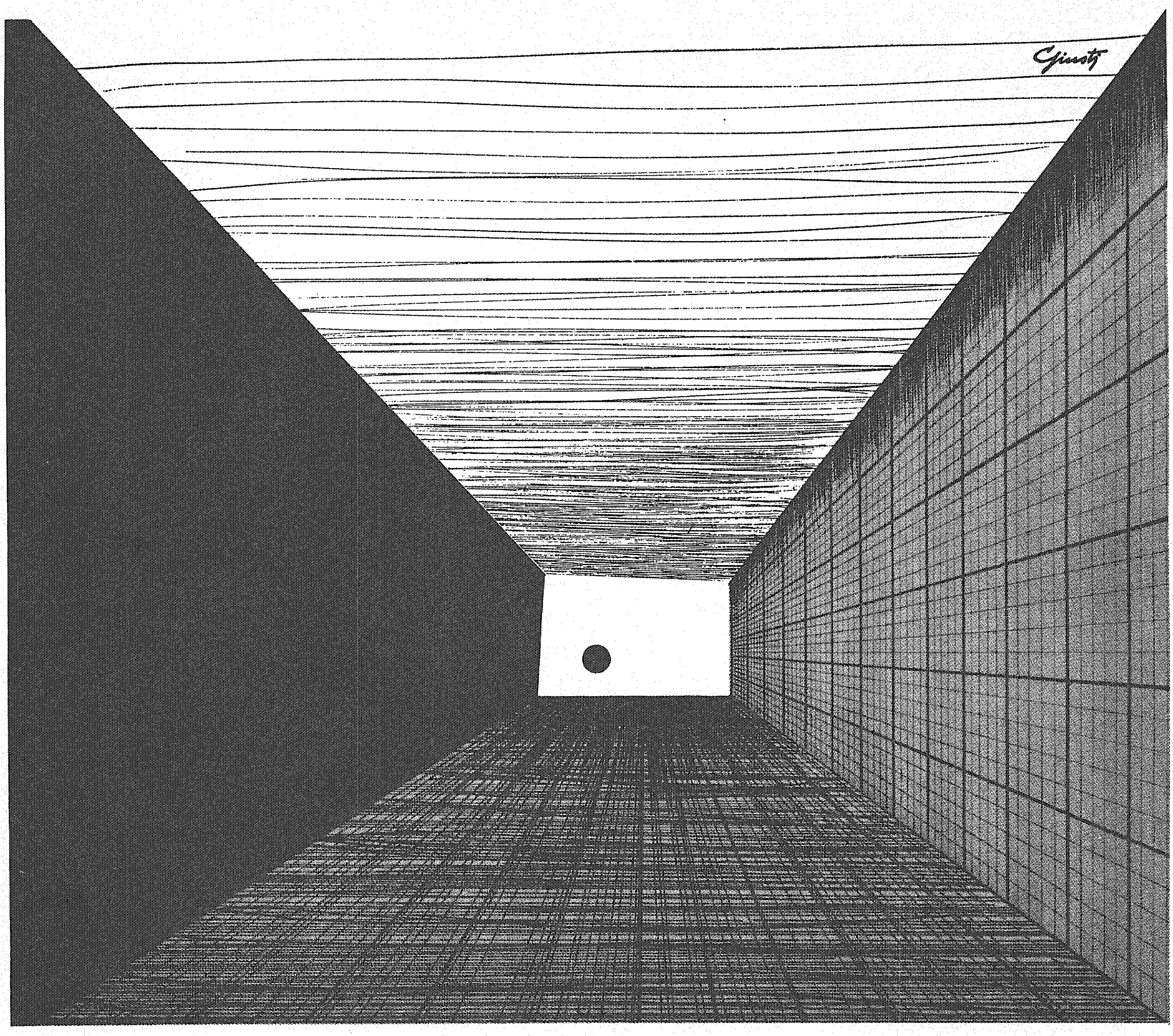

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Editorial

The Locusts Are Coming

There are 38,500 stories in the naked university. One of these stories concerns the arrival of a new freshman class. This annual drama is played out in our hallowed halls by a herd of bright-eyed, dimpled, rosy-cheeked children who have become students of this university. Kinda makes you think in a nauseous sort of way, doesn't it?

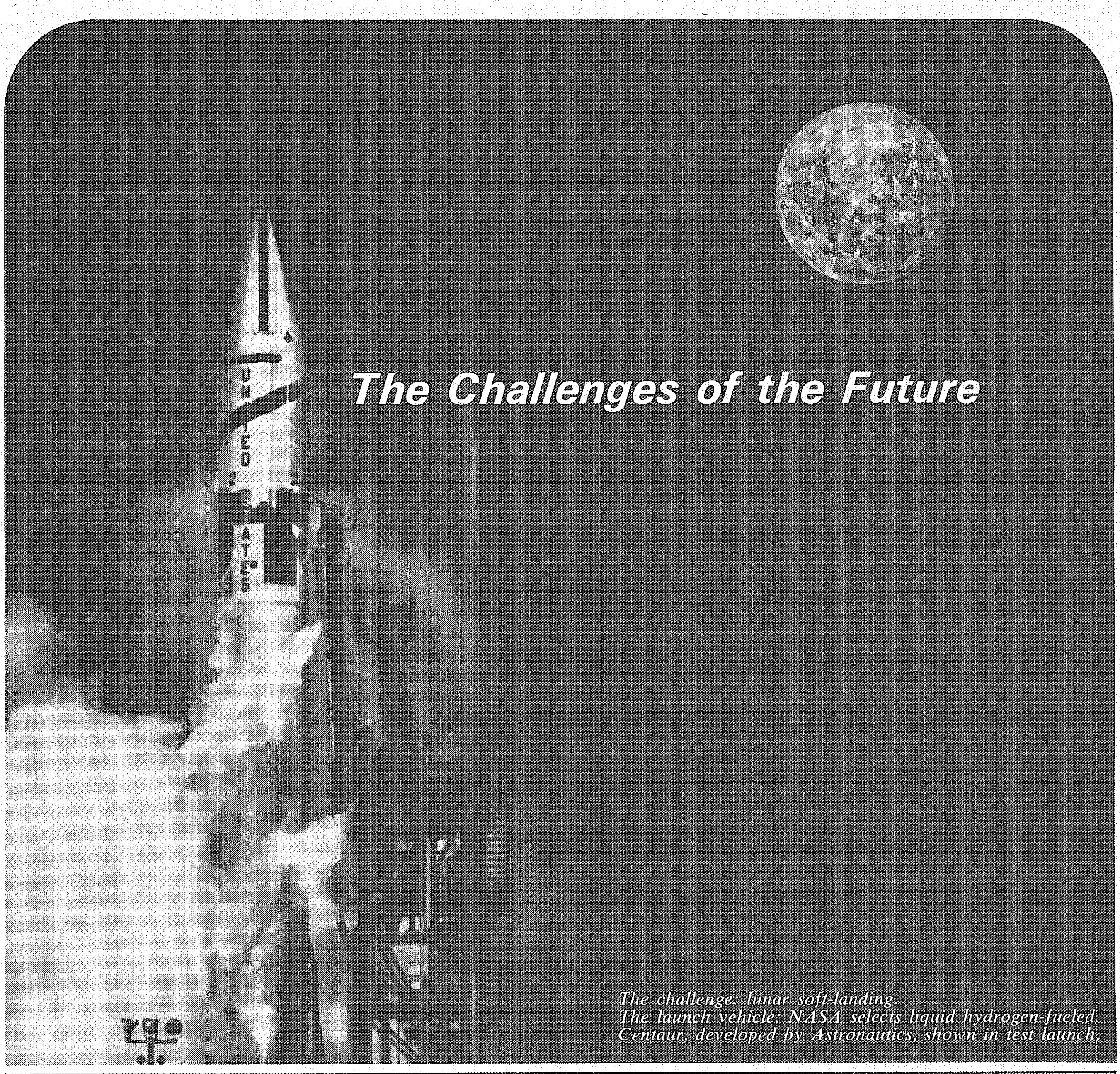
With their hands still warm from milking the cows and calloused from pulling the plows, these intellectually hungry young men and women have traded parity for Physics 11 and soil bank for west bank.

Much of the intellectual cream has entered IT. Two out of three will be back on the farm before the other one-third graduates. Kinda makes you think in a pleasant sort of way, doesn't it?

But let us analyze the anatomy of a freshman. Let us delve deeply into his tiny world and focus upon his first day in IT. The freshman on his first day always shows up with a briefcase filled with every book he owns. This acts as a combination security blanket and teething ring. It gives the new student confidence and blisters. Also on his first day the freshman invariably winds up in the Main Engineering study room. This apparently fills his need for togetherness by letting him share a table with seventeen other students. After a few minutes of attempted study, our freshman's growing stomach instinctively leads him to a milk(ing) machine. Having thus sustained his little body, he starts off for his next class. The freshman always arrives in class early and sits in the front row, hoping that when assigned seats in alphabetical order he won't be sitting next to an ugly girl. All he needs now is a freshman beanie, one with a propeller on the top. Fortunately this condition only lasts one year; every year.

By the way, welcome freshmen.

DEE



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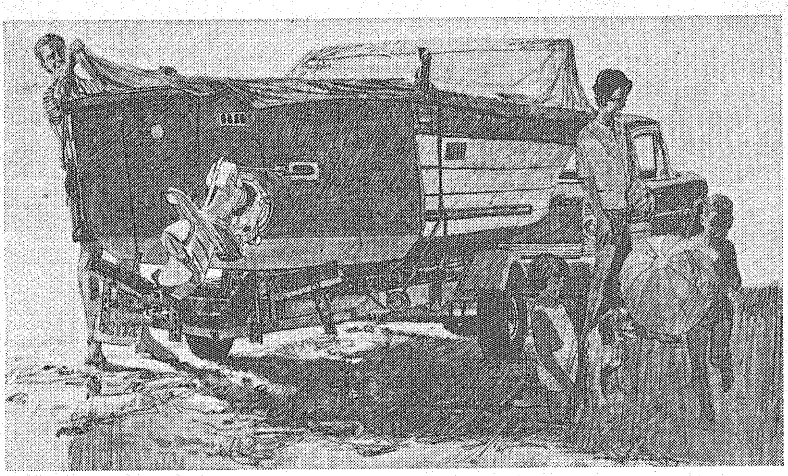

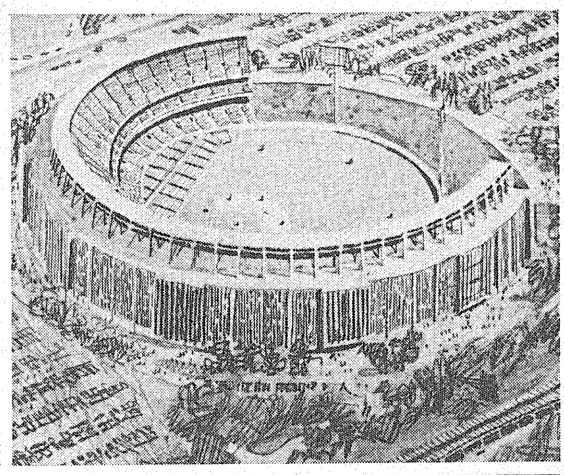

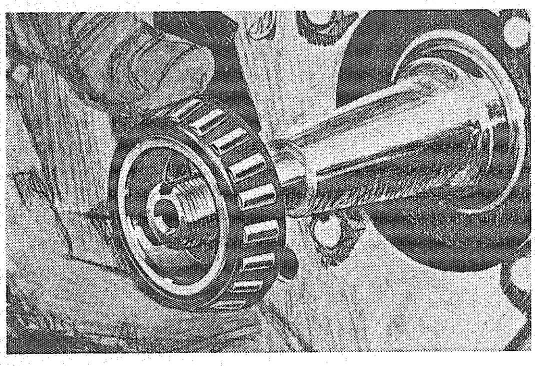

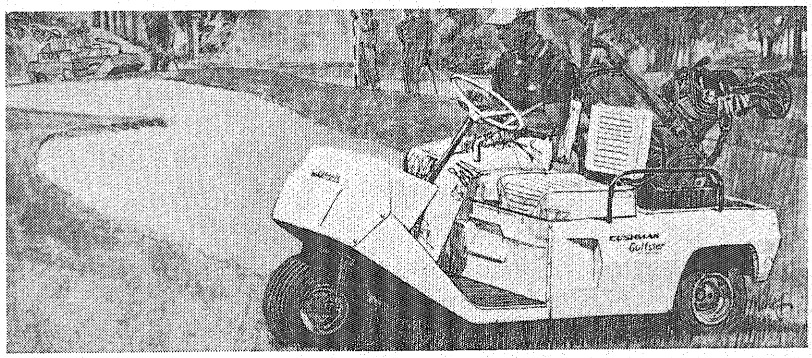

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ECHO

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ECHO

by F. S. HIRD, *Bell Telephone Co.*

Consideration of the use of communication satellites for long distance telephone transmission has brought into focus a fundamental problem in communications. It is customary to think of electrical transmissions being at the speed of light and the consequent lapse of time between the transmission and the reception being so short as to be immaterial. For most of the telephone usage this is true, but when the distances exceed about 1500 miles, the transit time becomes a consideration and as this distance increases it becomes more and more objectionable.

The feasibility of communicating between continents via orbiting radio repeaters has been demonstrated by the very successful Telstar, Relay and Syncom programs. The medium altitude satellites such as the Telstar or Relay type would orbit the earth at about 6,000 miles above the earth. The synchronous type has an orbit 22,300 miles from the earth. Transit times with satellites orbiting high above the earth's surface will in general be much longer than communications facilities, such as submarine cables that follow the earth's curvature. One of the major items of interest and areas for difference of opinion existing today in the communications satellite program is transit time. Echo is the shadow of transit time.

To gain an understanding of this situation, it is helpful to look at the technology of long distance telephony. It is a universal practice to employ a single pair of wires from the telephone set to the serving central office. Both directions of transmission are carried on the single pair. This is called two-wire transmission. The long distance network, on the other hand, has been developed into what is called a four-wire network. For reasons of electrical stability which will be explained later, it is common practice to employ a path for each direction of transmission. Obviously each circuit between two long distance users must have at least two junctions between two-wire facilities and four-wire facilities. It is these junctions, called hybrids, that are the elements causing most of the difficulty.

Figure 1 is a simple block diagram of a typical long distance telephone connection employing four-wire facilities connected to two-wire. Energy coming from telephone set #1 reaches the hybrid junction at Point B and passes through to the local line, Point C, and on to telephone set #2. Hybrid junctions are built to make the path from B to C and C to A have as low loss as possible and the loss from B to A as high loss as can be achieved. How well this is done is controlled by the ability to make the balancing circuit D as close to the electrical characteristics of local line C as possible. Inasmuch as local lines vary considerably in their characteristics due to differences in length, the network D can only be an average of the characteristics of line C.

It has been found that on the average, the energy going from B to A is only 15 decibels weaker than that going

TYPICAL LONG DISTANCE TELEPHONE CONNECTION

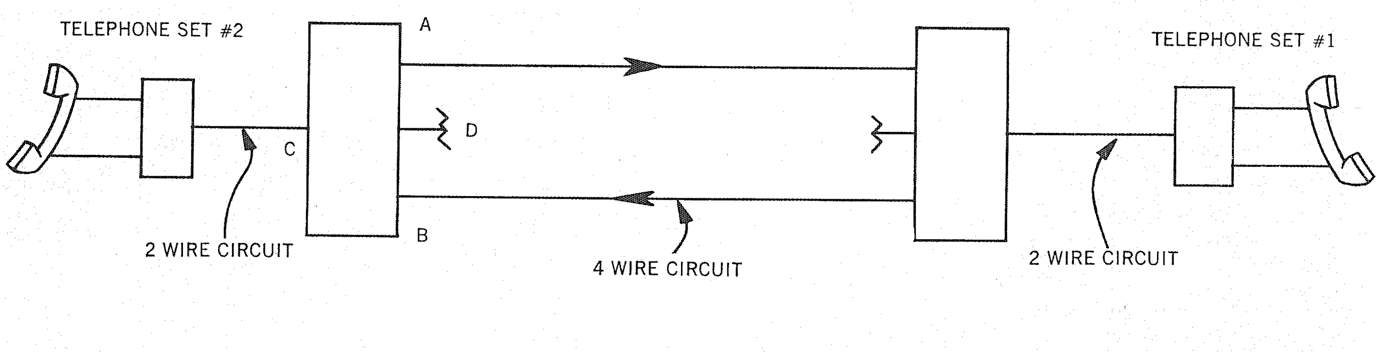

Fig. 1

UNICATION'S ACHILLES HEEL

from B to C. The talker at Station 1 will receive his own voice energy back in the form of echo at a level high

TELEPHONE ECHO PATHS IN A TYPICAL FOUR-WIRE CIRCUIT

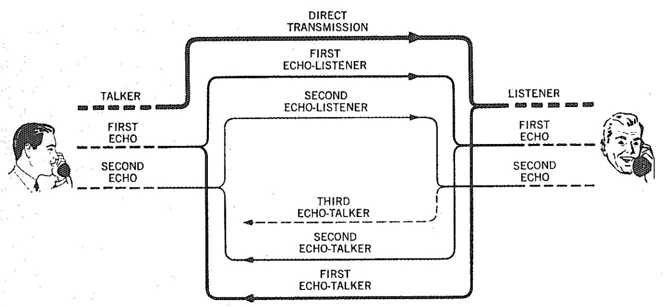

Fig. 2

enough to be heard. If the distance is short, he will not be able to distinguish this echo from the normal talking energy in his receiver, which is called side tone. Side tone has been built into telephone sets as a means of governing the level of talking. It is also beneficial in assuring the talker that his voice is being transmitted.

It is probably evident now why the long distance network has been built up on a four-wire basis. Amplifiers are needed profusely. An amplifier generally is a one-way device. Two amplifier units, one operating in each direction, would be needed at each amplifier location. There would need to be two hybrid junctions for each amplifier. The number of echo paths which would be set up would result in an electrically unstable circuit if today's high standard of performance were attempted. One means of reducing echo is to add to the loss of the circuits. Indeed, echo problems have increased as technology and economics have permitted transmission paths to be improved.

Figure 2 shows that echo currents circulate freely in a telephone connection. They are attenuated only by the loss in the circuit and the loss in the hybrid junction. When one encounters a circuit in which these echoes are too prominent, he considers it to be "hollow" due to the multiple echoes.

About 30 years ago, a device called an echo suppressor was developed to overcome echo effects. Basically the echo suppressor is a voice operated switch permitting transmission in only one direction at a time, thereby eliminating echo. These switches have sophistication built into them in order to allow a small amount of energy to return, otherwise the listening party would never be able to break into the conversation if he desired. There is another feature built in to cause the echo suppressor to remain closed for a short period of time after the last spurt of energy is transmitted by the talker. This is called hangover, and it is necessary to assure suppression of the echo from the last spurt of energy. Echo suppressors are used in the Bell System network on all circuits exceeding 1500 miles in length. As we shall see soon, the hangover problem becomes critical as the transit time occasioned by satellite transmission is incurred. Figure 3 shows the round-trip transit time of various long distance circuits. The first example was never realized, for carrier-type operation became possible before a transcontinental cable was built. It is apparent that satellite transmission causes long transit times due to the extended path to and from

EXAMPLES OF TRANSIT TIME

FROM	TO	VIA	VELOCITY MI. PER SEC.	TIME FOR ROUND TRIP-MILLISECONDS
N.Y.	SAN FRAN.	VOICE FREQUENCY CABLE	20,000	320
N.Y.	SAN FRAN.	RADIO RELAY	186,000	38
N.Y.	LONDON	SUBMARINE CABLE	120,000	70
HAWAII	LONDON	SUBMARINE CABLE, RADIO RELAY	–	160
N.Y.	LONDON	TELSTAR (13000 to 18000 Mi.)	186,000	140 to 200
N.Y.	LONDON	SYNCOM (49000 Mi.)	186,000	530
HAWAII	LONDON	2 TELSTARS	186,000	320 to 420
HAWAII	LONDON	2 SYNCOMS	186,000	1060

Fig. 3

the satellite. Long transit time is troublesome, first because the users are accustomed to response according to a time pattern which has been built up in telephony. Studies show that a talker saying "hello" will get a response after 0.4 seconds on the average. If he does not get it, he assumes either he was not heard or the listener is reluctant to respond. In addition to this effect, and the extended time to complete the conversation, it has been noted in the limited laboratory work done thus far that as the user continues to be exposed to the longer delay, he becomes more critical of it.

The echo problem is more acute. Obviously the hangover time must be extended for a much longer interval or the effect on the talker will be serious. Talking against delayed echoes is very difficult. In addition, there is the impression that there are other people talking on the circuit. Development work is being done on more modern echo suppressors to attempt to cope with the extra time. Presently, however, there is not enough data available to say with certainty that the new echo suppressors are successful or what the maximum delay can be without causing the users to be dissatisfied.

Recently at a meeting of the International Telegraph and Telephone Consultative Committee (CITT), an international body composed of representatives of the major telephone organizations of the world whose function is to coordinate the development of world-wide telephony and telegraphy, provisional standards for International Telephony were adopted covering transit time. Tentatively this body has determined that for up to 150 milliseconds mean transit time in one direction, transmission is assumed to be satisfactory without reservation. Mean one-way transit times of 150-400 milliseconds are provisionally acceptable. Transit times above 400 milliseconds are provisionally unacceptable. Experiments will be possible with "Early Bird" satellite which will be launched by the Communications Satellite Corporation early in 1965. This will be of the synchronous orbit variety and will permit further tests to learn of the experience of users with circuits with long transit times. As would be noted from Figure 3, the medium altitude satellite would be acceptable at present, but the synchronous orbit type would not be acceptable for more than one hop.

It is hoped that this presentation will permit the reader to view with understanding forthcoming events in the development of intercontinental transmission via satellites. The quality and reliability of intercontinental telephone service has improved considerably with the addition of submarine cables beginning in 1956 compared to service by high frequency radio circuits. Reaction to the improved service was reflected in the sharp rise in the volume of traffic to the areas served by both facilities. Satellite communications systems should further improve the overall reliability and quality of the intercontinental network; and in addition, provide greater service flexibility, for example, television service. In the final analysis however, the acceptance or rejection of this new facility is in the hands of the user. It is the history of communications that when there is a choice and no cost differential, users are intolerant of a service that is noticeably inferior to another. It will be interesting to watch the developments.

For a more detailed presentation of the transit time problem, the reader is referred to three papers on the subject in the November 1963 issue of the Bell System Technical Journal.

1. "The Effects of Time Delay and Echos on Telephone Conversations," J. W. Emling & D. Mitchell
2. "Echo Suppressor Design in Telephone Communications," P. T. Brady & G. K. Helder
3. "Subjective Evaluation of Delay and Echo Suppressors in Telephone Communications," R. R. Riesz & E. T. Klemmer

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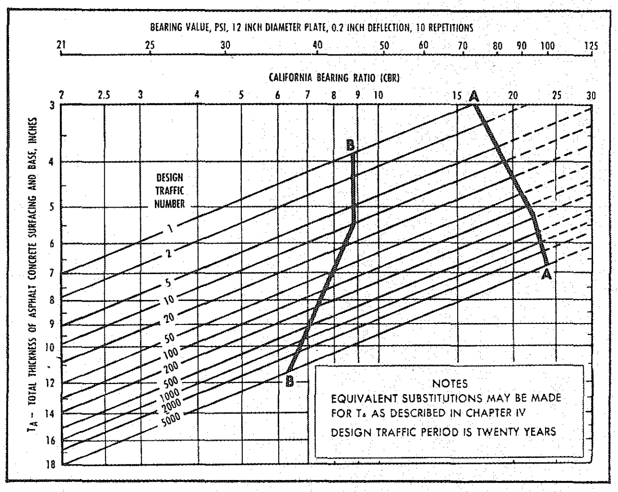

Thickness Design Charts like this (from the MS-1 manual) are used in this new computer-derived method. This chart enables the design engineer quickly to determine the over-all Asphalt pavement thickness required, based on projected traffic weight and known soil conditions.

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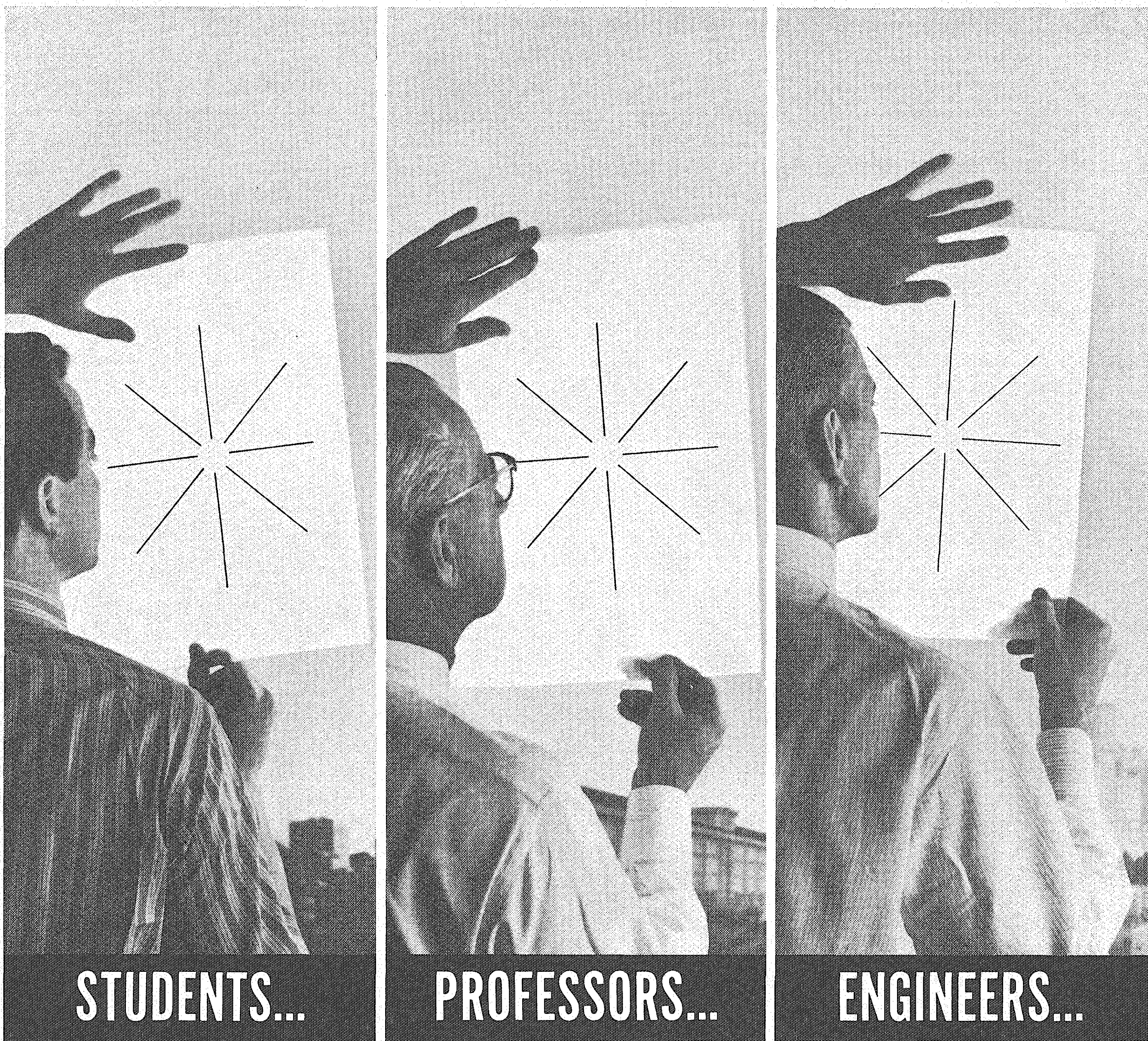

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TRANSISTORS

by RONALD C. ATTEMA, *ME '65*

The name "transistor" is a blend of the words "*trans*fer" and "re*sistor*." The patent records show the transistor to be the invention of John Bardeen and Walter H. Brittain in June of 1948 (patent No. 2,524,035 filed June 17, 1948).[2] Actually the transistor is the result of years of endeavor by scientists all over the world. In 1906 Greenleaf Whittier Pickard filed a patent request on the crystal detector as we know it today. In 1915 Carl Axel Frederick Benedicks, a Swedish inventor, first discovered the point-contact rectifying action of germanium. In 1942 Seymour Benzer invented the high-back-voltage rectifier at Purdue University. During World War II and the early postwar years, solid-state physics came to be applied to semiconductor behavior. Much of this work was accomplished at Bell Telephone Laboratories under the supervision of William Shockley, John Bardeen, and Walter H. Brittain.

Since its invention the transistor has illustrated the benefits which result from an effective exchange of information among scientists. The tremendous advances in transistor manufacture and design are due in part to this co-operation, the advance of solid-state theory, and the close relation in function between the transistor and the vacuum tube. The analogous function of transistors and electronic circuits (many already in existence at the inception of the transistor) has helped to make progress in the development of the transistor nothing short of phenomenal.

Reduction of Germanium Oxide

The initial step in the manufacture of transistors is the obtaining of germanium. The main source of germanium today is germanium dioxide which occurs as a by-product of the zinc-refining industry. The dioxide is heated in a reducing atmosphere, usually dry hydrogen, at 650 degrees C. for 3 or 4 hours. By this process the oxygen is driven off to form water vapor with the hydrogen and pure germanium results. After the reduction process is completed, the germanium is heated until it becomes molten (1000 degrees C.). This melting process is usually carried out in a gaseous atmosphere, such as helium or argon, to prevent oxidation.

In the next operation, the graphite boat bearing the molten germanium is slowly withdrawn from the melting furnace. The melt freezes progressively, finally producing a polycrystalline germanium ingot. This process is known as normal freezing. Normal freezing is also the first step in the purification process.

Purification

In normal freezing the impurities tend to become segregated because of the difference in the solubility of a given impurity. The ratio of impurity concentration in the solid to that in the melt is known as the distribution coefficient K. For most of the significant impurities (those which behave as donors or acceptors in germanium) we find that $K<1$. Now, assuming that the impurities which remain in the melt after reduction are uniformly distributed, the first part of the ingot to solidify gives up a part of its impurities to the remaining melt. The fraction of the impurity given up to the melt varies inversely with K. As the ingot is progressively frozen, the impurities are driven to the melt end until finally freezing is complete. The impure end is then removed, and a partially purified bar and a highly impure melt result.

The second step in the purifying process is zone refinement. Actually, zone-refining is a sophistication of normal freezing. A normally-frozen bar from which the ends have been removed at definite resistivities has an approximately uniform concentration of impurities. This bar is passed through a series of induction coils each of which produces a molten zone of definite length. These zones are each about 1 inch long and are spaced about 4 to 5 inches apart. A typical bar (approximately 1 inch in cross-sectional area) is passed through the zone-refining area at a rate of about 2 to 3 inches per hour.

A bar processed in the foregoing manner results in yields of about 55% by weight of "pure" polycrystalline germanium. This is the weight percentage of the original charge of germanium dioxide. The high degree of purification is necessary so that the doping process (the addition of a definite amount of impurity) can be verv accurately controlled.

Resistivity and Quality Control

The resistivity of the zone-refined bar is used very successfully as an indication of the impurity concentration. Resistivity measurement is also very important in transistor design. The early method for measuring resistivity was the whisker method. In this procedure a whisker point was placed on the germanium surface, thus forming a point-contact diode. The maximum-reverse voltage shown by the diode is measured and correlated with the resistivity. A survey of this turnover voltage (t.o.v.) along the length of the bar yields a resistivity profile (resistivity-vs.-distance along the bar). Today the four-probe method is used to establish the resistivity profile. An apparatus with four probes, spaced equally and in a straight line, is placed on the refined ingot. A voltage is then applied to the two outer contacts, and after the current is adjusted to a critical value, the voltage between the inner probes is a measurement of the resistivity. (Figure 1.) Measurements are taken along the length of the bar, thus measuring the resistivity profile of the bar.

It is known that in semiconductor material the conductivity is proportional to the net excess of one material over its opposite: i.e., n-type vs. p-type. Measurements of resistivity at room temperature, as is done in actual manufacture, give information only about the excess of the n-type or p-type impurity, not the specific amounts. In order to ascertain the actual amount of either type impurity in the material, measurements of resistivity and energy factors must be made over a wide temperature range. For a single crystal of semiconductor material, in which both impurities and thermally-excited carriers are important (which is the usual case), Equation 1 applies.

Equation 1:

$$1/\rho = G = q\,(\mu_n + \mu_p)\,\sqrt{n_i^2 + x_i^2} \pm q\,(\mu_n - \mu_p)x^3$$

ρ = Resistivity
q = Unit core charge
μ_n = Mobility of electrons
μ_p = Mobility of holes
n_i = Electron concentration in a pure semiconductor
x = $(N_D - N_A)/2$
N_A = Acceptor concentration
N_D = Donor concentration

The above equation is not directly applicable to the zone-refined bar because of the influence of grain boundaries and dislocations on mobility. It is known that when ρ is at its maximum, n_i and x have comparable values. n_i is known for all temperatures and x can be extrapolated from graphs. The procedure is to plot

FOUR-PROBE METHOD

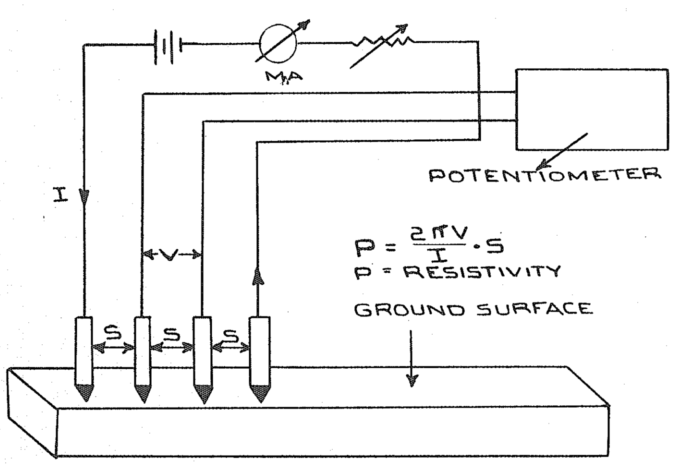


FIGURE 1

resistivity vs. temperature, and if the sample behaves as predicted by theory, x can be estimated from the temperature.

Growing the Single Crystal

The Czochralski technique is one of the most widely used methods of growing the single semiconductor crystal. This process is actually a combination of a growing and pulling process. (See Figure 2.) Material can also be doped in this operation.

A small single crystal of the material to be grown (seed) is oriented and brought into contact with the molten material. The function of the seed is to initiate a crystal growth with the desired orientation. To acquire a single crystal with a particular orientation, for example 111 (Miller's indices), the seed must be oriented in the 111 direction. The technique most commonly used for orienting the crystal is the Laue X-Ray reflection method. Small motors are provided to lower, raise, rotate, and in some cases to vibrate the seed while it is in the growing furnace.

The sequence is to lower the rotating seed (approximately 100 rpm) into the furnace until it comes into

CRYSTAL GROWING FURNACE

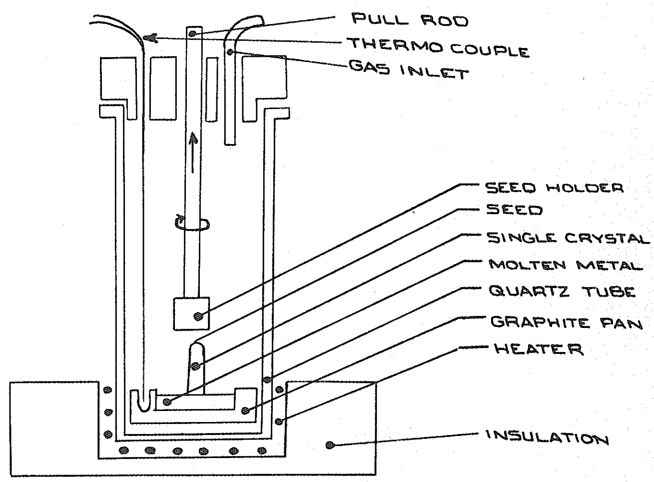


FIGURE 2

contact with the molten material. The seed is withdrawn at a definite rate (approximately 7 in/hr) and the heat input to the melt is reduced so that the material being withdrawn can reach its freezing point. By the constant control of heat to the furnace, the growing crystal and melt are kept in equilibrium resulting in a long cylindrical crystal (approximately 2-3 cm in diameter).

The crystal can be doped in this process to produce either n-type or p-type material. Grown junctions can also be formed with this method by proper control of all the process parameters. Doping is achieved by adding the proper-type material to the melt depending on its distribution coefficient (K). N-type and p-type impurities can be added to the melt (taking into account Kn and Kp) in the correct relative amounts to produce the exact balance of donors and acceptors desired in the final crystal.

Grown Junctions

A grown junction, for example, a p-n type, can be formed by adding a definite amount of n-type impurity to the melt and allowing the crystal to grow the desired amount. P-type impurity is then added in an amount sufficient to qualify the next section of grown crystal as p-type. There is no physical discontinuity in crystal structure across this junction. Sensitive electrical tests are required to locate its position in the final-crystalline cylinder.

Grown junctions of the p-n type can also be formed by varying the growth rate. The distribution coefficient (K) for many impurities varies with the growth rate of the crystal. Up to now we have referred to K at its equilibrium value: i.e., equilibrium between solid and melt. Using gallium and antimony (common doping agents) as examples, we can see how the variation of K with growth rate is put to use in junction formation. According to Figure 3, K for antimony increases markedly with growth rate while that for gallium remains essentially constant. In order to utilize this feature, a melt is readied and doped accurately with definite amounts of antimony and gallium. Crystal growth is carried out in the normal fashion with the rate being varied faster and slower in cycles. In this case the slower rate produces a p-type region and the faster rate a n-type region. The final result is crystal with many uniform, evenly spaced junctions: i.e., two junctions per cycle.

Slicing and Dicing

After the crystal has been formed, and after it has passed the quality control checks, it is ready to be cut into the required shape. Slices are made at right angles to the longitudinal axis of the cylindrical crystal (approximately .020 in thick). Dice or wafers are cut in a similar manner, usually with diamond saws. A recently introduced method of dicing employs a procedure similar to that used in cutting ordinary window glass (germanium is quite brittle with a hardness close to that of glass). A slice of crystalline material is scratched where a break is desired, and it is then broken under pressure. Yet another method of dicing employs cutting blades vibrating at low amplitudes and supersonic speeds. A die of germanium which meets all specifications up to this point is the basis for the construction of the transistor.

GROWN P-N JUNCTION DATA

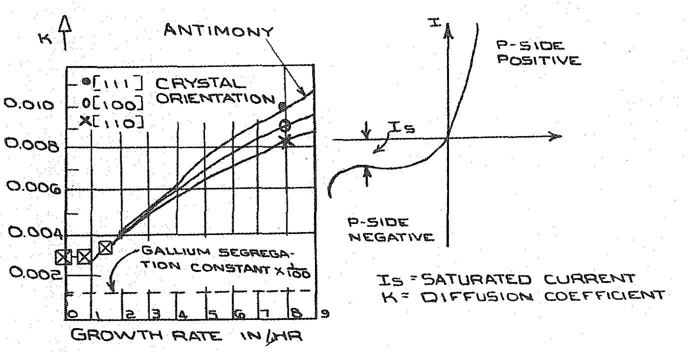


FIGURE 3

Etching

Etching is one of the most important tools in transistor production. The material can be subjected to etching at many points in its route from the reduction process to the point where it is assembled into a transistor. The ingot is usually subjected to an etch after it leaves the reduction process in order to remove surface oxides or other surface impurities. A common etch for this step consists of equal parts of hydrofluoric acid and nitric acid. This same etch is often repeated after zone refinement. Etching is also used to reveal grain structure and to reveal grain boundaries in imperfect crystals. For this purpose an etch which contains a very strong concentration of peroxide is used. Ferric chloride is also used to investigate grain structure; however, this process involves heating the sample until the etch boils. Etching is sometimes used to remove saw marks after slicing and always after dicing: i.e., before the final transistor assembly begins.

Carborundum lapping (grinding with carborundum paste) is used when saw marks and irregularities are too severe to be removed by etching. This process is also used in some cases to prepare the material for the four-probe resistivity check.

Assembly of the Transistor

In order to be brief and yet give a good factual description of transistor assembly, the production of the p-n-p type, audio frequency, alloy transistor will be described. For this type of transistor, assembly starts with n-type germanium of around 3 ohm cm. resistivity. Lifetime should be reasonably long (not less than 100 micro sec), since lifetime is a good indicator of crystal perfection. A maximum lifetime assures a minimum hole loss in the base region.

Indium buttons or spheres are used for the collector and emitter. The germanium dice and indium pellets must be fused together. They are first thoroughly cleaned, assembled in a jig (made of special material), and then fired in hydrogen at a temperature of approximately 500 degrees C. In this case the indium penetrates from both sides of the germanium pellet; thus, if penetration proceeds too far, the emitter and collector will contact each other, rendering the assembly useless. On the other hand, if penetration is insufficient, a transistor with a high base width results. A base width which is too high gives a transistor a poor frequency response and low values of A result.

Equation 2: $$A = \left| \frac{\delta I_C}{\delta I_E} \right|_{V_C = \text{constant}}$$

Where:

δI_C = Change in collector current
δI_E = Change in emitter current
V_C = Collector voltage

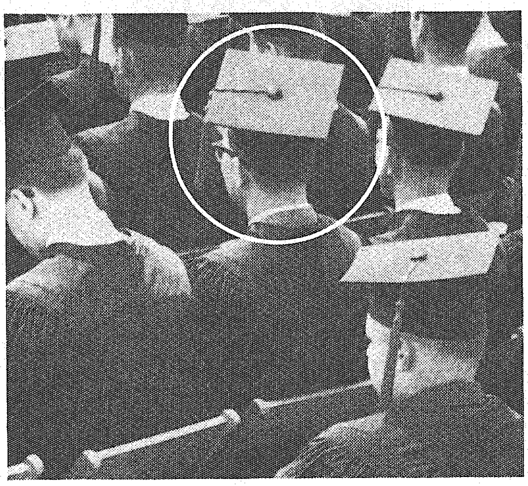
Since the solubility of indium in germanium is known over the useful temperature range, the correct dice and button size can be estimated. Another important requirement for good frequency response is that the junctions are plane parallel; this is especially true for high-frequency transistors.

One method of maintaining better control of the alloying process is to use two temperature stages. In this process the temperature is first brought up to around 350 degrees C. and is held here long enough to allow the indium button to wet the germanium without appreciably penetrating it. This procedure provides a uniform diffusion whereas in the single-step firing there is a tendency for the indium to penetrate the germanium at points only. (See Figure 4.)

A nickel tab, which has been tinned, is added to the germanium (simultaneously with the emitter and collector) to form the base of the transistor. Leads are then attached to the tab and buttons by using a special low-temperature solder. Two common solders used for this purpose are Cerrobend (m.p. 90 degrees C.) and Cerroseal (m.p. 120 degrees C.).

The final step is encapsulating the transistor to insure reliability and accurate operation. Encapsulating the transistor protects the transistor from mechanical damage and harmful impurities such as water vapor. (Water vapor can cause the ionization and migration of other contaminants.) In many respects, enclosing the transistor is as important as the manufacture of the transistor

(Continued on Page 38)



Tom Thomsen wanted challenging work

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T. R. Thomsen, B.S.M.E., University of Nebraska, '58, came to Western Electric for several reasons. Important to him was the fact that our young engineers play vital roles right from the start, working on exciting engineering projects in communications including: electronic switching, thin film circuitry, microwave systems and optical masers.

The wide variety of Western Electric's challenging assignments appealed to Tom, as did the idea of advanced study through full-time graduate engineering training, numerous management courses and a company-paid Tuition Refund Plan.

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The man who said "you can't take it with you" was born a long time before Garrett started making life support systems.

As a matter of fact, unless man *does* take his earthly environment with him into space, he hasn't got a chance.

For here is a world that has no oxygen, no pressure, no gravity.

To live and work for weeks and months in orbital flight – a need dictated by urgent space projects now in progress – man must have the most sophisticated life support system ever built.

It has to provide him with oxygen, water, pressurization – complete climate control.

It has to guard him against temperatures that range from near absolute zero to the re-entry heat of thousands of degrees.

It has to be a miracle package.

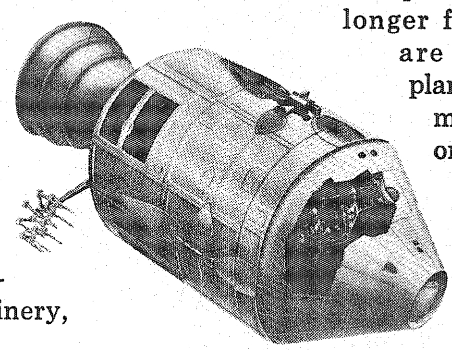
The question becomes: Who is now building such an environmental system?

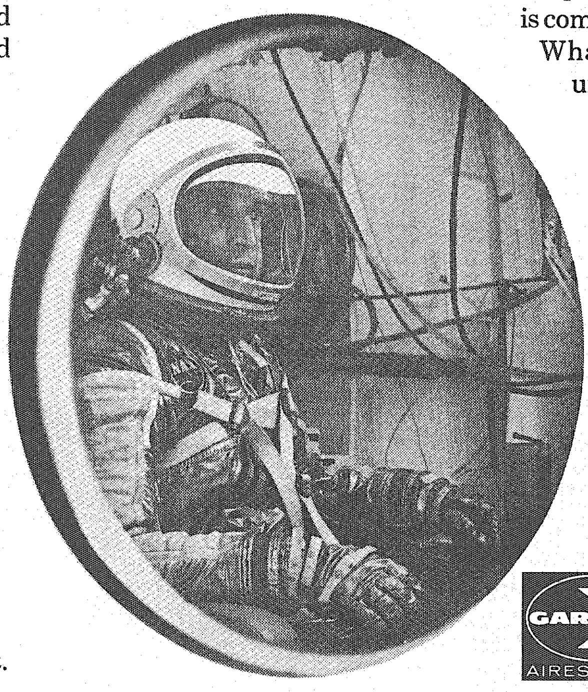
The answer is, of course, Garrett.

As long ago as 1941, Garrett management saw that man could go no higher, no faster, without pressurization of aircraft. When Garrett's AiResearch division delivered the first systems, suddenly the ceiling was off the world.

Today over 90% of the free world's aircraft carry Garrett environmental systems. Millions of hours of operation have been accumulated by heat transfer equipment, turbomachinery, controls.

This experience led Garrett to build the life support systems that protected our astronauts on the recent Mercury flights.





The same know-how is now at work supplying "shirtsleeve" environments for Gemini and Apollo. These systems will keep man alive for weeks in space. Now longer flights are being planned – manned orbiting laboratories and space stations. Garrett already knows how to solve life support problems for months in space. Much of the system work is completed and components built.

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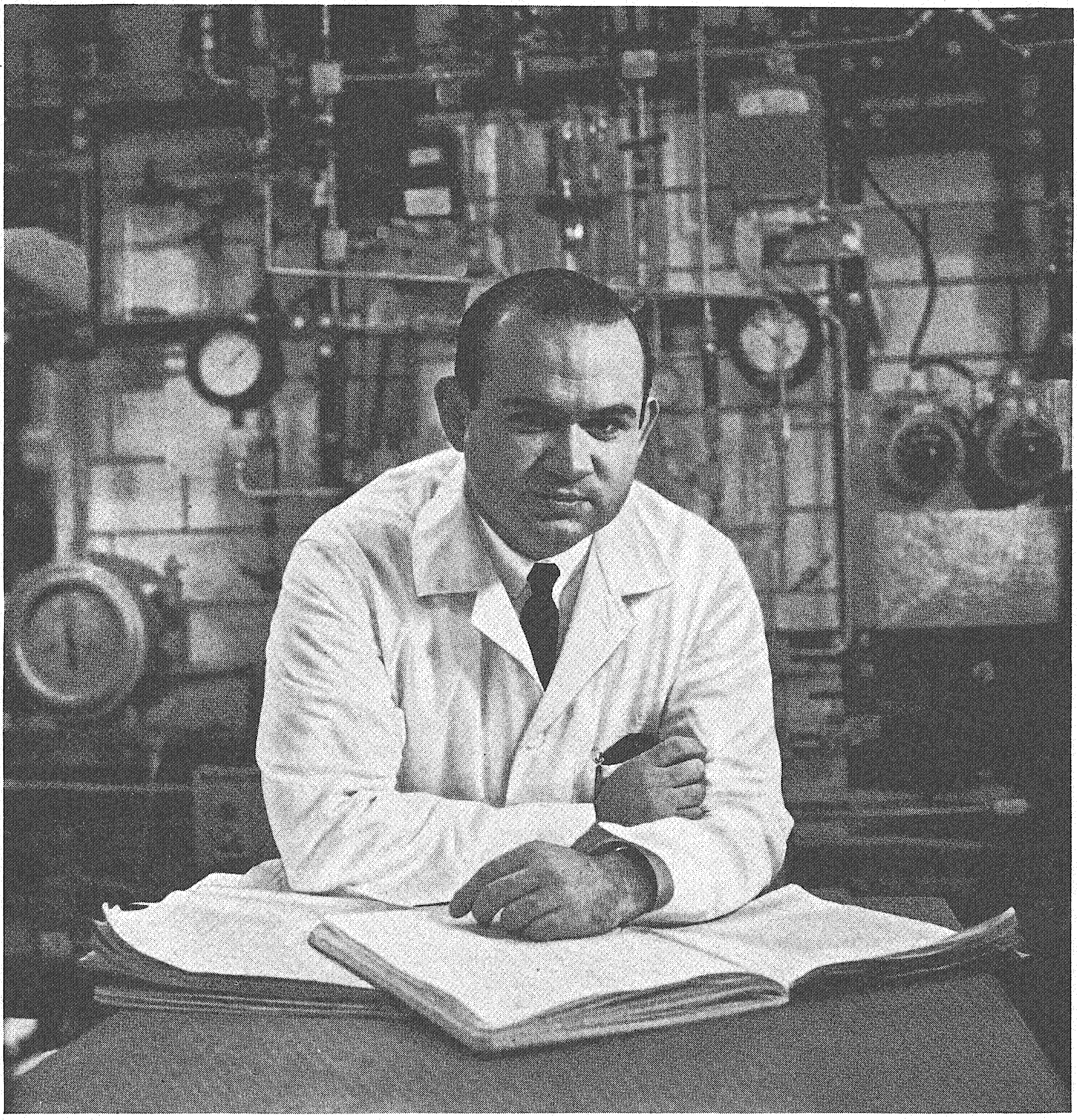
For further information about many interesting project areas and career opportunities at The Garrett Corporation, write to Mr. G. D. Bradley at 9851 S. Sepulveda Blvd., Los Angeles. Garrett is an equal opportunity employer.



Anyone for hydrodesulfurization?

How about it? Want to hydrodesulfurize? Hydrodesulfurize oil, that is. Fuel oil. Dr. James Mosby, Purdue, '64 does. He experimentally optimizes the commercial procedure for removing sulfur. He's been working on hydrodesulfurization ever since he joined the American Oil Company as a chemical engineer last January. That's his pilot plant behind him.

Even if you'd rather not hydrodesulfurize, there are literally scores of other science and engineering opportunities at American Oil. If you're interested in a career in the petroleum industry, write to J. H. Strange for information. His address: American Oil Company, P. O. Box 431, Whiting, Indiana.

STANDARD OIL DIVISION
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THE TACONITE

as told to SALLY AHOLA, *EE '67 by* D. W. SCOTT

When the United States held a monopoly on high-grade iron ore, mining companies turned their backs on low-grade iron ore, regarding it useless. However, taconite, the name given to this low-grade ore containing only twenty to thirty per cent iron, was not destined to remain in the earth as a worthless ore. Today, after forty years of research and experimental work, taconite has found its way to the blast furnaces.

The ever-growing taconite industry of today is a stage in a chain of events which started about sixty-five years ago with the beginning of the American steel industry. As the years progressed Minnesota became the leading iron ore producing state. The state's high quality ore was eagerly sought by steel producers. Because the ore was high quality, little equipment was needed in processing the ore for shipment. The ore was dug from the mine with steam shovels, loaded into railroad cars and brought to the Head of the Lakes for shipment to steel mills at lower lake sites. As time progressed, the ore was also sized, but the capital expenditure still remained relatively small. The Second World War and the Korean War witnessed the flexibility of the industry. As the demand for steel increased, the mining companies increased their tonnages. By merely adding more shovels and mobile equipment, the demands of a fluctuating market were met.

Because of the draft on the reserves of iron ore from these two wars, the government became concerned about the life of deposits. Extensive exploration for iron ore throughout the United States and the world was carried out. The search proved fruitful, for the amount of deposits found was very great. This result has had a tremendous bearing on the iron ore industry of Minnesota. Because development of the iron ore deposits in other countries has progressed at an almost unbelievable pace, the iron ore industry has become truly competitive.

About the same time that the exploration for new deposits was begun, considerable research was underway on the low-grade taconite ores. Researchers and experimenters sought to develop a process which would manufacture a high-grade concentrate from low-grade taconite ores. The final outcome of these years of experimental work and research produced the pellet. With the introduction of the pellet, the steel industry was revolutionized.

However, the processing of taconite requires a much greater capital investment and much more equipment than did the high-grade direct shipping ores. Because taconite is an exceedingly hard rock formation, the difficulty of drilling had made it impossible to process for many generations. Today jet piercers burn holes into the rock. These machines were especially designed for taconite since conventional drills were too slow and tended to wear out too fast. Generating a jet flame of 4300 degrees F., the jet piercers burn holes about forty feet deep into the taconite. These holes are then filled with explosives and the taconite is blasted loose. Power shovels then load the broken taconite into one hundred ton trucks or railroad cars which haul it to the coarse crusher. The crusher is a huge machine which works on the principle of a mortar and pestle, reducing the rock to pieces three and a half inches in size, or less. Fine crushers then complete the crushing job, reducing the size of each piece to three quarters of an inch or less.

Now the taconite must be ground to a size fine enough to allow the magnetic iron ore particles to be separated from the useless sand. This is done first in rod mills, which are large revolving steel drums which contain hard, alloy steel rods. As the taconite is fed into the drums, water is added and the rods tumble against each other, grinding the taconite to the consistency of coarse sand. Following this first stage of grinding, the taconite is pumped to large magnetic separators which reject the larger particles of sand and recover the magnetic iron ore particles. The final stage of grinding is done in ball mills which operate in closed circuit with classifying cyclones.

With the grinding stage completed, the mixture of water and taconite is pumped to the first of a series of

STORY

magnetic and hydro-separators, and the taconite which began as big chunks of hard rock in the mine is now becoming a concentrate of high-grade iron ore.

Normally two or more stages of magnetic separation are required to separate the iron ore particles. Inside the magnetic separators, which are revolving drums, powerful magnets are installed. These magnets attract the iron ore particles and reject the sand and other useless materials. Some plants also use hydro-separators which are deep tanks in which the magnetized ore sinks to the bottom, while most of the remaining waste material floats off the top.

The iron ore concentrate is then pumped to filters which remove the bulk of the water and the final product is a damp powdery material containing about ten per cent moisture.

However, the concentrate in this finely ground form could not be used in the blast furnace because it would be blown out the stack. Therefore the concentrate had to be reconstituted back into coarse particles, and thus the pellet was born. Pelletizing is a process which was largely developed at the Mines Experiment Station of the University of Minnesota. This process begins by feeding the finely ground concentrate into big revolving drums. A binding agent is added, and as the particles of iron oxide roll around in the drum, they cling to each other, much in the same way that a lump of snow forms into a snowball as it rolls down a hill.

The balls of concentrate, or green pellets, as they are called, are then fed into a furnace which bakes them at a temperature of about 2400 degrees F. The iron ore pellets which result are hard enough to undergo handling and shipping. They are the preferred food for blast furnaces. For every ton of pellets produced by this process, three tons of taconite must be mined. Thus two tons of taconite must be discarded for every ton of pellets which is finally produced.

At first blast furnace operators were reluctant to accept this new kind of iron concentrate, but it was soon discovered that these pellets were especially important in the blast furnace. They have a porosity or ability to breathe which makes for uniform temperature throughout their change in the blast furnace. Not only are these pellets high grade, but they also have an absolute uniformity. Every pellet is exactly alike. Because of these qualities, the taconite pellet has become the most desirable product for blast furnace consumption known today. They are much more valuable than even a natural ore which has a higher iron content. For example, a blast furnace loaded with high grade-natural shipping ore would produce approximately 1500 tons of pig iron per day. This same blast furnace loaded with taconite pellets would produce 3000 tons of pig iron per day.

With an abundance of iron ore available and with the established trend now moving from natural ores to pellets, the iron ore industry in Minnesota is faced with an entirely new situation. Even if natural ores had not been depleted by the demands of two wars, they would be a drug on the market, practically an obsolete product. Fortunately, two major mining companies began construction of large taconite plants in Minnesota prior to the vast discoveries in other areas. The Erie Mining Company at Aurora-Hoyt Lakes and the Reserve Mining Company at Babbitt and Silver Bay were the first major taconite plants in the world. Since then fifteen new taconite plants have been built. However, all of these, with the exception of 3 million ton Reserve expansion, were built outside of Minnesota. In the next two years three more plants will go into production, all outside of Minnesota.

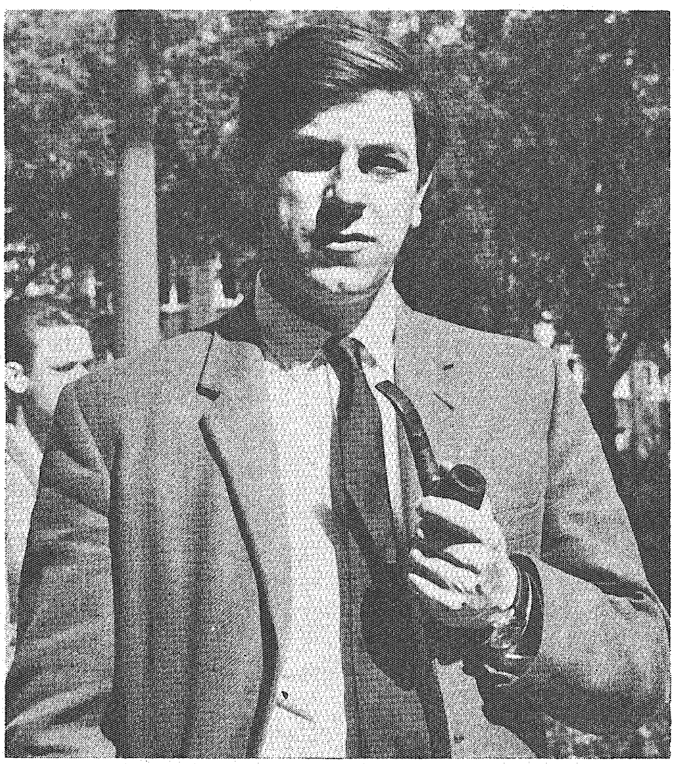
What is the future for our iron ore industry in Minnesota? Fortunately, Minnesota has taconite and other ores from which pellets can be produced. The tonnage is adequate to support a 65 million ton production for 250 years. Quality-wise these ores can compete on the world market. However, they must also be able to compete on a cost-wise basis. To produce pellets requires a tremendous capital expenditure, about one hundred thousand dollars for each man employed. This cost is probably higher than costs for any other manufacturing process. More man hours of work are also required. The production of a ton of pellets requires 2.6 times as many man hours as natural ores and for each man directly employed, 1.7 are employed in satellite industries. While the direct ore required only moderate capital investment and very few expendable supplies, pellet production requires enormous capital investment—35 million dollars for a millon ton plant—and enormous supplies.

Before investors will put up this kind of money they will shop around to determine where they can make their best investment. They do not overlook the fact that Minnesota had the first two taconite plants, but have attracted none since. Even though Minnesota has ore which will produce high quality pellets, the business climate appears unfavorable to today's taconite investors. Obsolete tax laws which were made when Minnesota still held a monopoly are causing investors to develop plants in other states.

If Minnesota can compete on the cost-wise as well as quality-wise basis in today's highly competitive market, it can become a leading producer of taconite pellets. But today the taconite industry stands at the crossroads. Will the people of this state respond to the challenge to keep Minnesota as a leading iron ore producer?

UP FRONT

by WILLIAM OTTO, *Met E '68*
JOHN WIIK, *EE '68*



DR. JOHN OVEREND

If one should happen to be strolling through the basement of the Chemistry building one might come face to face with a very impressive looking, dark-haired Englishman. This man would probably be Dr. John Overend, Associate Professor of Physical Chemistry, currently working on a high-resolution infrared spectrometer. After a year and a half of hard work, this project is nearing completion.

Dr. Overend was born of British parents in Keighley, England, in 1928. He started his education in a boys' grammar school in Keighley. Upon completion of two years in the British Army, he continued his education at St. John's College in Oxford, where in 1952 he received his B.A. in Chemistry. After receiving his degree, Dr. Overend went to work on high-resolution spectroscopy under Dr. H. W. Thompson. In 1955, Dr. Overend received his Ph.D., his thesis topic being "Spectra of Polyatomic Molecules."

Dr. Overend has been married ten years and in these ten years has been blest with three children: Susan, who is eight, Johanna, seven, and Christopher, five. Along with these three previous blessings, Dr. Overend has been awarded the Spring Coblentz Memorial Prize for work in spectroscopy research. He is a member of the American Chemists Society, the American Physical Society, the Optical Society of America, and the Faraday Society of London.

Although John Overend is kept busy teaching and working in his labs, he occasionally finds time to paint, sketch, and sail his boat on White Bear Lake.

Dr. Gordon Beavers, Assistant Professor of Aeronautical and Engineering Mechanics, was born in 1936 in Doncaster, England, and attended grammar school there. Doncaster's grammar school, which is the oldest in England, has been in existence since 1350. Upon completion of grammar school he attended St. Catherine's College of Cambridge University and received his B.A. Degree. Dr. Beavers then went to Harvard for a year and while working on his Masters Degree he became a McKay Fellow. After receiving an open scholarship in mathematics at Cambridge he returned and completed his Ph.D.

While in England he was employed by Rolls Royce and worked on flow-through axial turbo machinery. He enjoyed all the English sports, especially soccer and cricket, and has found their popularity lacking in America.

While teaching Aero 100-102 and Aero 145-147 this year he is also starting work on a shock tube and hopes to arouse interest among his students in this project. Dr. Beavers comments that the courses offered in Aeronautical Engineering for graduate students are extremely good and offer great opportunities to the student.

DR. GORDON BEAVERS

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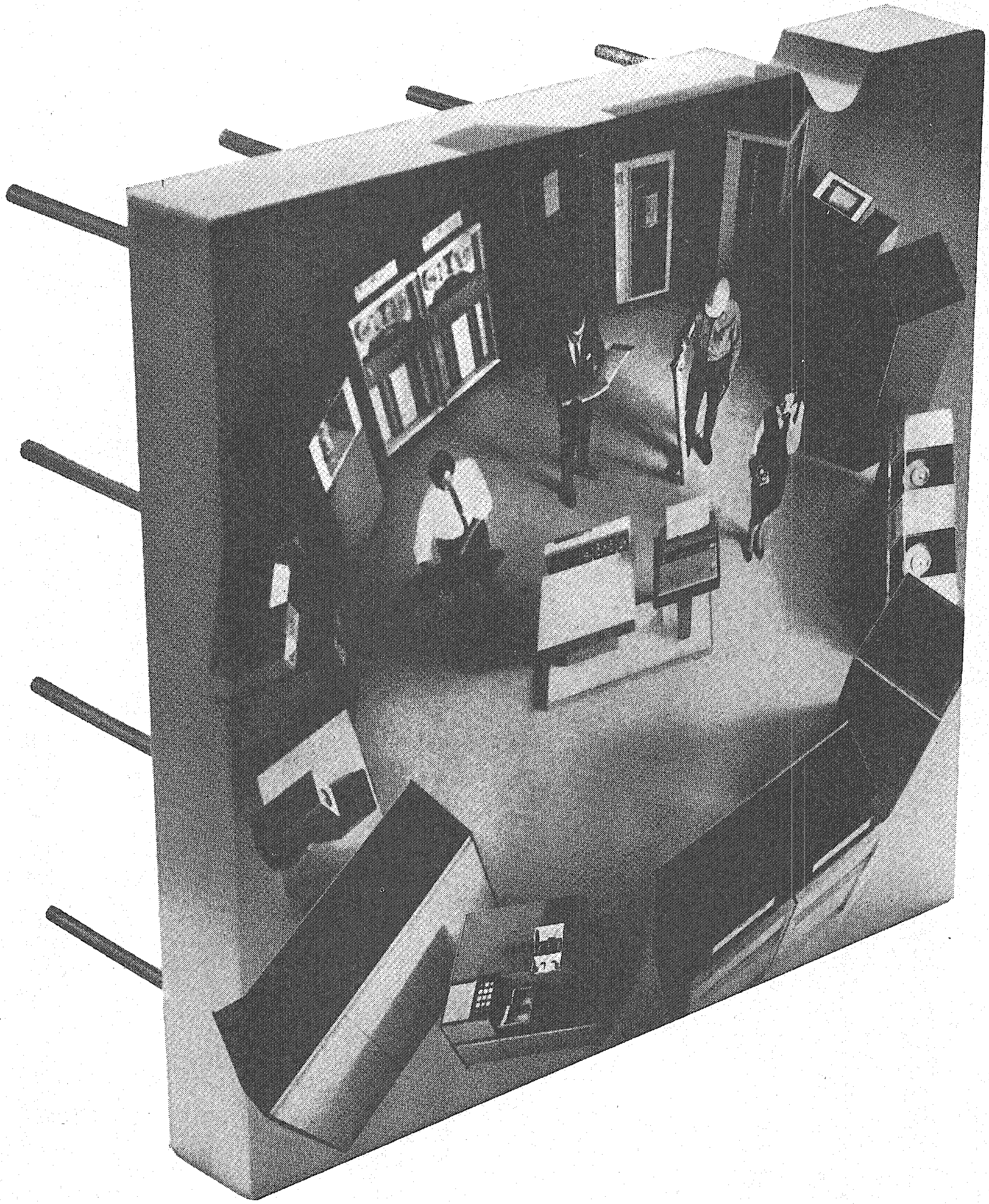
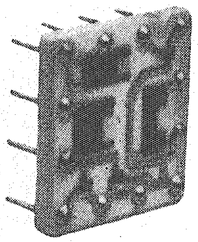


From little chips great computers grow...



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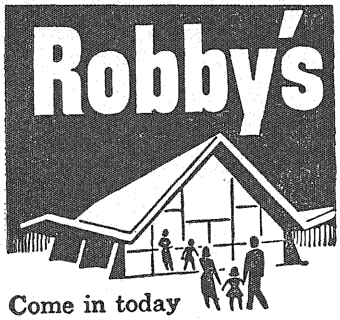

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Robbys

WHERE UNIVERSITY AND WASHINGTON MEET

SPLINTERS From the Log

by David E. Engen

A lobbyist who was opposing a large appropriation for a state college approached a legislator who boasted of his self-education.

"Do you realize," asked the portly lobbyist gravely, "that up at the university men and women students have to use the same curriculum?"

The legislator looked startled.

"And that men and women often matriculate together?"

"No!"

The lobbyist came closer and whispered, "And a young lady student can be forced to show a male professor her thesis?"

"I won't vote 'em a damn cent!" exclaimed the legislator.

• • •

During a recent trip to the LBJ ranch Hubert Humphrey took a tour of the Johnson cattle herd, and while walking through a small group of bulls he stepped on the Republican platform.

• • •

Lyndon: ". . . and remember, I'm an American first and a politician second."

TECHNOLOG political analyst: "Spoken like a true American politician."

• • •

Barry Goldwater would rather be far right than President.

• • •

Barry: "Why did the chicken cross the road?"

Nelson: "I don't know. Why?"

Barry: "To get from the left to the right."

• • •

Mr. and Mrs. Nelson Rockefeller = Happy and Unhappy.

• • •

There are only two kinds of parking left on campus—illegal and no.

• • •

Not everybody is for LBJ. The Fallout Shelter lobby recently came out in support of Senator Goldwater.

A recent test by an impartial research institute named *Raleigh* as the best cigarette to buy. It seems *Raleigh* is the only cigarette that gives you something in addition to lung cancer.

NO JOKE

A report on the daydream content of college students has some interesting implications. Among male students the No. 1 daydream involves money and cars. Next most popular men's daydream was of travel and adventure—with car. Sexual intercourse rated only 6th place, and marriage, which held the top place among women students, finished a poor 9th.

George Wallace would love Cyprus. They don't want to integrate, either.

• • •

The new Republican National Chairman is Dean Burch. You'll remember his father, Society Burch.

• • •

LBJ quote of the month: I didn't know Bobby Baker very well. All we did was exchange hi-fi sets.

• • •

LBJ has chosen "Happy Days Are Here Again" as his campaign song. A good song for Senator Goldwater might be "Beautiful Dreamer."

• • •

Tom: "Have you heard the latest elephant joke?"

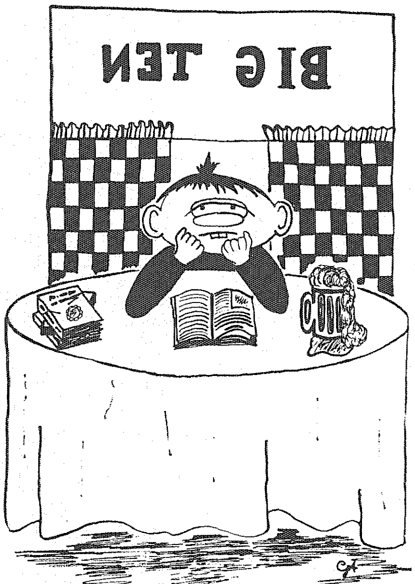
Jerry: "No, what is it?"

Tom: "William Scranton."

• • •

Barry, Barry, quite contrary,
How does your right-wing grow?
"With Klansmen and Birchers; extremists all,
And they'll be with me in the White House in the fall!"

Has Fall Quarter
Got You Down Already?



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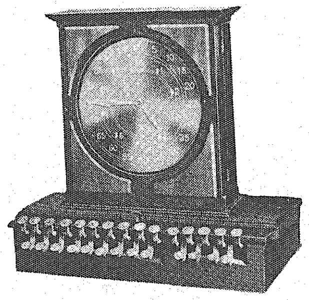
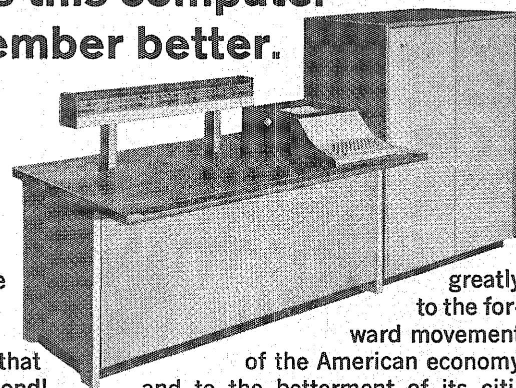


Today NCR's new thin-film rod memory helps this computer remember better.



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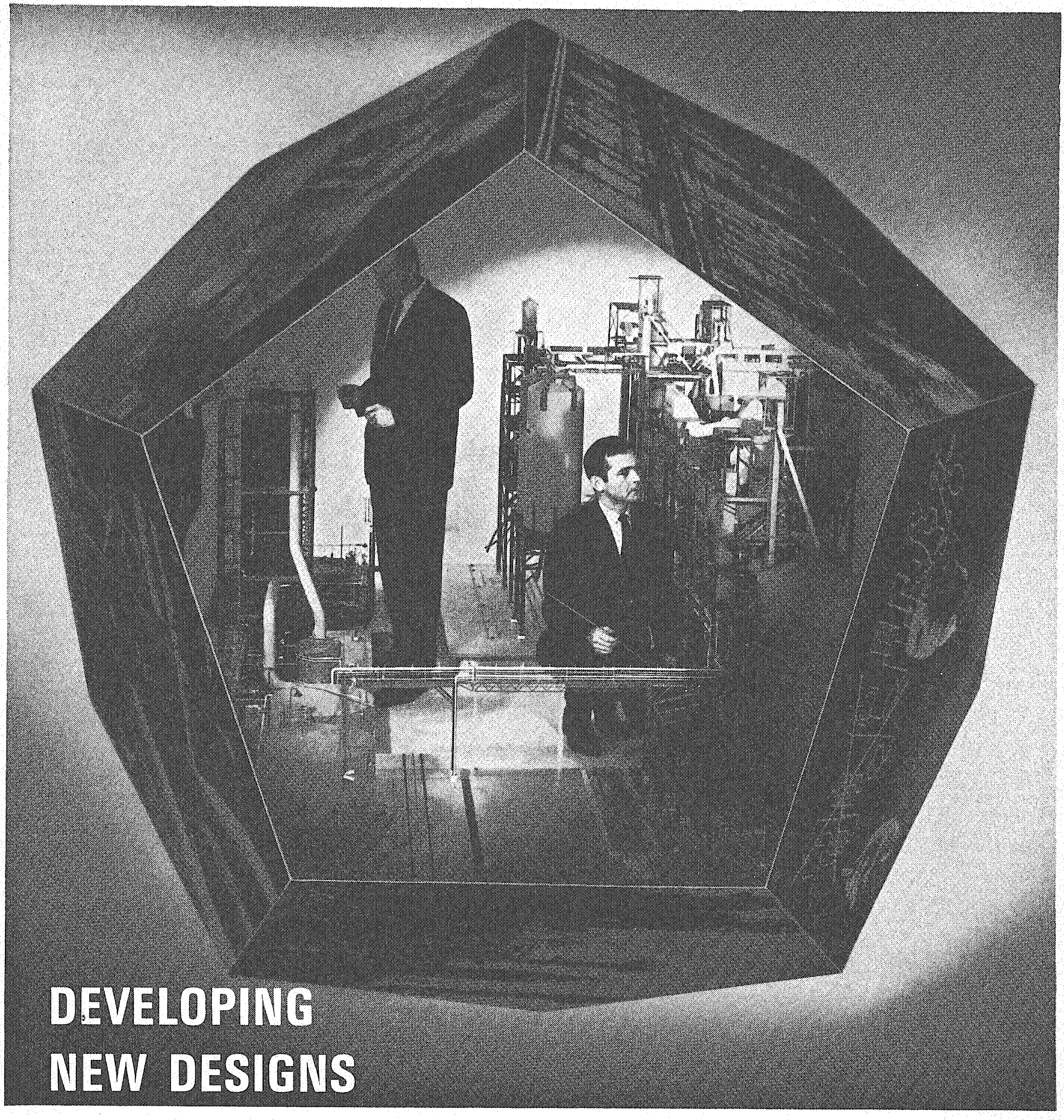

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TECHNOLOG CALENDAR OF EVENTS

Your Engineer's Guide to Campus Events

October 12-17	Homecoming Week
October 25-31	CLA Week
November 1-7	Campus Chest
November 15-21	Blood Drive
November 22-December 5	Holiday Gifts Drive
December 11	Study Day
December 12-18	Fall Quarter Final Exams
December 19	Fall Quarter Commencement
December 28-30	Orientation and Registration
January 4	Winter Quarter Classes Begin
January 11-17	Winter Week
January 14	MSA Day
January 17-23	International Emphasis Week
January 19-24	Bach Festival
January 22	Powell Hall Carnival
January 23	Foresters' Day
January 24-30	Accident Prevention Week
January 24-30	Greek Week
February 14-18	Minnesota Symposium
February 21-27	University of Minnesota Week
February 25	Charter Day Convocation
March 1-6	Red Cross Education Drive
March 12	Study Day
March 13-19	Winter Quarter Final Exams
March 20	Winter Quarter Commencement
March 24-26	Orientation and Registration
March 29	Spring Quarter Classes Begin
April 8-11	Model United Nations Conference
April 15	All-Campus Elections
April 23-24	Campus Carnival
April 24-25	International Spring Festival
April 25-May 1	Creative Arts Festival
April 30	Black Book Dance
May 6-8	Engineers' Day
May 7-8	Minnesota Royal
May 8	All University Parents' Day
May 12	Cap and Gown Day
May 12-13	Education Day
May 21	Journalism Day
May 23-June 12	Book Drive
June 4	Study Day
June 5-11	Spring Quarter Final Exams
June 10	Baccalaureate Service
June 12	Spring Quarter, Commencement

FINE ARTS

Minneapolis Symphony Concerts

October 16	Orchestral
October 23	Eugene Istomin, Pianist
October 30	Sidney Harth, Violinist
November 6	Leonid Kogan, Violinist
November 13	Charles Treger, Violinist
November 20	Byron Janis, Pianist
November 27	Emil Gillels, Pianist
December 4	"War Requiem,"—Soloists, Macalester Choir, Holy Childhood Boychoir
December 26	Ruggiero Ricci, Violinist
January 2	Norman Carol, Violinist
January 8	Bernard Haitink, Guest Conductor
January 15	Paul Kletzki, Guest Conductor
January 22	Max Rudolf, Guest Conductor
January 29	Mary Costa, Soprano
February 5	Henryk Szeryng, Violinist
March 12	Van Cliburn, Pianist
March 19	Artur Rubinstein, Pianist
April 2	Richard Tucker, Tenor
April 9	Hermann Uhde, Baritone
April 16	"Jeanne d'Arc au Bucher"—Vera Zorina, Narrator, Soloists, University of Minnesota Chorus
November 24	Marion Anderson, Special Concert

Masterpiece Series

October 1	Roberta Peters, Coloratura
October 20	Warsaw Philharmonic
November 10	Leonard Pennario, Pianist
November 17	Norman Luboff Choir
January 27	Alexander Brailowsky, Pianist
February 2	Ballet Folklorico
March 4	Robert Merrill, Baritone
March 4	National Ballet of Canada

Celebrity Series

October 15	Mantovani and His Orchestra
October 26	Royal Irish Brigade
November 4	H.M.S. Pinafore
December 1	The New Christy Minstrels
	Roger Williams (date to be announced)

U of M Theatre

November 5-7, 10-15	"Sing Out Sweet Land," Walter Kerr
November 26-28, December 1-6	"Six Characters In Search of An Author," Luigi Pirandello
January 28-30, February 2-7	"Julius Caesar," William Shakespeare
February 25-27, March 2-7	"The Crown Bride," August Strindberg
April 22-24, 27-May 2	"A Company of Wayward Saints," George A. Herman

SPORTS

Football Schedule

September 26	Nebraska (Here)
October 3	California (There)
October 10	Northwestern (Here)
October 17	Illinois (Homecoming)
October 24	Michigan (There)
October 31	Indiana (There)
November 7	Iowa (Here)
November 14	Purdue (Here)
November 21	Wisconsin (There)

Basketball Schedule

November 24	Intra-Squad Preview (Free)
December 1	South Dakota (Here)
December 4	Drake (There)
December 5	Iowa State (There)
December 8	Marquette (Here)
December 19	Utah State (Here)
December 22	Chicago Loyola (Here)
December 28-30	Los Angeles Classic Tournament (There)
January 2	Detroit (Here)
January 9	Wisconsin (Here)
January 16	Illinois (There)
January 23	Ohio State (Here)
January 25	Purdue (There)
February 2	Northwestern (Here)
February 6	Michigan State (There)
February 13	Illinois (Here—afternoon)
February 16	Wisconsin (There)
February 20	Northwestern (There)
February 23	Michigan (Here)
February 27	Indiana (Here)
March 2	Iowa (There)
March 6	Michigan (There)
March 9	Iowa (Here)

Hockey Schedule

November 17	Intra-Squad Preview (Free)
November 20	Alumni (Free)
November 27-28	Colorado College (Here)
December 4-5	Michigan (There)
December 19	U. M. Duluth (There)
December 29	Manitoba (Here)
January 1-2	Wisconsin (There)
January 8-9	Michigan State (Here—Saturday afternoon)
January 15-16	Michigan Tech (Here)
January 22-23	Michigan State (There)
January 29-30	North Dakota (Here)
February 5-6	U. M. Duluth (Here)
February 12-13	Colorado College (There)
February 19-20	Michigan (Here)
February 22	U. M. Duluth (There)
February 26-27	North Dakota (There)

HOLIDAYS

October 12	Columbus Day
November 11	Veteran's Day
November 26-28	Thanksgiving
February 12	Lincoln's Birthday
February 22	Washington's Birthday
April 16	Good Friday
May 31	Memorial Day (Sunday, May 30)

TWIN CITY AREA THEATER

St. Paul Theatre Guild

(dates to be announced)

"Barefoot in the Park"
"Any Wednesday"
"A Case of Libel"
"Oliver!"
"Dear Me, The Sky Is Falling"

Edyth Bush Theatre

(90 S. Cleveland Ave., St. Paul, 8:30 P.M.)

Sept. 26-28, Oct. 1-3, 8-10, 15-17—"All Because of Agatha"
Oct. 29-31, Nov. 5-7, 12-14, 19-21—"Berkeley Square"
Dec. 3-5, 10-12, 17-19—"Pleasure of His Company"
Jan. 7-9, 14-16, 21-23, 28-30—"Web of Murder"

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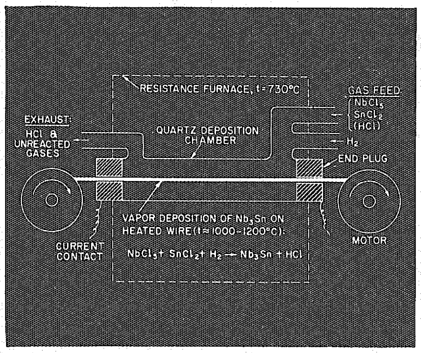
Superconductivity at RCA Laboratories

Vapor Deposition of Nb_3Sn



Apparatus for continuous vapor deposition of niobium stannide on ribbon.

Very-high-field solenoids capable of generating fields of 100,000 gauss now made with copper winding require about 100 tons of equipment and dissipate more than one megawatt of power as heat. Some superconductors, in particular the compound Nb_3Sn, can carry large electric currents with zero power dissipation even at high magnetic fields.[1] Hence, they can be used for the construction of light weight solenoids.

In the past, Nb_3Sn was prepared by metallurgical sintering techniques, which resulted in a porous and extremely brittle material not suitable for widespread use. In 1960, scientists in the Materials Research Laboratory, David Sarnoff Research Center, developed a vapor-phase transport process for preparing this compound for the first time in a dense crystalline state—and *in forms suitable for widespread use in both research and application.* It consists of a simultaneous reduction of gaseous mixed chlorides of niobium and tin by hydrogen at 900 to 1200°C.[2]

Based on this process, an apparatus was developed for continuous coating of refractory metal and ribbon with Nb_3Sn. The Nb_3Sn coated ribbon has both electrical and mechanical properties desirable for solenoid construction. It is very thin (typical cross section is 2 x 90 mil, thickness of deposit about 0.3 mil) and hence sufficiently ductile to wrap around diameters as small as ⅜ inch and it can support enormous currents densities: 1×10^6 amp/cm^2 at zero field, 3×10^5 amp/cm^2 in a transverse DC field of 92,500 gauss and 1.5×10^5 amp/cm^2 in a pulsed longitudinal field of 170,000 gauss. By comparison, copper can carry only 1×10^3 amp/cm^2 safely. Hence, superconductive solenoids approaching a field of 200,000 gauss appear feasible.

Reference—[1]*J. E. Kunzler, et al.* Phys. Rev. Letters 6, *89 (1961).*

[2]*J. J. Hanak, "Vapor Deposition of Nb_3Sn,"* Proceedings of AIME Conference on Advanced Electronic Materials, *August 1962.*

Parametric Amplifier

Experiments at RCA Laboratories show that superconducting films exhibit a nonlinear inductance at frequencies extending well into the millimeter-wave range. Frequency conversion was observed in tin films cooled below their critical temperature. Now amplification and oscillation have also been demonstrated. A superconducting "paramp" has been operated at 6 kmc with 11 db of net gain. Parametric oscillations at about the same frequency were also effected.

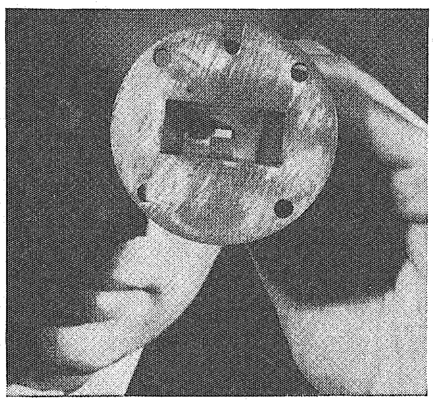
The superconducting film and the varactor differ markedly in many respects; hence, their circuit needs also differ. A study of the characteristics of superconducting films and parametric device requirements resulted in the concept of the "modified dielectric resonator." The resonator, which was used to demonstrate amplification, consists of a very low-loss, high-permittivity, dielectric cavity modified at one of its boundaries by a superconducting film.

The unit is placed in a waveguide where power is coupled to it with a movable short-circuit. The resonant frequency of the cavity is a function of its dimensions, the permittivity of the dielectric and the impedance of the film.

While it may be premature to speculate on the eventual role of the superconducting "paramp", it should be noted that the device, in principle, offers an outstanding set of features not to be found in the varactor or any other device. First, the frequency limit of superconducting films may extend into the sub-millimeter wave range. Secondly, it is expected that the noise performance of the device can match that of the maser. Furthermore, superconductors can be pumped with considerably lower power and at a lower frequency than either the varactor or the maser. Finally, since one can fabricate large-area films (as compared with lumped varactors), wide-band truly distributed traveling-wave parametric amplification may become possible.

Reference—A.S. Clorfeine, Applied Phys. Letters 4, *No. 7, 131 (1964).*

A.S. Clorfeine, Proceedings of the IEEE, *Vol. 52, No. 7, July 1964.*



Superconductive Magnet

Recently RCA developed a superconductive magnet believed to be the most powerful in the world, in a practical form that can revolutionize many aspects of solid-state electronics and high-energy physics research.

Success of this magnet and the attainment of zero current degradation using magnetic field stabilization followed research in superconductive degradation phenomena.

The device generates a magnetic field of 107,000 gauss. When commercially available, it will enable scores of small and medium-sized research laboratories to carry out experiments that now require large multi-million-dollar facilities in order to generate the immense magnetic fields needed for solid-state, atomic, and related areas of research.

Test data obtained under a NASA study contract played a significant part in RCA's development of the 107,000-gauss magnet. The present experimental unit has a bore of one inch, offering for the first time in a superconductive magnet a working area large enough for practical laboratory experiments. The company is continuing its work for NASA, exploring the feasibility of a 150,000-gauss superconductive magnet with a one-foot bore, designed for experiments in space propulsion techniques.

The experimental 107,000-gauss unit was built at the RCA Laboratories by an advanced development group of the RCA Electronic Components and Devices organization.

The experimental RCA magnet weighs 26 pounds and is about the size and shape of a half-gallon paint can. It is made superconductive by immersion in liquid helium and is started with the output of 6-volt storage batteries. By contrast, nonsuperconductive magnets developing similar magnetic fields require almost 1.5 million watts of power and enormous water-cooling systems.

Reference—Schrader, Freedman, Fakan, Applied Physics Letters, *March 15, 1964*

Schrader, Kolondra, RCA Review, *Vol. (25), No. 3, 1964.*

In addition to work in superconductivity, the David Sarnoff Research Center conducts a broad range of research projects requiring new concepts and ideas in materials, devices and systems. To learn about the many scientific challenges awaiting the advanced degree candidate in Physics, Electrical Engineering, Chemistry and Mathematics, please meet with our representatives when they visit your campus; or write to the Administrator, Graduate Recruiting, Dept. RL-9, RCA Laboratories, David Sarnoff Research Center, Princeton, N.J.

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Physics Building . . .

by STEVE LINDFORS, *Physics '67*

If you have ever walked through the basement or sub-basement of the physics building, you could hardly help noticing the great amount of equipment stacked in the corridors. This is not, contrary to popular notion, because physicists are naturally untidy. Rather, it is due to the increase in enrollment in physics and natural science and the number and extent of research projects.

Two moves to accommodate these expansions have been taken in the past few years. These are the South Addition, consisting of two floors being paid for entirely by the National Aeronautics and Space Administration, and the North Addition. This latter project, which will be the main topic in this article, is composed of four floors, a basement, and a sub-basement.

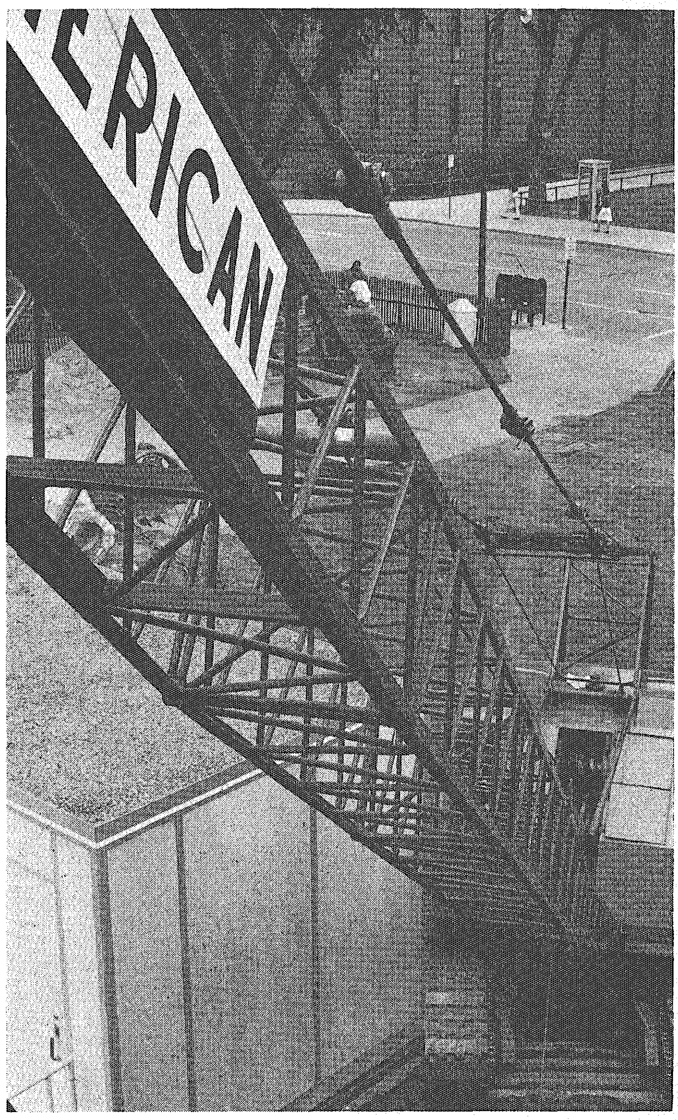
38-Year Old Idea

Even though these two additions seemed to rise in rapid succession, their conception dates back 38 years—to 1926—when the original building was constructed. In fact, behind the brick facade of the old building, the construction workers found pockets designed to hold beams for an expanded building.

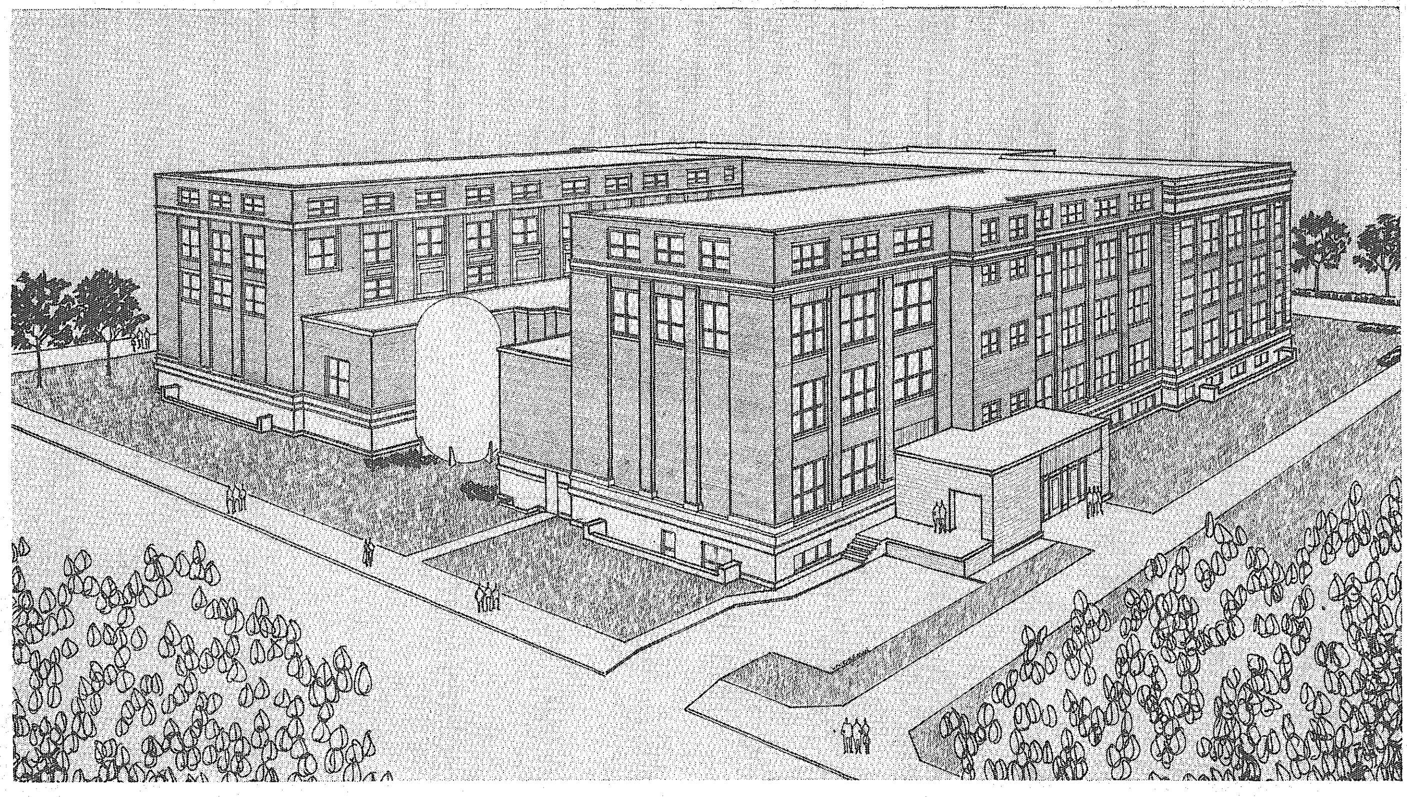
The need for larger building was, in contrast, fairly recent and began to be felt by many of the faculty in physics by the year 1960. Consequently, Dr. Alfred O. C. Nier, chairman of the physics department, and others in the Department, brought the needs to the attention of the Regents. The State Legislature then tried to appropriate funds for the new facilities. However, to do so, they would have had to have gone over the debt limit for that year. According to Dr. Nier, Amendment 2, which was voted on in 1961, would have allowed a higher debt limit in the State budget. However, it did not pass. Work on the South Addition proceeded despite the bill's defeat since the costs were assumed by NASA.

The defeat of the amendment actually postponed work on the other project for a year, according to Dr. Nier.

In the closing months of 1962 (by our calculations), the larger of the two projects finally got under way. (The costs, incidentally, were assumed mainly by the state, but the National Science Foundation matched the



Crane is used here to wreck shaft of old freight elevator on north side of building. End of building at bottom was removed by cutting torch to make way for new addition.



Courtesy of Toltz, King, Duvall, Anderson and Associates, Inc.

funds for the research part of the building.) The technical problems, such as soil tests, and information were worked out by Plant Services. Then, in February, 1963, the architects (Toltz, King, Duvall, Anderson & Associates, Inc.) began drawing the plans, which were officially completed on December 12, 1963.

The preliminaries having been completed, construction was begun in May of this year (by M. A. Mortenson Construction Company) soon after the South area had quieted down. Few problems were encountered and the work was going smoothly up until the beginning of Fall quarter, according to Mr. Leroy Tracy, construction superintendent at the project.

Excavation for the two subterranean levels of the building had to be done in two stages because of the cramped space. The division point between the stages was marked by the erection of a retaining wall to hold back the fill (see photo). After excavation, heavy duty footings were laid, and forms for the sub-basement walls were put into place. Most of the work on the project, for now at least, involves the construction of the forms and supports for each level. This takes beween two and three weeks per level, according to Mr. Tracy. All of the concrete for each level is poured at one time.

Basement Level

The next level, the basement, was the first one to have a concrete floor. Following the pouring of this level, the walls were no longer cast of concrete. For the last four floors, they will be of hollow brick, as in the old building. With brick walls, the forming of what vertically-oriented concrete there is becomes more critical. So, as you might expect, the vertical posts are highly reinforced with steel rods. The rods are interconnected ("tied together") from footings to fourth floor. Before each floor is poured, the reinforcing rods are made to extend about two feet above that level. The rods for the next level are later tied onto the extension (see photo).

Lest you be misled, the construction work does not consist "merely" of setting up forms and pouring floors. Much needs to be positioned in the forms before the concrete is poured, e.g., conduit, and tins (for the insertion, later, of pipes). If anything is not positioned correctly in the forms, or is not placed there at all, a hole for the required connection must be drilled in the freshly hardened concrete. However, this is rarely necessary.

Floor Construction

All levels, except the sub-basement, have their floors constructed in much the same way. A level plywood surface is erected, supported by the floor below, and "pans," looking much like an inverted kitchen sink, are placed evenly on the plywood. Varying the width of the pans changes the thickness of the supporting beams, and thus their strength. Therefore the thickness of a concrete floor has little to do with its load-bearing capacity. Incidentally, the floors are 6 inches thick.

Changing from floors to walls, work on the addition's brick facade is yet to be started. The outer brick wall is attached to the building by many horizontal rods, which can be seen there now in some areas. The walls are 20 inches thick.

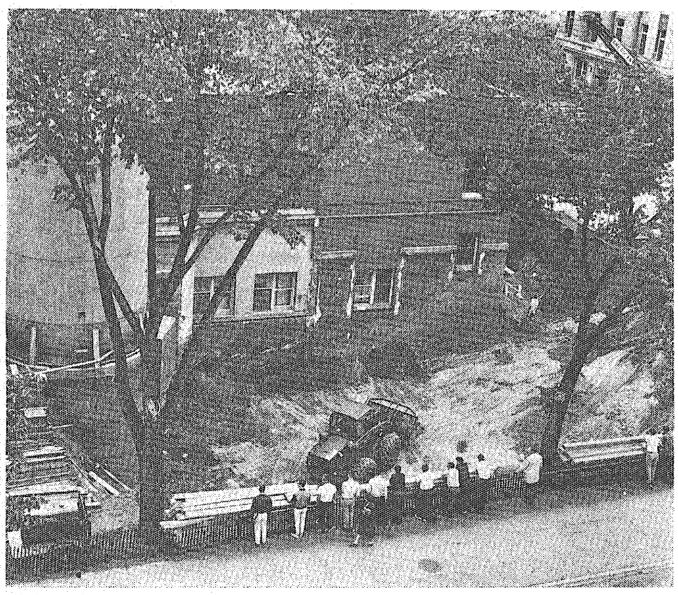
The weight of these bricks and the rest of the North Addition is borne by three not entirely separate entities. First there is terra firma. Second is what is officially called the "data processing center," which is what you have been walking on if you have ever passed between Physics and Morrill Hall. Third is the old structure. A rough estimate of the total load is 3000 tons.

Since you will probably be using the North Addition before the school year is finished, you might like to know what sort of facilities it will have. Most of the building, except the top two floors will be laboratories. The sub-basement will have four physics laboratories and one chemistry lab. In this level, the labs are sunk six to eight feet below the height of the existing corridor.

Addition's Facilities

The basement will have three laboratories, and a large extension of the machine shop. First floor has one lecture room (having 10 rows of seats), two laboratories and a five-foot extension of classroom 143 from the old building. Also on this floor will be the "vestibule," a 17-foot-wide entrance having four doors. It can be seen currently just west of the gray cooling shed, on top of the data processing center.

Second floor is somewhat similar, having three laboratories, one lecture room (with six rows of seats), and a fan room. The two lecture rooms in the new structure



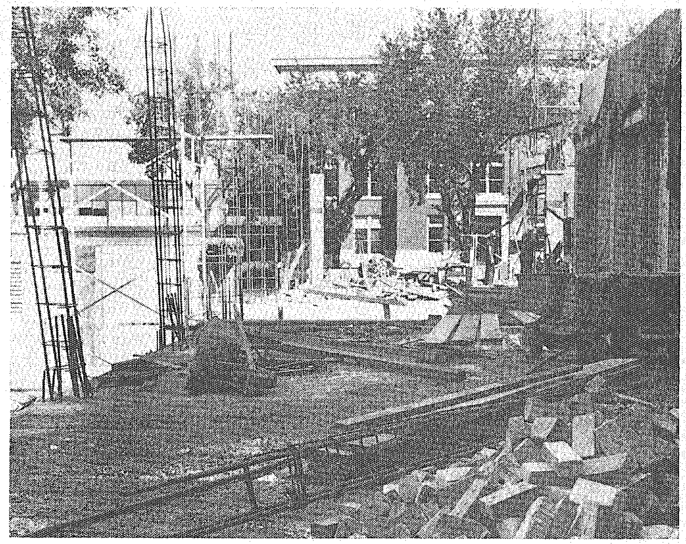
This view is of the first stage of excavation. Boards along sidewalk were eventually used for temporary retaining wall. Photo was taken in first week in June.

provide for the increased enrollment in physics and natural science, which, for Fall quarter, totals over 4,000. Third floor, like the fourth, consists mainly of offices. It has 14, besides the two secretaries' offices, facing Church Street. The floor also has a T.A. office (approximately 16' x 24'), and two laboratories. This floor should have been poured sometime during the first week of classes.

At the highest level, there are 19 offices, two secretaries' offices (positioned as on the floor beneath), a seminar room, and three T.A.'s offices. There will also be men's rest rooms on this and the second floors to accommodate the shortage of same.

Equipped Penthouses

The roof might be of little interest, except that it has several penthouses—but only for mechanical equipment. This includes the elevator penthouse—to hold the equipment for the new elevator that is to be placed in the shaft of the old, inside freight elevator. Another elevator is



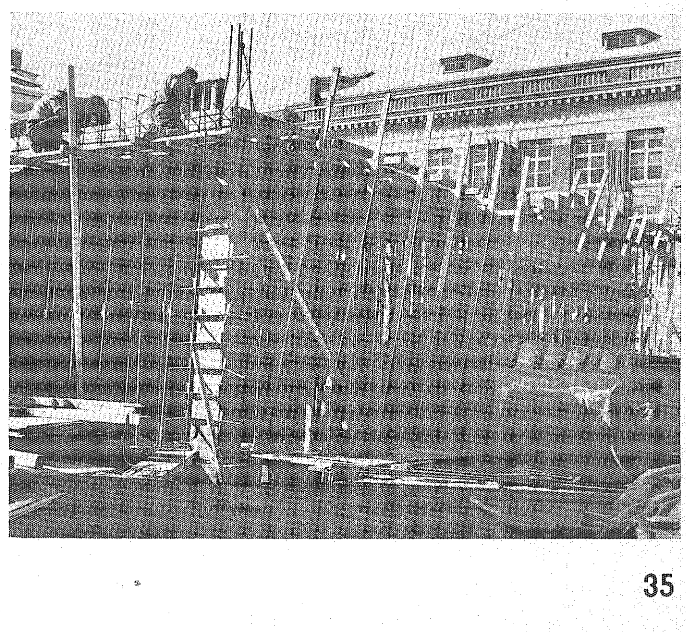
Steel reinforcing rods seen at left are tied to the two feet of rods from the floor below. All rods in supporting posts will eventually be tied together from sub-basement to roof. Tilting of rods at far left is caused by photographic distortion.

planned for the exterior. This will be a larger freight elevator and is to be placed just east of the new entrance.

The over-all architectural effect of the North Addition (along with the South Ad.) will be to form a three-sided courtyard bounded by two floors of building. The remaining open space—the fourth wall—may be filled in by a future addition and, as you might expect, there are provisions in the North Addition for such construction. The only physical obstacle in the way of this is the Van de Graaff generator, which is supposed to be removed soon, but may not be if those who use it have some good excuses.

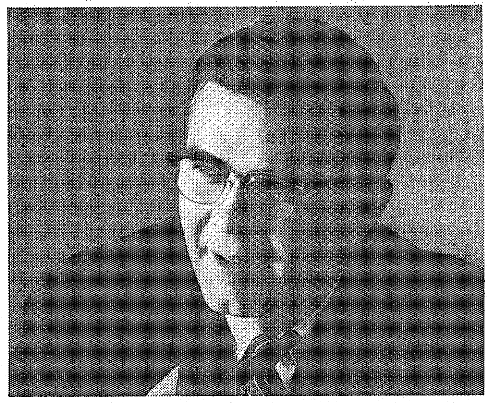
That addition's predecessor, the North Addition, is expected to be completed sometime in March, 1965. As for the construction now, forms for the fourth floor are being assembled at the time this is published.

Forms for first floor are under construction. Note construction workers at upper left putting in steel rods to reinforce horizontal beam. Steps at right center are part of lecture room.



STEP FORWARD WITH FORD MOTOR COMPANY

An Open Letter to the 1965 College Graduate from Donald N. Frey, Assistant General Manager, Ford Division of Ford Motor Company



Donald N. Frey was awarded a bachelor's degree in metallurgical engineering by the University of Michigan in 1947 and a doctorate in 1950. One year later, he joined Ford Motor Company as manager of the Metallurgical Department in the Scientific Laboratory. In 1962, Dr. Frey was appointed assistant general manager of the Ford Division with responsibility for all engineering, product planning and purchasing activities. He is 41 years old.

America's automobile industry is in the midst of a challenging era, with prospects of an even more exciting and demanding tempo in the years to come. Ford Motor Company is determined to achieve leadership in all phases of its operation. This leadership promises to bring lasting success to the company, its employes and its stockholders.

It will take people to accomplish this objective. Engineering, finance, styling, marketing, product planning, sales—all require people with the knowledge, judgment and personal drive to avail themselves of the unprecedented opportunities offered by a great industry.

The automobile business is growing. More cars are being bought now than ever before. With increases in population and consumer buying power, even more will be bought in the future. Realizing this, Ford Motor Company seeks to attract college graduates who have the capacity to grow with the company and the market.

Right now, our plans call for employing about a thousand of the best 1965 graduates we can find, with all types of educational backgrounds. We need specialists, but we also need persons with broad liberal-arts training who can handle a wide variety of assignments. Actually, in our company, many graduates grow into jobs totally unrelated to their degrees. They have discovered that Ford offers intellectually challenging opportunities for those with the ability to seize them. We invite you to make the same discovery.

Contact your Placement Office and arrange to see our representative.

Donald N. Frey

Ford
MOTOR COMPANY
The American Road, Dearborn, Michigan

An Equal Opportunity Employer

Spotlight on Local Industry

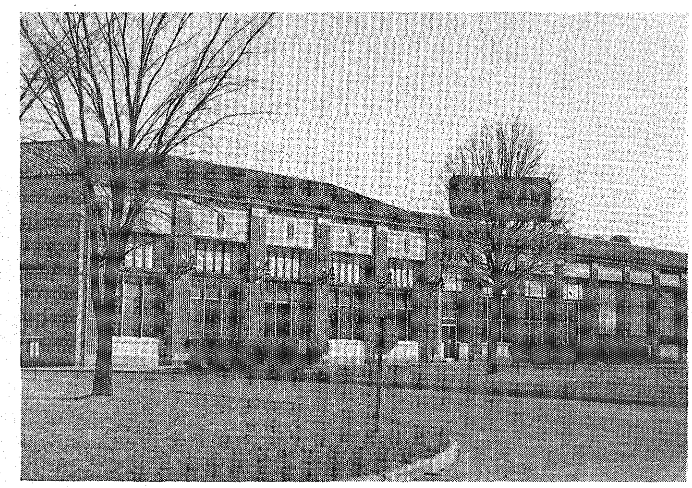
FORD MOTOR COMPANY

by ROBERT BRANDS, *CheE '69*

Since its incorporation, the Ford Motor Company has grown to be one of the leaders in today's automotive industry.

Employing more than 310,000 people, Ford has manufacturing companies in twenty-one countries and sales or assembly operations in another six. These countries include Rhodesia, Egypt, Malaysia, Italy, Finland, Belgium, Germany, England and Sweden.

The Ford Motor Company dates back to 1903 when Henry Ford, in a limited partnership agreement with Detroit coal dealer Alexander Malcolmson, filed the articles of incorporation for the Ford Motor Company. A month later Ford's first car, a two cylinder Model A, was sold. A little more than a year later, Ford Motor Company of Canada, Ltd., was incorporated near Windsor, Ontario. In 1914, the Ford Motor Company reorganized as a Delaware corporation to give greater scope to its operations. In 1922, the Lincoln Motor Company was purchased, and later, in 1938, Mercury production was started, with these two branches merging in 1945. During World War II, civilian automobile production was halted in order to accommodate wartime production of



Students participating in the work-study program at the Ford Plant include: Barney Dolby, David Goodwin, Carl Lindquist, and John Yonkowich.

Liberator bombers, jeeps, and aircraft engines. Production of civilian cars was resumed July 3, 1945. Almost two years later, company founder Henry Ford died, April 7, 1947, in Dearborn, Michigan. During the course of its growth, Ford achieved many firsts in the automotive industry. Among these are a longitudinally mounted engine with respect to the frame, the first production model with left-side steering, and safety glass as standard equipment. In keeping up with the expansion of international markets, Ford has, since 1958, initiated new manufacturing, assembly or distribution programs in fifteen countries.

Though Ford's major products are its cars, Ford has expanded its operations to include activity in other fields. One of these fields, closely related to the automotive industry, is the production of tractors, for both industrial and agricultural usage. Ford, whose tractor producing plants are located in the U.S., Great Britain, and Brazil, is recognized as one of the world's two largest manufacturers of tractors. In addition to Ford's tractor and automotive divisions, Ford purchased the Autolite Company, now one of its major subsidiaries. The Autolite Division deals mainly with the manufacture of various engine components. Certain Autolite products, for example, spark plugs and batteries, are installed as original equipment on Ford U.S.-built cars and are sold as replacement parts by Ford, Lincoln-Mercury, and Ford tractor dealers. In addition to dealing with automotive components, Autolite markets Ford-produced architectural plate glass, sheet and automotive replacement glass, and vinyl fabrics manufactured by Ford's Glass and Chemical Products Division.

Another subsidiary of Ford is Philco. Commercially, Philco produces various home appliances. Like Ford, Philco has plants in foreign countries, although not as many. Philco's Communications and Electronics Division is responsible for Ford's computer operations. This division, recently enlarged, is directing its attention and effort toward military-related computer and information systems, while still continuing to serve the special order scientific and industrial market. Philco's Lansdale Division initiated a separate micro-electronic operation to market and manufacture products along this line. Its Menlo Park, Calif., branch introduced a solid state power amplifier, in 1963, which is both smaller and more reliable than its vacuum tube counterpart. In addition to its electronics department, the Lansdale division supplies a portion of the automobile radios being put in production cars.

Both Ford and Philco, in addition to their regular operations, have received many government contracts for defense and space purposes. The company's special Military Vehicles Division was awarded a 76.6 million dollar contract to produce quarter-ton tactical trucks and to continue development of a five-ton, eight-wheel-drive truck, plus continued work on a helicopter-mounted grenade launcher. A Navy contract led to the development and testing of a six-hundred horsepower gas turbine engine. Aeronutronics Division of Philco is continuing development, testing and evaluation of the Army's Shillelagh surface-to-surface missile system and is also working on re-entry vehicles. Studies of penetration ability of long range missiles has led to more government contracts. Western Development Laboratories, under Philco, is developing and equipping a missile control center to be used in directing the Apollo and Gemini manned space flights. The Communications and Electronics Division has received Air Force contracts for work to be done in its communications and control systems. Altogether, Ford and Philco received, in 1963, government contracts totaling two-hundred and four million dollars.

Locally, Ford began assembly operations in 1913 in a small converted warehouse on South Third Street in Minneapolis. In 1915, Ford, because of limited facilities, moved to a new building on North Fifth Street in Minneapolis. Ten years later this building proved to be inadequate and in 1925, Ford moved to its present 174-acre site on South Mississippi Blvd. In addition to the main assembly plant, facilities include a hydro-electric plant and a steam plant. This local operation employs approximately 1,850 people, with an annual payroll of about 14 million dollars. It produces a car every 72 seconds, making a total of about 100,000 cars and trucks per year.

While assembling mostly the Galaxie model and trucks, this local plant manufactures a great deal of the auto safety glass used by Ford because of the excellent quality of the sand found under St. Paul.

The St. Paul plant is one of 17 such assembly plants in the U.S., and has a work-study program for engineering students. Its assembled vehicles are distributed to 11 sales districts serving 26 states including Alaska and Hawaii.

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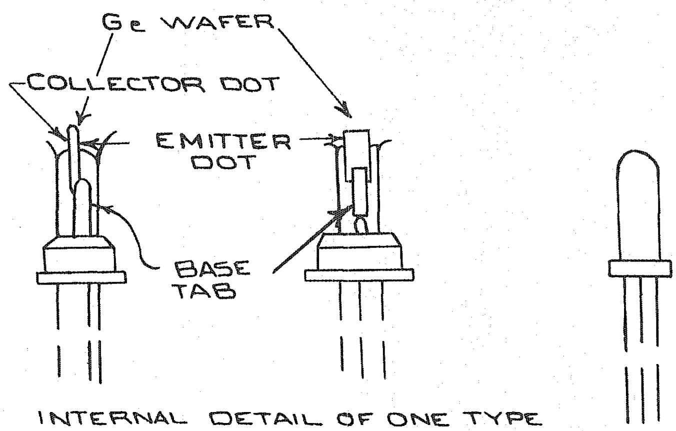
Transistors

(Continued from Page 14)

ALLOY TRANSISTOR MOUNTS



INTERNAL DETAIL OF ONE TYPE
FIGURE 4

itself. Transistors must be able to withstand dropping, bending of the leads, the thermal shock of soldering, vibration, etc. The coefficients of expansion must evidently be such that strain is prevented during thermal cycling. Bonding within the transistor must be such that fatigue, crystallization, and change in thermal impedance do not occur with age. The type of case also varies with the type of application for which the transistor is designed. In present practice the majority of transistors are hermetically sealed in glass, metal, or plastic.

Transistors, if carefully constructed, have no inherent failure mechanism to limit their useful life. Data shows that transistors can operate for 30,000 hours at maximum ratings without appreciable degradation in function. They perform their operations at ordinary temperatures and thus disipate very little heat to the ambient air; this feature helps to increase the life of other components of the system. The transistor's small physical size, sensitivity, and efficiency permit large safety factors in design, without appreciably changing the physical size of the system in which it is used.

Many of the scientific accomplishments of the last ten years would have been virtually impossible without the invention of the transistor. Observing that the transistor has been around only about fifteen years, we can look forward to many new types of application, and to a great improvement in quality and selection as manufacturing technique progresses.

* * *

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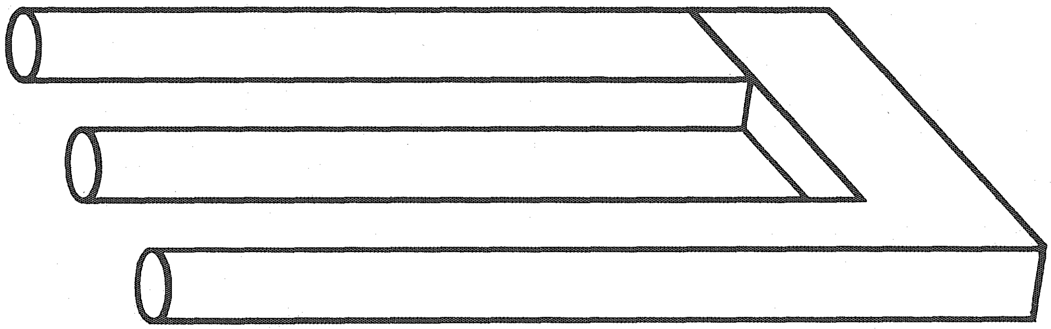

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It's a simple optical illusion, but it bothers you, doesn't it? It's hard to forget it until you've discovered what fooled you. There's something about an inquiring mind that won't let it forget a problem until it's solved.

In school, how many times have you worked half the night on an assigned problem until you solved it? After a while, it didn't matter whether the problem was assigned or not. *You* wanted the answer.

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Of course, we can't tell you the whole story here. To learn more about jobs at Honeywell, ask your advisor or Placement Director for our folder, PINPOINT YOUR FUTURE. It contains information on Honeywell products, plants and office locations.

If you're interested in Honeywell, why not talk to one of our recruiters next time he visits your campus? No deception there, OK? Just straight talk about what we have to offer each other.

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BRAIN TEASERS

by DIANNE CHRISTENSEN, *Physics '66*

1. What is the smallest number in which the digits are reversed when 2 is added to its double?

2. A wooden cube is painted black on all faces. It is then cut into 27 smaller equal cubes. How many of the smaller cubes are found to be painted on three faces, two faces, one face, and no face?

3. Mary Ann Moore's father has a yacht and so has each of his four friends: Colonel Downing, Mr. Hall, Sir Barnacle Hood, and Dr. Parker. Each of the five has one daughter and each has named his yacht after a daughter of one of the others, with no duplications. Sir Barnacle's yacht is the Gabrielle; Mr. Moore owns the Lorna; Mr. Hall the Rosalind. The Melissa, owned by Colonel Downing, is named after Sir Barnacle's daughter, Gabrielle's father owns the yacht which is named after Dr. Parker's daughter. Who is Lorna's father?

4. Three men are issued name tags, but each man is given the wrong tag. The name tags carry the names Smith, Brown, and Jones. What single question with a yes or no answer will allow correction of the erroneous name tag distribution?

5. A bucket is originally filled with ten pounds of sand. It is losing sand at a certain rate. This rate, in lbs./sec., is numerically equivalent to the acceleration of the bucket, in ft./sec.^{2}, which in turn, is numerically equal to one-half the weight of the sand (in pounds) remaining in the bucket at any given time. If the bucket is originally moving at a rate of —10 ft. per sec., and if the motion is taking place on a planet where the acceleration of gravity is one foot per second per second, how much work is done by the moving bucket from the time it contains ten pounds of sand until the time it is empty?

6. Once upon a time there lived a rich farmer who had 30 children, 15 by his first wife, who was dead, and 15 by his second wife. The latter woman was eager that her eldest son should inherit the property. Accordingly, one day she said to him, "Dear Husband, you are getting too old. We ought to settle who shall be heir. Let us arrange our 30 children in a circle, and counting from one of them, remove every tenth child until there remains but one, who shall succeed to your estate."

Quite astonished was the old man, as the first 14 children eliminated were by his first wife. Noticing this he realized that the odds were 15 to 1 that the latter wife's children would be chosen. "From this point on," the man suggested that they count backward from the the lone remaining child of the deceased wife. Which became the heir? What order did they start?

Answers in November issue.

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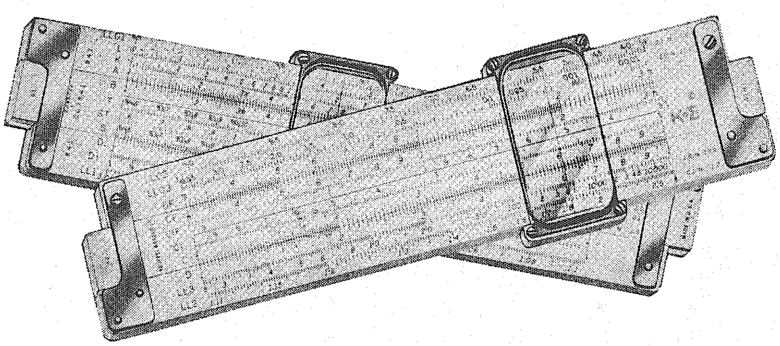

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In addition to the upcomingness, the flexibility, and the professionalism, one further characteristic can elevate the possessor above a merely good, satisfactory career: a feeling that "the company" really means "me" rather than some vague "them," a feeling which on fortunately rare occasions becomes so strong that he is willing to wage a stiff battle for a good idea.

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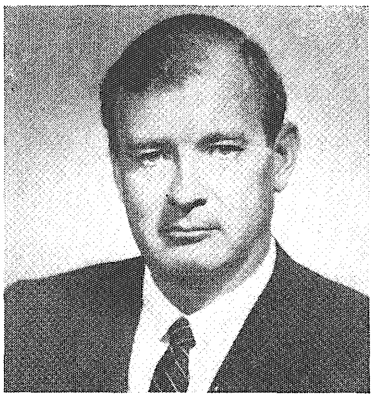
Advancement in a Big Company: How it Works

An Interview with General Electric's C. K. Rieger, Vice President and Group Executive, Electric Utility Group



C. K. Rieger

■ Charles K. Rieger joined General Electric's Technical Marketing Program after earning a BSEE at the University of Missouri in 1936. Following sales engineering assignments in motor, defense and home laundry operations, he became manager of the Heating Device and Fan Division in 1947. Other Consumer-industry management positions followed. In 1953 he was elected a vice president, one of the youngest men ever named a Company officer. Mr. Rieger became Vice President, Marketing Services in 1959 and was appointed to his present position in 1961. He is responsible for all the operations of some six divisions composed of 23 product operations oriented primarily toward the Electric Utility market.

Q. **How can I be sure of getting the recognition I feel I'm capable of earning in a big company like G.E.?**

A. We learned long ago we couldn't afford to let capable people get lost. That was one of the reasons why G.E. was decentralized into more than a hundred autonomous operating departments. These operations develop, engineer, manufacture and market products much as if they were independent companies. Since each department is responsible for its own success, each man's share of authority and responsibility is pinpointed. Believe me, outstanding performance is recognized, and rewarded.

Q. **Can you tell me what the "promotional ladder" is at General Electric?**

A. We regard each man individually. Whether you join us on a training program or are placed in a specific position opening, you'll first have to prove your ability to handle a job. Once you've done that, you'll be given more responsibility, more difficult projects—work that's important to the success of your organization and your personal development. Your ability will create a "promotional ladder" of your own.

Q. **Will my development be confined to whatever department I start in?**

A. Not at all! Here's where "big company" scope works to broaden your career outlook. Industry, and General Electric particularly, is constantly changing — adapting to market the fruits of research, reorganizing to maintain proper alignment with our customers, creating new operations to handle large projects. All this represents opportunity beyond the limits of any single department.

Q. **Yes, but just how often do these opportunities arise?**

A. To give you some idea, 25 percent of G-E's gross sales last year came from products that were unknown only five or ten years ago. These new products range from electric tooth brushes and silicone rubber compounds to atomic reactors and interplanetary space probes. This changing Company needs men with ambition and energy and talent who aren't afraid of a big job—who welcome the challenge of helping to start new businesses like these. Demonstrate your ability—whether to handle complex technical problems or to manage people, and you won't have long to wait for opportunities to fit your needs.

Q. **How does General Electric help me prepare myself for advancement opportunity?**

A. Programs in Engineering, Manufacturing or Technical Marketing give you valuable on-the-job training. We have Company-conducted courses to improve your professional ability no matter where you begin. Under Tuition Refund or Advanced Degree Programs you can continue your formal education. Throughout your career with General Electric you'll receive frequent appraisals to help your self-development. Your advancement will be largely up to you.

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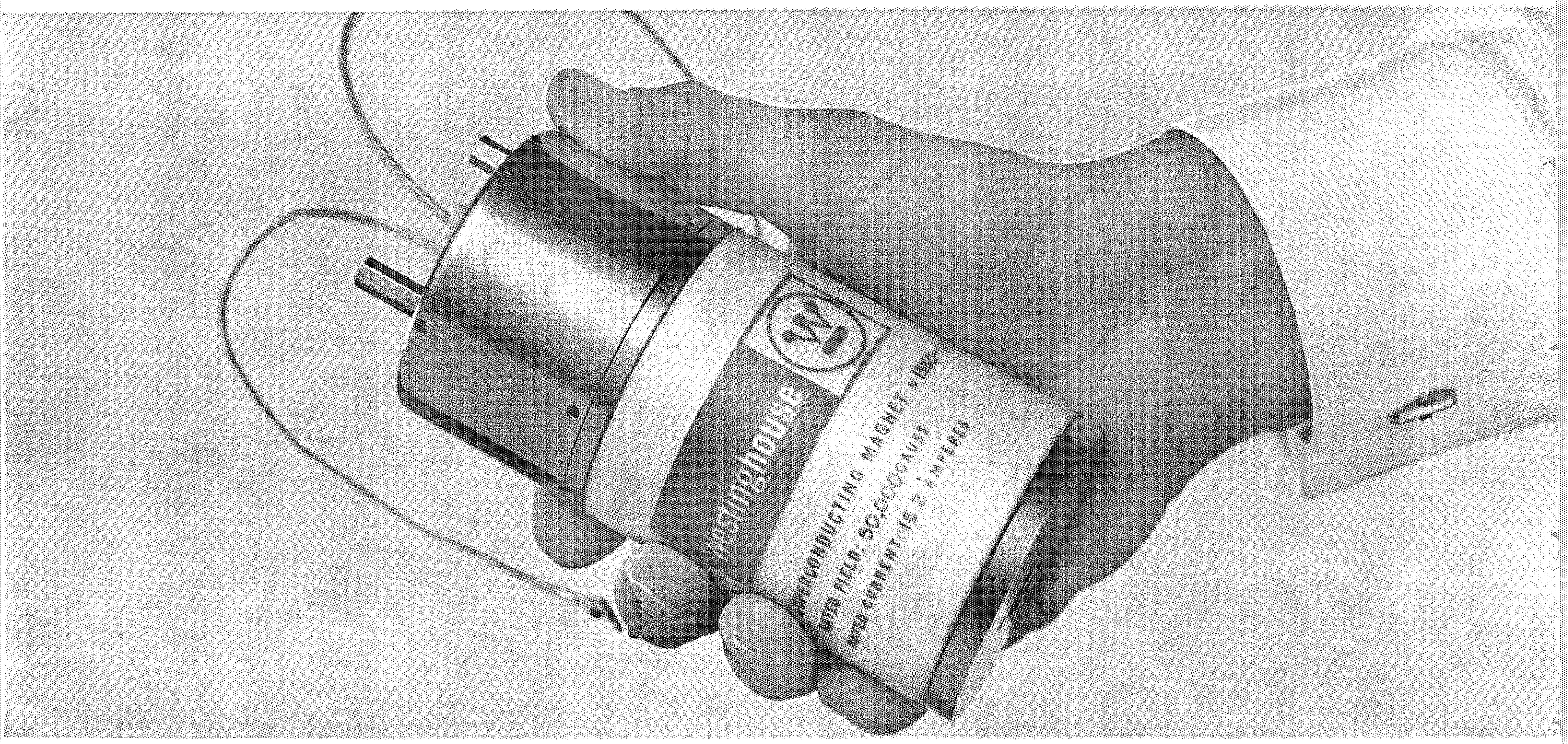

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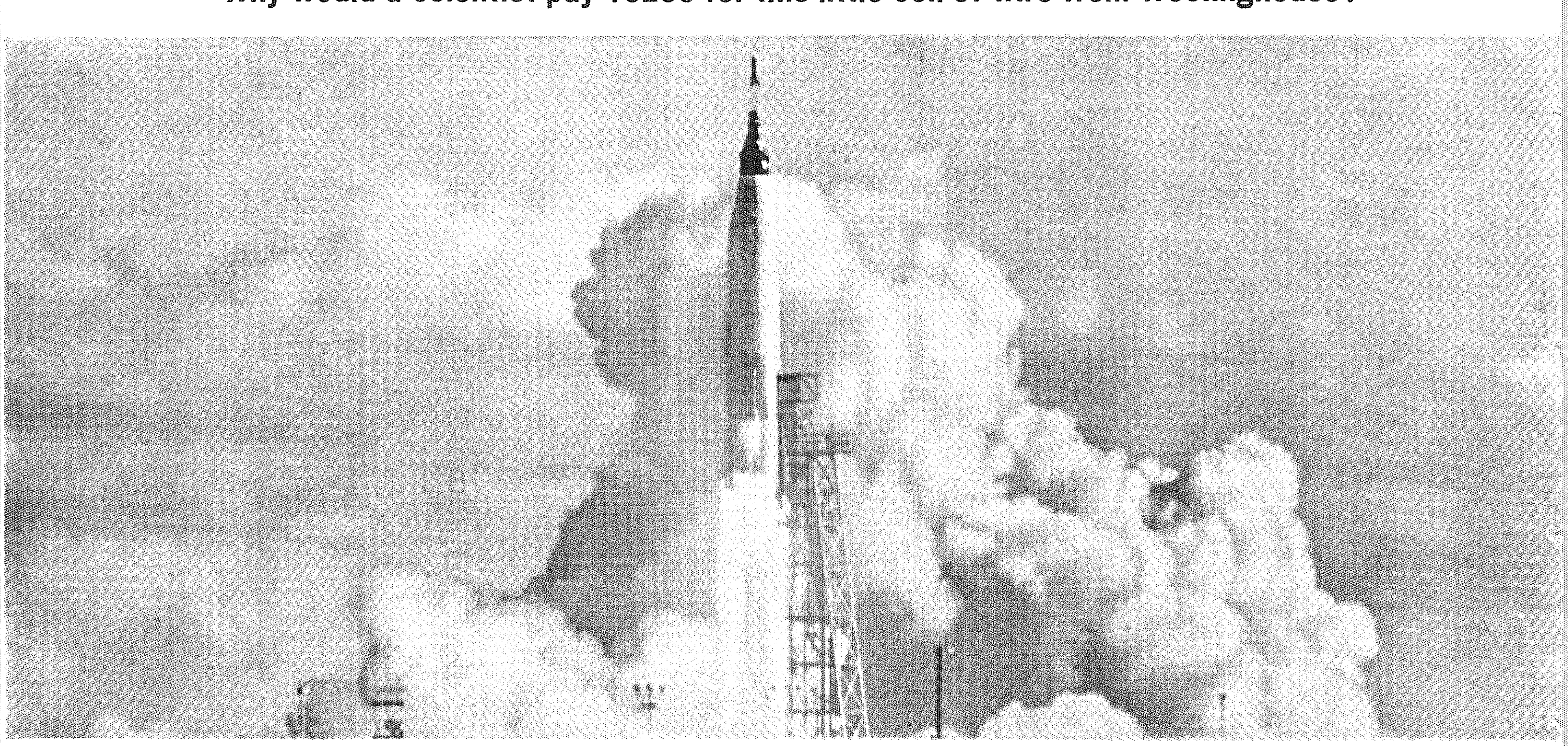

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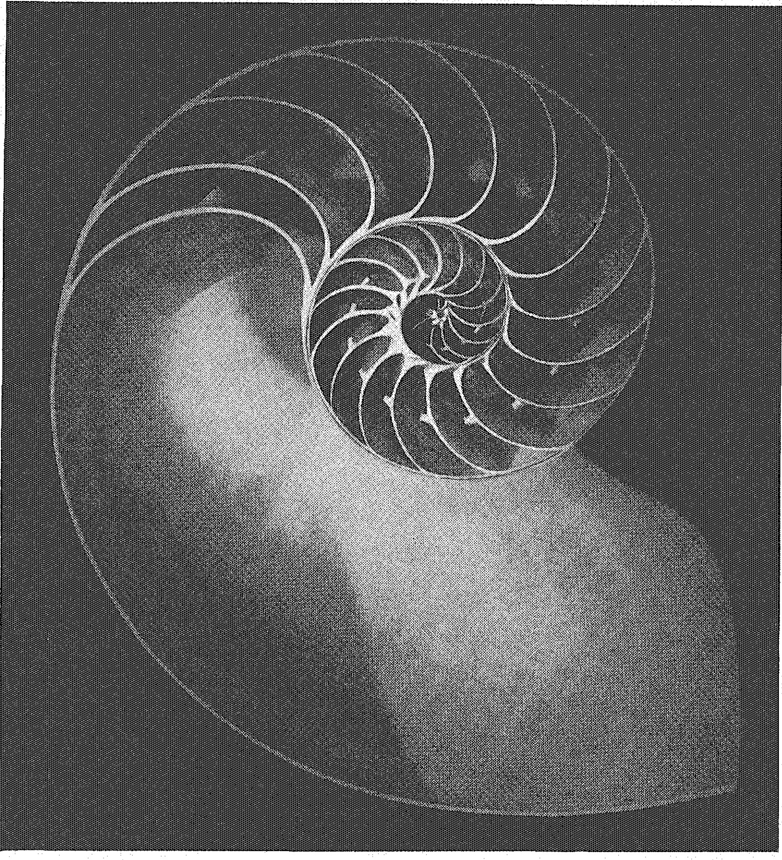

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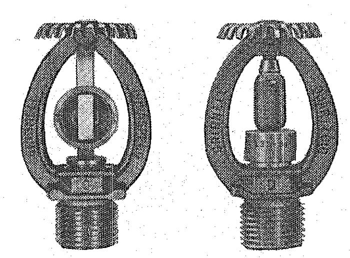

Grinnell Automatic Sprinklers include the Duraspeed® type (left) that incorporates a fusible-solder joint and the Quartzoid® Bulb type (right) filled with heat-expandable liquid.

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Official Student Publication of the Institute of Technology, University of Minnesota

Cover: "White" noise, with a Gaussian amplitude distribution, is pictured on this month's cover. White noise is that which has a constant power for all frequencies. More on noise in the article "Acoustic Noise Induced Vibration" on page 8.

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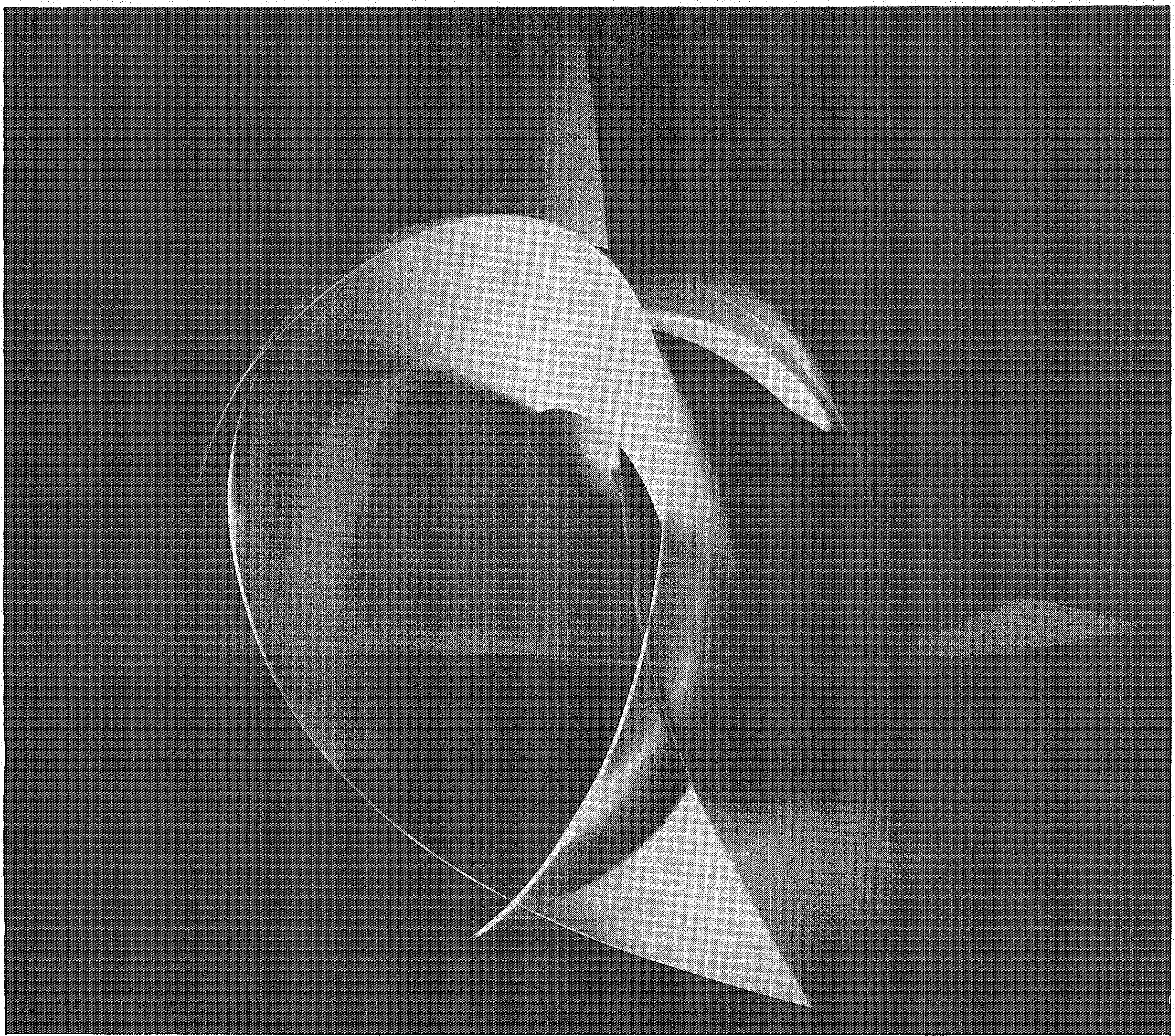

Construction in Blue and Black, Aluminum. José de Rivera. Collection of Whitney Museum of American Art, New York. Motion-study photograph by Herbert Matter

The art of sculpting a career

The man who created the sculpture shown above started his career as a tool and die-maker. The disciplines he learned in that exacting profession, coupled with his creative imagination, give his work the technical perfection and design vigor that have made him one of the world's most sought-after architectural sculptors.

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Editorial

"EDUCATION"

Now that mid-quarters are over—although some of us are still caught in their throes—perhaps there is a little time for all of us—freshmen to graduate students—to consider the meaning of "education." Webster gives the following definition: "education, discipline of mind or character through study or instruction." In particular, let's consider an engineering education.

From the student's point of view, getting a degree in engineering is often regarded as sheer drudgery, to be gone through only because of the promise of a high-paying job at the end of five years. The sole objective is money. "Discipline of mind or character" is about as far away from most engineering students' thoughts as one could get.

Now let's look at the other side of the coin. From many an instructor's point of view, an engineering education is merely covering the required course material in any one quarter and giving a mid-quarter and a final to see if anything sunk in. "Discipline of [the] mind or character [of his students] through . . . instruction" does not rank high among his goals either. This attitude on the part of instructors leads to an over-emphasis on grades.

The point is that our value judgments seem to have gone awry. Money after graduation and grades while attending the University are placed higher on the scale than knowledge. To quote Bret Harte: ". . . sad, . . . it is, but hadn't ought to be."

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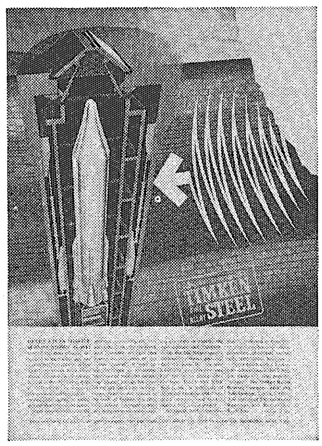
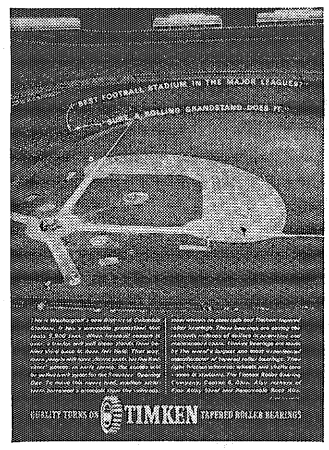




Acoustic Noise Induced Vibration

by RONALD V. LARSON, *M.E. '65*

Acoustic noise is sound whose wave form is very irregular in amplitude and in frequency. The psychological properties of noise—loudness and pitch—are correlated with a physical property. The loudness is related to the intensity and the pitch to the frequency.

Sound forces differ in general from forces of mechanical origin in that they alternate at very high frequencies and are smaller in size. The magnitude of a sound-pressure force is only 0.2 psi near a jet-engine exhaust. The zero decibel (db) level is referenced at 4.2×10^{-7} lb/ft^2 or 0.0002 dynes/cm^2.

Designers of aerospace equipment have become concerned about the intensity and frequency of noise. The new launching rockets are becoming more powerful and have higher intensity levels with broader frequency spectrums. The intensity level of a rocket engine at a constant thrust varies with frequency. Figure 1 indicates a correlation of thrust power level with frequency.

Acoustic noise tests have been devised to simulate the equipment's environmental conditions. These tests aid designers in evaluating aerospace equipment. The destructive vibration induced by noise occurs at the natural resonance modes of the equipment.

Noise Characteristics

The near field is simply defined as the region surrounding a noise source, such as a jet, within a distance of a few jet diameters. A more precise definition is to describe the properties within this region as observed during experimental studies. Pressures in the near field are a combination of acoustic pressures and hydrodynamic pressure fluctuations associated with the turbulent jet stream and vary as the second power of exhaust velocity. The noise intensity increases as the mass flow increases and as the temperature increases. The highest exhaust temperature produces the most efficient noise generation.

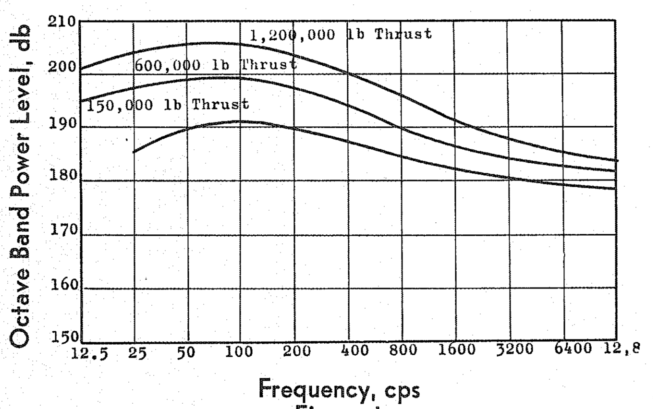


Figure I
Correlation of Thrust Power Level Versus Frequency For Three Different Rocket Engines

The far field is defined as the distance from a jet where noise sources in the exhaust can be considered to form a point source of continuous pressure fluctuations. A point of interest in this region is acted upon by a developed plane wave which is propagated past it. The pressure amplitude of the wave varies as the fourth power of exhaust velocity and attenuates as it propagates. The attenuation occurs because of absorption of energy due to the viscosity and thermal conduction of the ambient medium.

Noise Field Quantities

The level of booster-engine noise is a function of the dimensionless axial distance x/D. This noise level is influenced by the variation of the characeristic pneumatic impedance of the ambient air and motion of the noise source during flight. It is also dependent on exhaust velocity relative to ambient air.

Noise level of the boundary layer is a function of the local Reynold's number. When the Reynold's number exceeds a critical value along the body surface, the boundary layer becomes turbulent. A turbulent boundary layer is marked by rapid fluctuations in the fluid properties which, because of their random motion, become sources of noise. Data from experimental studies indicate that pressures on an exposed equipment surface with a turbulent boundary layer are about 20 db higher than for a laminar boundary layer. A further increase of 10 to 20 db in the surface pressure near a shock wave is also found.

Booster-engine spectrum level is a function of axial distance upstream and downstream of the nozzle exit. At any specified point in the near field, along the axis, all the frequencies in the spectrum have a nearly constant pressure-spectrum level. The deviation is only about 5 db.

The boundary-layer spectrum is a function of frequency and boundary-layer thickness. It follows an inverse relationship as indicated in the mathematical expression:

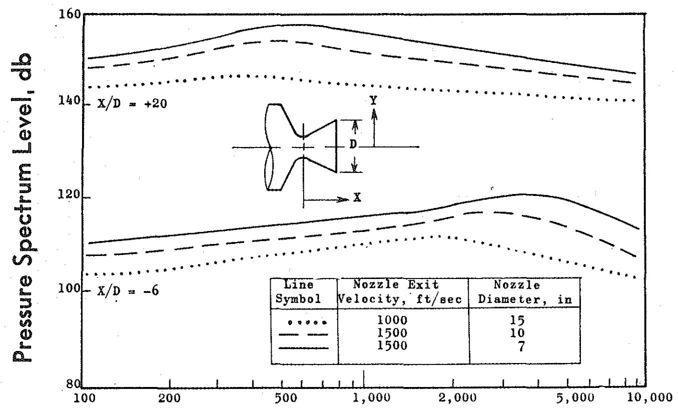
$$\text{Spectrum level (db)} = \frac{K}{F\delta}$$

where K can be considered a constant depending on Mach number and stream velocity, F is the frequency and δ is the boundary layer thickness. As a result, lower frequencies are more prominent at aft vehicle stations where the boundary layer thickens. Figure 2 illustrates a family of curves of expected frequencies and their respective pressure-spectrum levels.

The spatial correlation of the instantaneous pressures is a measure of the phase relationship at different points in the field and determines the effectiveness of the pressure field as an exciting force.

The locus of points in space of equal instantaneous pressure is called "an isocorrelation line." A plot of these lines forms an elliptical pattern around the jet boundary or rocket-engine exhaust nozzle. The major axis of the pattern coincides with the longitudinal axis of the nozzle. It appears that, for a given position within the field, the lower frequencies are associated with slower-moving eddies towards the center of the jet. In this near field, the propagation velocity of the wave front is not constant.

Sound-pressure correlations from the boundary-layer pressure fluctuations are only predictable for narrow frequency ranges and at constant free-stream velocities. The theories are not valid at supersonic velocities and at frequencies much higher than 2000 cps. The maximum frequency generated in the turbulent boundary layer of present-day space vehicles is about 50,000 cps. The data currently available is from isolated studies, and the results do not allow the application of any similarity consideration.



Frequency, cps

Figure 2

Typical Near-Field Noise Spectrum For Rocket Engines as a Function of Axial Distance, Nozzle Exit Velocity and Nozzle Diameter at a Radial Distance Y/D = 3

Random Excitation

Noise generated by rocket engines and turbulent boundary-layers is random in nature. It is not linear and not sine wave. Random noise is characterized by a pressure-time-history that is non-recurring, non-dissipative, and impossible to express by an analytic function. Because the frequency spectrum is wide and the amplitude is random, the spectrum is capable of simultaneously exciting many modes of vibration. The downstream spectrum in general has relatively more noise at the low frequencies and less at high frequencies. Upstream in the turbulent boundary-layer, the spectrum is continuous in nature up to at least 50,000 cps.

Noise Sources

Two general noise sources contribute to the overall noise levels during a complete flight of a space vehicle. Booster-engine noise prevails only during subsonic flight and the noise from the turbulent boundary-layer exists only during flight in an atmosphere. More specifically, the vibration of the airframe and the noise about it result from the aerodynamic turbulent boundary-layer, turbulence in the jet exhaust, and combustion instability. The first two sources are random in nature, and the latter is a quasi-periodic excitation.

Figure 3 illustrates the relative location of the noise sources for a missile. Since spacecraft is an integral part originally of a missile, it will therefore experience the same environment.

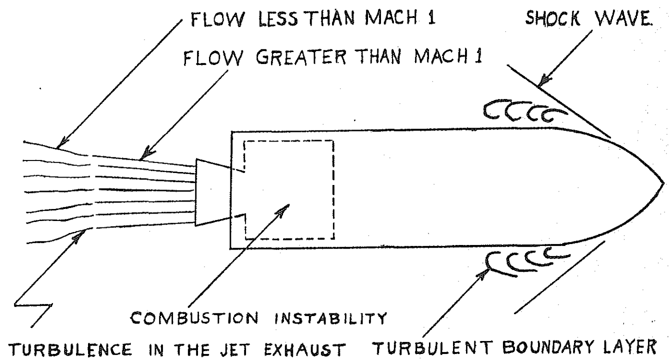


Figure 3

Location of Noise Sources During Initial Flight Stage

Data from static tests of rocket engines indicate that 0.5% of the total thrust is lost to acoustical noise generation.

Turbulence does not generate sound like a siren, or an air chopper. The fluctuations of pressure at a point, with their corresponding fluctuations of density, are unable to produce an acoustic source field in the manner of intermittent spurts of fluid. This is because in the turbulence no new field is introduced; hence the total monopole strength is zero.

Turbulence does not even generate sound similar to a bell, where momentum is periodically transferred to the air by the bell surface. This is because there are no external forces acting on the turbulent fluid and the internal actions and reactions balance.

Sound generated by turbulence is an effect of a higher order function, and is basically a quadrupole field generated by fluctuations—not of mass or momentum—but of the momentum flux. As a tensor it includes the kinetic energy. It includes also lateral momentum flux, i.e., flow of momentum perpendicular to itself, and it is this which is responsible for the bulk of the sound generated.

Jet Turbulence

Intense turbulence in the jet is created in the thin layer where the jet fluid, after leaving the nozzle, exchanges momentum with the ambient atmosphere. The observed variation in acoustic efficiency, directional distribution, and frequency spectrum with increasing jet velocity, are accounted for sufficiently by the representation of a jet as a distribution of acoustic quadrupoles in an otherwise undisturbed atmosphere.

In Figure 3 the region of the jet turbulence is indicated. The approximate mathematical expression for the total radiated power is

$$E = \rho \frac{d^2V^8}{c^5}$$

where ρ is the local density of the medium, d is the nozzle diameter, V is the exhaust velocity relative to the ambient medium and c is the local speed of sound.

Particular attention must be given to the combustion process. Coupling of the sound wave to the combustion process may occur in two ways. In general, the sound wave imposes both a fluctuating pressure and a fluctuating velocity on the combustion zone. Either of these may alter the chemistry and physics of the combustion process to convert some of the energy being released into acoustic energy.

Serious failures in equipment may result from vibration caused by acoustic noise. Two types of failures occur. A structure may undergo so many cycles of application and reversal of stress that cracks form and result in fatigue failure. This is referred to as "sonic fatigue." On the other hand, in cases where the stress is too small to cause fatigue, the amplitude of vibration of one element relative to another may become large enough to disturb the proper alignment or operation of the equipment.

Transmission of complex acoustic forces and the associated energy can be analyzed much the same as their electrical analogs. As any component of a system vibrates, there will be forces exerted on it by the surrounding and enclosed fluid. The forces are made up of three parts. One part in phase with the acceleration causes a slight increase in the effective mass of the component. Another part in phase with the velocity gives rise to a damping force and the component functions as an acoustic energy radiator. The third part may be important and apply in some cases. That is, concerning the fluid enclosed within the structure. At certain frequencies, standing waves can be set up inside the structure and inhibit movement of the walls.

The impedance of structures is high compared with the characteristic impedance of air. As a result, the structure accepts energy near the primary resonances and tends to reflect energy at all other frequencies. It has also been observed during noise tests that the temperature of the specific experimental specimens did not rise significantly. Therefore, it follows that much of the available energy either is not accepted at all or is re-radiated into the surrounding medium.

The conditions for maximum energy transfer are dependent on the angle of incidence of the acoustic pressure wave with respect to the surface of the structure. Tangential incidence is only about one-half the absorption of normal incidence. Normal incidence results primarily in the first mode response, whereas, in the case of tangential incidence, there are tendencies for higher order vibrational modes.

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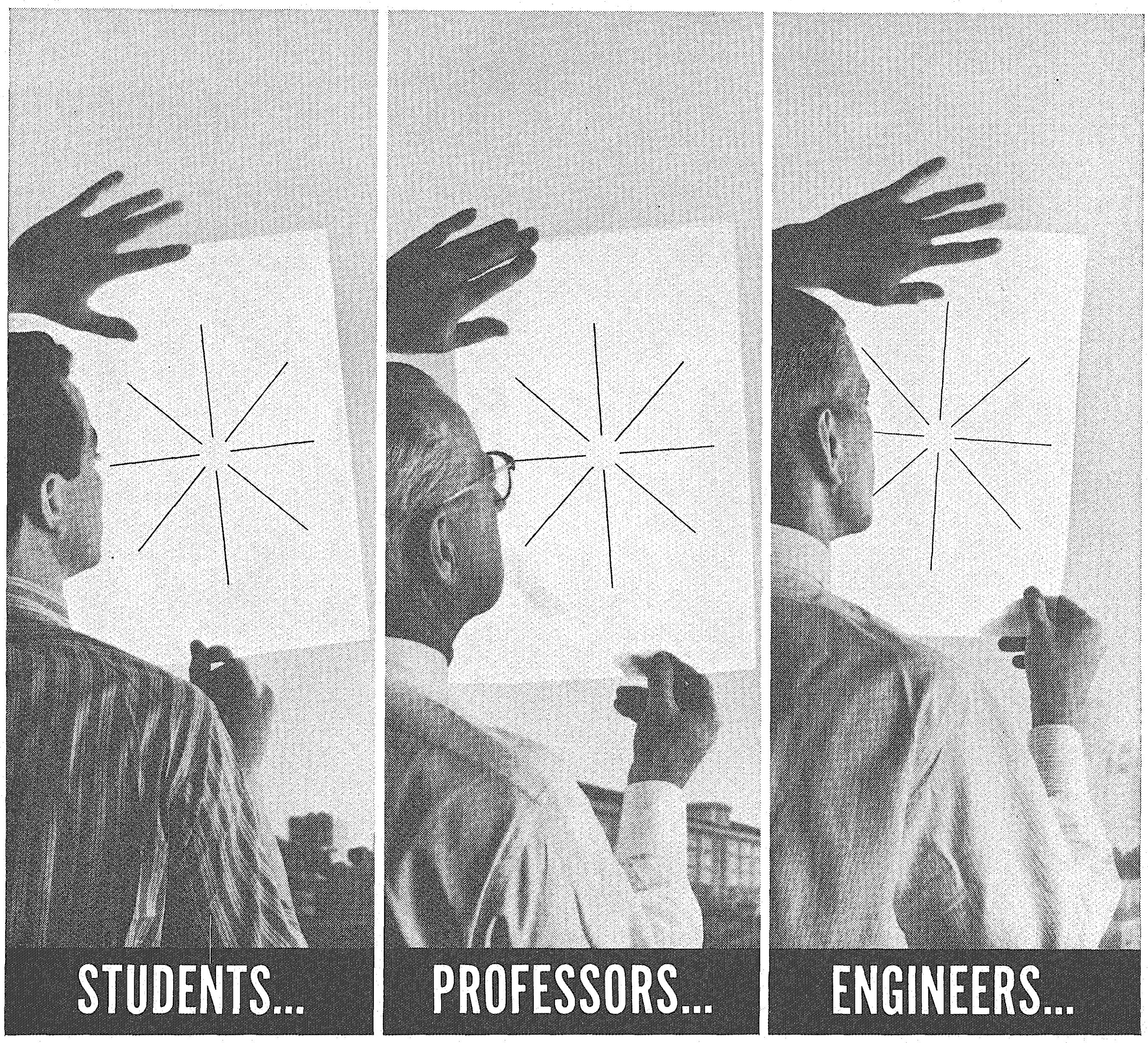

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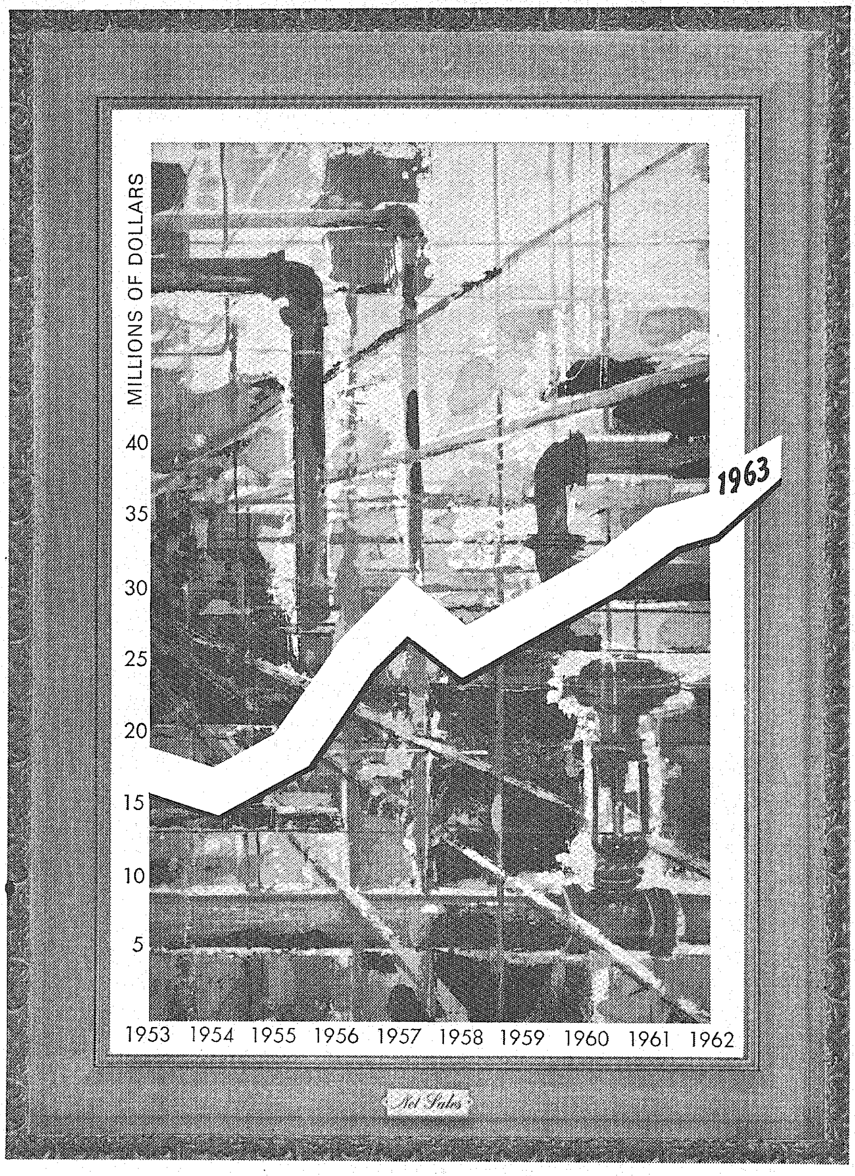

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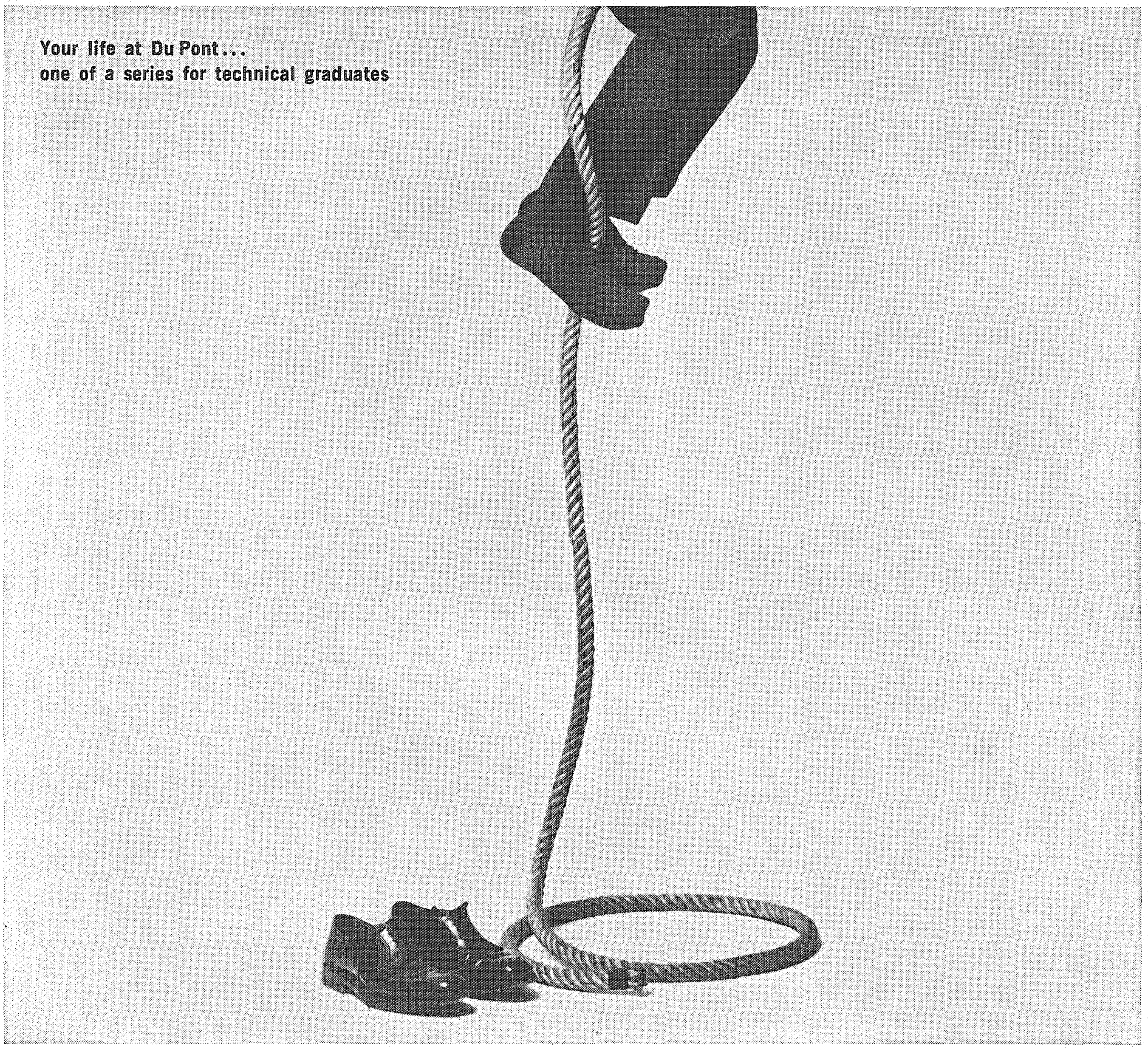

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LOW-TEMPERATURE REFR

by JAMES N. LANG, *M.E. '65*

All refrigeration processes develop low temperatures. "Low temperature" is a relative term, and to the air conditioning engineer it may mean temperatures near 32° F. only. To the physicist it may mean temperatures as low as –460° F., which is absolute zero. The science of low temperatures is called "cryogenics." The term "cryogenics" is derived from the Greek word "kyros," which means "cold."

The first low-temperature refrigeration systems were developed primarily for the solidification of carbon dioxide and the liquefaction and subsequent fractional distillation of such gases as air, oxygen, nitrogen, hydrogen, and helium.

In 1933 Giauque and Debye independently proposed the adiabatic demagnetization of paramagnetic salts, called "magnetic cooling," to obtain lower temperatures, and through their methods –459.9° F. was reached.

Vapor-Compression Systems

Vapor-compression systems can refrigerate to temperatures as low as –150° F. For these low temperatures, the vapor-compression system must be either a multi-stage or cascade system.

For producing low temperatures the multi-stage system must consist of two or three stages, seldom more. Two-stage compression with intercooling and removal of flash gas is often the ideal way to serve a low-temperature evaporator. In fact, this system requires less power input than a single compressor system operating between the same temperature limits. In large installations, three stages are recommended for evaporating temperatures below –75° F. and in small installations three stages should be used below about –100° F.

Some problems arise as evaporating temperatures drop. The compression ratio increases, and the volume rate of flow of refrigerant per ton of refrigeration increases. A high compression ratio reduces the volumetric efficiency of the compressor and also results in high compressor discharge temperatures. There is a definite need for multi-staging in low temperature refrigeration systems, since compression ratios have a practical limit of from 9 to 12. A study of Figure 1 shows why low evaporator temperatures require multi-staging. The high rate of flow per ton at low temperatures means that the compressor displacement must be very large. With a compressor of given displacement, therefore, the capacity dwindles at low temperatures. Another problem associated with low temperatures is compressor lubrication. It is, therefore, advantageous to use centrifugal compressors.

The cascade system combines two independent vapor-

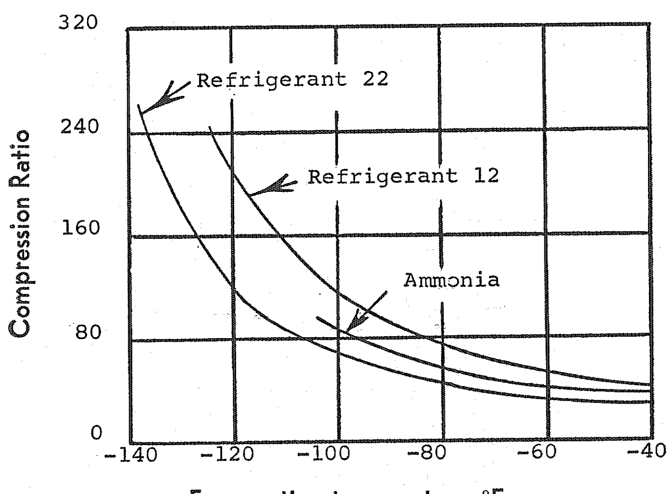


Figure I
Volume Rate of Flow Per Ton

compression systems, with the compressor of the low-temperature unit discharging its heat to the evaporator of the high-temperature unit. The two units in the cascade system may be either single stage or multi-stage, or combinations of both. Cascade systems usually use different refrigerants in the high and low units. A dense, high pressure refrigerant—such as refrigerant 13, ethylene, or ethane—may be used in the low temperature unit. A dense refrigerant with low volume rate of flow per ton allows the compressor to have a smaller displacement. A high-pressure refrigerant also minimizes leakage of air

GERATION

into the system.

The cascade system, while providing temperatures as low as –150° F., has some disadvantages. One is that there exists a temperature overlap in the cascade condenser. The condensing temperature of the low-temperature system is usually about five to ten degrees Fahrenheit above the evaporating temperature of the high-temperature system. The result of this overlap is a slightly higher power cost than would be otherwise experienced. Secondly, the two units making up the cascade system must be balanced so that all of the heat rejected by the low-temperature system is removed by the high temperature system, and still achieve the desired intermediate temperature. A paradox exists in that during start-up the desired low temperature could not be reached by the high-temperature system operating alone. Once the desired low temperature is reached, however, the high-temperature system may be more than adequate to maintain it.

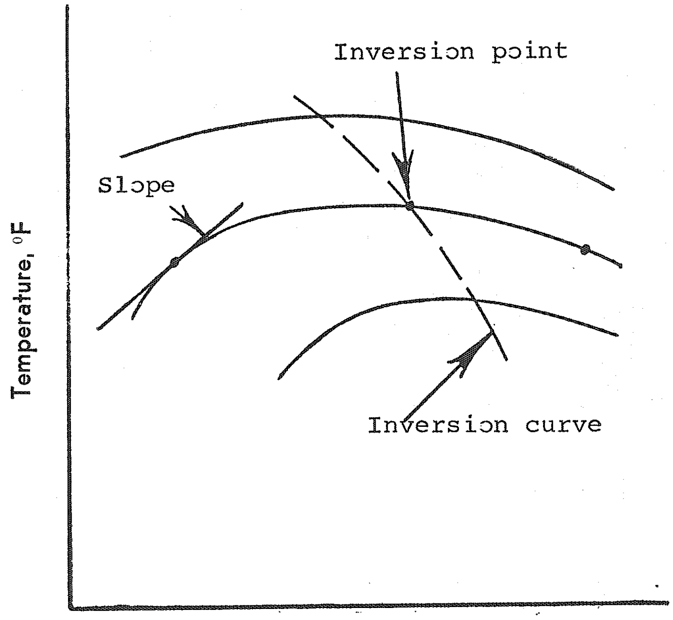
When a vapor-compression system operates at low temperatures, difficulties arise. Oil may not return from the evaporator to the compressor because of low refrigerant-flow rates; moisture in the refrigerant may freeze; a thermostatic expansion valve may demand more superheat, causing less effective use of the evaporator; and compressor discharge temperatures may become excessively high. Careful design and installation of the system is of utmost importance to eliminate or to minimize these difficulties.

Liquefied Gases

The liquefaction of gases has importance in two main areas. It may be a step in the separation of a mixture of gases, or it may be used as a source of low-temperature cooling. At present many gases are being shipped or stored as low-temperature liquids, allowing large savings of space. Liquid natural gas, for example, occupies only 1/600 of the space required when it is stored as a low-pressure gas.

In order to liquefy a gas, heat must be withdrawn from it. Two methods of expansion may be used to accomplish this: (1) a restrained expansion where work is performed by the gas, and (2) an unrestrained expansion or throttling of the gas.

When a gas is throttled, the enthalpy remains constant, but the temperature may either increase, decrease, or remain the same. The Joule-Thompson coefficient, $u = (\partial T/\partial P)_h$, indicates the direction of the temperature change of an expanding gas. If $u > 0$, the temperature decreases with throttling. If $u < 0$, the temperature increases with throttling. If $u = 0$, the temperature remains constant. For cooling, then, it is required that the gas show a large positive value of u. Figure 2 shows lines of constant enthalpy on temperature-pressure coordinates for a typical gas. The slope of the constant enthalpy line is the value of the Joule-Thompson coefficient at that condition. Thus, if throttling occurs from point 1 to point 2, the temperature will increase. If throttling occurs from point 2 to 3, or even from point 1 to 3, the temperature will drop. At point 2 the temperature is a maximum and the Joule-Thompson coefficient is zero. This



Pressure, psia
Figure 2
Lines of Constant Enthalpy
Actual Gas Temperature-Pressure Curves

temperature is called the "inversion temperature." Thus, in order for hydrogen to be cooled by throttling, its temperature must be below –108° F. before the throttling process is begun. Also, the farther the temperature is below the inversion temperature initially, the greater will be the temperature drop during throttling.

The simple Linde cycle is the most elementary air-liquefaction system. Since it is not the most efficient system available, it is used primarily in small installations.

Figure 3 is a schematic and temperature-entropy diagram for the simple Linde system. The system consists of a compressor, cooler, heat exchanger, expansion valve, and a separator. Air enters the compressor and is compressed to a high pressure (50 to 200 atmospheres), and then passes through the cooler which removes the heat of compression. The high-pressure air then flows through the heat exchanger to the expansion valve. The ad-

(Continued on Page 22)

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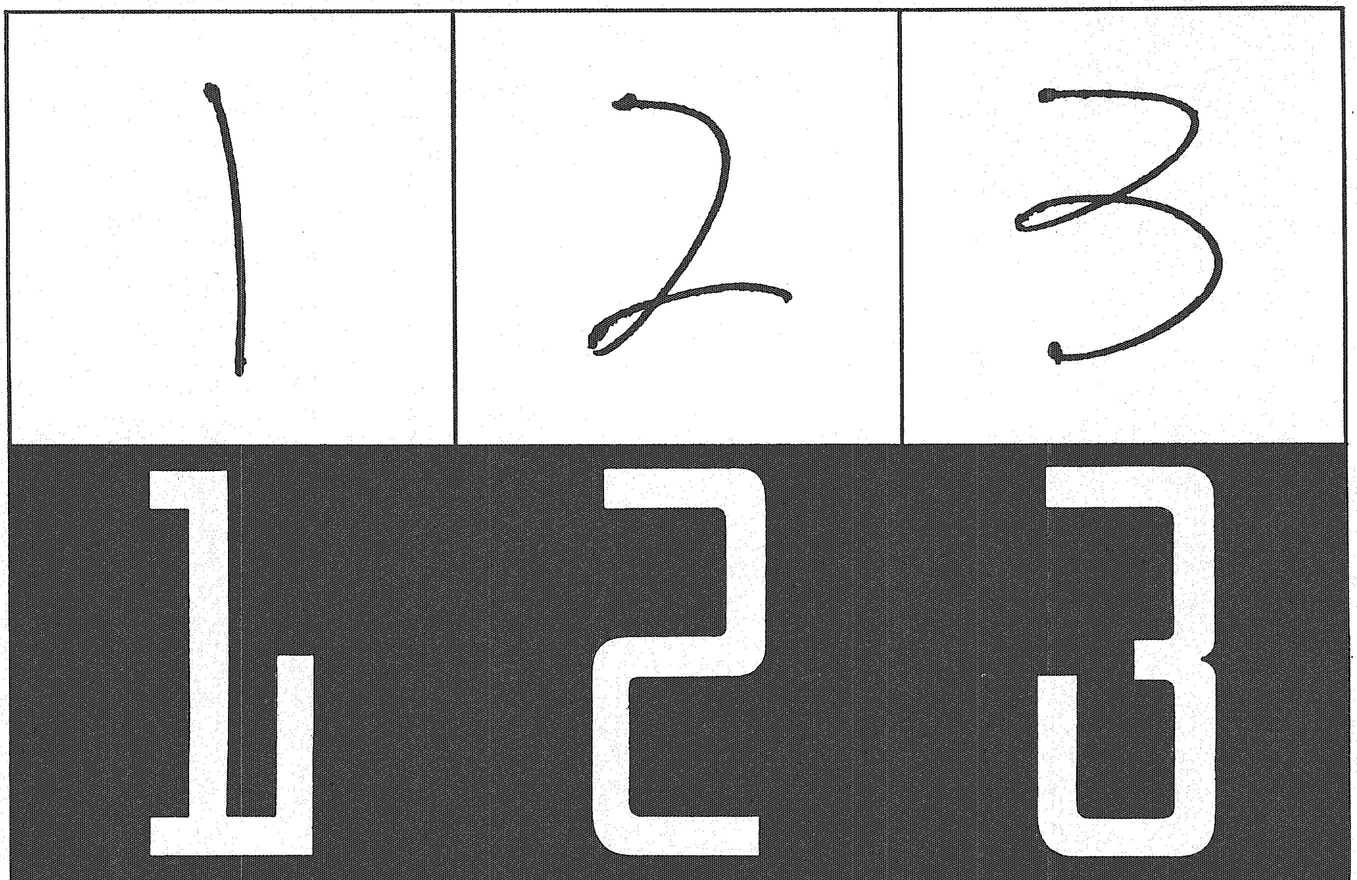

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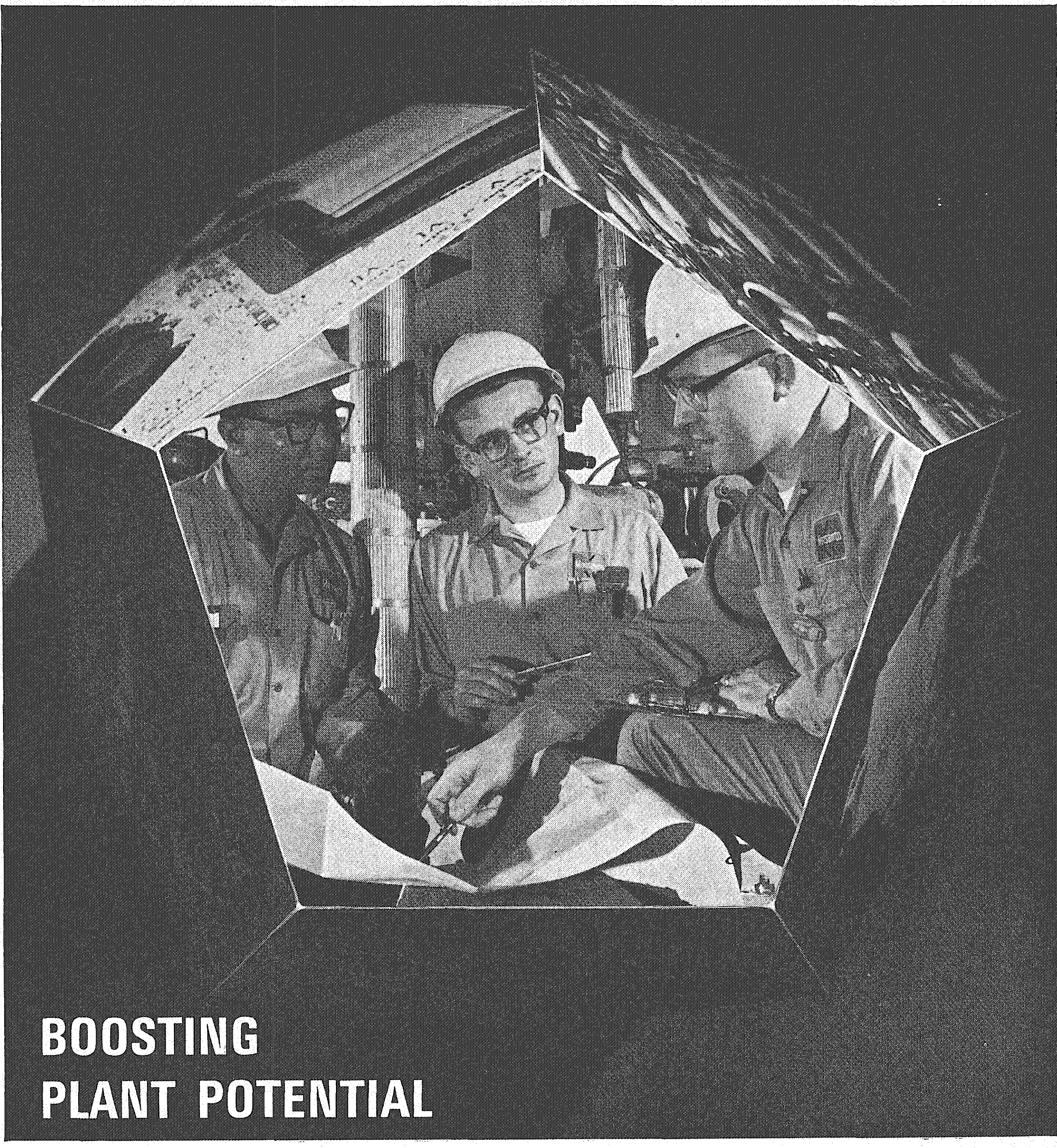

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WHAT'S NEW *in Engineering*

edited by STEVE LINDFORS, *Physics '67*

Survey by Satellite

A satellite system that could be used to survey underdeveloped countries was described several weeks ago at the 15th International Astronautical Congress. A technical paper presented there stated that the system would make it possible to locate a point on the earth's surface with an accuracy of 10 feet relative to a reference point.

Commenting on the paper and on the problem to which the proposed satellite system offered a solution, its author said the development of a country's natural resources depends, first of all, on a knowledge of the exact location of the country's geophysical characteristics.

"To build roads, to take advantage of the location of streams and land contours and to otherwise make good use of a nation's natural resources," the author said, "we first need accurate maps. The problem of exact border location alone emphasizes the need for accurate mapping techniques."

Obtaining such maps through the use of modern, although somewhat conventional, techniques has proved to be an expensive and time-consuming process involving many millions of dollars and years of effort.

The author said the proposed satellite surveying technique would make use of what is known as the Doppler shift in frequency of a radio signal. He explained the method this way: If we first establish a radio receiver at a known location and put a mobile receiver on a jeep some distance away we can measure the distance of the jeep from the known location. This is done by comparing the apparent difference in the frequency of the radio signal as received at the two locations."

It was pointed out that, while a satellite could be built specifically for surveying purposes, there are several satellites already in orbit broadcasting the required radio signals but for other purposes. These signals may be freely used anywhere in the world on a continuous basis without interference, he said.

With proper ground equipment, one mobile receiver on a jeep could pin-point five or six locations per day. Depending on the amount of equipment employed and the type of terrain involved, an entire country could be accurately mapped quickly and at a relatively low cost.

Even a Dog Can't Hear

In the neighborhood of 10,000 vibrations per second, sounds to the human ear become nothing more than thin, shrill squeaks. Sound waves almost a million times higher in frequency, 9×10^9 cps, were recently generated by scientists at the Westinghouse Research Laboratories. They predict the technique involved will eventually take them 100 times higher.

The vibrations are generated by a radical new form of piezoelectric transducer. Such a device has the unique ability to convert electrical pulsations into mechanical vibrations, which give rise to sound. It ordinarily consists of a thin wafer of a crystalline material such as quartz. But for use at high frequencies, ordinary piezoelectric crystals must be made so thin that they shatter under the vibrations they generate; they are so fragile that it is nearly impossible to handle them without breakage.

Now scientists connected with Westinghouse Research Laboratories have overcome this problem. To replace these thin, brittle wafers of quartz, they "grow" ultrathin films of crystalline cadmium sulfide built up atom by atom in an orderly, near-perfect fashion.

The films, only 10 to 100 millionths of an inch thick, are grown inside a vacuum chamber. They are deposited from hot vapors in such a way that the required numbers of the two kinds of atoms in the compound cadmium sulfide stack themselves up in perfect order to form what is felt to be a nearly continuous single crystal without gaps in its structure.

Westinghouse transducers are being used to study the basic structure of materials such as ruby and sapphire. Therefore, the thin-film transducer is deposited directly on the surface of a block of the material under study. The technique replaces a method in which the usual thin fragile transducer must be cemented to the block's surface.

In use, a short pulse of high-frequency microwaves is fed to the thin-film transducer. Mechanical vibrations of the same frequency are set up in the transducer, which transfers them to the entire block of material. These acoustic vibrations bounce back and forth inside the block and eventually die away. The lifetime of the sound waves and the velocity with which they travel yield basic data on the perfection of the physical structure of the ruby or sapphire or other material under study.

Semi-Waxed Fruit

Synthetic high gloss fruit and vegetable coatings that ensure freshness of produce have recently been developed. The new coatings, called "Vita-Brite," are a result of an intensive two-year research program to replace natural wax that is eliminated by washing produce prior to shipping. Tests on citrus fruits, tomatoes, and cucumbers have demonstrated their effectiveness. The new coatings, which can be sprayed or roller brushed onto produce, protect fruits and vegetables from moisture loss and shrinkage and inhibit green and blue mold decay. After application, wax-coated products will reach market with more retained moisture and flavor. The developer also believes high gloss coatings can increase salability by its eye-appeal to consumers, as well as by adding shelf storage life. All ingredients are reported to have been approved by the Food and Drug Administration.

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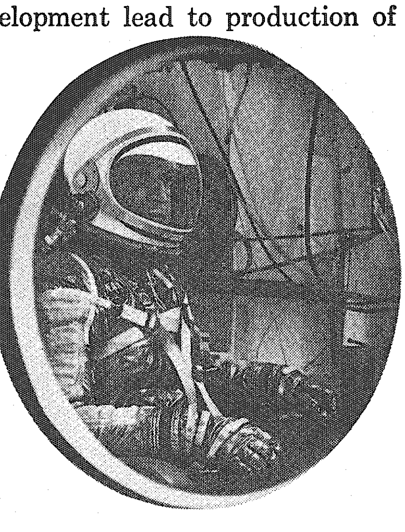

The product lines at AiResearch, Los Angeles Division, are environmental systems, flight information and controls systems, heat transfer systems, secondary power generator systems for missiles and space, electrical systems, and specialized industrial systems.

In each category AiResearch employs three kinds of engineers.

Preliminary design engineers do the analytical and theoretical work, then write proposals.

Design engineers do the layouts; turn an idea into a product.

Developmental engineers are responsible for making hardware out of concepts.

Whichever field fits you best, we can guarantee you this: you can go as far and fast as your talents can carry you. You can make as much money as any engineer in a comparable spot – *anywhere*. And of course, at AiResearch, you'll get all the plus benefits a top company offers.

Our engineering staff is smaller than comparable companies. This spells opportunity. It gives a man who wants to make a mark plenty of elbow room to expand. And while he's doing it he's working with, and learning from, some of the real pros in the field.

If the AiResearch story sounds like opportunity speaking to you—don't fail to contact AiResearch, Los Angeles, or see our representative when he comes to your campus.

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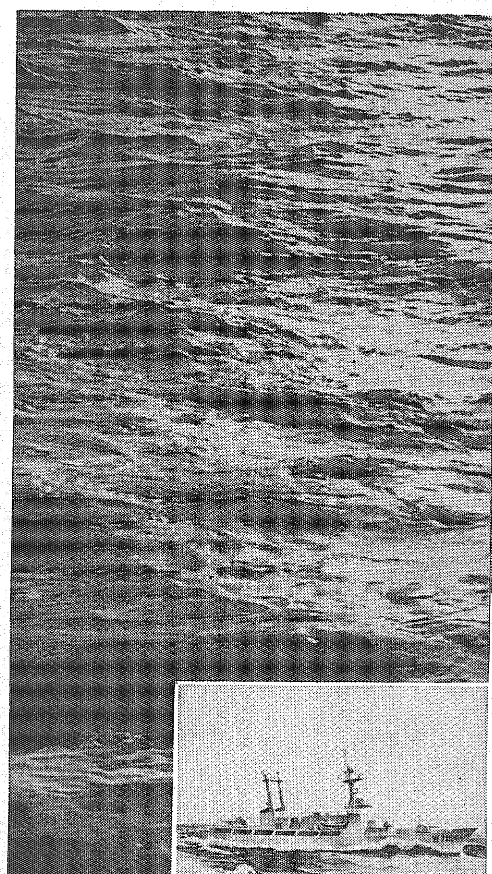

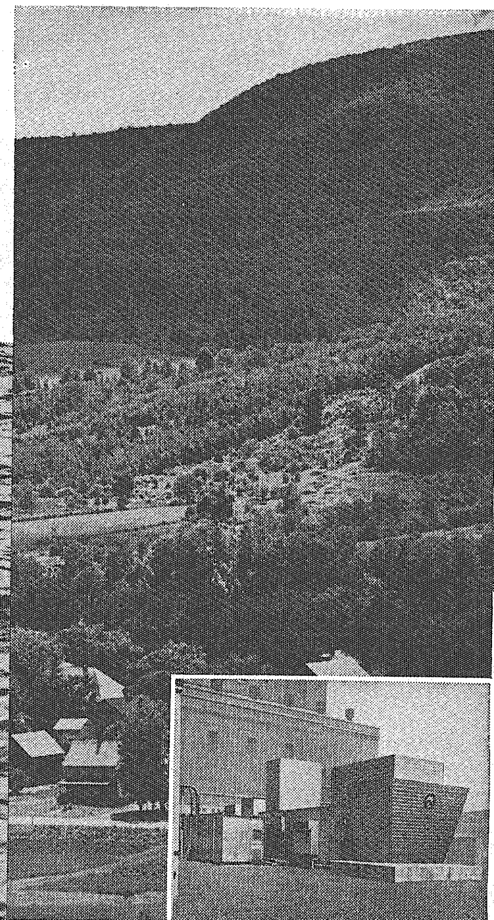

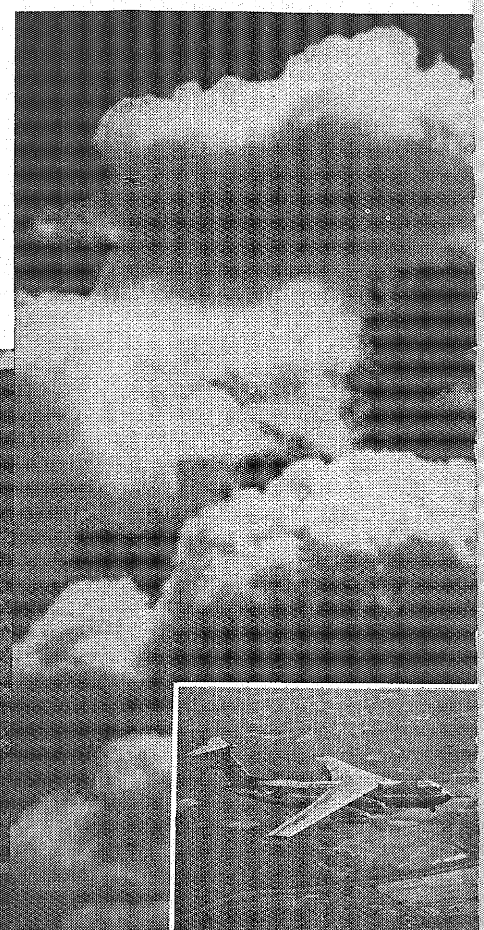

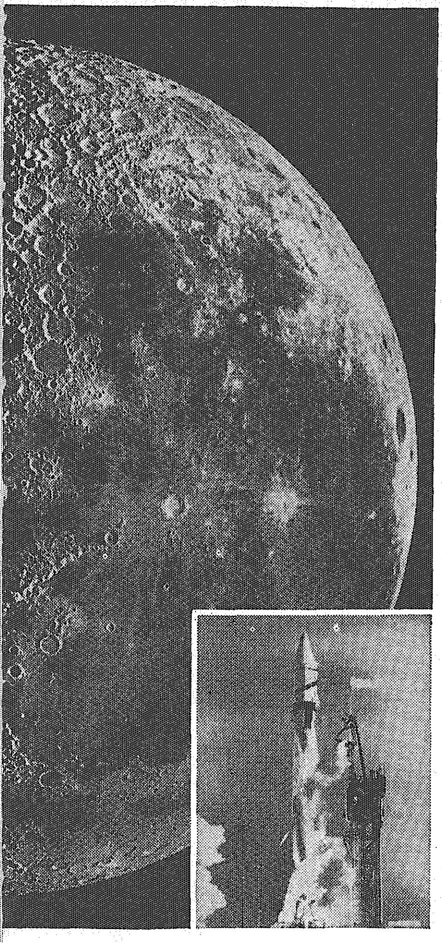

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Refrigeration

(Continued from Page 15)

vantage of a large value of the Joule-Thompson coefficient can be utilized if the air is cooled to a low temperature in the heat exchanger. The air expands to atmospheric pressure in the expansion valve and some liquid is formed. This liquid is removed in the separator while the remaining vapor recirculates back through the heat exchanger. This low-temperature vapor provides the necessary cooling for the high-pressure air entering the expansion valve. Make-up air is added to the system to replace that which has been liquified. The following example illustrates how the Linde cycle starts, from an initially ambient condition, and produces liquefaction.

1. The first pound of air leaves the cooler at, say, 100° F. and 3,000 psig. It is not cooled in the heat exchanger because that also is at 100° F. During expansion the temperature drops to 44° F. No liquefaction occurs, so that the one pound of air flows back through the heat exchanger to cool the next pound.

2. The second pound of air leaves the cooler at 100° F. but, assuming a perfect heat exchanger, it is cooled to 44° F. before expansion. During the expansion the temperature drops to –27° F. Still no liquefaction occurs, and the second pound of air flows back through the heat exchanger.

3. Subsequent quantities of air drop to lower temperatures, the inversion temperature is finally reached, and

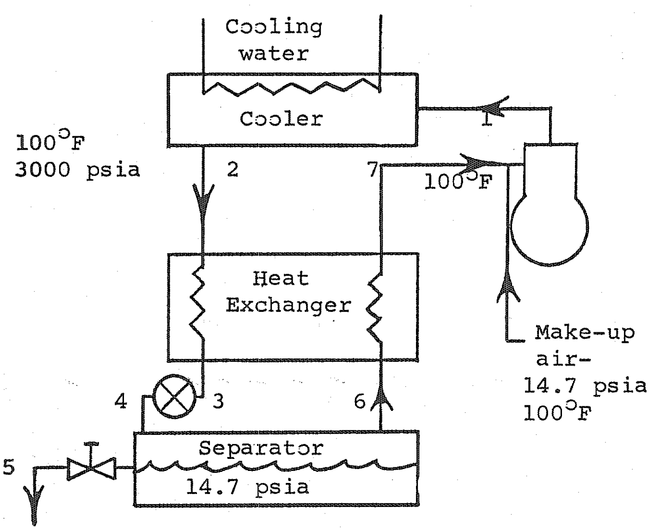


Figure 3
The Linde System

liquefaction begins. Complete liquefaction is impossible, since no vapor would be left to perform the cooling in the heat exchanger. An equilibrium is, therefore, established, and the cycle continues.

Modified Linde systems are available which provide for two-stage expansion and compression. These systems are more efficient and can be compared with the multistage or cascade vapor-compression systems.

A gas which performs external work during expansion experiences a greater temperature drop than when it expands in a throttling valve. The Claude system utilizes this principle and is, therefore, more efficient than the Linde system.

The elementary Claude system differs from the simple Linde cycle by the addition of an expansion engine and a second regenerative heat exchanger. Figure 4 is a schematic and a temperature-entropy diagram for the Claude system. Part of the air at point 3 is bled off and

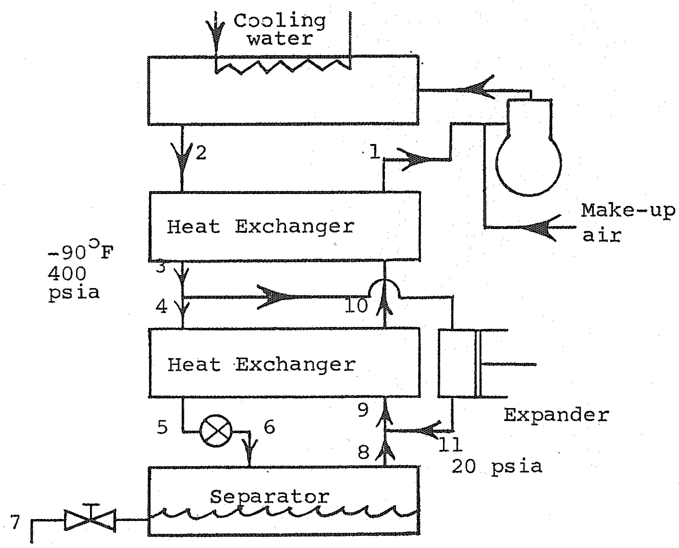


Figure 4
The Claude System

expanded through the engine. The low-temperature gas at point 11 then mixes with vapor coming from the separator, giving increased mass flow at point 9. The temperature of the air ahead of the expansion valve can thereby be maintained at a lower temperature in the Claude system than in the Linde system.

The Claude system also operates with a lower compression ratio than the Linde system. Reciprocating expanders are used in small installations, and centrifugal expanders are usually used in large plants. Control problems make it difficult to recover the power developed by the expander, and only where the power savings justify elaborate control systems is recovery feasible.

Of the gases available, helium has the lowest boiling temperature. At atmospheric pressure helium boils at 7.8° R., but by boiling it under low pressures, temperatures as low as 1.8° R. can be produced. Helium is usually liquefied by compressing it, cooling it with liquid hydrogen, and expanding it by throttling. The liquid hydrogen is produced by compressing it, cooling it with liquefied air, and expanding it by throttling. The liquid air is produced by a Linde or Claude cycle.

A new development for producing liquid helium, the Collins Cryostat, does not need liquid hydrogen. The system compresses the helium to about 225 psig; then the helium is water cooled and passed through heat exchangers and expanders. The expanders consist of non-lubricated, close-tolerance, reciprocating engines.

Solid Carbon Dioxide

Solid carbon dioxide, "dry ice," is a common low-temperature substance. Its heat of sublimation is used to maintain perishables at low temperatures, and to provide short-term refrigeration in laboratories.

Solid carbon dioxide, despite comparatively high manufacturing costs, has many unusual properties as a refrigerant. It is nontoxic and noncorrosive, and is easily handled and cut. At atmospheric pressure solid carbon dioxide sublimates directly from the solid to the gaseous state at a temperature of –109° F. and may, therefore, be used to maintain a wide range of temperatures. At atmospheric pressure the heat of sublimation is 246 Btu per pound, and if the gas is further raised to 32° F., an additional 27 Btu per pound of sensible heat is available. By increasing the pressure, the temperature of sublimation can be raised to the triple point (–69.9° F.), and above that corresponding pressure the solid passes through the liquid state before becoming a gas. Solid carbon dioxide is difficult to preserve because of its very low temperature, but losses may be reduced by the use of insulation or reduced pressure.

Carbon dioxide gas is liquefied by compression to pressures of from 900 to 1000 psia. It is then condensed in coils, which are usually water-cooled. There are three methods by which solidifaction can be achieved.

1. Removal of heat can be effected through the use of an auxiliary refrigeration system. This method is uneconomical because of the low temperatures required.

2. Evaporation of a portion of the liquid carbon dioxide can be used to obtain the desired low temperatures, but his method has found little use commercially.

3. The method of expanding the liquid to a pressure below that of the triple point, is the one most widely used for the large-scale production of solid carbon dioxide.

During expansion the carbon dioxide liquid flashes directly into gas and snow. This snow is quite porous and, after removal from the separator, it must be compressed by mechanical means into cakes.

The manufacture of carbon dioxide gas is a chemical engineering problem in itself. The principal source is from the heating, or the treatment, of limestone with acid. The controlled combustion of coke, that is, the process of hydrogenation, is a method by which large volumes of carbon dioxide may be obtained. Some carbon dioxide has been obtained commercially by the fermentation of organic substances.

Magnetic Cooling

Of all the gases used to produce low temperatures, helium has given the best results. The lowest temperature reached is .71° K, and lower temperatures may be reached by other means. The demagnetization of paramagnetic salts has produced temperatures as low as .001° K.

Substances, such as iron, attracted to a magnetic pole are called "paramagnetic." Some paramagnetic salts, such as gadolinium sulfate, have been found suited for obtaining low temperatures by their adiabatic demagnetization. Fig. 5 is a schematic diagram for cooling by this method, which is accomplished in four steps:

1. A paramagnetic salt is cooled to less than –459° F. by surrounding it with liquid helium boiling under reduced pressure.

2. A magnetic field on the order of 25,000 gauss is applied to the salt. This field aligns the salt molecules which give up heat in the process. The heat is absorbed by the liquid helium, and the temperature of the salt remains below –459° F.

3. The helium bath is removed and the salt is thermally insulated at a temperature below –459° F. The magnetic field is maintained during this step.

4. Finally, the magnetic field is removed. The molecules disalign themselves, requiring the absorption of energy. The result is adiabatic cooling of the salt. Such

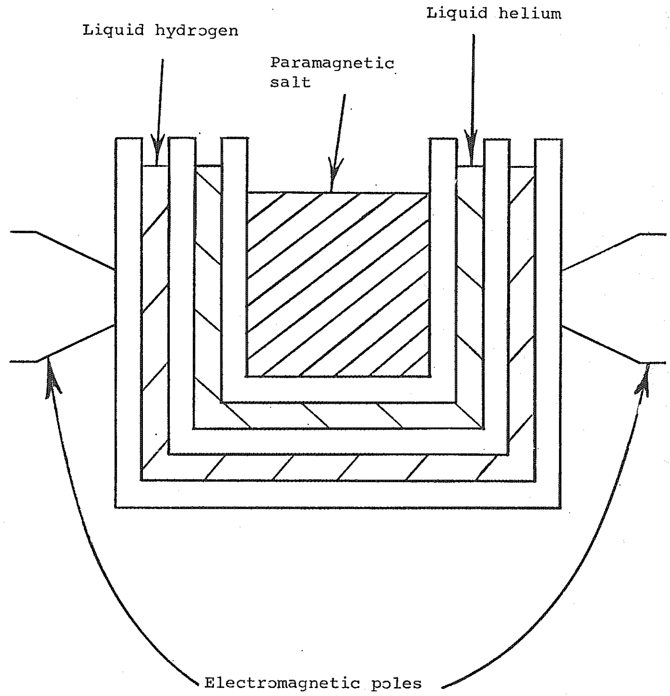


Figure 5
Magnetic Cooling System

low temperatures cannot be measured by ordinary means but must be calculated. The temperature may be calculated approximately by the Curie relation,

$$X = C/T$$

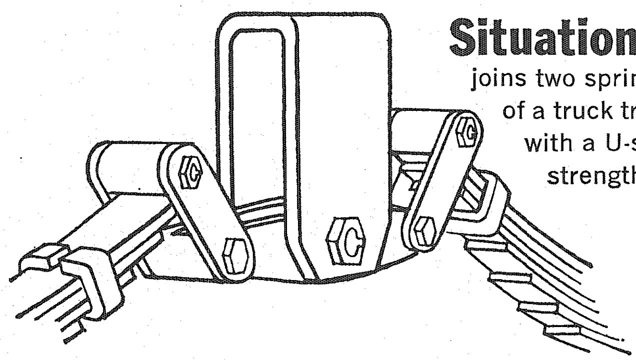
where X is the magnetic susceptibility of the salt, T is the absolute temperature, and C is a constant.

It has been proposed that further cooling be accomplished by aligning and then demagnetizing the nuclei of the atoms as well as the paths of the electrons. It is predicted that temperatures within one one-millionth of a degree of absolute zero may be attained by using this method.

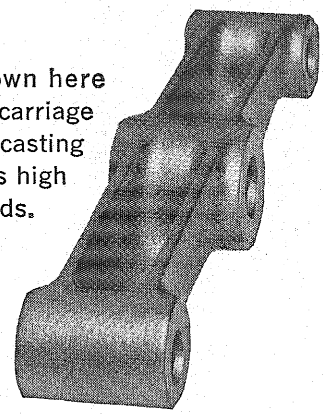
Conclusion

Low-temperature refrigeration systems vary widely in their construction and in the applications to which they are put. The best system for cooling large areas to temperatures no lower than –150° F. is the vapor-compression system. This system can take one of several forms. Solid carbon dioxide has not only many uses in the perishable foods industry, but also the advantages of being clean and easy to handle. The production of liquefied gases can produce temperatures within one degree of absolute zero. Liquefied gase requires far less space for storage, but the cost of attaining and maintaining the liquid form must be considered. Finally, the demagnetization of paramagnetic salts produces temperatures within one one-hundredth of a degree of absolute zero, but is not suitable for volume refrigeration.

How Would You Solve This Design-Material Problem?



Situation: The equalizer bar shown here joins two spring assemblies to the undercarriage of a truck trailer. It is a Malleable iron casting with a U-shaped cross section. It has high strength and weighs only 3.8 pounds.

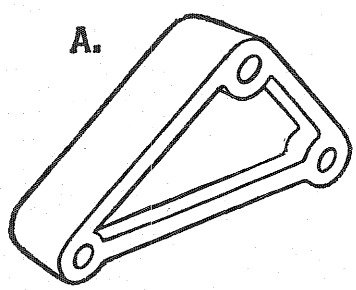


Problem:

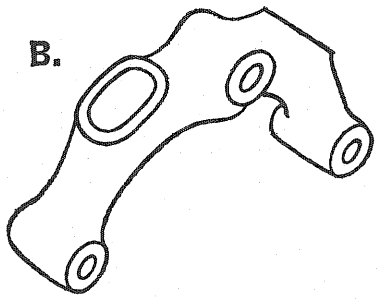
To raise the center hole 3 inches so that the unit can be adapted for use on house trailers. Costs must be kept to the absolute minimum to be successful in this highly competitive field.

Which design would you use?

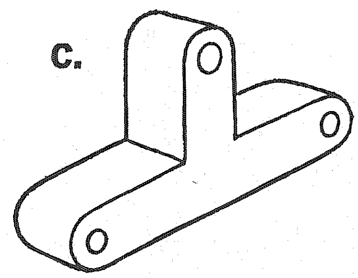
A.



B.



C.



Solution:

Illustration B, the curved tubular shape, has the best stress distribution characteristics because metal is placed where the load occurs—at the outer edges of the part. In this situation a solid cross section isn't indicated because very little of the load occurs at the center line. The material selected was again Malleable iron, combining high strength with design freedom.

Is this the solution you would have chosen? If not, it may be to your advantage to learn more about Malleable castings. Their many unique abilities are described in a new digest called "Design Criteria for Malleable Iron Castings". Send for your free copy today.

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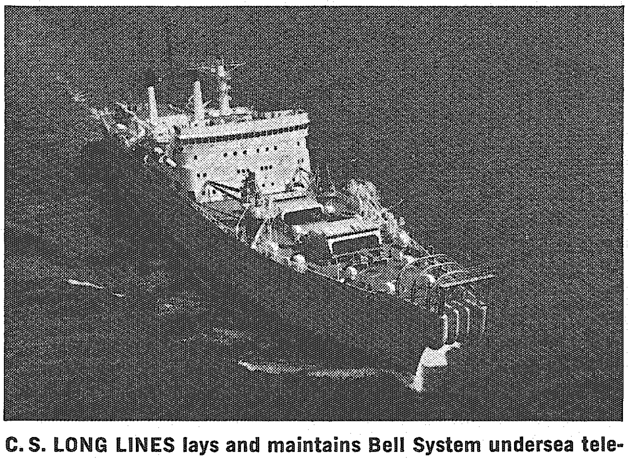

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SPLINTERS From the Log

by David E. Engen

Frank: I just met this girl whose measurements are 59-22-36.
Sam: What does she do?
Frank: Oh, she falls over a lot.

• • •

Male: "Are you afraid of the big, bad wolf?"
Female: "No, why?"
Male: "That's funny, the other two pigs were."

NO JOKE

In Edinburgh, Scotland, a pretty 19-year-old miss was recently arrested for riding in a wheelbarrow. While taking this jaunt, blonde and beautiful Anna Kesselaar was also bare. Her journey, aided by a willing male, was across the balcony of a theater in full view of a large audience attending what Miss Kesselaar and friend felt was an extremely staid conference. Judge Thomas McGregor considered this an improper contribution to the discussion.

In your heart you know he lost. . . .

• • •

Barry Goldwater would have made a tremendous president—of Austria-Hungary.

• • •

One of the ironies of life is that it's usually the warm girls, not the cold ones, who get the fur coats.

• • •

"No," said the centipede, crossing her legs, "a hundred times, no."

• • •

With due regards to old Charlie Darwin, although man has evolved to walk in an upright posture, his eyes still swing from limb to limb.

• • •

A recent poll taken to determine the main reason why men get up at night brought the following statistics:
10% to raid the ice box.
15% to visit the bathroom.
75% to go home.

• • •

Barry Goldwater is looking for a job. Too bad there aren't more openings at Wells Fargo.

MAUD AND CLAUDE

Maud: I found a wolf on the highway.
Claude: Where?
Maud: Under pass.

• • •

Maud: I found Al Capone in my Atlas.
Claude: Where?
Maud: Under world.

• • •

Claude: I found Jane Mansfield in a poverty pocket.
Maud: Where?
Claude: Under developed.

• • •

Claude: I found an EE Lab in my class schedule.
Maud: Where?
Claude: Under current.

• • •

Claude: I found the Minnesota Twins in the American League.
Maud: Where?
Claude: Under six other teams.

• • •

Claude: I found shorts at Nate's.
Maud: Where?
Claude: Under wear.

• • •

Claude: I found grave-robbers in Jackson Hall.
Maud: Where?
Claude: Under takers.

• • •

Claude: I found bar-bells at the Big Ten.
Maud: Where?
Claude: Under weight.

• • •

Claude: I found drinking in I.T.
Maud: Where?
Claude: Under age.

• • •

Maud: I found Bobby Baker in the White House.
Claude: Where?
Maud: Under the rug.

• • •

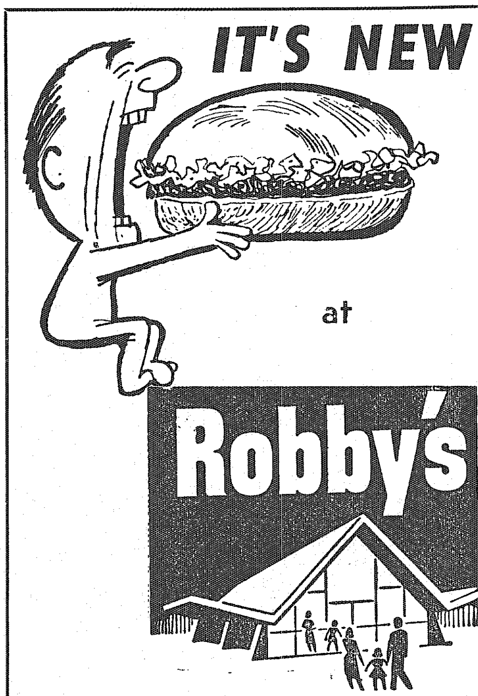
Maud: I found the Soviet spy system in America.
Claude: Where?
Maud: Under cover.

• • •

Maud: I found Barry Goldwater in my chemistry book.
Claude: Where?
Maud: Under reaction.

• • •

Claude: I found Christine Keeler in the British election.
Maud: Where?
Claude: Under Profumo.



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University at Washington
MINNEAPOLIS

Is it possible that a builder of space simulation equipment has a hand in Becky Hull's ballet lesson?

You'd expect that the leading maker of arc carbons that produce the brilliant light for projecting motion pictures would be called upon to duplicate the sun's rays in space simulation chambers. These chambers are used to test space devices, such as the communications satellites and space vehicles... and even the astronauts themselves.

And it probably wouldn't surprise you to learn that a company that produces half a dozen different types of plastics would also create an anti-static agent as part of the vinyl plastic it developed for phonograph records. This keeps dust from sticking to record surfaces. The sound is improved. The record lasts longer. And Becky Hull's ballet lessons are performed to music that's more faithfully reproduced.

But would space simulation equipment and better materials for phonograph records come from one company? Indeed they would, in the unusual case of the company known as Union Carbide.

All kinds of seemingly unlikely side-by-side activities turn up at Union Carbide every day. As a leader in metals and alloys, it developed a new, stronger stainless steel, and among the results are better subway cars for New York City. In cryogenics, it manufactures the equipment for a technique in brain surgery based on the use of supercold liquid nitrogen. Its consumer products include "Eveready" brand batteries and "Prestone" brand anti-freeze. And it is one of the world's most diversified private enterprises in the field of atomic energy.

In fact, few other corporations are so deeply involved in so many different skills and activities that will affect the technical and production capabilities of our next century.

And we have a feeling that Becky Hull's future is just as bright as ours.

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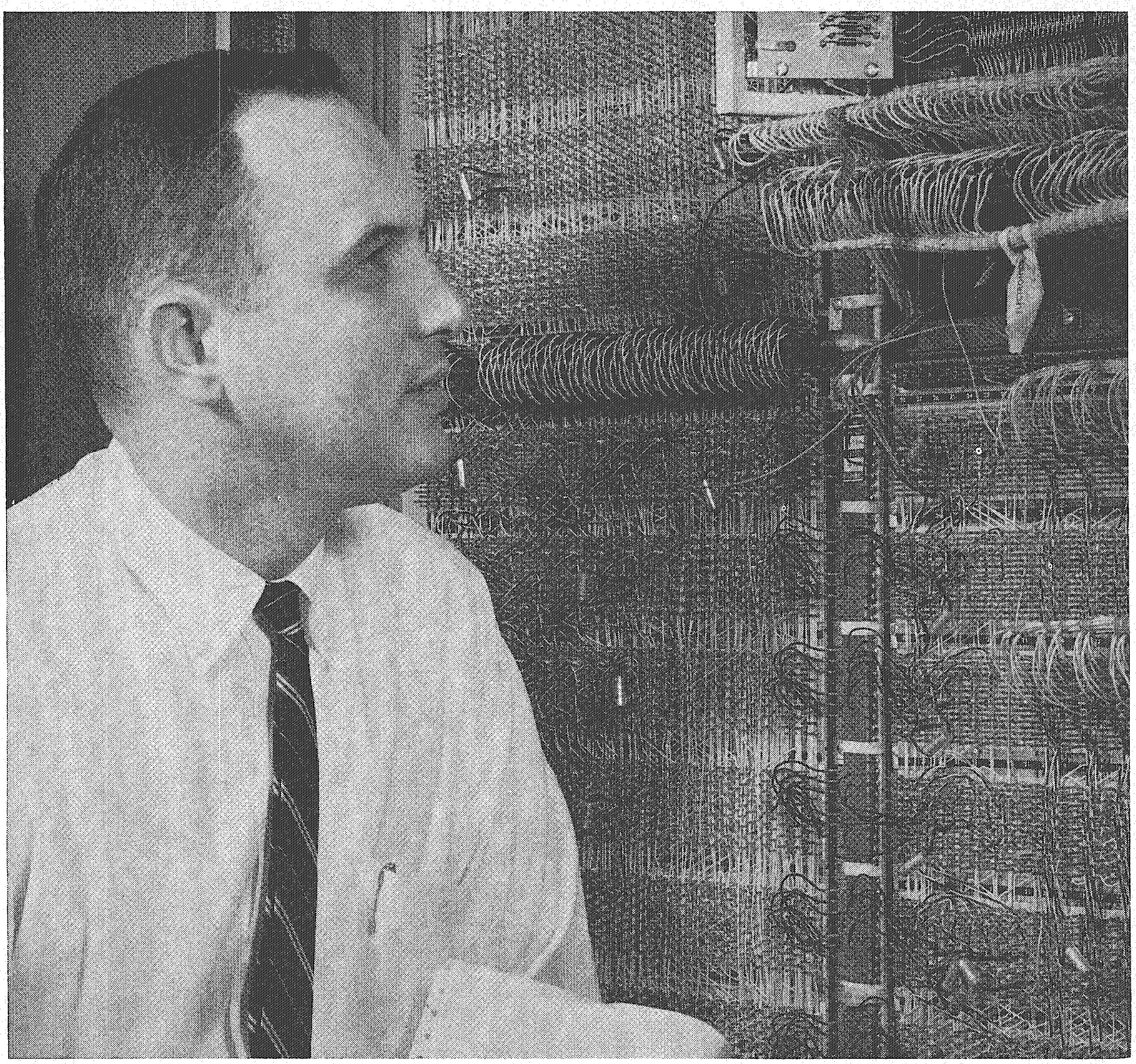

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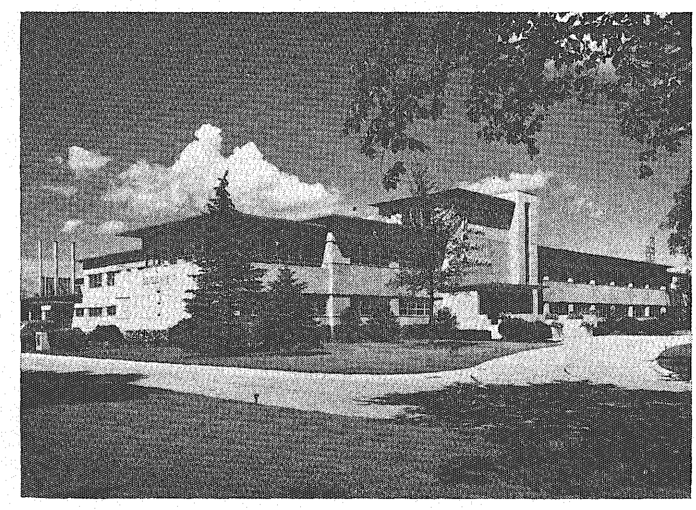
Spotlight on Local Industry

PORTLAND CEMENT

by DANIEL KEHRBERG, *Met E '69*

Throughout history man has searched for materials that would bind stones together into larger and more useful masses. The Egyptians had a form of lime and gypsum mortar used as a binding agent in their Pyramids, and the Romans developed a cement which produced structures so durable that they remain today. Their cement mortar, called pozzolana, was a mixture of slaked lime and volcanic ash from Mount Vesuvius and was capable of hardening under water.

The art was lost during the Middle Ages, and it wasn't until 1756 that a British engineer named John Smeaton came up with a lime that hardened under water—a hydraulic cement—as he experimented with limestone and mixtures of clay.



Main building of the $10-million, 37-acre research and development facility of the Portland Cement Association, located in Skokie, Ill.

The year 1824 saw another Englishman, Joseph Aspdin, patent a cement. He called it "portland" cement because its color was similar to the stone quarried on the Isle of Portland, near the British coast. The product, portland cement, is a unique combination of lime, silica, iron oxide and alumina.

The demand for cement in the United States caused by the construction of canals caused the United States to begin its own cement industry. Today, 98 per cent of the cement manufactured in the United States is portland cement.

Concrete is made by mixing a paste of portland cement and water with aggregates such as sand, gravel, crushed stone, or blast-furnace slag. As the paste hardens due to chemical action between the cement and the water, the aggregates are bound into a rocklike mass. The concrete may be made strongest by accurately proportioning and mixing the components so that the entire surface of every particle is coated, and so that all spaces between particles are filled with the paste.

The character of concrete is determined by the water-cement ratio. If one uses too much water, the paste is diluted, thin, and the hardened concrete weak. The key is to use as little water as possible, yet keep the concrete workable and the particles coated. All concrete can be easily molded and made to have any desired degree of water-tightness. It can be used as pipes to hold and transport liquids or for special purposes such as filter beds, where it is porous and highly permeable.

The Portland Cement Association is an organization designed solely to "improve and extend the uses of portland cement and concrete." For this reason, it is non-profit and unincorporated. Formed in 1916, its main offices are located in Chicago, Illinois. It is supported by more than 70 member cement companies which make contributions in proportion to their cement shipments. These member companies account for some 180 plants which produce a large proportion of all portland cement shipped in the United States and Canada.

The Association is concerned solely with four principal activities, and is unconcerned with production, distribution, pricing, or selling of portland cement. These activities are:

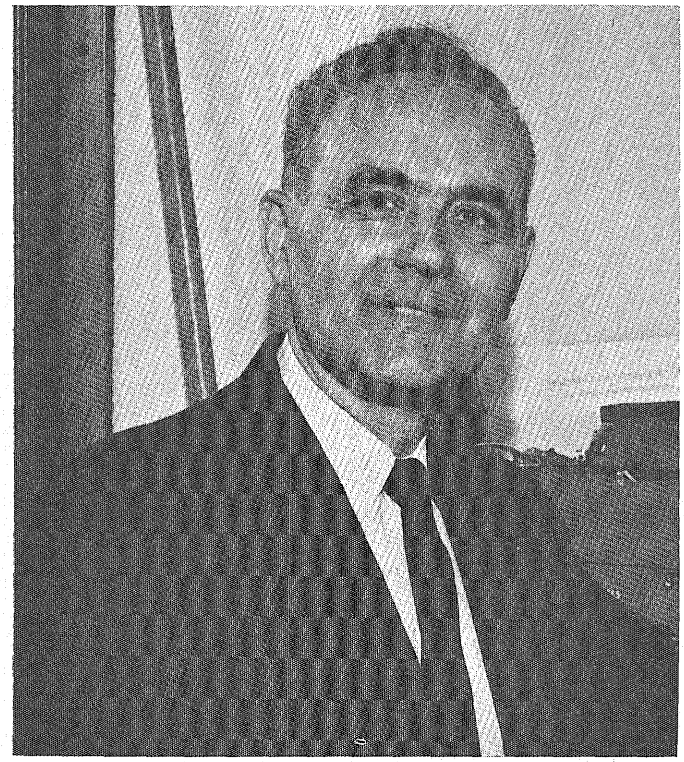
—scientific and engineering research in the field of portland cement and concrete;
—development of new and improved cement-using products and methods;
—promotion, educational work, and technical service to improve the quality of concrete and to increase its use;
—accident prevention work to encourage safety in the plants of its member companies.

In accomplishing this goal, the PCA maintains, in addition to its general office at Chicago, a research and development staff at Skokie, Illinois, and 46 district and regional offices throughout the United States and Canada. These regional offices employ more than 400 engineers in addition to some 100 scientists and engineers working at the Research and Development Division.

(Continued on Page 34)

UP FRONT

by WILLIAM OTTO, *Met E '68*
JOHN WIIK, *EE '68*



DR. KARLIS KAUFMANIS

Dr. Karlis Kaufmanis, Associate Professor of Astronomy, was born in Riga, Latvia, on February 21, 1910. Dr. Kaufmanis' education began in Riga where he attended the gymnasium and the teacher's college. Upon completion of his studies at Riga, Dr. Kaufmanis continued his education at the University of Latvia where he received his advanced degrees in astronomy.

Since his graduation from the U. of Latvia, Dr. Kaufmanis has delivered over three hundred public addresses, has either written or aided in the writing of over twenty textbooks on astronomy, and has conducted two television series on astronomy which won him the Katie Award for the best performance by a single individual on educational television. At present, Dr. Kaufmanis is working with four other astronomers on a junior high school text for the National Science Foundation, and is beginning to write a text of his own for college students of astronomy. The American Association for Advancement of Science, the American Astronomical Society, and the Mathematical Association of America are some of the organizations he belongs to. He has taught General Astronomy at the U. of M. and is now teaching a course titled Descriptive Astronomy.

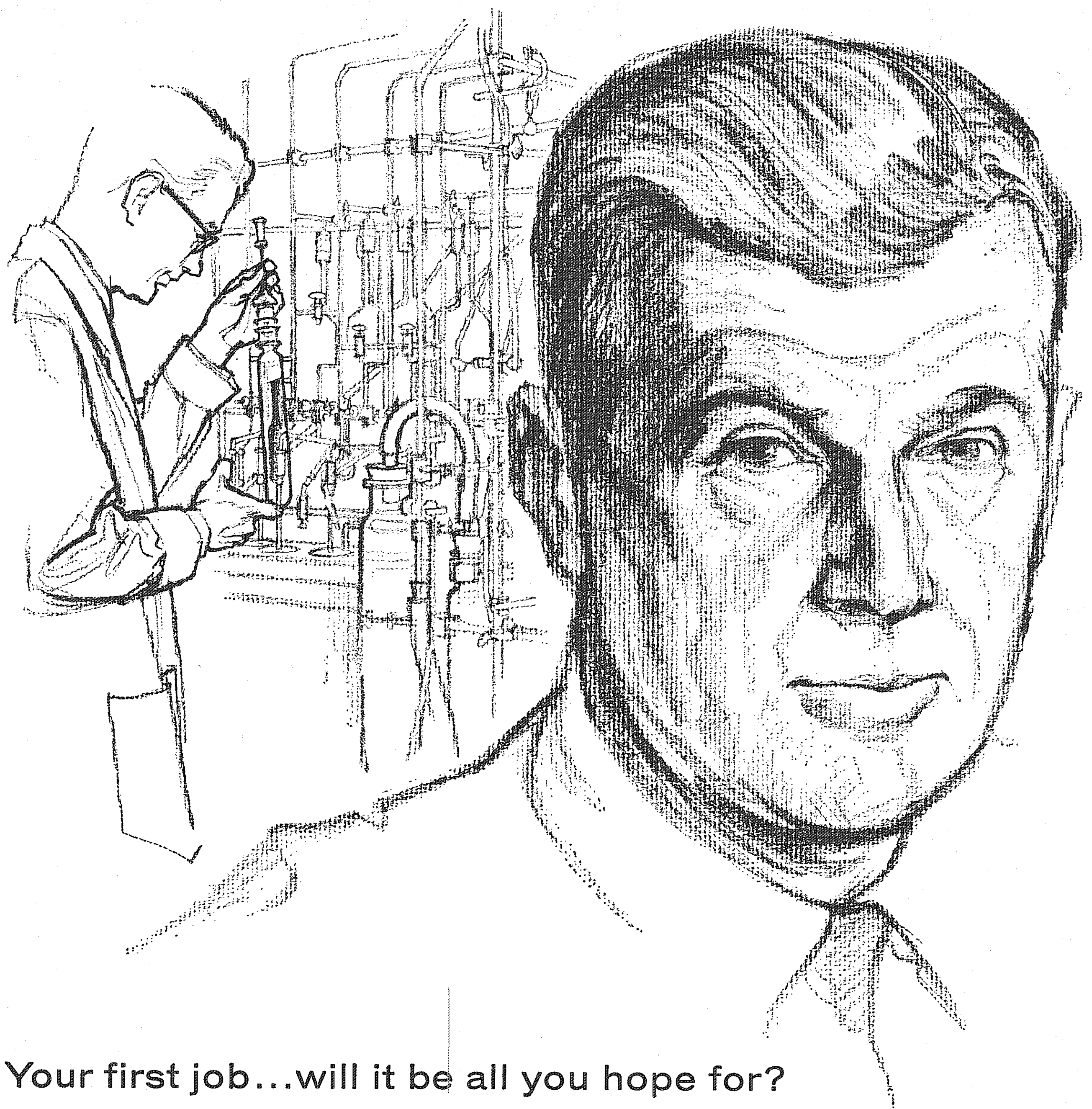
Away from the University, Dr. Kaufmanis busies himself with playing his violin and collecting "good" records. He has been married for twenty years and has a thirty-year-old stepson who is a plastic surgeon.

Dr. Walter K. Johnson, professor of civil engineering, keeps busy teaching C.E. 170, 171, 172, being advisor for the student chapter of the American Society of Civil Engineers, and being facuty advisor for Chi Epsilon, honorary civil engineering fraternity. In addition to his course work, Professor Johnson has been working with the Minneapolis-St. Paul Sanitary District on a project concerning nitrogen removal from waste water.

Professor Johnson, born on August 28, 1923, in Minneapolis, attended Roosevelt High School. During World War II he served in the Army Air Corps as a navigator in the South Pacific. After World War II, Professor Johnson attended the University of Minnesota and received his B.S.C.E. degree with distinction, M.S.C.E. degree, and Ph.D. While studying here, he was a member of Plumb Bob, the Tech Commission, and Tau Beta Pi (an engineering honor society). He is presently a member of the American Society of Civil Engineers, American Waterworks Association, Central States Water Pollution Control Association and the American Society of Engineering Education.

In his spare time, Professor Johnson likes to spend time with his family. He has a wife and three daughters. He likes all spectator sports and enjoys playing tennis, handball, and squash. He also enjoys working on projects around the house and listening to good music.

DR. WALTER K. JOHNSON



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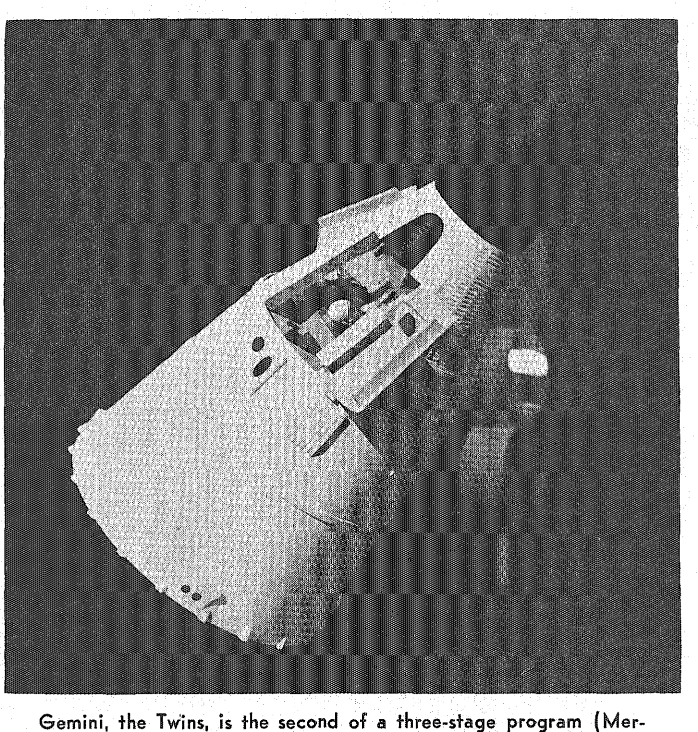
THRESHOLD TO SPACE . . .

by DIANNE CHRISTENSEN, *Physics '66*

Since the first American satellite, Explorer I, went into space, millions of dollars have been spent on the space race every day, innumerable people have become employed in some phase of space technology and 16 select men have been subjected to intensive training as astronauts. Why?

William Schneider, Deputy Director for Gemini, NASA, gave a few answers. Each answer to why we want to venture into space depends upon the interests of the person who answers. Why, for instance, go to the moon? Some advocate that we can thereby determine the moon's composition, others want to establish an observatory on the moon, still others feel that through lunar exploration we will be able to discover how the universe was founded. The real reason behind lunar, indeed all, space travel is that a country so employed thereby establishes a national capacity for endeavors which previously had not even crossed men's minds. Space travel necessitates a more highly educated society which leads to a more highly developed society. Man's appetite for knowledge cannot be appeased; as he learns more he becomes more aware of what he doesn't know and continues studying and experimenting. As man becomes more aware of the little he knows about space he works continually to learn more. Space travel becomes, then, a necessary part of man's education.

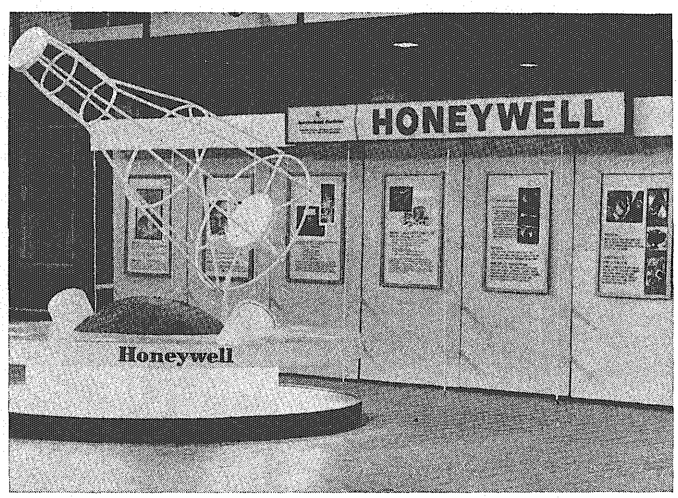
But, is it worth it? NASA is spending about $13.82 each second of every day for its operation, that is, about $1,200,000 a day! If one considers only the actual going, it is not worth it, but innumerable advantages result from space travel. Not only are we developing our capacity, but scientific education has been stimulated, new jobs have been developed, and international consideration, according to Representative Karth, chairman of the House subcommittee on space sciences, has been strengthened. In fact, presently there are about 20,000 companies employing 300,000 people involved in space projects. The satellites are important since a reflective body in space can serve as a relay station for electro-magnetic waves. If the satellite's position could be fixed, six satellites could serve the entire earth in radio and television transmission,



Gemini, the Twins, is the second of a three-stage program (Mercury, Gemini, Apollo) to land an American on the moon by 1970. The two-man Gemini capsule is planned for a series of earth orbits early next year.

according to F. A. Bratton, manager of the Echo II project at Schjeldahl Co. Much of the hardware used, time spent, and the technological knowledge and skill achieved in each project serves as a starting point for other projects. The United States is spending astronomical figures in monetary terms but actually only 1% of our gross national product is invested in space related projects. Is it worth the price of going? In preparation to go the price is high, very high. In the price to go, considering all advantages, the price is actually relatively low.

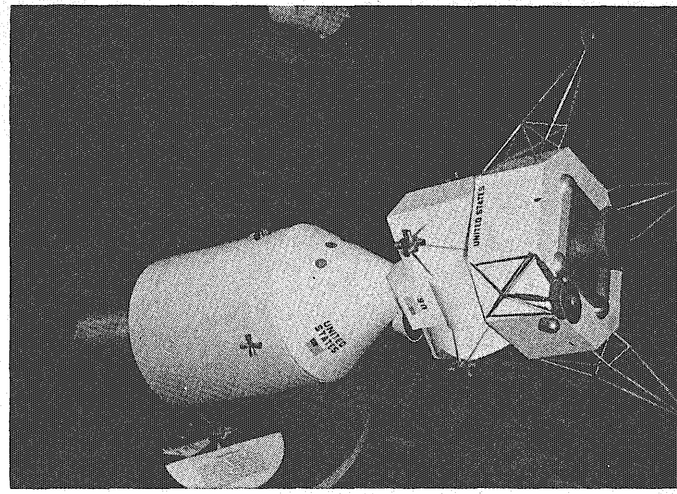
Why send a man into space, why not just a machine? Projects Mercury, Gemini, and Apollo are all oriented toward sending man into space and thereby exploring man's capability in space. A machine can function only when it has complete data, man alone can integrate incomplete data and determine a solution thereby. Man is efficient.



This Honeywell display appeared in the Threshold to Space October 4-10. The display, in Frederick Mann Court, told of Honeywell's contributions to America's space program.

When Gordon Cooper aligned his capsule when the automatic control system went out, we took one of the first steps toward manual control of space craft. In fact, not one Mercury capsule would have been successful without man, according to Mr. Schneider. In Gemini and Apollo man will do much more. He will be maneuvering rendezvous and docking, mating two things in outer space; he will be involved in extra-vehicular exploration as well as being more responsible for orbital control of the capsule. By sending man into space physiological aspects of space flight can be studied. Man, as a terrestrial organism, has a rhythm pattern of approximately 24 hours. Isolated brains, hearts, and other organs appear to reveal certain circadian rhythm, but what will happen to the astronaut who is removed from the earth's geophysical influences? Does weightlessness lead to calcium deposits in bones and to atrophy of muscles? Or do these things result from muscle inactivity? Answers to these questions can come only through space exploration.

If we do send satellites and rockets into space why aren't they all returned? Why are so many simply allowed to continue orbiting with no use or allowed to burn out? Probably they are not returned due to the almost insurmountable problems of trying to get back into the earth's atmosphere. If a capsule hits the atmosphere with an angle that is too great it will bounce off like a stone bouncing over water; if the angle is too small the



The three-man Apollo command module (cone-shaped section) and its storage and propulsion unit (cylindrical-shaped section) will rendezvous with the Lunar Excursion Module (LEM) in lunar orbit. LEM will then land on the moon with two men aboard. After exploring the surface, the astronauts will rejoin the command module, crawl back into it, jettison LEM, and return to earth.

capsule will burn. The energy dissipated in escape and re-entry is extremely high, on the order of 21 million foot-pounds per pound of weight. If two Volkswagens collided head-on at a speed of 65 miles per hour, the energy would only be one fiftieth of that needed to put one pound of weight into space. But the amount of energy dissipated to get things into space is equal to that involved in getting these things back. Although retro-rockets, compression and heat absorb part of this energy, parachutes or parachute devices are most commonly used to slow the space craft to a speed which will allow a safe landing. A safe landing for man is at a velocity of less than 20 feet per second without cushioning, and of approximately 50 feet per second with cushioning. One can visualize at least part of the immense problem of slowing a space craft from supersonic speeds to those insuring a safe landing, those involved in re-entering the atmosphere at the proper angle, and many others. These considerations make one realize that the knowledge one gains from those space crafts not brought back to earth is probably of less value than the cost of bringing them back.

Why go to the moon first? How can we land men or even a space module on a body about which we know little or nothing? The lunar project is but the first step to exploration of other planets. The moon is our first step because we know more about it than any of the other planets or bodies and it is the closest. The moon supposedly has a hostile environment; it is believed to be a high vacuum with large temperature differences and high radiation yet it has no hurricanes and less gravity than the earth. The few parameters known about the moon suggest an easier life there after a few basic adaptations are made by man in his mode of living. What is known about the moon? According to Dr. G. K. Wehner of Litton Industries, the surface is relatively all one color, there is little light reflected from its surface but that which is reflected comes from a strong back reflection. The low heat conductivity suggests that the moon is composed of a substance with low porosity, probably a dust with a consistency similar to that of snow since back reflections occur when the surface is bombarded with alpha-particles. The surface is getting progressively darker, becoming more enriched with metal atoms, especially the heavier atoms since they are less likely to be scattered during the bombardment. The metallic content on the moon is probably greater nearer the surface than it is at the center. The depth of the dust is estimated from a few centimeters to several kilometers, but it is believed that if the dust is thick its ability to support objects increases as its depth increases.

These were some of the points brought out in the "Threshold to Space" program held from October 4-10. The program included a number of displays, symposia and convocations and was sponsored by UBOG in cooperation with local industries, the U. S. Air Force, National Aeronautics and Space Administraion (NASA), and various departments of the University. What was the purpose? The chief objective was simply to acquaint the community with the contributions made to the national space effort by local business and the university. The displays in the Architecture Court and the CMU Main Ballroom provided visual reinforcement to the ideas covered by the speakers. The display in the Architecture Court consisted of a series of displays from local industry and different departments of the University. NASA's display in the ballroom gave a general outline of the history of manned space flight as well as films and recordings discussing the future plans of space projects, especially of the Gemini and Apollo projects. The speakers covered a wide range of topics including discussions of manned flight, life in space, communication and guidance, and management of research and development projects.

Splinters . . .

And then there was the Arts student who let his EE roommate fix him up for a blind date with Allis-Chalmers.

• • •

"Well, I certainly made an impression on her," said the cane-bottomed chair as the nude stood up!

• • •

Cop: "No parking. You can't loaf here."
Voice from the car: "Who's loafing?"

• • •

As Dr. Kinsey said—"You're all right in my book."

• • •

Diplomacy is the art of saying "nice doggie" until you can find a rock.

• • •

Definition of an atheist: A man who doesn't care about the outcome of the Notre Dame-SMU game.

* * *

Football season is great. It's the only time you can walk down the street with a girl on one arm and a blanket on the other without anyone becoming suspicious.

* * *

Girl: "Isn't that a lovely moon tonight?"
Boy: "I'm not interested in astronomy now, and besides I'm in no position to say."

Local Industry

(Continued from Page 29)

The Minnesota-Dakotas district office is located in the Northwestern Bank building in Minneapolis. In addition, there are engineers and specialists who work out of St. Paul, Duluth, Mankato, Fergus Falls, Fargo, Bismarck, Pierre, Rapid City, and Sioux Falls.

According to PCA, the key to today's concrete is lightness and strength. It can be used for such varied things as the retaining wall on a gigantic reservoir or a four-inch diameter pipe, or for highways, airports, floating drydocks and even ships. It is used for all parts of buildings —even to domed or arched roofs. And it is even used for playground equipment—such as concrete diving boards!

Modern concrete is no longer just concrete—it is reinforced, prestressed, or precast. Concrete is so complex today that its entire character may be changed or ruined due to the lack of skill of the man mixing the ingredients on the job!

Now, what is reinforced concrete? Concrete is stronger in compression than in tension, while steel is strong in tensile strength. Therefore, in making reinforced concrete, steel in the form of bars or mesh is embedded into it. However, in modern construction reinforced concrete was inadequate, and this century's scientists developed and improved it into prestressed concrete.

The basic idea in prestressing concrete is to reduce the tearing apart or tensile stresses which certain portions of bridges, buildings, or tanks and pipes are subjected to. This is done by stretching the reinforcing steel so as to superimpose compressive stresses in the concrete. This strengthening effect of compression can be compared to the squeeze put on a horizontal row of books when transferring them from one place to another. Prestressing now enables architects and engineers to build longer unsupported spans on bridges or ceilings than ever before.

The most startling development in concrete use was made 35 years ago by German architects—the shell roof. Concrete shell roofs are either barrel or dome-shaped and their strength comes from distributing the load stresses through the three-dimensional shape—the principle of the egg. This development has made easier the construction of buildings requiring large amounts of open space with no interior support columns, as in gymnasiums, or aircraft hangars.

Also, improvements are still being made in the chemical nature of the concrete itself. The computer and mathematical theory have led to many other improvements. The basic dome and barrel-shaped roofs now include folded plates and hyperbolic paraboloids, which are shapes in which the surface is curved on two planes.

Gone, certainly, are the days when a couple of men threw some cement, sand, and gravel together and mixed in water until it looked right! For today, concrete and its proper use have become so complex that they demand great skill, and the Portland Cement Association provides both the educational material and the assistance necessary to use it properly for better living in our modern concrete and atomic age world.

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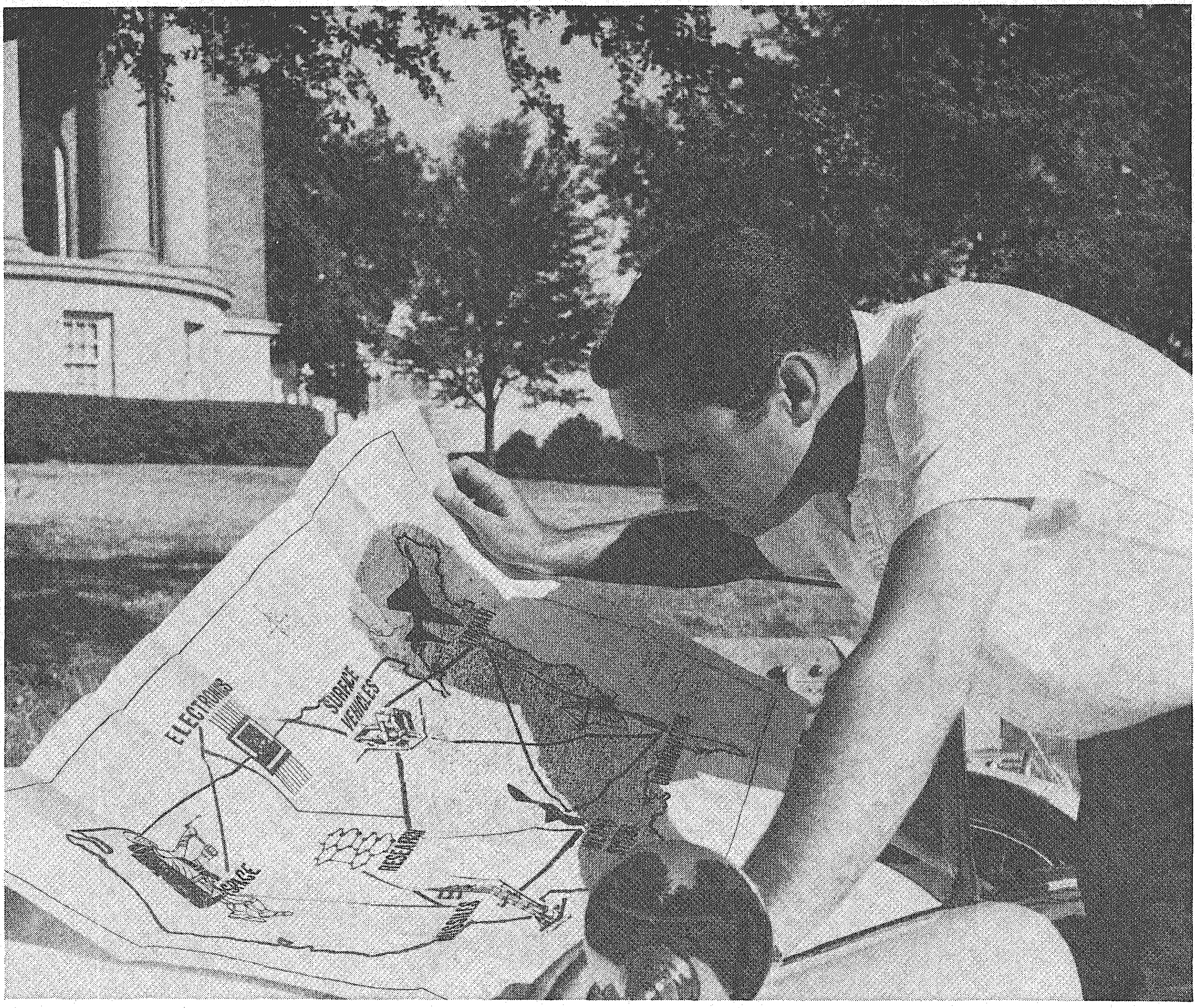

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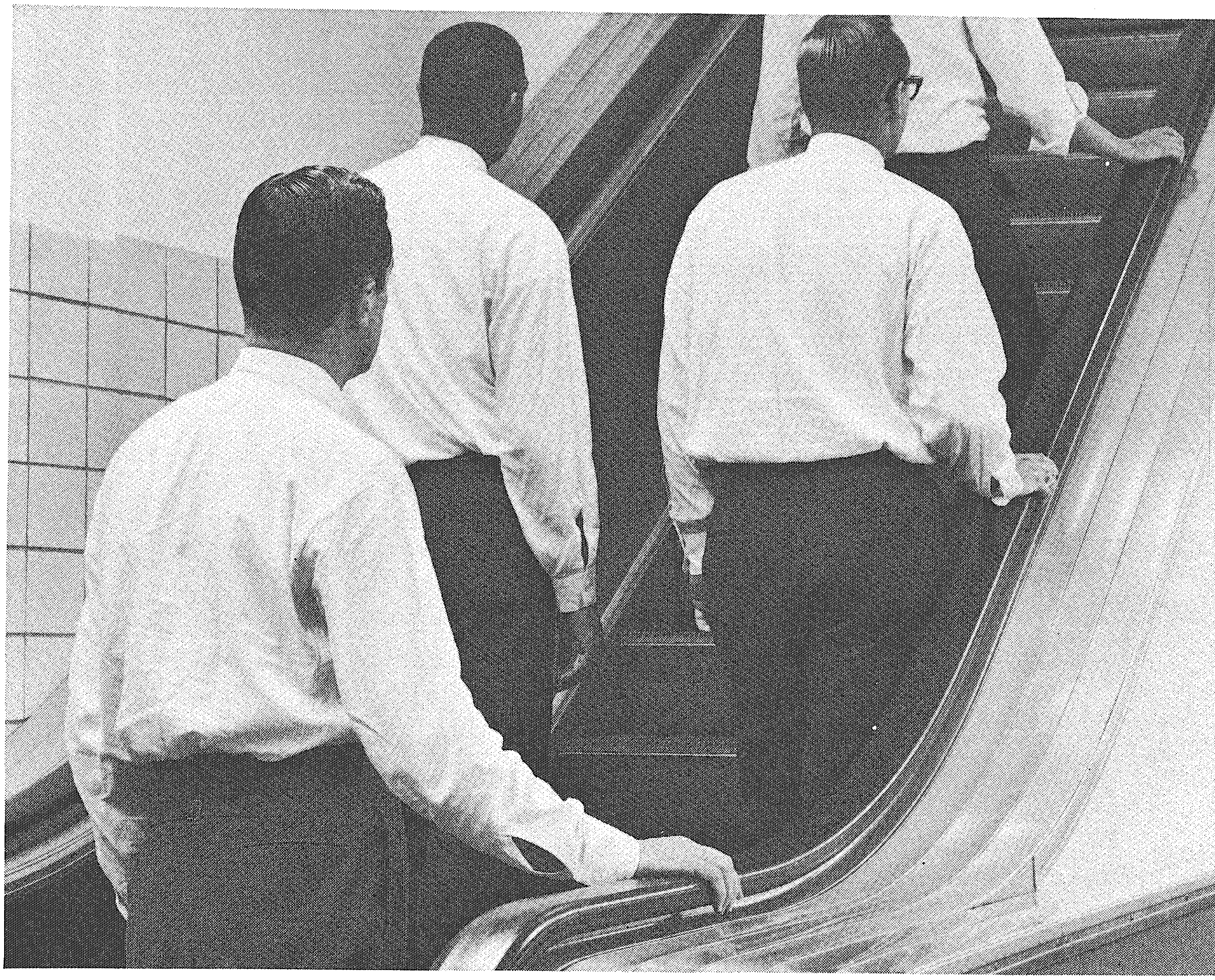

Sophisticated engineers can rise rapidly here

Ed, Bob, and Hipparchus (their true identities hidden here against pitiless kidding by all-too-real colleagues) are three Kodak mechanical engineers on their way to a management meeting for the up-and-coming. Let us consider differences rather than similarities.

Ed works on those inexpensive, sure-fire cameras that Americans as well as citizens of the rest of the civilized world think of when "Kodak" is mentioned. The big boss who chose Ed for his department says: "Along with Ph.D.s in solid-state physics, I look for B.S. and M.S. mechanical engineers from whom I can expect the unexpected. The spots for sophisticated engineering don't always have a sign over the door that says 'SOPHISTICATED.' Who would ever have dreamed ten years ago that low-price zoom lenses and automatic exposure-setters and through-the-lens finders could deliver the performance they do today? The doozers we have ready to unveil next year and the year after that are well in hand, fortunately. Then what?" Then what is Ed's responsibility. He will need help from fellows now in college. Maybe you.

Bob works on data-recording and information-retrieval photographic systems. His work has to impress cost-minded brother engineers in other companies as well as banks and other hard-nosed commercial customers. He meets the requirements of a boss who says: "The type I need was called an 'inventor' a generation ago. The difference is that in 1965 he will need a lot more mathematics, engineering physics, chemistry, hydraulics, electronics, and other book-learning than an inventor needed in 1925. When it comes time to relax, though, you'll find him building something with his hands, and it's probably something pretty clever and unusual that works real well." As it happens, Bob's main hobby is neither bridge nor folk singing.

Old Hip calls square dances and doesn't care who knows. Policy proscribes discussion of the nature but not of the philosophy of his engineering. His boss puts it: "In consumer and commercial products, where regular service can easily be part of the engineering plan, perfection would carry a price tag that made no sense. With us, a perfect score is the only acceptable goal. Nothing less makes economic sense. Before our guys can think of what is sensible, they have to think of what is possible. It can be very enjoyable for the right type of smart apple."

Drop us a line if you can see yourself as any of these three right types, whether in mechanical engineering, chemical engineering, electronic engineering, chemistry, or physics.

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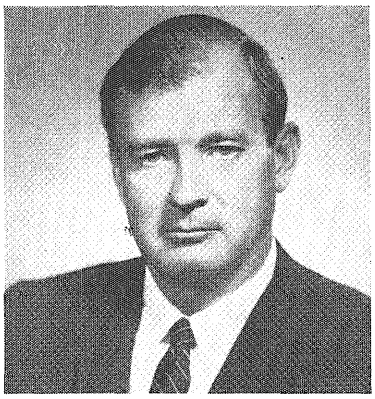
Advancement in a Big Company: How it Works

An Interview with General Electric's C. K. Rieger, Vice President and Group Executive, Electric Utility Group



C. K. Rieger

■ Charles K. Rieger joined General Electric's Technical Marketing Program after earning a BSEE at the University of Missouri in 1936. Following sales engineering assignments in motor, defense and home laundry operations, he became manager of the Heating Device and Fan Division in 1947. Other Consumer-industry management positions followed. In 1953 he was elected a vice president, one of the youngest men ever named a Company officer. Mr. Rieger became Vice President, Marketing Services in 1959 and was appointed to his present position in 1961. He is responsible for all the operations of some six divisions composed of 23 product operations oriented primarily toward the Electric Utility market.

Q. **How can I be sure of getting the recognition I feel I'm capable of earning in a big company like G.E.?**

A. We learned long ago we couldn't afford to let capable people get lost. That was one of the reasons why G.E. was decentralized into more than a hundred autonomous operating departments. These operations develop, engineer, manufacture and market products much as if they were independent companies. Since each department is responsible for its own success, each man's share of authority and responsibility is pinpointed. Believe me, outstanding performance is recognized, and rewarded.

Q. **Can you tell me what the "promotional ladder" is at General Electric?**

A. We regard each man individually. Whether you join us on a training program or are placed in a specific position opening, you'll first have to prove your ability to handle a job. Once you've done that, you'll be given more responsibility, more difficult projects—work that's important to the success of your organization and your personal development. Your ability will create a "promotional ladder" of your own.

Q. **Will my development be confined to whatever department I start in?**

A. Not at all! Here's where "big company" scope works to broaden your career outlook. Industry, and General Electric particularly, is constantly changing — adapting to market the fruits of research, reorganizing to maintain proper alignment with our customers, creating new operations to handle large projects. All this represents opportunity beyond the limits of any single department.

Q. **Yes, but just how often do these opportunities arise?**

A. To give you some idea, 25 percent of G-E's gross sales last year came from products that were unknown only five or ten years ago. These new products range from electric tooth brushes and silicone rubber compounds to atomic reactors and interplanetary space probes. This changing Company needs men with ambition and energy and talent who aren't afraid of a big job—who welcome the challenge of helping to start new businesses like these. Demonstrate your ability—whether to handle complex technical problems or to manage people, and you won't have long to wait for opportunities to fit your needs.

Q. **How does General Electric help me prepare myself for advancement opportunity?**

A. Programs in Engineering, Manufacturing or Technical Marketing give you valuable on-the-job training. We have Company-conducted courses to improve your professional ability no matter where you begin. Under Tuition Refund or Advanced Degree Programs you can continue your formal education. Throughout your career with General Electric you'll receive frequent appraisals to help your self-development. Your advancement will be largely up to you.

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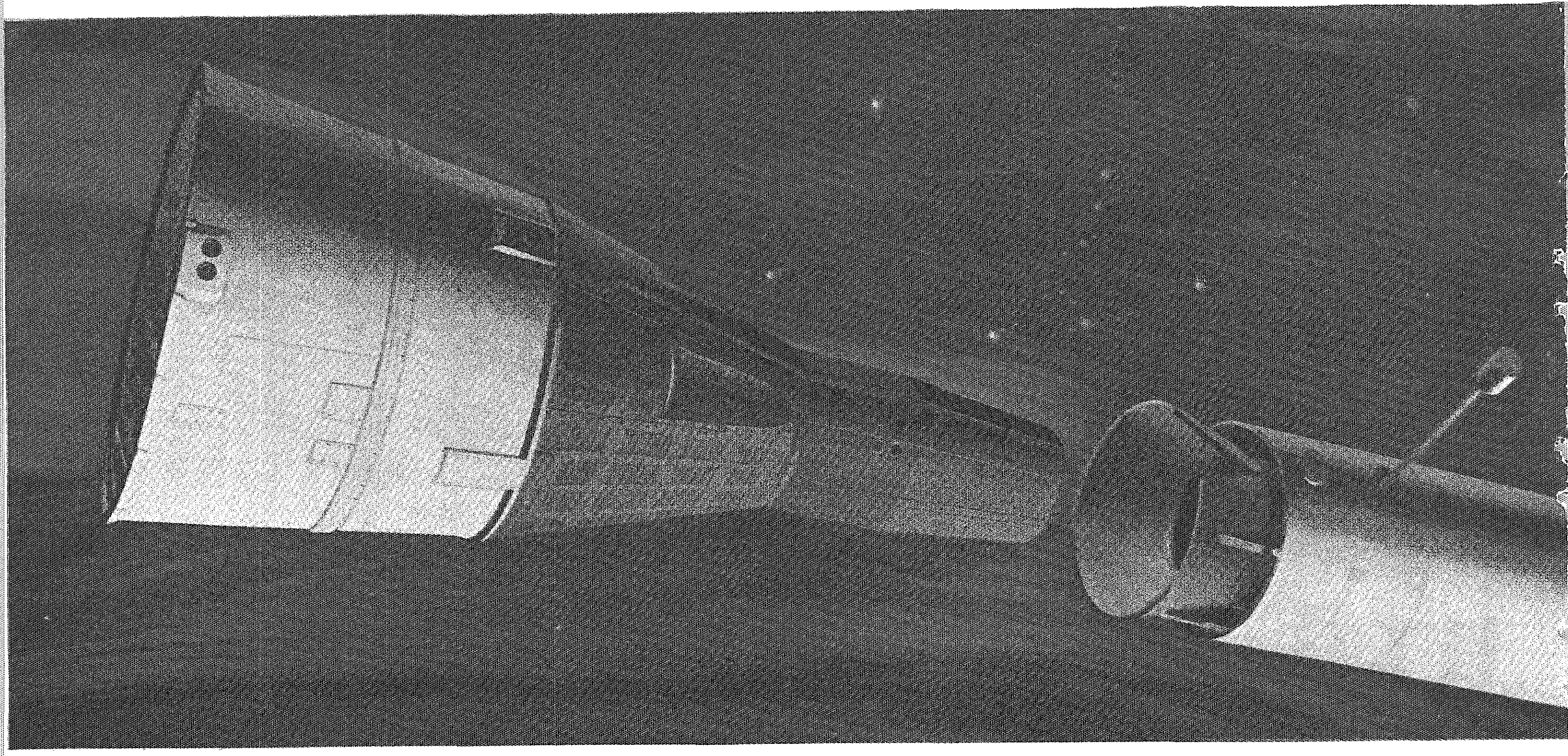
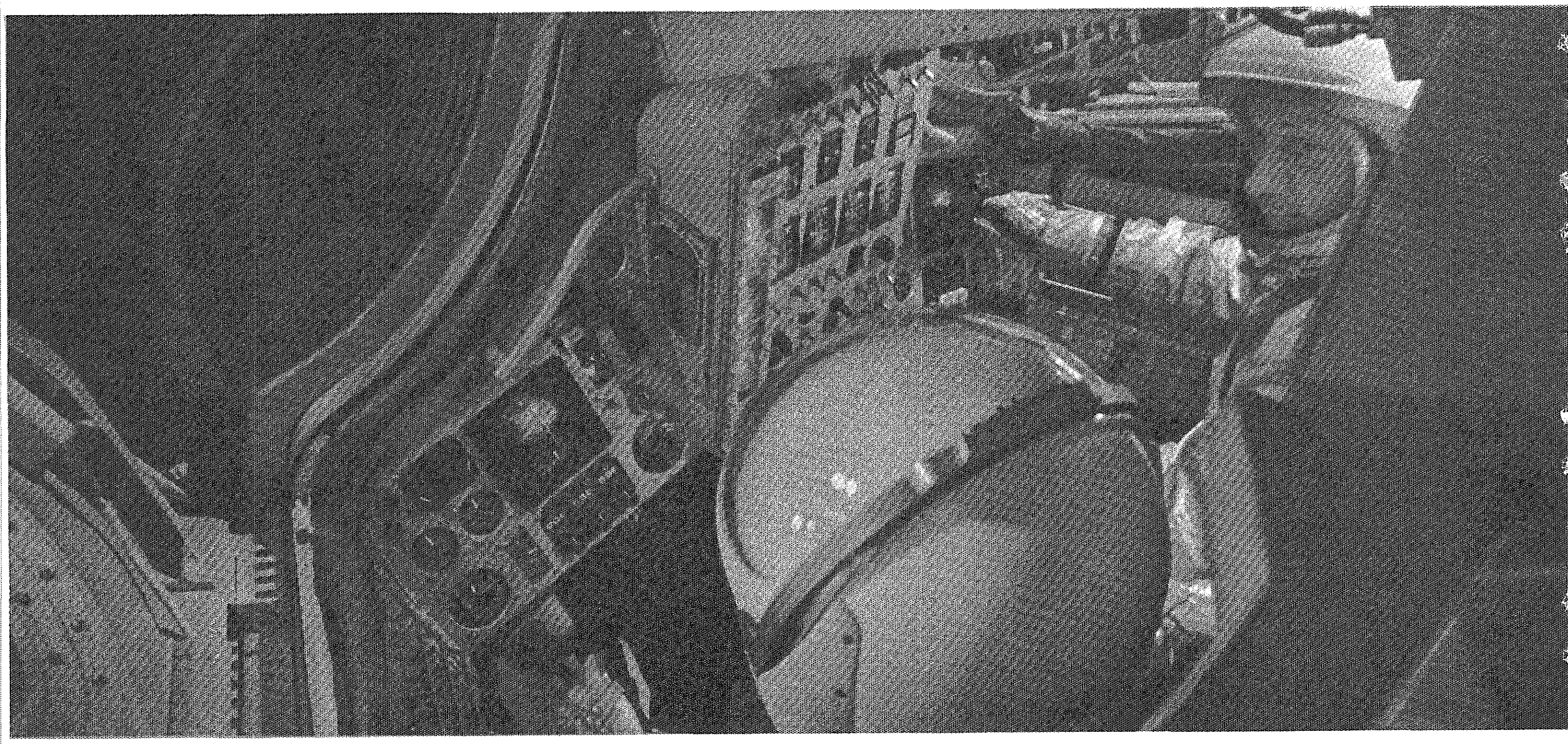


Moon shot rehearsal: when the Gemini spacecraft meets its target



Westinghouse radar will guide the astronauts to this meeting in outer space

When the Gemini two-man spacecraft lifts off, a dramatic dress rehearsal for the first moon trip will begin. The astronauts' mission: to maneuver their spacecraft and join it with an Agena rocket already orbiting the earth at more than 17,500 miles per hour.

A new Westinghouse radar system will guide the chase. Locating the target, the spacecraft will send out radar pulses. Computer-translated responses will guide the astronauts until the target is reached.

A vital prelude to future space travel, the rendezvous experiment will one day be routine. Meanwhile, Westinghouse is already working on other advanced radar systems for lunar landings, planet exploration, space station support and deep space missions.

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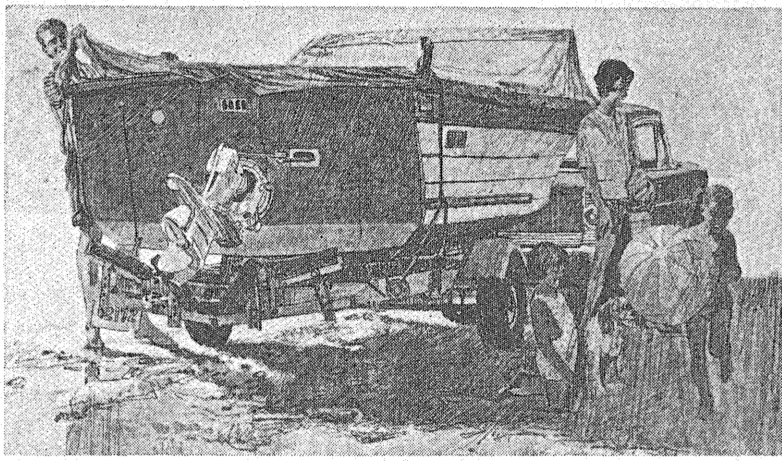

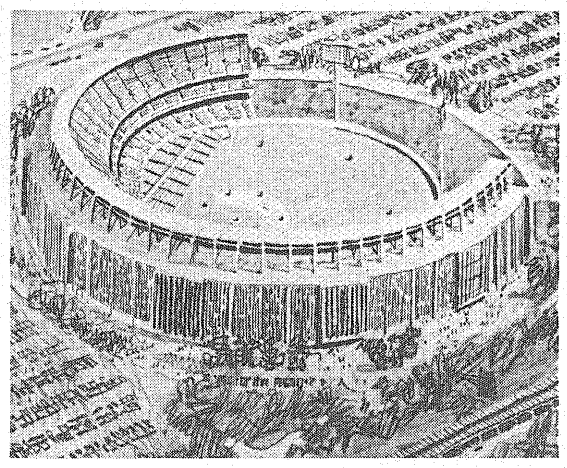

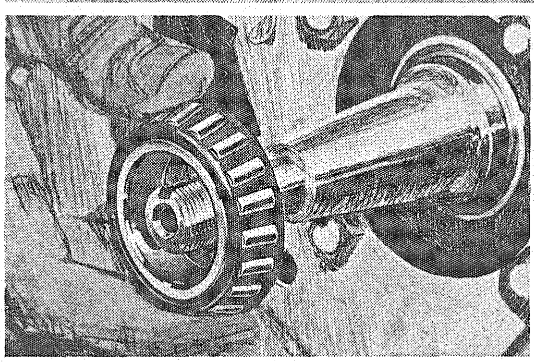

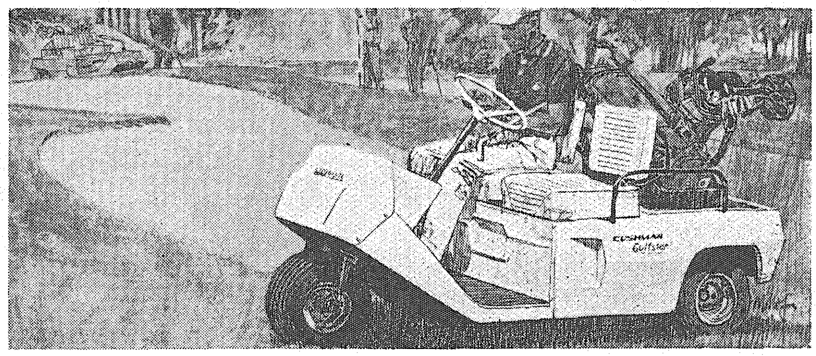

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TECHNOLOG

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Cover: Because of the rapid advancement of science and technology, engineering knowledge and ability rapidly become outdated. This month's cover pictures the prototype of an engineer worrying about slipping into obsolescence. More on "Obsolescence" on p. 8. Drawing by Ken Fletcher.

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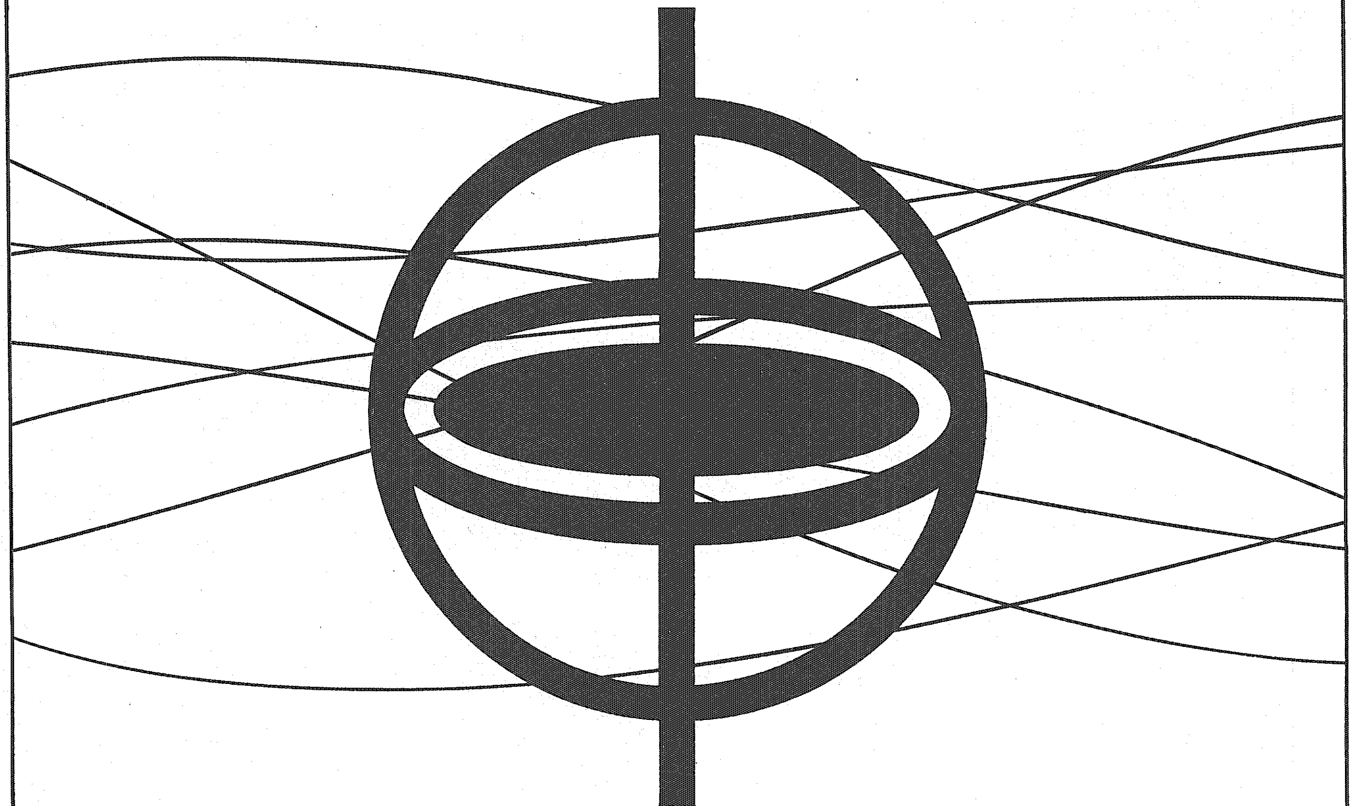
Stability



The stability of a body in motion can best be evaluated when interfering forces are severe enough to test its structure or divert it from a pre-established direction. A corporation is a body of people in motion and its stability is measured by planned achievement.

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Editorial

ONE MORE, ONE LESS

How many years should an engineer attend college? In the past the engineering curriculum was set at five years. However, the trend today has established the four-year program. To keep pace with other engineering colleges, Minnesota is now changing to four years. Not only is a new program being established, but the present curriculum will be changed to meet the needs of the existing students. It is not the incoming engineers, but those of us who began in a five-year program who will be affected most. How will this change benefit or hurt us?

Industry extends a very little salary advantage to the engineer with one more year of college. In fact, in some cases, there is no differential wage. The extra year of college is costing us about $7,500.

Our concept of an engineer's education is being changed. After being thoroughly indoctrinated into a five-year program, suddenly we are caught in an educational squeeze. Courses are being added, dropped and altered so that we may graduate earlier. Clearly our educational base will be restricted. Lowering the number of required nontechnical electives will limit our liberal education even more. But these courses must be sacrificed so that our scientific study can be completed.

Can all the scientific courses be crammed into four years? Other engineering colleges have proved that it can be done. With the high degree of specialization in industry today, the engineer is trained on the job, not in the classroom. After four years we will be ready to meet the challenge of industry.

SMA

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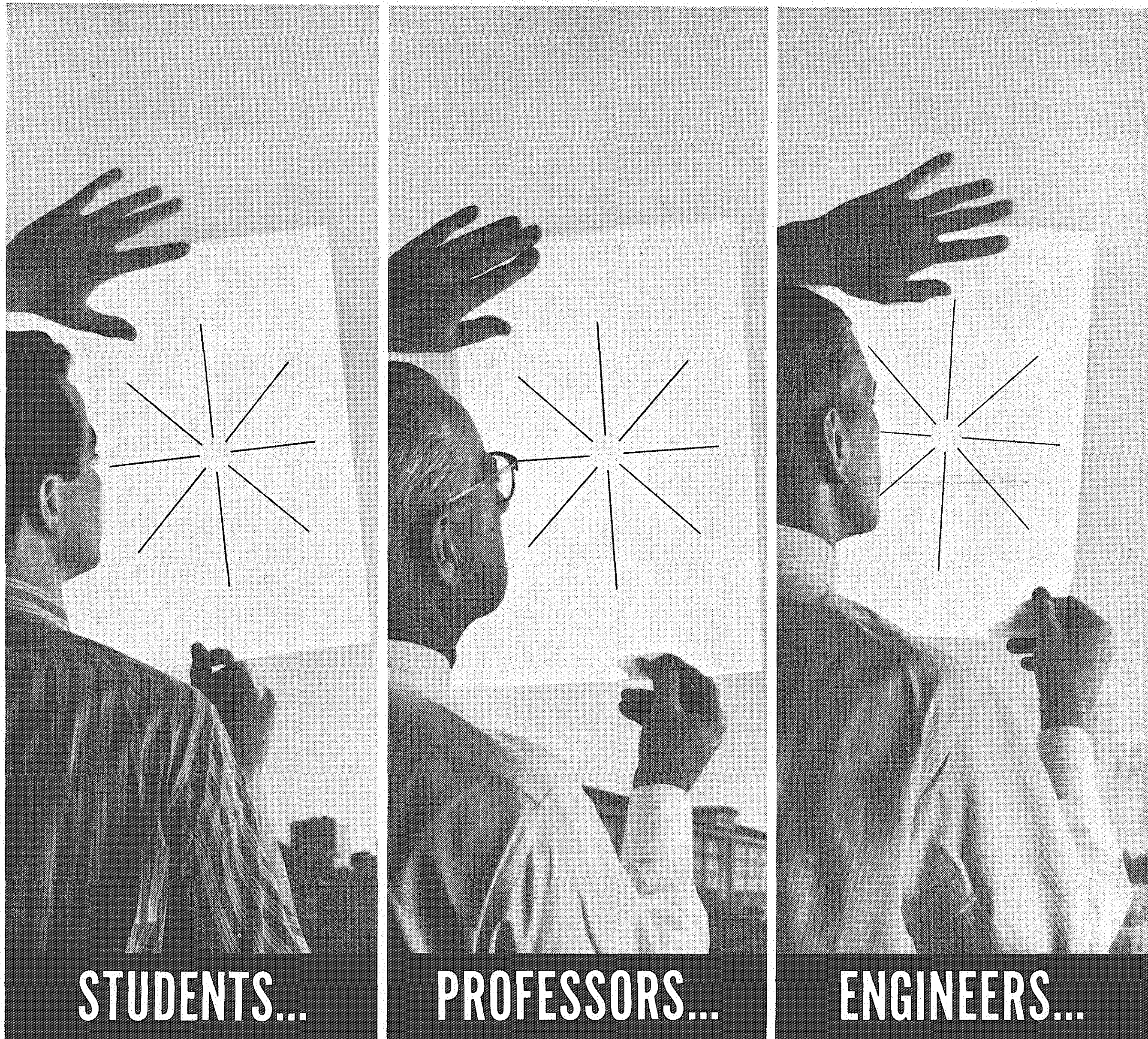

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One of the most important issues facing you today is the silent threat of your personal...

OBSOLESC

by JERRY A. KATZ, *IE Inst.*

Coping with the impact of constant change is a tough, endless job. Besides this flurry of technological changes, there are entirely new demands, new languages and disciplines, new threats, and new responsibilities. Alert professional men in industry are becoming more and more concerned about professional obsolescence.

This concern shows up in informal discussions, during trade conferences, on the speaker programs of professional societies, in the editorials of industrial magazines, and in the conversation of government officials. It also shows up in special campus courses set up expressly for professional men and in the enrollment figures of night and correspondence schools.

But it shows up most commonly in plain, old-fashioned worry. Worry about what is happening and what will happen next. Worry about not being able to read once-comfortable technical journals. Worry about how to cope with new pressures and new industrial environments brought about by technical innovation. Worry about the impact these are having, not only in the plant, but on the market-place. Worry about new management tools—how they work, how good they are, what the hazards are. Worry about massive investments in research and equipment necessary in the face of short and unpredictable product lives. Worry about how to communicate with and the advantage of specialists. Worry about how to keep up, where to turn, how to find time, what's most important.

And worst of all, perhaps, is the nagging worry about one's own basic ability to understand, master and use new industrial techniques, even if they are somehow thrown into his lap.

What throws any phenomenon into a threat is not knowing how to handle it or refusing to recognize it; and this holds true for personal obsolescence. Industry is uneasy, universities should be uneasy, even consultants are worried about keeping up themselves, let alone leading clients to a solution.

For the most part, professional and management societies look the other way. Their programs and speakers are more likely to explain the intricacies of "going public" or making an attitude survey. Technical societies do a better job, but their utility to others is compromised by the jargon of specialists and the tendency of every specialty to overvalue its contribution. Orientation seminars, such as those offered by the American Management Association, also provide a needed service.

Unfortunately, the more successful the technical man is, (or the longer he has been in industry), the more he needs broadening and updating, but the less likely he is to feel he can spare a significant block of time away from the job.

The fact of the matter is, nobody knows enough about obsolescence—just what it is, where it hurts, whence it shows up, how best to recognize, isolate, and attack it in specific situations. As a result it is extremely hard to handle. When a sharp man of 35 elbows aside a 50-year-old with 30 years of experience, it becomes too easy to get bitter over personal obsolescence. But obsolescence may have nothing to do with it. It may be a matter of economics, company politics, personalities, specialized training, or interests. Perhaps the experienced man is being saved for something better. Perhaps he has simply run out of gas, refused to transfer, or become an inflexible, plodding pay-check number: too old to start over, too young to retire. Any of these might be matters for concern, but they should not be confused with personal obsolescence.

WHAT OBSOLESCENCE IS

Personal obsolescence is many things. At one extreme, everyone is its victim because no one can know instantly everything that is happening that could affect his job or his industry. At the other extreme, obsolescence has few victims if the term is used to imply a serious lack of current knowledge such that a man is incapable of doing his present job. Between the two extremes is a range of interpretations. The appropriate one for you will be a

ENCE

function of your potential industry, its economic situation, your company and your specific job.

In general, personal obsolescence is the state of lacking sufficient knowledge to adequately exploit and anticipate the opportunities provided by relevant technological progress. Looking at it this way, obsolescence becomes more manageable. There is no need to try staying up-to-date on everything, but focus on *relevant* technological progress; and look upon your changes as opportunities, not threats. Be content to adequately exploit developments. Finally, the goal should be to maintain sufficient knowledge to do your job well, but not sufficient to be an expert. Your future job will not be doing work, but getting work done; not knowing everything, but knowing who knows.

YOUR SOLUTION

Fighting obsolescence is, much like the surge of technology behind it, a continuous process. You cannot hope to resolve it once and for all. Moreover, it is largely a do-it-yourself project. Don't expect the company, society, the government, seminars, colleges, or any group to take care of it for you painlessly. It demands individual effort; consistent, personal sacrifice; and inconvenience. This is pure and simple homework. But like all major undertakings, it looks hopeless until you isolate the specific areas of your own weaknesses and settle on some sort of plan for overcoming them.

1. Keep Perspective

Remember, there is nothing new or remarkable about graduating seniors, fresh out of college, knowing something about new techniques that weren't taught or didn't exist when present managers and chief engineers went to school. Any intelligent management expects this and further expects that these greenhorns will generate a lot of sparks in their enthusiastic attempts to set the world on fire. For the most part, such newcomers are secretly unsure of themselves and respond warmly to the manager who sincerely marvels at what they know and asks them to bring him up-to-date. The worst thing an established professional can do is damn them all as "theoretical" and take a position of invincible ignorance.

The scare talk about an engineer's "half-life" being ten years (half of what he knows will be obsolete in a decade) can be largely discounted. In the first place, technical work is not done in a vacuum. What with direct experience, the example of colleagues, papers and discussions at technical meetings, journals and industrial magazines, etc., you will probably learn more relevant material, in a given period, on the job than a man in class. Moreover, even if you have forgotten certain things (because you don't use them), you remember being exposed to them, and how and where to find them if the need arises. You can always turn to specialists who have had to follow developments closely. The task of keeping up-to-date is easily exaggerated. It is not necessary to be alert or on top of everything. Let the specialist specialize; the important thing is to have knowledge on tap.

The flurry of seminars and workshops, resident and correspondence courses, on-premises short courses, and the like gives the deceptive impression that just about everyone is going back to school. This is simply not true, but even if it were, it would not necessarily pertain to you. There is no assurance that such material would be relevant to your specific situation, nor that the leaders and lecturers have the latest information, nor that they will effectively cover it in appropriate depth.

The need for action is certain, but not necessarily urgent. There is time to pause and think matters through. Technological changes may seem to be sprouting up independently in many places at once, but they are usually inter-related and frequently predictable. Particularly in the realm of development as opposed to research, and of adapting or transplanting ideas as opposed to generating them. For example: given television and given tiny, solid-state circuitry in aerospace applications, it took no medium to foresee much smaller and more reliable TV sets. Similarly, cordless small appliances, edible food packages, canned soda pop, plastic buildings, high energy machining, integrated circuits, and stainless steel razor blades need not have come as complete surprises. Not technology itself, but its imaginative application is the threat and the opportunity you should be alert to. Read widely and use business discussions as early warning systems to alert you. Then you can *plan* your response to them.

You can also gain a little time while a new concept gains acceptance. Sportsmen will use plastic archery bows and fishing rods, but tend to sneer at plastics in firearms. Because of the high stakes involved, industry prefers to progress at a conservative rate. Continuous casting was around for years before it attracted serious interest. This inertia gives the alert professional valuable lead time to get ready to meet the changes he sees coming.

2. Isolate Problem

Will you feel your management or your engineering knowledge is inadequate? Has your chosen field changed

OBSOLESCENCE:

How do you score on this quiz?

This quiz may help you evaluate your own obsolescence and pin down areas in which you could use a disciplined brush-up. (We give no answers to these questions; they are to offer you insights into your obsolescence, not into certain technologies.)

1 HOW DOES SYSTEMS ENGINEERING DIFFER FROM: systems and procedures? value analysis? industrial engineering? operations research? project management? process engineering?

2 CAN YOU EXPLAIN, TO YOUR WIFE'S SATISFACTION, terms such as: total systems, materials management, information retrieval, direct costing, closed loop, group processes, theory x and theory y, interface, parameters, on-line, ambivalence, binary logic, motivational research, transducer, polymer, learning curves, simulation?

3 HAVE YOU QUIT READING your professional journal because the material is getting too hard to understand—"too technical"—too "impractical"? Do you have trouble keeping up the jargon peculiar to your industry or your field of specialization?

4 WHAT DOES PERT HAVE TO DO WITH: linear programming? probability theory? computers? How does it differ from critical path scheduling? flow charting? Gantt charting?

5 CAN YOU NAME TWO MAJOR CHANGES that have taken place, over the last five years, in the fields of: job evaluation, powdered metallurgy, work measurement, data processing, purchasing, packaging, metalworking, materials handling, bench assembly?

6 DO YOU HAVE TROUBLE helping the kids do their math or science homework? Can you still let your old texts fall open to any page and handle the problems on it?

7 LIST THE SIX MOST IMPORTANT innovations or trends that have shown up in your industry in the last 10 years. (Clue: What are leading companies in the industry doing, changing, or planning?)

8 ARE YOU FRANKLY SNOWED by some of the speakers at conventions and seminars in your field? Do you find yourself retreating to familiar "primer" sessions?

9 IF COMPUTERS WERE FREE, what five jobs would you first put on yours?

10 WHAT'S THE DIFFERENCE between line balancing and line of balance? quality control and reliability? programmed instruction and teaching machines? analog and digital computers? cryogenics and cybernetics? scientific management and management science?

11 NAME THREE WAYS your plant could use operations research if the money were available. (It is *not* "big plant stuff"!)

12 WHAT ARE THE TWO MOST IMPORTANT management or technical books you've read in the last year? (Good intentions don't count.)

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FIGHTING OBSOLESCENCE:

Where updating is needed most

Nearly 2,100 engineers were asked about personal obsolescence by two specialists from Pennsylvania State University—Drs. S. S. Dubin and H. LeR. Marlow. Men interviewed worked for 176 companies in over 20 industries. Questions ranged from how long the men had been out of school to what means they used to stay up to date. They were also asked which of 141 subjects they "should have" or "could use."

What topics 2,100 engineers want in:

MANAGEMENT

Job evaluation	68%
Human relations skills	61
Business law	57
Man-machine interface	55
Product planning	54
Analyzing ozganization effectiveness	53
Budgeting and auditing	51
Understanding individual and group behavior in work situations	47
Supervisory training for employee department	47
Decision making—simulation	45
Performance appraisal coaching	43
Selection and assessment of personnel	42
Value analysis	41
Data processing—decision making	40
Financial planning & forecasting	40

ENGINEERING SCIENCES

Engineering economics	68%
Engineering analysis	61
Computer programming—digital	57
Engineering materials—metals	55
Computer programming—analog	53
Information data processing	51
Electronics	47
Heat transfer	47
Construction materials	45
Engineering materials—plastics	43
Fluid mechanics	42
Stress analysis	41
Corrosion—electrometallurgy	40
Metallurgy	40

ENGINEERING ANALYSIS, DESIGN, & SYSTEMS

Automation	54%
Program evaluation review techniques	48
Instrument measurement, process control	47
Work simplification & measurement	47
Production management	46
Systems engineering	41

BASIC SCIENCES

Probability and statistics	62%
Review of college mathematics	53
Review of college physics	48
Calculus	47
Modern algebra	46
Differential equations	43
Modern analysis	43
Numerical analysis	42
Statistical inference	42

COMMUNICATIONS

Rapid reading	80%
Effective communication in organization	78
Conference leadership	77
Public speaking	76
Oral presentation of statistical and technical papers	74
Technical report writing	74
Business letter writing	70
Listening skills	67
Composition and rhetoric	57
Interviewing skills	53
Engineering graphics	42
Exposition narrative writing	39

What special programs they'd like to take:

Computer technology	**80.2%**
Instrumentation & control technology	**77.6**
General engineering technology	**74.2**
Electrical & electronic technology	**72.1**
Production technology	**61.8**
Drafting & design technology	**59.6**
Maintenance technology	**56.2**
Chemical technology	**54.4%**
Chemical engineering technology	**49.0**
Solid state technology	**38.6**
Air conditioning & refrigeration	**20.9**
Nuclear engineering technology	**19.4**
Surveying technology	**17.8**
Aeronautical & space engineering technology	**12.0**

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while you have remained essentially static, or is your field itself static? Will you become uneasy about the thrust of developments in your own specialty, in the specialties of men you may someday supervise, or in general?

If your concern is with the management area, will it be a matter of how best to lead technical manpower? Or, what techniques might improve your leadership of manpower? Will you become uneasy because you are managing technical manpower when you are secretly unsure of what they are doing? Maybe you will not be sure you are keeping up with a rapidly moving situation. Or, will you be concerned because you are in charge of work that you haven't done for many years? These are all different things and you will have to attack them in different ways.

The engineering and technology values are similar. Will you be an engineer-turned-manager who needs different skills (delegation, appraisal, motivation)? Are there communication problems with other disciplines? Will you be concerned because you have forgotten valid material since you graduated or because you remember what you had in school, but it is no longer adequate? Perhaps you will have stayed right up on top of your discipline but you have to get familiar with another discipline. (For example, electrical engineers increasingly have to have a working knowledge of solid-state physics). These things again, are all different problems that have to be attacked in different ways.

Having defined the general nature of your obsolescence, you can proceed to pin down specific subjects you need to know more about. The tables and checklist are such aids.

In doing so, discipline yourself. Don't muddy the waters by including topics you used to work with, or which you might find intriguing although they are not related to your work. Learn about them if you like, but don't consider shaky knowledge about them as part of your obsolescence; and don't try to out-expert each of the specialists reporting to you. You will be paid to consolidate their knowledge, not to duplicate it. On the other hand, you will have to be familiar with their jargon.

Whatever your field might be, you will probably benefit from a basic brush-up in mathematics and statistics when the time comes. Long the language of technology, they are more and more becoming the language of all forms of business. Contrary to what you think, these are not fixed, immutable fields; so the longer you put off your updating, the tougher it will be.

3. Preventive Action

The key to coming to grips with obsolescence is self-discipline. There are several tactics you can bring to bear, but every course of action boils down to study and there is really no way to make it "fun".

If your potential company offers in-plant instruction, or help for outside study, by all means take advantage of it. The mere regularity and formality of such classes, plus group pressure and competition, will make things easier to bear. This holds even if you have to take night classes on your own.

Next, set up a directed reading program for yourself. Ask for recommendations from company specialists or from local educators, as well as from trade associations and professional societies. Ideally, your study should be scheduled for a fixed time and place on a regular basis.

Trade magazines and journals are valuable sources of current material. Don't let them pile up because you are "too busy." You can't be too busy to do your job and this is an integral part of it. Clearly, you have to be selective. If you can get training in speed reading it might be worthwhile. But more important, teach yourself to "shift gears." Don't read technical material, comics, consultant reports, and James Bond adventures at the same speed. Get into the habit of learning during your conversations around the plant. Instead of rehashing ball games, find out about the jobs, jargon, and contributions of men with other specialties. *Constantly broaden yourself.*

An excellent resource that is often overlooked is technical salesmen from supplier companies. Pick their brains for knowledge and for clues to what may be in the wind. The same holds true for people from other companies that you will meet at seminars and conventions. One way to expedite this is to take office in the professional society most likely to benefit you. Remember too that steps taken today to cope with personal obsolescence may not be the best course of action in the future. It is important to stay flexible in your approach and response to technology.

One thing is certain in coping with personal obsolescence. The continuing collapse of time and the other disrupting trends in the economy make unwise the common strategy of the professional men over fifty: turn rump upwind, shut both eyes, and weather it out until retirement day. Somewhere along the line, such a man will become, not just obsolescent, but obsolete.

INDUSTRY'S SOLUTION

One way many companies encourage their people to stay up-to-date is to reimburse employees for the costs they incur in returning to school. One such plan is that of Grumman Airplane Engineering Corporation which offers full reimbursements to employees who finish an outside course with an "A". But the reimbursement for lesser grades is scaled down. Few companies feel flush enough to send hundreds of men back to school full time at full salary, as does International Business Machines Corporation (White Plains, New York). But the company that "can't afford" to repay at least part of an employees' investment in staying up-to-date, may soon find it can't afford to meet its payroll. This is particularly true of small plants that depend on nimble, informed, fast responses to opportunities. Most men, left to their own devices to fend off obsolescence, will either go to seed or go with an employer who nurtures progress.

Other company approaches include transporting employees to formal classes, and hiring professors from local colleges to give on-premises courses. They are not a cure-all, though. Major blocks of the latest knowledge are not being taught yet in schools.

Moreover, college technical courses may not be lean, quick, or distilled enough to suit industry's needs. In these cases, the company, perhaps cooperating with other firms in the area, has to press its own specialists or outside consultants into service as lecturers to accomplish its specific goals.

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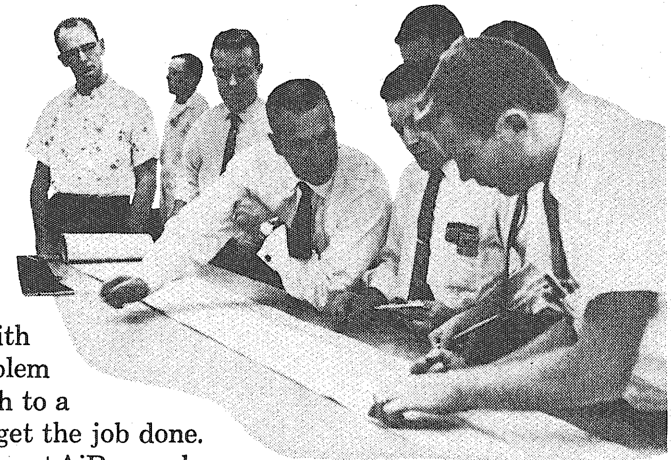

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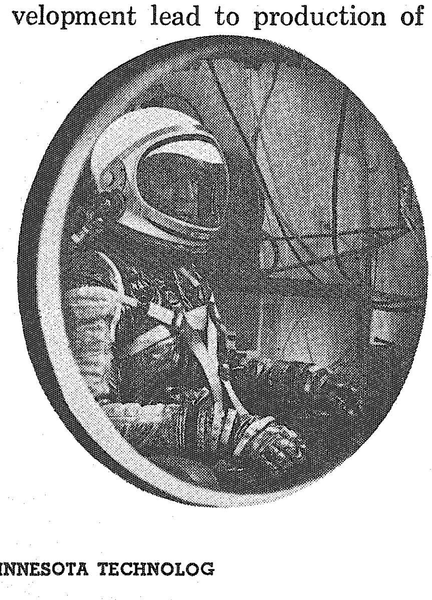

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Our engineering staff is smaller than comparable companies. This spells opportunity. It gives a man who wants to make a mark plenty of elbow room to expand. And while he's doing it he's working with, and learning from, some of the real pros in the field.

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In a field where meeting challenges pays off in rewards...

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ENGINEER'S VOCABULARY

A conference—A place where conversation is substituted for the dreariness of labor and the loneliness of thought.

To implement a program—Hire more people and expand the office.

Reliable source—The guy you just met.

Informed source—The guy who told the guy you just met.

Unimpeachable source—The guy who started the rumor originally.

To negotiate—To seek a meeting of minds without a knocking together of heads.

With modifications—Will be shipped to you in kit form. Put it together (if you can) yourself. Glue optional.

It is in progress—so wrapped in red tape that the situation is almost hopeless.

Consultant—Any ordinary guy more than 50 miles from home (must have briefcase).

Under consideration—Never heard of it.

Under active consideration—We are looking in the files for it.

Expedite—To confound confusion with commotion.

Channels—The guy who has a desk between two expediters.

A program—Any assignment that can't be completed by one telephone call.

A clarification—To fill in the background with so many details that the foreground goes underground.

See me or let's discuss—Come down to my office, I'm lonesome.

We are making a survey—We need more time to think of an answer.

Give us the benefit of your present thinking—We'll listen to what you have to say as long as it doesn't interfere with what we have already decided to do.

Note and initial—Let's spread the responsibility for this.

Let's get together on this—I'm assuming you're as confused as I am.

Interpretation—Your warped opinion pitted against your adversary's good sense.

Will advise you in due course—If we figure it out, we'll let you know.

Take some dictation—Come on over, honey, and we'll talk????

To give someone the picture—A long, confused and inaccurate statement to the newcomer.

Confidential—Spy bait and besides the stamp looks important.

Re-orientation—Getting used to working again.

A meeting—A mass mulling by master minds.

Research work—Looking for the jerk who moved the files.

Point up the issue—To expand one page to fifteen pages.

Expert—A person who avoids all small errors as he sweeps toward the grand fallacy. (Obviously confused.)

Could a U.S. firm that helped save a cotton crop abroad also have a hand in keeping Jayne Tippman's skin soft?

You'd expect that a U.S. company engaged in mining, production and marketing in over a hundred countries might have an impact on many national economies. And you'd be right. For instance, with an insecticide sold under the trade mark "Sevin," this company was largely responsible for saving a middle east cotton crop.

And when a leading chemical manufacturer's products include silicones, which have a soothing and protective effect on skin, they're bound to turn up in skin lotions, creams, and emollients. Jayne Tippman uses them to keep a glowing complexion that weather can't beat.

Cotton fields and skin lotions are unlikely markets for one company's products. Unless that company is Union Carbide.

But then, Union Carbide also makes half a dozen major plastics, along with plastic bottles and packaging films. And it's one of the world's most diversified private enterprises in the field of atomic energy. Among its consumer products are "Eveready" batteries and "Prestone" anti-freeze. Its carbon products include the largest graphite cylinders ever formed, for possible use in solid-fuel rockets. Its gases, liquefied through cryogenics—the science of supercold—include liquid oxygen and hydrogen that will be used to propel the space ships designed to reach the moon.

In fact, few other corporations are so deeply involved in so many different skills and activities that will affect the technical and production capabilities of our next century.

It's a future that glows like Jayne Tippman.

UNION CARBIDE CORPORATION, 270 PARK AVENUE, NEW YORK, N. Y. 10017. IN CANADA: UNION CARBIDE CANADA LIMITED, TORONTO
Divisions: Carbon Products, Chemicals, Consumer Products, Food Products, International, Linde, Metals, Nuclear, Olefins, Ore, Plastics, Silicones and Stellite

UP FRONT

by WILLIAM OTTO, *Met E '68*

DR. T. SHAO-CHUNG LEE

Dr. T. Shao-chung Lee, assistant professor of electrical engineering, was born in Suchow, Western China, on November 18, 1932. Eight years elapsed between his grade school education, which he received in Suchow, and his entering college at the National University of Taiwan. During this time he attended junior and senior high school at various places in Western China due to the war.

Dr. Lee has received various scholarships and grants during his education in China and Formosa. At present, Dr. Lee is teaching a third year class in circuits and is going to teach EE 113. In the past, Dr. Lee has taught EE 187, 188, 189, Acoustics, and Problems in EE.

Currently, he is doing research and writing in plasma physics, gas dynamics, and acoustics. Dr. Lee has been married for four years and has two children: Emily, who is two years old, and Jeffrey, who is one. His leisure time activities consist of amateur electronics and many varied outdoor activities such as swimming, hiking, etc. Dr. Lee enjoyed pheasant hunting in Western China, but has not attempted it in the United States. The remainder of his leisure time is dedicated to the two organizations that he belongs to—Sigma Psi and Eta Kappa Nu.

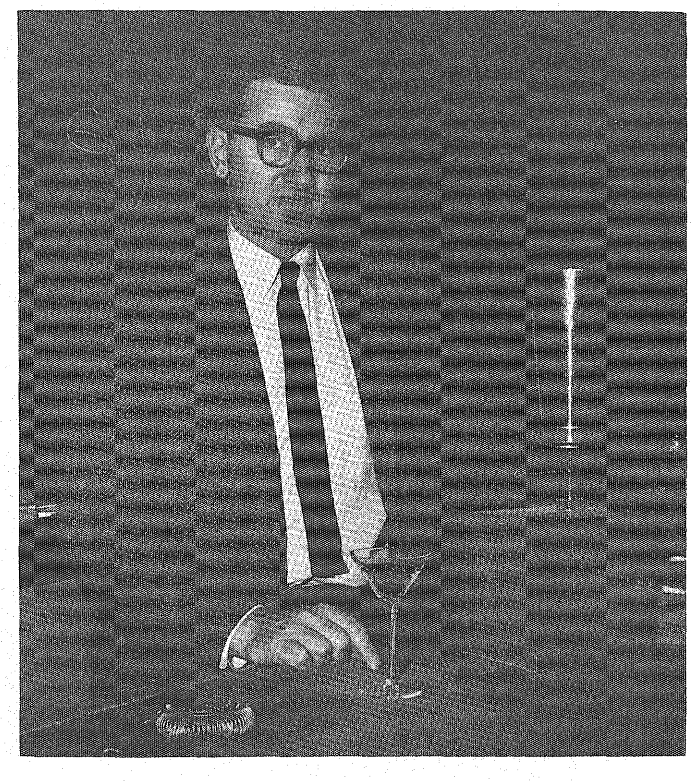
In the town of Göttingen, Germany, in 1924, a man by the name of Hans Wolfgang Julius Courant was born. When he was ten, Mr. Courant and his family moved to New Rochelle, a suburb of New York City, where he received his grade school education. After attending junior high school and high school at Fieldston School in New York, he completed his formal education at the Massachusetts Institute of Technology, where he received his B.S. and Ph.D. in Physics.

In 1954 Dr. Courant received a Fulbright Fellowship to Paris where he worked on cosmic ray physics. He has also received a Ford Foundation Fellowship and a National Science Foundation grant which allowed him to study in Geneva, Switzerland.

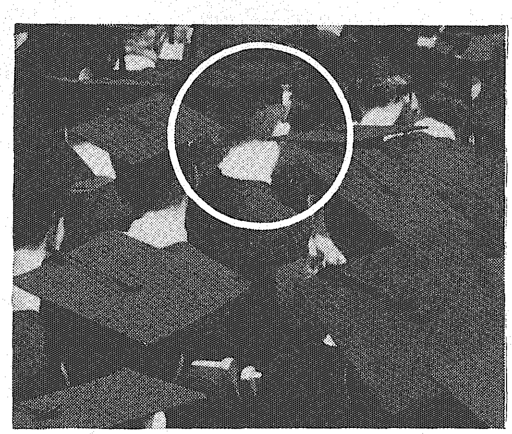
At present, Dr. Courant is teaching the physics series known to all who have taken it as "deadman's row," or Physics 11, 12, 13, 14, and is going to teach Physics 50 and 51. Along with his teaching, Dr. Courant commutes periodically to Chicago where he is working with the high energy accelerator at the Argonne National Laboratory in Chicago.

His plans for the future consist of the design and construction of a large bubble chamber which will contain five and a half tons of hydrogen for the study of elementary particles.

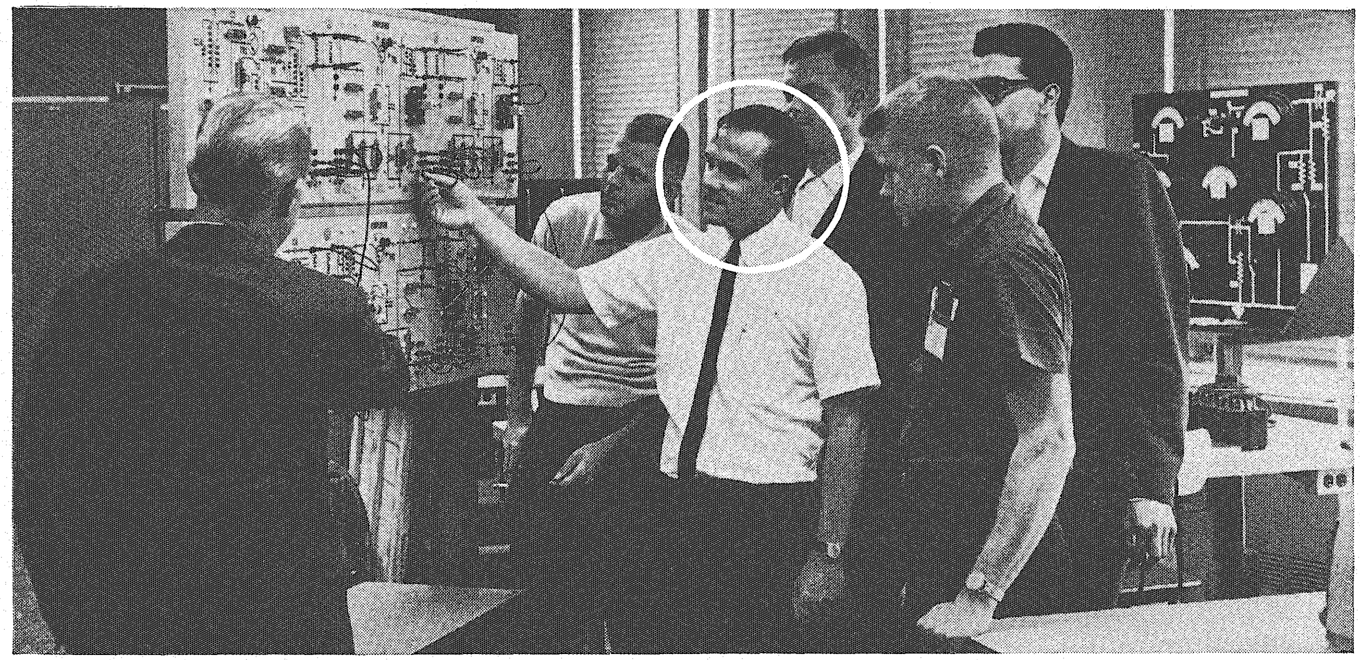
Here Dr. Courant is demonstrating the Faraday Ice Pail Experiment, proving that all charge is on the outside of the pail and all C_2H_5OH inside.



DR. HANS COURANT



Graduation was only the beginning of Jim Brown's education



Because he joined Western Electric

Jim Brown, Northwestern University, '62, came with Western Electric because he had heard about the Company's concern for the continued development of its engineers after college graduation.

Jim has his degree in industrial engineering and is continuing to learn and grow in professional stature through Western Electric's Graduate Engineering Training Program. The objectives and educational philosophy of this Program are in the best of academic traditions, designed for both experienced and new engineers.

Like other Western Electric engineers, Jim started out in this Program with a six-week course to help in the transition from the classroom to industry. Since then, Jim Brown has continued to take courses that will help him keep up with the newest engineering techniques in communications.

This training, together with formal college engineering studies, has given Jim the ability to develop his talents to the fullest extent. His present responsibilities include the solution of engineering problems in the manufacture of moly-permalloy core rings, a component used to improve the quality of voice transmission.

If you set the highest standards for yourself, enjoy a challenge, and have the qualifications we're looking for — we want to talk to you! Opportunities exist now for electrical, mechanical and industrial engineers, and for physical science, liberal arts and business majors. For more information, get your copy of the Western Electric Career Opportunities booklet from your Placement Officer. And be sure to arrange for an interview when the Bell System recruiting team visits your campus.

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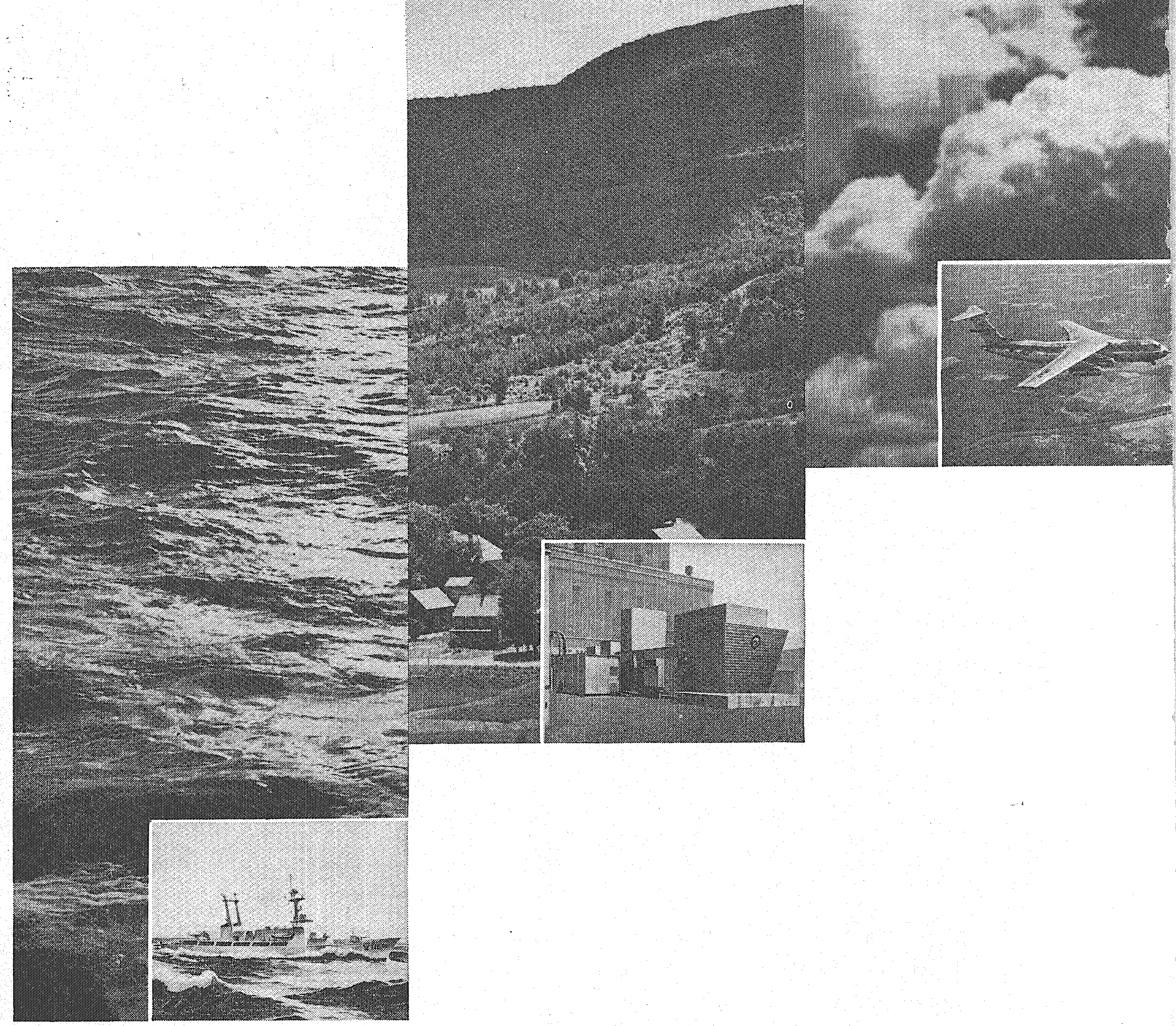

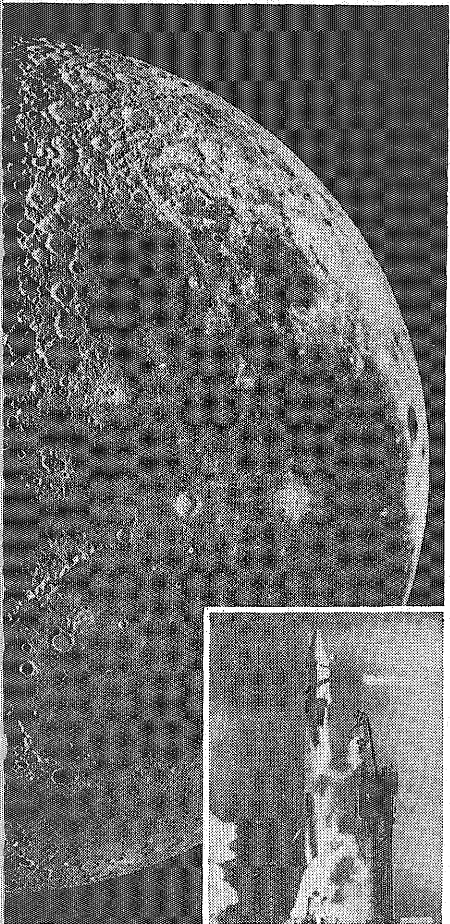

Being a technically trained man . . . we assume you are looking ahead to a career of exciting growth and accomplishment and that you are looking for a company possessing these same qualities.

If our assumption is correct, we would like you to take a close look at us. For this Company, while solving the problems of the day, thrives on a sort of creative restlessness which anticipates the challenges of tomorrow. And more important to you, it recognizes its engineers and scientists as the master key to its present success and future progress.

From a solid foundation of basic and applied research, our Company has gained a firm foothold in the land, sea, air, and space programs that are helping to shape our nation's future. Our engineers and scientists are exploring ever-broadening avenues of *energy conversion for every environment.* Should you join them, you'll be assigned early responsibility . . . to apply your engineering talents to such areas as advanced gas turbines . . . rocket engines . . . fuel cells and nuclear power.

Such trail-blazing projects command the best of varied talent. That's why you'll find at Pratt & Whitney Aircraft men with college training as diverse as their responsibilities. You will also find that opportunities for professional growth are further enhanced by our corporation-financed Graduate Education Program. Your degree? It can be a B.S., M.S. or Ph.D. in: **MECHANICAL • AERONAUTICAL • ELECTRICAL • CHEMICAL and NUCLEAR ENGINEERING • PHYSICS • CHEMISTRY • METALLURGY • CERAMICS • MATHEMATICS • ENGINEERING SCIENCE or APPLIED MECHANICS.**

For further information concerning a career with Pratt & Whitney Aircraft, consult your college placement officer—or—write to Mr. William L. Stoner, Engineering Department, Pratt & Whitney Aircraft, East Hartford 8, Connecticut.

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WHAT'S NEW *in Engineering*

edited by STEVE LINDFORS, *Physics '67*

Electronic Pyromaniac

Southwest Research Institute scientists in San Antonio, Texas, are studying the ignition of wood—both with and without starting fires.

One of their approaches to the problem has been to build a mathematical model of a fire in which they can burn as many mathematical wood samples as they want.

This entire simulated wood-burning process takes place at high speed inside the central processor of a General Electric 225 computer system. This government-sponsored program is designed to provide information which will contribute to fire-safety practices and solid fuel technology.

The "wood-burning" computer to date has analyzed dozens of combinations of wood thickness, wood symmetry, and source temperatures. On the average, each test involved in computing the status of ignition of the sample used about 400 different points in time.

This sophisticated computer approach to wood-burning has an additional advantage: no ashes to carry out.

Metal Exercise

A major innovation in the technology of metal rolling was recently invented at the General Electric Research Laboratory. The new process, in which metal strip is squeezed, bent, and pulled simultaneously, is called "Contact-Bend-Stretch" (C-B-S) rolling.

The technique is the result of fundamental studies of the effects of cyclic plastic strain on metal. It was discovered that metal strip could more easily be made thinner and longer if plastic bending was added to the forces of pressure and tension that are usually applied in a rolling mill.

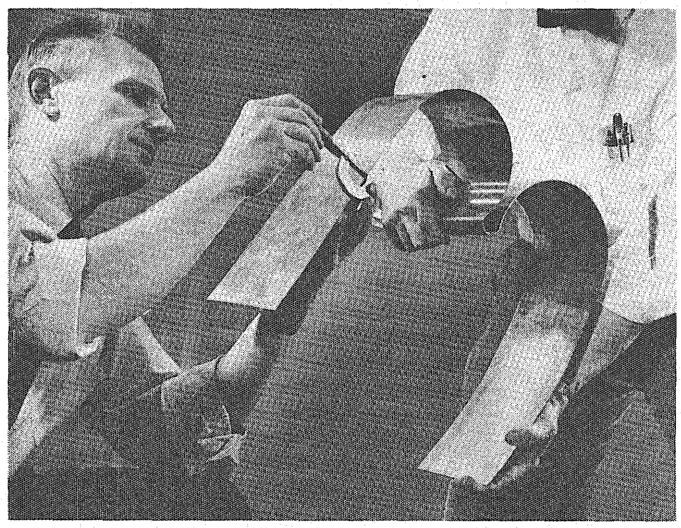
In conventional rolling, the metal is deformed by the contact pressure of two rolls, while the strip is pulled between them under tension. This operation might be described as "contact-stretch" rolling. If the metal is bent plastically at the same time, "contact-bend-stretch" rolling takes place.

In C-B-S rolling, the easier deformation of the strip, with the smaller forces that are involved, may make it possible to use smaller, lighter, less expensive mills. In addition, larger reductions in thickness can be achieved on each pass through the rolls, or stronger—or wider—or thinner materials rolled than on conventional mills.

A variety of metals have been rolled with the C-B-S technique including carbon and alloy steels, Rene 41 and other nickel-base alloys, copper, and molybdenum. Since C-B-S rolling permits greater reductions in thickness without intermediate annealing, the process appears especially advantageous in rolling materials that harden in working, such as stainless steel.

In one form of C-B-S rolling, a small roller with strip wrapped around it lies in the "saddle" between two work rolls. The latter revolve in the same direction, rather than in opposite directions, as in conventional rolling mills. Folds in the entry strip can't be drawn in and crushed between rolls, thus roll damage from "cobbling" is avoided.

A Contact-Bend-Stretch mill was dismantled in order



to remove the strip shown here, revealing how metal is bent around a small roller (center) located between two larger ones.

Atom Replaces Earth

An atomic definition of the second, the international unit of time, was authorized at 1725 Paris time, October 8, 1964, by the Twelfth General Conference of Weights and Measures, meeting in Paris that week. The International Committee on Weights and Measures, acting for the Conference, temporarily based the definition on an invariant transition of the cesium atom in expectation of a more exact definition in the future. The new definition replaces the definition of a second based on the annual orbit of the earth around the sun.

The action taken increases the accuracy of time measurements to a part in one hundred billion, an accuracy two hundred times greater than that formerly achieved by astronomical means. Moreover, these measurements can be accurately determined in a few minutes, as compared to the many years required to achieve an accuracy only one-hundredth as good by astronomical means.

The exact wording of the action of the Twelfth General Conference is: "The standard to be employed is the transition between the two hyperfine levels $F = 4$, $M_F = 0$ and $F = 3$, and $M_F = 0$ of the fundamental state $^2S_{1/2}$ of the atom of cesium 133 undisturbed by external fields and the value 9,192,631,770 herz is assigned." This definition is tied up with atomic processes taking place in the cesium-133 atom, the only non-radioactive nuclide of cesium which is different from the radioactive nuclei which are produced in atomic explosions.

To realize the radiation frequency of this transition, an atomic beam apparatus is used, commonly called an atomic "clock." Metallic cesium is placed in a small chamber which is heated, causing the cesium atoms to be emitted through a small hole into a beam tube. The atoms are separated into two beams by passing through an inhomogeneous magnetic field. Those with parallel magnetic moments go into one beam; those with anti-parallel moments into the other. If now the two beams are subjected to an oscillating electromagnetic field, the magnetic moments can be flipped from the parallel to the anti-parallel relationship or vice versa.

By well known electronic techniques the cycles of the oscillator can be counted—9,192,631,770 cycles of the oscillator are equal to exactly one second. In practice, however, oscillators are operated at other frequencies related to the cesium frequency by various circuit devices. These devices are used for the counting; they are operated continuously and they are checked from time to time against the cesium standard.

Although the atomic definition of the second enables scientists to maintain accurate and immediately available scales of time and of time intervals, astronomers are not put out of business in this timekeeping game. The earth's rotation is sufficiently irregular that for the navigator and the space scientist timing signals must be correlated with the earth's rotation. It is still the astronomer's responsibility to tell us when the seasons come and go, when eclipses are to be expected, and when Easter is supposed to come. The new atomic timekeeping is a great aid to the astronomer to help him keep track of the planets. Eventually, he will be faced with the problem of determining whether the time kept by an atomic standard is the same as that kept by the planetary motions.

Computer Tells All

Scientists are experimenting with a computer system which can simultaneously give individual instruction to a number of students in a wide variety of subjects, International Business Machines Corporation reported recently.

The IBM Research Division's experimental system makes the capabilities of a computer system accessible for convenient use in experiments by educators. The system is based on standard IBM equipment, but incorporates an experimental computer language that makes it simple for educators to put courses into the computer.

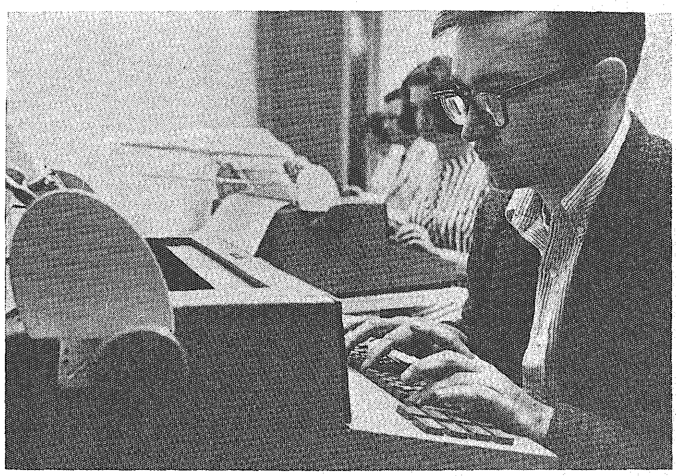
A variety of experiments can now be undertaken to evaluate "computer assisted instruction," and to devise and test ways of using the approach to best advantage. IBM emphasized that the ultimate usefulness of computers for instruction will not be known until extensive experiments have been conducted. Such studies will enable educators to learn how different subjects can best be taught with the system, and how computer assisted instruction might be integrated into the overall educational process.

In the experimental system, a teacher's instructions, questions and guidance are stored in the computer and presented to students on typewriter consoles or other student station equipment. Since the student's response—made on the typewriter—can be analyzed by the computer, presentation of subsequent course material can be tailored to the needs of each student.

At present, each student station consists of a typewriter console, through which the student receives directions from the system. The student's response on the typewriter can be many words in length. The computer analyzes the student's reply, and, according to the plan laid out by the teacher, responds with clues, questions, remedial study matter, drills, or the next assignment. The computer also can record response times, errors and other data on the student's performance. Thus, an extensive analysis of both student performance and the adequacy of the course is possible—with the opportunity of improving each.

The extensive record-keeping capability of the computer system will also permit valuable research on teaching techniques and the learning process itself. Thus, apart from its usefulness as an instructional tool, computer assisted instruction should lead to better understanding of the educational process.

Employees at IBM's Thomas J. Watson Research Center are shown taking experimental courses via computer assisted instruction.



Typewritten record of a lesson in mathematics, using computer assisted instruction. This sample lesson shows how specific hints and guidance can be given to a student in response to an incorrect answer. The letters in the left-hand column indicate: computer typeout (C) and student's answer (S).

C WHAT IS 2^3?
S -1
C DO *NOT* SUBTRACT. $2^3 \neq (2-3)$ OR $(3-2)$. TRY 2^3 AGAIN.
S 2.3
C 2^3 IS *NOT* ANOTHER WAY OF WRITING 2.3. ^{3} IS AN EXPONENT. TRY 2^3 AGAIN.
S 5
C DO *NOT* ADD THE BASE AND THE EXPONENT. $2^3 \neq 2+3$. TRY 2^3 AGAIN.
S 6
C DO *NOT* MULTIPLY THE BASE AND THE EXPONENT. $2^3 \neq 2 \cdot 3$. TRY 2^3 AGAIN.
S 8
C CORRECT

SPLINTERS From the Log

by DAVID E. ENGEN, *Pol Sci '67*

A college professor who was trying to teach one of his students to use correct grammar found that the student wasn't too eager to learn.

"What difference does it make if I say 'bad' or 'badly'?" he asked. "They both mean the same thing."

The professor pointed to a shapely girl who had just passed and said:

"Son, look at that girl and tell me, are you looking at her stern or sternly?"

• • •

FRICK & FRACK

Frick: I found Lamont Cranston on my radio dial.
Frack: Where?
Frick: Over shadow.

• • •

Frack: I found the Civil Rights movement.
Frick: How?
Frack: Over coming.

• • •

Frack: I found Beethoven's Fifth.
Frick: Where?
Frack: Over ture.

• • •

Frick: I found abroad in my Paris apartment.
Frack: Where?
Frick: Over seas.

• • •

Frack: I forgot my glasses at home.
Frick: Why?
Frack: Over sight.

• • •

Frack: I found myself in Comstock Hall.
Frick: When?
Frack: Over night.

• • •

Frick: I found Bridgit Bardot in my photo lab.
Frack: Where?
Frick: Over exposed.

The kiddies were being taken on a tour of the mint.

"Why is it," asked one of them, "that they stamp 'In God We Trust' on the pennies?"

"That," explained the guide, "is for the benefit of people who use them for fuses."

• • •

First Father: "Has your son's chemical engineering degree proved helpful since you took him into the business?"

Second Father: "Oh yes! Whenever we have a board meeting we let him mix the cocktails."

• • •

Drunk: "Ho, Lady, you got two ver' beautiful legs."

Girl (snapping): "How would you know?"

Drunk: "I counted 'em."

• • •

Christene Keeler has just written two books: "Life Under the Conservatives" and "Bedtime Tory."

And then there was the freshman who thought a logarithm was a forester's song.

• • •

Preparing to give a small boy an aptitude test, a psychiatrist told his attractive nurse to put a pitchfork, a wrench, and a hammer on the table. "If he grabs the wrench, he will be a mechanic. If he grabs the pitchfork, he will be a farmer. If he grabs the hammer, he will become a carpenter." The boy fooled everyone. Yes, he grabbed. . . .

• • •

Then there was the CE who told his date he was primarily interested in the study of strap tension on shell structures.

• • •

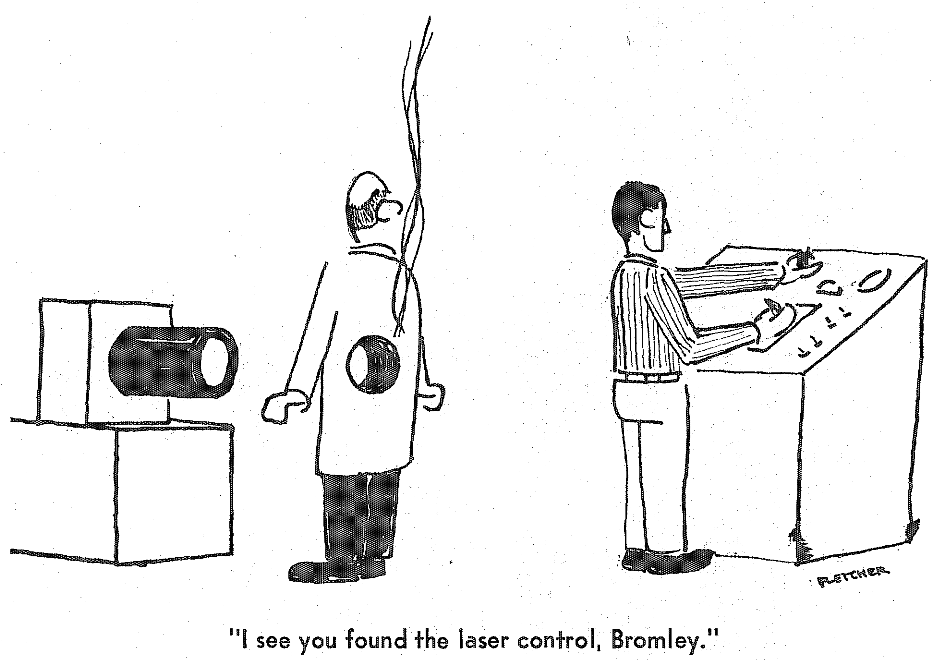
"Wait till you hear!" said one blonde to another. "I went to the movies last night and I had to change my seat three times."

"You mean you were actually molested?"

"Eventually."

NO JOKE

Great Britain is the only country with a national mouse club (founded in 1895). The National Mouse Club now recognizes all colors of mice except green. The Club rules specify that the ears should be large and tulip shaped, the tail tapered like a whiplash and, they add, "The mouse should be perfectly tractable and free from any vice."



"I see you found the laser control, Bromley."

"we explore freely . . .

and no restrictions are set upon our imagination."

The speaker was a brilliant young Navy scientist discussing his work, and he might well have been referring to the Naval Ordance Laboratory at White Oak, Maryland, where technological explorations are pursued to the ultimate advantage of the nation's posture of defense.

Who would have thought, especially before the advent of POLARIS, that a submarine could someday fire what appears to be an ordinary torpedo which would, a few seconds later, take off upwards into a ballistics trajectory . . . drop its rocket motor somewhere down-range . . . re-enter the water intact at supersonic speed . . . automatically arm itself . . . and let loose a nuclear blast that will decimate any number of submerged hostiles?

Today, SUBROC promises to be the deadliest anti-submarine warfare weapon ever devised, but when it was first dreamed up by NOL scientists back in 1957 it presented the thorniest set of problems yet to face the still-young missile age. That SUBROC itself, together with its sonar detection system and special digital computer fire control system, are almost ready for fleet use is a real tribute to NOL's creativity, technical direction, and test & evaluation capabilities.

But SUBROC—although an undertaking of incredible proportions—is just one in a long series of NOL projects in anti-submarine warfare, air and surface weaponry, aeroballistics, chemistry, explosives, and materials research. Many such dreams have become reality at NOL—seven new magnetic materials that have sharply upgraded magnetic amplifiers, magnetometers, and electromagnetic transducers . . . new ways to measure drag, stability, and heating effects of missiles traveling in excess of Mach 10 . . . the arming and fuzing devices for POLARIS . . . a new data reduction method for underwater acoustics that opens the door to *passive* sonar ranging . . . two new nuclear depth bombs . . . and literally hundreds more.

There are more than 1,000 graduate professionals at NOL-White Oak today, but the Laboratory is always interested in talented explorers—especially those delving into aero and electro technologies. And, to help you explore more freely (and productively), NOL offers:

- assignments of national importance
- the finest equipment and facilities to be had (900 acres of them)
- several programs for advance degrees in cooperation with Washington-area universities. The University of Maryland even holds some courses on NOL premises which you may attend during working hours. (NOL has always been fertile ground for PhD theses.)
- the stimulus of working with top people in their specialties, many of whom are staff members and lecturers at colleges and universities.
- the added stimulus offered by the Washington environment, now one of the top four R & D centers—private as well as government—in the country.

The same young Navy scientist we quoted earlier also remarked: "*. . . if a scientist wants the freedom to satisfy his intellectual hunger and open doors now closed to him, his best bet is to work for the Government.*"

NOL

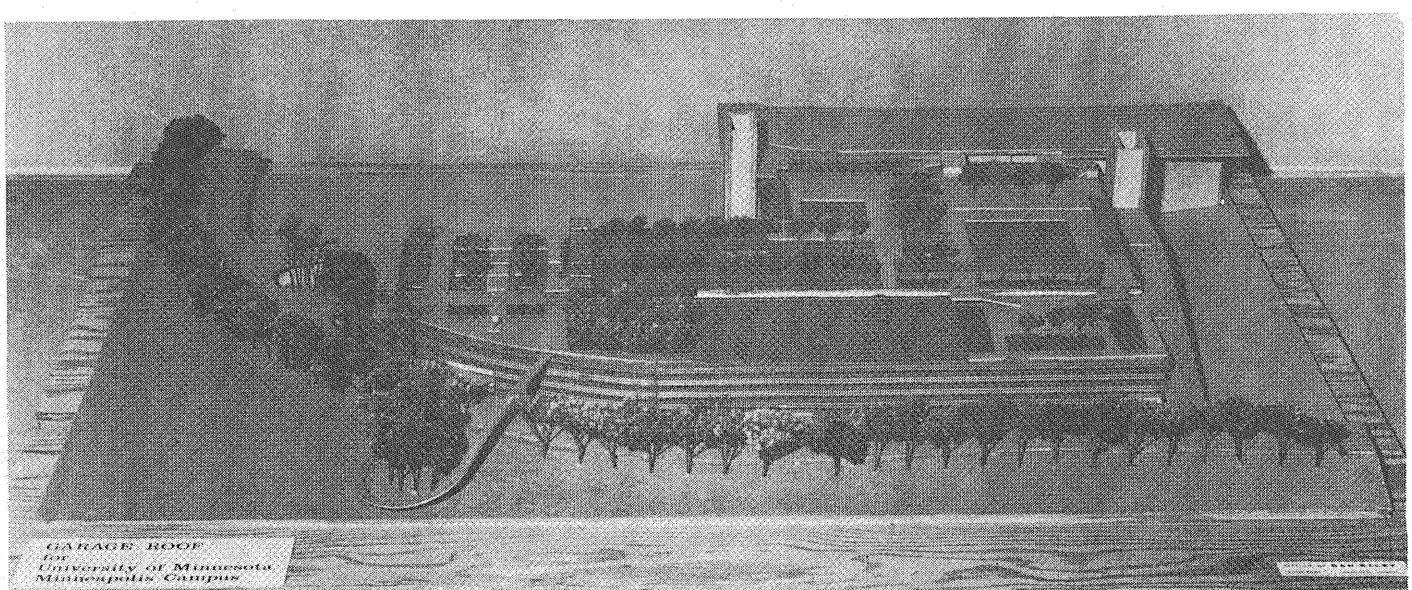
Check your College Placement Office for news of NOL interviews on campus, or write Lee E. Probst, Professional Recruitment Division, **Naval Ordnance Laboratory**—White Oak, Silver Spring, Maryland, for more details. The Navy is an equal opportunity employer.

PARKING . . .

by DIANNE CHRISTENSEN, *Physics '66*

No more parking on the river flats! Don't be too alarmed, this isn't going into effect yet, but eventually that area will become a park and playground. What about parking?

Sometime early next spring, construction will begin on a garage in the river bank south of the Union and



Architect's model of the proposed Coffman Union parking garage and landscaped terrace.

Comstock Hall. This garage, or group of superimposed garages will house approximately 2,000 cars whereas the flats have room for only about 1200 presently. Five levels are planned along with two landscaped terraces.

The landscaping is being done by Dan Kiley, one of the best there is, according to Winston Close, the advisory architect. The terraces, almost three acres in area, will have two pools, one directly south of Comstock Hall and another directly south of Coffman Union. The pools, or at least one, will be used for ice-skating during the winter. The terraces will also include grass, shrubs, and fountains. The Botany Department will work with the landscape, using the terraces as an experimental area and for demonstrations.

The first four levels of garages will each house approximately 450 cars. Entrance to the first level will be at the lowest point of East River Road, near the road to the flats. The second level will have two entrances and will operate functionally as two garages allowing special parking for groups. The third and fourth levels will each have one entrance. Access to the fifth level will be from a ramp from level four. Entrance to level four will be where the service drive for Comstock is now located. The fifth level will have a capacity of about 250 cars.

There will be self-parking of cars, and the drive areas will be completely one way. To cut confusion in finding cars, each level will be divided into sections; the lower four into sections A, B, C, D, and E. The choice sections, those nearest the elevators, will be filled first. A counter for each section will give the number of cars entering that section less the number leaving. This number will be relayed to a traffic control at the entrance. This datum, when combined with the other data in the traffic control, will indicate which section has available space.

The lower three levels will probably be used for contract parking; the upper two for transient parking.

Plans are being formulated for still further into the future. The two elevator shafts will allow the existence of a walkway from them to the first floor of the Union. A conference center may eventually be constructed between the Union and the garage above or possibly in place of the present Union terrace. Another possibility would be a small restaurant on the terrace. Such a restaurant would operate all year for students.

What about the technical problems encountered? The major problem is rock! The lowest level of the garage will be at an elevation of 763 feet, but there is rock up to 790 feet. Hence, huge masses of sandstone must be removed.

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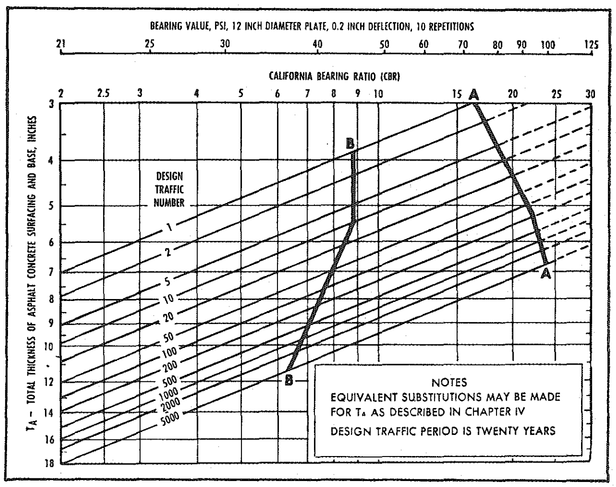
All the facts on this new method are contained in The Asphalt Institute's Thickness Design manual (MS-1). This helpful manual and much other valuable information are included in the free student library on Asphalt construction and technology now offered by The Asphalt Institute. Write us today.

*Asphalt Surface on Asphalt Base

THE ASPHALT INSTITUTE
College Park, Maryland



Thickness Design Charts like this (from the MS-1 manual) are used in this new computer-derived method. This chart enables the design engineer quickly to determine the over-all Asphalt pavement thickness required, based on projected traffic weight and known soil conditions.

THE ASPHALT INSTITUTE
College Park, Maryland

Please send me your free student library on Asphalt construction and technology, including full details on your new Thickness Design Method.

Name____________ Class______

School____________

Address____________

City____________ State______

Splinters . . .

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

• • •

A modern country is one which can ban fireworks and produce H-bombs.

• • •

ROTC student: "I haven't a pencil or paper for the exam."

Sergeant: "What would you think of a soldier who went into battle without a gun or ammunition?"

ROTC student: "I'd think he was an officer."

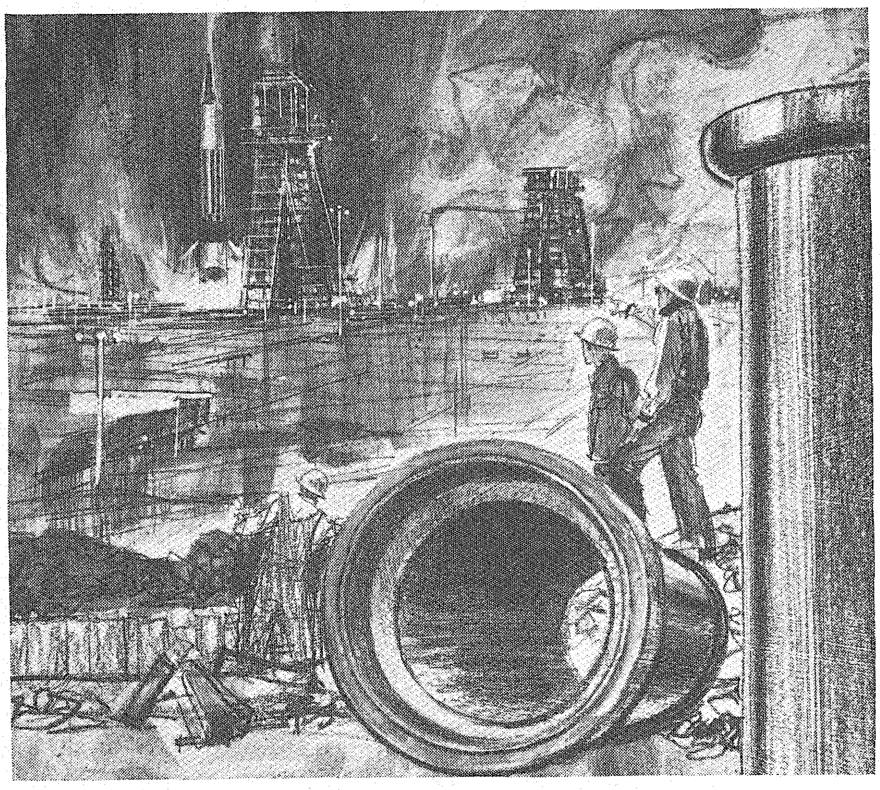
• • •

"I think all this stuff about college boys' lives being all wine, women and song is a great exaggeration."

"It certainly is—you just never hear any singing in the dorm."

• • •

Goblet: Baby sailor.



Why strength is so important to satellites . . . and sewer pipe

To withstand the fantastic force applied to it during launch, a satellite must be exceptionally strong. Strength must be an inherent part of its design and manufacture . . . and, it must retain this strength.

So it is with sanitary sewer pipe. The health of a community depends to a large extent on how well municipal sanitary sewers and house sewers do their job. They must not fail because of inadequate pipe strength. Strength must be an inherent part of the pipe.

Strength is an integral part of Dickey Perma-Line Clay Pipe. It's built right in. Nothing can take it away. The pipe body is so dense, there is strength to spare in all sizes, from 4-inch through 36-inch diameters.

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Dickey sanitary glazed clay pipe

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At their morning pep conference, a Chicago bookseller announced enthusiastically to his staff of salesmen: "Men, I've ordered 300 copies of 'What Every Expectant Mother Should Know'—and I'm counting on you boys to create a demand for them."

• • •

Upon seeing a little girl lead a cow along a country road, the parish minister stopped her and asked her: "Little girl, where are you taking the cow?"

"To the bull," replied the young lassie.

"Can't your father do it?" questioned the clergyman.

"Nope," answered the little girl, "only the bull."

• • •

"How did you find the ladies at the dance?"

"Oh, I just opened the door marked 'Ladies' and, sure enough, there they were."

• • •

In a Paris apartment, a French wife called her husband Pierre into the bedroom and said to him:

"Pierre, our son Armand has now reached the age where I think he is interested in girls. I want you to speak to him."

"About what?" Pierre asked.

"Tell him about the birds and the bees," she said.

Pierre protested and protested, but his wife was adamant, so he reluctantly walked into Armand's room.

"Armand," Pierre said, "you remember last summer when we took a trip to Marseille."

"Yes, Papa," Armand said.

"You remember we went to that house with the lovely ladies and the music and the wine?"

"Yes, Papa," Armand said, his eyes lighting up.

"You remember that beautiful brunette with the transparent dress who sat on your lap and ran her hands through your hair?"

"Yes, Papa!!" Armand cried excitedly.

"Then you remember her taking your hand and leading you up the stairs?"

"YES, PAPA!!!" Armand fairly yelled with glee.

"And you remember what you did?"

"YES-YES, PAPA!!!!" Armand cried.

"Well," Pierre said, "It's the same with the birds and the bees."

"Are there any East Coast labs doing Organic Research?"

"What's available in R & D around New York?"

"How about a sales assignment in the Chicago area?"

"DO YOU HAVE ANY MANUFACTURING FACILITIES IN THE SOUTH?"

"Could I start at a location with nearby graduate schools?"

"Any chance of moving around the country?"

ASK Allied Chemical

IF LOCATION is important to you in choosing your first job, why not talk to the company that has 130 plants and research centers throughout the U.S.A., as well as scores of sales offices from coast to coast? Your placement office can tell you when our interviewer will be on campus.

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Local Industry

(Continued from Page 30)

dustrial control systems the company builds for continuous process lines.

Hundreds of specialty devices, each with individual characteristics meeting the requirements of particular markets, are manufactured under the Specialty Products Division. Their electrical equipment performs key control functions aboard the two-man Gemini spacecraft. The division's aerospace switches and power relays also serve important control functions in the Minuteman, Apollo, Mercury and TFX designs. Cutler-Hammer thermostats are installed in hundreds of thousands of home refrigerators manufactured in this country each year. Rockette switches manufactured in this division are installed in busses and other vehicles to control lights, heaters and defrosters.

The Airborne Instruments Laboratory Division performs research and manufactures electronic products, with particular emphasis on complete aerospace systems and subsystems. A high percentage of the division's work is classified and is done for the military; a significant volume in unclassified areas is done for the non-military branches of the government; and a small but growing volume is performed in the commercial field. The Ionosphere Explorer satellite—designed and built by Cutler-Hammer's AIL Division and the Central Radio Propagation Laboratory of the National Bureau of Standards under the technical management and direction of the Goddard Space Flight Center of NASA—is assigned to measure the electron density of the upper ionosphere with the ultimate aim of improving radio communications throughout the world. The CYDAC cytophotometer, developed for the National Cancer Institute, is one of several data conversion systems produced by Cutler-Hammer in the expanding field of medical electronics. A diagnostic device, the CYDAC studies cells and their structure and records the data for subsequent computer processing. A cardiac pacemaker, which artificially stimulates the heart to continue beating when a patient suffers heart block, entered clinical testing last year. The pacemaker is a tiny radio transmitter which may be carried by persons suffering heart trouble. It emits a signal picked up from a receiver implanted in the body, and in the event of a blockage or failure of the heart, it can control the heart rate until medical attention is obtained. The transmitting device remains outside the body, permitting replacement of batteries without secondary surgery, which is required for earlier, totally implanted pacemakers.

All of the corporation's business outside the United States is handled by Cutler-Hammer International, C. A., (CHICA). Subsidiaries, licensees and sales representatives all form part of the international manufacturing and marketing network which carries Cutler-Hammer products into 72 countries of the world.

In the last fifteen years, Cutler-Hammer's sales have tripled, up from $40 million in 1948 to $126 million in 1963. The net sales for 1963 were second highest in company history. The increase in profit has been due in part to company expansion. Cutler-Hammer acquired the Thayer Scale Co. in 1956, Airborne Instruments Inc. in 1958, and Uni-Bus Inc. in 1961. CHICA was organized in 1956.

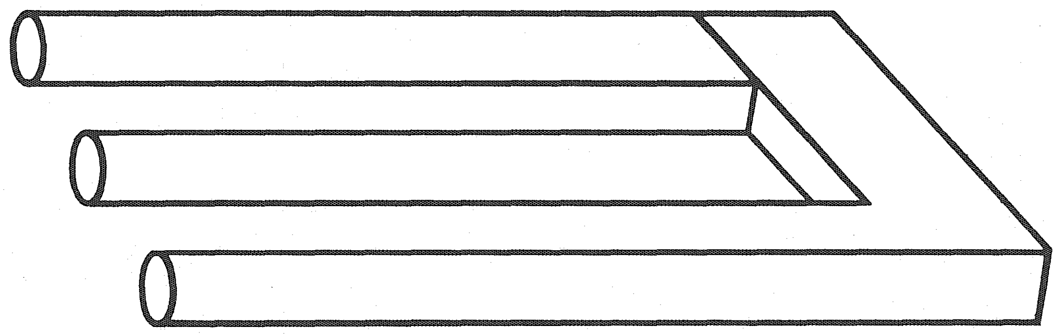
A second reason for increased profits has been research which has led to new products and new applications of existing products. Much of the recent emphasis has been on research in electrical and electronics fields. Particularly, emphasis has been on semiconductors and the generation and application of lasers. Experiments have now proved decisively that indium-antimonide veractor semiconductor devices make the practical achievement of the ultra-low noise amplification required for tracking objects in space possible.

Ruby lasers, used to detect pulses of very high frequency of coherent radiation, are being utilized for studying stimulated Raman emission and the search for an accompanying high power infra-red radiation.

Intensified research in the area of semi-conductor devices and detailed studies made on the application of coherent radiation from gas-type lasers hopefully will lead to new methods for achieving ultra-precision gaging.

Several new products were introduced during the past year and have met with good initial acceptance. Most notable are the numerical positioning control for machine tools, the ink mist suppression system to inhibit ink atomization in newspaper pressrooms and the SCR (silicon control rectifier) drive for newspaper presses. Perhaps most significant in terms of new business has been the new refrigeration thermostat which had been in development for several years. This improved product has met with excellent acceptance in the appliance industry and is achieving wide use in the new lines of the appliance manufacturers.

Now headquartered in Milwaukee, Wisconsin, where a new seven-story office and research center is under construction, Cutler-Hammer is a diverse and growing industrial complex. Founded in Chicago in 1892, it was a relatively small company specializing in electrical controls. One of its early developments was a starter rheostat which made the then new electric motor useful to man. Presently it spans electrical fields from power distribution and control equipment to numerically controlled automation systems for industry, to electronic equipment for aerospace systems and vehicles.



LOOK CLOSELY.
TRY TO FORGET IT.

It's a simple optical illusion, but it bothers you, doesn't it? It's hard to forget it until you've discovered what fooled you. There's something about an inquiring mind that won't let it forget a problem until it's solved.

In school, how many times have you worked half the night on an assigned problem until you solved it? After a while, it didn't matter whether the problem was assigned or not. *You* wanted the answer.

It's this kind of personal motivation we look for and like in a man. That's why we can do without "strangling" supervision at Honeywell. That's also one of the reasons engineers don't punch a time clock here. We hire men whose personal standards are higher than the discipline the job demands. We prefer to rely on a man's sense of personal responsibility to get the work done. This attitude has paid off in many ways.

We have one of the lowest turnover rates in the industry . . . less than half the national average. We can't help but feel that our atmosphere of professional freedom is one of the principal reasons.

Merit pay and promotion . . . are also a part of our policy. Good men like to set their own pace, and we like it that way. We pay and promote to recognize individual performance and progress. We'll push you along as fast as you can handle the work.

Tuition aid, too.
Honeywell men can get advanced degrees through company-supported programs. Greater knowledge will help both of us become first in the field.

What's here at Honeywell?
We employ over 48,000 people and we offer the stability and variety that go along with a broad-based company. We have 18 divisions, and we are constantly in need of more engineering and research people to staff them.

Briefly, our business is automatic control. And, we make all kinds: controls for homes and commercial buildings; weapons systems; products for aircraft, spacecraft and missiles; EDP equipment; instruments for process control and medical use; precision switches and semiconductors. In short, it would be tough to find a business or market we don't serve in some way.

Of course, we can't tell you the whole story here. To learn more about jobs at Honeywell, ask your advisor or Placement Director for our folder, PINPOINT YOUR FUTURE. It contains information on Honeywell products, plants and office locations.

If you're interested in Honeywell, why not talk to one of our recruiters next time he visits your campus? No deception there, OK? Just straight talk about what we have to offer each other.

Check the date for interviews. Or, write to Mr. H. P. Eckstrom, Corporate Director of Employment, Minneapolis, Minn. 55408.

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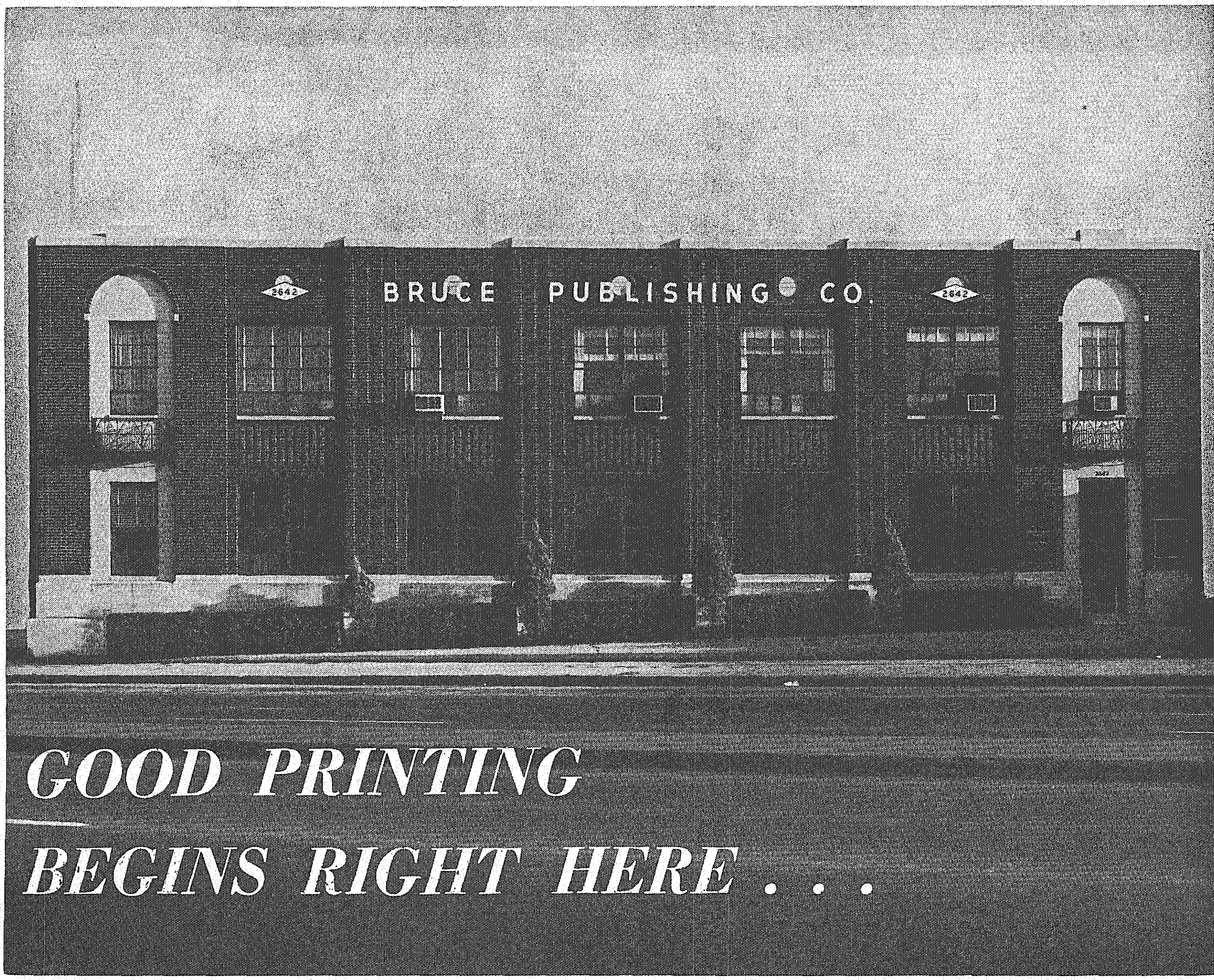

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Splinters . . .

In a recent economics class, the instructor was discussing the population explosion. Suddenly he stopped, smiled, and pointed out that "the only thing harder than getting a pregnant elephant in a Volkswagen is getting an elephant pregnant in a Volkswagen."

• • •

Judge: "So they caught you with this bundle of silverware? Whom did you plunder?"

Thief: "Two fraternity houses, your Honor."

Judge: "Call up the downtown hotels, sergeant, and distribute this stuff."

• • •

The car rounded the curve at 60 mph, skidded, went off the road, through a fence, and came to halt by a haystack. Finding no one hurt, the driver gave a sigh of relief and put his arm around his date's waist.

"Wouldn't it have been easier to run out of gas?" she asked.

• • •

The biggest joke around Republican National Headquarters deals with the day Barry would have been sworn in as President. "Repeat after me," says Chief Justice Warren: "I swear to protect this nation against its enemies, foreign and domestic, so help me God." "I swear," repeats Barry, "to protect this nation against its enemies, foreign and domestic, so help me God. You're under arrest, Warren."

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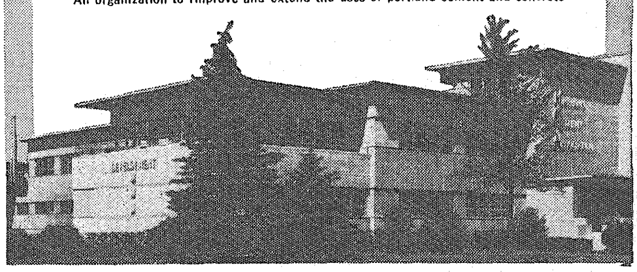

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BRAIN TEASERS

by ROBERT BRANDS, *ChE '69*

1. Find a number of the form aaabbbccc which when increased by unity, gives a perfect square of nine digits.

2. If n digits are required in the pagination of a book, how many pages are contained therein? For instance n=3001.

3. An observant IT student noticed a rope ladder hanging from a ship in a harbor, with its bottom six rungs underneath water. Also, he saw that each rung was two inches thick and that the rungs were nine inches apart. If the tide rose at the rate of five inches per hour, how many rungs were submerged in three hours?

4. How far can a dog run into the woods?

5. I was born on Monday, July 4, as were my only child and grandchild. If my child and I became fathers at the same age, and my grandchild was born in 1960, in what year was I born? (The people in our family don't marry until they are at least 15 years old.)

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

Answers in January issue.

Answers to November Brain Teasers

1. The only question that the man could ask of the native that would guarantee that the native, regardless of his tribe, would tell him was the correct road to freedom is, "what road would the people of your tribe tell me is the road to freedom?"

2. The blind man knew he had to have a white hat.

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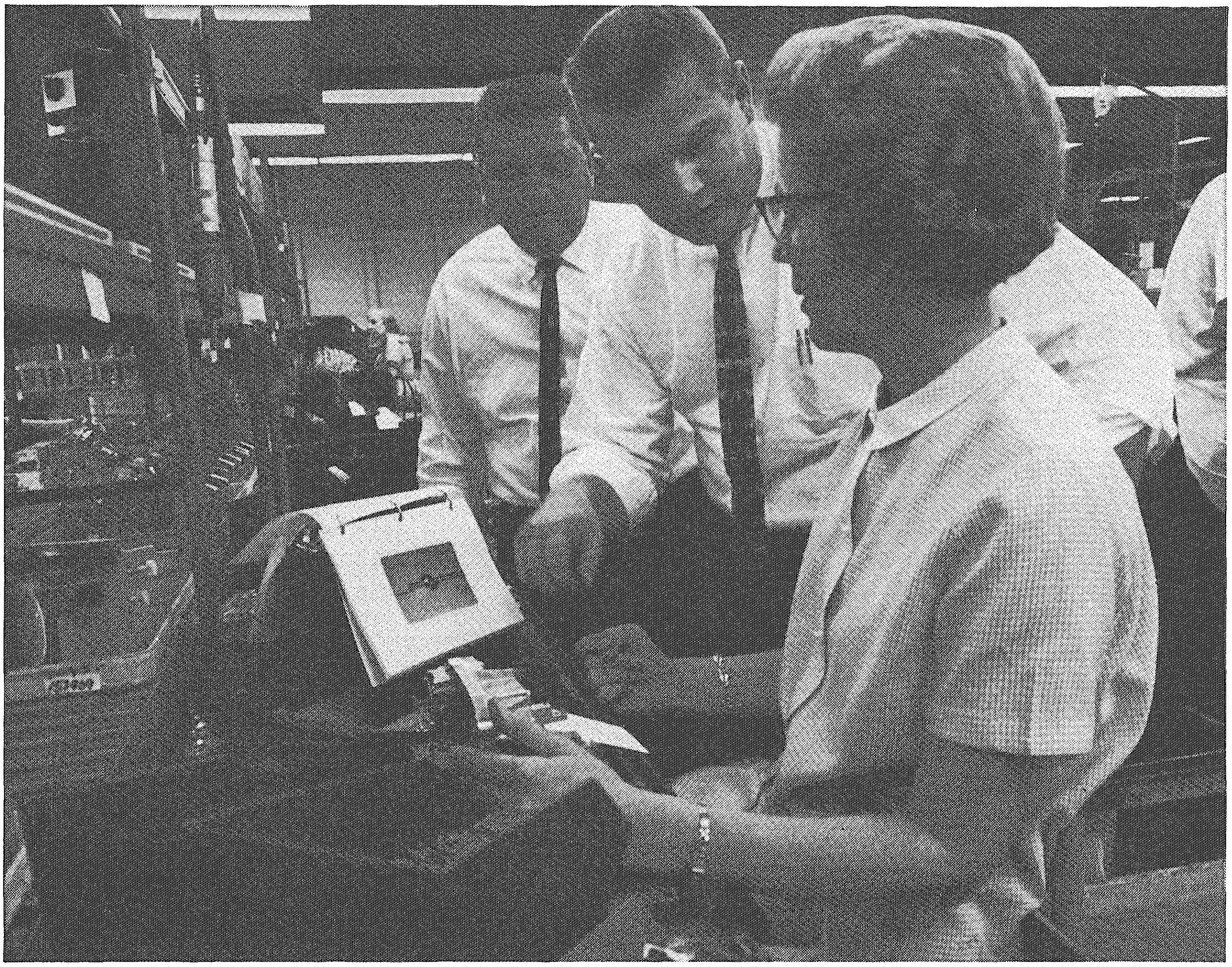

This is industrial engineering?

Yes.

And if that's all there were to it, our industrial engineering ranks couldn't possibly hope to deserve alert recruits from engineering colleges that lead rather than follow.

Watching an operator react to the explanation of a new assembly procedure is just one of the more easily photographed of a long series of subtle operations in the mathematics that link psychological, physical, and economic factors into a sense-making structure.

We admire fine intuitions in an engineer. We seek chaps who have involved themselves with nuts and bolts since childhood. Yet the task is to improve on the familiar fruits of intuition. The job consists of upgrading others' work and one's own to higher, more productive levels of abstraction than simple-minded busyness with nuts and bolts.

Kodak is of a size and diversity to afford room for more than one pattern in industrial engineering. A man's successive assignments here are as varied as his college courses. Confidence grows. He finds he has built a solid reputation by carrying a project from design to the stage, years later, where the aim is to squeeze another tenth of a percent into the production efficiency.

We also welcome another type. When a project reaches 80% of completion, this industrial engineering personality won't resent an invitation to form a new team with new counterparts in design and manufacturing engineering to start a new and more stimulating project. Gladly will he retain responsibility for the old one and six or seven that preceded it.

Drop us a line. Industrial engineers aren't all. We need to hear from mechanical engineers, chemical engineers, electronic engineers, chemists, and physicists as well.

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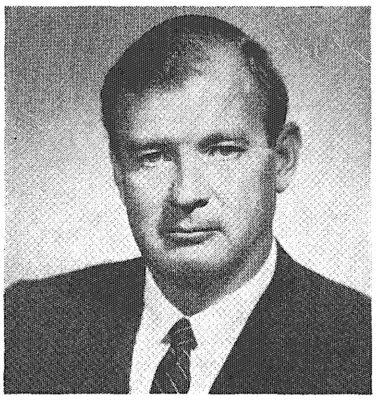
Advancement in a Big Company: How it Works

An Interview with General Electric's C. K. Rieger, Vice President and Group Executive, Electric Utility Group



C. K. Rieger

■ Charles K. Rieger joined General Electric's Technical Marketing Program after earning a BSEE at the University of Missouri in 1936. Following sales engineering assignments in motor, defense and home laundry operations, he became manager of the Heating Device and Fan Division in 1947. Other Consumer-industry management positions followed. In 1953 he was elected a vice president, one of the youngest men ever named a Company officer. Mr. Rieger became Vice President, Marketing Services in 1959 and was appointed to his present position in 1961. He is responsible for all the operations of some six divisions composed of 23 product operations oriented primarily toward the Electric Utility market.

Q. **How can I be sure of getting the recognition I feel I'm capable of earning in a big company like G.E.?**

A. We learned long ago we couldn't afford to let capable people get lost. That was one of the reasons why G.E. was decentralized into more than a hundred autonomous operating departments. These operations develop, engineer, manufacture and market products much as if they were independent companies. Since each department is responsible for its own success, each man's share of authority and responsibility is pinpointed. Believe me, outstanding performance is recognized, and rewarded.

Q. **Can you tell me what the "promotional ladder" is at General Electric?**

A. We regard each man individually. Whether you join us on a training program or are placed in a specific position opening, you'll first have to prove your ability to handle a job. Once you've done that, you'll be given more responsibility, more difficult projects—work that's important to the success of your organization and your personal development. Your ability will create a "promotional ladder" of your own.

Q. **Will my development be confined to whatever department I start in?**

A. Not at all! Here's where "big company" scope works to broaden your career outlook. Industry, and General Electric particularly, is constantly changing — adapting to market the fruits of research, reorganizing to maintain proper alignment with our customers, creating new operations to handle large projects. All this represents opportunity beyond the limits of any single department.

Q. **Yes, but just how often do these opportunities arise?**

A. To give you some idea, 25 percent of G-E's gross sales last year came from products that were unknown only five or ten years ago. These new products range from electric tooth brushes and silicone rubber compounds to atomic reactors and interplanetary space probes. This changing Company needs men with ambition and energy and talent who aren't afraid of a big job—who welcome the challenge of helping to start new businesses like these. Demonstrate your ability—whether to handle complex technical problems or to manage people, and you won't have long to wait for opportunities to fit your needs.

Q. **How does General Electric help me prepare myself for advancement opportunity?**

A. Programs in Engineering, Manufacturing or Technical Marketing give you valuable on-the-job training. We have Company-conducted courses to improve your professional ability no matter where you begin. Under Tuition Refund or Advanced Degree Programs you can continue your formal education. Throughout your career with General Electric you'll receive frequent appraisals to help your self-development. Your advancement will be largely up to you.

FOR MORE INFORMATION on careers for engineers and scientists at General Electric, write Personalized Career Planning, General Electric, Section 699-11, Schenectady, N. Y. 12305

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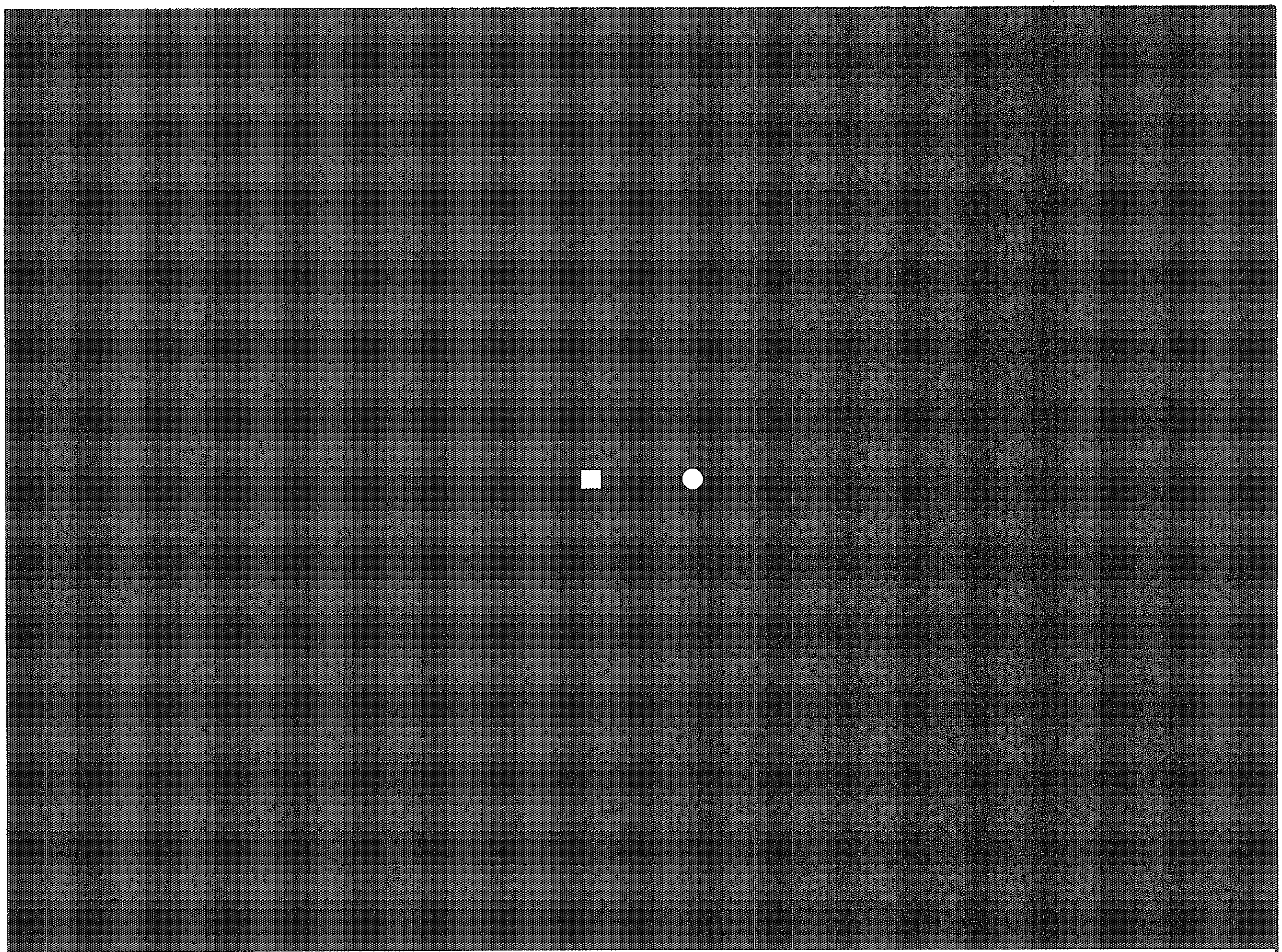

The small white rectangle above represents the approximate size of space required to contain one page of newspaper-size document reduced for storage through NCR's PHOTOCHROMIC MICRO-IMAGE process. The small white dot on the right shows the area that would hold thousands of microcapsules (cell-like structures containing useful materials) produced through NCR's amazing chemical process of MICRO-ENCAPSULATION.

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b. Prefer to work in systems analysis and techniques? ( ) or on equipment design? ( ) or multi-unit large systems? ( )

c. Aim to be a Technical Specialist? ( ) or Administrative Manager? ( ) or Program/Project Manager? ( )

d. Have an advanced degree in your sights? ( ) or feel BS is sufficient for satisfying career growth? ( )

Don't worry!

For those graduates who are uncertain regarding their career plans, we welcome the opportunity to discuss the wide variety of interesting and challenging assignments available with Sylvania Electronic Systems. SES is equipped to foster the professional growth of graduates with widely differing goals. This is possible primarily because SES is actually a highly diversified complex which encompasses 19 R&D laboratories, 4 manufacturing plants and a world-wide field engineering operation. The Division's mission is to manage government systems programs for General Telephone & Electronics, the parent corporation.

The small group form of organization — a traditional small company advantage — is practiced at SES to encourage individual progress and development. SES offers its personnel absorbing assignments to perform, yet also affords a bird's-eye view of the total picture in advanced electronics.

A wide variety of current in-house projects enables you to move right into the heart of today's most advanced developments in electronic systems. You may start here in a technical or administrative capacity in any one of these broad areas: **space/earth communications • electronic reconnaissance • detection • countermeasures • information handling • arms disarmament and control • sophisticated electronic networks such as the ground electronics system supporting Minuteman command and control functions.**

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Official Student Publication of the Institute of Technology, University of Minnesota

Cover: Pictured on this month's cover is a manual centrifuge, one of the simplest methods of separating solids and fluids of different densities. More on "Centrifugals and Centrifuges" on p. 8.

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Editorial

ARE YOU A JOINER?

Check yourself against this definition. A joiner is a student who joins an organization but doesn't participate in it. Unfortunately, as the long membership lists and low meeting attendance of IT organizations show, many of you engineering students are joiners.

Two main species of joiners abound in IT. First is the graduating senior who finds his company interview form looks rather bare, particularly after the headings "Professional Societies" and "Activities." It's a well-known fact that if your grade point average is low, it's wise to have several extracurricular activities to your credit. The question is, how can any graduating senior expect to get anything out of an organization, much less give anything to it, when he joins only a few months before graduation? This type of joiner is guilty of borrowing the prestige of the organization without contributing to it.

The second type of joiner is the freshman or sophomore who joins an organization because his friends did or because it is the proper thing for students in his major to do. He has given no thought to anything beyond signing the membership application.

Both types of joiners are in the category of members which organizations can easily afford to do without. They need members with a willing and active interest in the organization, not lengthy membership lists.

This year, the problem of joiners is particularly acute for the technical organizations. Because of the change from five- to four-year engineering programs, many of these organizations will lose some of their officers and most active members in March, and next year's potential leaders in June. Present third-year and lower division members—who are not just joiners—are needed to fill this leadership gap.

The point is, don't be a joiner. If you join an organization, do so because you feel the group is one which has something for you and to which you can make a positive contribution.

An important thing to remember, to quote one college interviewer, is that "the skilled interviewer can quickly determine whether the applicant has contributed to his listed activities or has been a joiner just to develop a more impressive résumé."

JEL

"The development of management is essential to our goal of great growth"

At the 1964 stockholders' meeting, Arjay Miller, President of Ford Motor Company, emphasized the Company's far-sighted recruitment program and its accent on developing management talent:

"One aspect of our planning is crucial to the success of everything else we do. It engages the best thoughts and efforts of our whole management team, from top to bottom, throughout the world. I am speaking of the development of management. The immediate future of our Company depends heavily upon the abilities of the people who are now key members of our management team.

"In the longer run, our future depends on what we are doing at the present time to attract and develop the people who will be making the major decisions 10 to 20 years from now. We are developing management competence in depth in order to attack the problems that will confront a company of great growth—and great growth (both in profits and sales) is exactly the goal we have established for Ford Motor Company.

"We are continuing to emphasize recruiting. Last spring, 180 of our management people devoted part of their time to recruiting outstanding graduates from colleges and universities throughout the U.S. Last year, these efforts resulted in our hiring over 1,000 graduates, 220 more than the year before.

"We are seeking and we are finding young men—and young women, too—with brains and backbone—people who have the ability and the desire to make room for themselves at the top. We give our trainees challenging assignments with as much responsibility as they can carry. We promote them as fast as they are ready. Those who are interested in easy security soon drop out. Those who have what we want stay with us, and move up quickly to increased responsibility and the pay that goes with it. Thanks to the quality of the people we are recruiting and developing, I am firmly convinced that our outlook is most promising."

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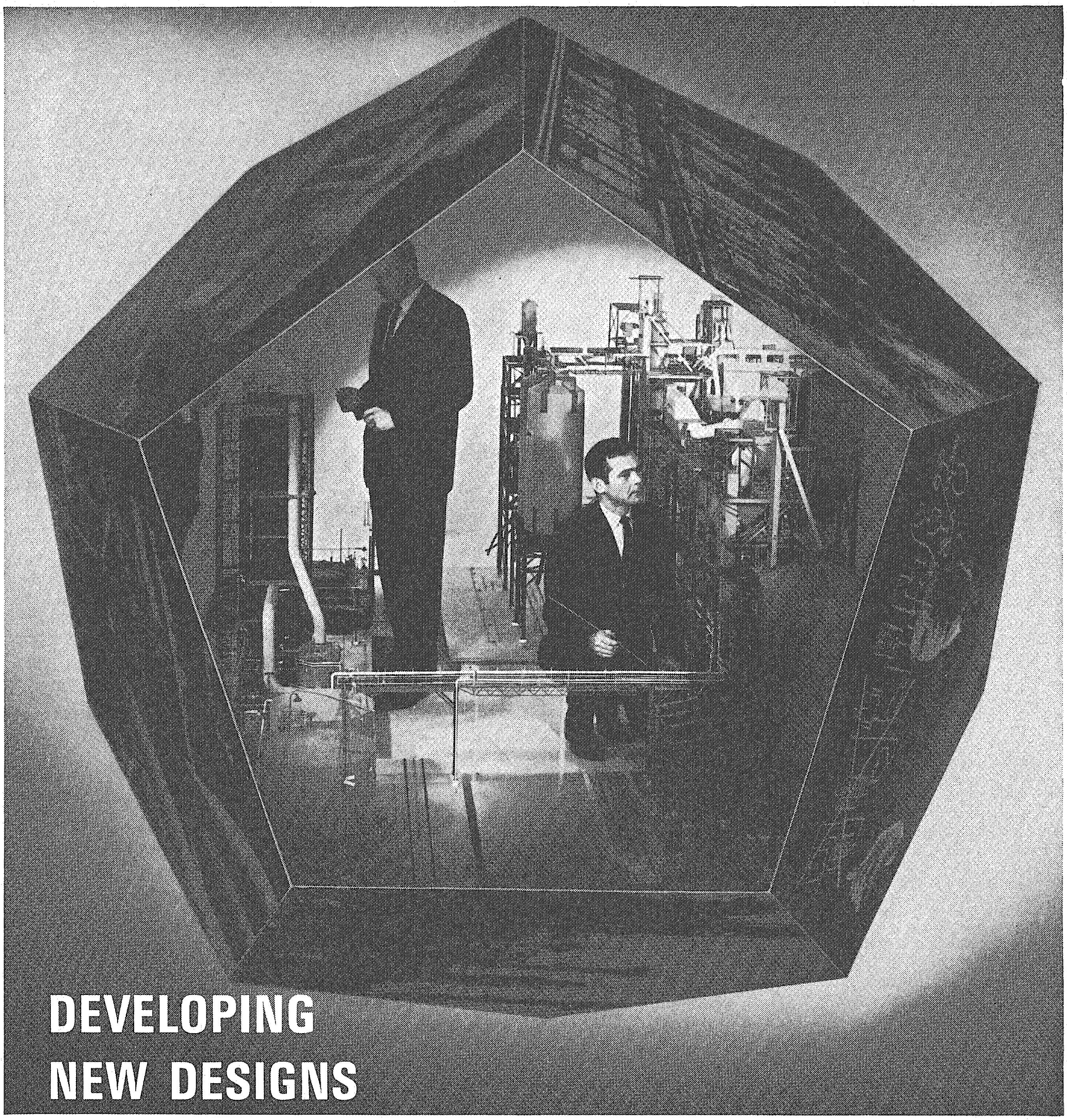

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CENTRIFUGALS AND

by DAVID J. KOLANDER, *Grad. Student*

Did you ever watch a pretty girl float down the street and did you ever stop to realize that centrifugal force plays an important part in the way she dresses, acts, and looks? From the skim milk which keeps her slim to the washable dress which looks so neat, from the soap which gives her complexion that glow to the sugar that gives her that bounce and energy, centrifugal force has probably been an important factor.

Centrifugal Force

Centrifugal force is widely used when a force greater than that supplied by gravity is needed for separation of solids and fluids of different densities. A centrifugal force is developed by moving a mass in a curved path. It is exerted in the direction away from the center of curvature of the path. The centripetal force is the force which is opposite to the centrifugal force and makes the mass follow a curved path. When the two forces are equal, the mass will follow a circular path.

The centrifugal force is given by the equation

$$F_c = \frac{mr\omega^2}{g_c} = \frac{m\mu^2}{rg_c}$$

The symbols in the equation stand for the following:

F_c = centrifugal force
m = mass
μ = peripheral velocity
r = radius
ω = angular velocity
g_c = conversion factor

The terms $\frac{r\omega^2}{g_c}$ and $\frac{\mu^2}{rg_c}$ are the acceleration in gees. The effectiveness of machines in creating centrifugal force is usually expressed in terms of gees.

Early Centrifugals

The earliest types of equipment using centrifugal force in the handling of materials were centrifugal filters. These machines were called centrifugals, and were used mainly to separate coarse solids from fluids. More recently, smaller high-speed machines have been developed which are called centrifuges.

CENTRIFUGES

The simplest type of centrifugal is the batch centrifugal. It consists of a suspended perforated basket with a

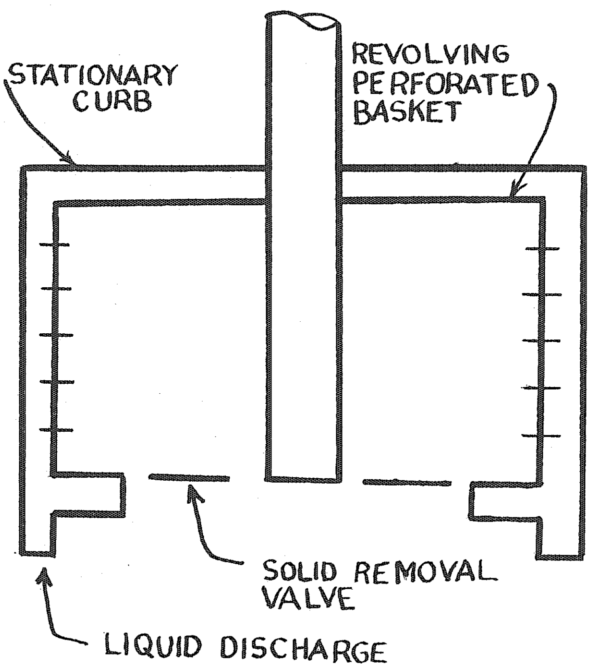

Fig. 1

driving force applied to the vertical shaft leading to the basket as in Figure 1. These baskets usually have diameters of 30 to 40 inches, and operate between 1000 and 2000 rpm. Equipment of this type is used by sugar refiners to separate and rinse sugar crystals, and is handy to separate many types of crystalline products. In operation, the basket of the centrifuge rotates at a slow speed. A thick slurry is fed in the top until a cake of solids forms on the screen at the bottom. The filtrate travels through the cake and the screen as in ordinary filtration. The feed is then stopped, and the cake is washed to remove the filtrate. The basket then rotates at a high speed to remove the wash liquid from the cake. After the wash liquid is removed, the basket is stopped and unloaded through the valve in its bottom. The solids drop through the opening to a drier below the centrifugal. A complete cycle such as this may take from a few minutes up to an hour, depending upon the amount of washing and spinning.

Batch Centrifugals

The batch centrifugal (Figure 2) is widely used in laundries and drug industries since the open top allows easy filling and cleaning. Automatic driers used in the home follow the same construction. This type of centrifugal can operate like a settler if it is equipped with a solid basket. In settling, the feed fills the basket to overflow, and the clear liquid is then removed at the top while the sludge collects at the sides and at the bottom. This machine can also be used as a particle classifier by

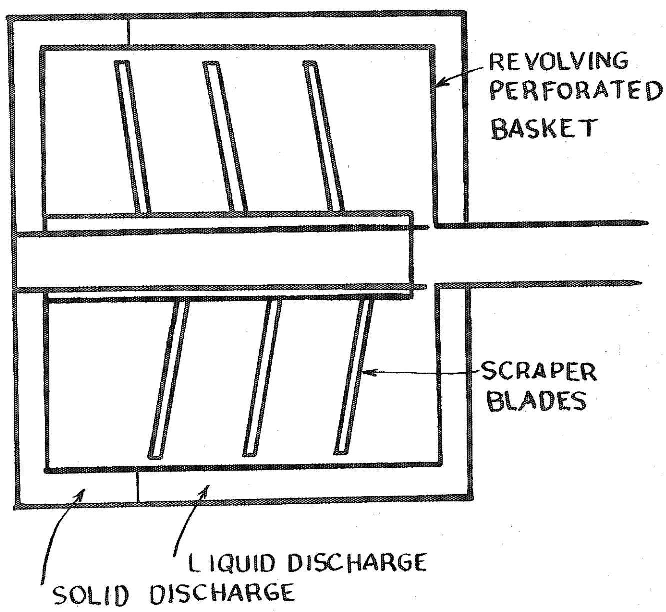

Fig. 2

increasing the feed rate. This causes the finer particles to overflow with the liquid while the coarser ones collect at the bottom. The feed must enter at the bottom of the basket for this settling operation to be successful.

The batch centrifugal filter can be run continuously if some method is introduced for removing the solids. A popular way of doing this is to place the perforated basket horizontally and put in a scraper as is shown in Figure 3. The feed comes in one end of the rotating cylinder, and the liquid drains through the basket while the cake is retained on the surface. The spiral scraper

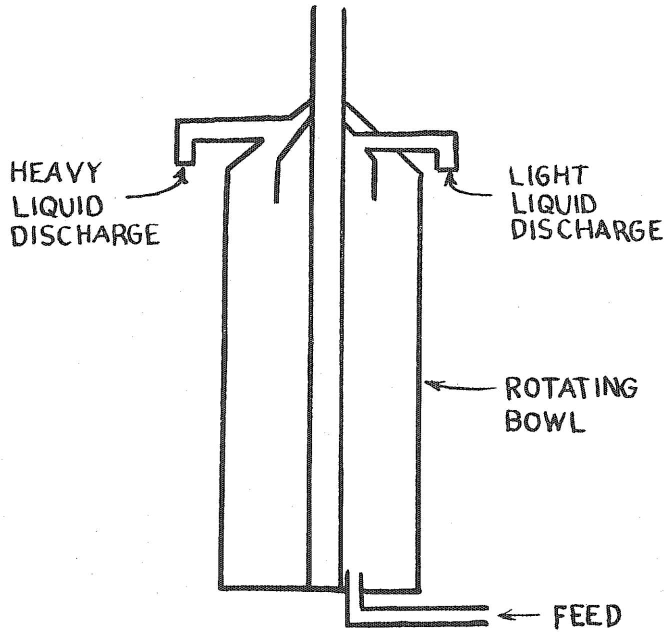

Fig. 3

keeps pushing the cake to the opposite end of the cylinder, where it is removed and dried.

To save labor, large batch centrifugals usually run automatically on a definite cycle. After the filter cake has built up to a predetermined thickness, the feed automatically shuts off, and wash water is sprayed through the cake. The basket then speeds up to remove the wash water; finally a scraper removes the cake from the basket.

Tubular Bowl Centrifuges

The smaller high-speed machines, called centrifuges, are used mainly to separate liquids of different densities, to break emulsions, and to classify or remove fine solids. The two most prominent types of centrifuge are the tubular bowl shown in Figure 4, and the disk bowl shown in Figure 5. Tubular bowl centrifuges are usually from 3 inches to 6 inches in diameter and up to 5 feet long. They can develop a centrifugal force per unit mass of up to 100,000 gees when operated above 15,000 rpm. The feed enters the bottom of the bowl through a nozzle and travels through a set of baffles which raise the speed of the feed to that of the bowl. Two liquids of different densities are separated as they move up the bowl, with the heavy liquid moving to the outside of the bowl. The liquids are drawn off at the top through two annular discharge ports, the heavy liquid going through the outer port and the lighter liquid through the inner port. These centrifuges are often used in the separation of oil and salted-out soap from an oil-soap-water emulsion. The soap floats with the brine to the outside of the bowl while the oil is carried out through the inner discharge port.

Disk Bowl Centrifuges

The disk bowl centrifuges have larger diameter bowls and operate at lower speeds. At 5000 to 10,000 rpm they develop a centrifugal force per unit mass of around 5000 to 10,000 gees. They consist of stacks of disks spaced at twice the distance of the largest particles to be separated. You may be familiar with this design in separators to remove cream from milk in the dairy industry. The feed enters at the top of the bowl and passes to the bottom where it approaches the speed of the rotating bowl. It then rises through holes in the disks. As the feed travels upward through the disks, the heavier component moves down the disks toward the outside of the bowl; the lighter liquid flows toward the center of the bowl. The separated liquids are then drawn off through ports at the top of the bowl.

Ultracentrifuges

For very difficult separations a machine called the ultracentrifuge is used. This machine has a very small bowl which, when rotating about 100,000 rpm, can develop a centrifugal force per unit mass of 500,000 gees. The ultracentrifuge appears mostly in the laboratory, and can be used to determine particle size or molecular weight by measuring the rate of separation of suspended particles. It can also separate isotopes because of the slightly different densities of their molecules. The great centrifugal force magnifies these slight differences many times so that the isotopes separate quite readily.

From isotopes to sugar crystals, centrifugals and centrifuges play an important part in the modern manufacturing processes used by industry in preparing the goods which you and that pretty girl use every day.

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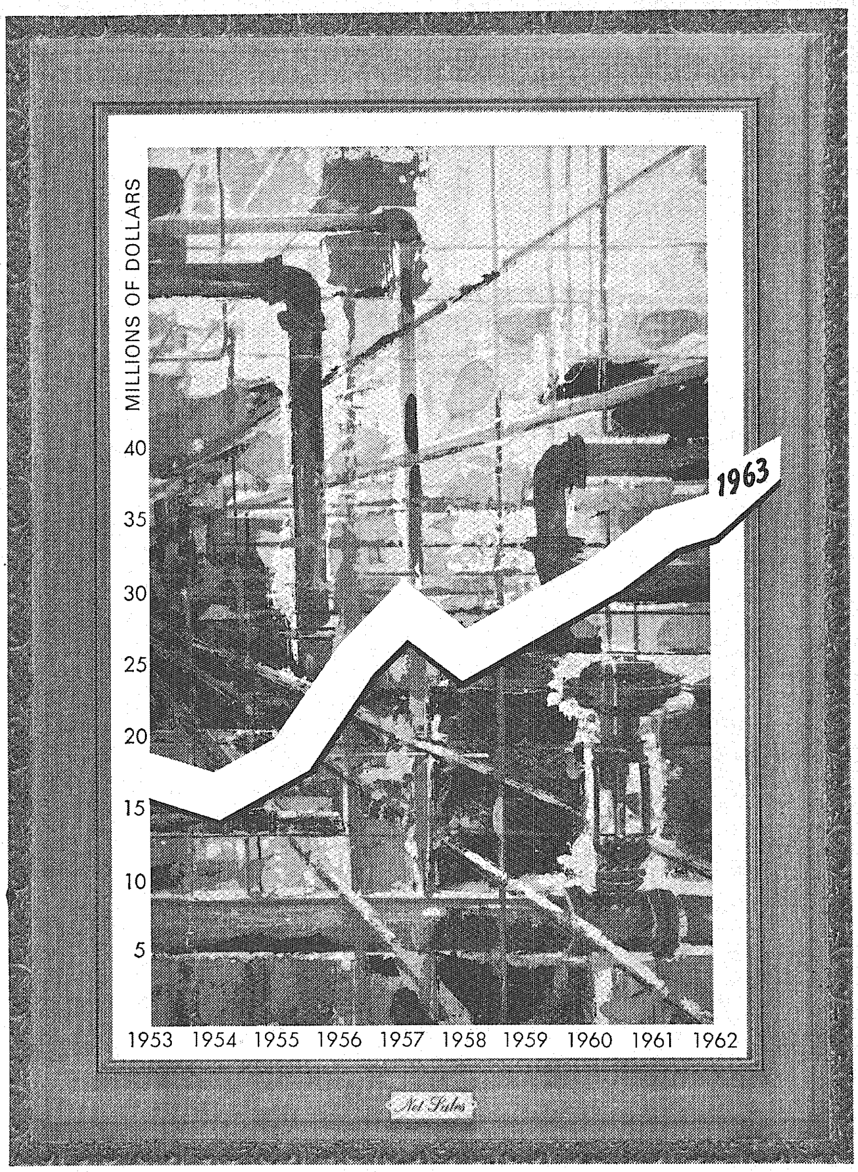

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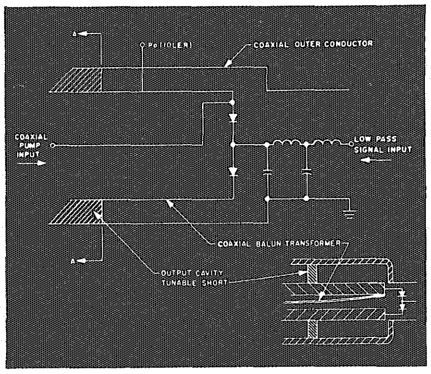
Defense Engineering at RCA

Current-Pumped Abrupt Junction Varactor Power-Frequency Converters

The varactor diode has become well known as an excellent device for low-noise amplification. Recently, however, the varactor diode has been used in high-level frequency converters as both a means of obtaining large amounts of power, tunable over wide bandwidths, and as a means of placing FM and PM information on a CW source, such as a varactor multiplier. The high-level parametric upconverter differs from a low-noise parametric amplifier in the area of conversion efficiency.



Coaxial-Balun Push-Pull Converter

One of the problems in the large signal solution for a varactor frequency converter is the infinite number of terms found when attempting to evaluate the Taylor expansion for charge as a function of voltage for an arbitrary varactor. If one reverses this approach, and finds the expansion for voltage as a function of charge, with a junction exponent, γ, of $\frac{1}{2}$ (abrupt junction varactor), it is found that the series is finite and easily utilized to find a more exact solution for the diode transfer impedance.

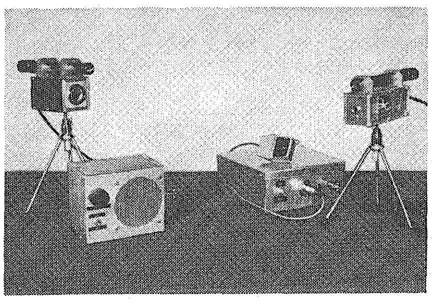
Because of its inherent symmetry, a push-pull application of the diodes provides a large degree of signal isolation, as well as an increase in allowable input power. This type of circuit provides an output at the upper sideband frequency which may be isolated from the pump circuit, by diode balance, without the need for lossy filters. Tunability is readily attained using the appropriate impedance matching networks without the added complications associated with low-loss tunable filters. A low-pass filter is necessary in the signal port to prevent the pump power from being dissipated in the signal circuit.

A simplified representation of a circuit using *only* coaxial networks, is shown in the figure. This particular circuit uses what might be referred to as a section of coaxial-coax. The diodes are pumped in series by means of a balanced transmission line, which may be designed using the techniques available for constructing "balun transformers." The signal is introduced through a low-pass filter and drives the diodes in the push-pull, parallel mode. The resultant idler is generated in a TEM mode, with the conductors acting as a quarter-wave coaxial tuning assembly. The output may be removed using a current probe, coupled to the idler center conductor at the proper impedance tap. The output cavity may be tuned by varying the position of the rear shorting wall (A-A), using sliding finger contacts. With this approach, power levels of several watts have been handled with a conversion loss of 3db compared to power level of several milliwatts with 10db conversion loss for conventional resistive mixers.

Reference—Perlman, B. P., "Current-Pumped Abrupt Junction Varactor Power-Frequency Converters," to be published March 1965, IEEE Transactions on Microwave Theory and Techniques.

Room Temperature GaAs Laser Communications

Communications was among the first applications considered after the invention of the laser. Practical realization of the goal was delayed by the difficulties associated with inefficient energy conversion and inadequate modulation techniques. The discovery of the semiconductor injection laser in 1962 greatly reduced these difficulties, but introduced the restriction of operation under cryogenic conditions. Gallium arsenide injection lasers



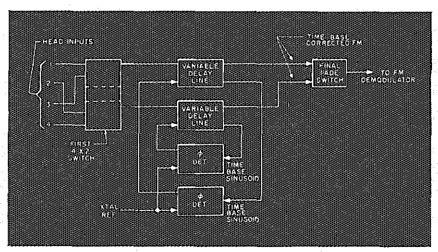
promise energy conversion efficiencies of 20-30%, while modulation of the optical signal can be accomplished simply by modulating the injection current. Early in 1964, the cryogenic restriction was eliminated when efforts of RCA scientists proved successful in discovering a type of gallium arsenide diode which exhibited laser action at room temperature with threshold currents much lower han those previously reported. This discovery permitted the engineering of a room temperature communications link and in May, 1964, such a communications link was demonstrated for the first time. The system employs pulse frequency modulation at a 20 kc repetition rate, has a bandwidth of 5 kc, and can operate in bright sunlight. Ranges up to three miles have been obtained while operating within the atmosphere. Using parallel diodes, a much greater range is feasible. The narrow linewidth of 20 angstroms permits the use of narrow band optical filters thereby reducing background noise. The system is free of radio frequency interference which plagues conventional communication systems, and is so efficient that three nickel cadmium batteries (the size of standard flashlight cells) can provide hours of continuous operation.

Reference—#1. H. Nelson, J. I. Pankove, F. Hawrylo, G. C. Dousmanis, C. W. Reno, "High-Efficiency Injection Laser at Room Temperature," Proc. IEEE (correspondence), Vol. 52, No. 11, p. 1360, Nov., 1964. #2. D. Karlsons, C. W. Reno, W. J. Hannan, "Room Temperature GaAs Laser Voice Communication System," Proc. IEEE (correspondence), Vol. 52, No. 11, p. 1354, Nov., 1964.

15 Megacycle Tape Bandwidth Response

RCA engineers have developed an advanced magnetic recording system with the highest bandwidth response reported to date. This achievement results from integrated efforts in all phases of magnetic recording, such as: air bearing design, high performance servos (50 kc response), precision mechanisms and magnetic head circuitry.

This recent accomplishment is being used in equipment with two 8 Mc bandwidth channels designed for application in a precision radar system. In this design the heads are rotated to achieve 3200 inch-per-second head-to-tape speed in a transverse scan mode. The unit uses a specialized form of a frequency modulated carrier system to achieve a response from 100 cycles per second to 8 Mc. The 3200 IPS head speed permits a wavelength of 0.32 mils at a 10 Mc FM carrier. Head gap lengths of 90×10^{-6} inches are employed to achieve FM response to 15 Mc.



Closed-loop electronically variable delay line system

In order to effect a high reproduction accuracy for radar use, five servomechanisms are employed to insure stability of tape and head motion. The most interesting of these is a pure electronic servo employing the principle of variable delay to remove time displacement errors from the signal. This system employs a 25 to 1 loop gain at a bandwidth of 50 kc. This closed-loop system achieves a time-base accuracy of ±10 nanoseconds. The rms value of this error is less than 5 nanoseconds, equivalent to less than 5 feet of radar range error, a new standard of excellence for radar recording accuracy.

Reference—F. D. Kell and J. D. Rittenhouse, "Advanced Tape Equipment for Instrumentation Recording," RCA Publ. No. PE-189, containing reprints of 13 technical papers on Magnetic Recording.

These recent achievements in Defense Engineering are indicative of the great range of activities in research, applied research, advanced development, design and development at RCA. To learn more about the many scientific challenges in both defense and commercial engineering awaiting bachelor and advanced degree candidates in Electrical or Mechanical Engineering, Physics, Chemistry or Mathematics, write: College Relations, Radio Corporation of America, Cherry Hill, New Jersey.

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M A R I N E R IV

by ROBERT L. JOHNSON, *ME '66*

Mariner IV is the largest task ever undertaken by the National Aeronautics and Space Administration (NASA). Mariner IV is the name given to an unmanned spacecraft launched from Cape Kennedy toward Mars. This mission has no equal, since the flight distance is some three-hundred-fifty-million miles and the travel time is about eight and one-half months. The next largest mission to it is the Mariner II flight of 1962, which was about one-hundred-eighty-million miles in length past Venus and three and one-half months duration. The great undertaking in this mission becomes evident when it is seen what demands will be placed on the accuracy and performance of the spacecraft.

The main objectives of the mission are: 1) to gain scientific knowledge of interplanetary space between earth and Mars and knowledge of Mars; and, 2) to gain engineering experience of long space flights. There are eight scientific investigations to be performed in the flight. Six of these investigations are concerned with radiation, magnetic fields, and micrometeorites, and the other two are directly concerned with photographs of Mars and the atmosphere there.

Suppose you were given the job of designing a spacecraft to perform these experiments reasonably well under the existing conditions; how would you go about doing it? The Jet Propulsion Laboratory (JPL) of NASA decided on a basic structure of an octagonal magnesium frame divided into eight parts. On top of this frame are four solar panels which are the primary source of power for the spacecraft.

In the octagonal frame, seven of the compartments are electronics compartments and the eighth is filled by the mid-course rocket propulsion system. The problem of temperature control is solved by putting louver assemblies on the outer surfaces and insulating the inner surfaces with thermal shields.

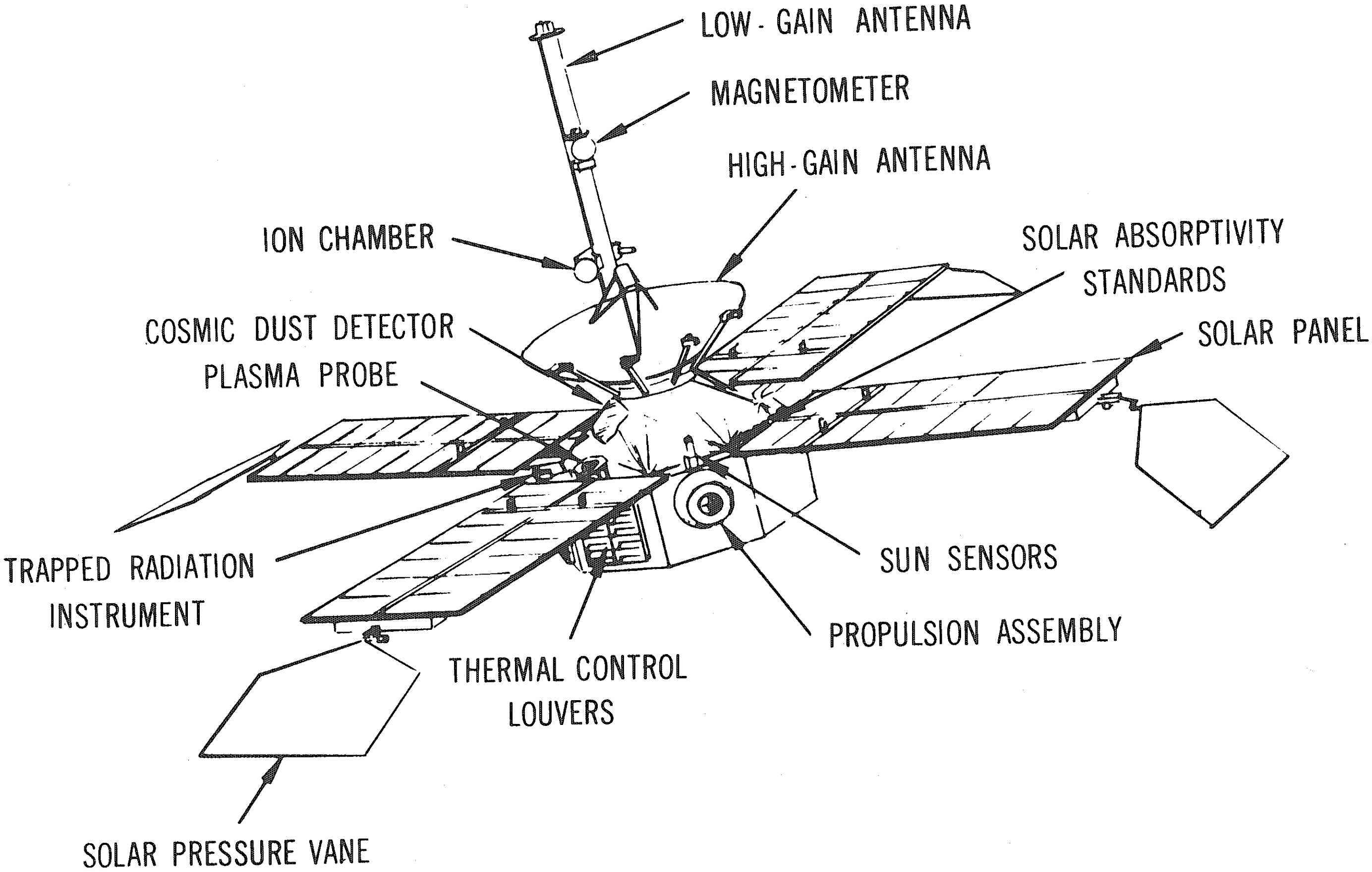
Experiments Performed

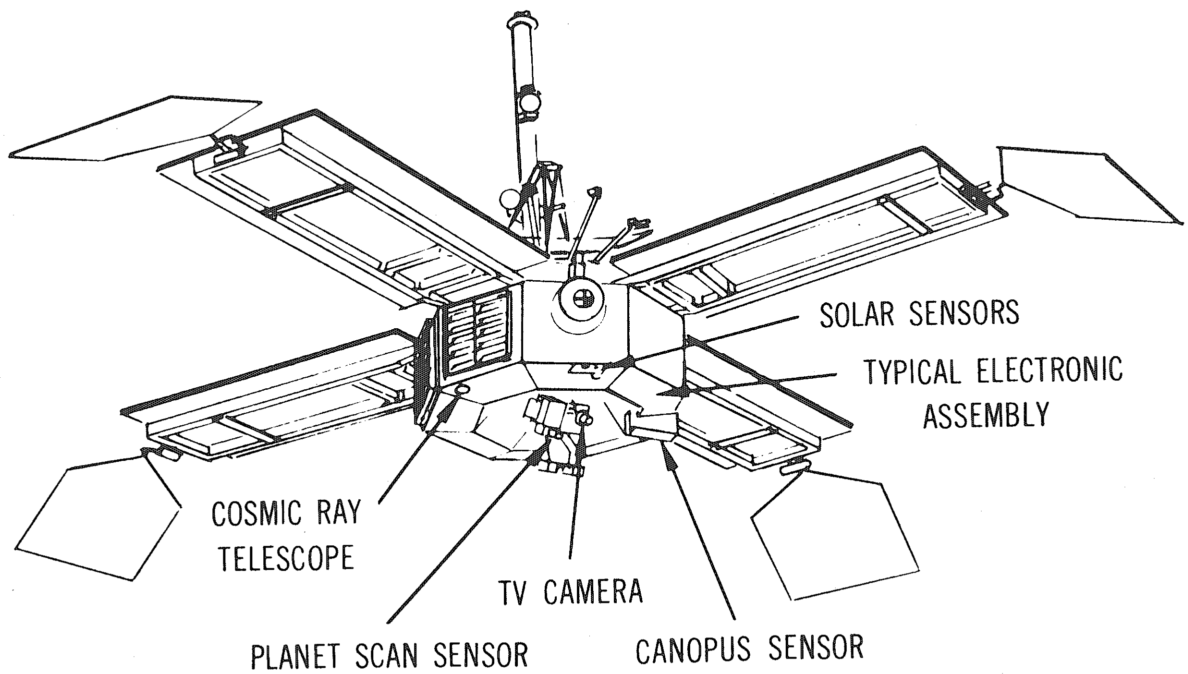
Mariner IV will perform eight interplanetary and planetary experiments. Seven of these experiments require scientific equipment and the eighth, which is occulation, makes use of the spacecraft communications system.

The simplest experiment done on the flight is occultation, which is designed to measure some characteristics of the Martian atmosphere. It is the simplest because it requires no extra equipment and it consists only of transmitting radio signals through the Martian atmosphere. The requirement for this experiment is that the spacecraft should pass behind Mars, at which time its radio signals will be changed in strength and frequency by the atmosphere. These changes are from refraction and diffraction which can be predicted from the effects on the Doppler shift.

A second experiment on the flight is the taking of pictures of the Martian surface. A television camera will take up to twenty-two black and white photographs. These pictures are stored on magnetic tape in digital form and played back after Mars is passed. Each photograph will take about eight and one-third hours to play back and, if the spacecraft is not out of communications

MARINER/MARS SPACECRAFT





range, each photograph will be played back a second time. The camera head is mounted on a movable platform with a wide angle planet sensor and a narrow angle Mars gate sensor. The wide angle sensor centers the planet in its field of view and when the narrow angle sensor centers on Mars, the tape recorder is turned on.

A picture forms on the vidicon target every forty-eight seconds. It takes twenty-four seconds for the scanning of the two-hundred-line picture and twenty-four seconds for erasure. The shutter speed can range from one-fifth to two-twentyfifths of a second.

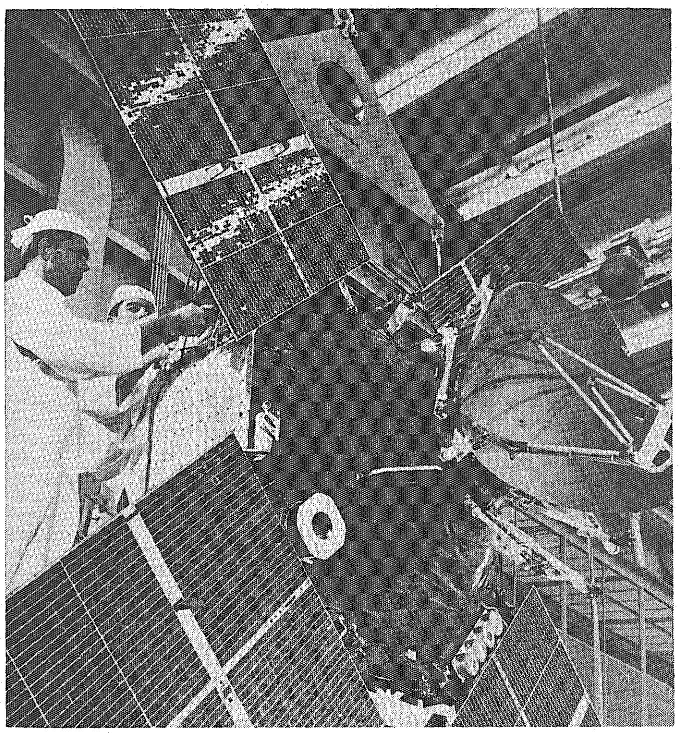
A third experiment, called the solar plasma probe, will measure densities, velocities, temperatures and directions of solar winds (low energy protons—thirty to one hundred thousand electron volts—that leave the sun at supersonic speeds). Solar wind, or solar plasma, can affect magnetic fields and cosmic rays and an understanding of these forces is needed for an understanding of the nature of interplanetary space. The solar plasma probe consists of a collector cup, high voltage power supply and circuitry to produce an output signal. In front of the collector cup is a fine mesh of tungsten wire that alternates rapidly between two negative voltage limits. Protons can then pass through or be repelled by the mesh if they have the appropriate range of energies. These protons produce an intermittent current which is detected. Higher energy protons pass through and produce a continuous current which is not detected and low energy protons are repelled.

A fourth experiment, called the ionization chamber experiment, is designed to measure radiation in the energy range of over ten million electron volts for protons, one-half million electron volts for electrons and forty million electron volts for alpha particles. The equipment for this consists of an ionization chamber which gives a measurement of the average energy and amount of radiation at these levels and a Geiger-Mueller tube to count individual particles. The ionization chamber is a five-inch stainless steel sphere filled with argon gas. The thickness of the sphere (one-hundredth of an inch) is sufficient to allow only particles above a given energy level to pentrate. The particles that penetrate ionize the gas, and an electric pulse proportional to the rate of ionization is produced. The Geiger-Mueller tube is shielded to allow penetration by particles of the same range as those detected by the chamber. The tube can detect up to fifty thousand particles per second.

A fifth experiment is the trapped radiation detector experiment to look for areas similar to the Van Allen belts of trapped radiation. The equipment for this is three Geiger-Mueller tubes and a solid state detector. The Geiger-Mueller tubes are shielded so particles can only enter at windows at the ends of the tubes. Two tubes will detect protons of over five hundred thousand electron volts, and electrons of over forty thousand electron volts. The other tube will detect protons over nine hundred thousand electron volts and electrons over seventy thousand electron volts while the solid state detector measures protons in two ranges: from five hundred thousand to eight million electron volts and nine hundred thousand to five and one-half million electron volts.

The sixth experiment is the helium vector magnetometer experiment which determines whether or not Mars has a magnetic field and any characteristics of that field. It also is to measure the magnitude and direction of the interplanetary magnetic field and investigate the interactions between planetary and interplanetary magnetic fields. The principle of the helium magnetometer is: the amount of light that can pass through helium gas in an excited state depends on the angle between the light axis and the direction of the surrounding magnetic field. A collimated, circularly polarized light passes through the excited helium gas and an infrared detector measures the amount of light which has passed through. The magnetometer should be able to detect instabilities of the solar wind caused by interactions of the solar wind and the planetary field. To detect a magnetic field around Mars, the spacecraft will have to come close enough to the planet so solar wind does not disturb the planetary field.

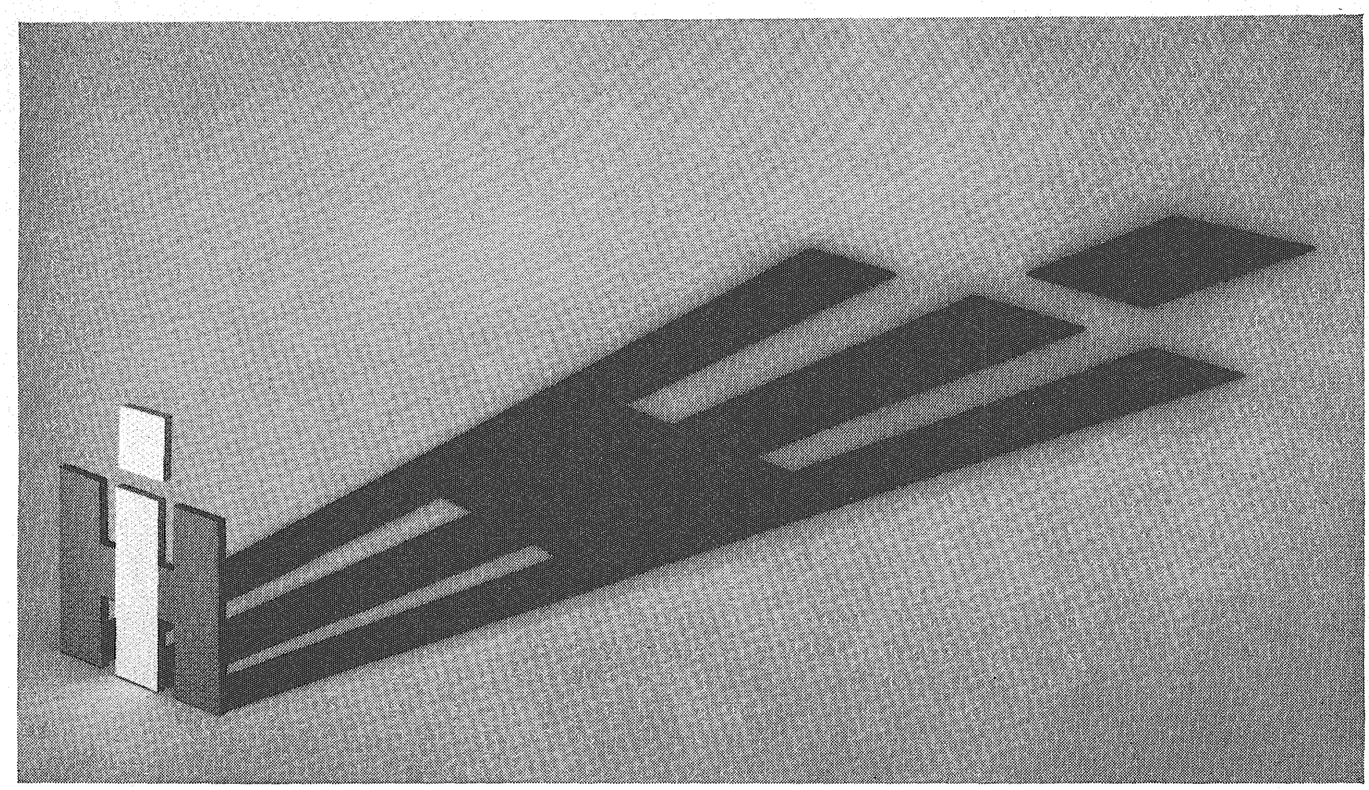
The seventh experiment of the spaceflight is the measuring of cosmic rays by a cosmic ray telescope. Cosmic rays will be classified according to type, energy levels and direction of motion. The telescope is composed of three coaxial gold-silicon solid state detectors with absorbing material in between. The three detectors



Mariner spacecraft is readied for shipment to Cape Kennedy by technicians at Jet Propulsion Laboratory in Pasadena, California. Solar cells mounted on four six-by-three-foot panels, will provide the spacecraft with power during the 8½-month flight through space. Fixed high-gain antenna will look directly at Earth during the latter half of the mission. The small white object in foreground of picture is the solar plasma probe. JPL builds the Mariner Mars Spacecraft for the National Aeronautics and Space Administration.

are aligned similar to lenses of a telescope, and particles will pass through either detector one, detectors one and two, or detectors one, two and three. These detectors yield pulses as particles penetrate them and a study of these pulses will give the type of particle and energy lost by the particle. The cosmic ray telescope can classify

(Continued on Page 52)



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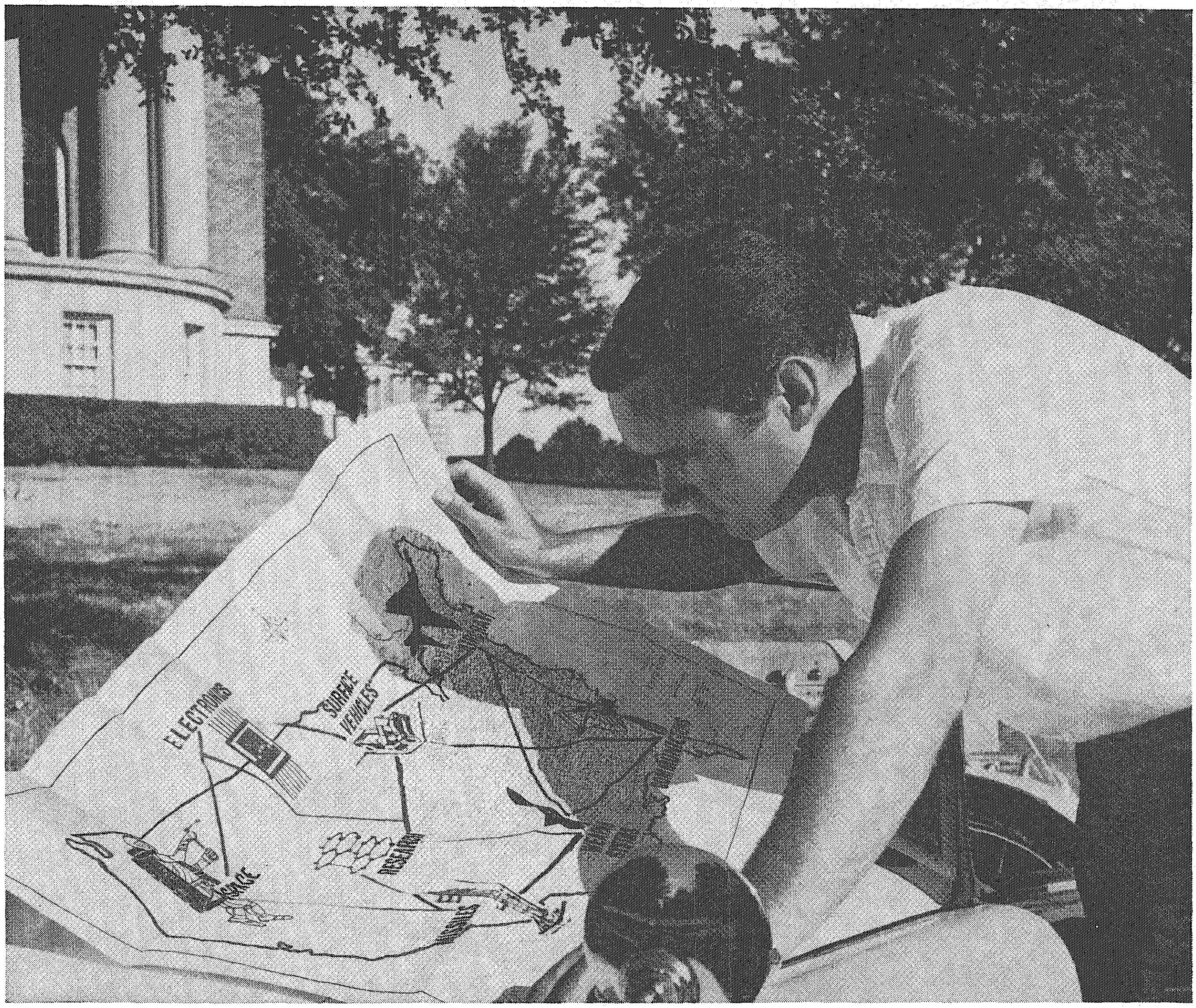

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J O Y C E

by PETER HALDEN, *ME-IE '65*

"Joyce has gone."

"What will we do now?"

Who is Joyce, you ask? You may not know her by name, but the chances are good that you have met her at least once per quarter for as long as you have been in IT. Up until December, it was her responsibility to see that registration problems were kept at a minimum.

If you were in an IT organization, your chances of knowing Joyce were even better. She has been of more than mere significant assistance to Technical Commission, Plumb Bob, and the TECHNOLOG, to mention a few. She also served as general advisor to E-Day chairmen who had difficulty. If there was ever any question about how something should be done or who should be contacted, Joyce was the best one to ask.

Joyce was Professor Barich's secretary and as such worked in both the Main Engineering office and on registration. Her activities around school, however, extended well beyond these areas. It isn't often that you find a faculty member that works hard to perpetuate E-Day, let alone a secretary, who isn't nearly so responsible for, nor necessarily interested in, the welfare of our college in general, and the students in particular.

In a system that seems to encourage disinterested or absent advisors and lots of thick and snarled red tape, it was like a breath of fresh air to be able to go to the Main Engineering office and find out just exactly what the story was.

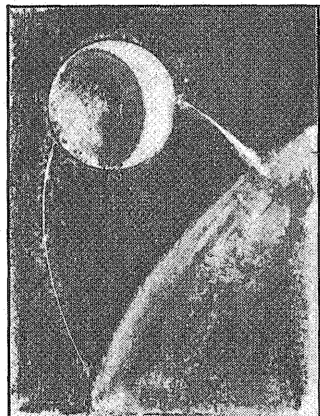
"What has happened to Joyce?"

That's probably your next question. The name of the villain who spirited her away is James Clayton Gay. Up until December, when he finished his Ph.D. thesis in metallurgical engineering, Jim could be found on the fourth floor of Mines and Met. Now, however, he has taken a job in a taconite processing plant in Silver Bay, Minnesota. Consequently, we no longer have Joyce with us.

Joyce professes that her lucky number is 13. You see, she and Jim were engaged on December 13, 1963, and married on June 13, 1964. Well, if anybody was going to steal her from us, we can at least be thankful that he was an engineer. After all, how much luckier can a girl be?

With this issue, we wish to extend our thanks to Joyce for the many times she has helped IT along the rocky road of time. Our best wishes to her and Jim in their future.

We need



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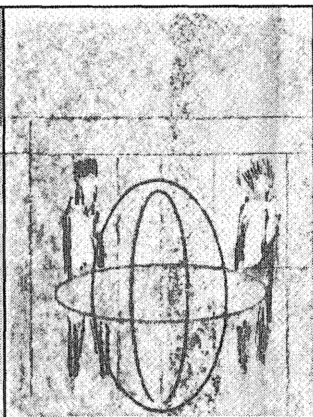

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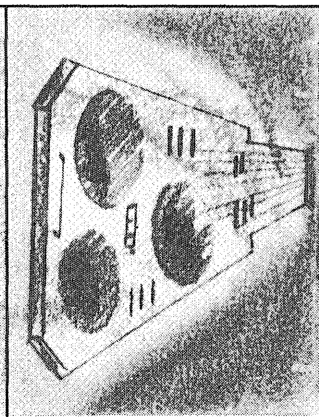
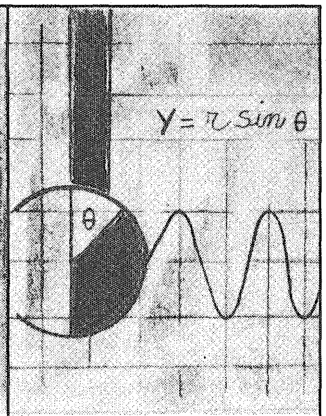


ELECTRICAL ENGINEERS

To design instrumentation for aeroballistic research; to develop portions of a new underwater communications or advanced submarine detection system; to solve fire control & guidance problems; and to perform circuit analyses... and



MATHEMATICIANS

To conduct numerical analyses, programming, and trajectory plotting.

but we want Tau Beta Pi types or equivalent!

Of course, every employer WANTS the cream of the crop, but the point is: we can get them! Not because of money or blue sky promises or "Extra" benefits, but because the Naval Ordnance Laboratory offers the best opportunity for vital research work in a near academic environment. (Some graduate degree courses are actually held here at NOL, and this is prime ground for PhD theses, as you may know.) Fact is, *some 40% of those graduates we hired last year were Tau Beta Pi members*, so you can understand our obvious pride.

The Naval Ordnance Laboratory takes the lead in the research, design, development, and test of all kinds of weapons systems and devices . . . ranging from the smallest arming circuit to a complete underwater-to-air-to-underwater nuclear missile system. (Not only was the SUBROC missile itself conceived and developed at NOL, but also its long-range sonar detection system and its digital computer fire control system.)

The NOL campus includes over 100 buildings on 900 acres of suburban countryside just outside Washington. The annual budget for *in-house research* averages some $30 MILLION, and our facilities are the finest in the world. *But hypersonic wind tunnels, pressurized ballistic ranges, 2,000,000 gallon hydrodynamics tanks, Mach 20 shock tunnels, 10-million volt x-ray equipment, IBM-7090's and all the other material benefits don't make a research laboratory.*

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TAU

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PI

Prize Winning Pledge Essay

Your Vote and the Predictions

by ROBERT L. WHEELER, *Math '66*

It was election day, Tuesday, November 3, 1964. Jack Peterson, like most voters, carefully considered the presidential candidates, made his decision and intended to vote. When he came from work, he and his wife decided to watch the television election coverage before they went to the polls. They watched in amazement as the computers flashed information on the television screen in front of them.

However, they soon began to see that their favorite was not faring well. The commentator read down the list of data: Johnson winner in Florida, 26% of the votes counted; Johnson probable winner in Michigan, 19% of the votes counted; Johnson probable winner in Minnesota, 12% of the votes counted. Then the master board appeared on the screen. Johnson had been declared winner in states with a total of 238 electoral votes, 32 votes more than needed for election.

As the the Petersons watched disappointedly, more information was relayed to the nation. By seven o'clock California time, the outlook for a Goldwater victory appeared so remote that Jack and his wife decided that their votes would be unimportant. They never went to the poll.

How many other votes were never cast due to this scientific election coverage? Could these votes have affected the election outcome? No one will ever know the answers to these questions, but I feel that the computer predictions broadcast to the nation did substantially influence election results.

The problem of television coverage influencing voters has been recognized previously. Election analysts have said that the predictions the night of the 1960 election affected some Western voters. Experts agree that the local television stations' predictions in the 1964 California primary aided Goldwater.

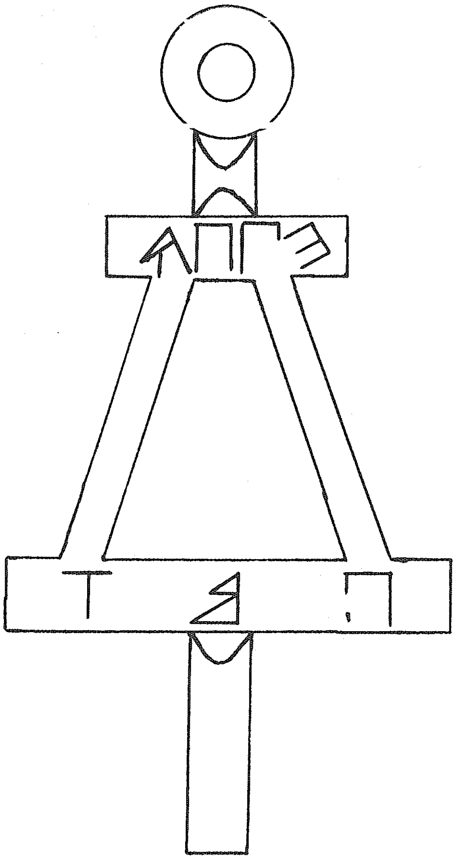
Today the situation is even more acute. Never before has so much data been presented to the public so rapidly. The three major networks combined their resources to form the Network Election Service, which tabulated the votes. Each network also had its own team of election specialists to analyze early results. Individual stations could thus give predictions and results with greater speed than previously possible.

The Columbia Broadcasting Company, because of pleas of politicians, agreed to distinguish between actual results and predictions, but the other two networks would not make this distinction. Nevertheless, as one watched a station of the Columbia network, he still had trouble telling predictions from results.

In future elections analysts will doubtless exceed their present capabilities for analyzing data and predicting results. As people are more exposed to computers, they will place more confidence in their predictions. Thus, unless the nationwide broadcasting of predictions is changed, future elections will be more affected by these predictions.

What can be done to avoid interference with political justice? The Federal Communications Commission suggests a system like that in Canadian election coverage. In Canada, predictions cannot be broadcast to any sections of the country where the polls are open. The United States could adapt this system on a time zone basis. Western voters would not be swayed by early Eastern results and predictions based on them. The possibility of predictions affecting the results would be eliminated.

Jack Peterson and his wife would go out to vote, and their votes might change the picture.



TAU BETA PI

by DOUGLAS GRAHAM, *ME '65*

Tau Beta Pi, the sole national honor society encompassing all of the engineering sciences, was founded in 1885 at Lehigh University by Dr. E. H. Williams, Jr., for the purpose of marking ". . . in a fitting manner those who have conferred honor upon their Alma Mater by distinguished scholarship and exemplary character as undergraduates in engineering . . . and to foster a spirit of liberal culture in the engineering colleges of America." Such a society was needed at this time since Phi Beta Kappa, then the only important national honor society, restricted membership to those students in the liberal arts.

The new chapter at Lehigh stood alone for seven years until, in 1892, a second chapter was established at Michigan State University. Other chapters were then added in quick succession, Minnesota joining the Association in 1909, until today there are 100,000 undergraduates in 114 of our nation's engineering schools actively maintaining chapters of Tau Beta Pi.

Prospective undergraduate candidates are selected twice during the academic year, once in the fall quarter and once in the spring; consideration being given only to juniors and seniors. To be eligible the juniors must be in the upper 1/8 of their class and the seniors must be in the upper 1/5 of their class. Following this preliminary consideration, the candidate must then successfully complete a pledge exam, an essay on a non-technical subject, and the polishing of the society's symbol—the bent. Members' names are entered in the Association archives and each receives a diploma of membership and a gold miniature of the bent.

Your fellow students who have achieved membership this fall quarter are the following:

Juniors:

John N. Fitch
Leland S. Grotte
Reginald C. Haines
Herbert A. Kirst
James H. Prestegard
Ronald D. Priebe
John M. Rockstroh
Stanley A. Vanneli
Larry E. Wittig
Robert L. Wheeler

Seniors:

Charles M. Anderson
Rodger O. Anderson
William W. Brooks, Jr.
Kenneth H. Danner
Vernon Eriksen
Lawrence J. Gardner
Allan Gebhard
Raymond P. Goedert
Norman G. F. Lee
Peter J. LeMay
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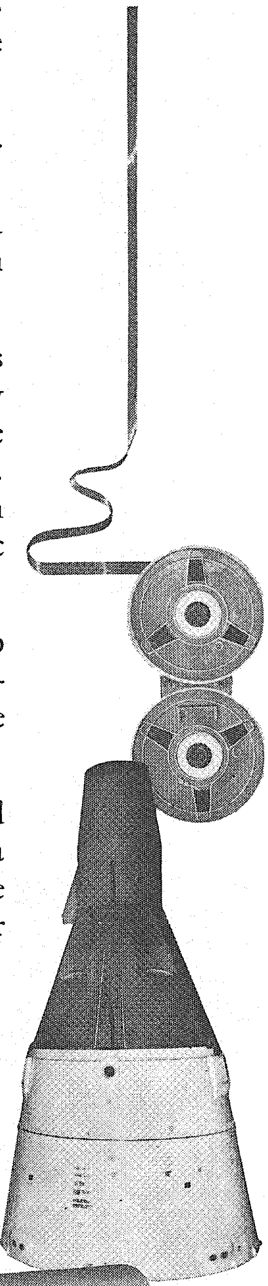
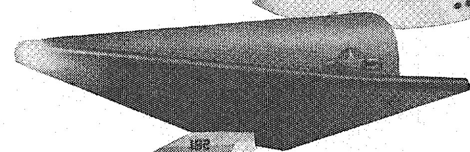
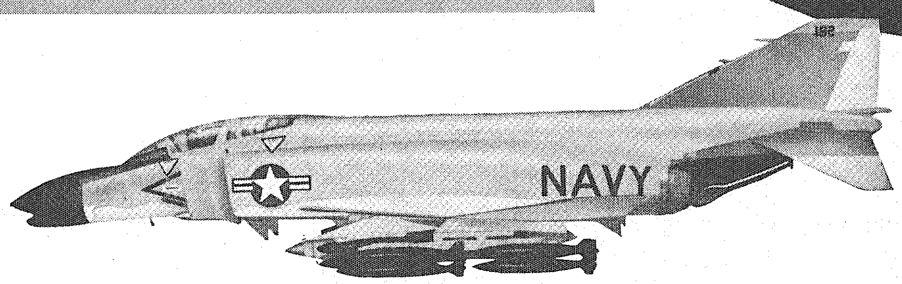
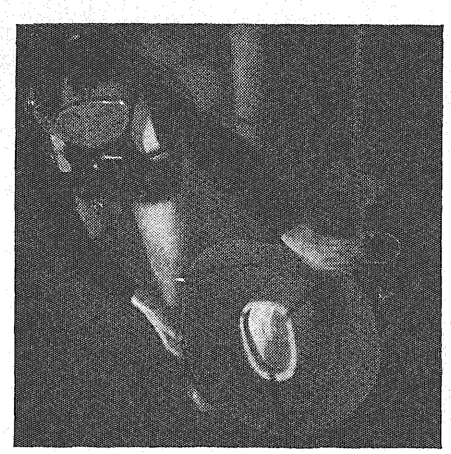
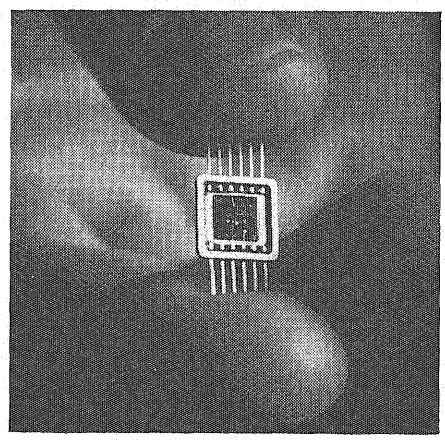




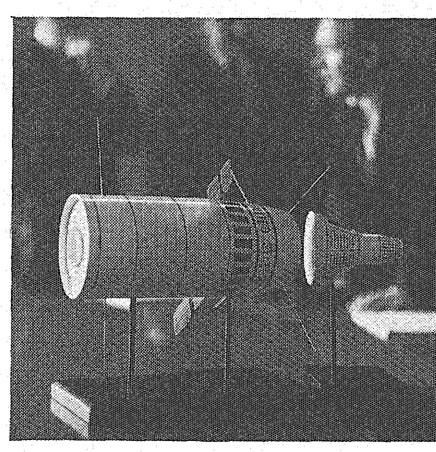




We do research on oceanics,

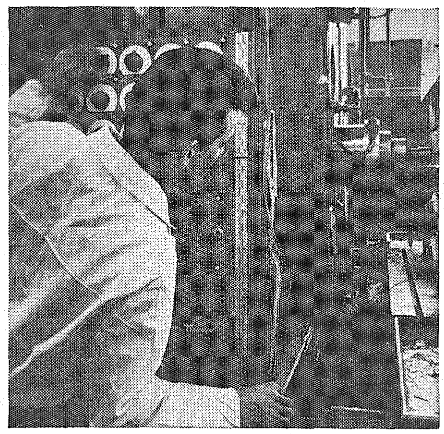


microcircuitry,

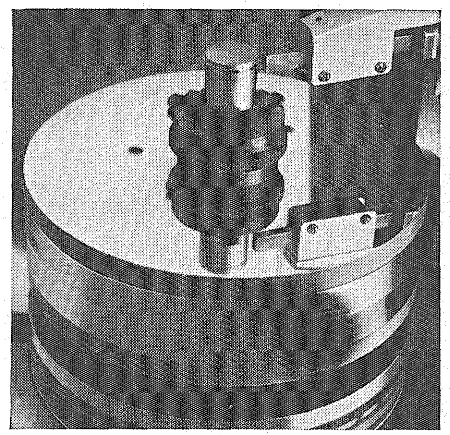


controls for space stations,

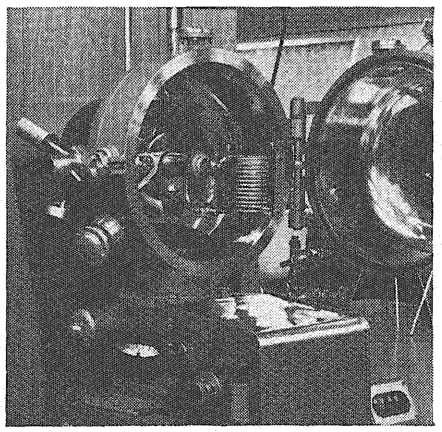
all-weather landing systems,



self-adaptive machines,

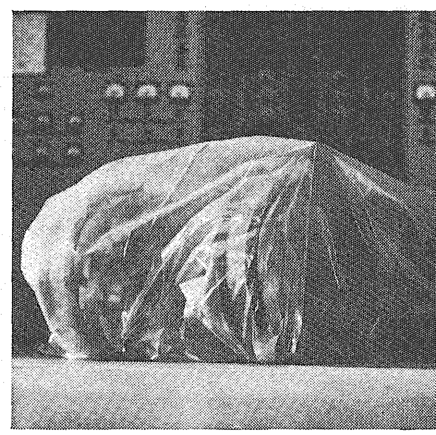


noncontact measuring gages,



high vacuum equipment,

automotive brakes,



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SPLINTERS From the Log

by DAVID E. ENGEN, *Pol Sci '67*

Once two soldiers came across a dead animal and an argument began. One soldier said it was a donkey, the other claimed it to be a mule. An officer happened by and they asked him to settle it. He said stiffly, "It's an ass; now dig a hole and bury it." As the soldiers were digging and grumbling, a pretty, little nurse walked by and asked sweetly: "What are you two boys digging? A fox hole?"

The two soldiers grinned dryly and answered, "Nope!"

• • •

He: What happened when you whistled at that beautiful girl walking her dog?

Him: She walked past me as if I were a lampost, but her dog didn't.

• • •

Not to mention the gung-ho young engineer who started at the bottom and stayed there.

• • •

Gin rummy: A lush who specializes.

• • •

The trouble with debating freedom with Milton Rosen is that it is a purely academic discussion.

• • •

Nothing robs a man of his good looks like a hurriedly drawn shade.

• • •

A bachelor is a cagey guy
Who has a lot of fun.
He samples every pretty wench
And never Mrs. one.

• • •

Once upon a time there were three coeds—a great big coed, a medium sized coed, and a little coed—who went for a walk in the woods. When they came back they were very tired and wished to go to bed. So they went to their rooms.

"Somebody's been sleeping in my bed," said the great big coed in a great big voice.

"Somebody's been sleeping in my bed," said the medium-sized coed in a medium-sized voice.

"Good night, girls," said the little coed in a little, little voice.

Then there was the engineer who was kicked out of R.O.T.C. because he was rotten to the corps.

• • •

He smiled at her across the candlelit table. She affectionately smiled in return.

"Smile like that again," he whispered.

She blushed and again cutely displayed her dimples.

"Just as I thought," he said. "You look like a chipmunk."

• • •

"See this jewelry?" said the sorority pledge. "It once belonged to a millionaire."

"Gosh," gasped an impressed sister, "what's his name?"

"Woolworth," the pledge replied.

• • •

"Do you cheat on your wife?" asked the psychiatrist.

"Who else?" answered the patient.

• • •

News item: Mrs. Bradley Fowler was granted a divorce after she told the judge her husband had spoken to her only three times since they were married. Mrs. Fowler was awarded the custody of their three children.

• • •

A bored cat and an interested cat were watching a game of tennis.

"You seem very interested in tennis," said the bored cat.

"It's not that," said the interested cat, "but my old man's in the racket."

• • •

I'll really laugh if the world ends just before they manage to destroy it.

• • •

No snowflake in an avalanche ever feels responsible.

• • •

The one who is absent from the bridge party gets the most slams.

• • •

Question on a job application: "Are you a natural born citizen?"

Answer: "No, Caesarean."

Room Change: Lower Division Anatomy, which usually meets in EE 31, will now meet in E 8.

• • •

At West Point a visitor noticed that all names engraved on a famous battle monument were those of the men in the Union army, killed in action during the Civil War. "Say," he called to a cadet, "what's this?"

"A tribute to the marksmanship of the Confederacy, Suh!" drawled the cadet.

• • •

He was an American. She was French. He was in New York buying furniture for his store in Oklahoma City. He met her on an elevator. She looked good to him. He looked good to her. She spoke French only. He spoke English only.

He took out a pad and pencil and drew a picture of a hansom cab with a question mark after it. She nodded yes. They went for a ride in the park.

He drew a picture of a restaurant. She nodded yes. They ate. He drew a picture of some dancers. She nodded yes. They danced.

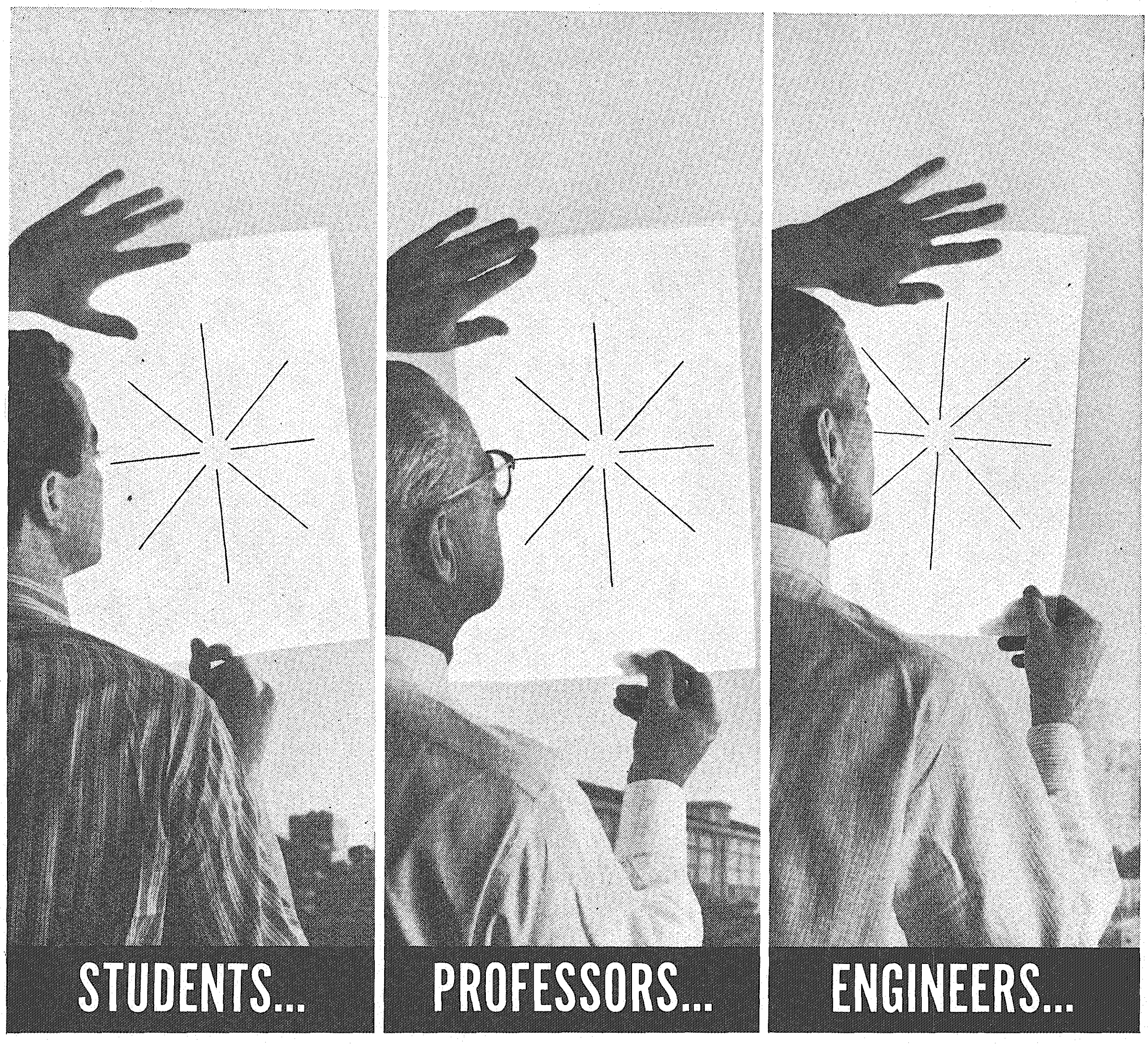
Then she took the pad and pencil. She drew a picture of a four-poster bed. That set him to wondering how she knew he was in the furniture business.

NO JOKE

Reprinted from the London *Sunday Telegraph:*

"I'm a small woman with a large bosom and the only car in which I can reach the pedal is a Mini. When I stop the car and lean forward to get from under the steering wheel my ample bosom sounds the horn. It's most embarrassing. Passing motorists glare and innocent bystanders jump out of their skins. It's most mortifying."

A newly married couple boarded the Golden State Limited for their honeymoon. They were in their berth and about every two minutes the bride would exclaim: "Johnny, I just can't convince myself that we are married." This went on and on for half an hour. Finally a voice from the other end of the car shouted, "Johnny, will you convince her so we all may go to sleep?"



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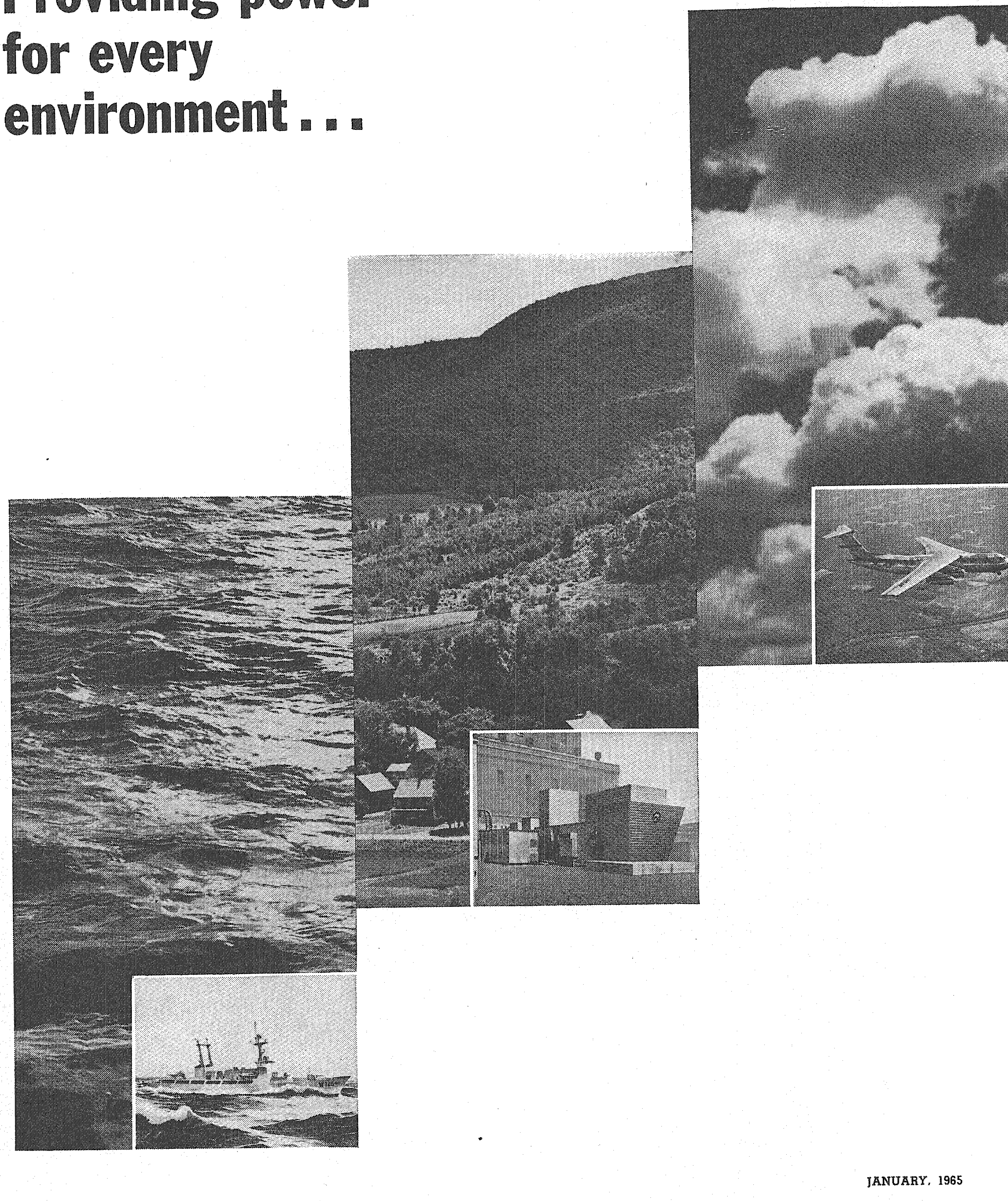

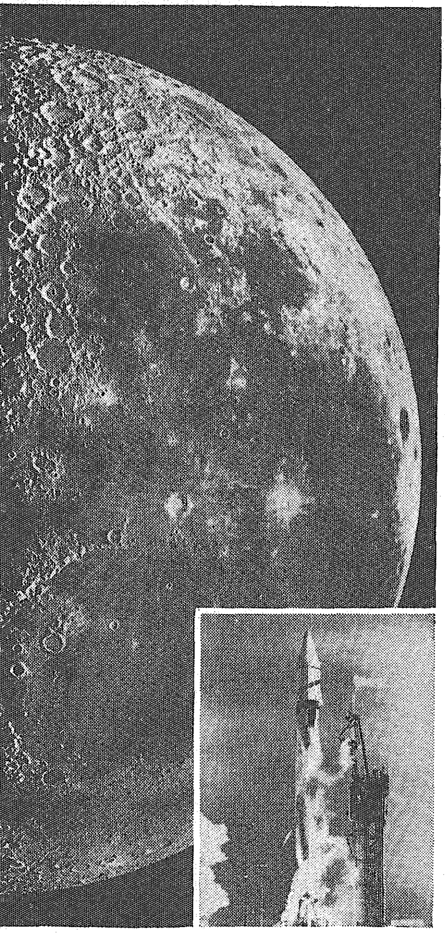

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FIVE YEARS BECOME FOUR . . .

by DIANNE CHRISTENSEN, *Physics Ed. '66*

Engineering programs, previously five years in length, will soon be converted to four-year programs. Full details of the change are not yet available, but at a conference planned for later this month the Institute of Technology, in cooperation with the University's Senate Committee on Industrial Relations, will discuss program modifications with representatives of other colleges.

Four-year Programs

Presently the individual engineering departments offer a four-year engineering-science oriented program. About one-third of the baccalaureate degrees in the Institute of Technology are four-year degrees. In the future, however, all baccalaureate programs, except that offered by the School of Architecture, will be four-year programs.

Why change from the five- to the four-year program? Initially one can consider the national changes involved in engineering education. Shortly after World War II, an increased need for more work in the social sciences and humanities, as well as basic sciences, in engineering programs was realized. The national response was varied. Columbia University and Case Institute of Technology, for example, expanded their engineering program with other programs to create a five-year degree which awarded both an engineering degree and a B.A. degree. Other universities, the University of Rochester and the University of Louisville, for example, established a coordinated program within the institution which involved the awarding of either one or two degrees at the end of five years. Generally this program was jointly administered by the liberal arts college and the engineering college. Still others, including the University of Minnesota, developed five-year engineering programs which were enriched in the social sciences and humanities but led to only one degree in engineering.

During the 1950's, major attention was focused on the content of the engineering program. One of the essential functions of an engineering education is the preparation of the individual to move into and develop new areas of engineering. Therefore the concepts of mechanics, electromagnetism, thermodynamics, fluid mechanics, and properties of materials, more commonly classified as "engineering science," were given more emphasis. The realization of the importance of development in new areas was reinforced by advances in areas including radar, the transistor and automation.

Impact of Studies

The impact of the studies on engineering education can be shown by the reaction of the Engineers' Council for Professional Development (ECPD), the accrediting agency for engineering programs. According to ECPD, an acceptable program must contain, besides the course work in mathematics and the basic sciences, "at least the equivalent of approximately one year of engineering science" which "provides depth of coverage" and in areas "not limited to those having apparent specific relevance to the major field . . . also recognition should be given to the emergence of new engineering sciences."

Further extension of the trends established during the 1950's have characterized the early 1960's. Two closely related developments of the early 60's include an increase in the emphasis on graduate study for engineers, and the recognition of the need for a semi-professional, the engineering technician, who is qualified to serve as an aid to the engineer, thereby making the fuller utilization of the competence of the modern engineer possible.

Significant Developments

Growth of graduate programs has, in some cases, deemphasized the importance of baccalaureate programs. Here, at the University of Minnesota, the baccalaureate program will remain the vital component of engineering education, at least in the foreseeable future.

Another significant development of the 60's is the establishment of two-year collegiate programs for engineering technicians. Minnesota lags in the development of these programs. However, the Liaison Committee on Higher Education has recommended the early establishment of programs meeting ECPD standards to be developed largely within state and junior colleges.

Another important consideration is the economic factor. Formerly graduates from a five-year program received sizable differentials in starting salaries over graduates with four-year degrees. However, this differential has decreased over the years, hence there should be no major differences in the requirements for baccalaureate programs.

General Characteristics

What are some of the characteristics of the four-year program?

1. The minimum requirements in the social sciences and humanities will be 39 quarter credits—two more than in the present four-year program.

2. The six quarter Lower Division courses in mathematics will remain unchanged. Five quarters of the program are required; the sixth is optional but required for some.

3. The present five quarters of required Lower Division courses in physics will be modified by integrating them more closely with courses in engineering departments. The requirements for graduation will be a minimum of four quarters in most departments.

4. All departments plan to accommodate transfer students. Generally transfer students who have completed six quarters of mathematics and one quarter of engineering mechanics can enter the third-year program and complete the four-year program on a regular schedule.

5. Transfer programs will continue to satisfy requirements for admission to the Upper Division on the same basis as at present. The Electrical Engineering Department will initiate discussions with respect to the introduction of a preparatory course in electrical principles at institutions where such a course does not now exist. Such a course could be transferred for credit in all engineering programs.

Departmental Changes

Department by department, the main curriculum changes are the following:

The new Aeronautics and Engineering Mechanics Program will be more flexible with some of the previously required courses being shifted to a technical elective status. In addition, four sequences have been revamped: Aero 100-101-102-103 (three credits each) will become Aero 100A-101A-102A (four credits each), ME 30-31 will be combined into one four-credit course, MM 27-28-29-40-41 will be compacted into three four-credit courses, and the EE sequence (with lab) will become two four-credit courses. Two courses have been eliminated altogether—Aero 6 and Met 56.

A switch to more of an option-type program is planned for Agricultural Engineering. Students will be required to specialize in one of the three main areas—Farm Machinery, Soil and Water, and Structures and Processing—and will take electives in the other two. More courses in plant and animal physiology will be introduced, and probably also a Work-Study Program.

The chief change in the Civil Engineering Program is that the summer camp has been dropped. Because of the course acceleration in high schools, the Math, Physics, and MM requirements have been lowered. The number of credits required in Structures and Surveying has also been lowered. Geology is no longer required, but may be taken as a technical elective. CE 121, Linear Programming, has been added.

Electromechanics is a new three-credit course which has been added to the Electrical Engineering Program. The number of credits required in Physics and MM has been lowered, and Speech 50 has been dropped. The EE electives requirement has been reduced from twenty-seven to sixteen credits.

In both the Geological and Mineral Engineering Programs, the courses have been broadened and some previously required courses are now electives. Both programs have dropped Geology 22 and English 85 as requirements, and both have added CE 125, a course on computer applications, (or a suitable alternate). Also included in both programs will be a two-quarter comprehensive study of a field problem. MetE 110-111 and MinE 171-172 will be alternative sequences rather than both being required. In addition, Mineral Engineering has eliminated EG 26, and no Engineering Graphics will be required for Geological Engineering.

The changes in the Metallurgical Engineering Program are mainly consolidation of courses, notably Met 180-181-182 will become a two-quarter sequence, and MetE 110-111-112 will be reduced to three credits per quarter. Some material, for example, Met 173-174-175, has been moved to the graduate level.

The general trends in the new Mechanical Engineering Program have been to consolidate the courses and make some of the required courses technical electives. The number of Physics and MM credits has been lowered

(Continued on Page 52)

Spotlight on

Local Industry

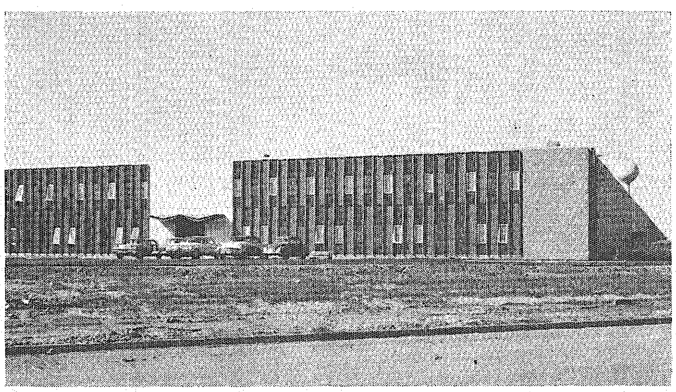
APPLIED SCIENCE DIVISION

LITTON INDUSTRIES

edited by DANIEL KEHRBERG, *Met E '68*

The Applied Science Division of Litton Industries develops and produces systems for the defense and space agencies of the United States government. Its primary business is to apply the scientific and engineering skills of its staff to the complex problems of modern technology—always concerned with total-system performance and the physical phenomena that affect it.

Because many of the problems presented to the division are of a fundamental nature, it also conducts a broad program of basic and applied research in the physical and biological sciences.



One of the Applied Science Division's two facilities is this plant located in Roseville.

Operating from facilities in Roseville and Minneapolis, the activities include work in the following fields: Adsorption Studies of Air Constituents and Power Surfaces—Aerodynamic Heat Transfer Studies—Aircraft Spray Tanks—Atmospheric Electricity—Bacteriology and Biochemistry—Balloon Design and Manufacturing—Balloon Flight Operations—Bacterial Warfare/Chemical Warefare Technology—Cathode Sputtering—Detection of Thunderstorms and Turbulence—Electrohydrodynamic Pumping, Filtration, and High-Voltage Generation—Environmental Control Systems—Ejectable Systems—Fabrics and Their Applications—Fine-Particle and Aerosol Technology—Grain-Boundary Studies—Heat and Mass Transfer Through Clothing—High-Frequency Communication Systems—Inflatable Shelters and Space Structures—Mathematical Analysis—Mechanical, Physical, and Chemical Properties of Materials—Meteorology and Geophysics—Microbiology—Rheology—Space Navigation Instruments—Submersible Systems—Magnetic Resonance—Management Sciences.

One of the most fascinating projects just recently completed by the Applied Science Division for the Woods Hole Oceanographic Institution was the design and fabrication of ALVIN, a deep-diving, two-man research submarine capable of exploring the ocean at depths of 6,000 feet. This unique tool for unlocking secrets of the sea has just passed a rigorous series of tests off Cape Cod. In early spring, ALVIN will undergo deep sea tests in southern waters. ALVIN was named for ALlen VINe, the Woods Hole Oceanographic Institution scientist who conceived the idea.

Equally interesting is the work ASD has done in the field of atmospheric electricity. Studies in this field increase the knowledge of meteorology and atmospheric physics. Through remote detection of electrical events in the atmosphere, the ability to forecast weather can be improved. Research in atmospheric electricity at Litton's Applied Science Division has led to several practical applications. Engineering refinements in the area of sferic detection have resulted in the development of instruments such as SPARSA to provide useful meteorological information. A SPARSA network recently installed at Cape Kennedy now constantly monitors the area for approaching thunderstorms and provides essential "prior to launch" information. Other instruments developed by ASD include the SFERETTE recorder, the Cloud Boundary Detector, and the Radiosonde Electrometer.

ASD has long been one of the leaders in balloon fabrication and technology, and has extended the use of inflatables to structures and to space environments. Nose cones designed and made by Litton's Applied Science Division open in space to eject self-inflating solar collectors and metal-coated reflectors for radar and radio

(Continued on Page 47)

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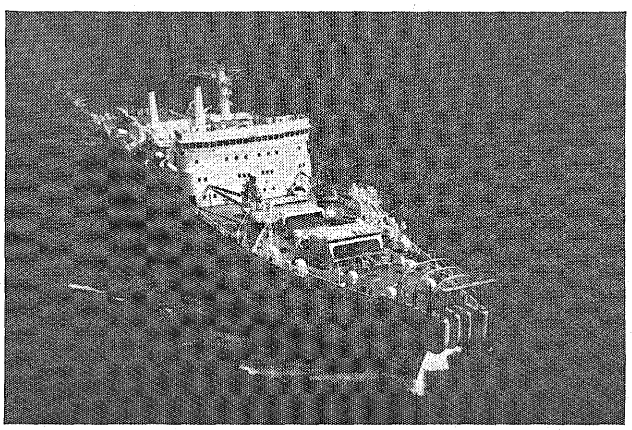

C. S. LONG LINES lays and maintains Bell System undersea telephone cables that provide dependable overseas transmission.

CONTROLLED POWER

With a 12-month output of well over 8 billion kilowatts, power dispatching on our system must be done with top accuracy and economy. Last year our power supply control center attained a new level of efficiency by adding computer control. The chart at right shows how the area generation requirement straightened out as the computer took over (see arrow). When the pen stays close to zero we are supplying our customers without borrowing from neighboring utilities or "spilling over" onto their interconnected systems. The computer also helps regulate exchange of power between these systems and provides cost accounting data as well.

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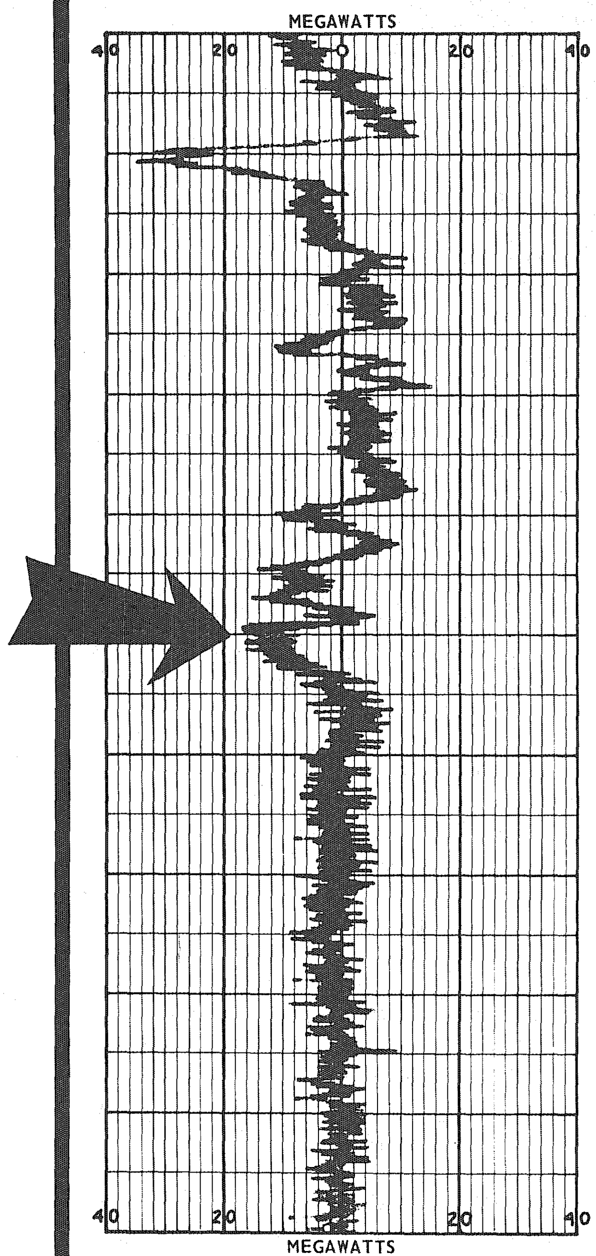
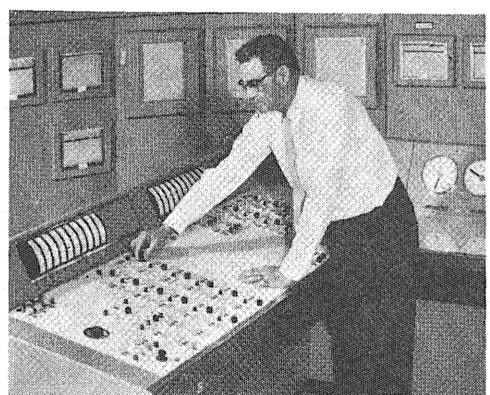
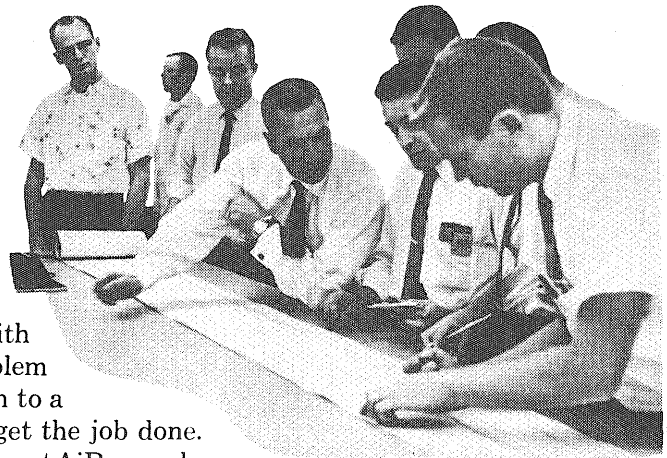




Why become an engineer at Garrett-AiResearch? You'll have to work harder and use more of your knowledge than engineers at most other companies.



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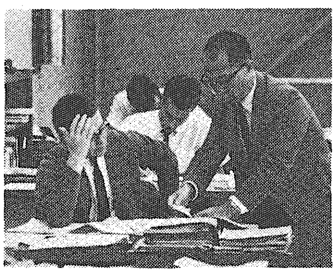
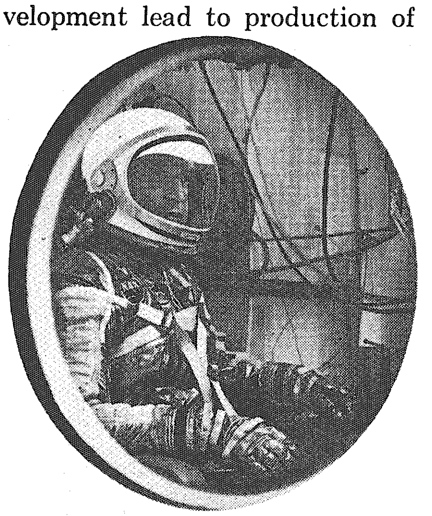


Our business is mainly in sophisticated aerospace systems and subsystems.

Here, research, design, and development lead to production of actual hardware. That means you have the opportunity to start with a customer's problem and see it through to a system that will get the job done.



The product lines at AiResearch, Los Angeles Division, are environmental systems, flight information and controls systems, heat transfer systems, secondary power generator systems for missiles and space, electrical systems, and specialized industrial systems.

In the Phoenix Division there are gas turbines for propulsion and secondary power, valves and control systems, air turbine starters and motors, solar and nuclear power systems.

In each category AiResearch employs three kinds of engineers.

Preliminary design engineers do the analytical and theoretical work, then write proposals.

Design engineers do the layouts; turn an idea into a product.

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Whichever field fits you best, we can guarantee you this: you can go as far and fast as your talents can carry you. You can make as much money as any engineer in a comparable spot – *anywhere.* And of course, at AiResearch, you'll get all the plus benefits a top company offers.

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UP FRONT

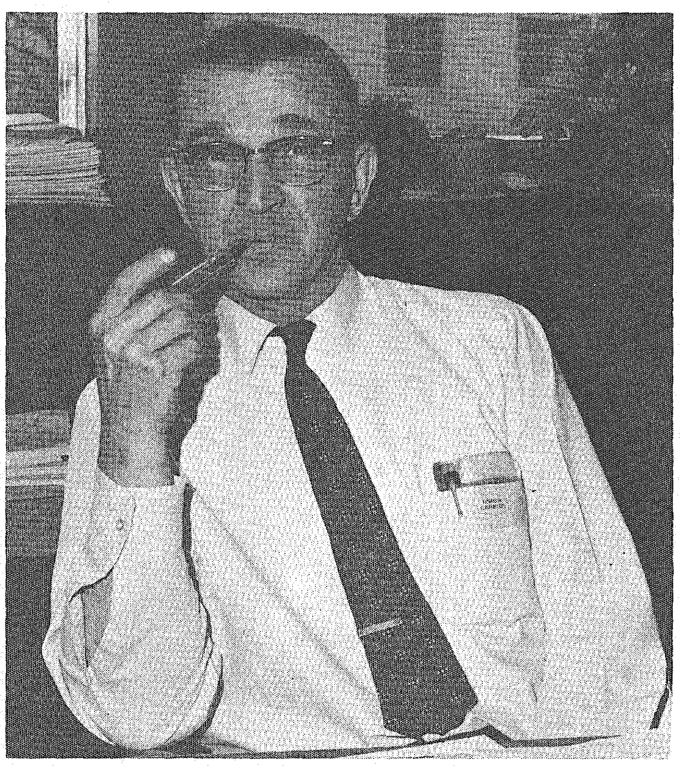
by ROBERT BRANDS, *CheE '68*

Dr. Lawrence E. Goodman, a professor in the Aeronautics and Engineering Mechanics Department, was born "a long time ago" in New York City. After attending grade school there, he went to Townsend Harris Hall for gifted boys where he received his high school education. He received his B.A. and B.S. from Columbia University and his Master's degree (in absentia) from the University of Illinois.

During World War II, he worked with a team which developed a radio proximity fuse. He then spent time in the Navy in the Pacific theater introducing the gun director associated with the proximity fuse. After the war, he returned to Columbia University where, with a National Research Council Fellowship, he received his Ph.D. in 1948. From 1949 to 1952, he was a research professor at the University of Illinois, and in 1953 he came to the University of Minnesota and has been here ever since.

He is a member of APS, ASME, ASCE, and SES, and director of an NSF undergraduate research program for the Department of Aeronautics and Engineering Mechanics. In addition to heading the undergraduate research program, he is teaching MM 28-29 and graduate school courses in mechanical vibrations of continuous media and the theory of elasticity in three dimensions. Dr. Goodman has also done consulting work on gyroscopes for Minneapolis Honeywell, the Atomic Energy Commission, and the Bureau of Ships. He has written a book with Dr. W. Warner, entitled *Statics and Dynamics*, now a text here at the University.

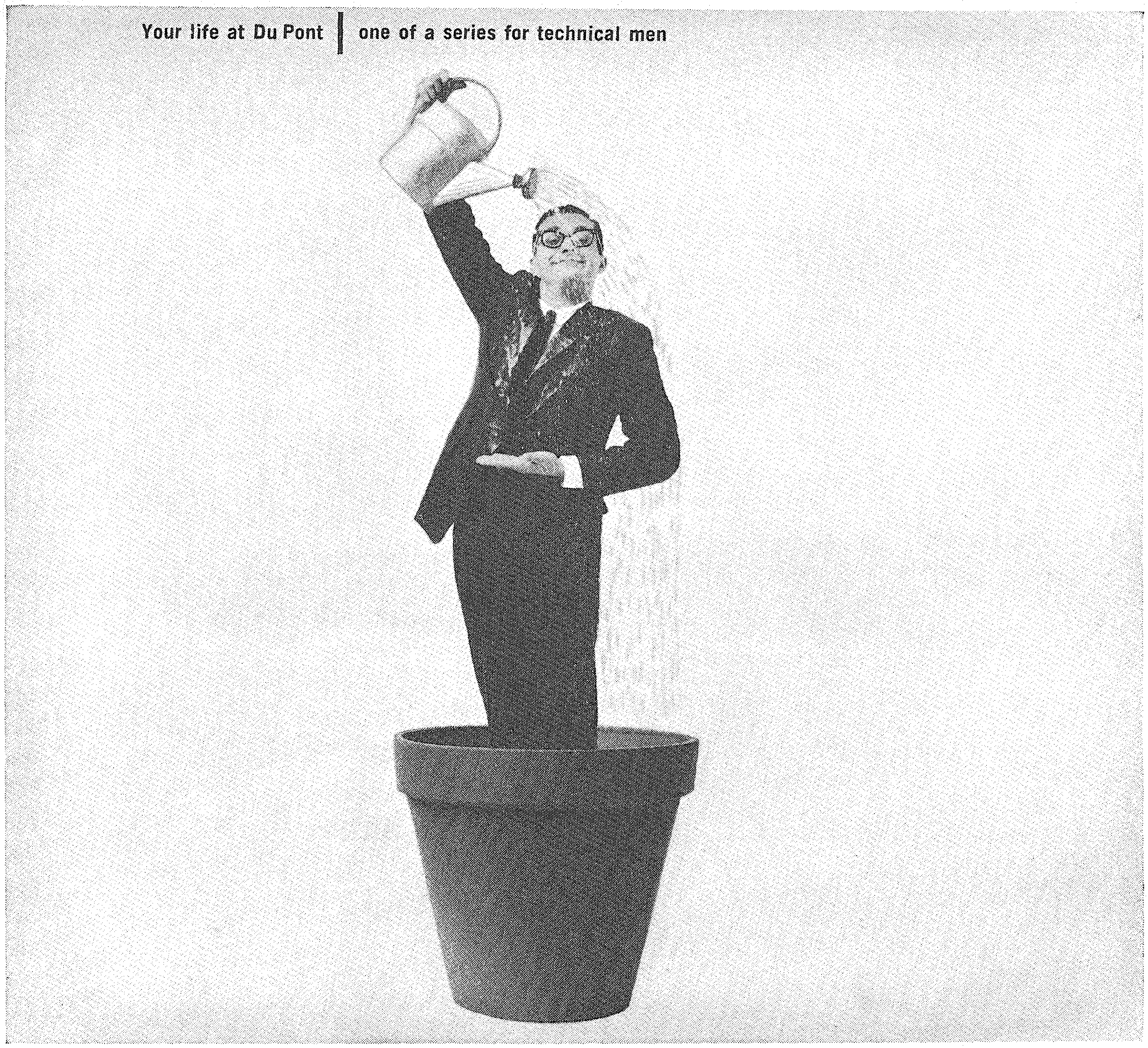
DR. LAWRENCE E. GOODMAN



DR. NORMAN H. CEAGLSKI

Dr. Norman H. Ceaglski, Professor of Chemical Engineering, was born in 1907 in Merrill, Wisconsin, where he attended grade and high school. After graduation, he attended the University of Wisconsin receiving his B.S. in 1928. He continued his education there and received his Master's degree in 1929. In 1936, he received his Ph.D. from the University of Wisconsin for his work in drying of granular solids. He then went to Iowa State University where he taught from 1936-1940 and from there to Washington University in St. Louis, where he taught from 1940-1946. He came to the University of Minnesota in 1946 and has been in the Chemical Engineering Department ever since.

Dr. Ceaglski has written several papers and one book on process control, his current, past and future interest, and is now finishing a second book on the same subject. He has been a recipient of a Fulbright Grant to Norway, has twice been the lecturer for the Humble Oil Co. summer lecture series in Baytown, Texas, and has been the guest lecturer for the A.C.S. Southern Lecture series tour. Dr. Ceaglski considers the high point of his career as being a visiting professor for one semester at Case Institute of Technology. He has also received various N.S.F. grants for research. Dr. Ceaglski is now teaching ChE 100, 171-3 and a new course in numerical and computer methods in ChE. Dr. Ceaglski is a member of AIChE, ACS, Tau Beta Pi, and Sigma Xi, to name a few of the organizations of which he is a member.



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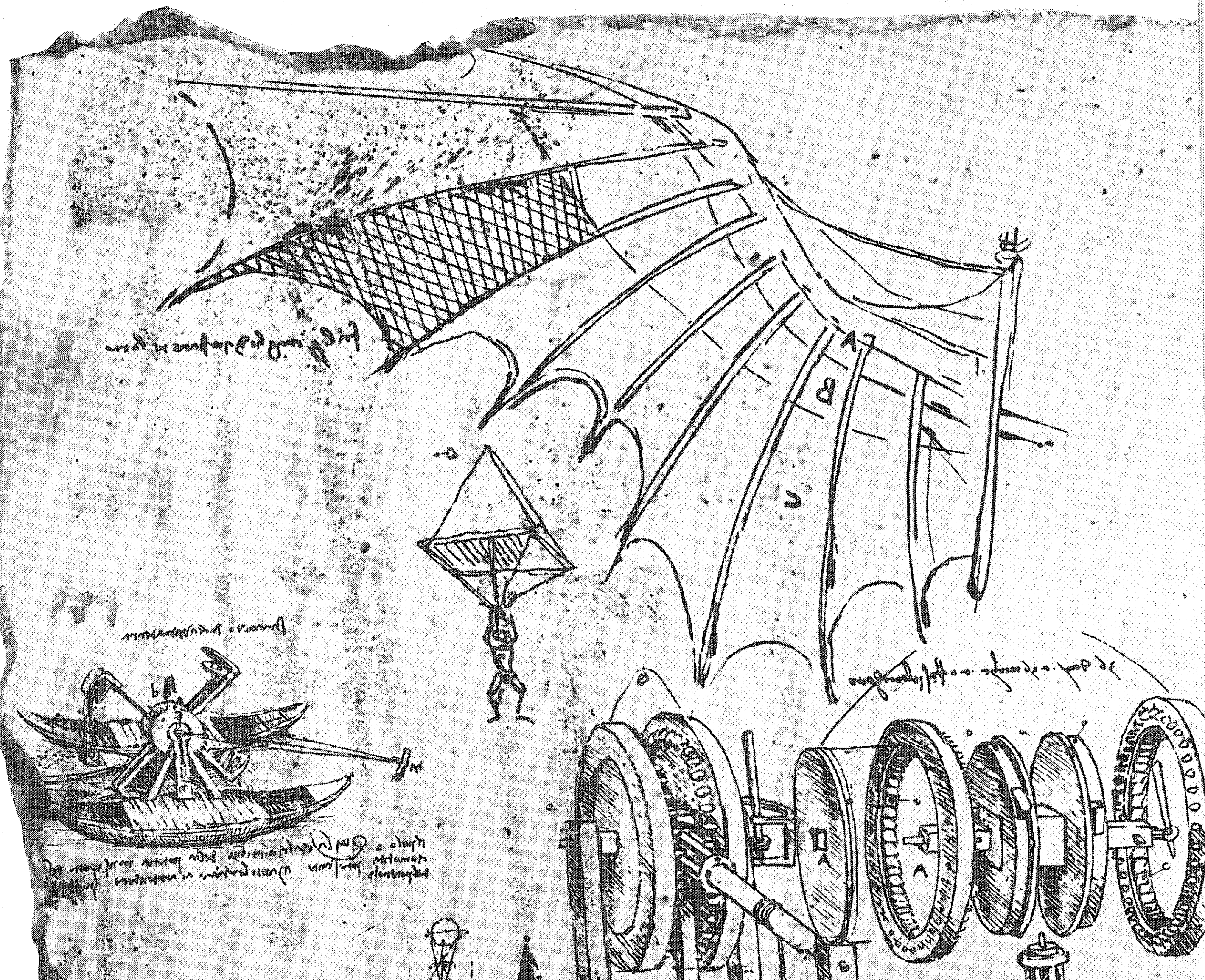
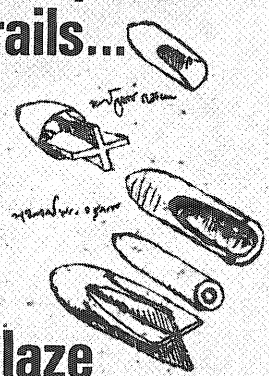


Leonardo da Vinci blazed many new trails...



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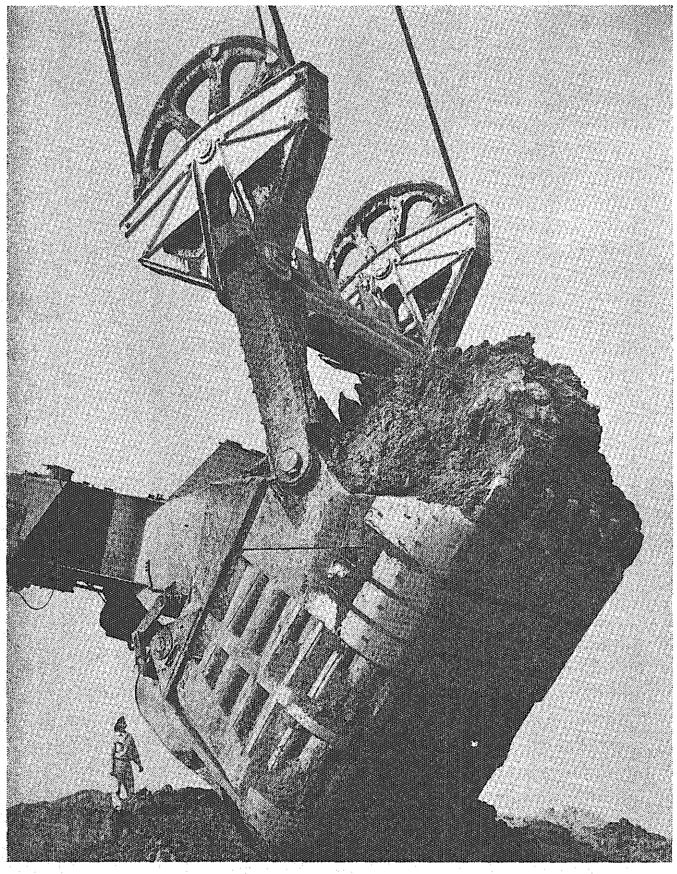
WHAT'S NEW *in Engineering*

edited by STEVE LINDFORS, *Physics '67*

World's Biggest Dip

Trick photography? No! That six-foot-two-inch man with the safety helmet is standing next to the world's largest dipper—at the business end of the world's largest



mobile land machine, a strip mining shovel manufactured by the Bucyrus-Erie Company.

The dipper devours over 140 cubic yards, or 250 tons, of earth with one bite and releases its load as far as 400 feet away. This earth, called overburden in mining parlance, is set aside and the veins of coal are exposed for other shovels—about 1/10th the size—to remove.

The lip of the big dipper alone weighs 20 tons and is made from a 16-foot wide casting, largest ever poured in the history of the Bucyrus-Erie foundry.

Record Rocket Roars

The largest solid propellant rocket motor yet built by man roared into ear-shattering life recently at Lockheed Propulsion Company's Potrero, California, facility.

A segmented 156-inch-diameter rocket, standing nearly 75 feet tall and holding 650,000 pounds of propellant, for more than two minutes shoved downward on its test stand with million-pound force in a futile attempt to cleave its way through the earth's crust.

White-hot flaming gases hurtling many hundreds of feet skyward with incredible speed gave it the look of a comet arrested in mid-flight.

Air Force and Lockheed Propulsion officials termed the firing fully successful—an emphatic reconfirmation of the feasibility of 156-inch-diameter solid rockets for heavy-duty military and civilian space booster assignments. The Space Systems Division, Air Force Systems Command, is in charge of the national program to develop them, and the Air Force's Rocket Propulsion Laboratory gives technical direction.

The nose-down static firing was the second consecutive successful test conducted in the large motor program. It followed by exactly 125 days the first full-scale firing, in the same test stand and using the same high-strength steel motor case.

The latest test motor—though identical in outer dimensions—was more "fully packed." It contained 30 per cent more propellant and developed 30 per cent more thrust than in the previous successful firing. So in its turn, the 650,000-pounder became the world's "heavyweight champion."

Lines Forcibly Mapped

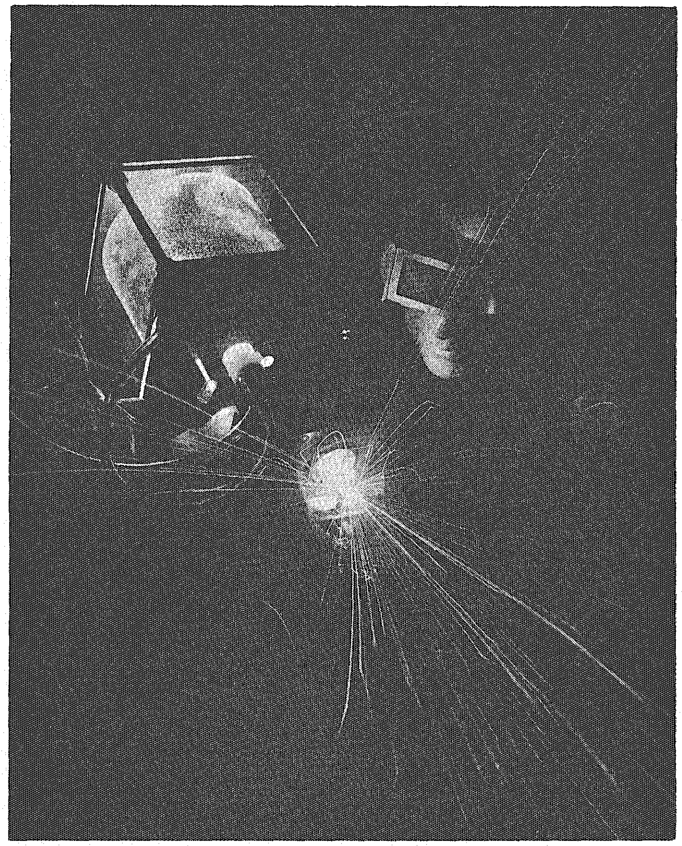
Force lines in interplanetary magnetic field have been "mapped." The feat was a joint result of a satellite in space—the first interplanetary monitoring probe (IMP-I), and an observatory instrument—a solar magnetograph at Mount Wilson Observatory, California. The information gained confirms the "water sprinkler" hypothesis that lines of force emanating from the sun in the plane of the earth's orbit behave like streams of water whipping out from the head of a lawn sprinkler, due to the spinning of the sun and the flow of a "solar wind." The data are part of a series of findings showing that outer space is a sea of ionized gases, atomic particles, shifting magnetic fields, and planetary debris.

Insects Go Batty

Electronic bat sounds drive insects away. Scientists of the U. S. Department of Agriculture's Research Service, in cooperation with the South Carolina Agricultural Experiment Station, are studying the reactions of the destructive bollworm moth to bat cries simulated on electronic equipment. Night-flying bats locate their prey by squeaking as they fly and listening for the echo of their cries. Insects, however, can pick up the sound waves through resonance hearing organs, called tympanums, which vibrate. Thus warned of the bat's approach, the insects begin evasive action. In laboratory tests, scientists tried varying sound frequencies and measured the response. They found that the bollworm (Heliothis zea) responded in the same manner to the simulated sounds as to actual bat cries. It is hoped that insect pests can be driven away by generating appropriate frequencies over farm fields.

Laser Has a Blast

A beam of light from this experimental ruby laser at the Westinghouse Research Laboratories gives off a shower of molten metal as it blasts its way through a piece of aluminum. This experiment demonstrates the tremen-



dous concentration of light energy which can be obtained from a laser beam. Other current aspects of laser research include: studies of the effects of laser beams, improved laser materials, energizing of lasers (pumping), use of the device for microwelding and cutting, and basic research on the phenomenon itself.

Psychoanalysts Can't Match It

A new instrument of advanced design that simultaneously analyzes as many as six static or dynamic samples with maximum speed and accuracy, the "Multichannel Vacuum X-ray Spectrograph," has recently been developed.

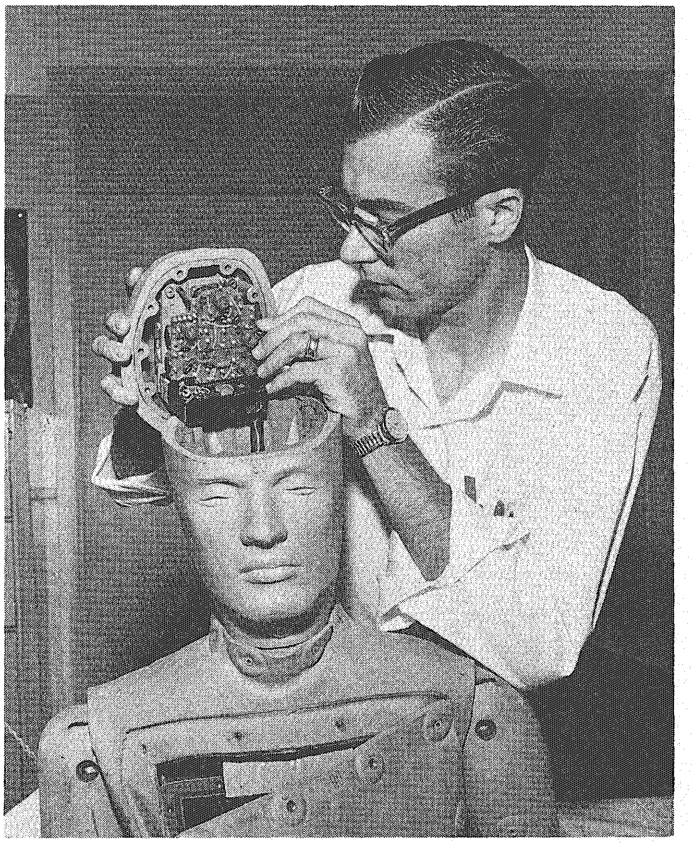
This unique instrument has been tested on problems involving tetraethyl lead in gasolines, SiO_2 (8%) in a continuously flowing slurry of taconite ore, and similar applications. Normal time for determining up to six elements in powdered sinters, slags, cements and cement raw mix samples is approximately one minute.

Static samples in the form of powders, liquids and solids are presented to the instrument by means of a motor-driven carrier belt. Dynamic samples such as continuously flowing slurrys or solutions are passed through a flow analyzing cell. Analytical results are permanently recorded by a digital printer, strip-chart recorder, or data processor which translates intensity into per cent concentration.

A manual keyboard facilitates identification of a sample or series of samples directly on the data tape. Visual trend information can be recorded for use in process control applications where upper and lower limits are established. The new instrument fills a long-awaited need of the analytical chemist—it provides operating flexibility, easy sample handling at high speed, and minimum analysis time.

Andy Encounters Forces

Moon-bound Apollo astronauts will know pretty much what to expect from acceleration and "G" forces thanks to "ANDY" the anthropomorphic dummy shown below getting his "brain." "ANDY's" skull, fitted out with 13 tiny electronic sensing and transmitting devices, together



with the rest of the humanoid, is now undergoing drop tests and other pre-manned-flight experiments.

These experiments are being conducted by North American's Space and Information Systems Division, Downey, California, for NASA's Manned Spacecraft Center, Houston, Texas, as part of the Apollo program. The electronic skull package senses the rate changes and "G" forces on the dummy's head through use of tiny subminiature rate gyros and accelerometers for all three axes of movement. Rate changes of up to 500° per second and accelerations of ±50 G's may be encountered by the dummy during some phases of the flight. Thus, by comparing the dummy's encountered forces with man's known capabilities, flight regimes for Apollo can be established to protect the Moon voyageurs during their trip.

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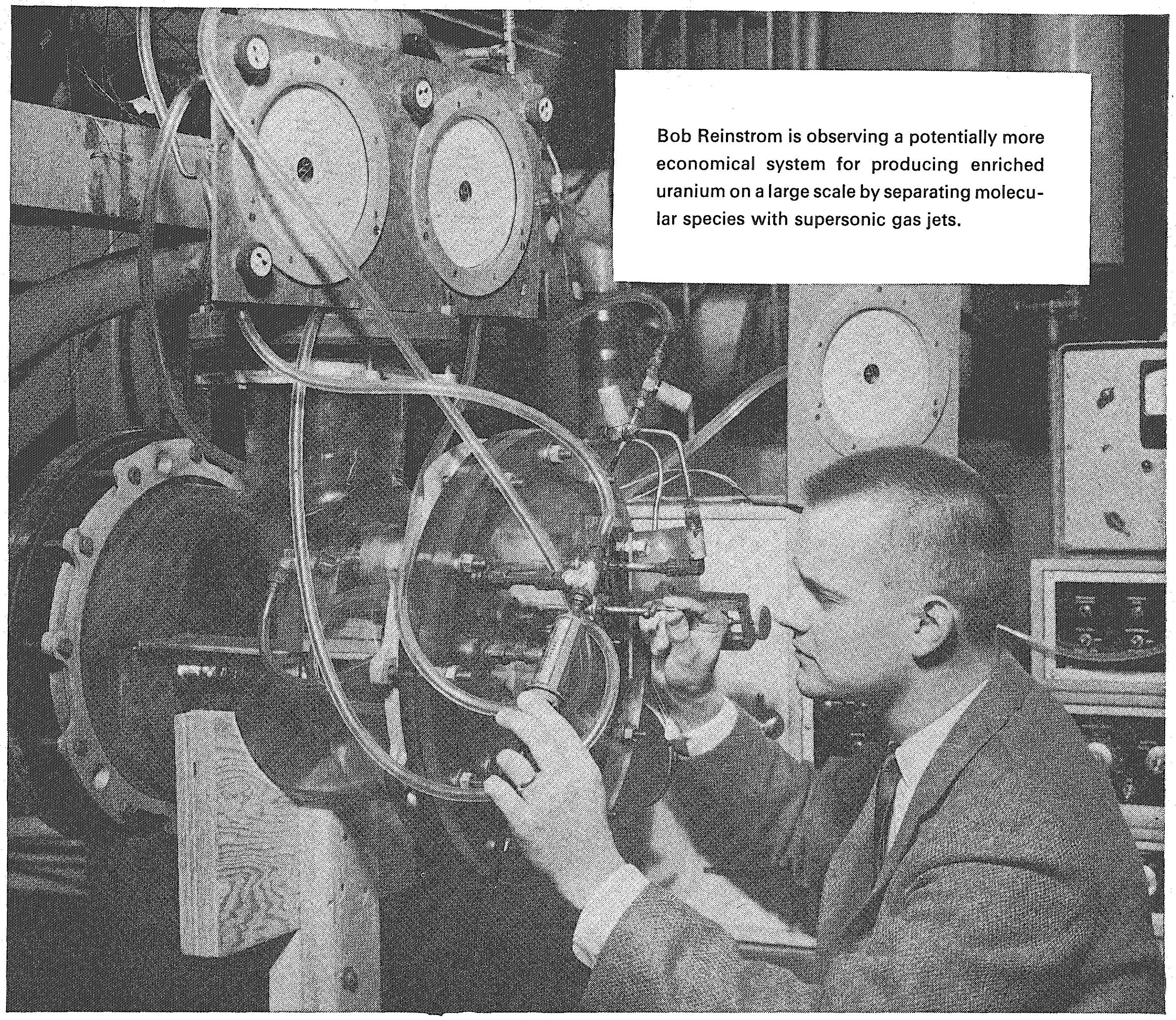

Young Engineers Find Opportunity at Allison

■ Bob Reinstrom came to Allison Division, General Motors, early in 1962 following his graduation from the University of Minnesota with a BS degree in Mechanical Engineering.

As a research engineer at Allison, he has been associated with the Nuclear Liquid Metal Cell Program, the MCR (Military Compact Reactor) Project, and the Energy Depot Project. In these assignments, he has contributed to these studies:

1—Analysis and design of heat transfer equipment to investigate boiling, condensing, and thermal cycling in closed liquid metal systems.

2—The steady-state parametric optimization and transient behavior analysis of nuclear reactor systems.

3—Thermodynamic analysis of open chemical processes.

Presently, Bob is doing graduate work in engineering at Purdue University-Indianapolis campus . . . one of the many advantages of a job with Allison.

Allison's broad education and training programs offer unlimited opportunities to the young graduate engineer desiring education beyond the normal four or five years of college training.

If you're interested in knowing more about Allison's Graduate Study Program, see our interviewer when he visits your campus. Or, write now for your copy of Allison's brochure, explaining your opportunities for advancing your professional career at Allison. Send your request to: Allison Division, General Motors Corporation, Indianapolis, Indiana 46206, Att: Professional and Scientific Placement.

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Allison GM

THE ENERGY CONVERSION DIVISION OF GENERAL MOTORS, INDIANAPOLIS, INDIANA General Motors

Attention! Seniors!
For The Second Straight
Year We Present The . . .

WINTER QUARTER INTERVIEWING SCHEDULE

Tuesday, January 12

Central Intelligence Agency (2nd Day)
Dow Chemical
Firestone Tire & Rubber Company
General Motors Corporation
Lubrizol Corporation
Martin Company (Denver)
Monsanto Company
Stanford University

Wednesday, January 13

Dow Chemical (2nd Day)
Firestone Tire & Rubber Company (2nd Day)
General Motors (2nd Day)
Harold J. Westin & Associates
Interior—Reclamation
Martin Company (2nd Day)
Monsanto Company (2nd Day)
Phillips Petroleum (Idaho Falls)
Worthington Corporation

Thursday, January 14

Babcock & Wilcox
Dow Chemical (3rd Day)
General Motors (3rd Day)
Martin Company (3rd Day)
Monsanto Company (3rd Day)
TRW Space Technology Laboratories
United Aircraft Corp.—Research Labs.
West Bend Company

Friday, January 15

American Oil (Res. & Dev.) and Amoco Chemicals Corporation
Brunswick Corporation
General Mills (2nd Day)
Geo. A. Hormel & Company
Mechanical Handling Systems
Parke-Davis & Company
Pennsylvania Railroad Company
TRW Space Technology Labs. (2nd Day)

Monday, January 18

American Can Company
Brown & Bigelow
Commonwealth Edison Company
Cummins Engine Company
Jones & Laughlin Steel
Minnesota and Ontario Paper Co.
National Steel Corporation
Pillsbury Company
Sinclair Companies
Sinclair Refining Company
Timken Roller Bearing Company

Tuesday, January 19

American Can Company (2nd Day)
Bell System
Goodyear Aerospace
Goodyear Tire & Rubber Company
Linde—Division of Union Carbide
National Steel Corp. (2nd Day)
Sinclair Companies (2nd Day)
Timken Roller Bearing Co. (2nd Day)
Univac

Wednesday, January 20

Bell System (2nd Day)
Falk Corporation
Goodyear Aerospace (2nd Day)
Goodyear Tire & Rubber Co. (2nd Day)
Linde (2nd Day)
Mallinkrodt Chemical Works
Univac (2nd Day)

Thursday, January 21

Bell System (3rd Day)
General Telephone Co. of Wisconsin
Mallinkrodt Chemical (2nd Day)
Raytheon Company
Sherwin-Williams Company
United States Steel Corporation
Univac (3rd Day)

Friday, January 22

Bell System (4th Day)
Interstate Power Company
Maytag Company
Mitre Corporation
Pittsburgh Plate Glass Co. (Chemical Div.)
Raytheon Company (2nd Day)
Rockwell-Standard Corporation

Monday, January 25

Bureau of Public Roads
Eastman Kodak
Devoe & Raynolds Company
Green Giant Company
John Deere & Company
Ling-Temco-Vought, Inc.
Minnesota & Ontario Paper Company
Reserve Mining Company
Skelly Oil Company
United States Atomic Energy Commission

Tuesday, January 26

Armco Steel Corporation

Eastman Kodak (2nd Day)
Inland Steel Company
Ling-Temco-Vought (2nd Day)
Minnesota Mining & Manufacturing Co.
Motorola
Trane Company
Wisconsin Electric Power Company
Wisconsin Power & Light Company (summer)

Wednesday, January 27

Archer-Daniels-Midland Company
Beloit Corporation
Caterpillar Tractor Company
International Business Machines
Minnesota Mining & Mfg. (2nd Day)
Motorola (2nd Day)
Naugatuck Chemical Division
Trane Company (2nd Day)
Westinghouse Electric Corporation
Wisconsin Power & Light Company

Thursday, January 28

Argonne National Laboratories
Caterpillar Tractor Co. (2nd Day)
International Business Machines (2nd Day)
Minnesota Mining & Mfg. (3rd Day)
Northern States Power Company
Walker Manufacturing Company
Westinghouse (2nd Day)

Friday, January 29

Celanese Corporation of America
Continental Can Company
Farrington Electronics, Inc.
Globe-Union
Nekoosa-Edwards Paper Company
Northern States Power Co. (2nd Day)
Powers Regulator Company (The)
Union Carbide (Silicones Division)
Westinghouse (3rd Day)

Monday, February 1

American Oil Company (Mfg. Dept.)
Control Data Corporation
Emerson Electric Company
Ford Motor Company
Fairbanks, Morse & Company (Beloit)
Honeywell
Mead Corporation (The)
Republic Steel Corporation

Tuesday, February 2

Aluminum Company of America
Amphenol-Borg Electronics Corp.
Automatic Electric Company
Control Data Corporation (2nd Day)
Ford Motor Company (2nd Day)
Honeywell (2nd Day)
Xerox Corporation

Wednesday, February 3

General Electric Company
Harnischfeger Corporation
Honeywell (3rd Day)
Kimberly-Clark Corporation
National Cash Register Company
Oscar Mayer and Company
Whirlpool Corporation

Thursday, February 4

Douglas Aircraft
General Electric (2nd Day)
Harnischfeger Corporation (2nd Day)
McDonnell Aircraft Corporation
Naval Ordnance Laboratory
North American Aviation (5 Divisions)

Friday, February 5

City of Detroit
Douglas Aircraft (2nd Day)
General Electric (3rd Day)
McDonnell Aircraft (2nd Day)
North American Aviation (2nd Day)
National Security Agency
Rohm & Haas Company

Monday, February 8

Amsted Industries
Boeing Company
Charmin Paper Products
Collins Radio Company
Hewlett-Packard Company
Olin Mathieson Chemical Corporation
Pratt & Whitney Aircraft
Standard Oil Company of California

Tuesday, February 9

Aeronutronic Division (Philco Corp.)
Allied Chemical Company
Boeing Company (2nd Day)
Collins Radio Company (2nd Day)
Hewlett-Packard (2nd Day)
Olin Mathieson (2nd Day)
Pratt & Whitney Aircraft (2nd Day)
Procter & Gamble Company
Standard Oil Co. of Calif. (2nd Day)
Sundstrand Corporation

Wednesday, February 10

Abbott Laboratories
American Air Filter Company
Boeing Company (3rd Day)
Corning Glass Works
Cutler-Hammer
Esso Research and Engineering
Humble Oil and Refining
Jersey Production and Research
Procter and Gamble (2nd Day)
Union Carbide Chemicals Corporation

Thursday, February 11

Allegany Ballistics Laboratory
Bemis Bro. Bag Company
Boeing Company (4th Day)
Hercules Powder Company
Esso Research & Engineering (2nd Day)
Humble Oil & Refining (2nd Day)
Jersey Production & Research (2nd Day)
Procter and Gamble (3rd Day)
Union Carbide Chemicals

Friday, February 12

Holiday

Monday, February 15

Hughes Aircraft Company
International Milling Company
Rosemount Engineering
Shell Companies
Timken Roller Bearing Company

Tuesday, February 16

David Taylor Model Basin
Hughes Aircraft Company (2nd Day)
Pittsburgh Plate Glass Company
Rosemount Engineering (2nd Day)
Shell Companies
United States Army Materiel Command
Universal Oil Products Company
Warner Electric Brake & Clutch Co.

Wednesday, February 17

Allis-Chalmers Manufacturing Co.
California State Personnel Board
Carrier Air Conditioning Company
Cornell Aeronautical Laboratory
Dow Corning Corporation
Goodrich-Gulf Chemicals
Lockheed-California Co. (Burbank)
U. S. Army Materiel Command (2nd Day)

Thursday, February 18

Allis-Chalmers (2nd Day)
Dow Corning (2nd Day)
Consumers Power Company
International Harvester Company
Lockheed-California Co. (2nd Day)
Sylvania Electronic Systems

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Friday, February 19

Aeronautical Systems Division—Wright-Patterson AFB, Ohio
Baxter Laboratories, Inc.
International Harvester Co. (2nd Day)
Kennecott Copper Corporation (Western Mining Division)
Roy C. Ingersoll Research Center (Borg-Warner Corporation)
Rural Electrification Administration

Monday, February 22

Holiday

Tuesday, February 23

Allen-Bradley Company
American Oil
E. I. Du Pont
Fisher Governor Company
General Foods Corporation
Phillips Petroleum Co. (Oklahoma)
Square D Company

Wednesday, February 24

Allen-Bradley Company (2nd Day)
Chrysler Corporation
Detroit Edison Company
E. I. Du Pont (2nd Day)
Fabri-Tek, Incorporated
National Bureau of Standards
Northern Natural Gas Company
Swift and Company
Wyoming State Highway Commission

Thursday, February 25

Aerojet-General Corporation
Bendix Corporation
City of Milwaukee
E. I. Du Pont (3rd Day)
Louis-Allis Company
Socony Mobil Oil Company
State Highway Commission of Wis.

Friday, February 26

Aerojet-General Corp. (2nd Day)
Louis-Allis Company (2nd Day)
Minnesota Highway Department
Rex Chain Belt Company
United States Gypsum Company

Monday, March 1

CBS Laboratories
Hoffmann-La Roche
Horbison-Walker Refractories Co.
NASA-Lewis Research Center
Naval Research Laboratory
Skidmore, Owings & Merrill
Texas Instruments
U. S. Forest Service

Tuesday, March 2

Clinton Corn Processing Company
Economics Laboratory, Inc.
Marathon, Div. of American Can Co.
NASA-Lewis Research Center (2nd Day)
Naval Research Laboratory (2nd Day)
Texas Instruments (2nd Day)
Velsicol Chemical Corporation
Washington State Highway Commission

Wednesday, March 3

General Dynamics Corporation
International Minerals & Chemicals
Iowa State Highway Commission
U. S. Geological Survey (2 Divisions)
Chas. Pfizer & Company, Inc.

Thursday, March 4

American-Standard Industrial Division
Climax Molybdenum Company
General Dynamics (2nd Day)
International Minerals & Chemical (2nd Day)

Friday, March 5

AiResearch Manufacturing Co. (Arizona)
Consolidated Papers
Erie Mining Company
General Dynamics (3rd Day)
U. S. Army Engineer District, St. Paul Corps of Engineers

Monday, March 8

Carrier Research & Development Co.
County of Los Angeles
NASA-Flight Research Center (Edwards, California)
Pittsburgh-Des Moines Steel Company
Texaco, Incorporated

Tuesday, March 9

Chicago, Rock Island and Pacific Railroad Company
Wood Conversion Company
NASA-Flight Research Center (2nd Day)

Wednesday, March 10

NASA-John F. Kennedy Space Center
NASA-Manned Spacecraft Center
NASA-Marshall Space Flight Center
Quaker Oats Company

Local Industry

(Continued from Page 32)

transmission. ASD-made inflatable radomes and air-supported shelters are familiar sights at many military bases.

High-altitude balloons account for part of the activity at the Applied Science Division because of man's desire to collect scientific data above 100,000 feet. Concurrent with high-altitude balloon activities is the design of aerodynamic shapes like the "AEROKITE" whose unique configuration permits its use in high winds. A unique application of the "AEROKITE" balloon was recently demonstrated in a surface-to-air pickup system at the Atlantic Missile Range.

Associated with balloon techniques is the instrumentation developed by ASD for air sampling at altitudes up to 150,000 feet and the development of launch techniques that have enabled Litton to launch balloons from Minnesota, the Arctic, remote Pacific islands, and many other parts of the world.

Aerosol physicists at ASD have developed Large Volume Sampling devices for analysis of the soil and atmosphere on Mars. Instruments developed by aerosol physicists at Litton also sample the air we breathe to tell the concentration of harmful bacteria or other particulate matter.

The Division's basic research program is under the direction of Dr. G. K. Wehner, a scientist of international reputation in the field of ion bombardment and plasma physics. When target material is bombarded, some of its atoms shoot out due to a momentum transfer from the bombarding particle. This effect is known as sputtering. Possible applications of the sputtering phenomenon to space travel include electric propulsion, sterilization of spacecraft, solar-wind bombardment, thin film deposition, and many others.

During a period of eight years, ASD scientists developed and built an Electron Mirror Microscope, which is the largest and most sensitive in the field. This unique instrument allows visual presentation of purely electrical phenomena in the following areas of research: 1) resistive and capacitive microcircuits, 2) potential distribution across transistor junctions, 3) thin film insulators, 4) homogeneity of thin film and bulk materials, 5) ferroelectric materials, 6) magnetic materials, 7) thermionic surfaces, 8) photosensitive materials, 9) space-charge distribution in the vicinity of a thermionic surface, 10) magnetic fine structure of superconductors, and 11) contact potentials such as might be introduced by adsorbed layers. The best indications of the scope of this instrument are the sizes of its specimen area and main viewing screen. Specimens as large as 75 mm. in diameter can be inserted at the specimen stage, and the main viewing screen has a diameter of 165 mm. Three of these instruments are now operational in the division's microscopy laboratory.

The people who work at Litton's Applied Science Division are professionally oriented: over 50% of them have college degrees. Many of the research people are international authorities in their fields; scientific journals like the *Journal of Applied Physics* have published dozens of articles by those who work for this Twin Cities company. The average length of service with the division is over nine years. Many of the scientists and engineers were formerly associated with the Aerospace Research and Engineering Department of General Mills, Inc., which was acquired by Litton in September, 1963.

Founded in 1953 by Charles B. ("Tex") Thornton, Litton Industries, the parent corporation, has 99 plants in the United States and 15 foreign countries. It is among the 100 largest corporations in the United States, with 1964 sales of over $750 million. Litton produces products ranging from nuclear submarines to subminiature solid state devices. One of its divisions, Ingalls, is the third largest shipbuilder in the nation. Litton is a leading manufacturer of calculating machines (Monroe), cash registers (Svenska), and typewriters (Royal). Many of the Litton divisions develop and produce systems for the defense and space agencies of the U. S. government. Some of the rapid growth of the company can be attributed to the acquisition of various companies, including the Applied Science Division in the Twin Cities.

Splinters . . .

There is only one engineer who ever got rich. He recently died in Colorado and left a fortune of $50,000 which he amassed through unceasing toil, superhuman perserverance, and the death of an uncle who left him $49,000.

• • •

E.E.: "I nearly ran over a pedestrian a few minutes ago and I think he was from Miami."

M.E.: "How did you know he was from Miami?"

E.E.: "Well, when he reached the sidewalk I heard him say something about the sun and the beach."

• • •

If boys grow up to be adults, do girls grow up to be adultresses?

• • •

It's not the hop, skip, and jump between the twin beds that wears out the carpets, but the slow drag back.

• • •

After delivering Mrs. James of her ninth child, the doctor called the husband aside.

"Next time you feel like propagating," he said, "ask yourself if you can support another child."

"Doc," replied James, "When I feel like propagatin', I feel like I could support the whole state of Georgia."

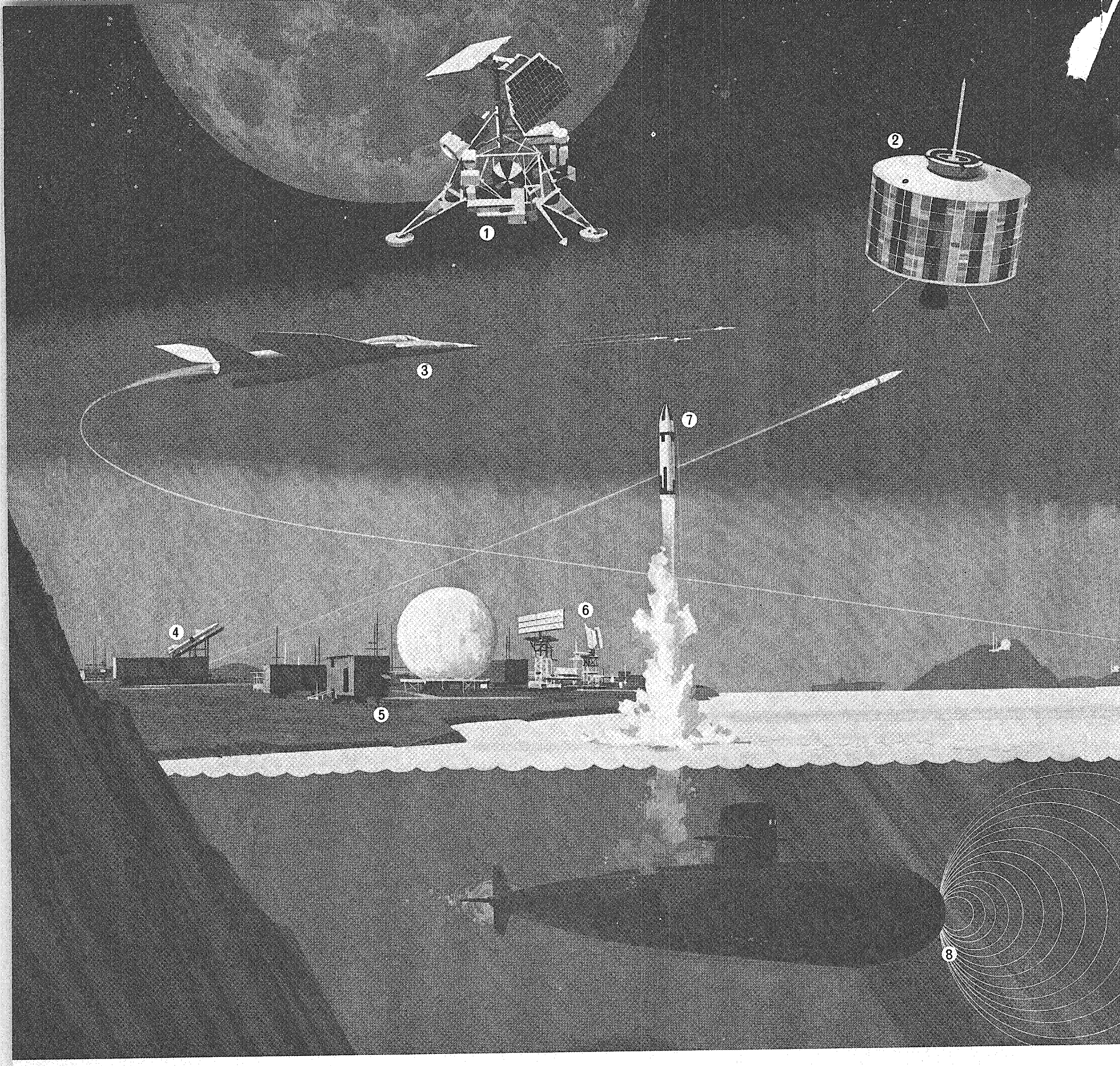
• • •

Marcella: "You've been stenographer for nearly all the big shots in this department, haven't you?"

Beverly: "Yes, I'm just about on my last lap now."

• • •

She was only an undertaker's daughter, but gosh what she'd undertake.



Opportunities at Hughes for EE's—Physicists—Scientists:

from the ocean floor to the moon...and beyond

Hughes sphere of activity extends from the far reaches of outer space to the bottom of the sea . . . includes advanced studies, research, design, development and production on projects such as: ① **SURVEYOR**—unmanned, soft-landing lunar spacecraft for chemical and visual analysis of the moon's surface; ② **SYNCOM** (Synchronous-orbit Communications Satellite)—provides world-wide communications with only three satellites; ③ **F-111B PHOENIX** Missile System—an advanced weapon system designed to radically extend the defensive strike capability of supersonic aircraft; ④ **Anti-ICBM Defense Systems**—designed to locate, intercept and destroy attacking enemy ballistic missiles in flight; ⑤ **Air Defense Control Systems**— border-to-border control of air defenses from a single command center—combines 3D radar, real-time computer technology and display systems within a flexible communications network; ⑥ **3D Radar**—ground and ship-based systems give simultaneous height, range and bearing data—now in service on the nuclear-powered U.S.S. Enterprise; ⑦ **POLARIS** Guidance System — guidance components for the long-range POLARIS missile; ⑧ **Hydrospace** — advanced sonar and other anti-submarine warfare systems.

Other responsible assignments include: ATS (advanced technological satellites), TOW (wire-guided, anti-tank missile system), VATE (automatic checkout equipment), advanced infrared systems, electronic signal processing, space communications, parametric amplifiers, airborne radar systems, reconnaissance systems, aerospace vehicle development, missile/spacecraft power & propulsion systems...and others.

B.S., M.S. and Ph.D. Candidates

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February 15 & 16, 1965

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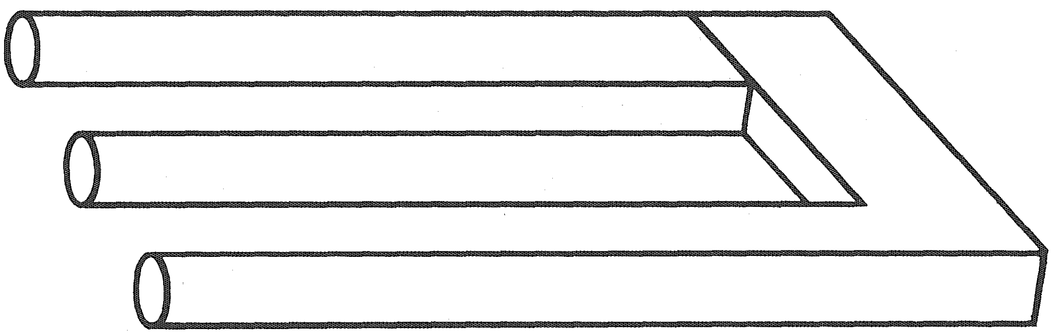

LOOK CLOSELY.
TRY TO FORGET IT.

It's a simple optical illusion, but it bothers you, doesn't it? It's hard to forget it until you've discovered what fooled you. There's something about an inquiring mind that won't let it forget a problem until it's solved.

In school, how many times have you worked half the night on an assigned problem until you solved it? After a while, it didn't matter whether the problem was assigned or not. *You* wanted the answer.

It's this kind of personal motivation we look for and like in a man. That's why we can do without "strangling" supervision at Honeywell. That's also one of the reasons engineers don't punch a time clock here. We hire men whose personal standards are higher than the discipline the job demands. We prefer to rely on a man's sense of personal responsibility to get the work done. This attitude has paid off in many ways.

We have one of the lowest turnover rates in the industry ... less than half the national average. We can't help but feel that our atmosphere of professional freedom is one of the principal reasons.

Merit pay and promotion ... are also a part of our policy. Good men like to set their own pace, and we like it that way. We pay and promote to recognize individual performance and progress. We'll push you along as fast as you can handle the work.

Tuition aid, too.
Honeywell men can get advanced degrees through company-supported programs. Greater knowledge will help both of us become first in the field.

What's here at Honeywell?
We employ over 48,000 people and we offer the stability and variety that go along with a broad-based company. We have 18 divisions, and we are constantly in need of more engineering and research people to staff them.

Briefly, our business is automatic control. And, we make all kinds: controls for homes and commercial buildings; weapons systems; products for aircraft, spacecraft and missiles; EDP equipment; instruments for process control and medical use; precision switches and semiconductors. In short, it would be tough to find a business or market we don't serve in some way.

Of course, we can't tell you the whole story here. To learn more about jobs at Honeywell, ask your advisor or Placement Director for our folder, PINPOINT YOUR FUTURE. It contains information on Honeywell products, plants and office locations.

If you're interested in Honeywell, why not talk to one of our recruiters next time he visits your campus? No deception there, OK? Just straight talk about what we have to offer each other.

Check the date for interviews. Or, write to Mr. H. P. Eckstrom, Corporate Director of Employment, Minneapolis, Minn. 55408.

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SAWDUST From the Log

A young man contemplating matrimony wanted to propose and didn't know how, so he went to his dad for advice.

"Well, son," said the old man, "I don't know that I can help you much. With me and your maw it happened one Sunday evening, when yer maw and me was a sittin' on the sofa. We was just a talkin' along and purty soon yer maw leaned over and whispered in my ear and I said, 'You are?' and the next day we were married.

• • •

An entrant in a long distance swimming contest in the English Channel was a girl from Italy. She amazed everybody by outswimming all the top athletes from the rest of the world. Questioned by reporters on her background, she explained the formula for success: "I was a street walker in Venice for two years."

• • •

Veteran: "Last night I persuaded my girl to say yes."

Novice: "Congratulations, when's the wedding?"

Veteran: "Wedding? What wedding?"

• • •

"Do you like dancing?"

"Yes, I love to!"

"Good, that's even better than dancing."

• • •

A boy and girl were out driving. They came to a quiet stop on a country lane and the car stopped. "Out of gas," said the boy.

The girl opened her purse and pulled out a flask.

"Wow," said the boy, "a bottle—what is it?"

"Gasoline," replied the girl.

• • •

Two stenographers were discussing the handsome salesman in their office. One of them observed, "He dresses so well."

The other, with a knowing light in her blue eyes, agreed and added happily . . . "And so quickly, too."

"My wife is scared to death someone will steal her clothes."

"Doesn't she have them insured?"

"She has a better idea than that. She has a guard in the closet to watch them. I found him there last night."

• • •

A college football coach was surprised to see a busty coed wearing a varsity sweater. Stopping the girl, he growled:

"What are you doing with a letter sweater? Don't you know you're not supposed to wear one unless you've made the team?"

The coed smiled, then cooed, "WELL?"

• • •

Ken: "What did the usherette say when her strap broke?"

Ray: "I dunno."

Ken: "I have two down in front."

• • •

Men will get mad and tell you to go to . . . Women will smile and lead you there.

Adultery: Two wrong people doing the right thing.

• • •

Women should be obscene and not heard.

• • •

A pharmacist found it necessary to leave his drugstore one day. He asked his soda clerk to keep an eye on things until he returned. No sooner had the pharmacist left than in staggered a lushed-up character demanding in a loud voice some medicine to cure his hiccups.

The druggist returned and asked if there had been any customers and the soda clerk replied:

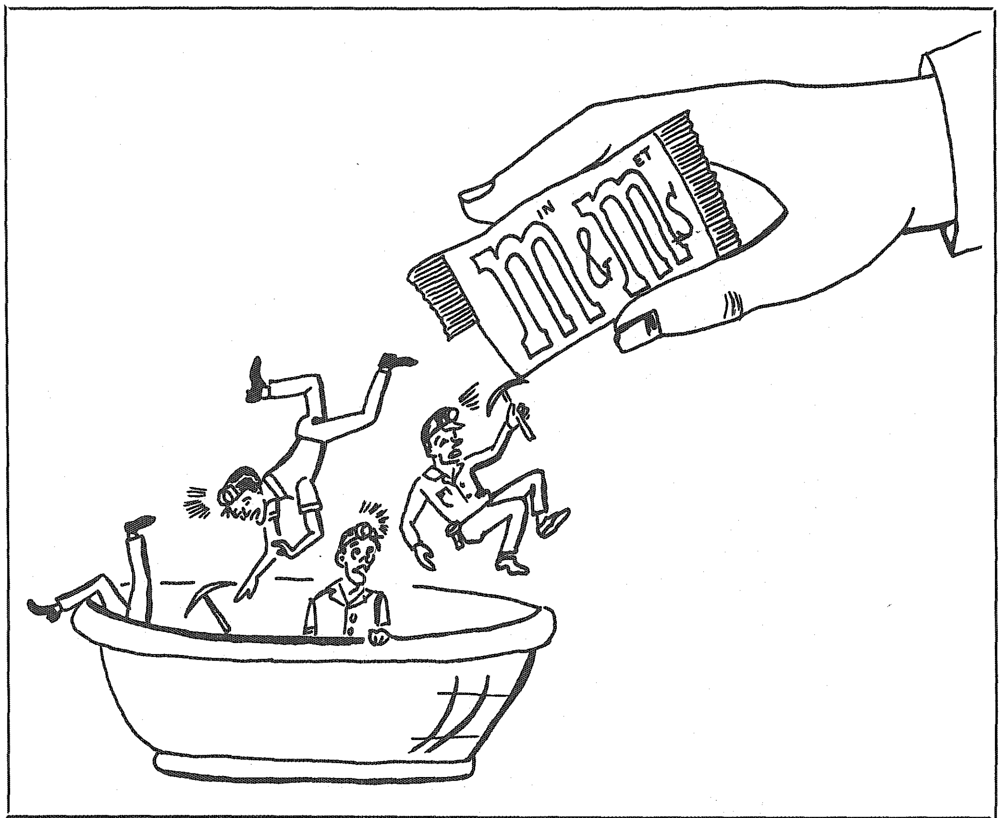
"Only one, a drunken guy with a bad case of the hiccups."

"Well," asked the druggist, "did you tell him to come back when I was here?"

"Oh, no," answered the kid soda jerker, "I took care of it myself. I mixed him up a cup of epsom salts with citrate of magnesia, castor oil and mineral oil; then I gave him some Ex-Lax to nibble on. He took it right then, too."

"Great Scott!" said the druggist, turning pale, "That mixture won't stop the hiccups!"

The soda clerk smiled knowingly and said: "Want to bet? Take a look outside; there he is holding on to that lamp post afraid to hiccup!"



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Best wishes for the quarter and the year.

Engineering Book Store.

BRAIN TEASERS

by GERALD JOHNSON, *ME '67*

1. In a certain area of South America there is a tribe which executes all white men who enter their kingdom. As it was, one day a missionary ventured into this area and was captured. To execute this poor fellow they decided either to boil him in oil or shoot him with a poison arrow, depending on the following condition: the missionary would make one final statement and depending on whether it was true or false, they would boil him in oil or shoot him, respectively. However, he made one statement that so baffled the whole tribe that they let him go. What was his statement, assuming that the members of the tribe knew all?

2. If it takes seven men seven days to dig seven holes, how long will it take seven men to dig half a hole?

3. You have a dollar and you need 100 pieces of candy, so you rush to a candy store, but alas, they don't have any penny candy. They do have pieces for ½ cent, 2 cents and 3 cents. The 3-cent candy is the most desirable, and you wish to get as many of those as possible. But remember, you must get 100 pieces. How would you spend your dollar if you must buy at least one at each price?

Answers in February issue.

Answers to December Brain Teasers

1. 111999888, (10583) –1
2. 1,027 pages.
3. 6 rungs.
4. Only half way.
5. 1904.
6. The water level will drop. While in the boat, the bricks displace an amount of water equivalent to their weight. When immersed, they displace an amount of water equivalent to their volume. This latter displacement is less and the water level drops.

A Box of Chocolates

"Grampa," said young Evelyn, "had such a bright idea the other day. He said he wanted to find out how greedy we were."

"What happened?" I asked.

"You tell him, Charles," said Evelyn.

"Well," said Charles, "he produced a big box of chocolates and gave it to Evelyn—"

"No, he gave it to Kitty," corrected Evelyn.

"Anyway," said Charles, "he gave it to one of them. Then he explained that all of us could eat as many chocolates as we liked. At the end of the day, Kitty would report the number of chocolates eaten. Then each of us would receive, from Grampa, one penny for each chocolate eaten by somebody else, less three cents for each chocolate eaten by himself (or herself)."

"What a cunning scheme!" said I. "I'll bet it didn't cost Grampa very much."

"Didn't it just!" said Clair. "It cost him all of $4.69."

"Whoever ate all the chocolates?" I asked.

"Edna ate the most," said Charles. "Then came David. I forget about the rest of us. But I remember that no two of us ate the same number and that each of us ate at least one."

How many children in all ate chocolates, and how many did Edna eat?

This is the first of a series of problems which will be appearing in the *Technolog* during Winter Quarter. Answers may be obtained from *Gopher* salesmen who will be easily identified. Students may also obtain the answers, and buy their *Gopher*'s, at the *Technolog* office, Room 2, Mechanical Engineering Building.

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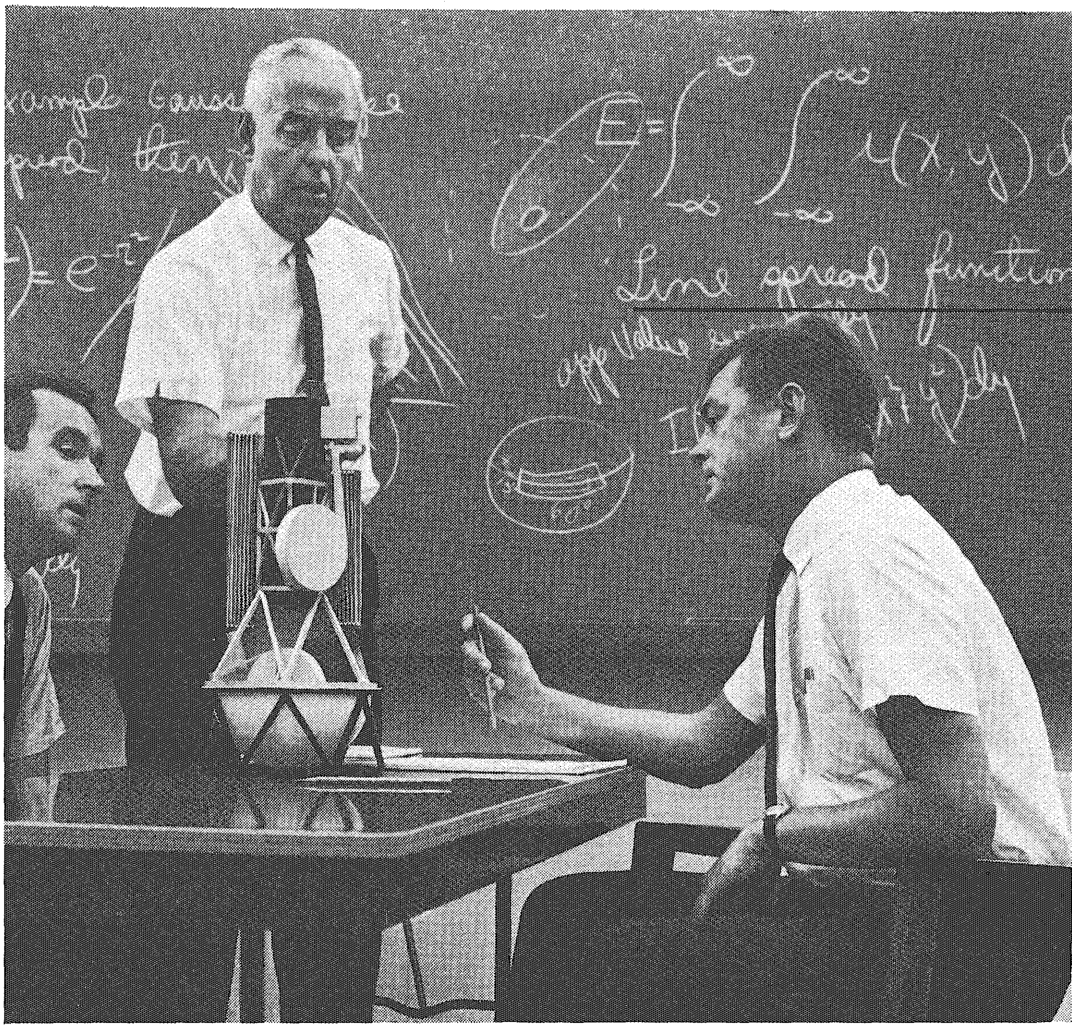

Some M.E.s are going to learn what this means

The mechanical engineer who decides to join forces with us upon completion of his formal education will discover soon enough that the biggest part of his education is still ahead of him. This cliché can be interpreted two ways.

The literal way—"Line spread function" mathematizes certain aspects of image structure in optical theory. Very few mechanical engineers shelter behind academic ivy long enough to get that deep into other men's games. If, for example, we need mechanical engineers capable of communicating with our optical physicists for a common purpose—and we have such purposes in our little-known but heavy aerospace commitments—we had better provide the right fertilizer for ivy ourselves. So we do. Some of the more sophisticated current ideas on what constitutes engineering have strong partisans among the men from whose ranks a newcomer can pick his boss here.

The hard-boiled way—The nice part about being an engineer here is that a man can find a level of sophistication to suit his interests even without risking the shifting sands of international policy. We are plainly, frankly, proudly, and gloriously commercial. We need men to whom to teach the technical subtleties of making money from satisfying the everyday needs of people and of business. When done properly, it can be as challenging to the intellect as the work of the engineer across the road who gets the same signature on his paycheck for ideas on palpating the moon.

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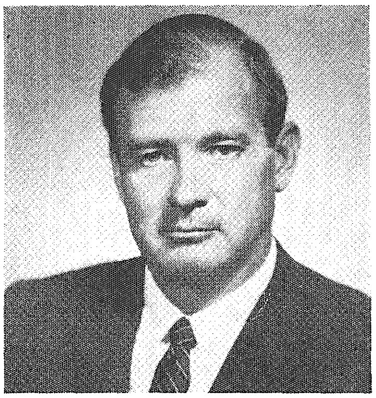
Advancement in a Big Company: How it Works

An Interview with General Electric's C. K. Rieger, Vice President and Group Executive, Electric Utility Group



C. K. Rieger

■ Charles K. Rieger joined General Electric's Technical Marketing Program after earning a BSEE at the University of Missouri in 1936. Following sales engineering assignments in motor, defense and home laundry operations, he became manager of the Heating Device and Fan Division in 1947. Other Consumer-industry management positions followed. In 1953 he was elected a vice president, one of the youngest men ever named a Company officer. Mr. Rieger became Vice President, Marketing Services in 1959 and was appointed to his present position in 1961. He is responsible for all the operations of some six divisions composed of 23 product operations oriented primarily toward the Electric Utility market.

Q. **How can I be sure of getting the recognition I feel I'm capable of earning in a big company like G.E.?**

A. We learned long ago we couldn't afford to let capable people get lost. That was one of the reasons why G.E. was decentralized into more than a hundred autonomous operating departments. These operations develop, engineer, manufacture and market products much as if they were independent companies. Since each department is responsible for its own success, each man's share of authority and responsibility is pinpointed. Believe me, outstanding performance is recognized, and rewarded.

Q. **Can you tell me what the "promotional ladder" is at General Electric?**

A. We regard each man individually. Whether you join us on a training program or are placed in a specific position opening, you'll first have to prove your ability to handle a job. Once you've done that, you'll be given more responsibility, more difficult projects—work that's important to the success of your organization and your personal development. Your ability will create a "promotional ladder" of your own.

Q. **Will my development be confined to whatever department I start in?**

A. Not at all! Here's where "big company" scope works to broaden your career outlook. Industry, and General Electric particularly, is constantly changing — adapting to market the fruits of research, reorganizing to maintain proper alignment with our customers, creating new operations to handle large projects. All this represents opportunity beyond the limits of any single department.

Q. **Yes, but just how often do these opportunities arise?**

A. To give you some idea, 25 percent of G-E's gross sales last year came from products that were unknown only five or ten years ago. These new products range from electric tooth brushes and silicone rubber compounds to atomic reactors and interplanetary space probes. This changing Company needs men with ambition and energy and talent who aren't afraid of a big job—who welcome the challenge of helping to start new businesses like these. Demonstrate your ability—whether to handle complex technical problems or to manage people, and you won't have long to wait for opportunities to fit your needs.

Q. **How does General Electric help me prepare myself for advancement opportunity?**

A. Programs in Engineering, Manufacturing or Technical Marketing give you valuable on-the-job training. We have Company-conducted courses to improve your professional ability no matter where you begin. Under Tuition Refund or Advanced Degree Programs you can continue your formal education. Throughout your career with General Electric you'll receive frequent appraisals to help your self-development. Your advancement will be largely up to you.

FOR MORE INFORMATION on careers for engineers and scientists at General Electric, write Personalized Career Planning, General Electric, Section 699-11, Schenectady, N. Y. 12305

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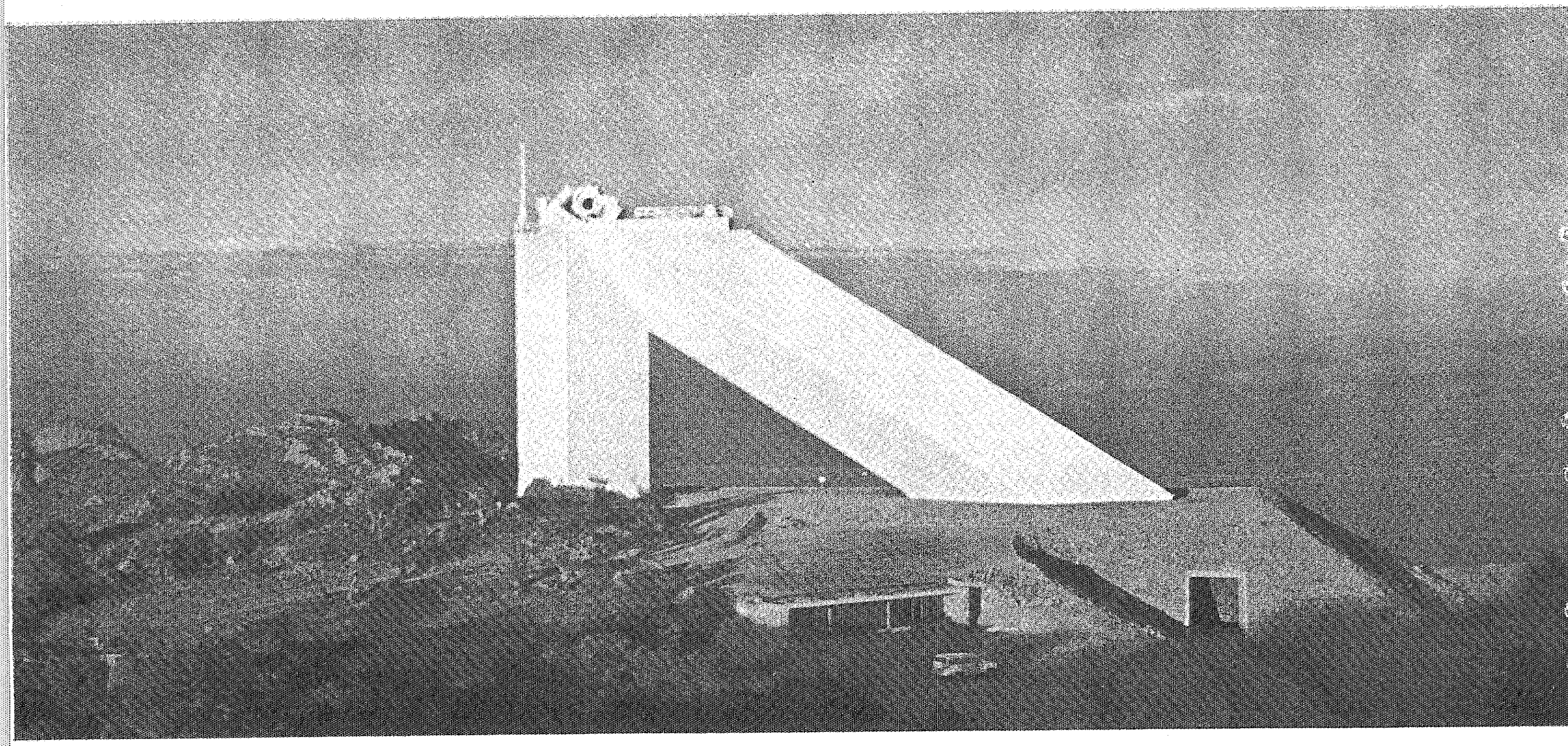
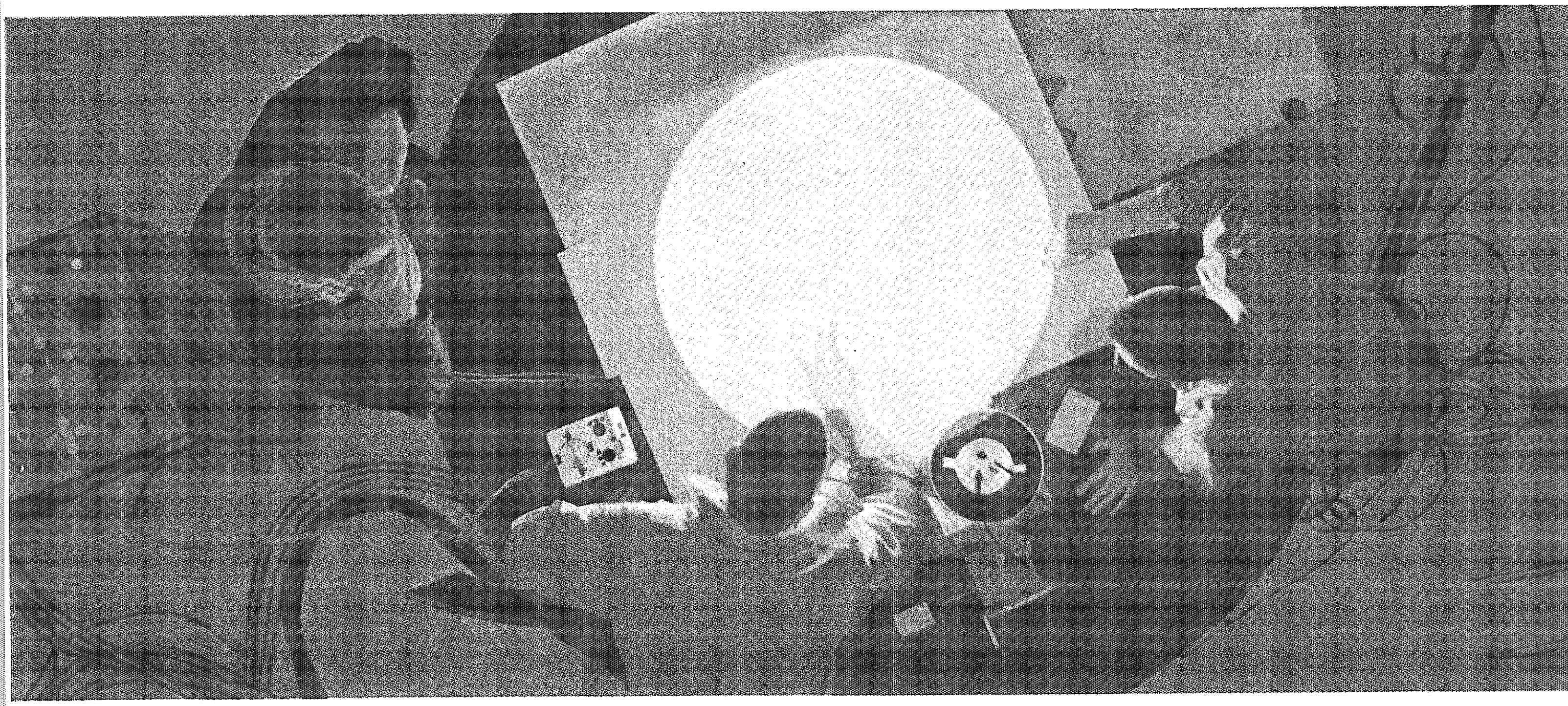


On top of Kitt Peak, the world's largest solar telescope



gives scientists the largest image of the sun man has ever had

At the top of the gleaming white tower in the upper picture is a 60-inch quartz mirror which precisely tracks the sun all day in the clear, dry air above the Arizona desert.

It is cradled in a carriage called a heliostat, built by Westinghouse.

Part of this telescope is tunneled out of the flank of the mountain. Sunlight is reflected 480 feet down this tunnel and back up 280 feet into a dark viewing room by means of two other mirrors, also on Westinghouse mountings.

By studying the sun's image here, scientists hope to learn more about the sun's magnetic field and how sunspots affect our weather and communications.

The 60-ton heliostat at the Kitt Peak National Observatory is designed to track the daily motion of the sun to an accuracy of 1/1000 of an inch.

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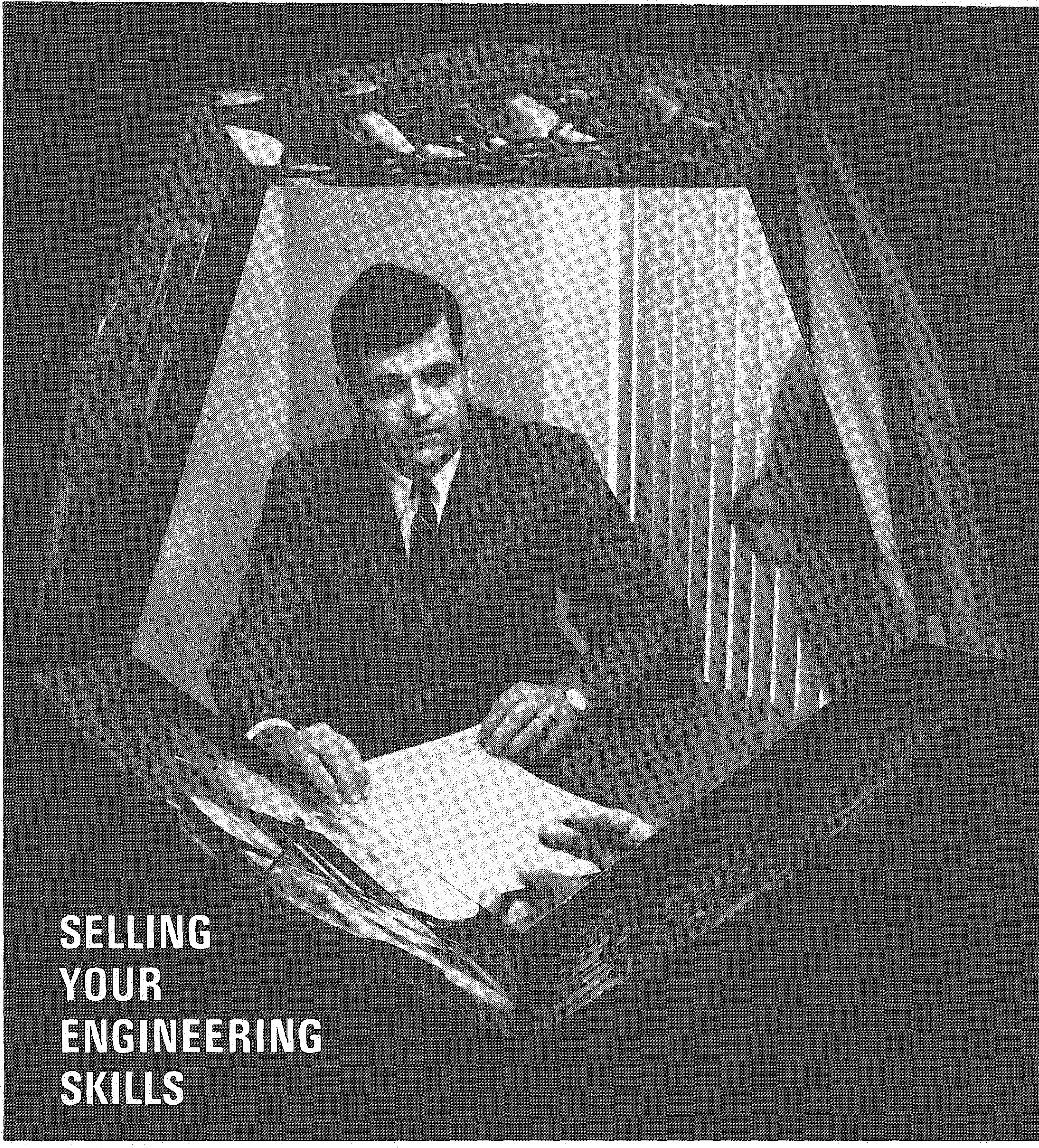

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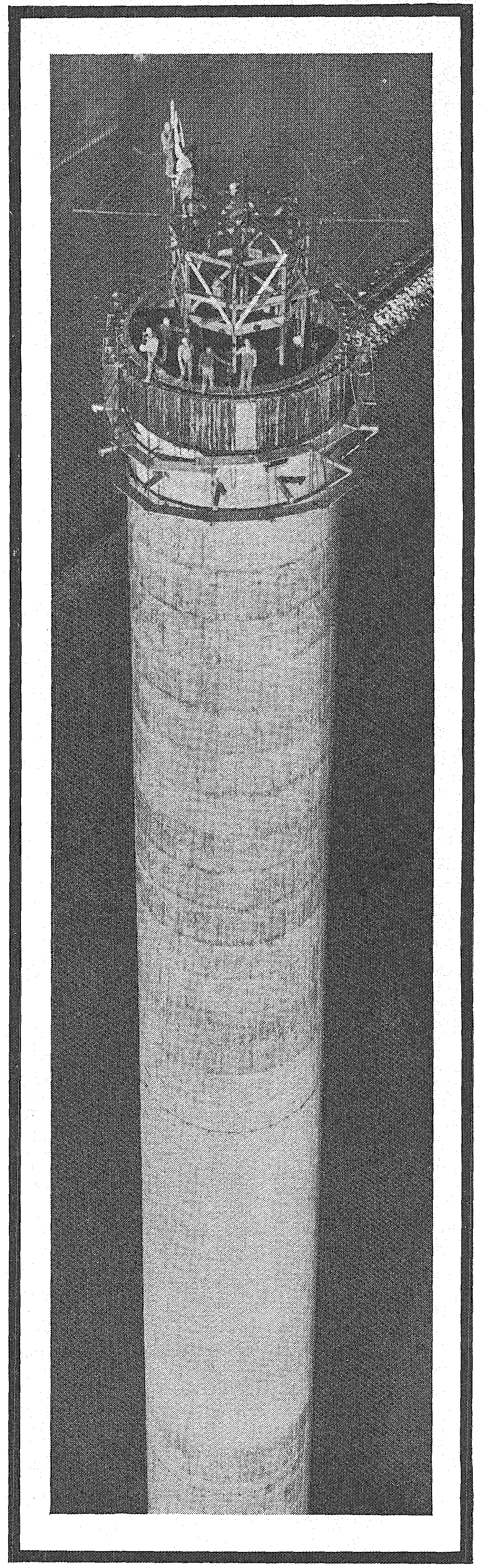

Minnesota TECHNOLOG

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Cover: The new Washington Avenue Bridge, under construction just south of the present bridge, is pictured on this month's cover. For full details, see p. 24.

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Editorial

PROJECT AWARENESS

What is college? The usual reply includes not only classes and study, but also activities and fun. However too many students seem to forget what activities I.T. has to offer.

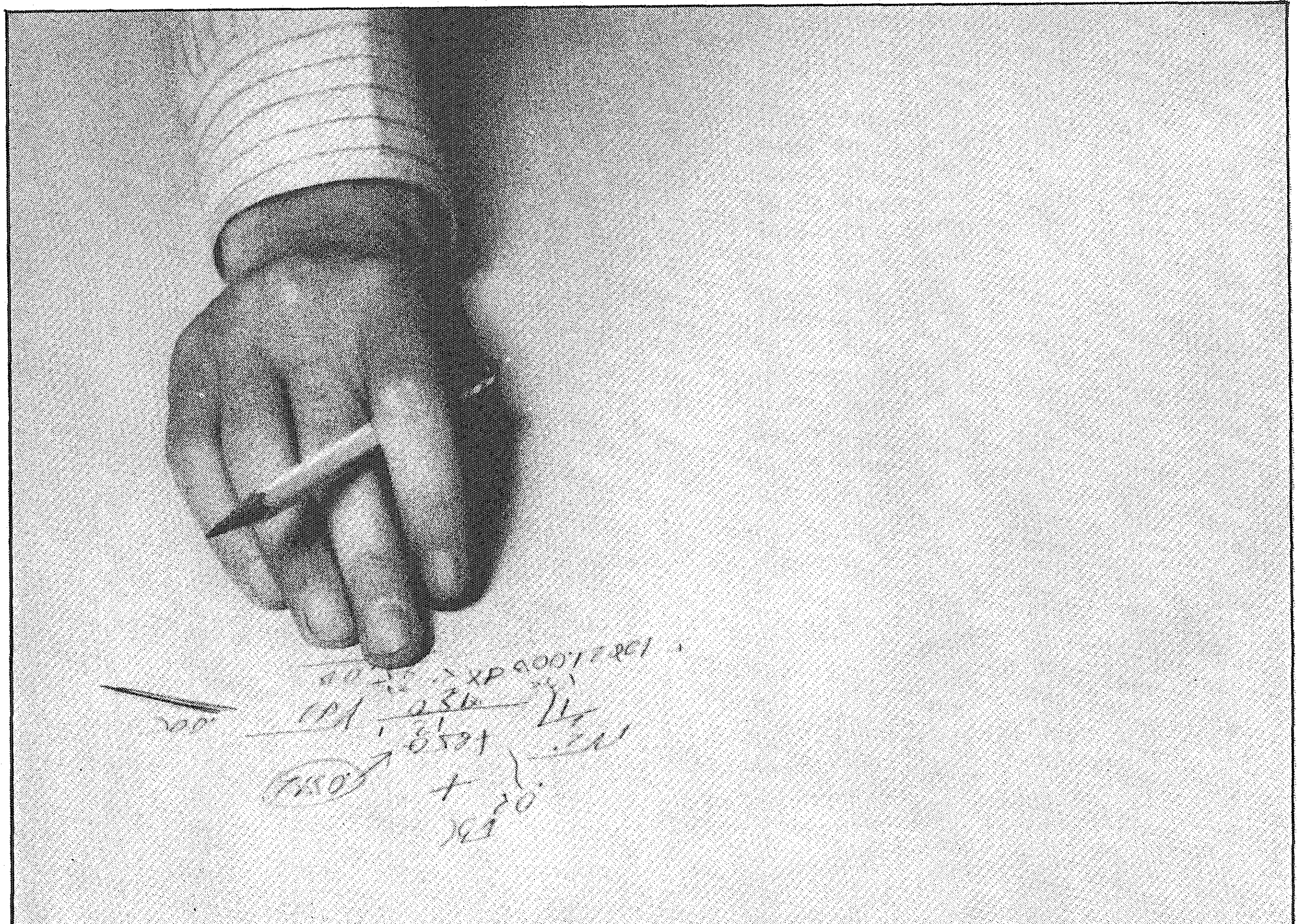
Tacked on the wall outside E 133 is an E-Day poster with a committee sign-up sheet. As usual, the blanks far outnumber the filled-in names. E-Day can use help, especially third-year students. With the four-year plan now in effect, it is vital that all underclassmen, not only third-year students, participate in this year's activities.

On February 24, at 3:00 p.m. in the Union Ballroom, I.T. will hold its first all I.T. student convocation. A highlight of this meeting will be one of the speakers, our Dean, Athelstan Spilhaus. This year we won't need to wait until E-Day to see him. A prominent representative from industry will be the other speaker. The purpose of this convocation is to inform the student of the opportunities available to him.

E-Day and the all I.T. convocation are only two of the many activities in which an I.T. student can participate. Another alternative is joining a technical society. All these groups would be more than happy to have more active members. Now is the time to begin Project Awareness. As a first step, why not attend the all I.T. convocation on Wednesday, February 24. Will I see you there?

SMA.

What is a chemical engineer doing at NCR?



Lots of things. With a BS, MS or Ph.D. in chemical engineering, he may be working with plastics, polymers, inks, paper, metals, foods or pharmaceuticals.

In NCR's Finishes Control Laboratory, his assignment might deal with new process design for electro or electroless plating. Or with new etching techniques for printed-thru-hole circuit boards.

In Chemical Development, he might be working with special paper products for business systems (such as carbonless transfer and thermocopy paper, punched cards, and tape). He might be developing new media storage by changing materials and coating techniques.

In the Plastics Laboratory, you may find him evaluating new materials, determining new methods of production, developing new processes or improving old ones.

Capsular Research and Product Development would involve him in NCR's unique microencapsulation process which locks up a material in a microscopic capsule for subsequent release. This has applications in such fields as pharmaceuticals, foods and adhesives.

In NCR's Materials Analysis group, he might assist our research organizations — qualifying production materials or developing new wet and dry test techniques.

If your interests fit into this broad picture of process development, product development and product application, we'd like to hear from you. Write to Thomas F. Wade, Technical Placement, NCR, Dayton, Ohio 45409. An equal opportunity employer.

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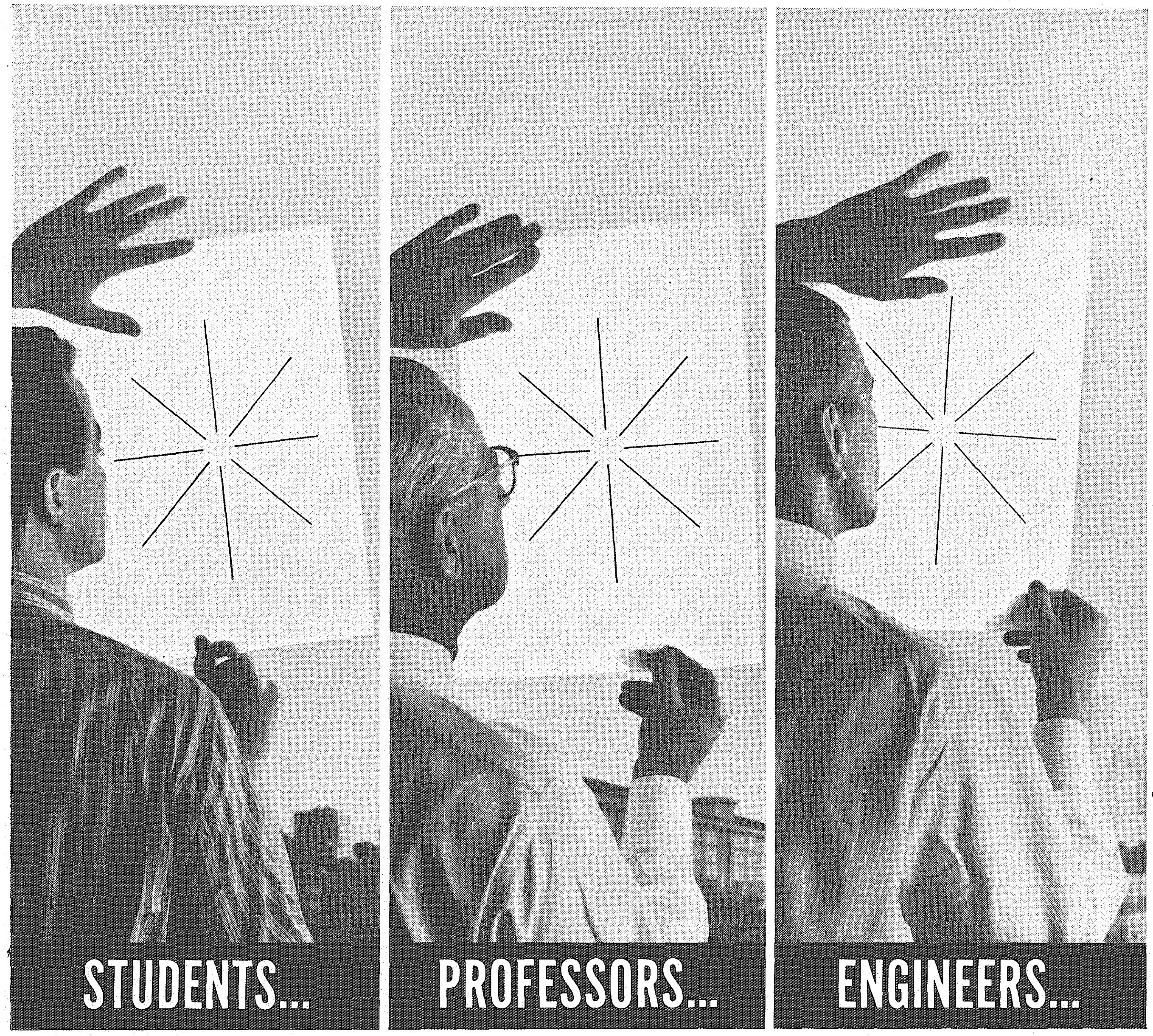

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PESTICIDES IN WATER

by CHARLES R. BOWMAN, *Grad. Student*

The introduction of DDT and 2,4-D during World War II was the beginning of a revolution in the pesticide chemical industry. Before the war, the principal pesticides were either inorganic compounds or naturally-occurring organic compounds. Today there is a tremendous array of synthetic organic pesticides on the market and the quantities and varieties produced are increasing. It is estimated that over 4,000 commercial pesticide preparations are available in the United States.

The use of synthetic organic pesticides is very extensive and is increasing. Figure 1 illustrates this increased use by year. In 1942, an estimated 633,943,000 pounds were sold at an estimated value of $346,441,000.

An interesting calculation can be made to relate these quantities to the annual runoff of all watercourses in the

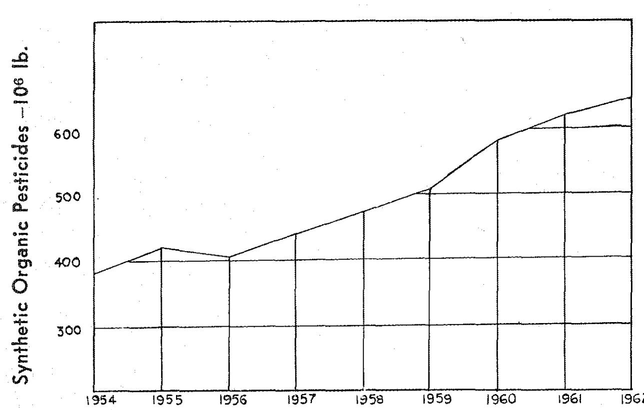


Fig. 1.
Synthetic Organic Pesticide Use in the United States.

United States. If the total sales of pesticides in 1962 were diluted by the average runoff of 1160 billion gallons per day, the resulting concentration would be about 0.18 ppm. This figure indicates the order of magnitude of the quantities involved. Of course, only a portion of these chemicals reach watercourses, but the use of pesticides is far from uniform either geographically or in time.

The term pesticide includes many compounds intended for a variety of purposes. Pesticides are used to control insects, mites, ticks, fungi, rodents, pest birds, predatory animals, rough fish, plant diseases and weeds. They also act as regulators of plant growth, as defoliants, and as desiccants.

These compounds, when applied to foliage, soils, and watercourses, are certain to be moved by rainfall and runoff into our rivers. Some of these chemicals are quite resistant to removal by biological degradation or physical action and because of their toxicity, are a potential public health problem.

When pesticides reach a watercourse, they do not necessarily remain in solution. The greater part is believed to be taken up by bottom silts. This fact may be a distinct aid in the pesticide pollution problem. Tarzwell has reported that in ponds under study, those having clay bottoms and considerable organic material seem to absorb or render nontoxic considerable amounts of DDT.

Although pesticides exist in extremely small amounts in our waters, there is a possibility of concentration through the biologic food chain. The plankton in the water absorb the pesticides, the herbivores eat the plankton, the small carnivores eat the herbivores, the larger carnivores eat the smaller carnivores, and throughout the chain, each link increases the concentration of pesticides. Such buildups have resulted in several wildlife kills.

Benefits of Pesticides

Rachel Carson has created a great deal of public awareness of the hazards and detrimental effects resulting from the use of pesticides. Until the publication of *Silent Spring*, very little public attention had been given to the potential hazards of pesticides. However, reading her book may lead people to forget the benefits accrued by use of pesticides.

Our material standard of living has been greatly improved during the twentieth century by increased control over the environment. Few recent developments have been so effective or have had application in such a wide range of human endeavor as the pesticide chemicals. Pesticides have increased the production and improved the quality of food, feed, and fiber. They protect our natural resources and keep in check many kinds of nuisance and disease-spreading insects as well as unwanted plants.

Hazards of Pesticides

Because pesticide chemicals are designed to kill or upset the metabolism of some living target organism, they are potentially dangerous to other living organisms. The effect on humans is usually not readily apparent. Except in cases of large single exposures which result in acute poisoning, pesticides may be an insidious hazard. The biological effects may be cumulative over long periods of time and the hazard to the individual depends upon lifelong exposure.

Pesticides taken in by the body are stored in the fatty tissues which make up about 18 per cent of the total body weight. Here they pose no problem. However, if the body draws upon the reserves of fat, the toxic effects take place. This is especially detrimental if a weight loss should occur during illness.

Fish are particularly sensitive to low concentrations of insecticides. The effects on these organisms are readily apparent and are most frequently reported as an indication of pollution. The chlorinated hydrocarbons are extremely toxic to fish, with endrin being the most toxic. Table 1 indicates the concentrations of various chlorinated hydrocarbons that will produce a 50 per cent fish kill in 96 hours.

Measurement of Pesticides

In order to properly evaluate the problem of pesticides in water, accurate measurement is a prime requisite. Measurement of pesticide concentrations in water involves processes which far exceed the measuring techniques of common sanitary analysis. The concentrations generally measured are in parts per billion or micrograms per liter, although part-per-trillion accuracy is available. Such small concentrations necessitate large samples for routine analysis, and because of this the carbon absorption technique has been developed.

This method uses the adsorptive capacity of activated carbon to concentrate organic materials from large water samples, measuring up to 5,000 gallons. The Public Health Service notes, however, that the concentration values obtained for specific substances with this method must be considered minimum values. First, the efficiency of the adsorption on, and desorption from, carbon cannot be expected to be 100 per cent for all compounds. Secondly, until a means is available to gather organics adsorbed on the suspended solids as well as the organics in solution from the large sample, the determined concentrations must be considered low.

Following filtration, the carbon is dried and extracted successively with chloroform and alcohol. Subsequent removal of excess solvent leaves the chloroform residue extract for examination. This extract is separated into groups based on solubility differences, and the largest fraction, the neutrals, is analyzed for pesticides. The analysis is either by electron capture gas chromatography or microcoulometric titration gas chromatography. Using the former method, the potential sensitivity for a 5,000-gallon sample is $5x10^{-8}$ micrograms per liter and $2.5x10^{-7}$ micrograms per liter for a 1,000-gallon sample. The latter method has a potential sensitivity of $2.5x10^{-6}$ micrograms per liter for a 5,000-gallon sample.

TABLE I

Amount of Chlorinated Hydrocarbon Insecticides which may cause fifty per cent fish mortality in 96 hours.

Insecticide	*Concentration (μg/liter)*
Endrin	0.60
Toxaphene	3.5
Dieldrin	7.9
Aldrin	13
DDT	16
Heptachlor	19
Chlordane	22
Methoxychlor	62
Lindane	77
BHC	790

From C. M. Tarzwell, "The Toxicity of Some Organic Insecticides to Fishes," Proceedings of the Twelfth Annual Conference, Southeastern Association of Game and Fish Commissioners, 1958.

Problems of Pesticides

The major concern with regard to pesticides in water supplies is of course their toxicity for humans. However the toxicity of pesticides in our drinking water is not the only problem. Serious taste and odor problems often result from relatively low concentrations of pesticides. Also it should be remembered that public water supplies are used for watering lawns, shrubs and flowers, and for filling aquariums. It will certainly not help a water utility's public relations if residues of pesticides kill the customer's petunias or guppies.

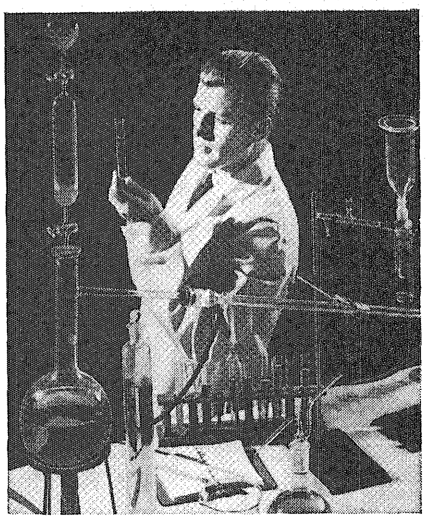
Several of the chlorinated hydrocarbons have threshold odor concentrations on the order of a few parts per billion. Such low concentrations indicate that a careful watch should be kept on the concentrations of such chemicals in water supplies to prevent possible problems before they occur. In many cases the odor problem is apparent before the toxicity is of concern. In general, the pesticide concentrations in our waters resulting from terrestrial uses has not reached this point. A more immediate problem is created by the use of fish poisons. Many upstream water supply reservoirs are used for recreational purposes, and as a part of the improvement program rough fish are often poisoned prior to restocking with more desirable species. Two pesticides, rotenone and toxaphene, have been used for fish eradication. Both are effective but there are certain differences that are worth noting.

Rotenone is one of the oldest pesticides. It is prepared from a tropical plant called cube and is thus a natural organic pesticide. Toxaphene is a newer pesticide made up of a mixture of chlorinated camphene products. It falls in the chlorinated hydrocarbon class.

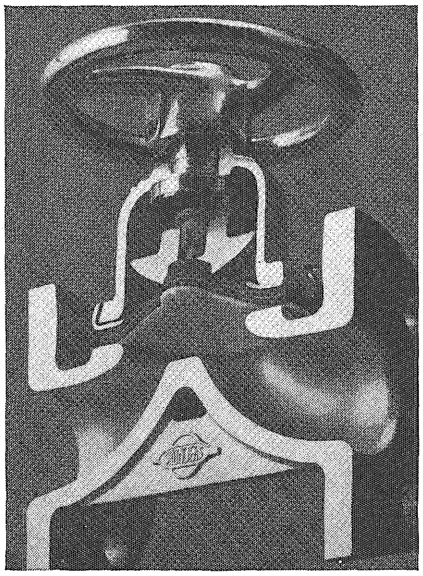
The toxic components of both rotenone and toxaphene can be removed from water by use of activated carbon. However the duration of this special treatment will vary depending upon the chemical to be removed. Rotenone is readily detoxified by the action of light and air and under favorable conditions will have a maximum life of much less than 1 month. Toxaphone, on the other hand, is relatively stable. The reported length of time a water remains toxic after treatment with toxaphene varies, ranging from a minimum of four weeks to a maximum of more than two and one-half years. Thus, proper selection of pesticides can show economic benefits as well as minimize polluted conditions.

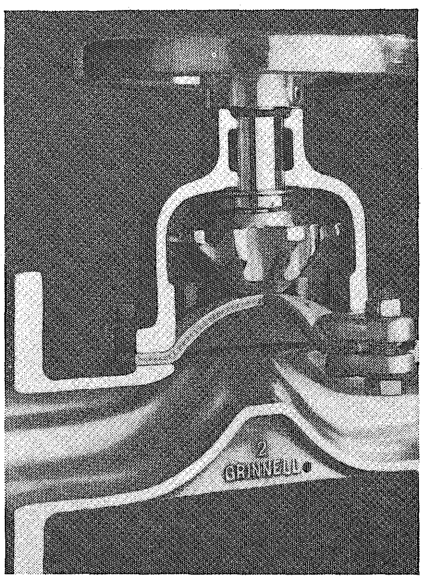
Control of Pesticides

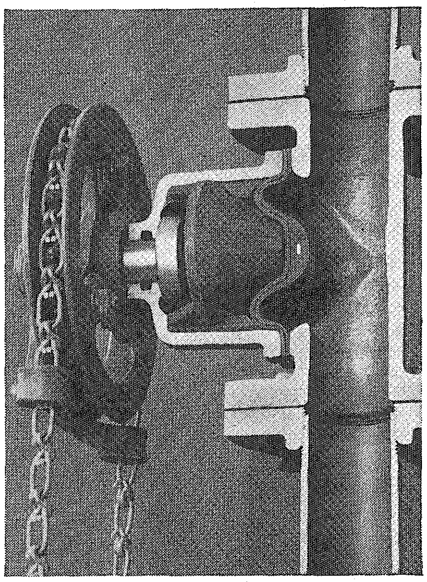
To date, little has been reported about the concentrations of pesticides in our water. The U. S. Public Health Service, through its water pollution surveillance system, is presently measuring concentrations of nine pesticides throughout its 131-station network. The chemicals measured are all chlorinated hydrocarbons: aldrin, dieldrin, endrin, heptachlor, lindane, heptachlor epoxide, DDT, DDD, and DDE. The first publication of results will be available early this year and should serve to guide any action which may be required in this field.



From acetaldehyde to zinc-sulfate . . .







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Dr. Tang was graduated from Chinese National Central University in 1944. He received his M.S.M.E. from the University of Wisconsin four years later, and in 1952, received his Ph.D.C.E. from the University of Florida.

Joining Allison in 1959, he is currently responsible for research in fluid dynamics and heat transfer devices for auxiliary power generation for space, under sea and terrestrial power plants. In the course of this work, he also carries out studies in boiling and condensing liquid metals, radiant heat transfer and phase separation in aerosols.

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Send your request to: Allison Division, General Motors Corporation, Indianapolis, Indiana 46206, Att: Professional and Scientific Placement.

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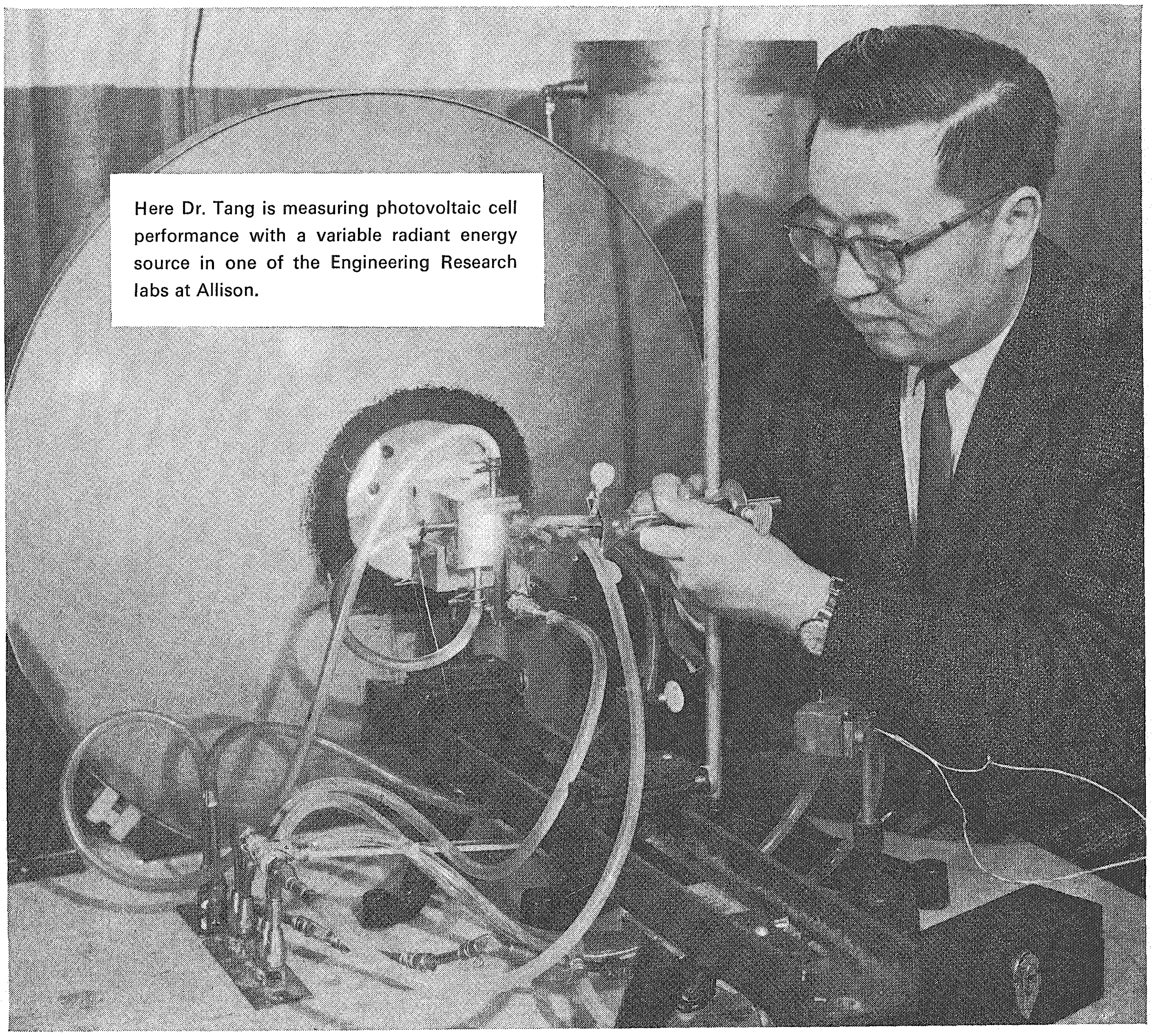
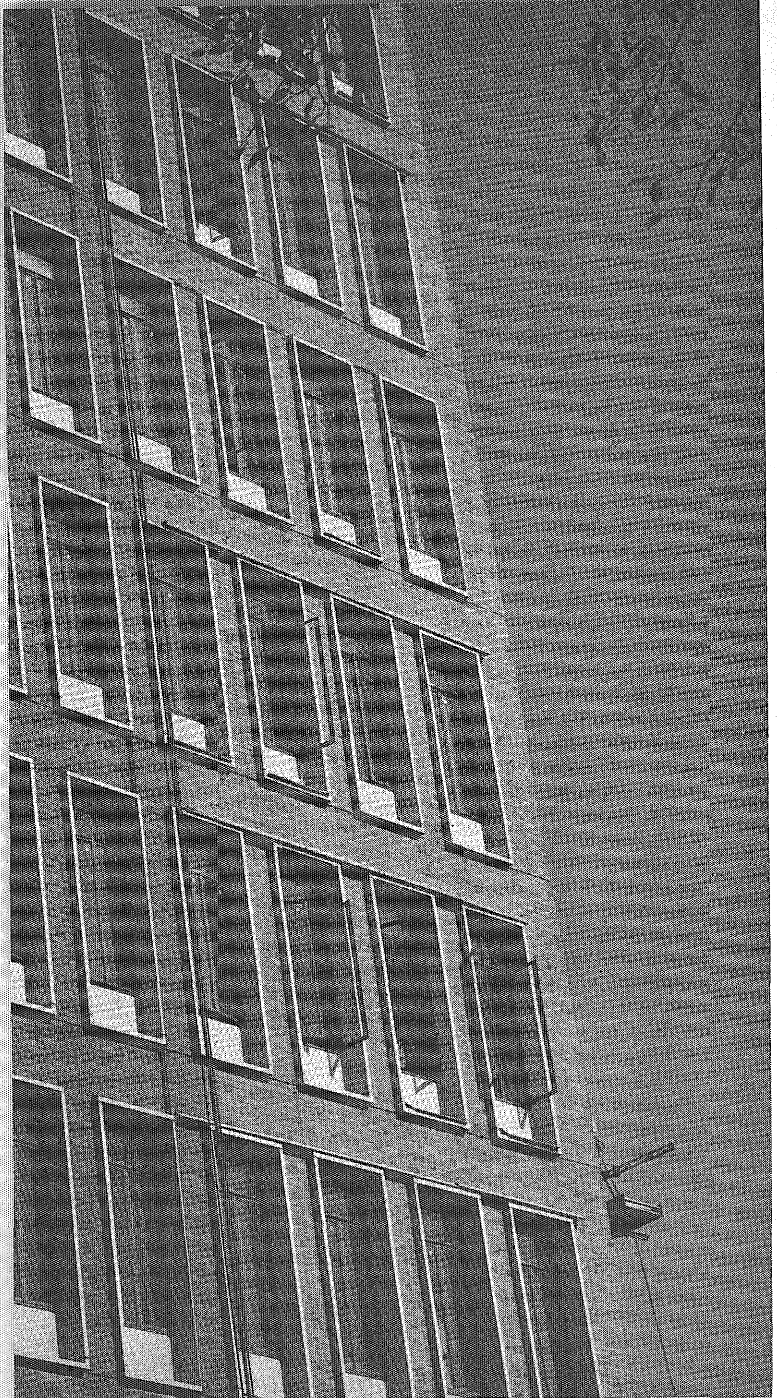


Here Dr. Tang is measuring photovoltaic cell performance with a variable radiant energy source in one of the Engineering Research labs at Allison.



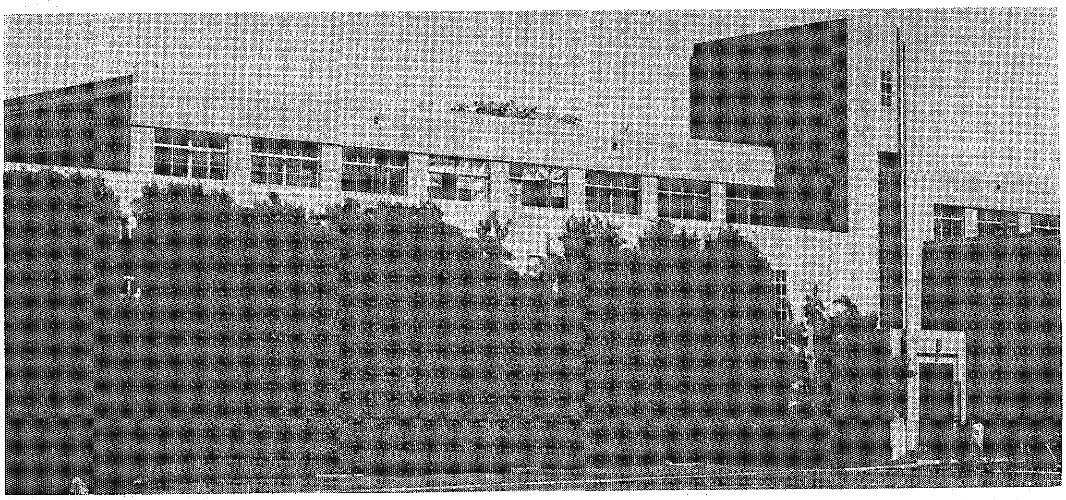
The West Bank buildings are designed in the modern vernacular. The conceptual idea—vertical composition—is unusual in campus planning, but it is the most efficient use of ground space. Glass breezeways connect the Social Science Tower with the Business Administration Building shown here.

ARCHITE
AT THE

by JACQUELINE E. LANDER, *Math '65*

Architectural styles at the University of Minnesota range from the Romanesque Revival of Pillsbury Hall—popular in the 1880's—to the contemporary high-rise styling of the buildings on the West Bank. Included are such features as the animal bas-reliefs of the Museum of Natural History, the machicholations (floor openings) in the embattlements of the Armory, the reinforced concrete skeletons of the Social Science Tower and School of Business Administration, and the fifty-six figure frieze midway between the floor and the roof on the facade of Burton Hall. As the University has grown, many architectural styles have appeared on campus, but the general trend has been toward emphasizing function, as well as architectural beauty.

Picture Credits: Business Administration, Mall—Plant Services; Museum of Natural History, Pillsbury, Folwell, Burton—University News Service; Armory, Ford, Physics, Wesbrook—John Wiik, TECHNOLOG

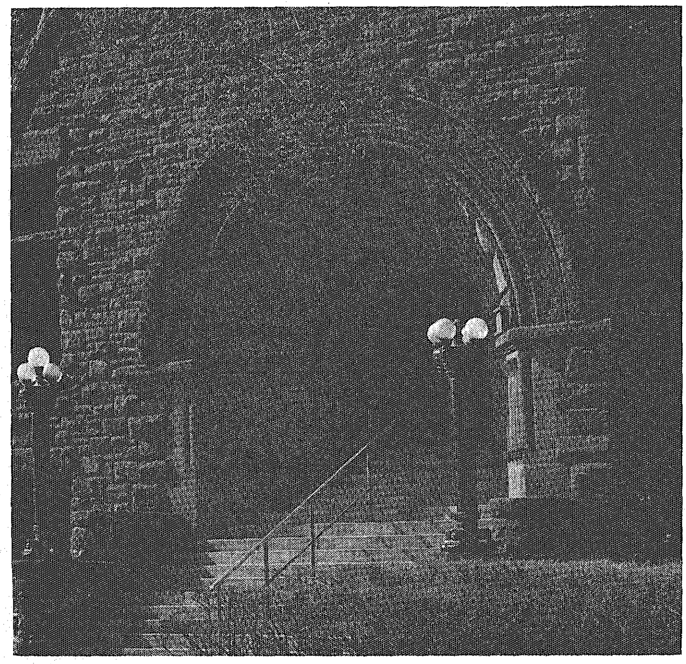


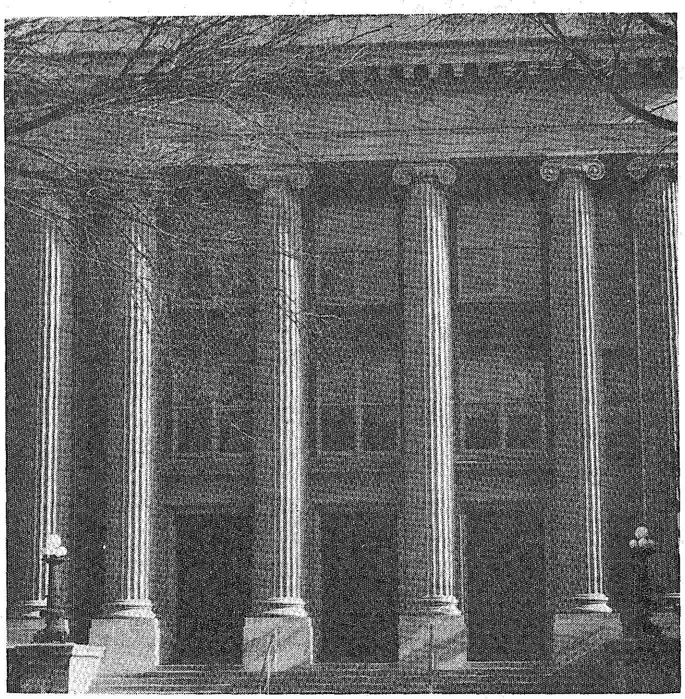
One room of Old Main (no longer standing) was the original home of the Museum of Natural History. After moves to Pillsbury Hall and then to the Zoology Building, the Museum settled in its present structure. Faced with Bedford, Indiana, limestone, the abstract geometric design is typical modern architecture of the 1930s. A new wing will expand exhibit space and research area.

CTURAL VARIETY
UNIVERSITY

An echo of a medieval fortress is the Armory, built in 1896. Medieval towers were offset at the top so that hot tar could be dropped on invaders, and slots in the walls were for shooting arrows without making oneself an easy target. The witch's cap turret was the standard way of roofing towers of walled fortresses. The only missing features here are the portcullis and a moat.

The oldest building on campus is Pillsbury Hall, built in 1889. Two of the identifying features of Romanesque Revival Architecture, of which this building is an example, are round arches and the use of cut stone of random sizes. Another feature is engaged columns which flank the entrance in this picture.

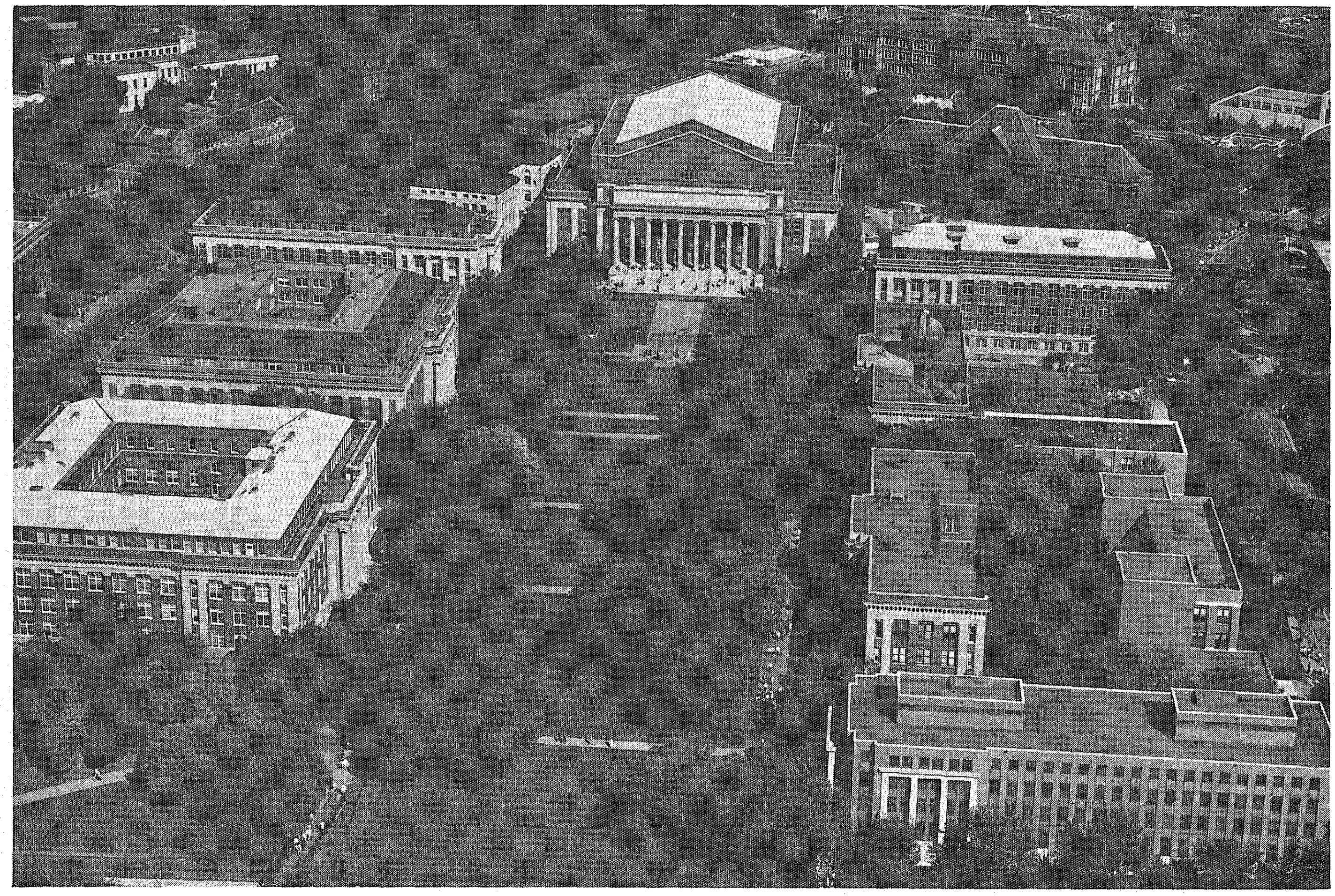




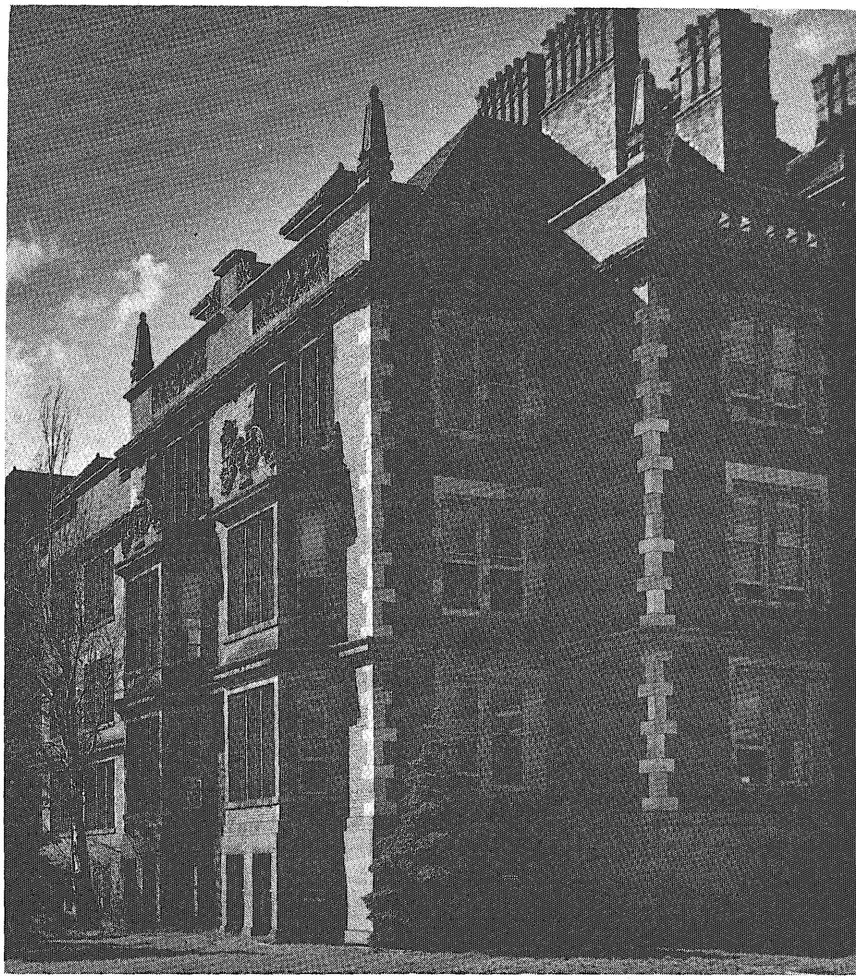
Ford Hall is in the same architectural style period as the Museum of Natural History. Although the fluting of the square columns is the only classic detailing, Ford fits architecturally with the other, classic revival, Mall buildings. Another feature of this hall is the curtain wall principle used in the Mall entrance facade.

The Ionic Greek Revival style of the Physics building is utilized for all of the Mall buildings with the exception of Ford Hall. A volute at the top of each of the fluted columns is the chief feature characterizing this architectural style. The Physics Building was built in 1900, but it was not occupied until two years later.

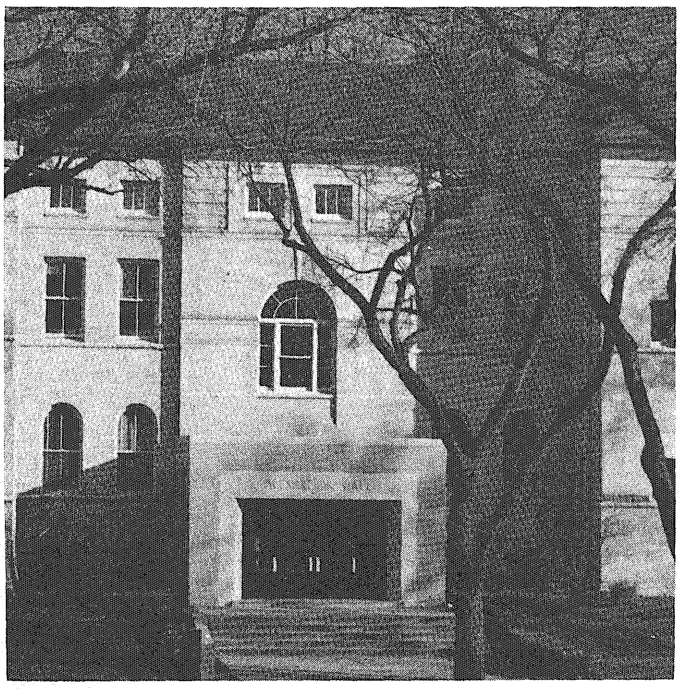
Cass Gilbert designed the Mall, giving it the extreme formal treatment which originated with the Fifteenth Century Grand Plan of Paris. The symmetrical quadrangles were the height of style at that time.



Folwell Hall is a collection of English styles of architecture. The chimneys are Georgian, and the projecting bay windows and handling of the mass elements are expressions of English Gothicism which originated at Oxford and Cambridge Universities. The overall style is almost Tudor, with brick used with stone quoins. A classic example of Tudor Architecture is Hampton Court, built in the Fifteenth Century for Henry VIII by Cardinal Wolsey. About five centuries younger, Folwell was built in 1907.



Modernized Romanesque Revival is the style of Wesbrook Hall which was originally the Medical Sciences Building. The Romanesque rounded arches are a recurring feature in architectural history. When it was first built in 1896, Wesbrook had six-foot eaves around the entire building, but these had to be removed because ice formed on them and water which backed-up behind the ice seeped through the roof. The more contemporary doorway was added in 1947.



Burton Hall is designed like the Parthenon in Greece. The two outer columns of the octostyle Doric portico lean toward each other and the buildings. If lines through the inner columns are drawn from the intersection point of the extended center lines of the outer columns, the inclinations of all are seen to be like fragments of the spokes of a wheel. So cleverly is this done throughout the structure, that an optical illusion of straightness is achieved.

WHAT'S NEW *in Engineering*

edited by STEVE LINDFORS, *Physics '67*

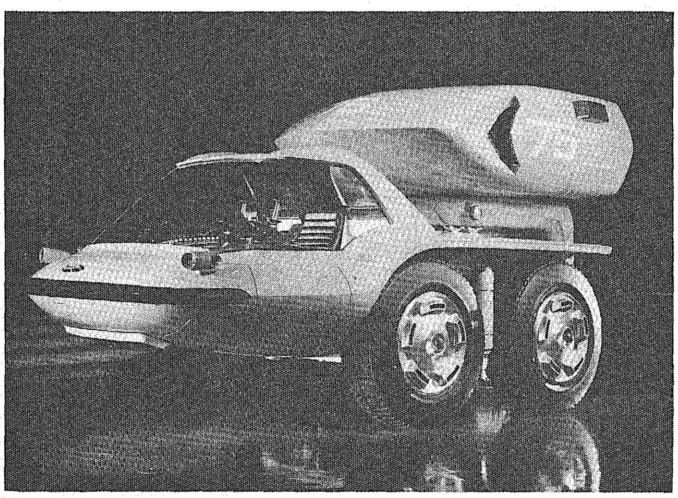
Skin Also Communicates

Research exploring "skin communication" is being conducted at Princeton University. It might someday allow the blind-deaf a function normally outside their experience. Vibrations, the means of communication, are arranged in a language of 45 elements. Failure of the skin to distinguish well among voice frequencies led researchers to develop a light, powerful vibrator that can be attached anywhere on the body. One person who learned "vibratese" received messages at 38 words per minute with 90 per cent accuracy.

Cargoes Quantized, Too

A turbine-powered freight hauler which could carry containerized cargoes at new peaks of efficiency on tomorrow's express highways has been shown by General Motors.

Named the Bison, it shows a sleek new design for heavy cargo vehicles combining power, speed and utility with outstanding appearance. It anticipates the day when



much of our freight may be moved in standardized containers which can be automatically loaded, unloaded, sorted and stored by electronically-controlled equipment.

The Bison was designed and built as an experimental vehicle. It would have a twin-turbine power plant providing 1,000 hp from two turbines of 280 and 720 hp, based on the GT 309 developed by General Motors Research Laboratories.

The two turbines are enclosed in a pod mounted behind the cab over the "fifth wheel" (trailer attachment point) and the four driving wheels. This location improves aerodynamic flow by filling the gap between tractor and trailer roofs and provides cleaner air for the turbines. The engines can be lifted off singly for service or replacement.

The 280-hp unit, a regenerative type, would provide power for normal highway cruising conditions. The non-regenerative, 720-hp unit would add its power when needed for acceleration or climbing grades, or for pulling two or more trailers. Power could be distributed to all axles on both tractor and trailer units by a turbine electric system.

The Bison's cab provides comfortable seating for two, ahead of the engines and wheels. Windshield and side windows are combined in a single panoramic window giving uninterrupted vision to the operator. Easy entrance and exit is provided by a forward-tilting canopy and a step which folds down as the canopy opens.

The Bison is steered with two coupled hand grips on a console extending over the driver's lap. He tilts the grips from side to side to turn the vehicle. Also on this console are the steering option selector lever, speedometer, and a maintenance monitor light which shines green while all systems are "O.K.," amber when something requires attention at the next service opportunity, and red when a malfunction renders the Bison inoperable.

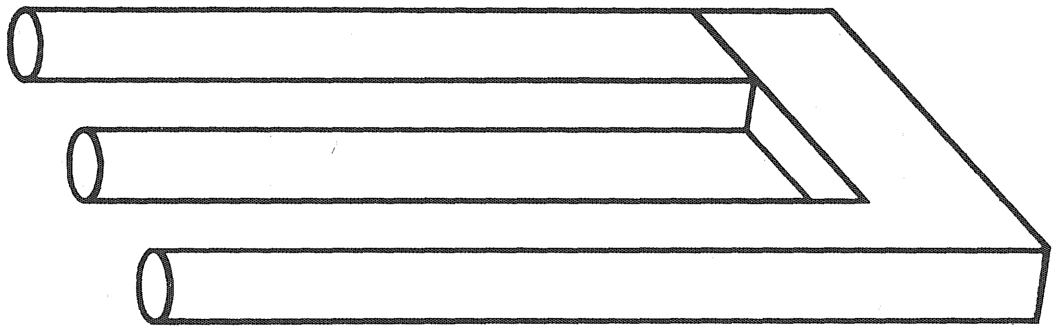
Unique engineering features of the Bison include a trailer locking device and a four-option steering arrangement. This provides the stability and safety advantages of a straight bed truck on the highway and makes possible exceptional maneuverability in urban traffic and freight terminals. With an adapter, the Bison also could handle present-day semi-trailers.

The Bison's trailer is designed around a standardized container system using rigid weatherproof containers of 8x8-ft cross-sections in 10, 20, 30 and 40-ft lengths. This system has recently been approved by the American Standards Association and is already in use.

Containers could be removed individually and new ones added as the Bison calls at various terminals on its programmed route. At the terminals, they could be transferred by automatic equipment to smaller delivery trucks or other modes of transport, or stored in open, pigeon hole-type buildings. The entire terminal operation could be automatic, with loading and unloading of vehicles and sorting and movement of containers controlled by electronic equipment.

Hi Slow Silver

Low cost projection prints from microfilm are said to result from a British development. The device uses an ultra-violet optical system for projection of microfilm images onto diazo papers, offset masters, slow silver photographic papers, and sensitized lacquers for printed circuit production. Using 35mm and 16mm roll and strip film, microfilm, and all aperture cards, the equipment provides variable enlargement of prints for filing and distribution systems. Equipment is designed in units so that the range of the basic printer-viewer can be increased to a maximum of 30 by 40 inches by addition of modification units.



LOOK CLOSELY.
TRY TO FORGET IT.

It's a simple optical illusion, but it bothers you, doesn't it? It's hard to forget it until you've discovered what fooled you. There's something about an inquiring mind that won't let it forget a problem until it's solved.

In school, how many times have you worked half the night on an assigned problem until you solved it? After a while, it didn't matter whether the problem was assigned or not. *You* wanted the answer.

It's this kind of personal motivation we look for and like in a man. That's why we can do without "strangling" supervision at Honeywell. That's also one of the reasons engineers don't punch a time clock here. We hire men whose personal standards are higher than the discipline the job demands. We prefer to rely on a man's sense of personal responsibility to get the work done. This attitude has paid off in many ways.

We have one of the lowest turnover rates in the industry . . . less than half the national average. We can't help but feel that our atmosphere of professional freedom is one of the principal reasons.

Merit pay and promotion . . . are also a part of our policy. Good men like to set their own pace, and we like it that way. We pay and promote to recognize individual performance and progress. We'll push you along as fast as you can handle the work.

Tuition aid, too.
Honeywell men can get advanced degrees through company-supported programs. Greater knowledge will help both of us become first in the field.

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We employ over 48,000 people and we offer the stability and variety that go along with a broad-based company. We have 18 divisions, and we are constantly in need of more engineering and research people to staff them.

Briefly, our business is automatic control. And, we make all kinds: controls for homes and commercial buildings; weapons systems; products for aircraft, spacecraft and missiles; EDP equipment; instruments for process control and medical use; precision switches and semiconductors. In short, it would be tough to find a business or market we don't serve in some way.

Of course, we can't tell you the whole story here. To learn more about jobs at Honeywell, ask your advisor or Placement Director for our folder, PINPOINT YOUR FUTURE. It contains information on Honeywell products, plants and office locations.

If you're interested in Honeywell, why not talk to one of our recruiters next time he visits your campus? No deception there, OK? Just straight talk about what we have to offer each other.

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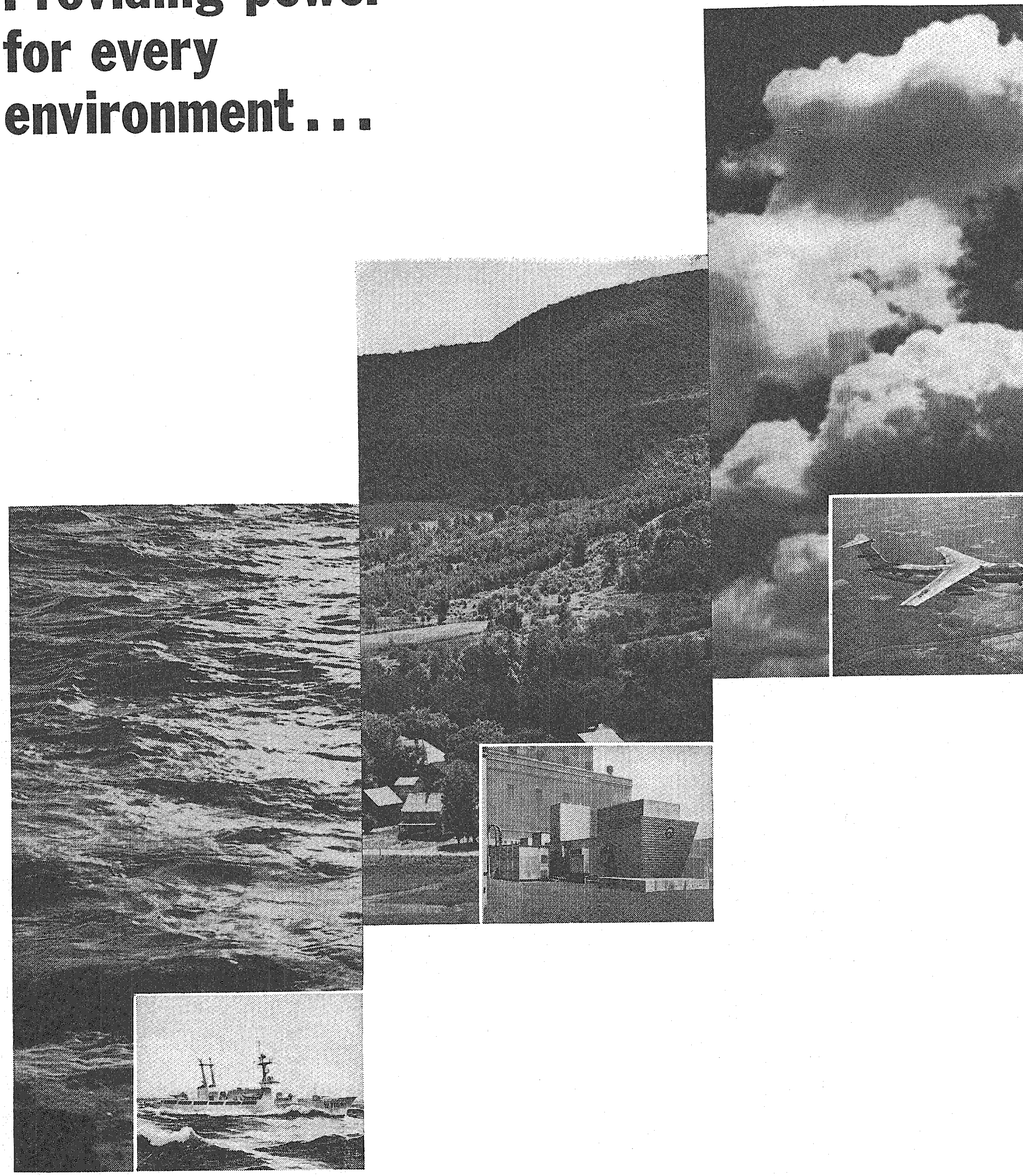

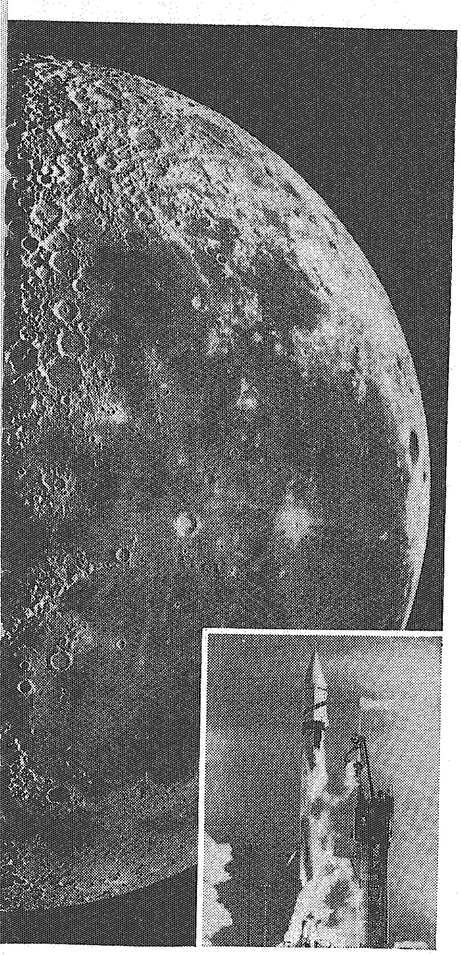

Being a technically trained man . . . we assume you are looking ahead to a career of exciting growth and accomplishment and that you are looking for a company possessing these same qualities.

If our assumption is correct, we would like you to take a close look at us. For this Company, while solving the problems of the day, thrives on a sort of creative restlessness which anticipates the challenges of tomorrow. And more important to you, it recognizes its engineers and scientists as the master key to its present success and future progress.

From a solid foundation of basic and applied research, our Company has gained a firm foothold in the land, sea, air, and space programs that are helping to shape our nation's future. Our engineers and scientists are exploring ever-broadening avenues of *energy conversion for every environment.* Should you join them, you'll be assigned early responsibility . . . to apply your engineering talents to such areas as advanced gas turbines . . . rocket engines . . . fuel cells and nuclear power.

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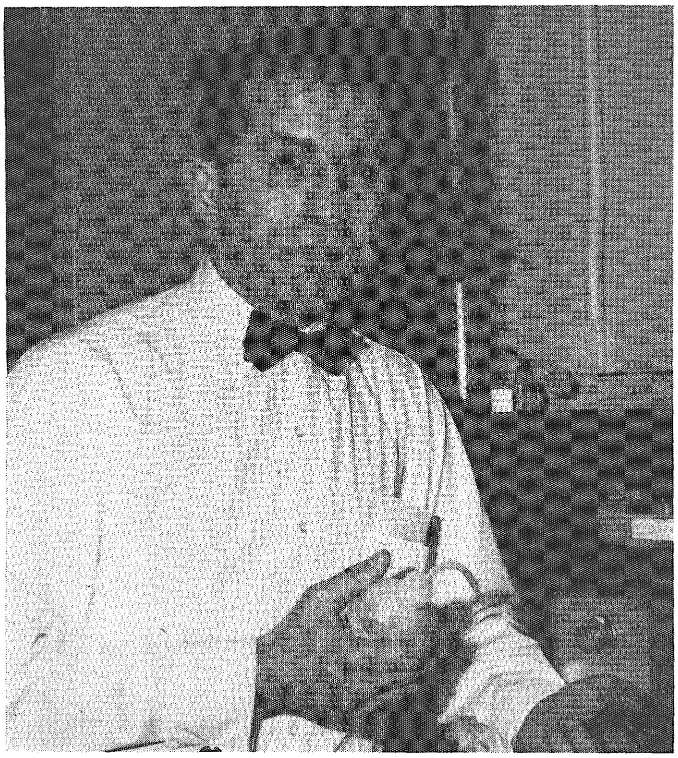
UP FRONT

by ROBERT BRANDS, *CheE '68*



DR. GUST BITSIANES

Dr. Gust Bitsianes, Professor of Metallurgical Engineering, is well known among graduate students in Met. E. because he is the supervisor of graduate work in this field.

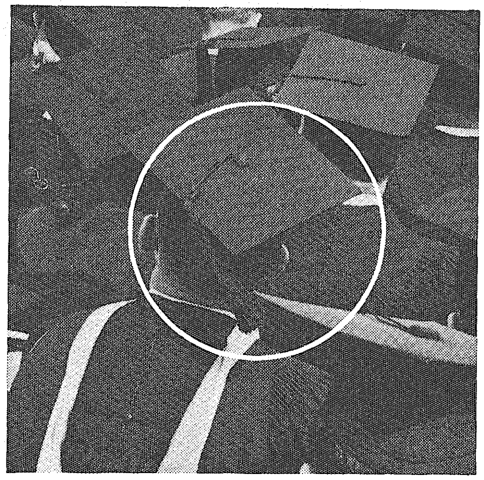
Dr. Bitsianes received his university education here at the university, where, in 1941 he received his B.Ch.E. with high distinction. He continued his graduate work here and received his Ph.D. in Met. in 1951. While he was working toward his Ph.D., Dr. Bitsianes spent two years on the Manhattan Project, and divided the rest of the time between his research and a position as an instructor here at the U where he has been teaching ever since. Dr. Bitsianes has had varied professional experiences ranging from consulting work to research, with most of this experience in the latter field. He has received numerous awards for papers in the field of iron and steel. Among these are the J. E. Johnson Jr. Award, the Journal of Metals Award, and in conjunction with R. S. Schluter, the Robert H. Hunt Medal. Dr. Bitsianes considers the Robert H. Hunt Medal as the high point of his career.

Outside the university Dr. Bitsianes is a member of the A.I.M.M.E., The Iron and Steel Institute of London, Sigma Xi, Phi Lambda Upsilon, and Alpha Chi Sigma. In addition to his organizations and university activities, Dr. Bitsianes has found time to compile an expansive list of publications, and has conducted research in extractive metallurgy and high temperature reactions.

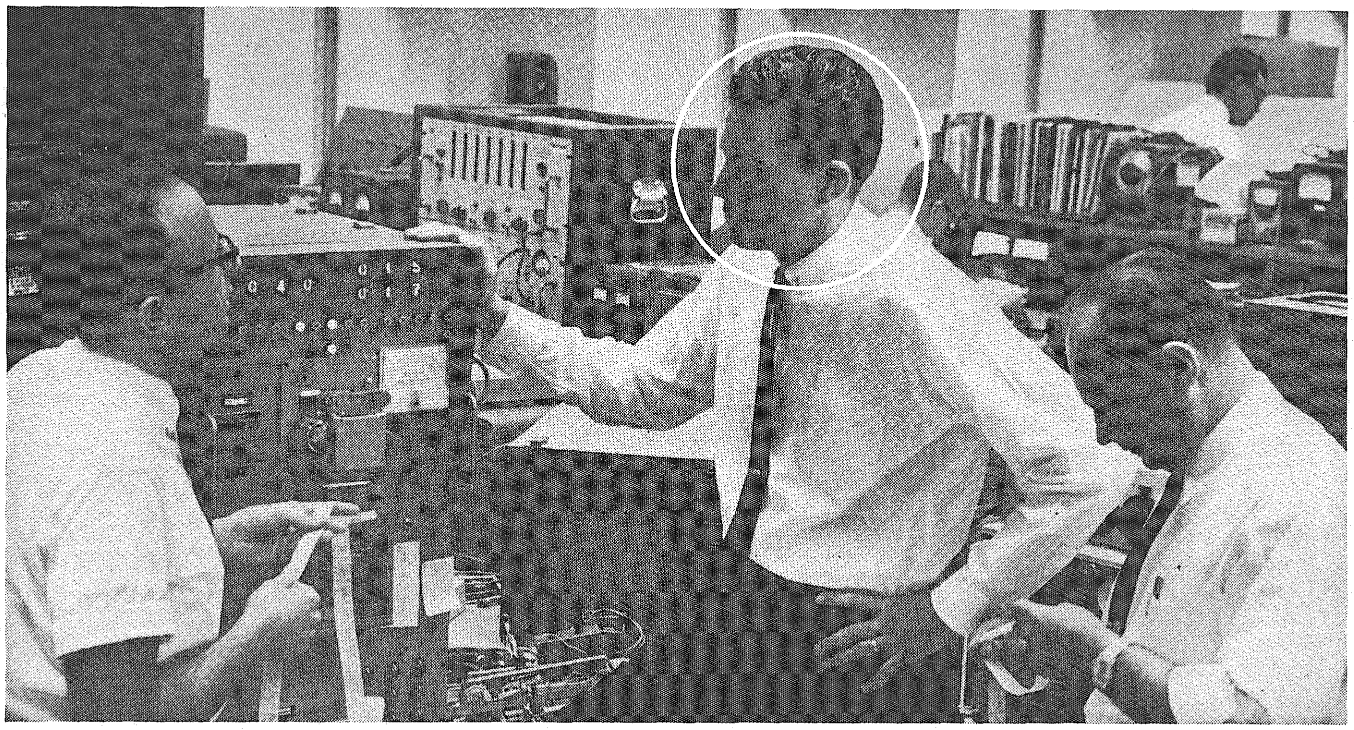
Dr. Tibor Zoltai, head of the Geology and Geophysics Department, is kept very busy with his current research projects on crystal structures and related subjects, in addition to being head of the Geology and Geophysics Department and teaching a course in X-ray minerology. Dr. Zoltai, after leaving his native Hungary in 1945, has received his higher education in five different countries and has been taught in four languages. His undergraduate work was done at the University of Graz in Eatvos Lorant Polytechnique in Budapest and the Sorbonne in Paris. He received his B.A.Sc from the University of Toronto in 1955. From there he went to M.I.T. where he received his Ph.D. in 1959 for his research on the crystal structure of coesite and the classification of silicate minerals. Dr. Zoltai came to the U of M in 1959 and has held his present position since 1964.

Besides his academic activities, Dr. Zoltai is a member of many professional societies including the A.C.A., A.I.P.G., G.S.A. and Sigma Xi to name only a few. Dr. Zoltai has a long list of publications to his credit, some of which are used as texts in other schools. His manual on X-ray minerology is used as a laboratory manual here at the U. He has also received several research grants for crystal structure analysis, delivered talks to local technical organizations, and been a delegate to many technical conventions.

DR. TIBOR ZOLTAI



John Lauritzen wanted further knowledge



He's finding it at Western Electric

When the University of Nevada awarded John Lauritzen his B.S.E.E. in 1961, it was only the first big step in the learning program he envisions for himself. This led him to Western Electric. For WE agrees that ever-increasing knowledge is essential to the development of its engineers—and is helping John in furthering his education.

John attended one of Western Electric's three Graduate Engineering Training Centers and graduated with honors. Now, through the Company-paid Tuition Refund Plan, John is working toward his Master's in Industrial Management at Brooklyn Polytechnic Institute. He is currently a planning engineer developing test equipment for the Bell System's revolutionary electronic telephone switching system.

If you set high standards for yourself, educationally and professionally, let's talk. Western Electric's vast communications job as manufacturing unit of the Bell System provides many opportunities for fast-moving careers for electrical, mechanical and industrial engineers, as well as for physical science, liberal arts and business majors. Get your copy of the Western Electric Career Opportunities booklet from your Placement Officer. And be sure to arrange for an interview when the Bell System recruiting team visits your campus.

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E-DAY

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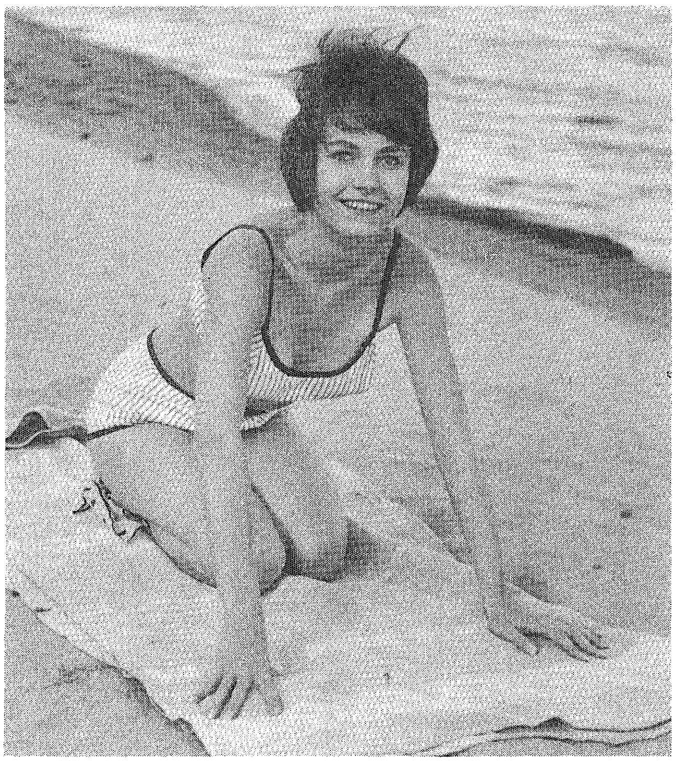
SIGN UP OUTSIDE E 133



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The winning design merits a fin ($5.00) and 50 points towards the E-day all participation trophy or anything else you need 50 points for. The rules, as listed below, give all the information necessary to complete your entry. We all should do that little extra to make E-day really great.

RULES

1. Button design should be on 8½x11 paper and must be designed within a 7″ circle.
2. Minimum information to appear on button in some form:
   51st Anniversary
   E-Day 1965, May 6 - 8
   University of Minnesota
3. Limit of four colors.
4. Button designs are due by 5:00 P.M., March 12.
5. Bring all designs to the E-DAY box in 133 Main Engineering.
6. Prize will be awarded May 8, at the E-DAY BRAWL.
7. Remember, the button is about 2½″ in diameter, so consider this in your design.

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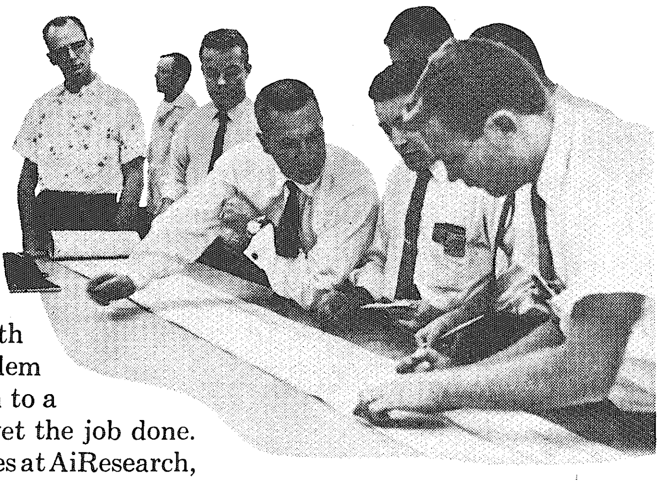

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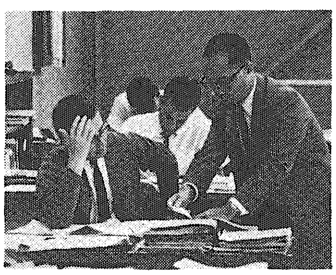

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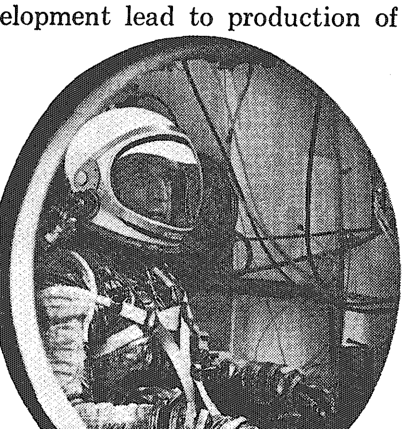

The product lines at AiResearch, Los Angeles Division, are environmental systems, flight information and controls systems, heat transfer systems, secondary power generator systems for missiles and space, electrical systems, and specialized industrial systems. In the Phoenix Division there are gas turbines for propulsion and secondary power, valves and control systems, air turbine starters and motors, solar and nuclear power systems.

In each category AiResearch employs three kinds of engineers.

Preliminary design engineers do the analytical and theoretical work, then write proposals.

Design engineers do the layouts; turn an idea into a product.

Developmental engineers are responsible for making hardware out of concepts.

Whichever field fits you best, we can guarantee you this: you can go as far and fast as your talents can carry you. You can make as much money as any engineer in a comparable spot – *anywhere.* And of course, at AiResearch, you'll get all the plus benefits a top company offers.

Our engineering staff is smaller than comparable companies. This spells opportunity. It gives a man who wants to make a mark plenty of elbow room to expand. And while he's doing it he's working with, and learning from, some of the real pros in the field.

If the AiResearch story sounds like opportunity speaking to you—don't fail to contact AiResearch, Los Angeles, or Phoenix, or see our representative when he comes to your campus.

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GARRETT

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THE BRIDGE . . .

by DANIEL KEHRBERG, *Met E '69*

The present Washington Avenue bridge was built in 1885. Only two trusses supported this original bridge which was only 17 feet wide with a little additional width added by the sidewalks. In 1890 the Minneapolis streetcar company added a middle truss for support of a pair of streetcar tracks. In 1906, the city of Minneapolis added the two outside trusses to give the bridge its present width of 38 feet.

Due to its inadequacies in modern times and because of its extreme age, the Washington Avenue bridge is being replaced. In February of 1963 the contract was signed for the construction of a new span across the Mississippi. The plans were drawn up by Sverdrup and Parcel and Associates, Inc., of St. Louis. The new bridge is being built at a cost of $3,061,000 by the Minnesota Highway department as part of a new access system for proposed freeways. Plans are also under way as to the fate of the old bridge which is demolition immediately after completion of the new one.

The new bridge will be 72 feet wide and will consist of two levels—one for automobiles and the other for pedestrians. On the lower level there will be four twelve-foot traffic lanes, two running in each direction. The total length of the bridge will be 1,131 feet with some additional approach ramps being added later to give access to the upper level. The largest span is 315 feet and goes directly over the main channel.

The original contract called for completion by last November, but construction was slowed because of difficulties in the molding and welding of the steel girders which were being fabricated in Orange, Texas. But difficulties arose because of the high humidity in Texas and the lack of knowledge and experience in the welding of this type of steel. The first problem was finding good materials of the sizes and thicknesses needed. The next problem was welding; cracking in the weld and in the basic material. This problem was finally solved by utilizing a welding process called stick welding. The new bridge will be one of the first bridges completed using a new high strength steel with a yield of 100,000 pounds per square inch. Previous steels have never exceeded 50,000 psi yields.

The lower level will be lighted by fluorescent tubes arranged along the outside edges of the four lanes alternating with those of two other rows down the center. The overall effect will be similar to that of the tunnel under Fort Snelling.

The lower level of the bridge should be completed by midsummer. The painting, however, will probably take until 1966 to complete. The painters cannot begin work until the concrete slab has been poured. This slab is the last to go on, and because of the messiness of concrete, there will be parts that will have to be cleaned before they can be painted. This gives the bridge

Architect's drawing of finished bridge showing upper level student walkway.

a much neater appearance and a better coating of paint. Also, steel can only be painted in fair weather, not when it is either cold or wet. The color of the completed bridge will be aluminum, similar to that of the interstate bridges being built.

Although Washington will follow its existing route on the east bank side, an entirely new route will be developed on the other side. On the west bank side it will go under Cedar and connect up with a new freeway, 35W. With exits at both Cedar and 35W, Washington Avenue will then divide itself and continue toward the loop via 3rd street and away from the loop via 4th street. On the west bank side large recessed bus stops will be built allowing places where passengers may be let out to use stairways up to the level of the west bank classrooms. Otherwise, the automobile traveler to the west bank will have to exit on Cedar and double back via existing side streets.

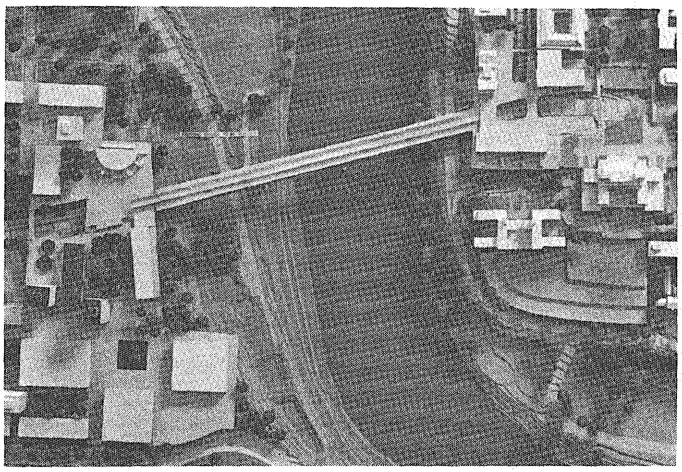
The upper level walkway will be built entirely by the University from donations and gifts. The cost is set at $319 thousand; the completion date is set hopefully at fall of this year. It is to be 72 feet wide with a 36 foot wide covered walkway running down the middle. The sides of this walkway will be mostly glass, with about one-third of these panels sliding to offer open air comfort and ventilation during pleasant weather. The ends will always be open.

The walkway will be heated by steam lines from the east bank heating plant to the west bank buildings. These steam lines will run down the ceiling of the covered area and will provide heat by radiation as the steam is carried to the west bank buildings. The present steam lines run across the Northern Pacific railway bridge just up the river, and then through an underground tunnel to the west bank buildings, but it is considered better to have two separate lines making the crossing. Most certainly, however, the biggest advantage to the student will be the shelter from the wind.

The upper level of the bridge will be connected with the east bank buildings by a raised plaza running from the bridge to the mysterious balcony on the new Science Classroom building. The upper walkway will also be extended to connect to the mall in front of Coffman Union. The same style of lighting on the mall will be utilized in lighting the pedestrian walkway over the Mississippi and the sidewalks of the west bank. These connections on the east bank will be built this summer for use in the fall.

On the west bank side, connections will be made to existing buildings by a temporary timber ramp. This ramp will give access to the classrooms, but will also allow space for the construction of the latest addition to the west bank. The new building, hopefully to be approved in May by the Legislature, will contain eight large classrooms similar to those in the new Science Classroom building on the east bank. It is to be built parallel to the existing west bank classroom building but will sit overlooking the river in approximately the same spot the workmen on the bridge now park. The entire ground level will be a glassed-in study area in addition to food services. The study space will have one of the most breathtaking views possible of the east bank campus and the Mississippi River.

It is interesting to note that there is only a three foot difference between the upper level of the bridge and the existing level of the west bank buildings. Also, the elevation of the balcony on the Science Classroom building, the level of Coffman terrace, and the level of the mall is 838 feet, while the present level of the west bank



Model showing completed bridge and walkway connections. (N↑)

classrooms is 830 feet. As a result the bridge has a slight slope, but this slope is far too level to give the effect of walking uphill to the east bank or downhill to the west bank. However, far more significant is the fact that students will be able to leave a building on one bank and walk to a building on the other bank without going up or down any steps or waiting for any traffic signals. The mall will extend effectively at the same level to join the west bank to the east bank.

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SPLINTERS From the Log

by DAVID E. ENGEN, *Pol Sci '67*

Overheard in a Zen Coffee-Urn:

First Cat: (Very down) Soooo, like . . . I bought her a Scotch, y'know So dig: One sip, man, and she's all over me. She says 'Let's widen to your pad,' so we split and she's got her clothes off on the stairs, man, and in the kip she was like the end, baby! She was the wildest! On one sip of Scotch, man! . . .

Second Cat: (Unresponsively) Groovy, So why be bugged?

First Cat: Man . . . I think I coulda had her on a beer.

• • •

"Your feet are cold." he complained to his little bride, "keep them on your own side of the bed."

She began to sob. "You're cruel," she cried, "you never used to say that to me before we were married!"

• • •

He: "You remind me of the ocean."

She: "You mean that I'm wild, romantic, and restless?"

He: "No, you make me sick."

• • •

How do you kill a madras elephant? Spit on him till he bleeds to death.

• • •

Once upon a time there was a man who asked a woman to marry him. She said, "No." And they lived happily ever after.

• • •

A girl was telling a boy friend that she realized she was very popular, but she didn't know why.

"Do you suppose it's my complexion?"

"No," he said.

"My figure?"

"No."

"My personality?"

"No."

"I give up."

"That's it!"

• • •

Did you hear about the two girls who walked accidentally into the men's dormitory?

One fainted, but the other stayed calm, cool, and collected.

We know a girl who thinks she's a robot just because she was made by a scientist.

• • •

"Do you really love her?"

"Do I love her? Why, I worship the ground her father struck oil on."

• • •

"Do I love her?"

"Yes, every chance I get."

• • •

A sweet young thing breezed into a florist shop, dashed up to an elderly chap puttering around a plant and inquired, "Have you any passion poppy?"

The old boy looked up in surprise. "Gol ding it!" he exclaimed. "You just wait until I get through prunin' this rose!"

NO JOKE

In 1770 the British Parliament passed a law against obtaining husbands by false pretense, that read as follows:

"That all women of whatever age, rank, profession, or degree, who shall after this act, impose upon, or seduce and betray into matrimony any of His Majesty's subjects by virtues of scents, paints, cosmetics, artificial teeth, false hair, Spanish wool, iron stays, bolstered hips, or high-heeled shoes, shall incur the penalty of the law now in force against witchcraft and like misdemeanors, and the marriage under such circumstances shall be null and void."

Sitting in a tavern with a humanities professor the other day I heard a tale of woe that I must relate to you. It seems that a girl the prof was hot over consumed much money in this very bar, and turned out to be a shill instead of a fine companion. Said the professor, "Immoral, and immoral and immoral, creeps in this pretty piece from date to date, to the last dribble or reordered wine. . ."

Conscience is defined as the thing that hurts when everything else feels great.

• • •

Overheard in a parked car near campus: "Slow down, Columbus, you've discovered enough for tonight."

• • •

Don't start vast projects with half vast ideas.

BIG TEN

In the land of sky blue waters,
There stand the hallowed halls,
Of Minnesota.
On the riverbanks of the mighty Mississip',
There lay the students,
Of Minnesota.

• • •

Wouldn't it be great,
If everyone,
At Michigan State,
Got caught.

• • •

Sing me a song of Ohio State,
That a meadowlark could envy;
Tell me a story of an OSU co-ed,
That Christine Keeler could envy.

• • •

There is a hole in Evanston,
They call Northwestern U.
It's been the ruin of many co-eds,
Who thought it was a school.

• • •

They call the Illini, Fighting,
Because they have to;
The professors fight for Champagne,
And U of I co-eds fight because of it.

• • •

Indiania is a bust in sports,
It's easy to make the team;
As I. U. co-eds can testify.

• • •

If you attend school in Madison,
Is your main concern,
The last syllable,
In Wisconsin?

• • •

Michigan battles for the Little Brown Jug,
They won it back last year;
Their co-eds battle for their honor,
And they lose it every year.

• • •

All the fertilizer,
Heaped up high,
Could never equal,
The way they pile it in Iowa.

• • •

Is it true,
That everyone at Purdue,
Does?

An auto on the thruway was speeding at 90 miles an hour. The brakes wouldn't hold, so the woman driver screamed at her husband, "What should I do? What should I do?" Said the husband calmly, "Hit something cheap."

• • •

Sign in front of the crematorium: "We're Hot For Your Body."

• • •

"Doin' anything Saturday night?"
"Nope."
"Kin I use your soap?"

It's easier for a girl to walk the straight and narrow if she happens to be built that way.

• • •

Engineer: "I'm not feeling myself tonight."

Coed: "You're telling me."

• • •

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

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

Why total cost is so important to tiny tots... and taxpayers

Total cost of what? Sanitary sewers. It makes no difference if they're municipal sewers or house sewers. There's still an initial cost . . . and a total cost. It's the total cost that's important. It includes building the sewers initially, plus the cost of repairs and maintenance . . . even replacement if the pipe disintegrates.

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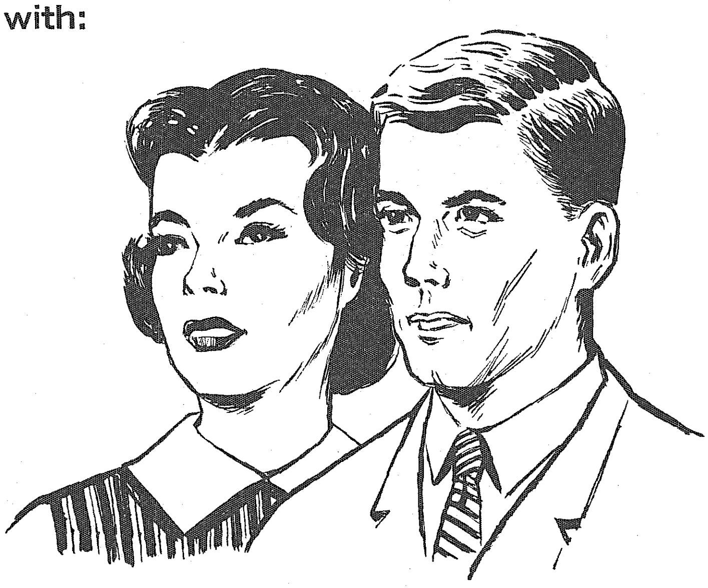

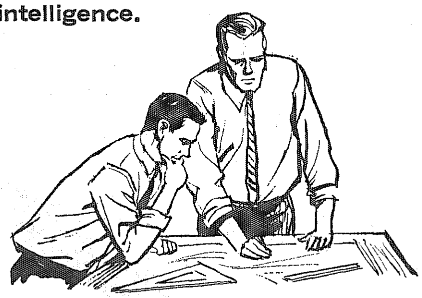

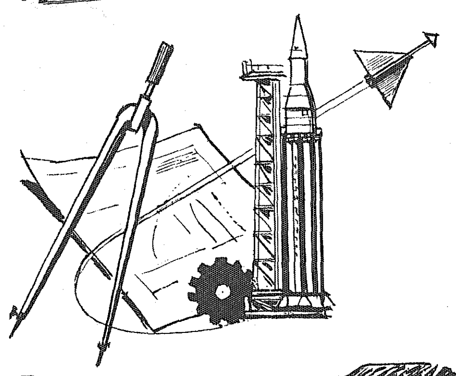

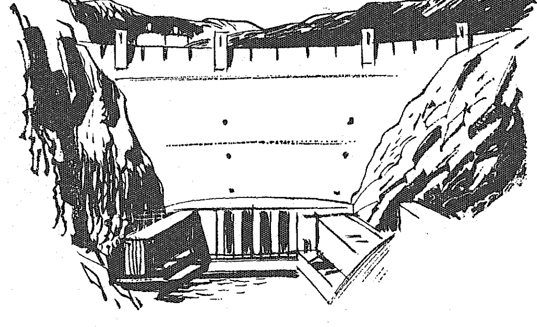

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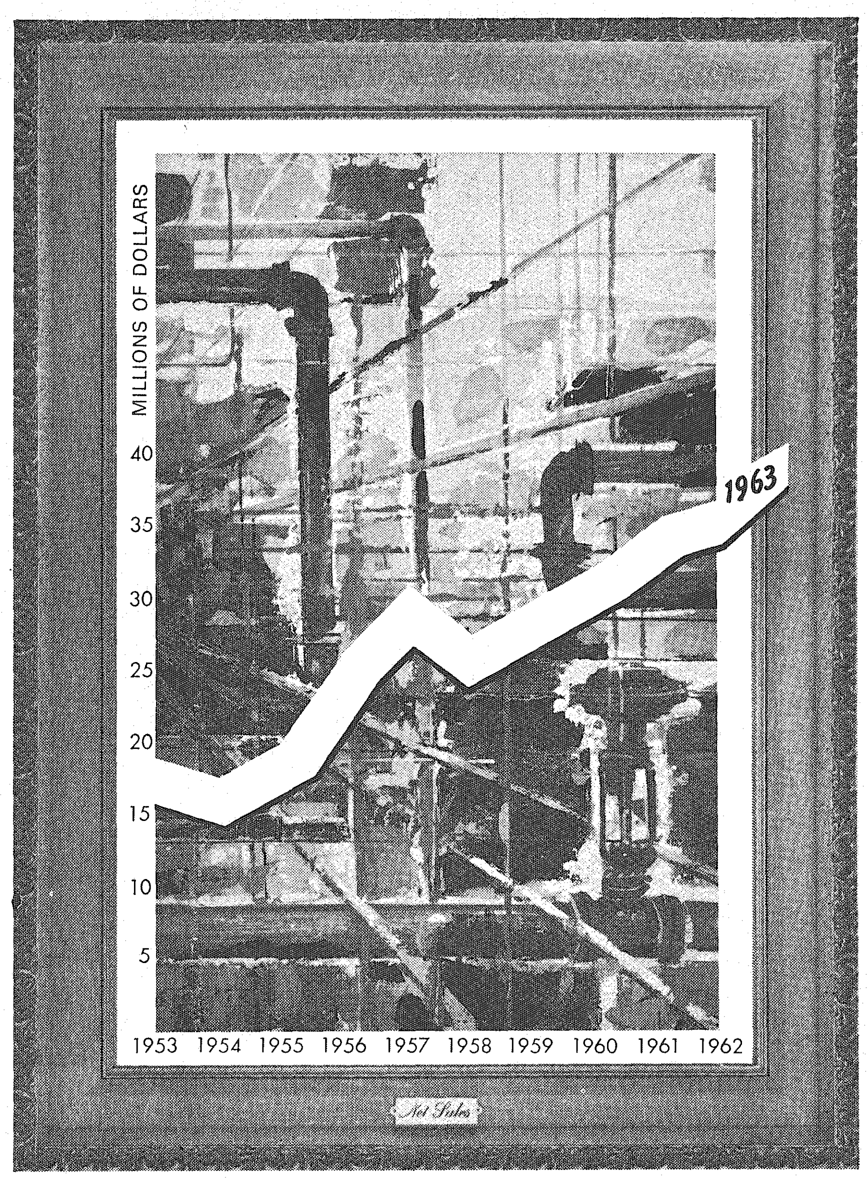

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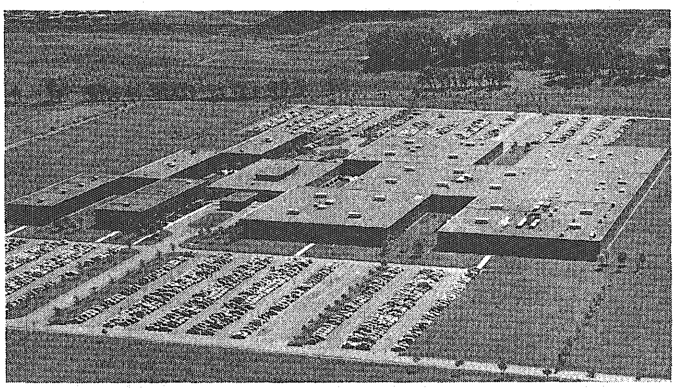
Spotlight on
Local Industry

I B M

by DANIEL KEHRBERG, *Met E '68*

In 1911 three companies merged to form the Computing-Tabulating-Recording Company, which later (in 1924) adopted the name International Business Machines Corporation or commonly called IBM. IBM's original products were commercial scales, tabulating machines and time recording equipment, with little emphasis on tabulating machine products.

One of IBM's earliest plants in Endicott, N. Y. originally employed 300 people, most of whom were at work in the production of time recording equipment. In 1916 under the leadership of the late Thomas J. Watson Sr.,



Pictured is IBM's Rochester plant and research facilities. John T. Costello is a work-study student at IBM this quarter.

the company borrowed $40,000 to expand, with $25,000 of this going to product research and engineering. This original investment and others following it proved fruitful, for today the little facility in Endicott encompasses some 2 million square feet of area with over 9,000 employees who turn out a wide range of products.

Prior to the beginning of the depression, the data-carrying capacity of IBM cards was increased from 45 to 80 columns, thus paving the way for a new series of machines introduced in the 1930's. These machines could not only perform addition and subtraction, but they could also keep records and perform accounting operations. These early improvements proved fruitful, for in 1936 IBM was in a position to provide the machines and services for the "Biggest accounting operation of all Time"—the Social Security Program.

In 1933 IBM entered the electric typewriter business, and in two years, with a research investment of more than a million dollars, the first IBM electric typewriter was put on the market. During World War II, the federal government used more than 5,000 IBM accounting machines to keep track of men and materials. IBM also produced naval and aircraft fire control instruments, Browning automatic rifles, director and prediction units for 90mm anti-aircraft guns, bombsights, and aircraft engine parts.

The first large-scale computer built by IBM was placed on the market in 1944. It was called the Automatic Sequence Controlled Calculator and was an electro-mechanical device that made use of relays and tape-controlled programming devices. It was followed by the Selective Sequence Electronic Calculator in 1948 and the IBM 701 in 1952. Since this time subsequent data processing machines have been improved and extended so that today IBM manufactures a full line of computers for both business and scientific applications.

Today, IBM's manufacturing facilities are located in 17 plants across the United States and 16 plants abroad. In addition, research, development, and product engineering are carried on in 25 modern laboratories both here and abroad. To market and service its equipment, IBM maintains 190 sales offices and an additional 100 service locations in the U. S. There are also 315 sales locations abroad. A subsidiary of IBM, the Service Bureau Corporation, furnishes data processing services on a contract basis to customers throughout the U. S.

IBM's several hundred products fall into seven major categories:

........Small, medium and large-scale electronic computers and data-processing systems,

........punched card accounting and statistical machines,

........electric typewriters, electronic accounting machines, and dictating equipment,

........advanced systems for military and space applications,

........special purpose and advanced electronic information processing systems for business and government use,

........supplies, including IBM cards, typewriter ribbons, carbon paper, and magnetic tapes,

........industrial products.

In 1956 IBM started its manufacturing facility at Rochester, Minnesota, which comprised about 660,000 sq. ft. Soon after, a Development Laboratory of 220,000 sq. ft. was added. Rochester IBM manufactures a wide range of data processing machines. However, it is chiefly concerned with the development and manufacture of input/output equipment for electronic data processing systems, banking systems, character recognition equipment, and medical electronic equipment development. Many of Rochester's 25 products can be combined with others to form IBM data processing systems which process information aiding our country's business and industries in addition to providing a vital new tool in the field of scientific research.

Research in the development laboratory at Rochester takes many forms. In 1958 cooperative research began between IBM and the Mayo Clinic physicians. Modern electronics techniques are being developed to assist in gathering analysis and presentation of medical data. Also under study at Rochester are Optical Character Recognition Systems which, at present, have character sensing and document handling techniques which are capable of handling a wide range of document sizes and various types of printing.

The Technical Assistance Department at Rochester offers aid to the research engineers in three ways: (1) machine technology aids in circuit design and industrial design; (2) the advanced technology section is dedicated to the exploration of new materials, processes and design methods; and (3) the Rochester Computations laboratory aids the Research Department with its computing center staffed by experienced programers, mathematicians and engineers equipped with the latest IBM computers. This latter organization conducts exploratory programming in support of general Rochester objectives.

The latest discoveries and advancements at IBM prove exciting not only to the engineer, but also to the casual observer. IBM's latest computer has an electronic storage system capable of containing more than one billion items of information. The information stored in this system can be continuously updated, and any of it can be retrieved and entered into a computer for processing in less than two-tenths of a second.

A new programming system at IBM makes it possible for the engineer to write a problem for solution by a computer in the engineering terms familiar to him. Also, a program developed for the printing industry by IBM and the Oklahoma Publishing Company involves the use of data processing systems for the automatic setting of type used in newspapers, books, magazines, and brochures. As the text is fed into the computer, it hyphenates the words and spaces out the lines to the correct column width. It then creates instructions of paper tape which the printer's automatic linecasting machines can use to set the story in type.

A new technique developed by IBM for the manufacturing industry is the Automated Design Engineering system. This enables a computer to produce automatically the engineering designs required to custom-build transformers, turbines, motors, and other electrical products. The computer is able to identify the steps involved in designing an electrical product, and from the specifications fed into it can produce in minutes the complete design and all the steps needed to manufacture the product.

Other new programs at IBM include a method for using a computer to develop the most effective distillation processes for the production of the various kinds of chemical and petroleum products. Computers also prepare the punched tape instructions to be used by automatic machine tools in the milling of intricate metal parts.

IBM computing systems were a part of the tracking system which followed astronaut L. Gordon Cooper's progress on his 22 trips around the earth. During the Mercury series of manned space flights, IBM computers performed approximately nine trillion computations. IBM is developing a more advanced information-handling and control system which will be used for the up-coming two-man Gemini flights and later for the three-man Apollo flights to the moon.

In the area of defense, IBM computers are used in the all-inertial achiever guidance system which directs Titan II intercontinental ballistic missiles to their targets.

The company is also experimenting with a laser device that would enable astronauts in flight to communicate with ground control stations over a beam of light. They are also developing an on-board information system for a manned space station capable of orbiting the earth for a year or more.

Determining the atomic structure of tiny crystals, a tedious job for scientists, has been improved by IBM. The company recently demonstrated an experimental computer-controlled system which can do much of the work automatically. It positions the crystal, makes X-ray beam measurements of it, and then records and processes the results.

Although big things in research are constantly happening at IBM, little things are not neglected. In 1963, IBM introduced a data processing card with round corners. The rounding of the corners increases the card's resistance to the wear that occurs with constant handling and filing. Yes, IBM has certainly proved a leader in the development of computers and computer uses in our modern age.

The Fire Research Center, with its huge furnaces, is just one of the important modern facilities at the $10,000,000 Research and Development Laboratories of the Portland Cement Association.

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TECHNICAL COMMISSION

The Technical Commission is the executive body of the Technical Association, an association composed of all students registered in the Institute of Technology. Its purpose is "to provide a federation of students and departments in the Institute of Technology and to enable the students of the various departments to act as a unit in all matters of general interest to their college and to the University."

The Tech Commission, as it is most commonly called, is composed of representatives of the recognized departmental societies, four members elected at large from the Institute, three MSA representatives, a freshman representative, the TECHNOLOG editor, General Chairman of E-Day and three faculty members.

Although the Commission is not a new organization, its new constitution was adopted at the I.T. general election last spring. The annual budget is presented here as specified by the Constitution. Last year Tech Commission operated at a small deficit which was offset by the balance from the previous year.

Regular meeting dates are not specified, but meetings are held at least twice a month. With the change from the five to the four-year plan, Tech Commission has found itself busy planning the all I.T. meeting and working with the societies to stimulate more interest among the first, second, and third year students.

Statement of Receipts and Disbursements
July 1, 1963 through June 30, 1964

RECEIPTS		
*Interest on Investment	$ 2.23	
E-Day Assessment	58.55	
Transfer from MSA	114.00	
TOTAL RECEIPTS		$174.78
DISBURSEMENTS		
Freshman Coffee Hour	$ 40.60	
Pictures	3.28	
E-Day Expenses	32.00	
Keys	124.44	
Financial Service Charge	2.00	
TOTAL DISBURSEMENTS		$202.32
Disbursements in Excess of Receipts		$ 27.54
Balance in Bank as of July 1, 1963		$ 27.68
Balance in Bank as of June 30, 1964		$ .14

*This organization has $50.00 in the Student Organization Group Investment Trust Fund.

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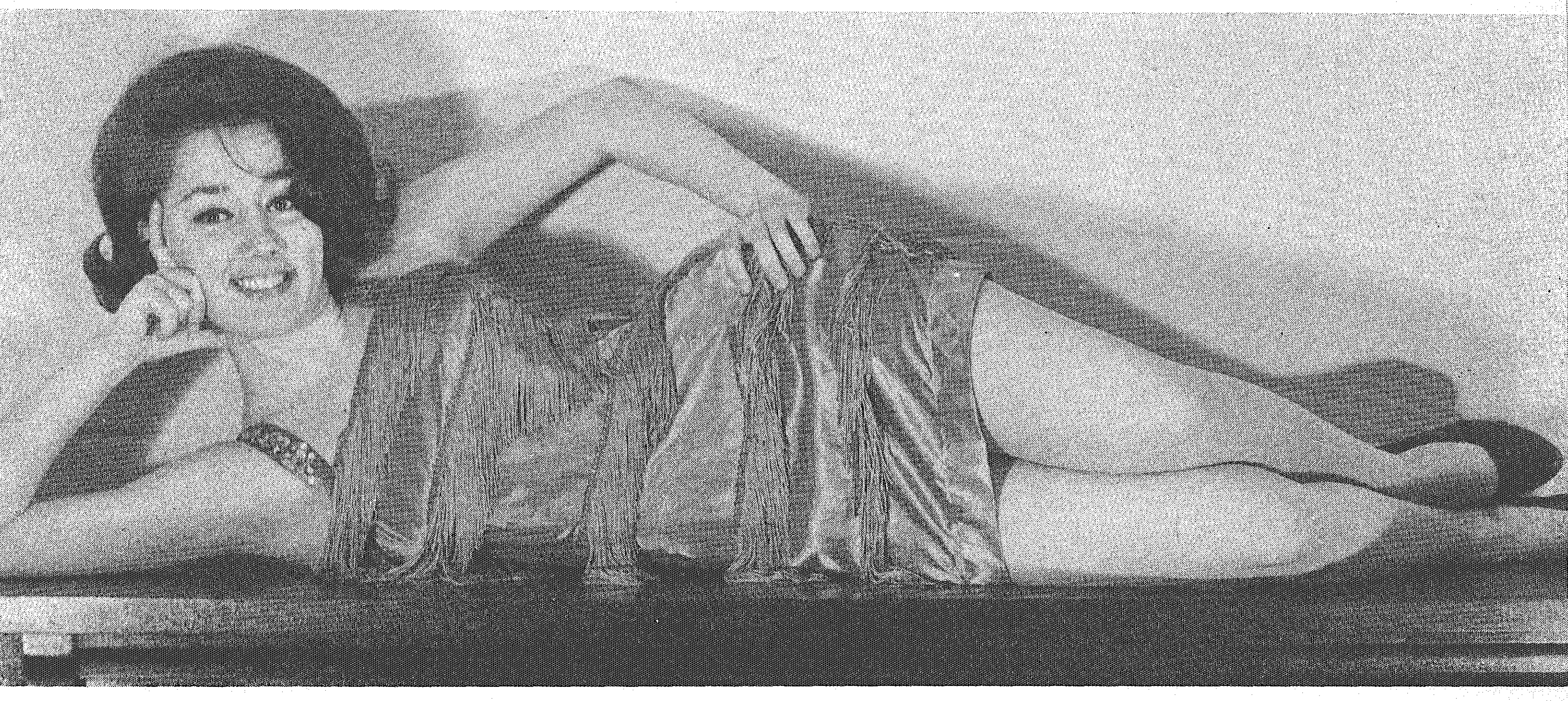
A Valentine's card,
from the Technolog
for all of you
to enjoy . . .

MISS

KATHY ♥ ♥ BINA

F E B R U A R Y



Photos by Gregory

Every engineer with a good memory might recall last year's E-day. If you do you'll surely remember Miss Kathy Bina, one of the queen candidates. That was a good year. Another good year occurred two decades ago when the stork brought the Bina household a baby girl. She must have been a beautiful baby, 'cause boy look at her now.

Some of Miss Bina's interests include ice skating, water skiing, and chalet skiing. She has also done some modeling for Powers. Kathy is majoring in elementary education with a Spanish minor. She is a member of the Greek system and is quite good in the Roman: XXXV-XXIII-XXXVI.

Last month the pin-up's measurements would have been difficult to calculate. Our master mathematician goofed. Now they will be easy. The coefficient of x^2 should have been a negative 672.

BRAIN TEASERS

by GERALD JOHNSON, *ME '67*

1. What is the smallest square number which, when squared, results in the largest possible succession of equal digits?

2. Which is greater: e^{Π} or Π^{e}?

3. I made a smart move marking down those shirts from $2.00," remarked Mr. Gaberdine to his wife, "We have disposed of the entire lot."

"Good!" exclaimed Mrs. Gaberdine, "How much profit did you make?"

"We haven't figured it out yet, but the gross from the sale was $603.77."

How many shirts did Mr. Gaberdine sell and at what price did he sell them?

4. Don't change the position of any of the figures and don't add any other figures, but do use mathematical signs to make this into an equation. There are two solutions possible.

$$2 \quad 9 \quad 6 \quad 7 = 17$$

5. Hans, Reinze, Egbert, and Pedro, who are taxi-drivers, are going fare-hunting tomorrow on a boulevard that runs directly North and South, with no traffic lights. They estimate that equal numbers of pedestrians walk in each direction, at an average speed of four miles an hour.

Hans says, "You're all crazy to use up gas cruising around all the time. I'm going to park beside the curb until a fare comes along."

Reinze says, "I'm going to cruise up and down at four miles an hour and I'll have twice your chance of picking up a fare."

Egbert says, "Eight miles an hour for me, up and down the boulevard, and I'll have twice as much chance as either of you."

Pedro says, "I'm going to average twelve miles an hour and I'll have twice as much chance as Egbert of getting a fare."

Question: Are any of these gentlemen right?

Answers in March issue.

Answers to January Brain Teasers

1. He stated, "I will be shot."
2. You can't dig half a hole!
3. Seventeen 3-cent pieces, five 2-cent pieces, and seventy-eight ½-cent pieces.

Monkey Business

Hanging over a pulley is a rope with a weight at one end; at the other end hangs a monkey of equal weight. The rope weighs eight ounces per foot. The sum of the age of the monkey and his mother is eight years. The mother is as many years old as the weight of the monkey in pounds. The mother is twice as old the monkey was when the mother was half as old as the monkey will be when the monkey is three times as old as its mother was when she was three times as old the monkey. The weight of the rope and weight is half again as much as the combined weight of the weight and the monkey.

How long is the rope?

This is the second of a series of problems which will be appearing in the *Technolog* during Winter Quarter. Answers may be obtained from *Gopher* salesmen who will be easily identified. Students may also obtain the answers, and buy their *Gophers*, at the *Technolog* office, Room 2, Mechanical Engineering Building.

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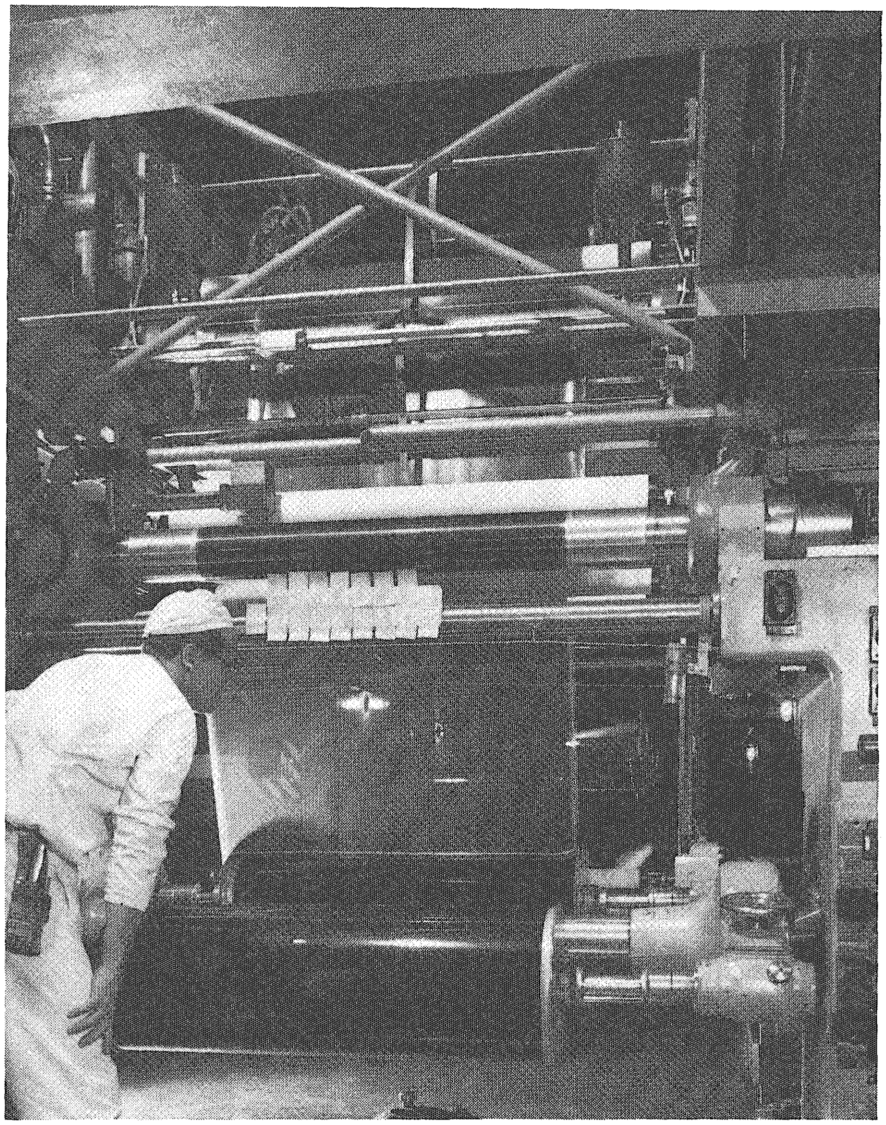
Design a better one and call it chemical engineering



We understand as well as the next company the difference between, let us say, a chemical equipment design engineer and an electro-mechanical development engineer. To turn out the volume we intend of such a fantastically demanding cross-product of chemical and mechanical engineering as a KODAPAK Cartridge of KODACHROME-X Film, we have to interest fresh graduates answering to both these job descriptions and many, many others.

In talking to shoppers from the campus, we find it wise to be very specific about job descriptions. We would create the wrong impression at the interview by referring to the job available as "professional engineer."

The young man is winding up four or five years of building himself into a good all-around engineer. Now comes the time to get specific. He is smart enough to know that the demand by strong organizations for all-around engineers under 25 can be expected to remain slack. He is right. The projects awaiting engineers are terribly specific. But if he has picked the right employer, he will find that with each project brought off well the walls between the compartments of engineering get a little softer.

By the time he discovers he has been transformed into that vague "professional engineer," he is having too much fun fighting our competitors by the boldness of his concepts to care what specialty he promised to devote his career to.

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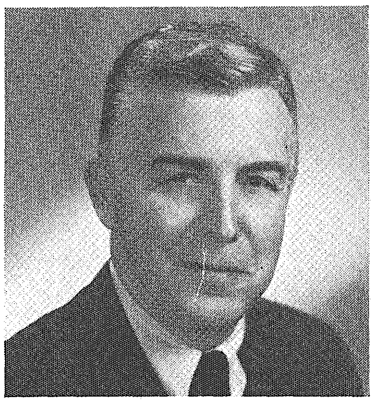
Should You Work for a Big Company?

An interview with General Electric's S. W. Corbin, Vice President and General Manager, Industrial Sales Division.



S. W. CORBIN

■ Wells Corbin heads what is probably the world's largest industrial sales organization, employing more than 8000 persons and selling hundreds of thousands of diverse products. He joined General Electric in 1930 as a student engineer after graduation from Union College with a BSEE. After moving through several assignments in industrial engineering and sales management, he assumed his present position in 1960. He was elected a General Electric vice president in 1963.

Q. **Mr. Corbin, why should I work for a big company? Are there some special advantages?**

A. Just for a minute, consider what the scope of product mix often found in a big company means to you. A broad range of products and services gives you a variety of starting places now. It widens tremendously your opportunity for growth. Engineers and scientists at General Electric research, design, manufacture and sell thousands of products from microminiature electronic components and computer-controlled steel-mill systems for industry; to the world's largest turbine-generators for utilities; to radios, TV sets and appliances for consumers; to satellites and other complex systems for aerospace and defense.

Q. **How about attaining positions of responsibility?**

A. How much responsibility do you want? If you'd like to contribute to the design of tomorrow's atomic reactors—or work on the installation of complex industrial systems—or take part in supervising the manufacture of exotic machine-tool controls—or design new hardware or software for G-E computers—or direct a million dollars in annual sales through distributors—you can do it, in a big company like General Electric, if you show you have the ability. There's no limit to responsibility . . . except your own talent and desire.

Q. **Can big companies offer advantages in training and career development programs?**

A. Yes. We employ large numbers of people each year so we can often set up specialized training programs that are hard to duplicate elsewhere. Our Technical Marketing Program, for example, has specialized assignments both for initial training and career development that vary depending on whether you want a future in sales, application engineering or installation and service engineering. In the Manufacturing Program, assignments are given in manufacturing engineering, factory supervision, quality control, materials management or plant engineering. Other specialized programs exist, like the Product Engineering Program for you prospective creative design engineers, and the highly selective Research Training Program.

Q. **Doesn't that mean there will be more competition for the top jobs?**

A. You'll always find competition for a good job, no matter where you go! But in a company like G.E. where there are 150 product operations, with broad research and sales organizations to back them up, you'll have less chance for your ambition to be stalemated. Why? Simply because there are more top jobs to compete for.

Q. **How can a big company help me fight technological obsolescence?**

A. Wherever you are in General Electric, you'll be helping create a rapid pace of product development to serve highly competitive markets. As a member of the G-E team, you'll be on the leading edge of the wave of advancement—by adapting new research findings to product designs, by keeping your customers informed of new product developments that can improve or even revolutionize their operations, and by developing new machines, processes and methods to manufacture these new products. And there will be classwork too. There's too much to be done to let you get out of date!

FOR MORE INFORMATION on careers for engineers and scientists at General Electric, write Personalized Career Planning, General Electric, Section 699-12, Schenectady, N. Y. 12305

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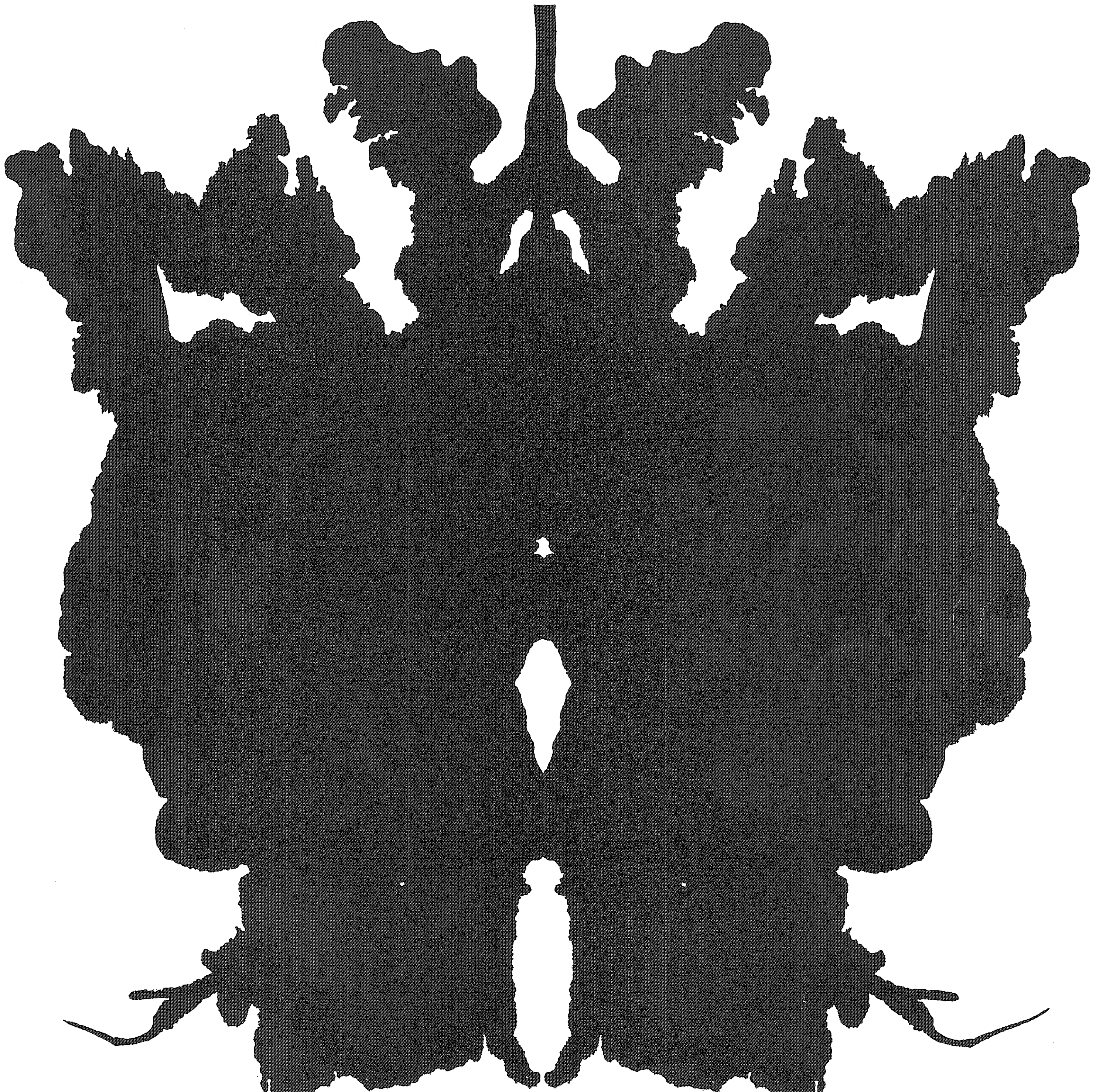

MARCH 1965

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These examples indicate that the talents of chemists at all levels in every major chemistry field—physical, organic, polymer, analytical, engineering, electrochemistry, and paper chemistry—are utilized in NCR's research and development programs. Many of these are related to business systems which are normally associated with NCR; there are also other programs that have considerably broader applications.

What would you do at NCR? Send us an outline of your interests and qualifications to determine if a career position currently exists. All correspondence will be given confidential consideration. T. F. Wade, Technical Placement, The National Cash Register Company, Dayton 9, Ohio.

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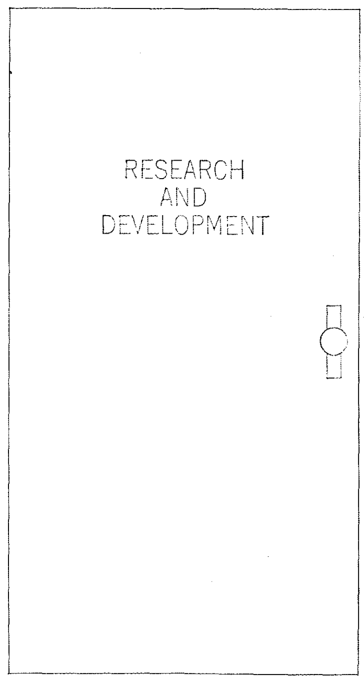

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d. Have an advanced degree in your sights? ( ) or feel BS is sufficient for satisfying career growth? ( )

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Cover: Human engineering is based on the idea of adapting machines and structures to people. In order to do this, individuals must first be analyzed. One psychological tool for analysis is the ink-blot test—so we present a Rekow-Otto ink blot on this month's cover. "Human Engineering" is on p. 8.

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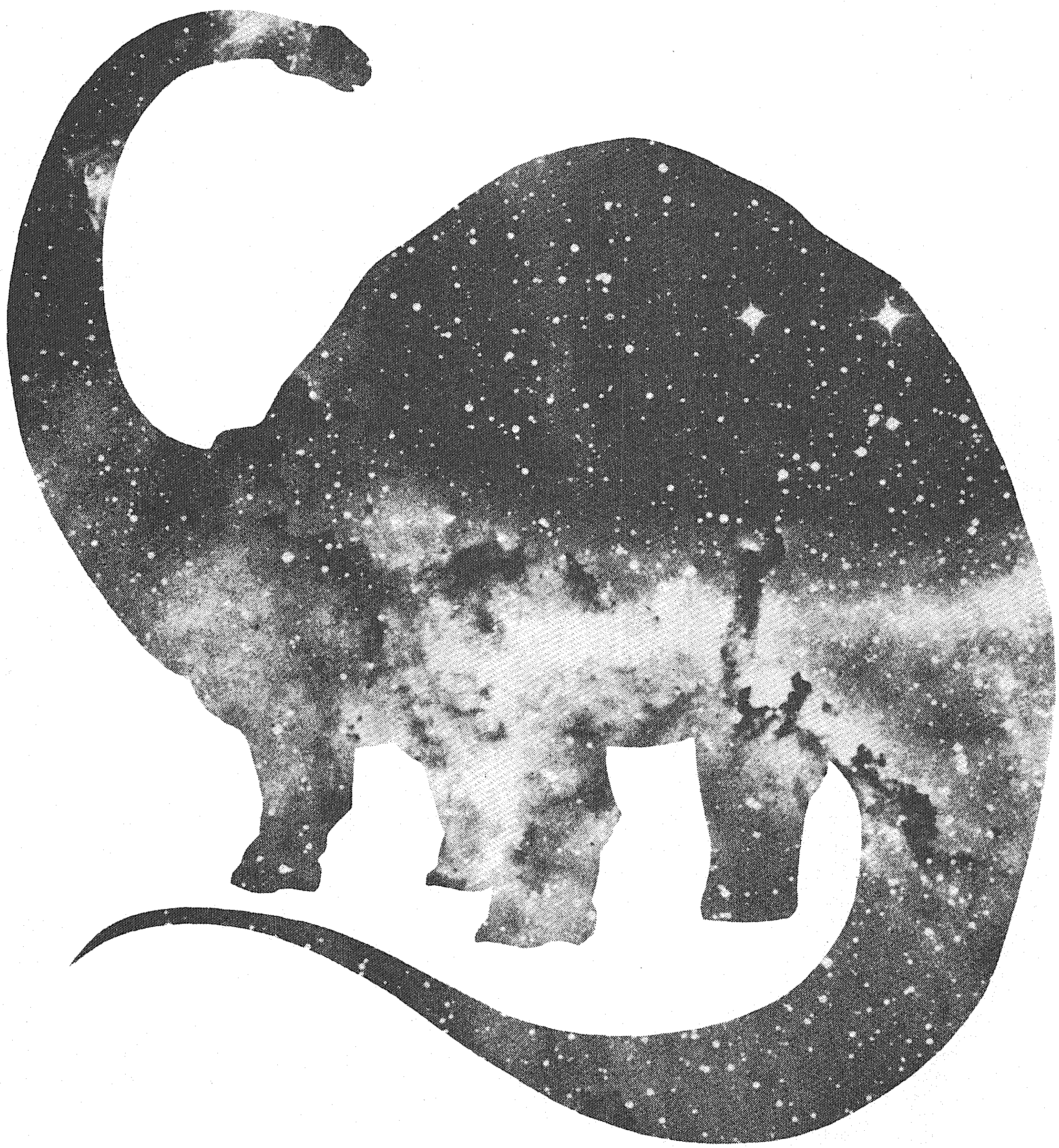

Editorial

M. S. M. S.

Congratulations to the new Minnesota Students Mathematics Society. It has been a long time since there was such an organization here at the University of Minnesota. (At least none of the math professors we asked can remember one.)

The new math society fills several needs. For one thing, it enables undergraduate math students to hear professional mathematicians speak on topics not often covered in classroom lectures. Question periods follow.

A second need which the Math Society fills is that it provides opportunities for math majors to get acquainted with other math majors.

This is all well and good and we wish the new math society the best of luck in recruiting new members and attaining a firm place among IT organizations. But, we do have one complaint, and that is this. The officers have made it too easy for the other members. All they have to do is dutifully check for notices of meetings and then show up at the proper time and place. Membership in the new Math Society may be valued too lightly if it is so easily acquired and maintained.

There must be something for the other members to do. As starters, how about forming discussion groups for those interested in particular topics in mathematics. Another possibility is a series of book reviews on new books in the field. A third suggestion is a semi-tutorial system where struggling students could obtain aid from someone who's already taken the course. For further suggestions, why not consult the members? Many of them are probably eager and able to take a more active part in the organization.

JEL

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Dale Anderson
B.A., Wittenberg University

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U.S. Air Force

Designing machines to fit the man . . .

HUMAN ENG

by ROYAL J. DOSSETT, *EE '59*

Man is a weak animal, an even weaker machine. Though man embodies many desirable features, he is limited in range of senses—seeing, hearing, feeling, smelling, tasting. He is limited mechanically—torque, force, speed, power. Generally he wears out in 70 or 75 years. He has constant fueling and maintenance problems during his life span.

The one unique human feature is a device capable of original thought. Man's brain enables him to extend his body by artificial means, instruments and machines. It is important that these instruments and machines properly fit the senses or muscles they are extending. Man and machine must be as one.

Sense-extending devices enable man to receive input data from miles away, from microscopic intelligence, and from macroscopic universes. Muscle-extending devices allow him to exert physical force in greater proportions, over longer distances, upon minute objects, or in a different form. It should now be obvious that any machine, even so-called automated machines, ultimately concern an operator. The problem is then: build the machine to fit the man.

The design engineer is so conscious of circuit analysis, stress and strain, or heat transfer and loss, that he may neglect to consider the person who is to use the device. This aspect is, in itself, a field of engineering—human engineering—and a fascinating one at that.

Early in the machine age, it was common practice to build a machine, then select and train an operator to run it. No particular consideration was given to the limitations of man when designing the machine. The result was an awkward combination of man and machine. Even after the operator had mastered the skill of operating the device, full efficiency was not derived from the machine.

Designers finally began to see the need for adapting the machine to fit the man rather than vice-versa. Prior to World War II, however, most attempts were based on past experience rather than on experimental evidence. About this time, hundreds of new, complex devices were being built, especially in the field of military electronics and military aviation. These machines failed to perform as their designers had predicted. These machines required tasks, both physical and sensory, that most operators could not perform. Apparently, more work had to be done to fit the machine to man.

Psychologists had long been studying the sensory and motor capabilities of humans. Perhaps closer teamwork between these people and design engineers would result in a better man-machine relationship. Early attempts were highly successful. They opened a new science—human engineering.

Great strides were taken in the following years, especially by the military. Most of the work was kept confidential, for military reasons. Bit by bit, however, concepts and ideas began leaking into private industry. Companies began hiring specialists to design controls and to make time-and-motion studies on operations.

The early '50's witnessed the birth of a style-conscious public regarding machines. This meant that machines must not only run well, and last a long time, but they must look nice and be easy to operate. The field of industrial art grew rapidly. Automobiles, appliances, furniture, buildings, all began to change rapidly with each new model. The science of human engineering was no longer a baby but a full-grown field of study.

Specialists make studies of human capabilities. Other specialists apply these studies to adaptation of machines. But it is still up to the design engineer to see that the machine performs its function. He must be not only part theorist, part technician, part machinist, but also part human engineer.

The design engineer must take many things into consideration—space for the operator, control arrangement, visual displays, safety features, environmental conditions, and the most efficient utilization of the operator's skills.

The Senses

Vision is man's most important liaison with his surroundings. Care should be taken in designing equipment to utilize this factor properly. Scales and dials should be simple and easy to interpret. They should be properly sized and located. Controls, instruments, and working areas should be properly illuminated without glare. Color choice should be eye-appealing, functional, and should follow standard color-coding rules. Contemporary coloring and configuration should be used whenever possible.

Audition is man's next most important link with his environment. Ambient noise levels should be kept low and not be distracting. Signal levels should be considerably higher, but not frightening or painful. Communica-

EERING

tion mediums should be intelligible and non-fatiguing. All signals should be easy to interpret. Physical equipment such as handsets and loudspeakers must be easy to use and properly located.

Touch, the sense of feeling, ranks third. Controls should be easy to recognize, even in the dark. This means several different control shapes, orderly placement, and positive indication of setting (on, off, etc.). Controls should have a slight "feel," such as a sensible "click" on a pushbutton or a detent on a rotary control.

Taste and smell can occasionally be utilized. Pungent odors can be used to indicate leakage or overheating. Taste can sometimes be relied upon to distinguish between two or more substances. Generally, however, taste and smell buds must be appeased rather than utilized in equipment design.

Design Factors

Environments must provide the proper setting for the task to be performed. Temperature and humidity should be designed for maximum comfort. Operator spaces must be well ventilated. Illumination should be non-glaring and of sufficient level for the task. Where dark-adaptation of the eyes must be retained, red lighting is preferred. Subtle, pleasant colors are best for background and large expanses of fixed machinery. Vibration and noise should be isolated from the operator.

Furniture should be properly designed. Consoles, chairs, and work space must be built for human use, not some mythical robot. Controls should be within easy grasp. Chairs must be comfortable but rigid. Working areas should be conveniently placed, out of the way of controls.

Cabinetry must be carefully considered. Panel size should follow standard heights and widths to fit in with other equipment. Careful planning allows one cabinet or enclosure to be used for several types of instruments. Odd configurations should be avoided unless they are compatible with present-day enclosures. Large devices can be built on a modular, or add-on, basis. This approach also allows removal of sections for maintenance or for operational modifications.

Control design is almost a science in itself. Several types of controls can be used—rotary knobs, levers, joysticks (a type of lever), cranks, wheels, push rods, pull handles, pistol grips, triggers, foot pedals, knee bars, elbow plates, and a host of others. The choice will depend upon force requirements, sensitivity, response speed, duty cycle, location of control, maintenance problems, acceleration forces, multiplicity of similar actions, pitch, roll, and vibration present, and ultimately upon man's muscular dexterity and capacity.

Connections should be as universal as possible. Standard terminal blocks and couplings should be used. Dangling or non-removable cables are to be avoided.

Styling should be contemporary. This will allow the user to integrate the machine with other equipment. Careful styling can cover ugly component layouts and disguise the "mass-produced look." Selection of colors is also very important in styling. Often, special configurations and color combinations identify a product with a manufacturer. All these qualities increase a product's sales-potential.

Design Techniques

Evaluation of the tasks is perhaps the first step. What is to be done? Who is to do it? How often is it to be done? How much force is required? What accuracy is necessary?

Sketches can be made of the equipment for further mental evaluation. This technique is probably the most valuable tool available to the human engineer as well as to the electrical or mechanical engineer. Sketching can be heavily relied upon to communicate ideas and evaluate them.

Cutouts may be made to "juggle" components until optimum placement, size, and configuration are arrived at. Color choice may be made after control placement has been decided.

Models could be constructed to better visualize appearance, etc. This three-dimensional sketching often points up bad design before expensive prototypes are built.

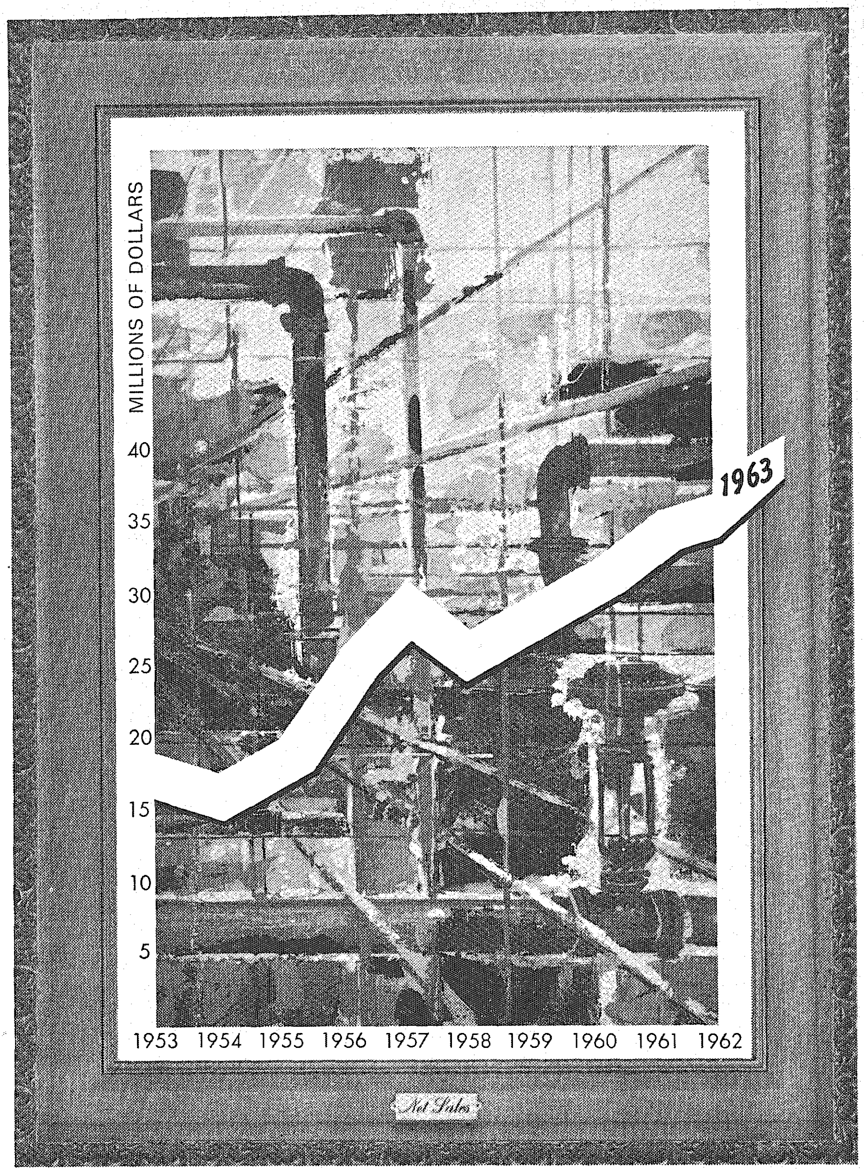
Full-size mock ups allow prospective operators to "play-act" their duties. Poorly placed controls and instruments may be quickly spotted and re-located.

Prototypes, hand-built working models, will iron out most remaining bugs. The device may be rebuilt and rebuilt until optimum design is reached.

Pilot runs of the device, put into actual operation for a trial period, provide operator evaluation under actual conditions. Changes can still be made before going into full-scale production.

Flexibility of design will allow future revisions to keep up with public tastes and demands. A little foresight on the part of the designer may save thousands of dollars in retooling or remodeling costs.

Sound technical engineering is vital if a device is to function properly and last a long time. Equally important is the human engineering. A well-built device is no good if it can't be operated efficiently. Good styling may mean the difference between a sale and no sale. And lastly, a nice looking, easily operated device gives a rare feeling of satisfaction to its designer as well as contentment to its user.



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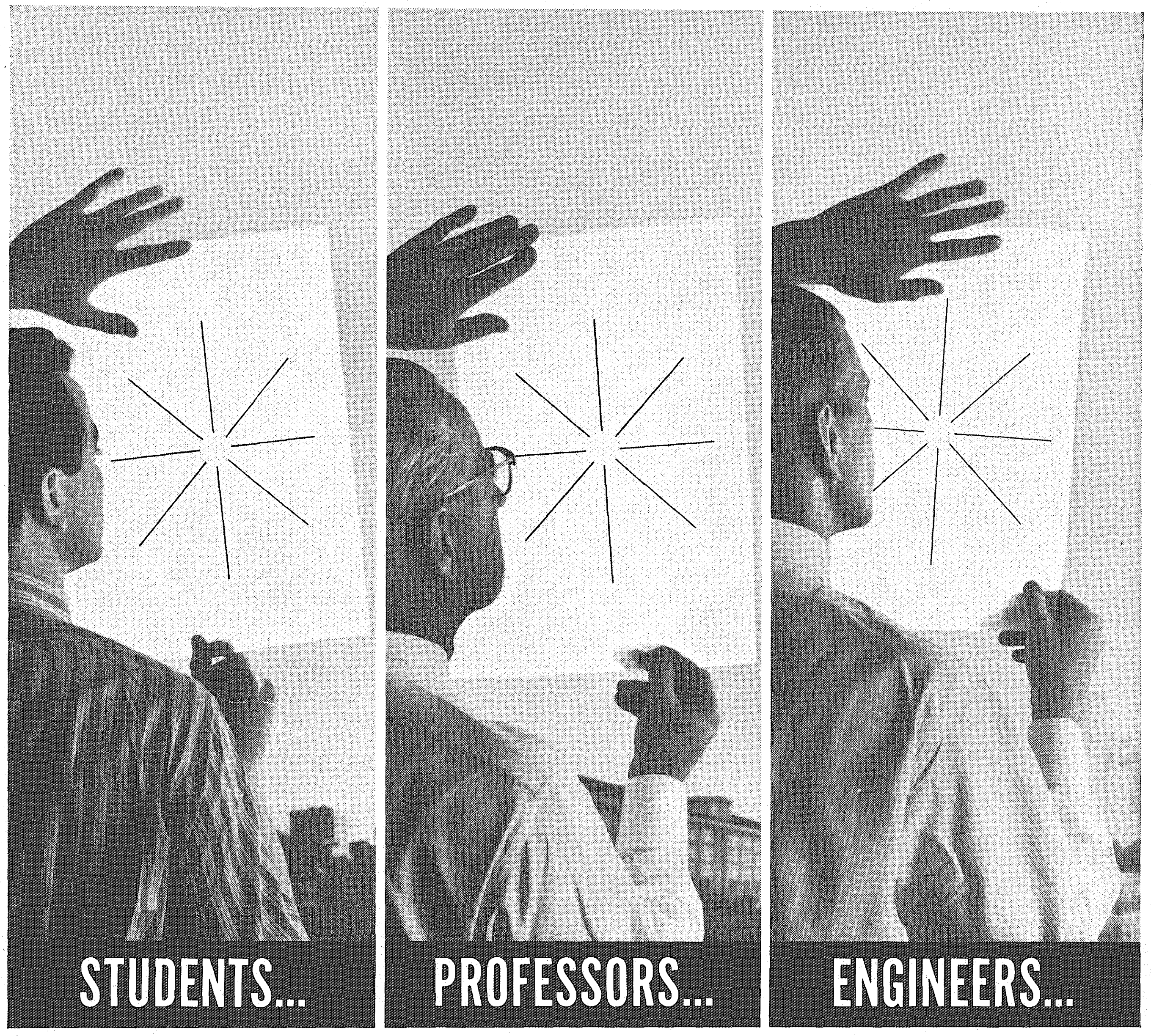

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WATER TREA

by ROBERT J. HART, *ME '65*

Although water-treatment principles have been known for hundreds of years, water treatment has received serious attention only for the past few decades. The ancient Greeks first noted that a residue remained when water was boiled and they formulated the equation

$$\text{Fire} + \text{Water} \rightarrow \text{Earth} + \text{Air}$$

which related the four elements that they believed comprised the universe. While the Greeks discovered that natural water contained impurities, it was discovered only several centuries ago that repeated boiling and condensation left progressively less residue in the boiler.

Water treatment didn't become a necessity until the invention of the steam engine. The steam engine required comparatively large (by standards of that time) amounts of steam, thus necessitating large power boilers. The use of untreated water in these boilers led to scaling and corrosion, which would eventually cause the boiler to fail. The steam engine also spurred water treatment in a less obvious manner. At the time of the steam engine's invention large scale production needed a source of power. Since the steam engine was a source of power, the industrial revolution became a reality. Today industry consumes most of the water used in this country. As more and more water is used for more and more purposes, new and better treatment processes must be found, especially if we are to keep our water supplies clean and free from pollution.

What is water treatment, and why is it necessary in the first place? As complicated as it appears, water treatment is simply fitting water to do a particular job. The accomplishment of this task requires removing or minimizing undesirable qualities and adding desirable qualities to the water. Once the characteristics of the raw water are known, proper treatment is prescribed by the purpose for which the water will be used. Industrial water can be classified into four categories: boiler-feed water (used in steam plant and heating applications), process water (used for industrial processes found in mining, steel, etc), cooling water, and general-purpose water (laundering, personal use, cleaning, etc.). All but process water can be found in a modern steam plant; consequently we will concern ourselves here with the remaining three divisions.

Anyone familiar with steam plants realizes that water treatment presents a serious problem. The treatment is one of two kinds: either external treatment of raw water, which is a purifying process, or internal treatment, which requires adding properties to the boiler water and removing undesirable gases and solids. While external treatment is essentially the same for all units up to a very high pressure and supercritical ($>$3206 psi), internal treatment varies considerably as pressure increases.

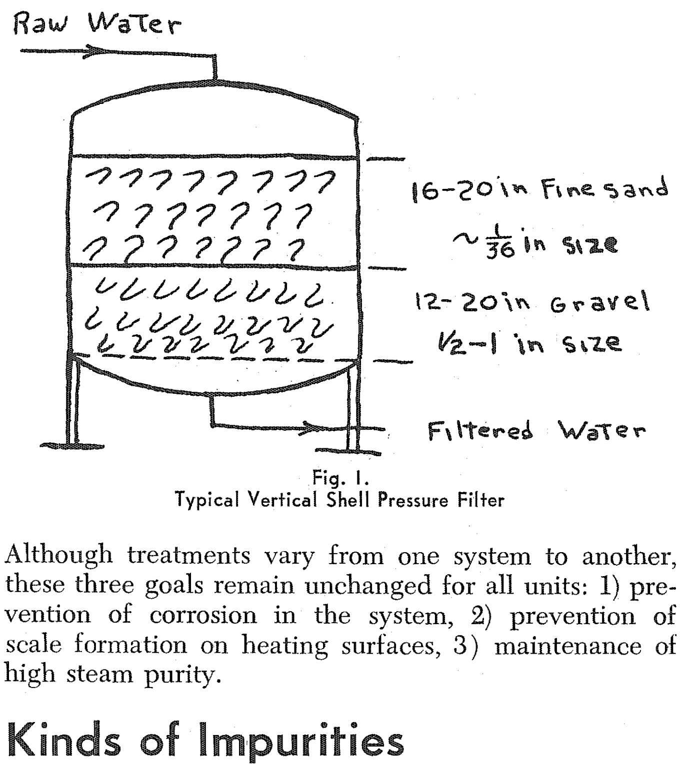


Fig. I.
Typical Vertical Shell Pressure Filter

Although treatments vary from one system to another, these three goals remain unchanged for all units: 1) prevention of corrosion in the system, 2) prevention of scale formation on heating surfaces, 3) maintenance of high steam purity.

Kinds of Impurities

Before raw water can be treated, it is necessary to determine the type and quantities of impurities present. The impurities found can be grouped as follows: 1) suspended solids and liquids (oil, minerals, vegetable matter), 2) coloring material, 3) bacteria and other micro-organisms, 4) semi-colloidal substances (usually complex amino acids), 5) dissolved gases, 6) mineral salts (anions Cl, HCO_3, etc.; cations Ca, Mg, etc.), 7) silica. The importance of removing these impurities varies considerably, depending on whether the water will be used for cooling or boiler feed. Suspended solids are not a serious problem in the case of river water used

TMENT

for condenser-circulating water, although a problem exists for other cooling purposes. The worst problems caused by suspended matter would be excessive erosion and plugging of pipes and tubing. Coloring material and semi-colloidal substances present no problem unless the concentration is exceedingly high, in which case the softening process might be impaired. Bacteria and other micro-organisms can generally be ignored in the boiler-feed water but present a problem in cooling water, especially circulation water. Slime and algae grow on water-side condenser surfaces and quickly reduce condenser efficiency. Ignoring the condition may result in eventual restriction of the condenser.

Mineral salts present the biggest problems if they are allowed to reach the boiler. The chief troublemakers are the bicarbonates of calcium and magnesium. These salts are formed by the natural reaction of water, carbon dioxide, and carbonate as follows:

$$CaCO_3 + CO_2 + H_2O \rightarrow Ca(HCO_3)_2$$

The problem arises as a result of the bicarbonate's decreasing solubility with temperature. This reverses the reaction liberating carbon dioxide and scaling calcium carbonate (calcite). An additional reaction takes place with magnesium at high temperatures,

$$H_2O + MgCO_3 \rightarrow CO_2 + Mg(OH)_2$$

thus liberating additional gas and scaling brucite $Mg(OH)_2$. In addition to calcium and magnesium salts, sodium salts make up a good portion of the remaining salts. As a rule sodium salts are highly soluble and non-scaling at all temperatures. Sodium bicarbonate ($NaHCO_3$) is the only one that causes trouble in boilers, since it reacts with water to form carbon dioxide and caustic soda (NaOH). In addition to the bicarbonates, natural water contains small quantities of sulfates (SO_4) and even lesser quantities of chlorides and nitrates (NO_3). These enter in the form of metal salts such as the above mentioned calcium and magnesium and potassium, iron, zinc, aluminum, and copper.

Hardness, the measure of these salt concentrations, is a measure of the soap-wasting qualities of water due to the calcium and magnesium ions forming fatty acids (scum) when reacted with sodium salts. Since other metallic ions cause hardness also, the term as originally defined is somewhat misused. Hardness is subdivided into two parts: temporary and permanent hardness, obsolete terms being replaced by "alkaline hardness" and "non-alkaline hardness", respectively. Alkaline hardness consists of bicarbonates, carbonates, and hydroxides. Natural waters contain mostly bicarbonates, but carbonates and hydroxides are included to allow ready application to boiler water. Temporary hardness comes from the rapid decomposition of bicarbonates upon heating. Non-alkaline (permanent) hardness is a measure of the amount of sulfates, chlorides and nitrates. The sum of the alkaline and non-alkaline hardness equals the total hardness.

Another large group of impurities consists of a group of dissolved gases. As shown previously, carbon dioxide is a by-product of bicarbonate breakdown. While it is not particularly damaging to the boiler, it reacts with condensate-forming carbonic acid, which can corrode piping. Perhaps the most troublesome gaseous impurity is oxygen. All but an insignificant amount of oxygen enters by leakage at bolted flanges and pump seals that are under a vacuum. From there, dissolved oxygen flows throughout the system, where it attacks pipes and tubing. Ammonia (NH_3) forms by the decomposition of organic matter. Ammonia increases the pH of the water and is often added in the form of hydrazine to control the pH where solid chemicals can't be used. Two other treatment

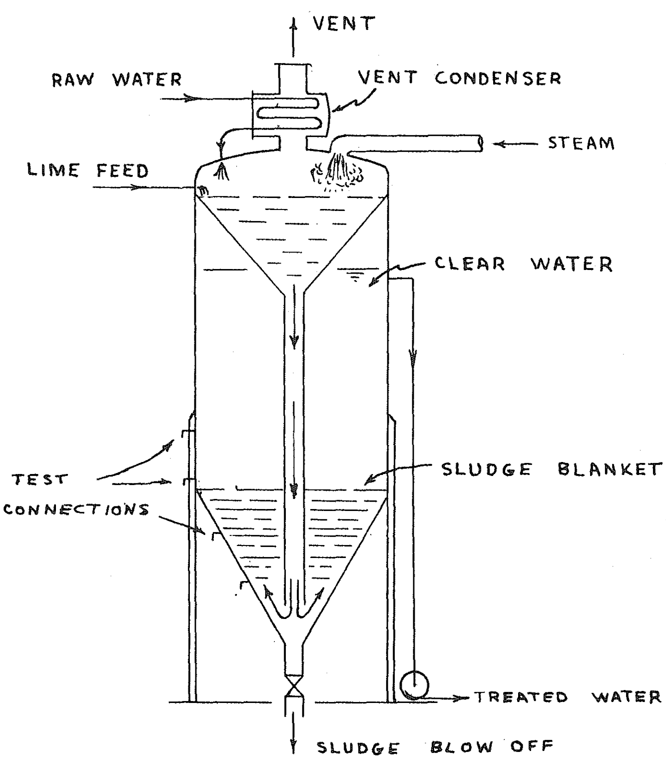


Fig. 2.
Hot Lime-Soda Softener

by-products are hydrogen sulfide and sulfur dioxide. Both are formed by the breakdown of sodium sulfite which is used as an oxygen scavenger, and neither is particularly harmful.

The last impurity found in water is silica. Silica exists in all natural waters in varying quantities. It seems to cause the most trouble because very little is known about its behavior in a boiler. Silica's solubility increases with boiler pressure and can be ignored for pressures below 400 psi. It precipitates out in a variety of complicated molecules combined with other elements forming a hard deposit on heating surfaces. Its most annoying feature is that it carries over with the steam and either chokes superheater tubes or deposits on turbine blading, rapidly reducing the airfoil efficiency. The only way to remove high silica concentrations is by blowing down the boiler, thus wasting both heat and water. Since it is impossible to get rid of silica (it is present in the boiler steel), it becomes a problem in economics. Keep boiler silica just low enough so that turbine blading won't become too fouled between major overhauls, at which time it can be mechanically removed.

External Treatment

The external treatment of natural water may require any number of three processes: filtering, softening by conventional chemical methods, or softening by deionization, which is becoming increasingly popular where ultrapure water is required.

Water filtration to remove suspended solids is a relatively simple procedure. Pumping raw water through a pressure filter (Fig. 1) effectively removes suspended sediment. Water passing downward through the layers of sand and gravel (though any number of other materials such as coal, coke, charcoal, or excelsior can be used) usually loses all suspended particles in the upper six inches of the bed. When the pressure drop across the bed reaches a predetermined level indicating that the bed is choked with sediment, backwashing cleans the sand and separates the two layers so that the filter can return to useful service.

The softening process applied to the filtered water depends on the intended use of the water. If the water is to be used in low-pressure boilers (such as heating boilers or old power boilers), the choice would normally be between two methods: cold-lime or zeolite softening. Cold-lime softening is acceptable for small quantities of water. Since hydrated lime $Ca(OH)_2$ is economically undesirable in quantities, cold-lime processing is usually based on calcium oxide CaO. Reacted with water as follows,

$$CaO + H_2O \rightarrow Ca(OH)_2$$

the desired hydrated lime is produced to do the softening. All the by-products of possible reactions of hydrated lime with hardness components of water are insoluble except for $CaSO_4$ and $CaCl_2$, which cause hardness. This requires the addition of soda-ash (Na_2CO_3) to remove these remaining hardness salts. Cold-lime softening is no longer a popular method of water softening, chiefly because of its low efficiency with anything but small quantities of water.

If larger amounts of water are required and extreme purity is not a requirement, the zeolite softening is ideal. Zeolite softening is an ion exchange process normally making use of a synthetic resin in a reaction replacing the hardness-causing metallic ion with sodium. This process will be described later in connection with the demineralization process. Zeolite softening offers the advantage of simple operation and complete removal of hardness. Its drawbacks are that it doesn't remove alkalinity, reduce total solids, or remove silica.

The most popular softener for boiler water is the hot lime soda ash softener (Fig. 2). These units operate in the temperature range of 228-240°F (saturation conditions at 5-10 psig). In addition to removing hardness, these units remove silica and provide complete deaeration and filtration. The softening reactions taking place in the hot lime soda ash softener are identical to those in the cold lime softener, although the efficiency is greatly increased with increased temperature. In addition to the lime and soda ash, magnesium oxide is usually added to remove silica. While a number of magnesium compounds are effective for silica removal, magnesium oxide is the most efficient and doesn't increase the dissolved solids content. The exact chemical reaction for silica removal is unknown, but the process appears to be one of absorption, with the silica being removed in a colloidal suspension rather than a chemical compound. Factors influencing silica removal are increased absorption rate with higher temperatures and sludge recirculation. pH is not critical but seems to be optimum at about 10. Surprisingly, time is the least important factor for silica removal, with the retention time of most softeners (1 hour) being more than sufficient.

The only serious drawback to hot-lime softeners is maintaining the sludge blanket level (determined by test connections), especially under varying loads. When the

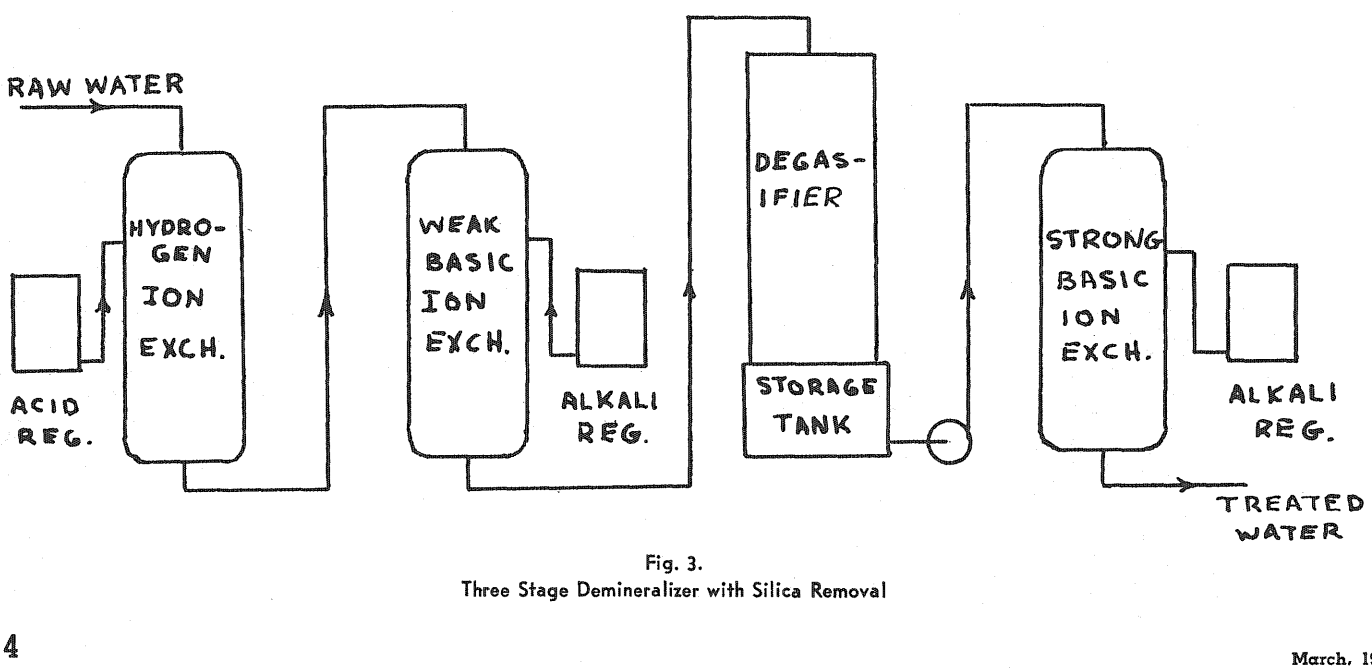


Fig. 3.
Three Stage Demineralizer with Silica Removal

sludge blanket becomes stirred up, sludge and lime may enter the treated water-discharge pipe and be pumped into evaporators and on to the feedwater system.

While a hot lime soda ash softener can do a reasonably efficient job, the need for ultrapure water in modern steam generators and the discovery of new highly basic anions for silica removal have caused an increased popularity in demineralizers (Fig. 3). In addition to supplying superior water, many demineralizer applications have proved more economical than distillation processes. The demineralization process is quite simple. Demineralizers make use of cations which replace metallic cations with hydrogen ions; a process identical to hydrogen zeolite softening. Common practice uses a sulfonic acid group as the active atom group, with the balance being any insoluble, stable and permeable resin. When the ion exchange material is spent, the hydrogen and basic beds must be regenerated by acid and alkali, respectively. Since it would theoretically take an infinite number of exchangers to remove all the objectionable ions in raw water, the effect is produced in an ingenious manner. By mixing both anions and cations in a mixed bed, the last remaining ions can be removed. By having each resin of different size, backwashing with water separates

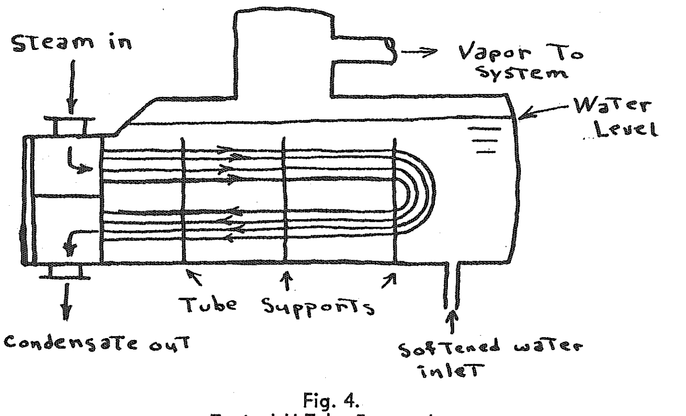


Fig. 4.
Typical U-Tube Exaporator

them into two layers for regeneration, after which they can be remixed by jetting air into the bed.

The quality of water produced by a demineralizer approaches a conductivity of 0.04 micromhos/cm., i.e., that of pure water, where all the ionization is H and OH ions. This quality decreases only slightly until breakthrough in the bed occurs. At this time the bed is spent and needs regenerating. By monitoring the conductivity, breakthrough can be anticipated and the beds regenerated before causing any harm. While demineralizers are used for raw-water treatment in most applications, supercritical boilers require that at least a fraction of the feedwater be treated within the cycle in order to maintain the high standards required for these forced circulation boilers.

Internal Water Treatment

The term "internal water treatment" refers to precautions taken to protect the boiler and other containing equipment from possible damage by impurities in the water and steam or from the water itself. To guard against water contamination, all units employing chemical softeners make use of evaporators (Fig. 4). Softened water is evaporated by bleed steam from the turbine to insure a minimum of solids getting into the boiler. Deposits on tubing are removed by a process called "cracking," where the tubes are alternately heated and rapidly cooled. The process effectively removes deposits though it can promote the occurrence of leaks in some evaporator designs.

Once the water reaches the boiler, the situation becomes a little more complicated. While one might assume that water of high purity would be ideal, the fact is that high purity water may be more corrosive than raw water, especially if oxygen is present. Water at elevated temperatures is highly corrosive and attacks the steel as follows,

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$$

forming magnetite. The magnetite layer protects the steel from further attack by the water. The dominant factor in protecting the magnetite layer is pH with the optimum in the 11-12 range. pH less than this value results in an acid corrosion and at values greater than 12 the magnetite becomes excessively thick and breaks down. In the case of conventional boilers (natural circulation), the addition of caustic soda (NaOH) maintains the correct pH. With forced-circulation boilers, where solids are prohibited, pH must be maintained by feeding ammonia or hydrazine.

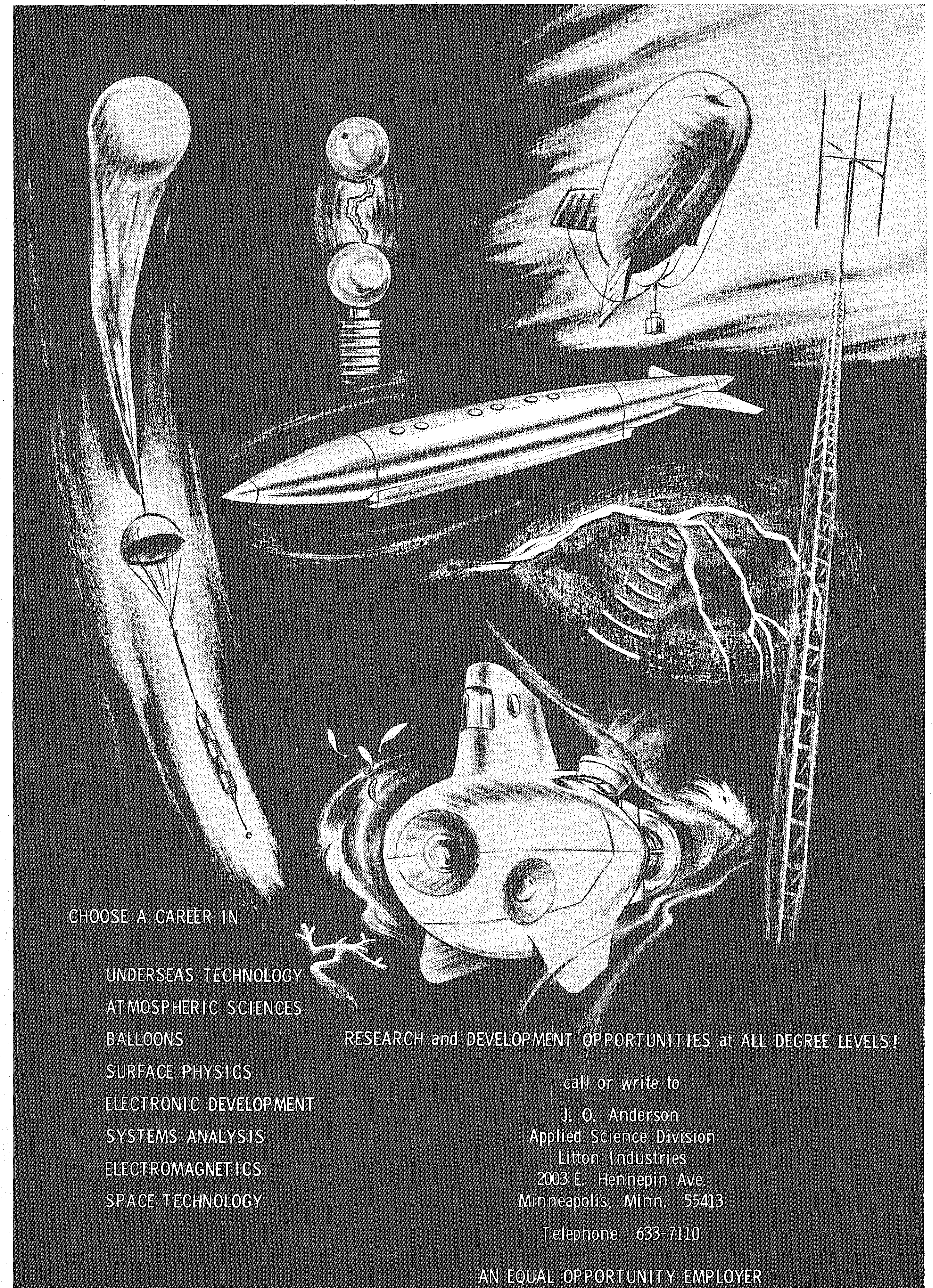
Scaling

Scaling remains the most dangerous and complicated boiler condition to be found. Scale results from the traces of hardness that enter the boiler with the feedwater. Hardness breaks down to the previously mentioned scalers such as calcium carbonate, magnesium hydroxide, etc. Contrary to what was once believed, scale is not necessarily a simple deposit of these compounds, but may rather be a complicated molecule containing silica. Two examples of these are serpentine ($3MgO \cdot 2SiO_2 \cdot 2H_2O$) and xonolite ($5CaO \cdot 5SiO_2 \cdot 2H_2O$), materials discovered with the aid of X-ray diffraction. The trouble caused by scale is not clogging of the pipes with deposits (an insignificant problem in steam plants), but rather the insulating qualities of the scale. It has been shown that up to 2 percent can be lost in efficiency because of boiler scale. This loss alone makes chemical treatment economical for an industry where a fraction of one percent loss can mean thousands of dollars annually.

The serious problem results from the low heat-transfer coefficient of scale and the heat rate necessary to generate steam. It has been shown that scale has a thermal conductivity, K, of about 1.5 (K for steel = 26). Compounding this problem is the porous texture of many scales which become steam-filled and reduce K to about 0.75, equal to that of firebrick! With a heat transfer rate of 100,000 Btu per hour per square foot and a porous scale layer of 0.04 inches, metal temperatures will have to be in the neighborhood of 1000°F, a temperature considered unsafe for most common steels. Some porous scales of $K \geqq 0.2$ will cause failures with a thickness less than 0.01 inch. The treatment of boiler water with an excess of any of the sodium phosphates effectively softens the water and stops scaling. All phosphates precipitate calcium in the form of tricalcium phosphate sludge.

Although dissolved gases don't cause trouble in the

(Continued on Page 42)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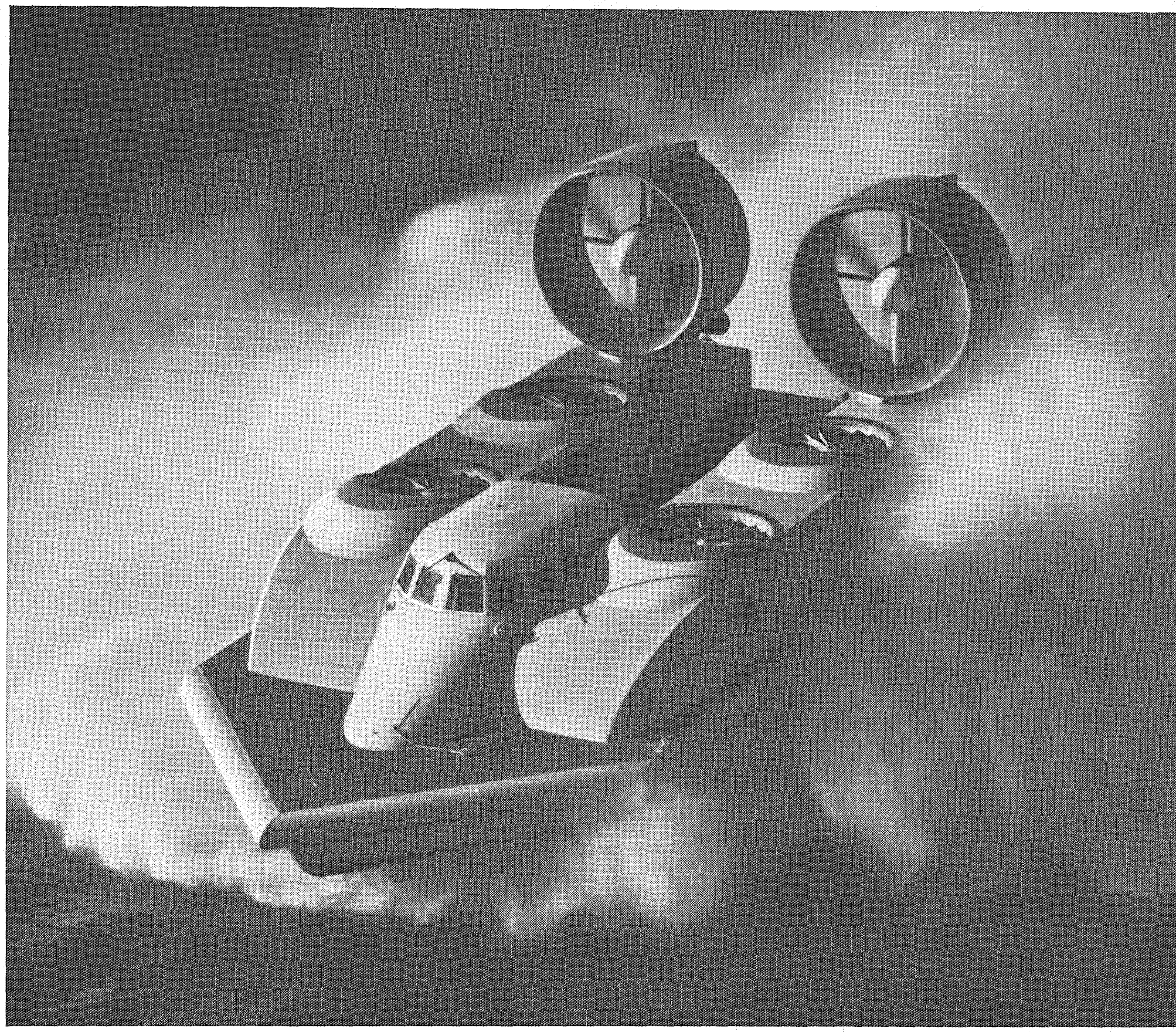

Don't miss the boat!

The boat is the Navy's Hydroskimmer, powered by four 1100-horsepower gas turbines built by the Solar Division of International Harvester.

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WHAT'S NEW *in Engineering*

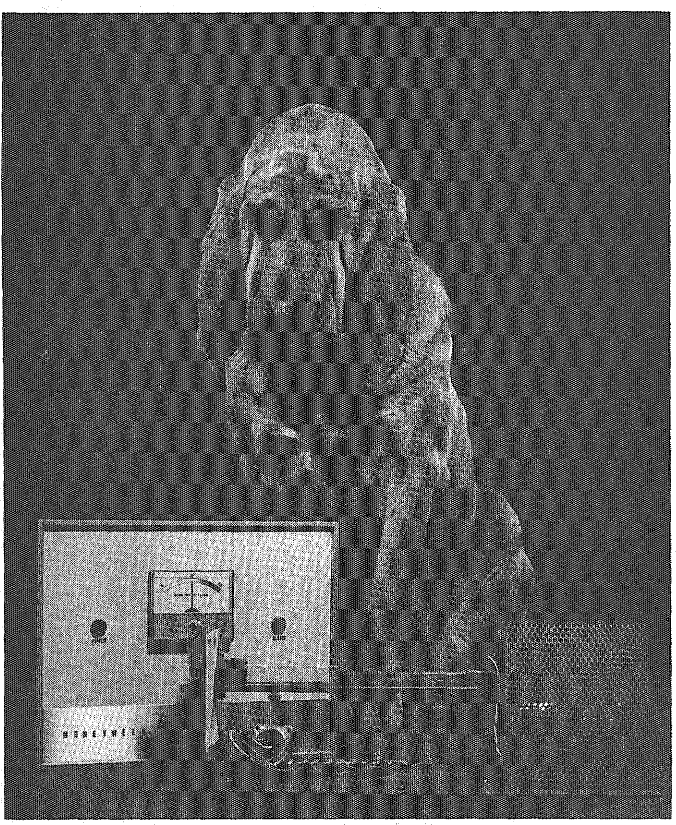
edited by STEVE LINDFORS, *Physics '67*

Bloodhound Has Competitor

An ultrasensitive "electronic bloodhound" that detects vapors from hydrocarbons, chlorinated hydrocarbons, aromatics, ammonias, amines, industrial monomers and volatile acids at levels as low as 10 parts per million (ppm) has been announced.

The unit—called Per-tector—can be used in factory and industrial applications, process control, research installations, chemical laboratories, wherever such vapors are used.

The basic unit detects perchlorethylene and ammonia.



With minor engineering changes, it can detect the groups listed above plus various lacrymators, solvents, toxics and vesicants. The Per-tector continually sniffs samples of air. When the perchlorethylene (or other gas) concentration reaches a pre-set level (usually 40 ppm) the unit automatically closes a relay to flash a warning signal, turn on ventilating fans or take whatever other action is programmed.

The Per-tector consists of a sampling chamber (sniffer) and a remote amplifier relay. The sniffer can be installed anywhere vapors are present. The amplifier relay can be mounted at a remote location any distance from the sniffer.

Operation of a typical Per-tector unit was described as follows:

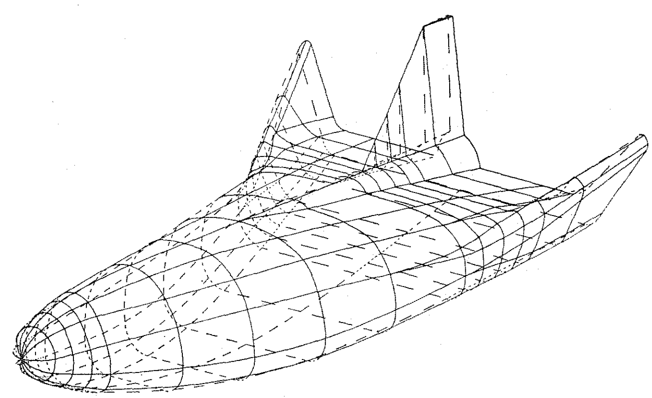
A fan draws air into the sampling chamber between two electronic tubes, one a special source lamp giving off ultraviolet rays and the other a sensor that responds only to this ultraviolet radiation. So long as no perchlorethylene is in the air the sensor picks up the full radiation from the ultraviolet lamp.

When even a minuscule amount of perchlorethylene vapor, which absorbs ultraviolet, is carried in the air, the sensor immediately detects it. The amount can be less than .00025 per cent. As the concentration reaches the pre-set limit, the Per-tector automatically triggers a relay to turn on ventilating fans or a warning signal.

First Poet, Now Artist

Defining the shape of things to come is taking a new twist at The Boeing Company where computers are being used as tools to design space vehicle shapes.

Boeing's Aero-Space Division applied mathematics organization has developed a technique called geometric



computing which can design vehicle configurations capable of controlled flight through the earth's atmosphere on a re-entry path, with savings in time, money and material. Similar computer work is being done by other Boeing divisions aimed at solving design problems for their own unique product lines.

Using a computer, Boeing's applied mathematics personnel can develop raw engineering data, season it for a computer's taste buds, then feed it into the machine which draws a three-dimensional shape of the proposed spacecraft, based entirely on the diet of figures provided by mathematicians.

This computer-drawn design can take the form of a line drawing for visual study or a tape which, when fed to a machine, dictates what shape will be carved in metal according to the computer design.

These mathematical drawings of spacecraft provide graphic information for engineering evaluation and analysis. Engineers in Boeing's flight technology department, with assistance from the applied mathematics organization, have worked out equations for figuring surface pressures and aerodynamic heating rates in hypersonic flight. When these equations are given to the computer, the lift, drag, and control characteristics of advanced re-entry vehicles can also be calculated, saving many hours of laborious engineering calculation.

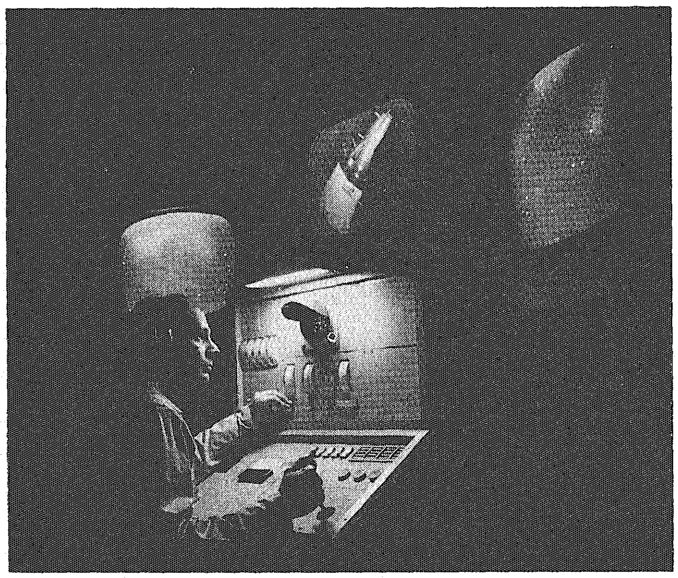
Flight technology engineers point out that geometric computing does not eliminate the need for engineering calculation or testing, but it does allow some preliminary design work to be performed quickly and easily.

Geometric computing can also be used to establish the position of major subsystems within a shape. It would have required 35 weeks to design radiation protection systems for deep space vehicles using conventional methods. The computer did the work in two weeks.

This new Boeing capability is considered a significant advance in engineering design techniques. Design changes can be incorporated into a study with minimum effort, providing engineering flexibility of a high degree.

Lassie on Window 2

If you were an astronaut, here's what you'd see from your windows as your spacecraft rendezvoused with another orbiting craft to link up and transfer men and supplies. The "windows" actually are TV screens on which computer-driven views are presented exactly as



they would be seen by an astronaut. The manned orbital laboratory simulator shown here is part of an advanced system, called an Integrated Manned Space Systems Simulator, which is nearing completion at the Astronautics Division of General Dynamics Corp., San Diego. When completed, the entire system will be capable of simulating in detail every conceivable manned mission in earth orbit, to the moon, or to any planet in the solar system. Its purpose is to study man's role in space to gain a better understanding of the requirements for crew systems and spacecraft design.

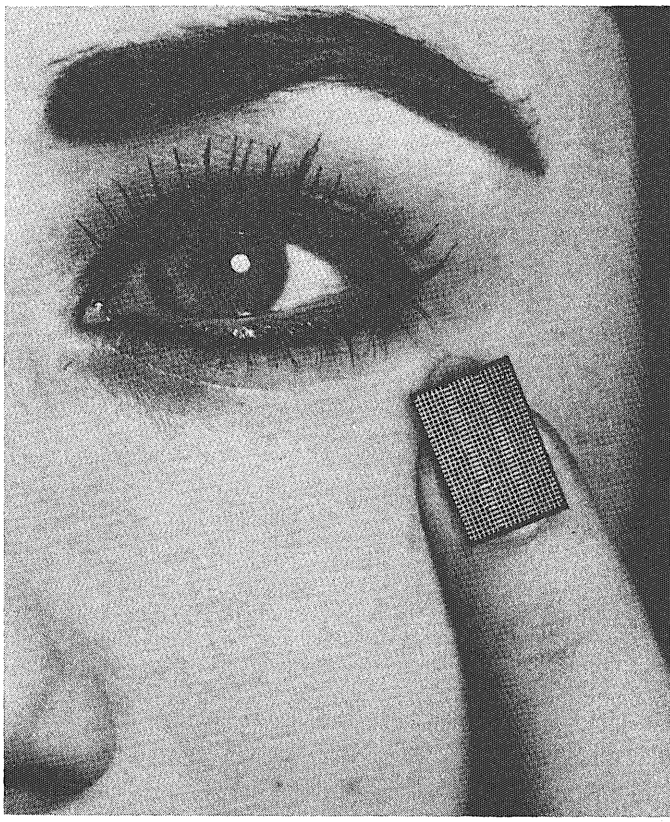
Flashy Circuit

Nobody knows how many angels can dance on the head of a pin, but a team of scientists revealed that they've built the equivalent of 576 separate light bulbs on a single chip of silicon no larger than a lady's fingernail.

Working in the research and development laboratories of Fairchild Semiconductor the scientists developed a solid state electronic device which contains 576 light-emitting diodes on a silicon rectangle barely 5/8 inch on its longest dimension. The diodes, which can be flashed one at a time or in various combinations, are used to record complex data on photographic film.

Called the FLPA-200, this newest advance in electronic integrated circuit technology has more active elements in one solid piece of material than ever before achieved.

First application for the FLPA-200 is in a photographic



reconnaissance camera system. As the film passes through the camera, the tiny device flashes various dot combinations that indicate all the information needed by the experts in later analysis of the photos. The job had been done previously by a bulky system of prisms, optical lenses, cathode ray tubes and power supplies.

From a scientific point of view, one of the most amazing aspects of the device is the precise arrangement of the diodes. They are arranged in 32 rows of 18 diodes each, and the spacing is 18 thousandths of an inch from center-to-center, each way. Since each diode in itself is a fairly complicated electronic device, considerable development was required to produce 576 diodes at the same time, all with the same operating characteristics, all the same size, and all performing perfectly.

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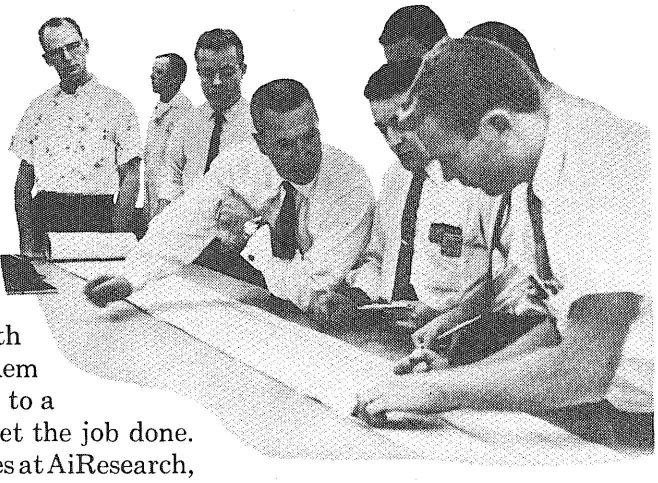

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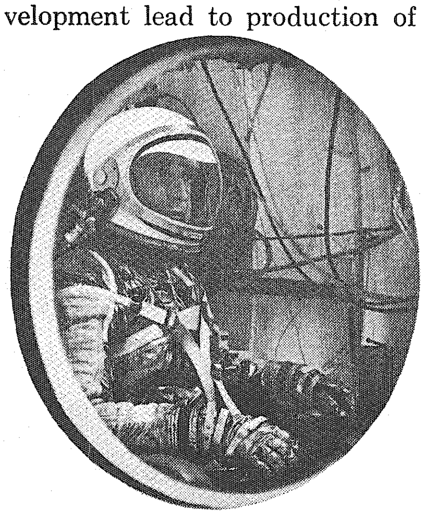

The product lines at AiResearch, Los Angeles Division, are environmental systems, flight information and controls systems, heat transfer systems, secondary power generator systems for missiles and space, electrical systems, and specialized industrial systems.

In the Phoenix Division there are gas turbines for propulsion and secondary power, valves and control systems, air turbine starters and motors, solar and nuclear power systems.

In each category AiResearch employs three kinds of engineers.

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Developmental engineers are responsible for making hardware out of concepts.

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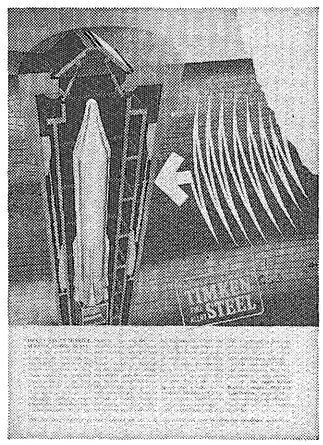

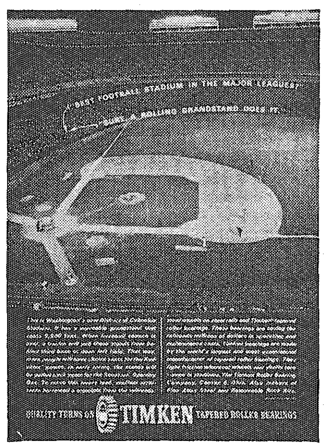

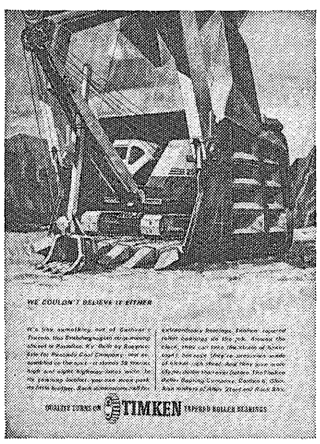

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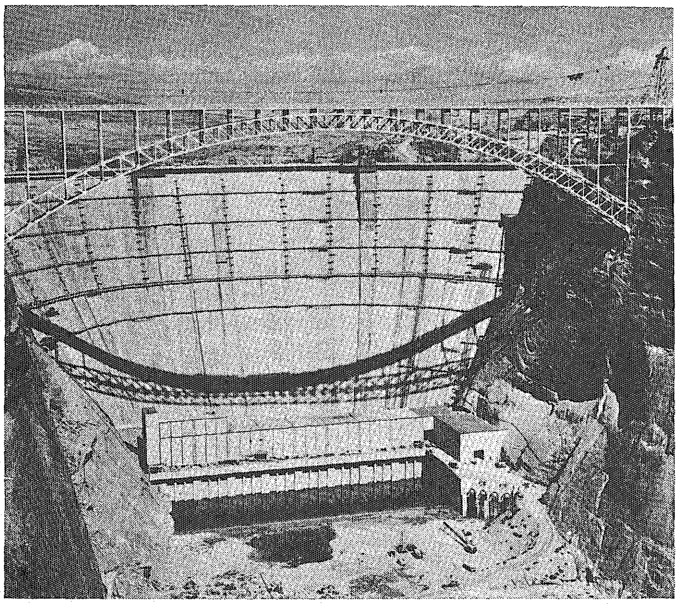


Glen Canyon Unit—Colorado River Project

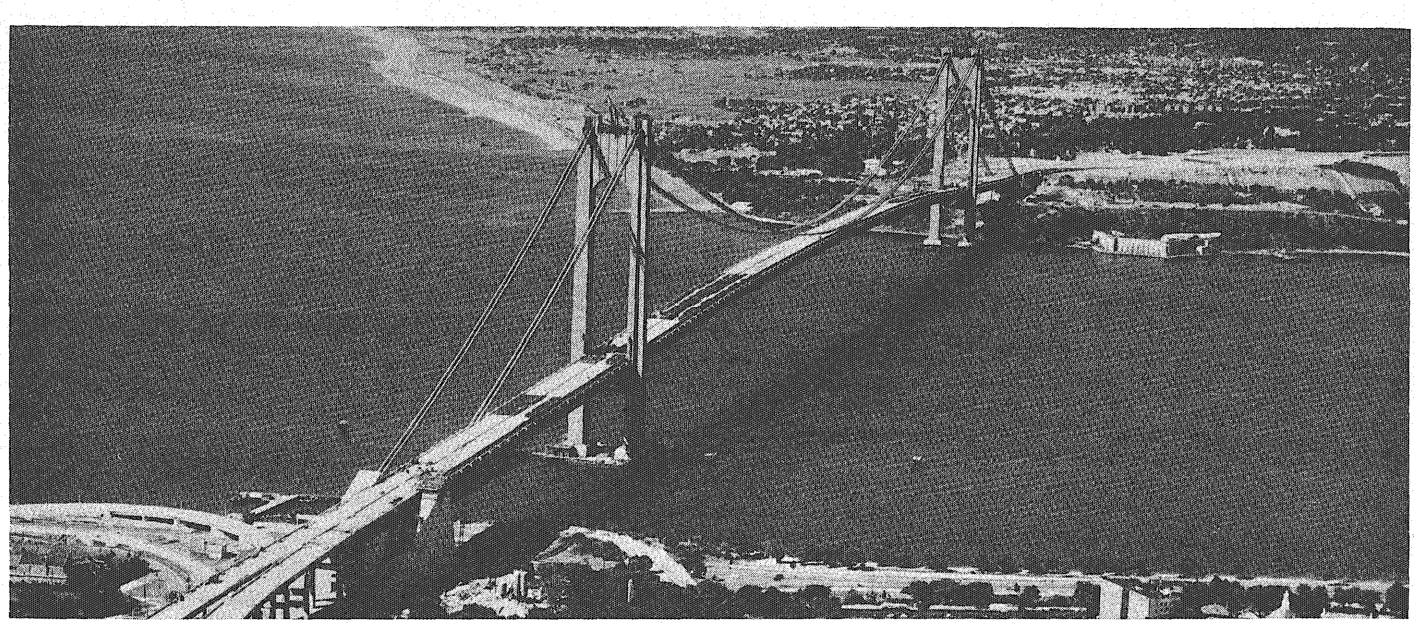
by JACQUELINE E. LANDER, *Math '65*

The "Outstanding Civil Engineering Achievement" award is presented annually by the American Society of Civil Engineers to the project which "demonstrates the greatest engineering skills and represents the greatest contribution to civil engineering and mankind." A seven-member panel of editors of engineering magazines picks the winner in the national competition. The selection is confirmed by the ASCE governing board and announcement of the winning project is made at their March meeting. Nominees for the 1965 award are: the Verrazano-Narrows Bridge and approaches in New York City; the District Filtration Plant in Chicago; the Flood Control and Water Conservation Project of the Los Angeles County Flood Control District; and the Chesapeake Bay Bridge-Tunnel.

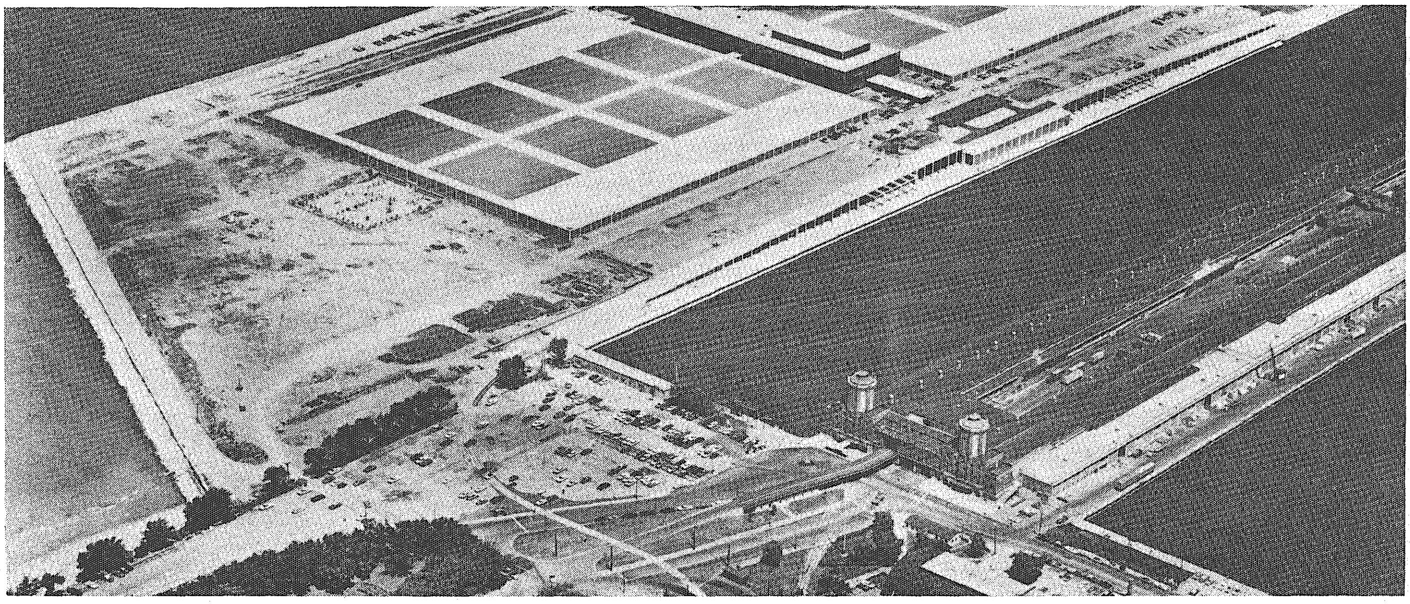
The 17.6 mile Chesapeake Bay Bridge-Tunnel, opened in April, 1964, combines 12½ miles of low-level trestle,

(Continued on Page 43)

Chesapeake Bay Bridge-Tunnel Project


Verrazano-Narrows Bridge


Pacoima Spreading Grounds and Diversion Channel—Los Angeles County Flood Control District


Chicago's Central District Filtration Plant

MSPE Silver Anniversary Roster Is Dedicated to Prof. James Jay Ryan, P.E., MSPE "Engineer of the Quarter Century"

The Minnesota Society of Professional Engineers honors Professor James Jay Ryan, Jr., P.E., as "Engineer of the Quarter Century" in connection with its 25th Anniversary. In dedicating their Silver Anniversary Roster to Mr. Ryan, MSPE looks back years behind 1939, MSPE's founding date, and recognizes that here is a man who was gifted with an engineering mind and then went on to realize his potential.

Born and raised in LeClaire, Iowa, the son of a real estate and insurance agent, he was "interested in building things as a young boy". Although his father wanted him to be a lawyer, he wanted to be an engineer and an engineer he became. Graduating from high school when he was just sixteen years old, he went to business school for a year and then on to the University of Iowa where he graduated Tau Beta Pi in Mechanical Engineering, 1925.

Ryan treasures his six years of experience while doing fundamental design for Westinghouse in vibration research and development immediately following completion of his undergraduate college work. He feels that his industry engineering experience before becoming a teacher was very important. While with Westinghouse he taught night courses for two years which provided completion of the basic groundwork for his greatest life work, teaching.


Prof. James Jay Ryan, Jr.

Professor Ryan is an *inventor* of world renown, developing the now almost universally used Flight Recorder for aircraft, several safety devices for ground vehicles such as automatic seat belts and hydraulic bumpers and Recording Tensiometers. An *author*, he has written numerous papers on vibration, photoelasticity, lubrication, instrumentation, stress analysis and transportation safety. As a *professional* engineer, he has been president of MSPE and ASME, Minn. section, and has served on the Minnesota Board of Registration and numerous professional committees and public interest groups.

Teaching, however, has been his first love and the fulfilling of his great desire. Ryan reminisces, "I always enjoyed being with the students in the class." He did all else to live for his students and to set an example for them. His gift of wit was successful in increasing educational interest by adding humor to subject matter presentation. It is safely within the mark to comment that every student represented by the 6777 grades he gave in thirty years of teaching remembers Professor "Jim" Ryan and wants to be a better engineer because of his influence upon his life.

DEDICATION RESOLUTION

WHEREAS Professor James Jay Ryan, Jr., P.E., has meritoriously served the engineering profession for the past thirty-eight years:

—as a creative contributor in vibration and stress analysis;

—as an engineering educator who instilled in his students not only a desire to excel technically, but also to render service to the engineering profession and mankind as a whole;

—as an inventor of automotive and aircraft safety devices;

—as a tireless worker and officer of professional and technical engineering societies which have flourished under his leadership; and

—as a member of the State Board of Registration for Architects, Engineers, and Land Surveyors.

NOW THEREFORE be it resolved that in recognition of such meritorious service, the Board of Directors of the Minnesota Society of Professional Engineers, on this twenty-first day of November, nineteen hundred and sixty-four has honored Professor James Jay Ryan, Jr., P.E., as the "Engineer of the Quarter Century" and has dedicated the forthcoming edition of the Society's 25th anniversary roster to him.

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As part of a continuing effort, programs have been designed to analyze communications needs of an area for determining the best plant network layout and switching office location.

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The computer supplies more significant data, and supplies it much faster, than laborious, manual calculation methods. The engineer is thus relieved of dull, time-consuming computation, and he plans facilities with increased confidence—knowing that he is providing efficient and economical communications, tailored for a given area.

You may well find a rewarding career in the Bell System, where people find solutions to exciting problems. The Bell System companies are equal opportunity employers. Arrange for an on-campus interview through your Placement Office, or talk to a local Bell System company.

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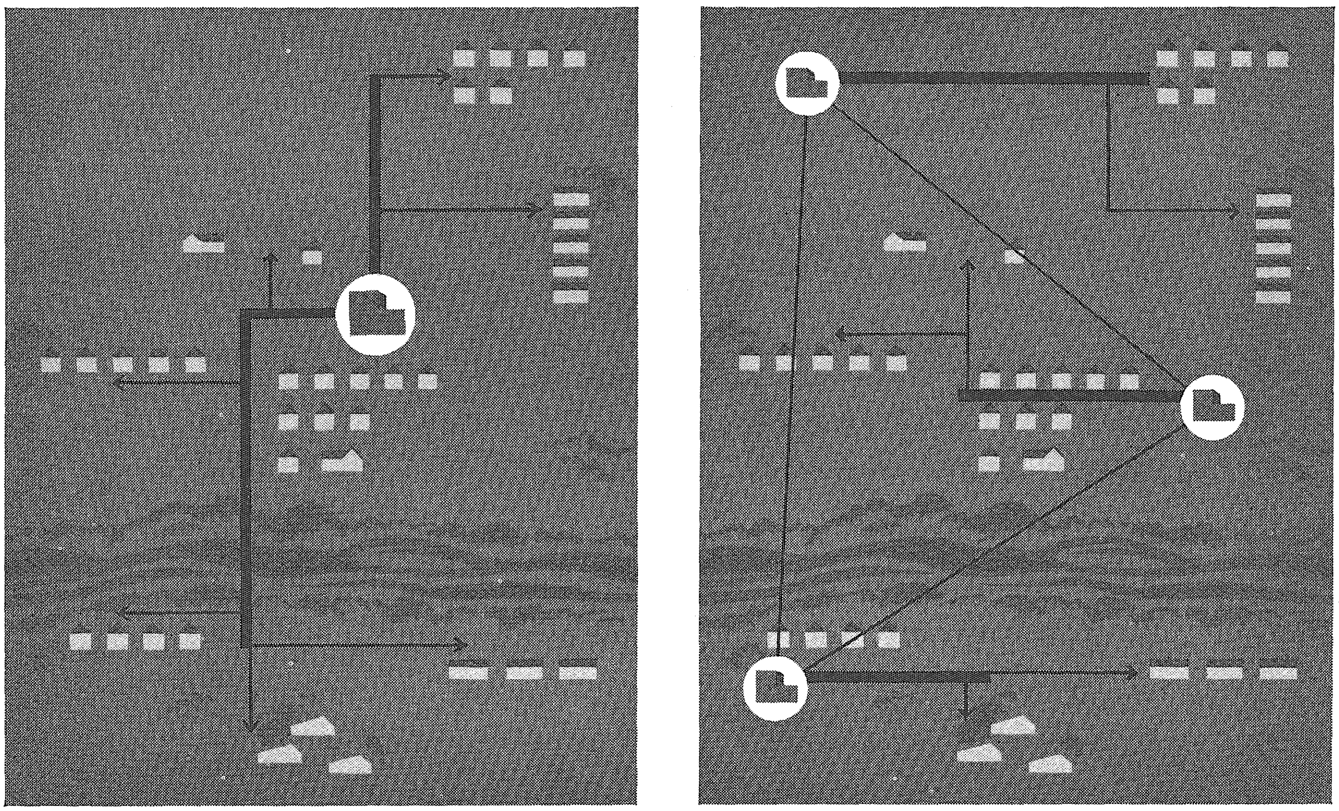

This? In this hypothetical geographical area, communications could be supplied with one large telephone switching office and a network of cables (left), or with three smaller offices and a different network (right). Many other combinations of offices and cable networks might be possible. This situation, although hypothetical, is typical of the complex telephone engineering problems that are being solved with the aid of computer programs designed at Bell Laboratories. **Or this?**

SPLINTERS From the Log

by DAVID E. ENGEN, *Pol Sci '67*

Chem. Prof.: "This fluid turns blue if your unknown is basic, and red if the unknown is acid."

Sudent: "Sorry, but I'm color blind. Got anything with a bell on it?"

• • •

Some people sow their wild oats on Saturday night and then go to church on Sunday and pray for crop failure.

• • •

The husband told the Judge, "I came home and there was my wife in the arms of a strange man." "What did she say when you surprised her?" asked the Judge. "Well Judge, that was what hurt me the most," said the husband. "She turned around and saw me and then said, 'Well, look who's here, Old Blabbermouth! Now the whole neighborhood will know."

• • •

Wayne: "Look at this ring. My father took it off a dead Jap."

Gordon: "I didn't know your father was in the war."

Wayne: "He wasn't. Our gardener died."

• • •

The young reporter dashed into the editor's office and shouted, "I have a perfect news story!"

The editor looked up from his proofs and asked, "Man bites dog?"

"No," the reporter said, "Bull throws professor!"

• • •

Proud parent, upon meeting the new first-grade teacher: "How do you do, Miss Smith. I'm the father of the twins you're going to have in September."

• • •

Lawyer: "Why do you want to get divorced?"

Client: "Because I'm married."

• • •

An impatient old lady making a trip by bus became irritated at the many stops. "Such a slow bus," she snapped. "I believe we stop at every telephone pole."

"Why not, lady?" replied the driver. "This bus is a Greyhound."

A few years ago, Uranium cost two dollars a ton. Then someone found out it could kill people.

• • •

"But darling, this isn't our baby."
"Shut up, it's a better buggy."

NO JOKE

A police car in California followed a suspected traffic violator into an automatic gate parking lot recently. The police car was some distance behind and found, once inside, that the bird had flown. The policeman, renewing pursuit, approached the gate, to find that it could be opened only with two quarters. He had a quarter and a $5 bill. A radio message brought another patrol car. No quarter either. Twenty mintues later, the police car was released. The suspect, unsportingly, hadn't waited. Shades of the U of M police.

Overheard at a bridge party: "Take your hands off my trick!"

• • •

Then there was the porcupine who bent his quills trying to overpower a wire brush in a dark corner.

There are three ways to break up a dinner conversation: 1) Ask the lady on your right if she is married. If she says yes, ask her if she has any children. If she says no, ask her how she does it. 2) Ask the lady on your left if she is married. If she says no, ask her if she has any children. 3) Lean across the table and ask the lady facing you if she has any children. If she says yes, ask her if she is married.

• • •

CE (over phone): Is Emily in?

Maid (also over phone): She's taking a bath.

CE: I'm sorry. I have the wrong number.

• • •

Definition of a meteorologist: A guy who can look at a girl and tell whether.

• • •

A beautiful co-ed walked by me all dressed in red, and as she did she reminded me of a fire engine. Why? Because she wore red and a newspaper is read and what you read are lines and the printer who sets these lines is a liner and a liner is the Queen Mary and the Queen Mary sails the ocean blue and in the ocean blue there are fish and the fish have fins and the Finns fought the Turks and the Turks fought the Russians and the Russians are red and a fire engine is red, and that is why this co-ed reminded me of a fire engine.

• • •

He, to his date in strapless gown: "All evening you've been asking me 'How do you like my dress?', 'How do you like my dress?' Now lets drop the subject."

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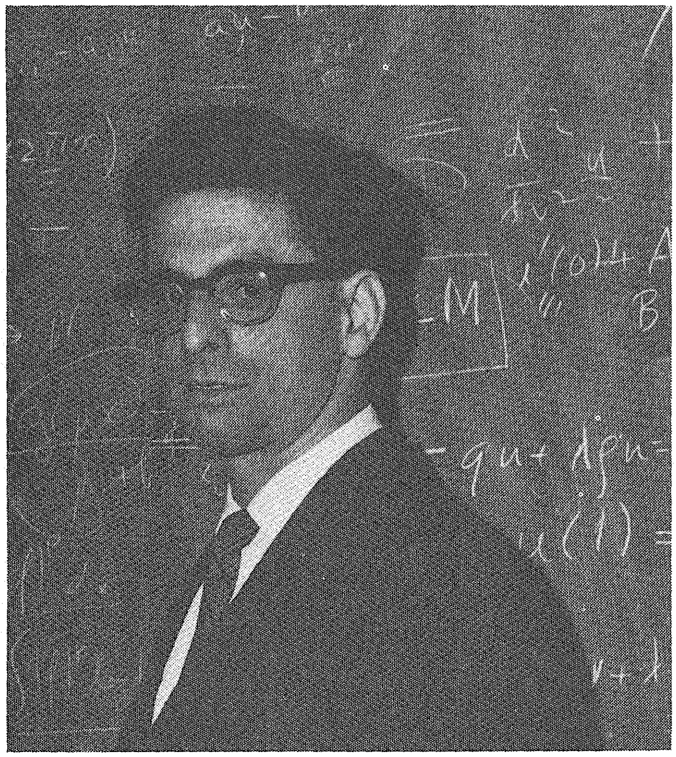
UP FRONT

by ROBERT BRANDS, *CheE '68*



DR. WEINBERGER

If you had, by any chance attended a Mathematics Symposium in Russia during August of 1963, you would probably have heard Dr. Hans Weinberger, one of this month's featured professors, deliver a talk on partial differential equations.

Dr. Weinberger was born in Vienna in 1928. Ten years later, he came to the U.S. where he settled in Pennsylvania with his family. He received most of his education here in the U.S. and attended Carnegie Tech. for his college education. He received his B.S. and M.S. in 1948, and D.Sc. in Mathematics in 1950. After receiving his D.Sc. from Carnegie, he went to the University of Maryland where he conducted research and taught in the Institute of Fluid Dynamics and Applied Math until 1960. In 1960 he came to the University of Minnesota. While here at the University, Dr. Weinberger has taught courses in Advanced Partial Differential Equations, Advanced Calc., Numerical Analysis, and is currently teaching the 173-5 sequence. He has also received an NSF grant for work in partial differential equations. His past and current interests lie in approximate solutions of differential equations. Dr. Weinberger has recently finished a book, *Partial Differential Equations*, and is working on another dealing with maximum principles in differential equations.

Outside the University, Dr. Weinberger's time is spent with his wife and three children. With what little time he has left, he enjoys the theater and woodworking projects.

One of the lesser known departments of I.T. is the Agricultural Engineering Department. As such, few students have heard of Dr. Landis Boyd who has just recently been appointed head of that department. He also teaches an introduction to agricultural engineering course and plans to teach a graduate course in research methods next year. Before coming to the University he was on the faculty of Cornell University from 1948 to 1964. His work there included research, teaching, and administrative duties.

Dr. Boyd was born in 1932 in Creston, Iowa, where he grew up and received his pre-college education. He then attended Iowa State University where he received his B.S.A.E. in 1947, his M.S. in 1948, and his Ph.D. in 1959. Dr. Boyd has received notable awards, among these the A.S.A.E. Graduate Paper Award and the N.A.T.O. Postdoctoral Fellowship Award. His past projects include research in timber mechanics and livestock crop storage requirements. His plans for the future include the development of model techniques for research in agricultural engineering and the utilization of computer methods in teaching and research.

DR. BOYD

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Upon completion of the program, Holcomb started with the new T78 Regenerative Turboprop Engine Mechanical Design Group. He is currently assisting in design and development of the gear section.

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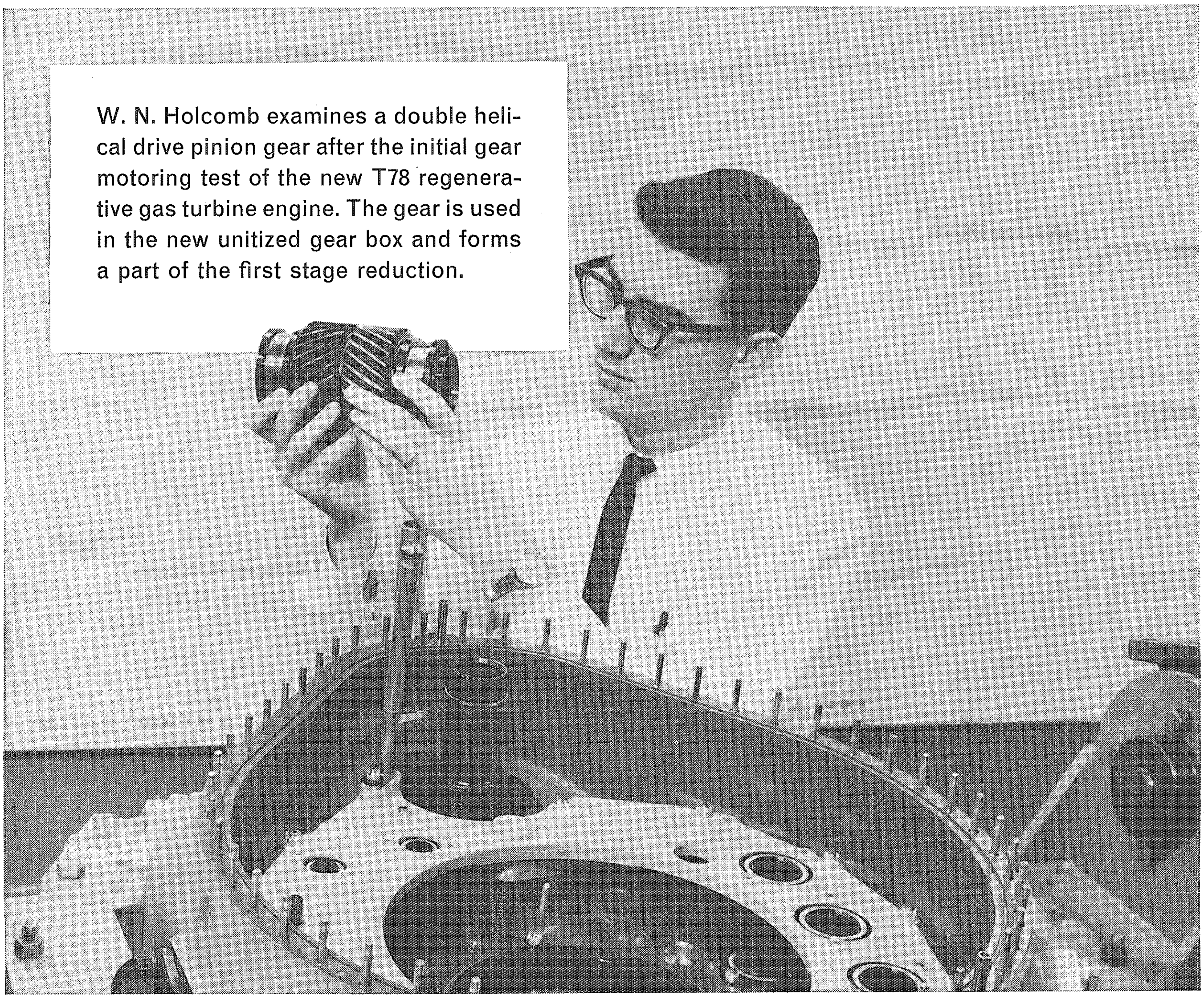
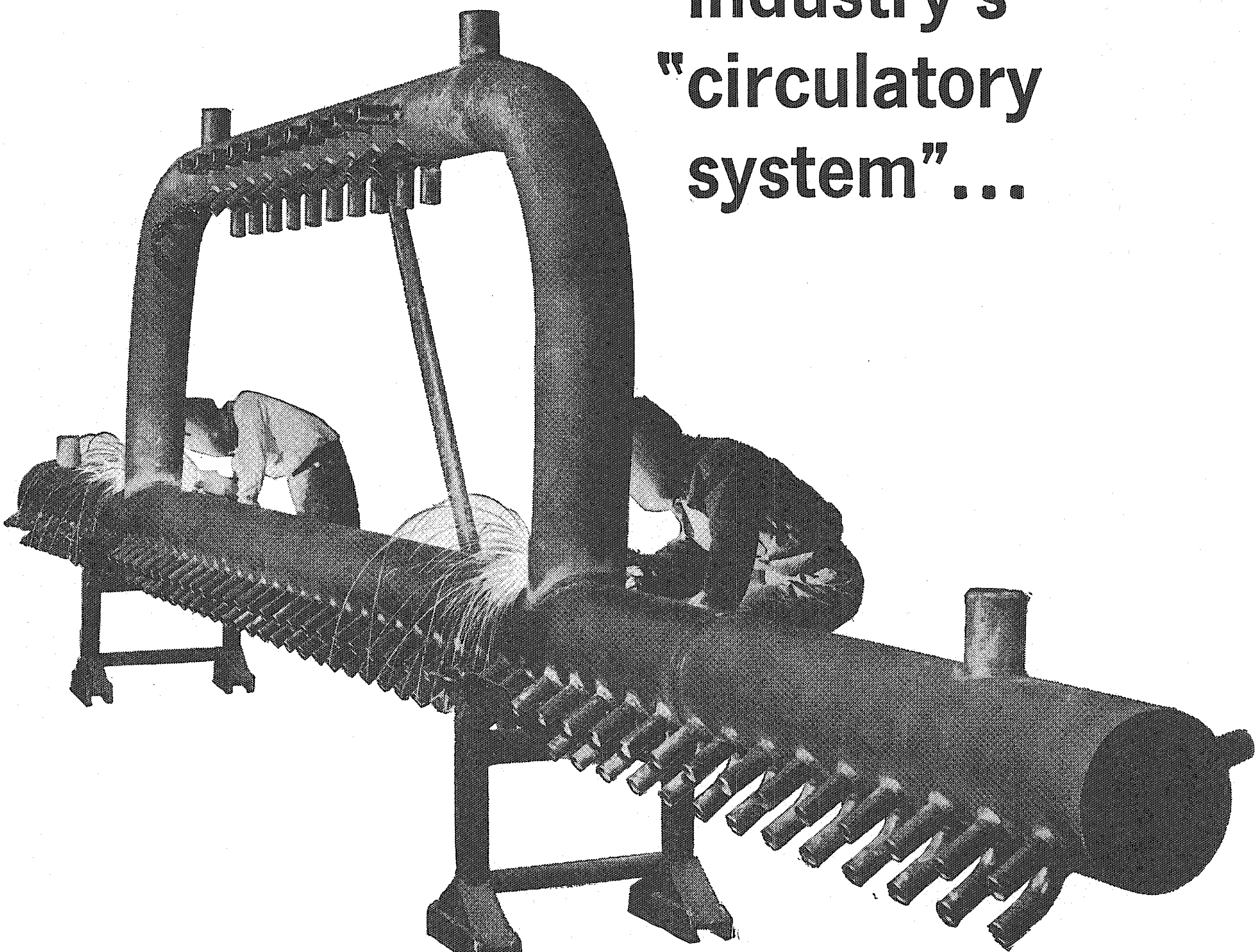


W. N. Holcomb examines a double helical drive pinion gear after the initial gear motoring test of the new T78 regenerative gas turbine engine. The gear is used in the new unitized gear box and forms a part of the first stage reduction.

building industry's "circulatory system"...



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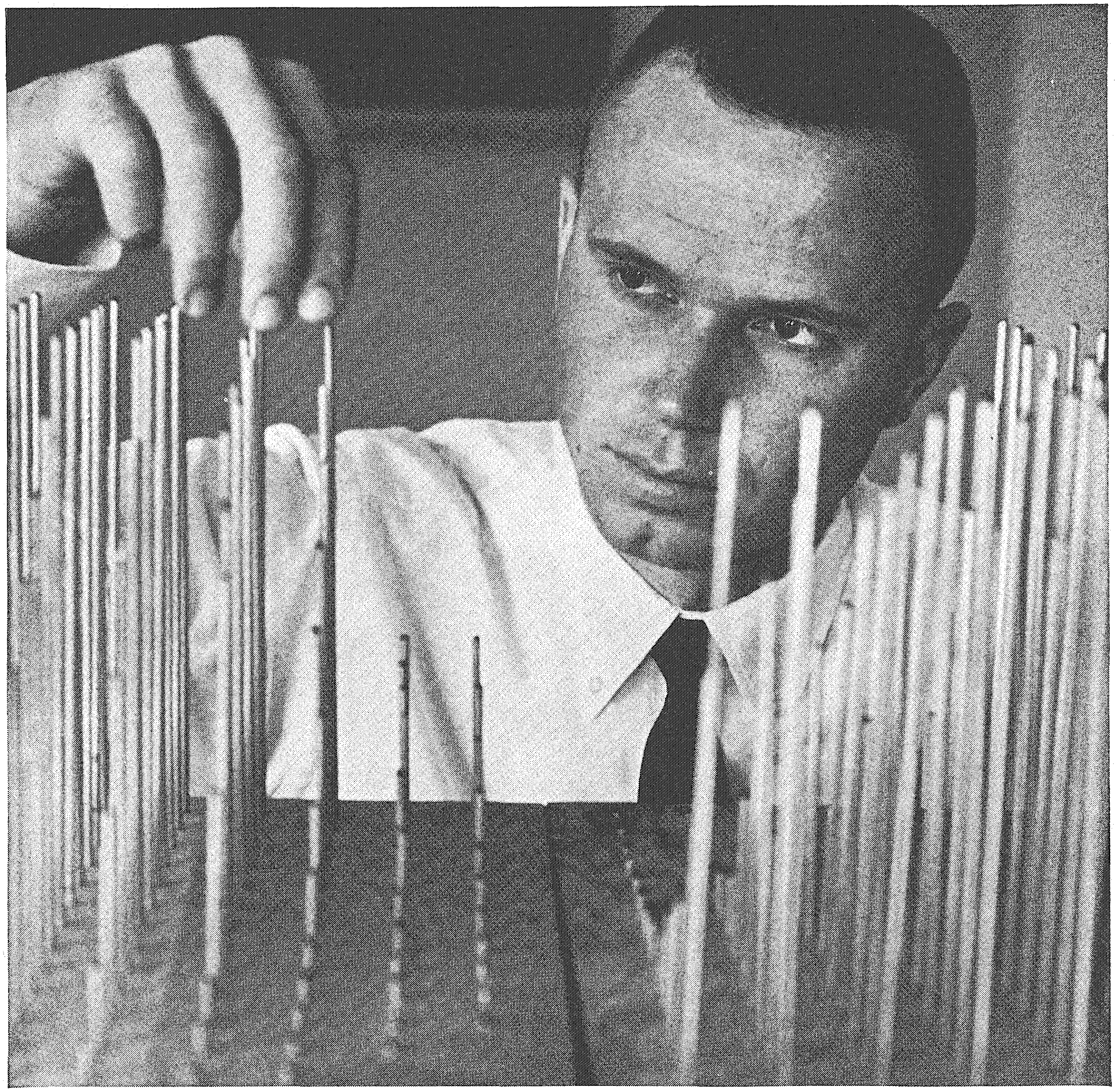

Special agent plots overthrow of hidden enemy.

The hidden enemy is vapor in automobile fuel lines. Causes vapor-lock that stalls cars on warm days.

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In his spare time, Dr. Becker is boning-up on car engines of the future. Maybe someday he'll help us formulate a new kind of fuel for a yet-unknown engine.

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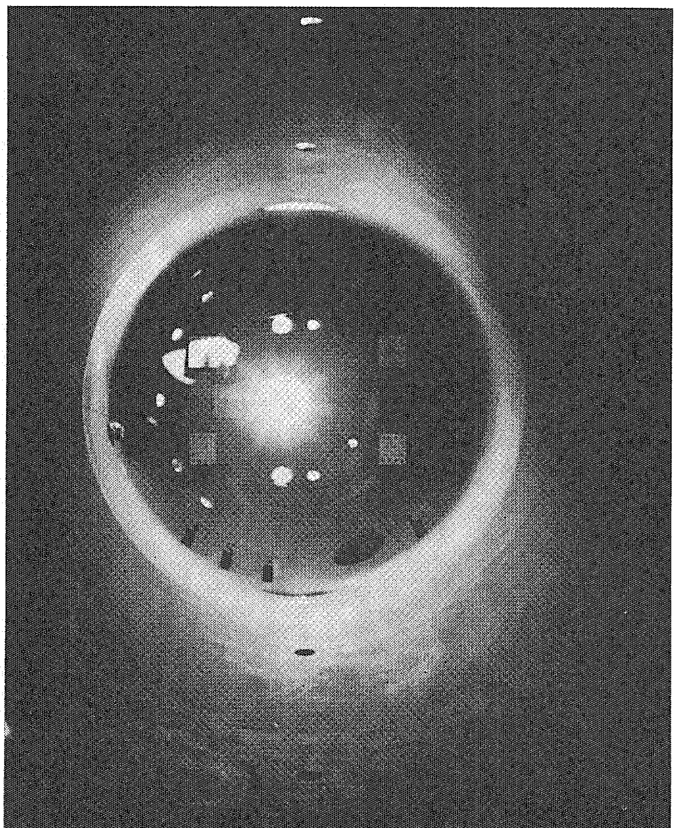
Keep up with the current trends . . . the University's new . . .

VAN de GRAAFF GE

by DIANNE CHRISTENSEN, *Physics Ed. '66*

Did Dr. Van de Graaff really develop the Van de Graaff generator? Yes, . . . it was developed at MIT in the early 1930's. In fact, Dr. Van de Graaff is presently working at the High Voltage Engineering Corporation, a company which manufactures the generator, in Burlington, Massachusetts. One of the most recent advances in its design was the development of the tandem accelerator which was introduced in 1956. The first generator with a tandem accelerator was installed at the Chalk River Laboratories in Canada. The new accelerator being constructed on the river flats near the 10th Avenue bridge, near the linear accelerator here, is a tandem Van de Graaff generator, model M-P, which is a larger model than the previous ones.



A view of the inside of the accelerator.

What is a tandem Van de Graaff? Negative ions enter the generator on the left, for instance, and are attracted through a vacuum to a positive terminal in the center. The ion then passes through a region filled with gas. Collisions occur between the ions and the electrons of the gas atom; the ions then become positive and are accelerated, by a repulsive force, by the same potential. Two times as much energy is available from hydrogen using the same voltage. More energy is released for heavier atoms since more electrons are available. A ten million volt potential is maintained at the center of the new Van de Graaff; the present generator can obtain a maximum potential of 4 million volts. With the new generator, researchers will be able to produce 20 million volt proton deuterons and approximately 40-60 volt protons for carbon. The virtue of the new generator, according to Dr. J. M. Blair, is that it can accelerate a number of kinds of ions to higher energies than previous models could. It is anticipated that it will be able to produce ion beams with greater intensity, i.e. with greater current.

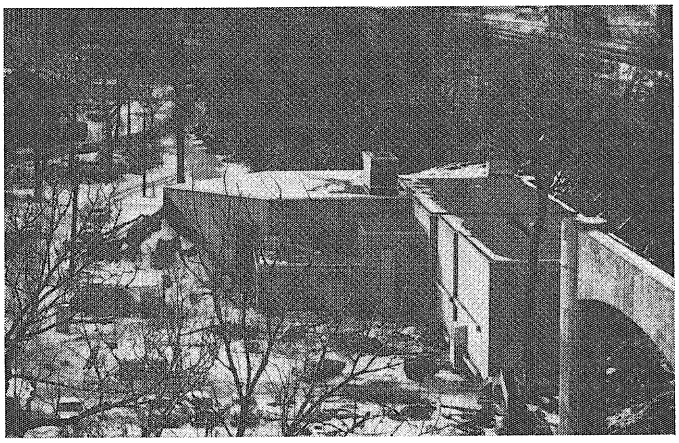
What about the present Van de Graaff? The present generator began operation in 1938; it is now obsolete in many respects. Besides the advantages already mentioned, the new generator will be more flexible. The old generator will continue operation for a few more years, NERATOR

at least until all the thesis problems involving its usage have been finished. In approximately two years the old generator will no longer be used. Some of the equipment will be moved to the new lab however, but the machine itself is no longer adequate.

Construction of the new accelerator began in April of 1964. The accelerating tank was put in place in late November of last year. Presently the small parts are being installed. Another addition to the laboratory will be started in a few months. The accelerator should be in operation near the end of the year.

How much does it cost to build an accelerator of this type? The Atomic Energy Commission paid the High Voltage Engineering Corporation three million dollars. It cost $200,000 to put it together, and the equipment in the laboratory and the other large equipment cost approximately $350,000. The total cost, besides the initial three million dollars, is approximately three-quarters million dollars.

The AEC furnished money for projects such as this to further research in nuclear physics. It recently bought two accelerators—one is being built at Yale, the other here. The National Science Foundation is buying one of these model M-P generators for the University of Rochester in New York. A fourth is being financed by

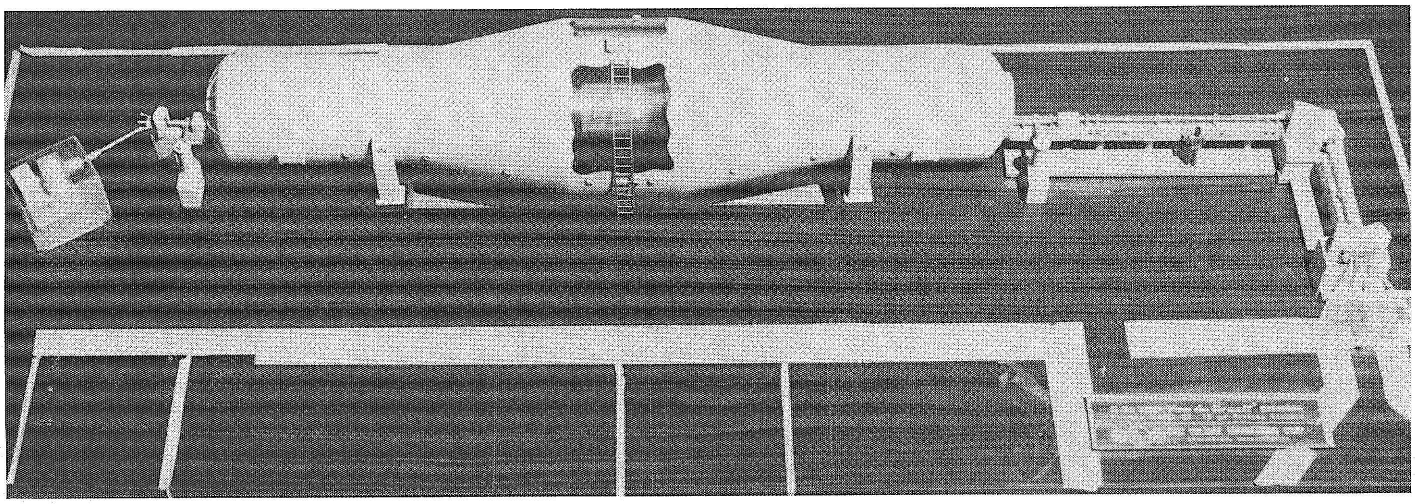


The building housing the new accelerator, located on the river flats near the 10th Ave. bridge.

the Canadian AEC for its laboratories at Chalk River. Germany has the 5th model. A sixth is being built at the factory to test the design of the generator.

Who is involved in this project? Dr. John Williams is the head of the project. Other professors involved include Drs. J. M. Blair, N. M. Hintz, G. Greenlees, R. K. Hobbie, C. H. Poppe, and R. E. Brown. Many of the researchers involved in this project are also active in work with the linear accelerator. The building is being done by local companies—the general contractor is Gunner Johnson and Son; the electrical contractor is Northstar Electrical; and Pierre Aircon is the contractor for plumbing and heating.

The new Van de Graaff generator, then, will allow increased research in nuclear physics by producing higher energy ions which may eventually allow production of ion beams with a higher intensity. The new research will soon be possible which may result in a further breakthrough in present atomic and quantum theories.



The model of the new 20 million volt tandem Van de Graaff generator. Gunner Johnson and Son is the general contractor.

Splinters . . .

M.E. "I'm grasping for words."
Coed: "I think you're looking in the wrong place."

• • •

Statistics show there are three classes of coeds: the intellectual, the beautiful, and the majority.

• • •

Ecstasy is something that happens between the scotch and soda and the bacon and eggs.

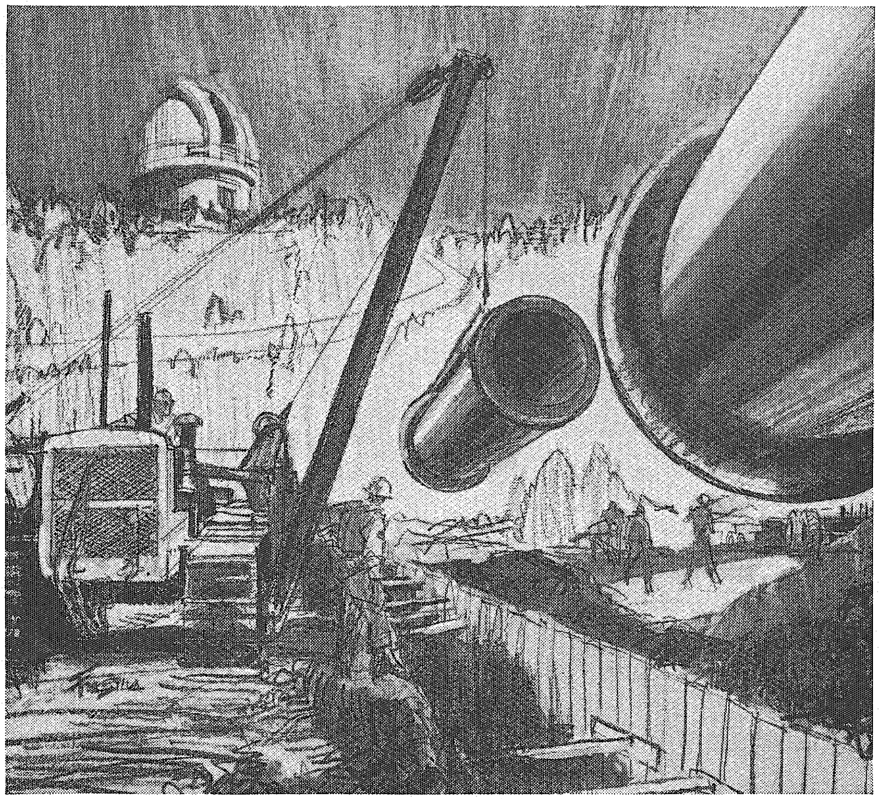
Two businessmen were watching a nightclub show. As a gorgeous Latin went through her torrid dance routine, one remarked, "Lots of pepper."
"Nice shaker, too," his companion added.

• • •

Doctor: "Lay off booze for a couple of weeks, and you'll be right as rain."
Patient: "Are you sure there isn't a simpler way . . . like, say, an operation?"

• • •

Comic strip: A burlesque queen who tells jokes during her act.



Why tightness is so important to Palomar...and pipe joints

At Mt. Palomar in California, astronomers using the world's largest telescope, sometimes wait years for planets to move into position for viewing and photographing. Imagine what would happen if light leaked into the telescope at the crucial moment. Think of the waste of time . . . and patience . . . and the expense.
You may not realize it, but the same thing applies to sewers. Both house sewers and municipal sewers. People sometimes wait for years to get sanitary sewers . . . and then ground water pours in. Sewers are overloaded. Operating costs go up. Problems begin to pile up. All because the joints in the sewers are not tight.
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Imagine the little boy's embarrassment when he opened the wrong door in a train station waiting room and hollered "Extra paper."

IN MEMORIAM

This last month a great tragedy befell the Institute of Technology. An institution as dear to our hearts as the slide rule has perished. We now wish to add our remembrances to yours. For somewhere engineers are happy, but not at Minnesota. The Big Ten has burned down.

• • •

If, as scientists say, sex is such a driving force, why is so much of it found parked these days?

• • •

The moon was full, the night was warm and the car radio was playing romantic music.
"Kiss me," pleaded the boy.
"No!" said the girl. "Drive to another place."
So he drove for a few minutes and parked again. This time the girl launched the offensive. When the boy came up for air he asked the girl why she'd changed her mind.
"Oh, I knew what I wanted," said the girl. "I just didn't believe in love at first site."

• • •

A John Birch Society chant:
Two, four, six, eight,
We wanna escalate.

• • •

Hurrah for Maxwell,
He's our man;
If he can't do it,
Nguyen Khanh.

• • •

Familiarity breeds attempt.

• • •

Love—the delusion that one woman differs from another.

• • •

"Do you smoke?"
"No."
"Do you drink?"
"No."
"Do you neck?"
"No."
"Well, what do you do for fun?"
"I tell lies."

• • •

Coed #1: "I caught my boyfriend necking."
Coed #2: "I caught mine the same way."

Like to Follow Girls?

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for the school year 1965-66,

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DATA PROCESSING DIVISION

Spotlight on
Local Industry

PILLSBURY

by DANIEL KEHRBERG, *Met E '68*

The year 1869 saw a certain young Charles A. Pillsbury become the third partner in a flour milling business. He was to try his luck at bolstering the declining business of his two partners. To develop that small flour mill into one of the largest in the world proved no small task. This original mill had a capacity of but 150 barrels a day, while today the Pillsbury Flour Mills Company's business has grown to proportions that equal over 25,000 barrels

Pillsbury's Research and Development Laboratories in Minneapolis

of flour daily.

One year later, in 1870, Charles A. Pillsbury supervised the installation of, and perfection of, the middling purifier. A short time later, Mr. Pillsbury adopted the steel roller process of milling, and with the extension of the railroads throughout the Midwest, he was soon able to make Pillsbury's Best flour famous throughout the world for being a premium quality. Within a year he had remodeled the decrepit mill and had astounded his partner's with a $6,000 profit.

In 1871, the firm of C. A. Pillsbury & Company was organized, with Charles A., his brother Fred C., their father George A., and their uncle John Sargent Pillsbury assuming complete ownership. Successive years saw them add five more mills to their holdings in the Minneapolis area. But, soon the business went beyond the facilities acquired, and in 1881 they built the celebrated Pillsbury "A" Mill, in Minneapolis. At first this had a daily capacity of 7,000 barrels, but this capacity has been doubled through the improvement of machinery.

By 1886 the Pillsbury milling capacity was over 10,000 barrels daily—a substantial increase over the original 150-barrel capacity of the original mill. Charles Pillsbury's business record was not, however, an unbroken chain of successes. In 1877, the Anchor Mill was destroyed by fire and in 1882 the Empire, Minneapolis, Pillsbury B, and Excelsior Mills suffered similar fates. The subsequent construction of the A mill, and the total production listed above for the year 1886 show that the disasters did not stop him, but stimulated him to greater activity. Some of the burned mills were rebuilt and equipped with the latest machinery, and large elevators were also erected.

In 1890, the Pillsburys disposed of their holdings to the Pillsbury-Washburn Flour Mills Company, Limited, but retained a large interest in the new company, although the bulk of the stock was purchased by an English syndicate. Mr. Pillsbury's connection with the milling industry did not halt with the sale of his interests. On the contrary, he was named as head of the new business and directed its course successfully for many years. At his recommendation, the company secured a controlling interest in the water power at St. Anthony Falls, and constructed an auxiliary dam a short distance below the Falls. This added 10,000 more horsepower to the company's resources.

The story of the Pillsbury XXXX's is another interesting sidelight in the growth and development of this company. According to an old legend, three X's were the symbol of bread. Supposedly the symbol "XXX" originally referred to the Crucifixion with the "X" representing one of the crosses on Calvary. Medieval millers adopted the mark "XXX" to signify the highest grade of flour for bread. When Charles A. Pillsbury heard the story he decided that he would revive the ancient custom adding one more "X" to signify that Pillsbury's Best was really the best.

The new company's progress continued in the same tradition as had that of the original Pillsbury's. By 1930 flour mills were added in Kansas, New York, West Virginia, Oklahoma, Oregon and Illinois. Ten years later Philip W. Pillsbury, Grandson of Charles A., was elected president.

Soon, enlargement brought manufacturing facilities on the West Coast. Pillsbury purchased Globe Mills in 1940, and additional flour and feed mills were added at Ogden, Sacramento, and Los Angeles. Seventeen offices now serve this area as a part of Pillsbury's grain merchandising division, and in 1949 a feed ingredients merchandising division was organized which today operates eight offices.

In 1940 new convenience mixes were introduced to the American housewife, with Pillsbury in the forefront. Mixes were also introduced to commercial bakeries, hotels, and restaurants.

With the purchase of Ballard and Ballard of Louisville, Kentucky, refrigerated products joined the growing family of Pillsbury products. At present, Pillsbury's line of refrigerated biscuits totals twenty-four items, and five new plants have been added.

Turbo milling was the first major breakthrough in flour milling technology since the roller mill and middling purifier, which were introduced in the 1870's. The new process, developed in 1957, uses an application of the air vortex principle in creating man-made hurricanes to reduce flour and then reassemble it into new flours of varying characteristics. Four mills have this kind of equipment.

In 1958 Pillsbury Mills, Inc., became The Pillsbury Company, a move which was parallel with the company s expansion beyond traditional grain-based products. The following year the company introduced convenience potato products in the institutional market and in the consumer market shortly thereafter.

Pillsbury's first manufacturing venture outside the United States and Canada was its purchase of the majority interest in the Mocama flour mill near Caracas, Venezuela in 1959. Other overseas development included flour licensing and technical assistant agreements in El Salvador, Guatemala, and a joint ownership agreement to build and operate a mill in Ghana. Presently the company exports flour to more than 85 overseas markets.

The European common market was first "invaded" with Pillsbury's products in 1961 with the acquisition of a controlling interest in a major French food company which is a leading manufacturer of a number of specialty baked foods. This French company operates seven plants in three locations and employs more than 1,000 people. Pillsbury entered the frozen food field in 1961 and currently markets seven frozen desserts.

The currently popular diet-type soft drink market was aided by Pillsbury's extended manufacturing facilities for the production of calcium cyclamate, the non-caloric sweetener used in Sweet-10. This product also led to Pillsbury's production of the presweetened sugar-free drink, Funny Face.

The company's international operations were extended again in 1963 with the purchase of companies in West Germany, England and Switzerland. In the fall of the same year, *The Pillsbury Family Cook Book* was published. Packed with information, this 576-page book contains over 2,000 recipes and illustrations to aid American women in modern food usage and convenient methods to feed her family.

A remarkable new Instant Blending Flour was introduced early last year. It is produced by "agglomeration." The granular flour pours freely, requires no sifting, and dispenses instantly in cold liquid.

The Pillsbury Company is the 38th largest national advertiser according to *Advertising Age*. It is the nation's second largest milling company, General Mills being the largest. Pillsbury achieved the highest sales and earnings on record in the fiscal year ending last May 31. Sales rose 6.3% to $44,361,776, the eighth consecutive advance, and net earning increased 15.1% to $9,033,027.

In the past year Pillsbury introduced more than 30 new products, and put several others into test markets. It has become the largest manufacturer of prepared food mixes in the U. S. Its three major operating areas—consumer, industrial and agricultural—now operate as complete business enterprises. Each handles its own production, procurement, marketing and accounting. The Pillsbury line of consumer products is exported to nearly every country in the free world, including military installations and army commissaries. Pillsbury products are also produced in Switzerland, West Germany, England, France, Australia, New Zealand, Venezuela and El Salvador.

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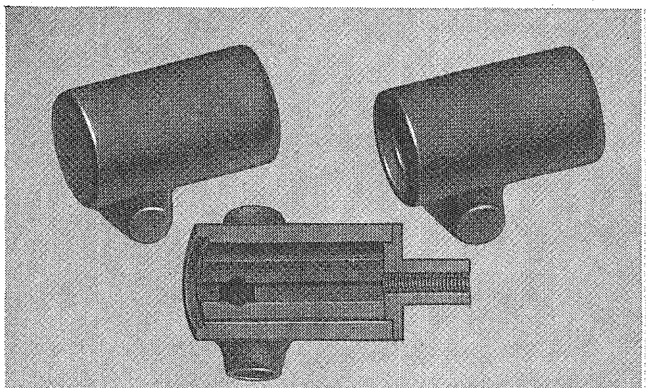
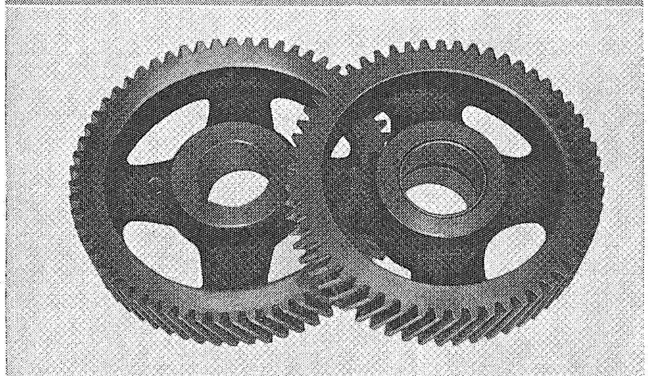


Stop Wasting Metal

Why pay for 2.8 pounds of metal . . . then machine out and scrap 1.2 pounds? Changing this snap coupler to a Malleable iron casting with a cored center reduced initial cost 31 cents and cut the first interior machining operation by 72 per cent (subsequent operations were up to 25 per cent less expensive, too). Through expert use of cores in parts that require interior design details, your Malleable foundry puts metal only where it is useful.

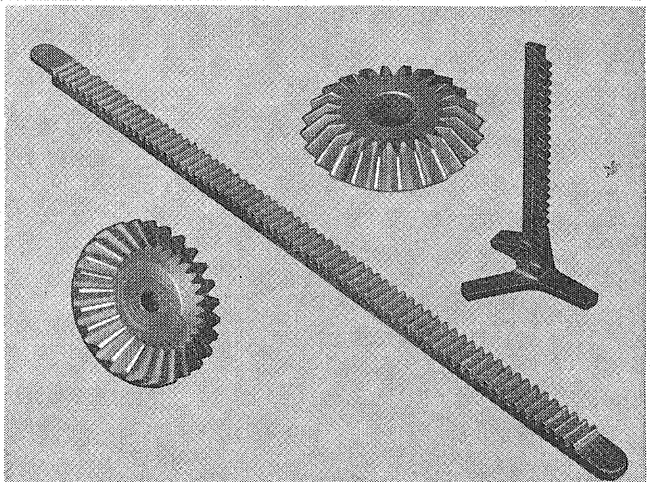
Stop Assembling

Making a bracket out of steel plate is very simple . . . until it's time to weld nine individual pieces into a finished product with the necessary dimensional accuracy. It's slow and costly. Redesigned and made as a single Malleable casting, this motor mount for an industrial overhead door opener has the required accuracy, strength and better appearance . . . and cuts costs 23%.



Stop Needless Hardening

Pearlitic Malleable provides both excellent wear resistance and bearing properties. These camshaft and idler gears wear as well without hardening as other hardened ferrous metals previously used for these parts, but tool life and machining time are greatly improved. If still harder surfaces are needed, pearlitic Malleable takes either flame or induction hardening exceptionally well.



Stop Unnecessary Machining

Malleable producers cast parts so close to finished shape that very often little or no machining is required. These Malleable iron gears, for example, are used without any machining on the teeth.

There are many ways you can do a better job at less cost with modern Malleable castings. Our new brochure, "Design Criteria for Malleable Iron Castings", tells how.

Send for your free copy today.

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CE Award Nominees

(Continued from Page 22)

four man-made islands raised from the bottom of the Bay, two tunnels, each over a mile long, a high and medium-level bridge, and several miles of approach roads. The superstructure for each trestle span consists of precast, prestressed concrete units resting on precast concrete pile caps which are supported by sand-filled 53-inch diameter concrete piles. The steel superstructure for the high-level bridge was assembled in a harbor and then floated to the site and lowered onto concrete piers.

Driving time between New York and Florida is cut by an hour and a half by way of the new bridge, and the motorist avoids Washington, D. C., and Baltimore.

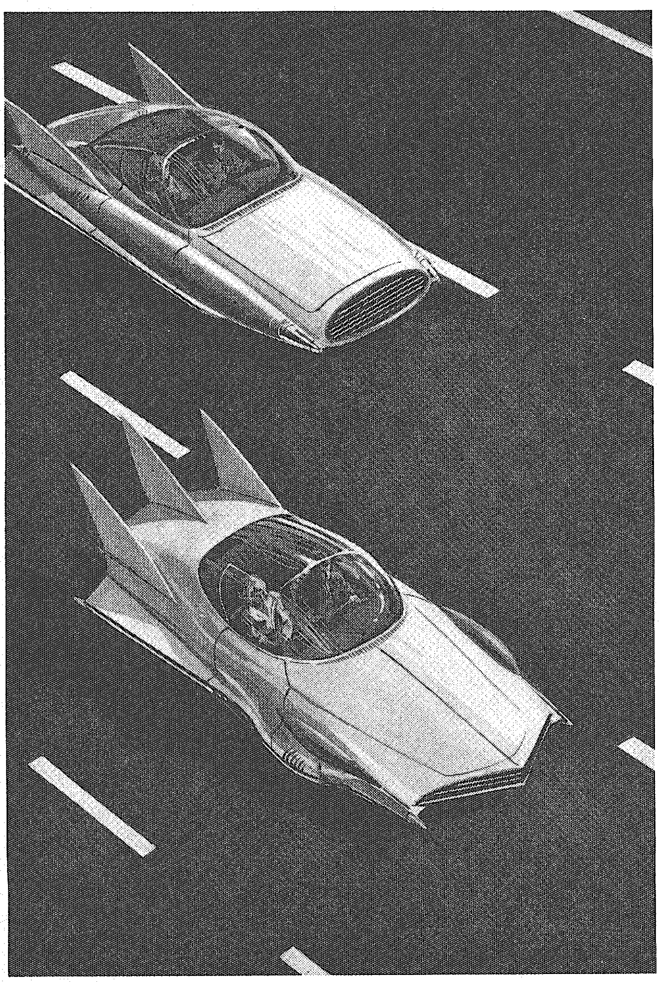
The Verrazano-Narrows Bridge, built by the Triborough Bridge and Tunnel Authority, links New York City and Staten Island. It was opened on November 21, 1964, realizing a dream which was first planned fifty years ago. This Bridge is the world's longest suspended span. It is so long that the two 693-foot supporting towers are 1⅝ inches further apart at the top than at the bottom due to the curvature of the earth.

Chicago's Central District Filtration Plant has a world record-breaking capacity of 960 million gallons per day. Its output replaces the raw, unfiltered water from Lake Michigan treated only with chlorine, which people living in the northern two-thirds of the city and 33 suburban communities had been drinking. The new plant is located on a 61-acre peninsula that juts out into Lake Michigan. The facility is 1,100 feet long and 180 feet wide. It extends from 36 feet below the lake level to 25 feet above.

The Los Angeles Flood Control and Water Conservation Project is noted for its integrated concepts of flood peak regulation, debris control, channelization, urban storm runoff replenishment of ground water basins, and protection of the fresh water aquifiers against sea water intrusion. It pioneered many of these concepts, notably the development of a fresh water pressure mound as a barrier against sea water intrusion, the development of an accurate formula for prediction of the rate of debris production in mountain watersheds, and a comprehensive approach to a metropolitan storm drainage system involving 72 individual cities.

The 1964 outstanding civil engineering achievement was the Glen Canyon Unit of the Colorado Project. This project is one of the largest construction projects ever undertaken in the United States. Rising 710 feet, the dam is only 16 feet less than the Hoover dam in height, but exceeds it in concrete volume. Over 5,000,000 cubic yards of concrete went into the dam's construction. The Glen Canyon Bridge, which is adjacent to the dam, is the world's highest single span steel arch. The reservoir, approximately 186 miles long, and the 900,000 kw power plant are creating a new recreational and economic opportunity in a wide region which was once almost uninhabitated, arid wasteland.

Previous winners of the award were the Ohio River Valley Clean Streams Program—1963; the Intercontinental Ballistic Missile Program—1962; the John F. Kennedy International Airport—1961; and the St. Lawrence Power and Seaway Project—1960.



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BRAIN TEASERS

by GERALD JOHNSON, *ME '67*

1. A sphere twelve feet in diameter rests on top of a pole sixty feet in height. On the sphere stands a man whose eyes are six feet above the sphere. Find the area of the ground not visible to him.

2. You have ten stacks of ten 50¢ pieces. One stack contains counterfeit coins. The weight of a 50¢ piece is not known, but you do know that a counterfeit coin weighs one gram more than a real one. What is the minimum number of weighings on a balance scale required to find the stack of counterfeit coins?

3. When you cross the international date line, do you lose a day or gain a day?

4. Solve the equation $(x+1)(x^2+1)(x^3+1) = 30x^3$ for x.

5. If my father is 50 and I am ½ as old as my oldest brother and he is ⅓ the age of my mother, but my father is twice as old as my oldest brother, who is 4 times as old as my eldest sister, how old is my cousin George?

6. All other things equal, which will cause the greatest racket, two arguing E.E.'s at a distance of four feet from you, or three arguing M.E.'s at a distance of six feet?

7. John spent one tenth of his life as a child, one fourth as a student, and worked for three years before he married. He had three children whose ages differed by two years; the first arrived after three years of marriage. At the time of John's death, the sum of the ages of the children was 93. How old was John when he died?

Answers in May issue.

Answers to February Brain Teasers

1. 38

2. e^{Π}

3. He sold 349 shirts at $1.73 apiece.

4. $2 \times 9 + 6 - 7 = 17$
   $(296 - 7)^{1/2} = 17$

5. Egbert was correct. Reinze will have the same chance for a fare as Hans. Egbert will have twice the chance of both Reinze and Hans. Pedro will have a greater chance than Egbert, but not twice as much.

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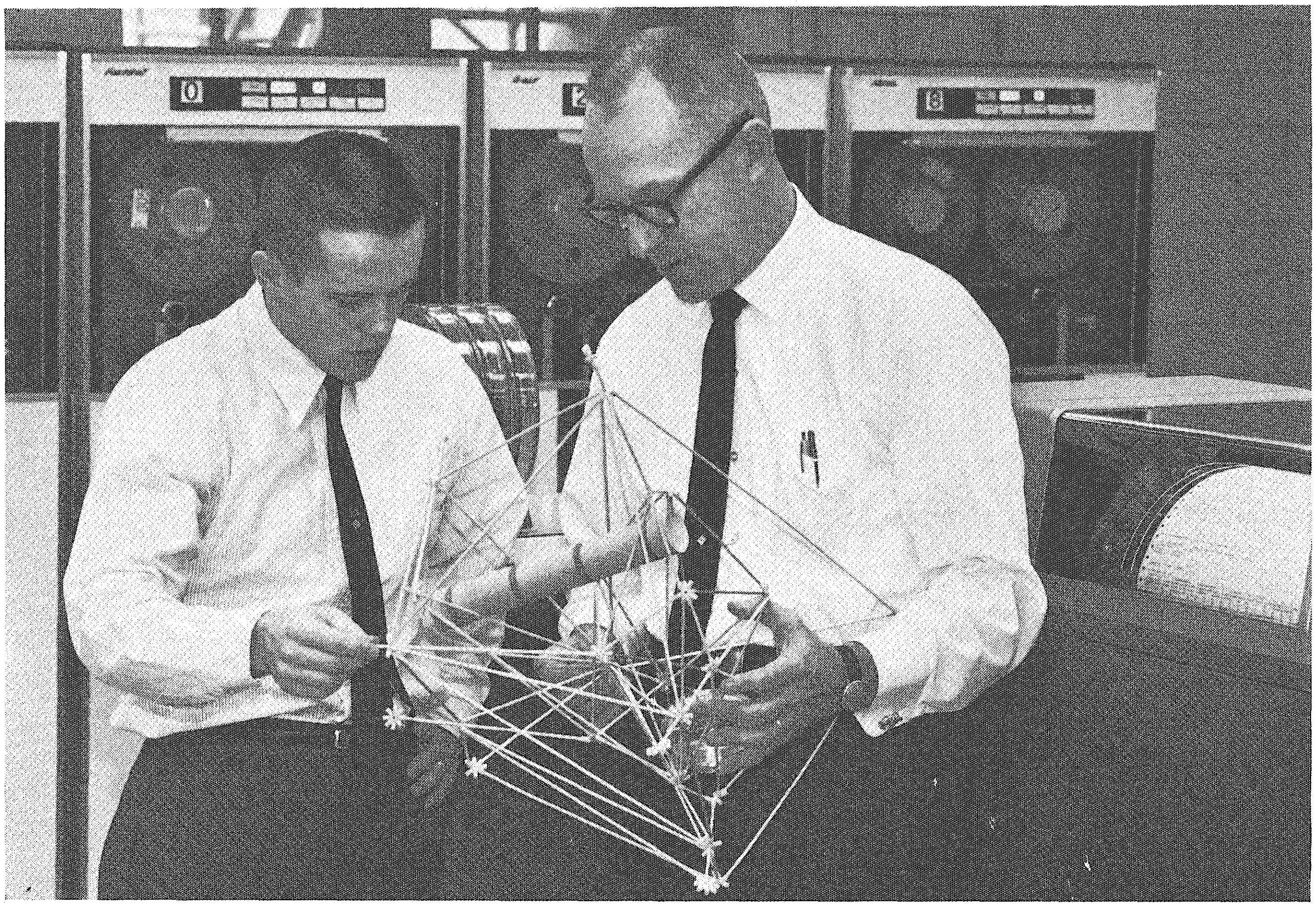

10 years from now he may tire of working with computers

10 years ago he didn't wait for a computer's verdict

People matter more than computers

To lure smart young engineers, we feature up-to-date computer facilities. That's one good reason to have computers. We have even more compelling reasons, not all to be found in our widely advertised product lines like family cameras, film, textile fibers, office equipment, plastics, etc.

What prudence prevents us from publicly spilling is what occupies and fascinates a large corps of mechanical engineers like Edward T. Kern *(right)* and his younger colleague, William S. Walsh. To more colleagues from among the mechanical engineers of the Class of 1965, we hereby offer our persuasive combination of long-haul stability and internal mobility.

We respect an engineer for requesting a chance to broaden himself by a change of assignment. Both men pictured here did so.

When we hired Ed fresh out of college in 1947, we had him spend a year personally running a lathe and doing bench assembly on new production equipment for film manufacture. (We rarely start engineers that way any more.) Then, until 1955, he developed machinery for paper-sensitizing and film-emulsion coating. Next came a stint bossing a 75-man crew that erected, maintained, and repaired buildings and equipment for processing KODACOLOR Prints and other large-volume photographic products. Feeling his feet all too firmly on the ground after three years of this, he decided to grapple with a subtler form of reality than concerns the average pipefitter, electrician, or bricklayer.

This decision he made just in time to join his present team, then forming. For a while he found himself pitching in with proposal preparation, customer contact, subcontract technical co-ordination, customer briefings, etc. Gradually the assignment evolved from communicating *about* technical matters to generating rather fundamental technical content of his own. This he does today, living the life of the systems engineer, surrounded by logic, concepts, and limiting parameters.

Bill, a 1962 graduate, spent his first year in vibration analysis and learned how unimportant is the distinction between an E.E. (which his diploma calls him) and an M.E., under which heading he now ventures on the same frontier with Kern. Before we throw him his retirement party, for all we know, he may win honors as the greatest living expert on knitting machinery. We have many interests.

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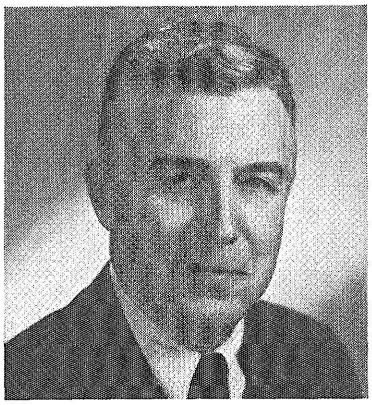
Should You Work for a Big Company?

An interview with General Electric's S. W. Corbin, Vice President and General Manager, Industrial Sales Division.



S. W. CORBIN

Wells Corbin heads what is probably the world's largest industrial sales organization, employing more than 8000 persons and selling hundreds of thousands of diverse products. He joined General Electric in 1930 as a student engineer after graduation from Union College with a BSEE. After moving through several assignments in industrial engineering and sales management, he assumed his present position in 1960. He was elected a General Electric vice president in 1963.

Q. **Mr. Corbin, why should I work for a big company? Are there some special advantages?**

A. Just for a minute, consider what the scope of product mix often found in a big company means to you. A broad range of products and services gives you a variety of starting places now. It widens tremendously your opportunity for growth. Engineers and scientists at General Electric research, design, manufacture and sell thousands of products from microminiature electronic components and computer-controlled steel-mill systems for industry; to the world's largest turbine-generators for utilities; to radios, TV sets and appliances for consumers; to satellites and other complex systems for aerospace and defense.

Q. **How about attaining positions of responsibility?**

A. How much responsibility do you want? If you'd like to contribute to the design of tomorrow's atomic reactors—or work on the installation of complex industrial systems—or take part in supervising the manufacture of exotic machine-tool controls—or design new hardware or software for G-E computers—or direct a million dollars in annual sales through distributors—you can do it, in a big company like General Electric, if you show you have the ability. There's no limit to responsibility . . . except your own talent and desire.

Q. **Can big companies offer advantages in training and career development programs?**

A. Yes. We employ large numbers of people each year so we can often set up specialized training programs that are hard to duplicate elsewhere. Our Technical Marketing Program, for example, has specialized assignments both for initial training and career development that vary depending on whether you want a future in sales, application engineering or installation and service engineering. In the Manufacturing Program, assignments are given in manufacturing engineering, factory supervision, quality control, materials management or plant engineering. Other specialized programs exist, like the Product Engineering Program for you prospective creative design engineers, and the highly selective Research Training Program.

Q. **Doesn't that mean there will be more competition for the top jobs?**

A. You'll always find competition for a good job, no matter where you go! But in a company like G.E. where there are 150 product operations, with broad research and sales organizations to back them up, you'll have less chance for your ambition to be stalemated. Why? Simply because there are more top jobs to compete for.

Q. **How can a big company help me fight technological obsolescence?**

A. Wherever you are in General Electric, you'll be helping create a rapid pace of product development to serve highly competitive markets. As a member of the G-E team, you'll be on the leading edge of the wave of advancement—by adapting new research findings to product designs, by keeping your customers informed of new product developments that can improve or even revolutionize their operations, and by developing new machines, processes and methods to manufacture these new products. And there will be classwork too. There's too much to be done to let you get out of date!

FOR MORE INFORMATION on careers for engineers and scientists at General Electric, write Personalized Career Planning, General Electric, Section 699-12, Schenectady, N. Y. 12305

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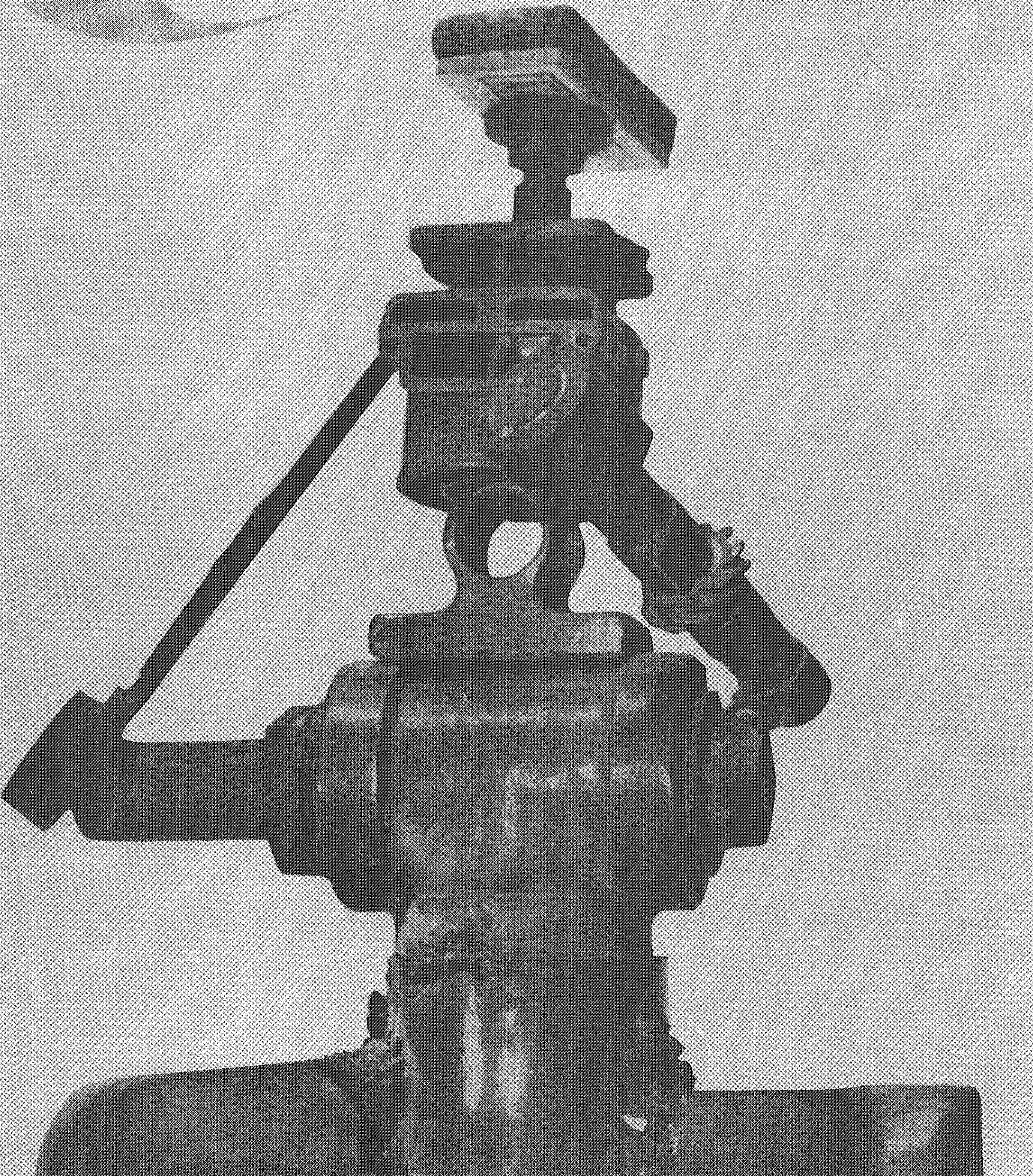

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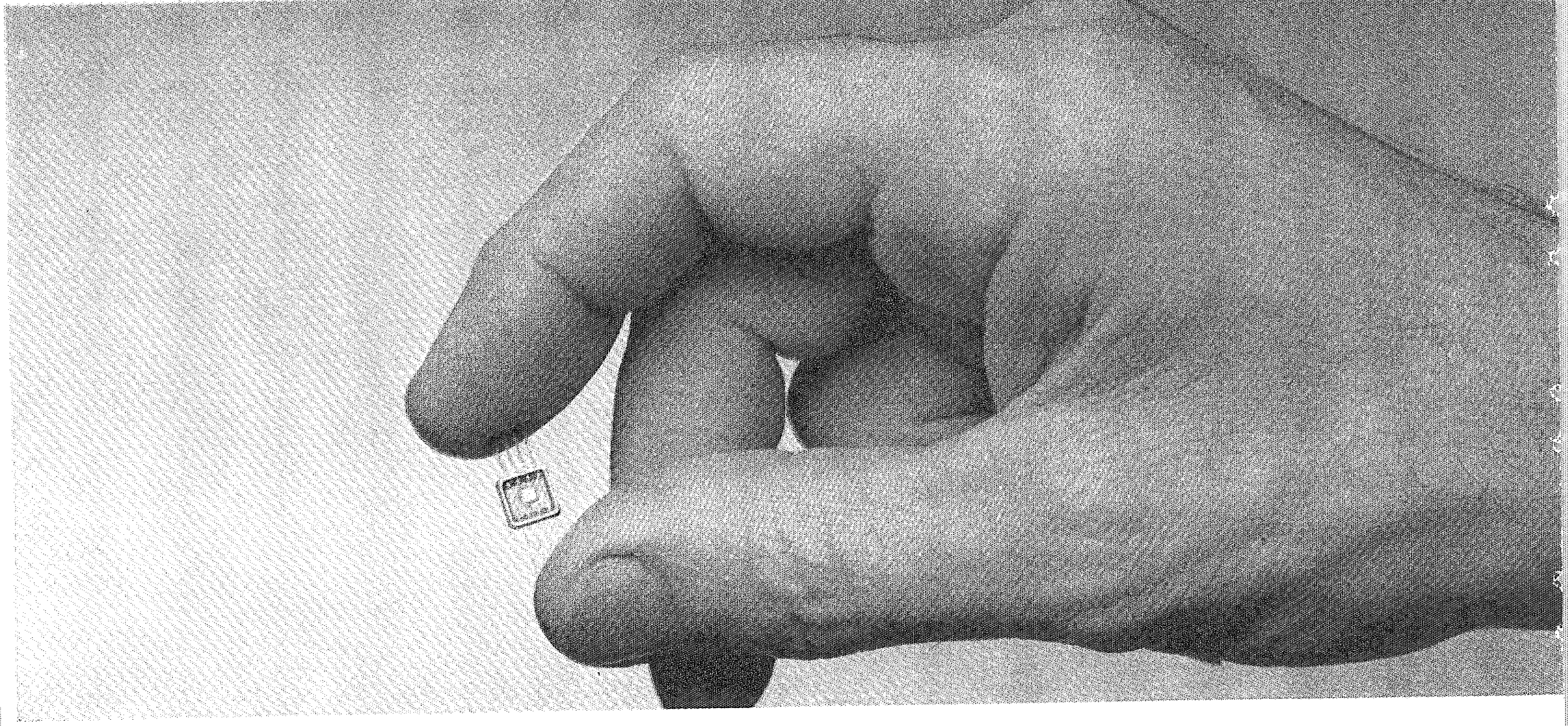
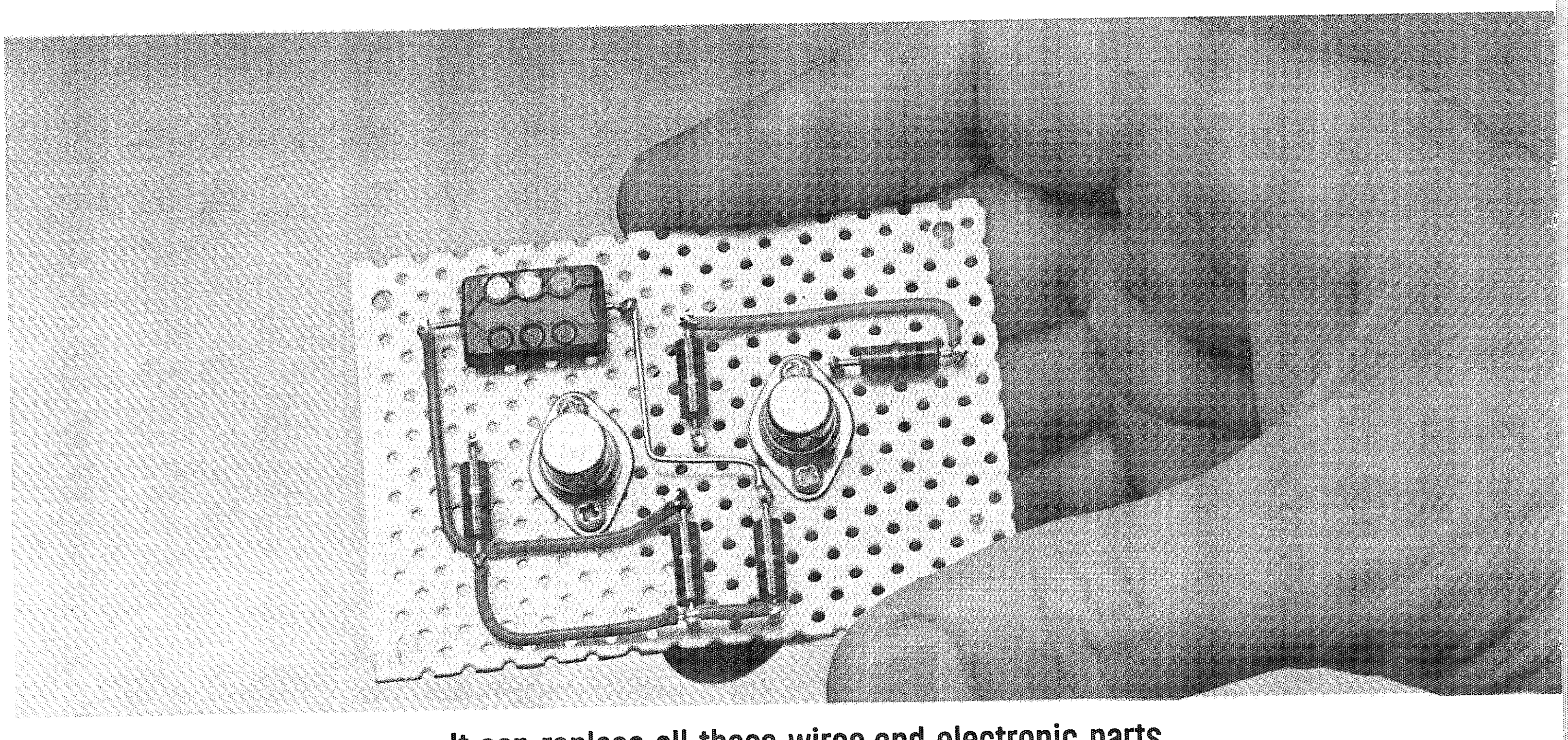


This tiny device is an ultra-reliable Westinghouse TV amplifier



It can replace all these wires and electronic parts

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Other Westinghouse functional electronic blocks are just as small. They're used in experimental products like a pocket-size TV camera and a radio receiver that's half an inch square and an inch long.

Today, Westinghouse makes these ultra-reliable little devices mostly for military applications.

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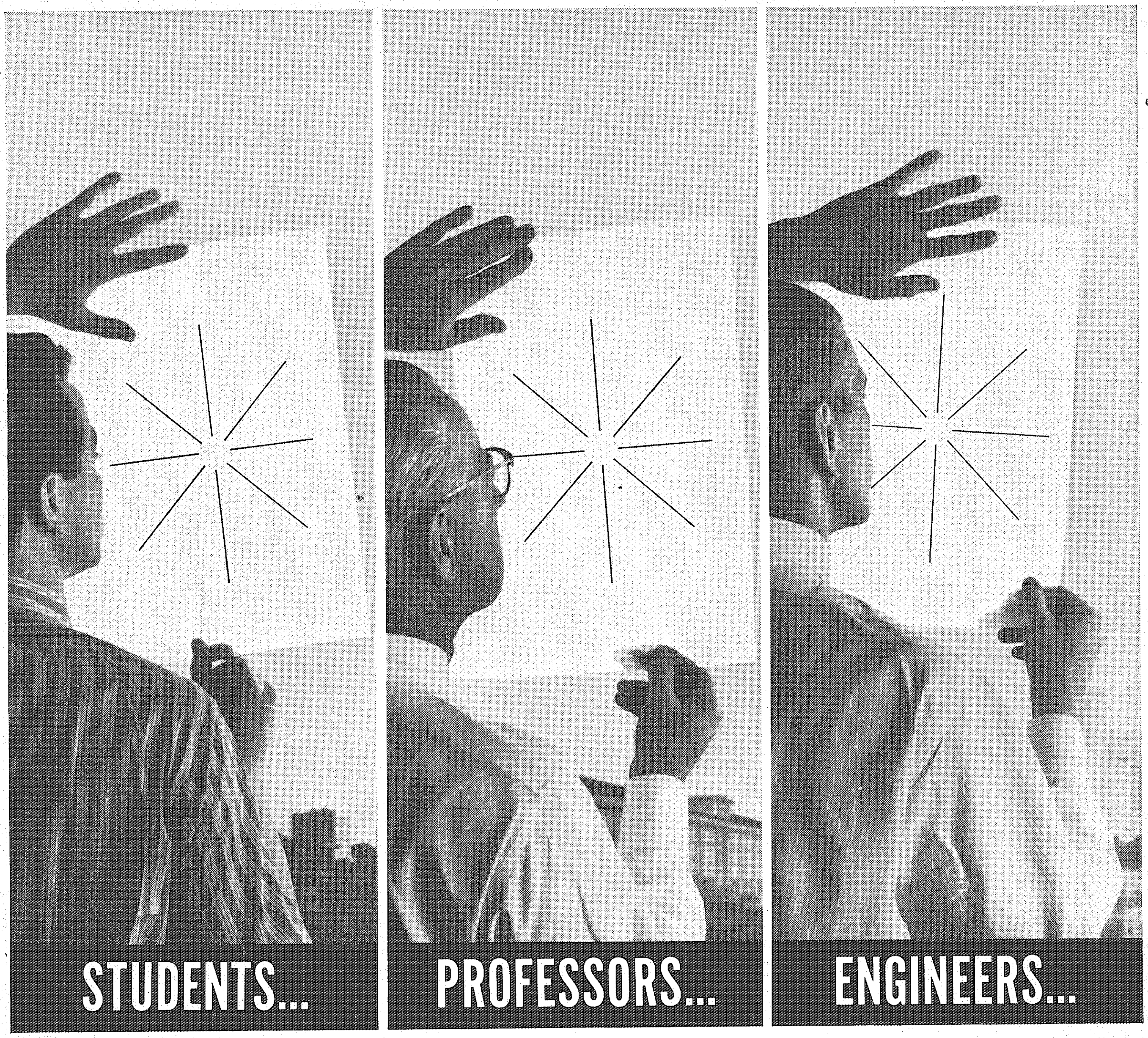

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(From the President's Letter, REC's 1964 annual report)

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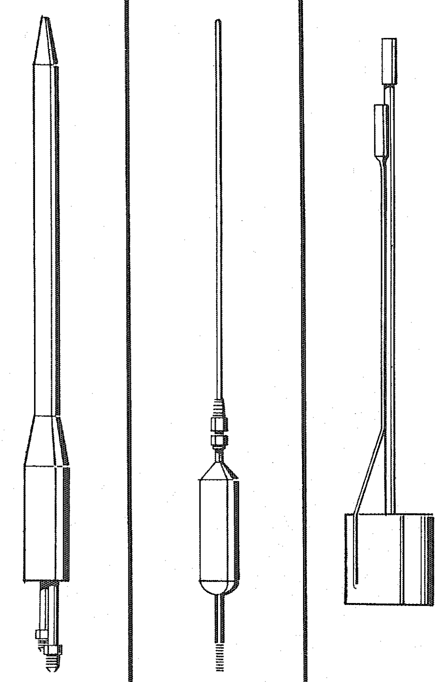
REC's growth and success are obvious when one considers that its sales have risen from $29,000 in 1956 to a projected sales figure of over $9,000,000 in 1965. For continued growth, success, expansion and diversification, REC will continue to look to Engineering. REC's generous profit sharing program provides very material rewards for those who are contributing to this effort. If you want to be a part of this future, REC is interested in you.

REC is especially interested in Engineers with B.S. Degrees who want to take advanced courses under our 100 percent tuition reimbursement program and in Engineers with M.S. and Ph.D. Degrees.

If you are looking for opportunity, responsibility and a chance to retain your individuality, we invite you to consult your placement office and arrange for an interview with our representative.



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Ford Motor Company is:

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James E. Mercereau
B.A., Physics, Pomona College
M.A., Physics, Univ. of Ill.
Ph.D., Calif. Institute of Tech.

What does it take to "spark" a man to his very best . . . to bring out the fullest expression of his ability and training? At Ford Motor Company we are convinced that an invigorating business and professional climate is one essential. A prime ingredient of this climate is the stimulation that comes from working with the top people in a field . . . such as Dr. James Mercereau.

Jim Mercereau joined our Scientific Laboratory in 1962. Recently, he headed a team of physicists who verified aspects of the Quantum Theory by creating a giant, observable quantum effect in superconductors. This outstanding achievement was the major reason the U. S. Junior Chamber of Commerce selected Dr. Mercereau as one of "America's Ten Outstanding Young Men of 1964." Your area of interest may be far different from Dr. Mercereau's; however, you will come in contact with outstanding men in all fields at Ford Motor Company.

We believe the coupling of top experience and talent with youth and enthusiasm is stimulating to all concerned. College graduates who join Ford Motor Company find themselves very much a part of this kind of team. If you are interested in a career that provides the stimulation of working with the best, see our representative when he visits your campus. We think you'll be impressed by the things he can tell you about working at Ford Motor Company.

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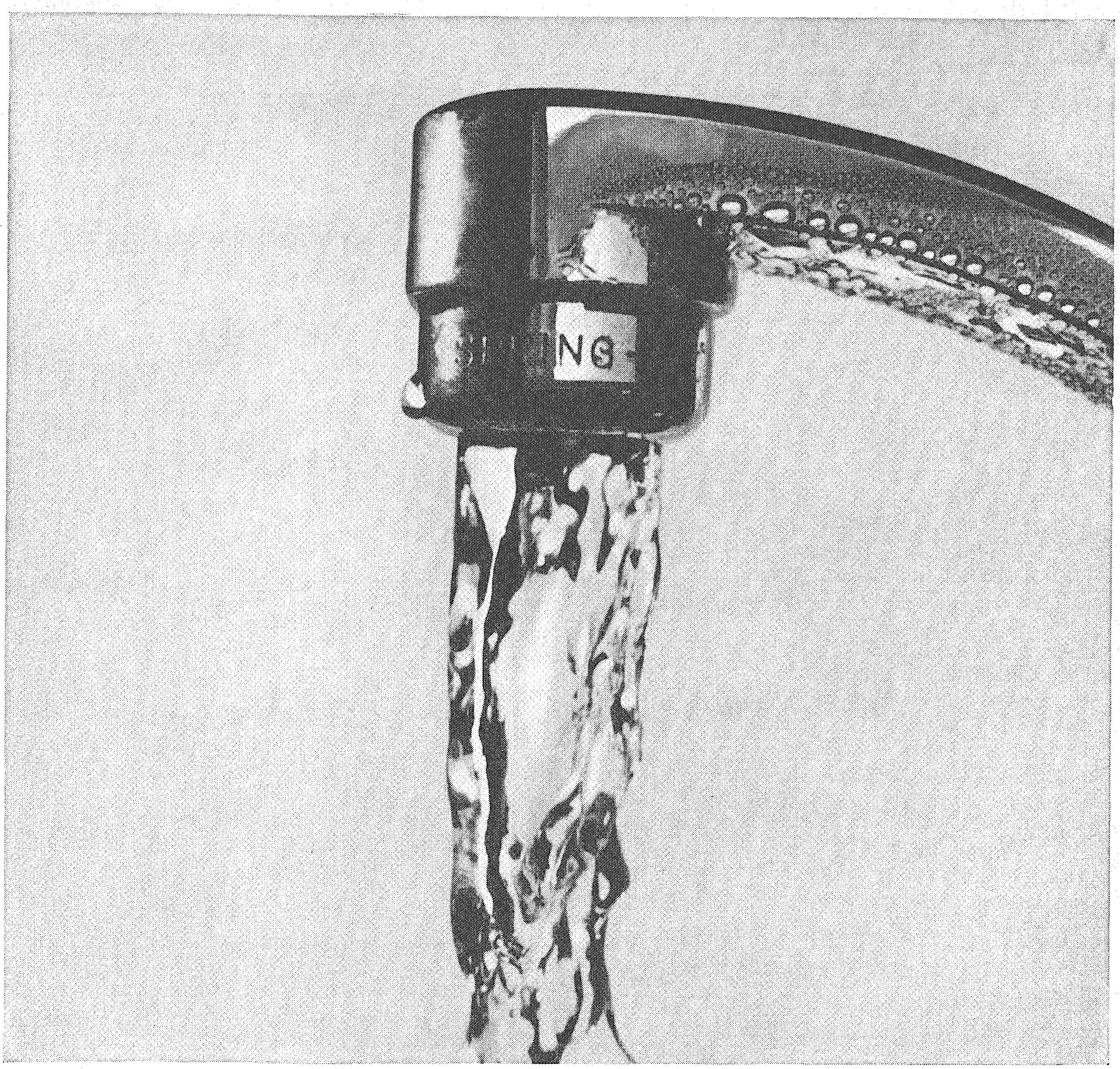


Who's helping make water come clean again?

The same Union Carbide that helped develop a new stainless steel used in subway cars.

Streams and rivers in many parts of the country were being plagued with foam, partly due to detergents. In some areas foam even came through the faucets . . . because old detergents kept on foaming after they went down the drain.

Now things are changing—the result of ten years' work by detergent manufacturers. We've helped by being the first to come up with new kinds of detergent chemicals that let the suds do their work in the wash and yet allow foam to be broken down quickly after use.

We've been busy improving many things. Our research work on stainless steel helped develop a new grade of steel that has recently been used to reduce the weight and cost of subway cars. We came up with new kinds of corrosion-resistant alloys for use in the chemical industry. And recently we introduced a plastic drinking straw that won't turn soggy.

To keep bringing you these and many other new and improved products, we'll be investing half a billion dollars on new plant construction during the next two years.

Union Carbide Corporation, 270 Park Avenue, New York, N. Y. 10017. In Canada: Union Carbide Canada Limited, Toronto • Divisions: Carbon Products, Chemicals, Consumer Products, Fibers & Fabrics, Food Products, International, Linde, Mining & Metals, Nuclear, Olefins, Plastics, Silicones, Stellite

UNION CARBIDE

A little over a year ago these ivy covered halls resounded with the controversy of debate. Our Great Debate set the champion of the world pacifist conspiracy against St. Paul's favorite tire salesman-politician. The first anniversary of the debate passed (thankfully) without much notice. But while our attention was focused on The Great Debate much more significant events were happening completely unnoticed. Let us therefore turn back the clock and follow the clandestine adventures of the . . .

SON OF MILTON ROSEGROWER

by DAVID E. ENGEN, *Pol Sci '67*

Scene 1: As our story opens we find our hero, Milton Rosegrower, Jr., quietly studying his sociology on the second floor of his God-fearing home.

"Red," as young Milty is affectionately called, "Will you come down here a minute?"

"O.K., Dad." Red misses a step and falls down the stairs.

"Are you all right?"

"Sure Dad, I'm fine. Those old tires you covered the stairs with softened the fall."

"I called you down to say that I'm going to speak at an American Legion hate rally and I'd like you to come along."

"Well, gee, I don't know."

"I'm really going to give it to them University reds tonight."

"But Dad, I go to the U. and there aren't any communists there."

"I know that, but you want your old man to be re-elected, now don't you?"

"I guess so. I'll go."

"Fine, son, fine."

Scene 2: Later that night at the American Legion hate rally, Red, who has been listening to the speeches, leaves to get some air. Outside he meets a girl also getting some air or putting some on.

"Hi."

"Humf."

"Why are you humfing me?" asked Red.

"Well, you are a stranger even if you do come from a God-fearing home."

"Well we don't always have to be strangers. My name's Red. What's yours?"

"Betsy, Betsy Ross Sibling."

"Gee, that name sounds familiar."

Author's Note: Any connection between any person, living or dead, with any character in this story is purely coincidental.

"It ought to be. She made the first flag you know."

"No, no. I mean Sibling."

"Well there is a high school in [West] St. Paul with the same name."

"No that isn't it, but then I suppose Sibling is a rather common name. A lot of people probably have that name."

"Ten."

"Ten what?"

"There are ten Siblings in the Twin Cities."

"No kiddin'? Say hows about you and me cuttin' out for the Big Ten?"

"I want to stay."

"Why?"

"I have this patriotic thing."

"Have you seen a doctor?"

"Yes, it's hopeless. Everytime someone mentions commie or red I break out in a rash, foam at the mouth, and generally become a bundle of hate."

"But my name is Red and when I mentioned it you didn't become a bundle of hate."

"Gloryoskeyzero! That's right."

"You see, we were made for each other."

"Maybe."

"If you don't want to leave here now, hows about me and you gettin' together next Saturday?"

"Okey Dokey."

"See you then."

Scene 3: Well, next Saturday comes and goes with Red and Betsy hitting it off real well. After several more dates our young couple decide they are right for each other and want to get married. They now have to tell their parents. Let's first look in at the Rosegrower home.

"Say, hey Dad."

"Yeah, Red."

"I've been thinkin'."

"I hope you've been thinking *right* thoughts. Get it, right-wing thoughts. Funny, funny."

"I'm serious, Dad. I've decided to get married."

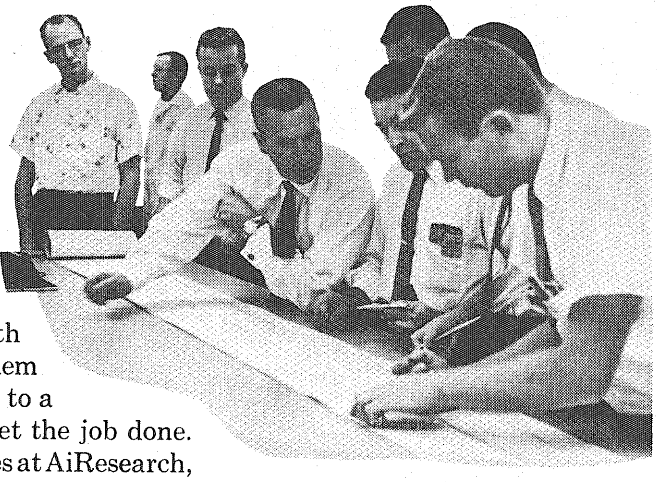
"Do you have to?"

"Of course not!"

"Then why do you want to?"
"I'm in love."
"That's a pretty feeble excuse."
"It's not an excuse!"
"O.K., O.K., don't get mad. I suppose if your mind is made up I'll have to give my blessing. By the by, who is the lucky girl?"
"Well, er-"
"Come on, tell me."
"Her name is, well-er-"
"That's a funny name for a girl!"
"I haven't given her name!"
"She does have one?"
"Oh yes, she's got a name all right."
"Well, what is it?"
"Betsy Ross Sibling."
"Sibling! ! !"
After Milty Sr., regains consciousness the conversation continues:
"Sibling! ! !"
"Well he's got a nice daughter."
"Sibling! ! !"
"She's very beautiful."
"Sibling! ! !"
"She's got good teeth."
"Sibling! ! !"
"She has a very substantial dowry."
"How much?"
"10,000 dollars, a house, two cars, and a John Birch Society handbook."
"I know you'll be very happy together."
"Gee, thanks Dad."
Scene 4: Red leaves joyously to tell Betsy that his father approves and that they can get married. Meanwhile, at the Sibling household:
"Say, hey Dad."
"Hello, Betsy. Do you want to talk to Daddy?"
"Yeah, Pops. Like me and this stud want to get hitched."
"That's nice."
"I think so."
"What's the young man's name?"
"Well-eh-"
"That's a funny name for a boy."
"That isn't his name!"
"Oh."
"His name is Milton Rosegrower, Jr."
"Oh."
"Don't you object?"
"Nope."
"Why not? I thought you and Milton Rosegrower were enemies."
"Just a publicity gag."
"A publicity gag?"
"That's right. You see, Milton Rosegrower didn't think he could be re-elected and my lecture enrollment was falling off, so we made a deal. I'd write a letter to the *Minnesota Daily Worker,* then he'd challenge me to a debate and we'd both get what we wanted plus a lot of TV royalties. We really are good friends. I buy all my tires from him."
"Gloryoskeyzero! We can get married."
"Quite so."
Scene 5: Betsy rushes out of the house to keep a date with Red at the local malt shop. We join them there.
"Sigh."
"Slerp."
"Sigh."
"Slerp."
"Must you keep slerping that malt?"
"I'm sorry, Betsy."
"Sigh. Ain't love swell?"
"Yeah, swell. Say, where should we go on our honeymoon?"
"How about going to Gettysburg, Lexington, Con-
(Continued on Page 24)

"She made the first flag you know."

Why become an engineer at Garrett-AiResearch? You'll have to work harder and use more of your knowledge than engineers at most other companies.



If you're our kind of engineer, you have some very definite ideas about your career.

For example:

You've worked hard to get a good education. Now you want to put it to work in the best way possible.

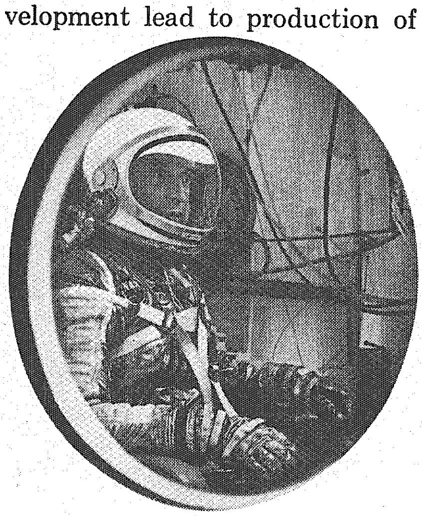
You will never be satisfied with run-of-the-mill assignments. You demand exciting, challenging projects.

You not only accept individual responsibility – you insist upon it.

Does that sound like you? Then AiResearch is your cup of tea.

Our business is mainly in sophisticated aerospace systems and subsystems.

Here, research, design, and development lead to production of actual hardware. That means you have the opportunity to start with a customer's problem and see it through to a system that will get the job done.



The product lines at AiResearch, Los Angeles Division, are environmental systems, flight information and controls systems, heat transfer systems, secondary power generator systems for missiles and space, electrical systems, and specialized industrial systems.

In the Phoenix Division there are gas turbines for propulsion and secondary power, valves and control systems, air turbine starters and motors, solar and nuclear power systems.

In each category AiResearch employs three kinds of engineers.

Preliminary design engineers do the analytical and theoretical work, then write proposals.

Design engineers do the layouts; turn an idea into a product.

Developmental engineers are responsible for making hardware out of concepts.

Whichever field fits you best, we can guarantee you this: you can go as far and fast as your talents can carry you. You can make as much money as any engineer in a comparable spot – *anywhere.* And of course, at AiResearch, you'll get all the plus benefits a top company offers.

Our engineering staff is smaller than comparable companies. This spells opportunity. It gives a man who wants to make a mark plenty of elbow room to expand. And while he's doing it he's working with, and learning from, some of the real pros in the field.

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***is* challenge**

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No—we're not the largest—yet. But we do make the most complete line of refrigeration, air conditioning and heating equipment in the world. From the Americas to Zeeland—you can find one of our products at work.

Speaking of work—why not get in on the ground floor and grow with us? Write Director of Technical Services, Dunham-Bush, Inc., West Hartford, Conn.

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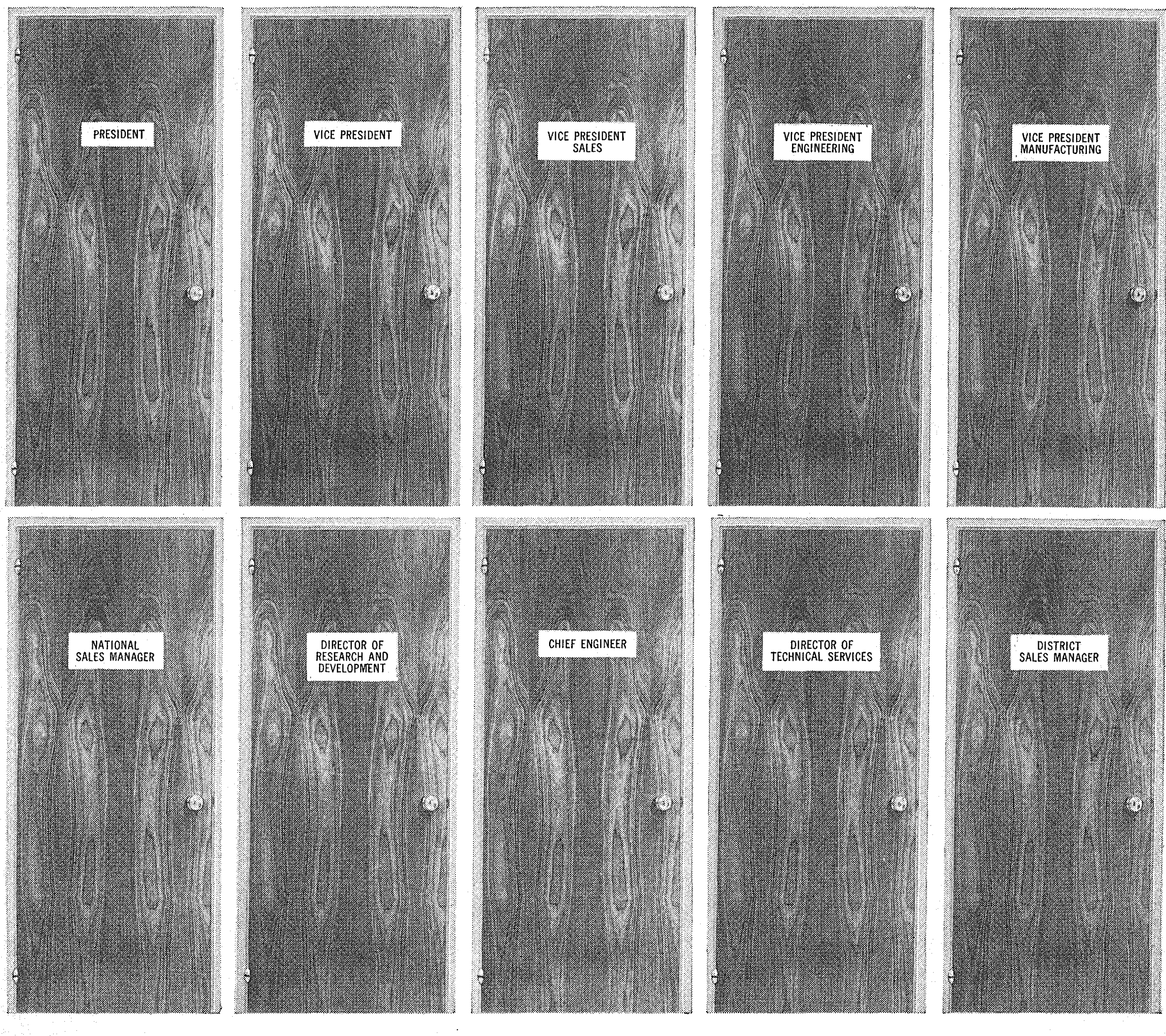
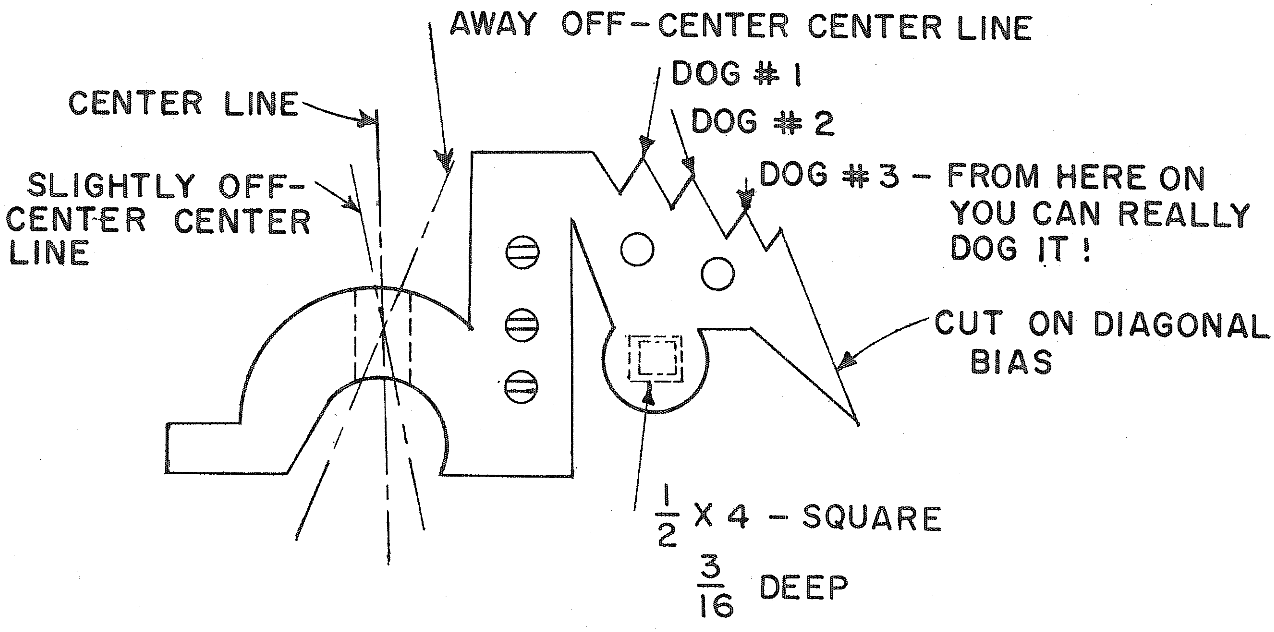
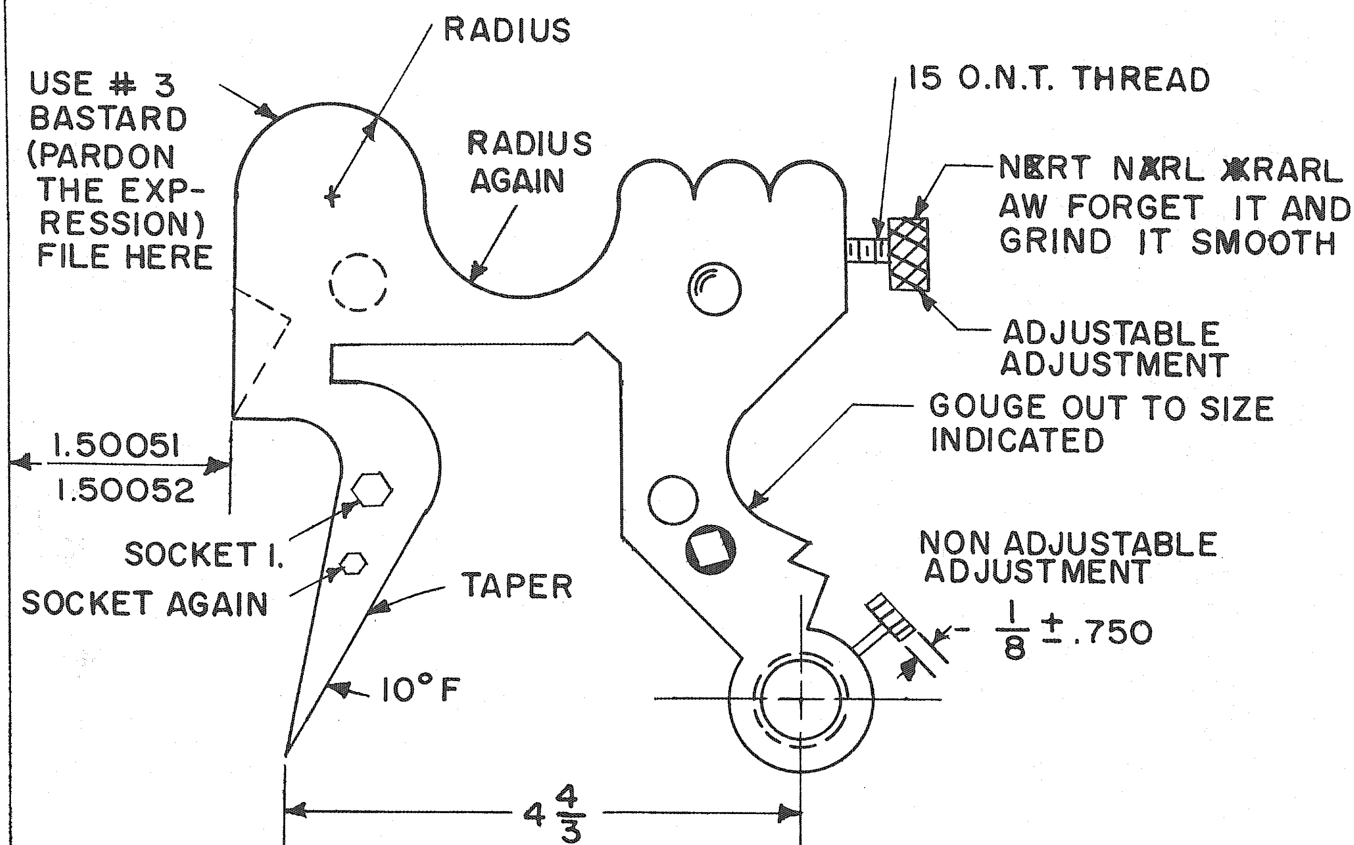
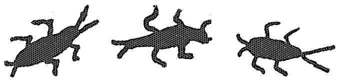




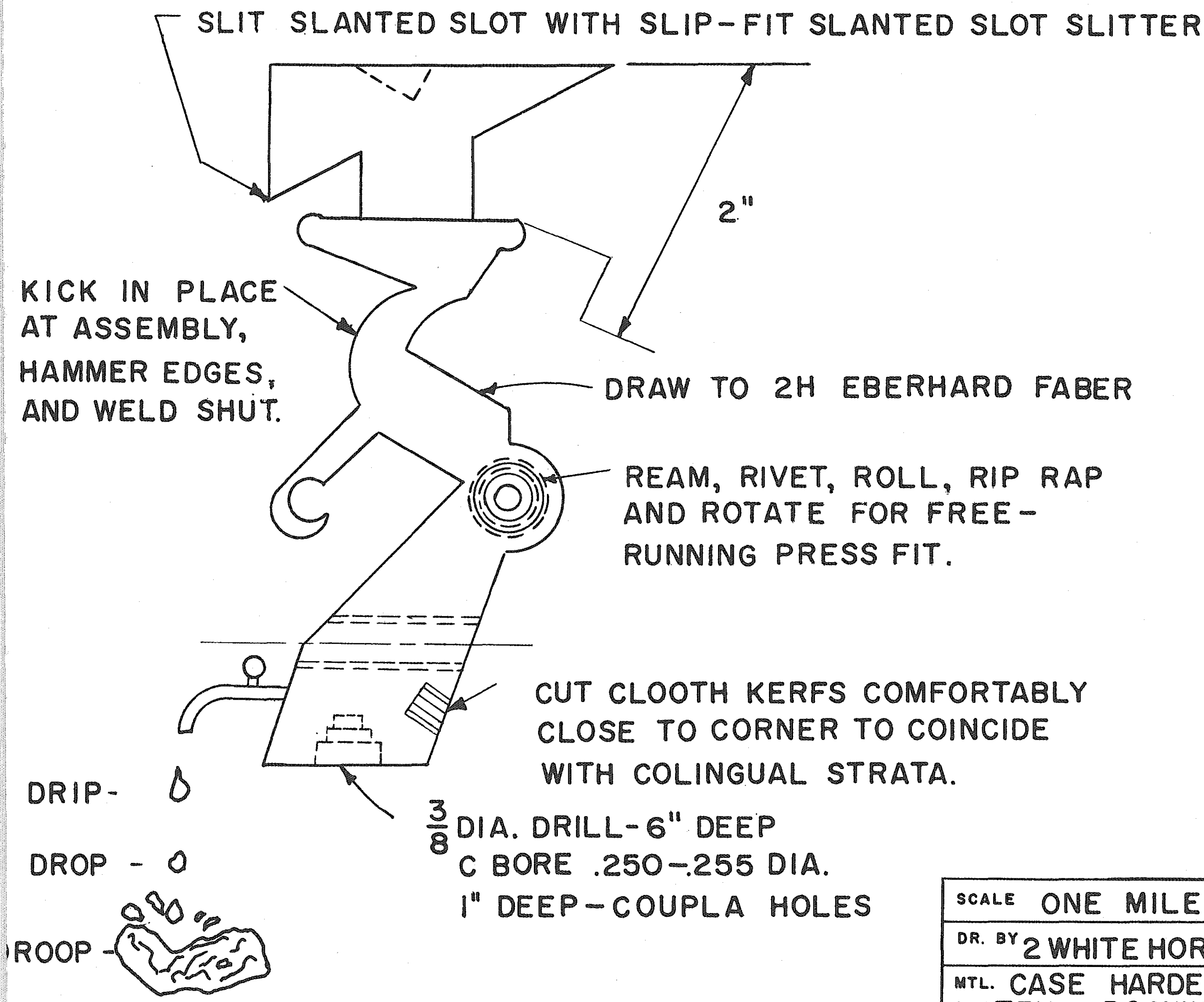
THIS IS HOW TWO LINES OF PRINTING LOOK
WHEN THEY ARE PRINTED UPSIDE DOWN.



AZ	3-1-65	REVISED
BA	3-15-65	REVISED REVISED
BB	3-30-65	REVISED REVISED REVISION
BC	4-1-65	REVISED REVISION RE-REVISED
BD	4-2-65	WHOOPS—CHANGED AGAIN
BE	4-4-65	PUT IT BACK LIKE IT WAS BEFORE



BUGS TO BE ELIMINATED AT FINAL ASSEMBLY.



SCALE ONE MILE

DR. BY 2 WHITE HORSES

MTL. CASE HARDENED LATEX — ROCKWELL X

SEQUENCE
1. FIDDLE
2. DIDDLE
3. PIDDLE
4. HIRE NEW MAN

NAME
WATER COOLED ELECTRONIC GLOOP

PART NO. 123-456-789

SPLINTERS From the Log

by DAVID E. ENGEN, *Pol Sci '67*

What do you get when you cross an elephant with a grape?

(elephant) (grape) sin Θ where Θ is the angle between the stem and the trunk.

• • •

Rules for handling women electrically:

If she talks too much—Interrupter.
If she wants to be an angel—Transformer.
If she meets you halfway—Receiver.
If she gets too excited—Controller.
If she gets up in the air—Condenser.
If she gets hungry—Feeder.
If she sings inharmoniously—Tuner.
If she is wrong—Rectifier.
If she is too fat—Reducer.
If she gossips too much—Regulator.
If she wants to get married—RESISTOR!

• • •

English instructor: "Do you enjoy Browning?"

Student: "No, but I sometimes have to resort to it around exam time."

• • •

The apple of every man's eye is the peach with the best pear.

• • •

Used car dealer (driving up a hill): "This is the opportunity of a lifetime."

Customer: "Yes, I can hear it knocking."

She: "There's one thing I want to tell you before you go any further."

He: "What's that?"

She: "Don't go any further."

• • •

Q: How do you tell whether your goldfish is a boy or a girl?

A: To the water in the goldfish bowl add one-half ounce of sulfuric acid. If he comes floating to the top, he's a boy. If she comes floating to the top, she's a girl.

• • •

As long as there are final exams, there will be prayers in our schools.

• • •

Counselor: "How do you like this room as a whole?"

Freshman: "As a hole, it is fine; as a room, not so good."

• • •

Overheard in E.E. Lab—

Tony: "Roy, grab this lead. Feel anything?"

Roy: "No."

Tony: "Then watch out for the other one, its carrying 22,000 volts."

• • •

There is a rumor in ME 133 that the prerequisite for MM29 is a previous attempt at MM29.

• • •

Censors: People who inhibit the earth.

"Boy, am I scared! I got a letter from a man saying he'll shoot me if I don't stay away from his wife."

"Well, all you have to do is stay away from his wife."

"Oh, yeah? He didn't sign his name!"

• • •

A democracy is where a man can choose his own form of government—like a blonde, brunette, or a redhead!

• • •

Then there is the girl who no longer objects to being kissed because she points out that the last ME she slapped chewed tobacco.

• • •

The police station had been quiet all day and most of the week. The men were playing cards to pass the time. "What a life," grouched one of the officers. "No fights, no burglaries, no riots, nothing, not even a stabbing. If it stays this quiet, they'll reduce the force."

"Rest easy, Mike," said the Captain, raising the pot. "Things will break soon. You've got to have faith in human nature."

• • •

The mother of a pretty young girl was asked by her daughter, "What do you give a man who has everything?"

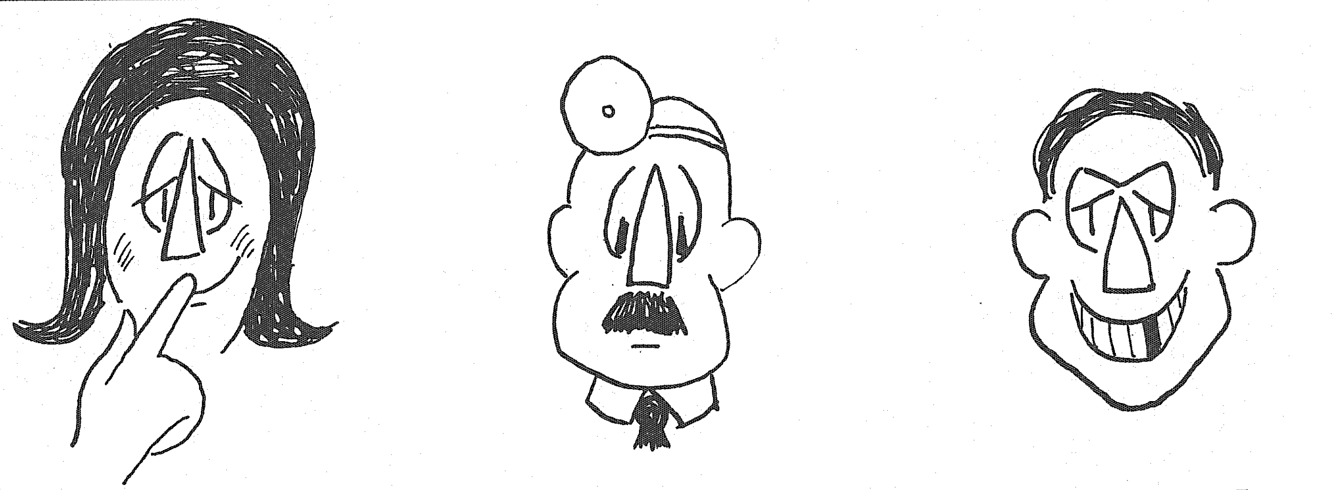
Replied her mother, "Encouragement, dear, encouragement."

• • •

History credits Adam and Eve with being the first bookkeepers, because they invented the loose-leaf system.

• • •

I walked into the barbershop,
The sign was very queer,
"During alterations
We will shave you in the rear."



SHE GOT IT . . . HE SEES IT . . . MACLEAN'S DID IT.

DEEP FREEZE

Not a giant ice house, but a voluminous deep freeze for liquid natural gas. That's what this tank will store to assure that customers of Wisconsin Natural Gas Company will be warm on extremely cold winter days.

It is one of three or four such plants currently planned or under construction in the U. S.

The double wall insulated metal tank will hold more than 3 million gallons of gas liquefied at —267 degrees. That's compact storage for the equivalent of 250,000,000 cubic feet of natural gas — a ratio of 630 to 1.

The LNG plant will liquefy 750,000 cubic feet of gas a day during normal operation. Its capacity will be 25,000,000 cubic feet a day during peak winter days.

Savings in demand charges from the pipeline company should pay for the $2 million plant in about five years.

LNG peak-shaving is just one more application of space-age technology by our engineers to assure economic and dependable delivery of energy. We offer engineering posts in many fields to challenge your technical as well as your managerial abilities.

WISCONSIN ELECTRIC POWER COMPANY SYSTEM

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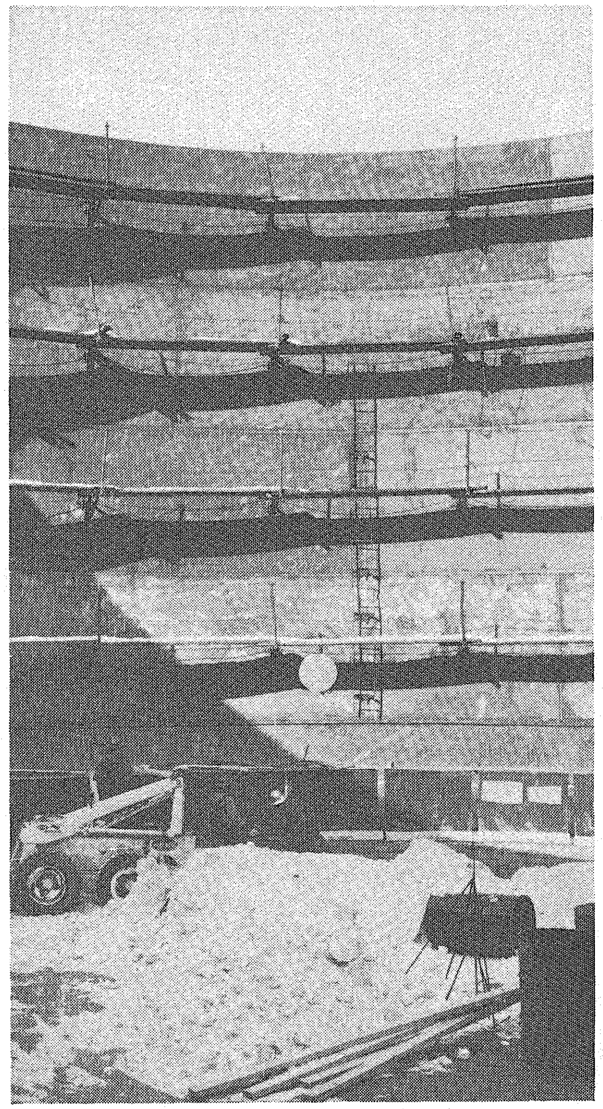
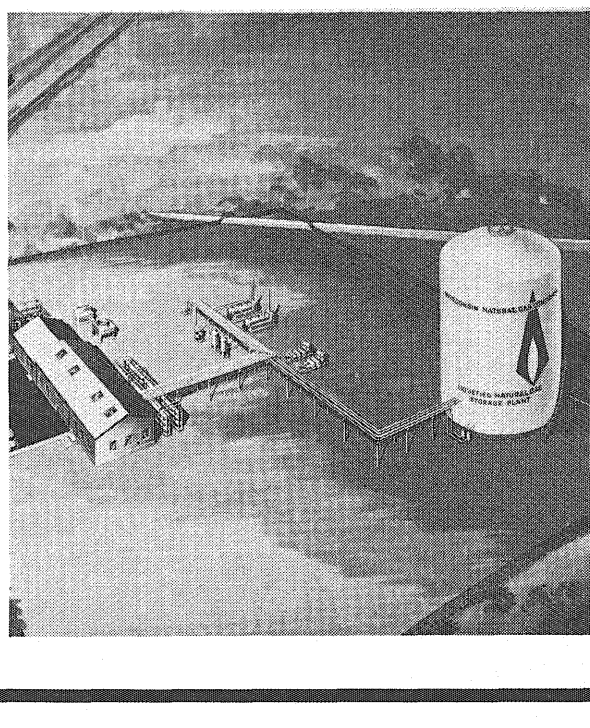
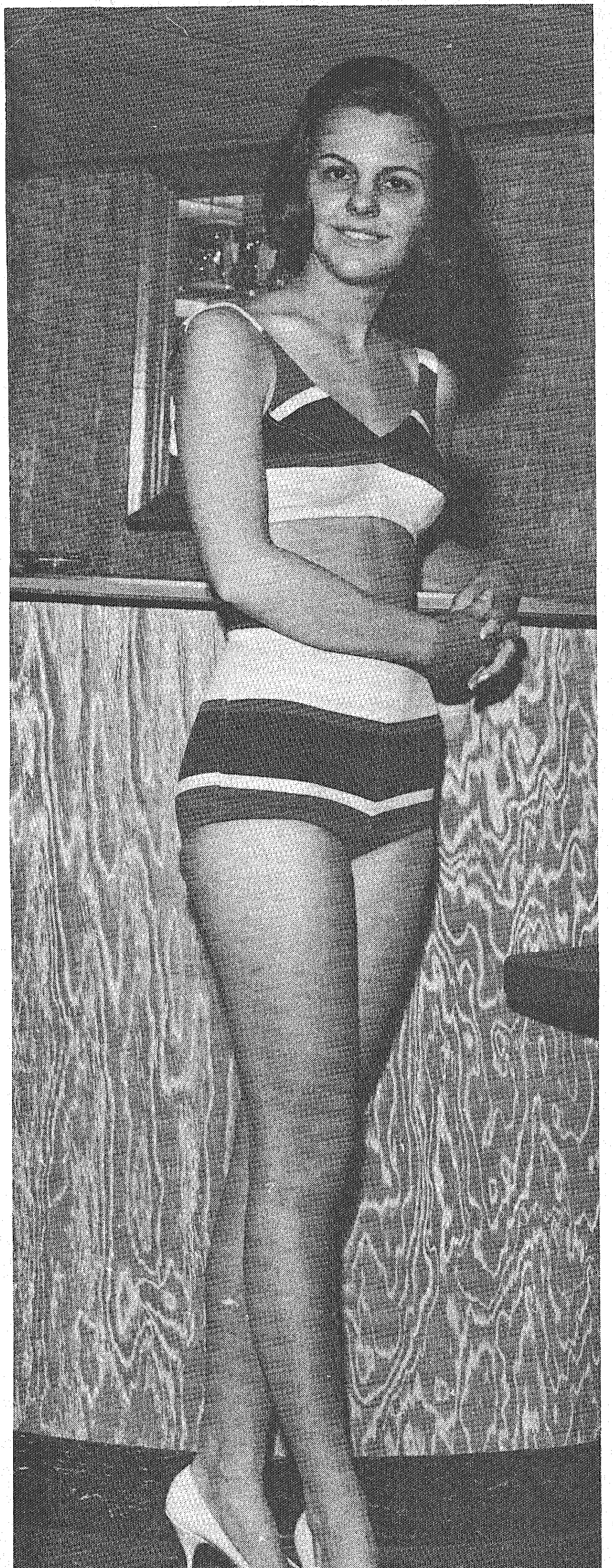
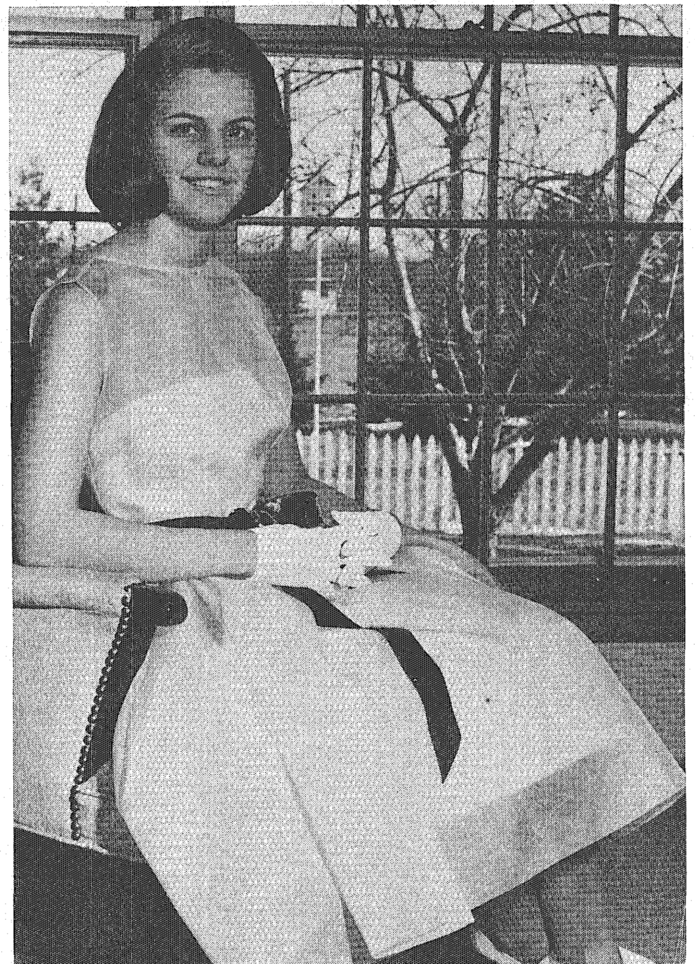
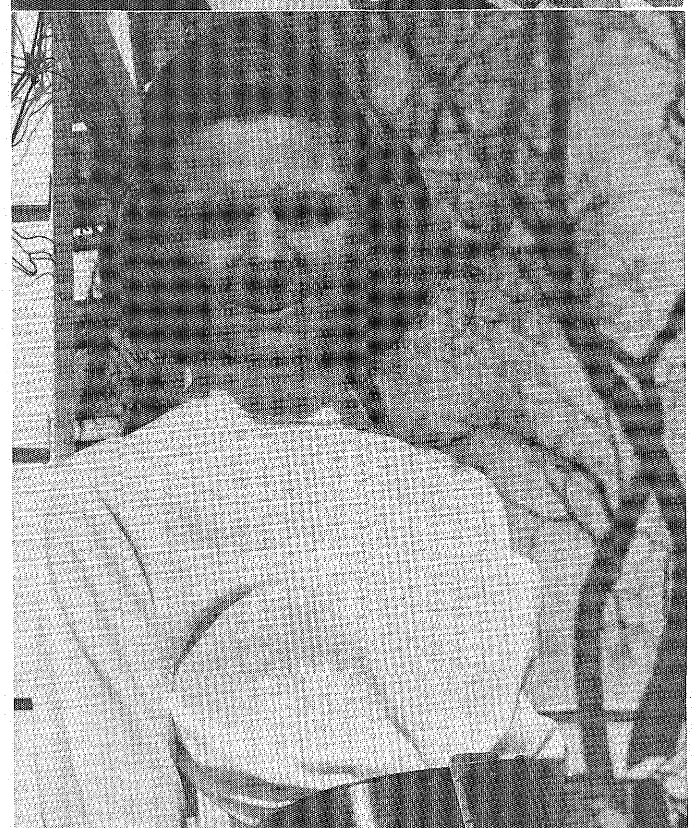
Racine, Wis.





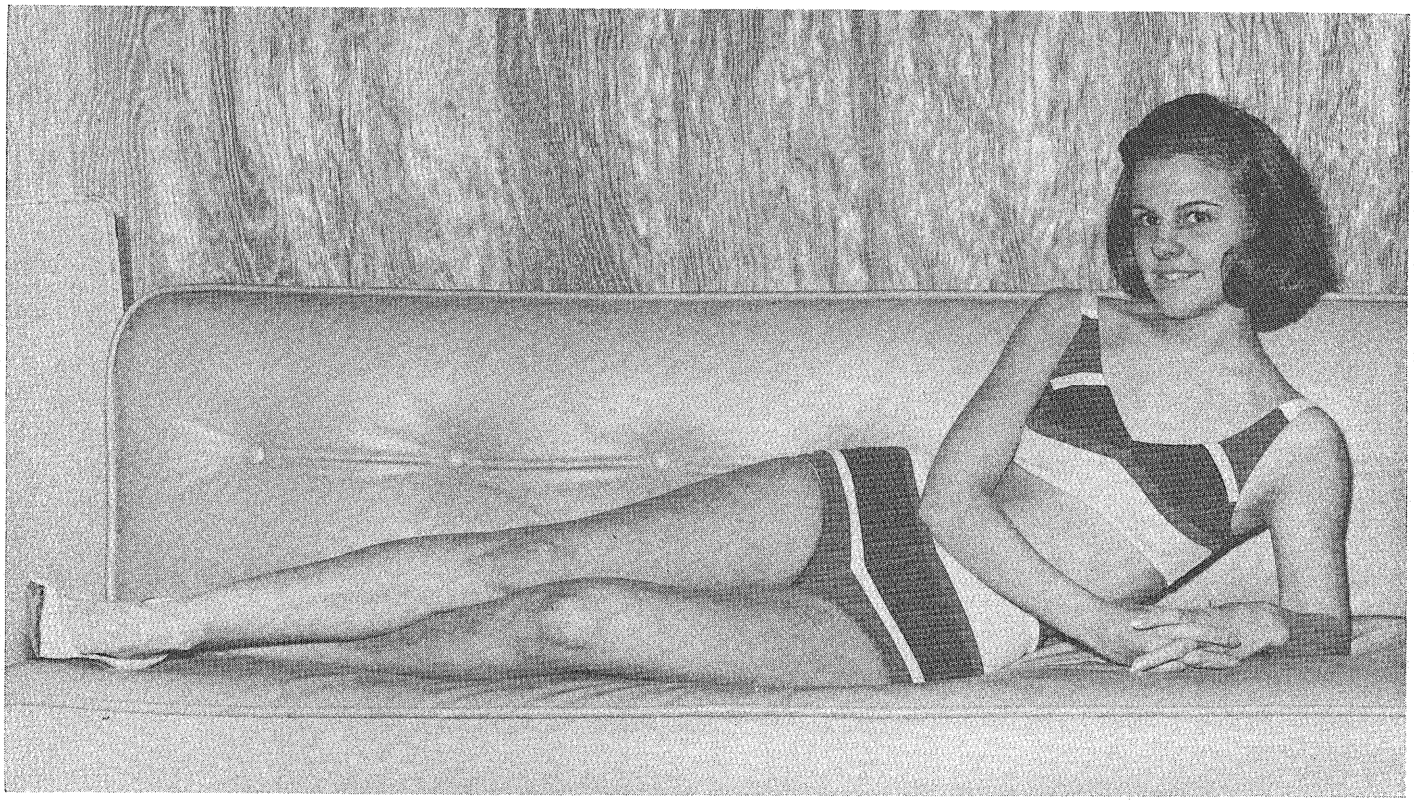






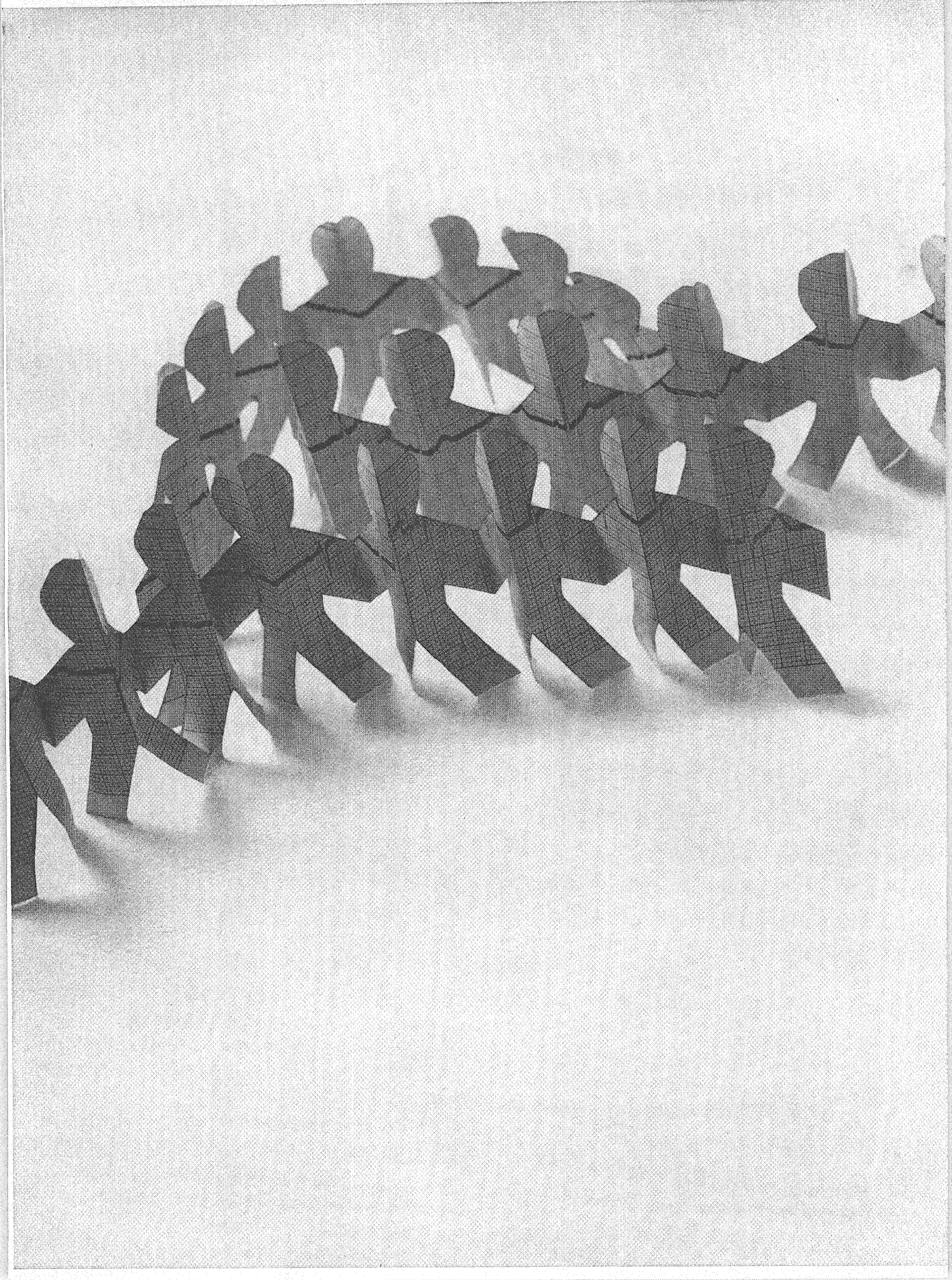
Miss April 1st—15th

SUE RAINER

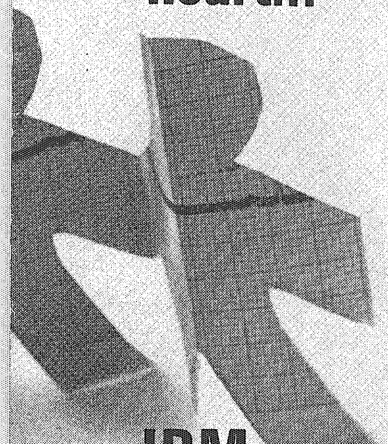


Miss Sue Rainer is Miss April 1st through the 15th. She is the daughter of a very famous family in Monaco. New Jersey that is. During her stay in Minnesota, Miss Rainer visited the Guthrie Theater, the White House, Barney's Fun House and our dark room. She was very impressed, especially in our dark room.

Miss Rainer has recently joined the Peace Corps and is currently assigned as a chorus girl in Nairobi, Kenya. We admire her dedication among other things. Mainly: 34-22-34.



Signals from the heart...



IBM computers help doctors study them

At IBM you can help solve basic problems in many different fields. Currently IBM engineers are assisting university doctors in the use of computers to analyze and evaluate electrocardiograms. These experiments could give physicians greater insight into the workings of the human heart.

At IBM there is always a variety of problems to tax your imagination. If you don't know enough about a specific technology, you can learn it on the job at IBM from leaders in the field—or study it in one of our advanced education programs.

Just ask us about the areas of work you're interested in. Your college placement officer can set up an appointment with our interviewers. Or write directly to Manager of College Relations, Dept. 915, **IBM**® Corporate Headquarters, Armonk, N.Y. 10504. IBM is an Equal Opportunity Employer.

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LIVING LENS OR WHAT TO DO 'TIL THE VIET CONG COME

Do you think he's discovered that we stole his watch yet?

There's no doubt about it. I've just got to install indoor plumbing.

Whee! I'm a fairy!

Next time I get a better lawyer.

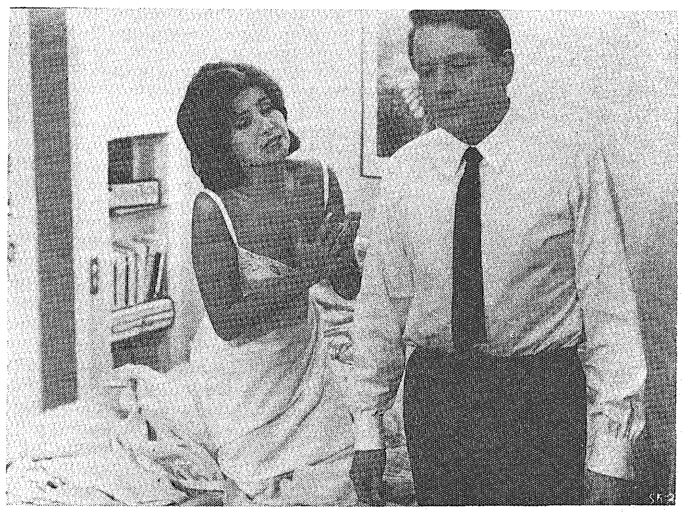
I said the *material* was felt!

Who will save me from the campus police?

Maybe it's Khrushchev?

I don't care what those psychiatrists say, I'm sure people are following me.

I wonder if Lady Bird will come down tonight?

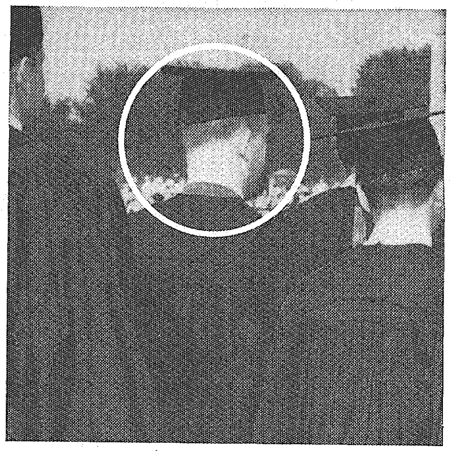


Please, alderman, if you don't turn me in I'll give you your money back.

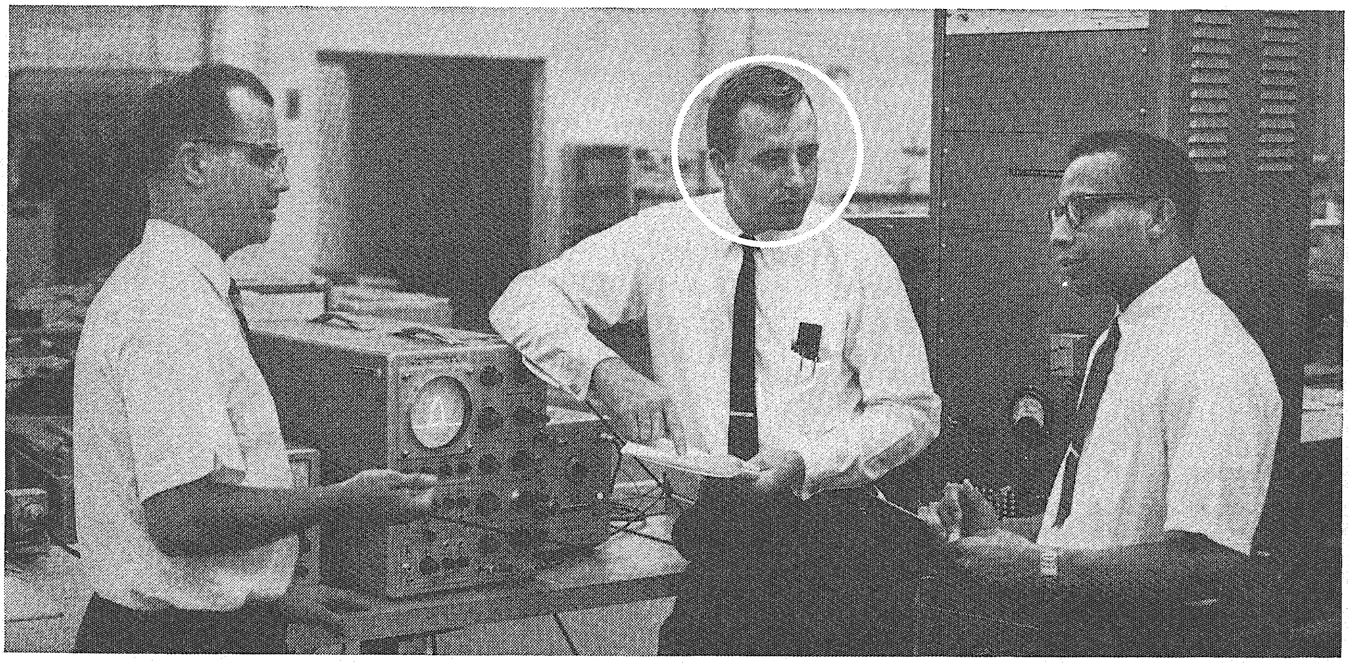
IT'S TIME AGAIN FOR THAT . . .

MICKEY MOUSE PERSONALITY INVENTORY

1. Do you agree with the Testing Office Head Psychologist, Dr. Tass, that those who feel intense patriotism for their country are "Queer"?
   yes____ no____
2. Do you often get headaches?
   yes____ no____ very____
3. Do you feel intense patriotism for your country?
   yes____ no____
4. Do you lie?
   yes____ no____ if the price is right____
5. Do you feel that the imperialists are out to exploit you?
   yes____ no____
6. Do you have relatives in the old country?
   da____ nyet____
7. Do you have relatives in this country?
   yep____ nope____
8. Do you like Mom's apple pie?
   yes____ no____
9. Do you feel that psychologists should be better paid?
   yes____ no____
10. Do you study each of these questions carefully?
    yes____ no____ restate the question____
11. Do you give up your seat in a crowded bus to a lady?
    yes____ no____
12. Why?
    like to stand____ don't know____ am foolish____
13. Do peculiar odors come to you?
    yes____ no____ have cold____
14. Do you go with peculiar odors?
    yes____ no____ don't know her____
15. Do you often feel strange compulsions?
    yes____ no____ don't know her____
16. Do you like political parties?
    yes____ no____ never been invited____
17. Do you think the statue of Liberty is a menace to navigation?
    yes____ no____ only during Russ hour____
18. Do you often faint in crowds?
    yes____ no____ ohhh!____
19. Do you often join the *Daily* staff?
    never____ no____ seldom____
20. Do you enjoy *Technolog* jokes?
    always____ always____ always____
21. Are you shy in sexual matters?
    yes____ hell, no!____ blush!____
22. Do your friends usually do what you want them to do?
    yes____ no____ only in parked cars____
23. Do you feel a tight band constricting around your head?
    yes____ no____ ouch!____
24. Do you like mail order catalogs?
    yes____ no____ depends on the males____
25. Do you consider yourself another Napoleon?
    yes____ no____ Bonaparte or Solo____
26. Do you love your father?
    yes____ no____ which one____
27. Do you often feel depressed?
    yes____ no____ only in English lecture____
28. Do you feel that people are out to get you?
    yes____ no____ only on pay day____
29. Are you indecisive?
    yes____ no____ can't say____
30. Do you cheat on exams?
    yes____ no____ let me check somebody's notes____
31. Do you consider nude models odd?
    yes____ no____ not odd, but often____
32. Does MSA do what you want it to?
    aye____ nay____ you must be kidding____



Tom Huck sought scientific excitement



He's finding it at Western Electric

Ohio University conferred a B.S.E.E. degree on C. T. Huck in 1956. Tom knew of Western Electric's history of manufacturing development. He realized, too, that our personnel development program was expanding to meet tomorrow's demands.

After graduation, Tom immediately began to work on the development of electronic switching systems. Then, in 1958, Tom went to Bell Telephone Laboratories on a temporary assignment to help in the advancement of our national military capabilities. At their Whippany, New Jersey, labs, Tom worked with the Western Electric development team on computer circuitry for the Nike Zeus guidance system. Tom then moved on to a new assignment at Western Electric's Columbus, Ohio, Works. There, Tom is working on the development of testing circuitry for the memory phase of electronic switching systems.

This constant challenge of the totally new, combined with advanced training and education opportunities, make a Western Electric career enjoyable, stimulating and fruitful. Thousands of young men will realize this in the next few years. How about you?

If responsibility and the challenge of the future appeal to you, and you have the qualifications we are looking for, talk with us. Opportunities for fast-moving careers exist now for electrical, mechanical and industrial engineers, and also for physical science, liberal arts and business majors. For more detailed information, get your copy of the Western Electric Career Opportunities booklet from your Placement Officer. And be sure to arrange for an interview when the Bell System recruiting team visits your campus.

Western Electric MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

AN EQUAL OPPORTUNITY EMPLOYER

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SEX

and the

COLLEGE PROFESSOR

As I rose from my lonely bed this morning with my usual pre-shower depressed feeling, I tried to think what made today different from the other miserable 364. As usual, I couldn't think, but I try anyhow. I stumbled down the hallway knocking on doors and asking everyone. God, I hoped it wasn't the first day of final week. No, worse yet, it was the first day of spring quarter. The light slowly filtered into my feverish, hangoverish, brow. Today was my first day of class with the uninhibited, totally individualistic, and utterly unique professor—that controversial, knuckleheaded, blockbrained Bullford X. Wibley. Of course, now I remember, I am the only IT student—non-Pol Sci major to be allowed in his class. It came about because I went and bent that stupid IBM card. I felt it would be an exciting experience, seeing how the other half—the CLA half—lives.

Soon with a brand new—depressingly new—notebook in my hand I was off to class. I arrived early and selected a seat between a very brainy-looking girl and a rather drippy-looking boy. As I waited, I thought of how best to approach this new course and instructor. I decided to use "caution," simply for lack of knowing a bigger, more impressive type approach with a more impressive type word. The students around me seemed to display a feeling of spiritual oneness and a feeling of identification with the man who entered suddenly, slyly from the side. I was scared.

This man was the students' liberator, their messiah. I was overcome with a feeling of conspicuousness, while the students around me displayed open and mixed love and hate. He stood like a god preparing to lead his people from the bondage of Victorian morals. He walked up and down across the front and looked deep into the inner self of each student. I felt, as all must have, that he was looking at me, and me alone. I think my inner self must have been showing. I checked my zipper, and then just for no good reason at all hurriedly buttoned up the top button of my shirt. I opened my notebook and stared at the blank pages to save myself from his penetrating stare. The room was filled with silence. Then he spoke and his god image was reinforced.

"My name is Professor Wibley. I am your instructor and you are to be my friends, my disciples, and my followers." Friends! The girl next to me had tears in her eyes, the crowd was tense, and I felt like slapping my new friend on the back and asking how the chances were for an "A" in this course. The class seemed already to have become one, and I had become one also; one not in the class. He spoke again.

"Our society as it stands today is a contradiction, a blaspheming lie to our basic needs and desires. In the next ten weeks I will try to point out these idosyncrasies, I will try to guide you on the line of rightness, true enlightenment, not pseudoenlightenment. Even today there are those that will try to stifle my truth, but in the end they will fail." He took a deep breath and mopped his forehead. For a horrid moment I thought everyone else would do the same.

"You ask me, what is the truth? In the weeks to follow I will point out my truth. What is truth? Truth is directed knowledge. The rightness or wrongness of something is in the mind's eye. Here, write this down. Remember this not for this hour or this quarter, but for all of your life." He walked over to the blackboard and wrote in a squeeky and caked way the following quotation, beside which in my notes I cautiously wrote "remember this not for this hour, this day, or this quarter, but remember for the final." Here is his quotation:

"Once I dreamed of life's sweet expectations,
Now I am chained to its bitter limitations."
—JWB

JWB? Who is that? I hoped he would ask, for the sudden answer dawned on me. It had to be either John Wilkes Booth, or Jack W. Benny. But he chose to explain it himself. "JWB was a great student philosopher like yourselves. He grew up in a frustrated society, tormented by feelings of guilt and oppression. The only way he could escape the society which thus imprisoned him was through a violent death—suicide. Look at yourselves, my friends. Don't you identify with this great man's comment? Are you not torn by the same frustrations that killed him?"

The only frustration that was tearing at me at that moment, was one of sheer fear because I had forgotten to use the can before coming to class.

"There are those who say morals are for our happiness —yet they cause us unhappiness. In the realm of sex, we learn from early childhood that it is "naughty" to admire a female form, that it is sinful to indulge in the pleasures of the opposite sex. And are we happy because of this?"

A few students timidly ventured a guess. "No?"

"Ask yourself, can you truly say that you are happy because of this? Certainly not!" Happy? If he means what I think he means, I am not one to argue. If he thinks he can get it given away free—let him try. Even if he falls short, he may succeed in getting all IT students some student discount cards.

"Morals enlarge the very thing that they try to prevent. Sex is not evil. Basically sex is a relaxing and enjoyable stimulant. It is needed in our society to ebb away the feelings and frustrations of normal everyday life."

Frustrations of everyday life? Boy, just think of the hours of flying time one could stack up relaxing with Bullford's wonderful stimulant during final week!

"Our churches today are confused. On one hand, they say don't indulge; it is a sin, a mortal sin. Yet on the other, they say that sex is a gift of God, something to be cherished, something wonderful. The church's attitudes change with the time. At the present moment, they are floundering toward a more tolerant outlook, a more liberal view of sex. Is sex good or bad? Let's consider the church as a source for understanding. The church as it stands today is fragmented in a multitude of sects. Name calling and bickering among the sects confuse them about the very topic they are supposed to be enlightened in. Therefore, can we take the reasoning of the church as a valid standard of guidance?"

As he said this, I was playing that little game with my hands that all good little Sunday School children played. "Here's the church, and here's the steeple, open up the doors and look at all the people!" Everytime I tried it, though, I counted ten people, seemingly making a one-to-one correspondence with my ten fingers. When you subtract for the pastor, priest, or rabbi, and then the organist, custodian, ushers, and Sunday School teachers, you don't have any people left—even pretending that this church employs the smallest number of people on Sunday. After trying this several times, I began to see his point—or at least think his point was justified. There were no people! My childhood illusions were shattered. I began to hate him.

"In the weeks to follow, I will attempt to sweep clear the muck and superstitious fiddle faddle, and replace it with scientific clarity. This, students, is my basic truth: Sex. Sex as it stands is good! The ways of expressing sex at any time are natural—and anything that is natural is good. One who suppresses sex is a hypocrite. Sex is good. Everything that is good should be exploited. If one wants sex in the morning, it is good to have sex in the morning."

The entire audience seemed absorbed by a mass hysteria as professor Wibley continued his verbal orgasm.

"If sex is wanted in a pew, it is good to have sex in a pew. Sex in the morning, sex in the evening, sex all the time. The suppression of sex is evil!"

Something seemed to grip the whole room. I seemed to be the only person that was not completely transported. Everyone picked up the chant: "Sex, Sex, Sex is good, sex is good!" The boy on my right was running his hands up and down his thighs, while the girl on my left was frantically chanting along and drawing Ben Casey symbols in her notebook. I couldn't believe it. This was something one just hears about but never really believes. The hairs on the back of my neck were rising and I had the strongest feeling of not knowing whether to get up or sit down. He continued to speak, screaming over the crowd's chanting.

"I will lead you out of darkness. I will part the waters for you. I will bring down the wall of ignorance, and I will lead you to the land of milk and honey. And finally, I will be willing to die on the cross of truth for you. If we succeed, your daily life will be of my blood and of my body. I am your life, I am your happiness. I am yours!" I seemed to have heard this whole bit before somewhere. They all began to chant "Everybody loves Professor Wibley, Everybody loves Professor Wibley, everybody loves Big Daddy Wibley." This too sounded familiar, and on a vague hunch, I got a small calendar out of my wallet to check the year. It was only 1965.

"As I said before, there are those who will try to stop me. Will you let them stop me?"

"No, no," they chanted.

"Will you let them spit in my face?"

"No! No! No!"

"Is not sex good?"

"Yes! ! !"

"Do you not love sex?"

"Yes, yes!"

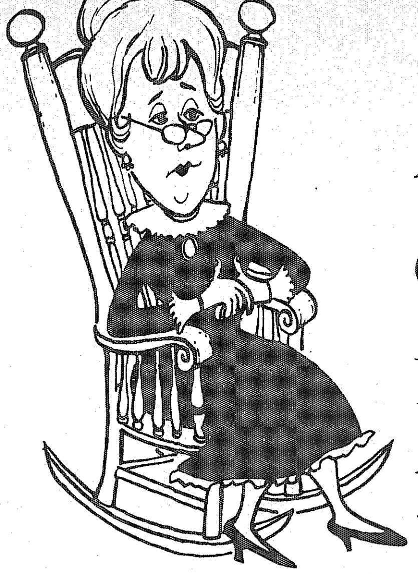
"Do you not love truth?"

"Yes! Yes!" Everyone was standing and screaming by this time. That is, everyone except me. I couldn't stand up for reasons I have already mentioned. I was in control if I stayed seated.

"I am sex. I am truth. Do you love me?" As the students wildly screamed "Yes!" over and over making an African ritual out of the word, Professor Wibley strutted over to a map and pulled it down revealing a map of the Western Hemisphere. Over the top of the U.S. was a picture of Filton Fosen, and a small, hardly recognizable obscene word was scrawled across Canada. As he did this he screamed: "Do you hate those who will try to stop me?"

"Yes, yes. Hate, hate, hate!" Everyone joined in the singing of their new hate song. Professor Wibley fell to his knees and bowed his head. The room seemed to become dark except for a lone spotlight from above which shone on the lone figure before the class. Several students ran up and tore down the picture. As Wibley bowed, the chanting ceased and the room fell into a reverent silence. In the back I could see a boy with an Oedipus complex and a girl with an Electra complex hugging each other in their new-found understanding. The bell rang, and nobody moved. The place was still dark. If it wasn't for my pressing engagement I would have probably stayed too, but good-god who knows; they may still be there!

As sleep at last overcomes me, I must close this journal for another day, and reflect back on how it has been just a typical day at the U of M. Someday, I'll reread this journal and look back with fond memories on my college days, but I really must quit babbling on now, after all, I've got a cancel-add slip to fill out.



AUNT CRAPPY BUTT'S IN

Dear Aunt Crappy:

I am redecorating my bachelor-girl apartment from French Provincial to Danish Modern. I enjoy the new furniture, but there is one piece of my old furniture I cannot part with. The only problem is that it doesn't fit into my new decor. Tell me what I can do with an antique chest.

MISS CHIPPENDALE

Dear MISS CHIPPENDALE:

Not much.

Dear Aunt Crappy:

I followed your advice and ruined my life. You are a bungling, meddling, assinine old biddy.

RICHARD BURTON

Dear RICHARD BURTON:

Well, you ain't exactly Cary Grant yourself.

Dear Aunt Crappy:

When I came to the University I was sweet and innocent, but now I need your help. I met this very handsome boy, and we started to go steady. Before I knew it he was in the army, and I was in trouble. Help me.

DESPERATE

Dear DESPERATE:

Call 373-3298 and ask for Sam.

Dear Aunt Crappy:

I have just completed two quarters in I.T. and have been unable to get a date. I never had any trouble in high school with girls, but I can't make any time in college.

LOVE STARVED FRESHMAN

Dear LOVE STARVED:

You are too fussy. I know for a fact that there are lots of eligible young things in I.T. just waiting for a young man like you. You can't neglect them just because they're boys.

Dear Aunt Crappy:

I am quickly coming to my wit's end. You see I am a Shaker and am married to a very beautiful girl. Every time I look at her and see her beautiful body with its supple skin and rounding curves, I want to rush up and grab her and shake her hand. Is there any way I can suppress this terrible shameful desire?

THINKING OF SINNING

Dear THINKING:

Wear gloves.

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ROSEGROWER . . .

(Continued from Page 7)

cord, Philadelphia, and Washington, D. C.? We could see all them historic places that made America the greatest country in the world if all these liberals wouldn't keep selling out to the commies."

"I was thinkin' about Reno. It's really a fabulous place. You haven't lived 'til you've heard the ruffling of cards, the silver-tongued croupiers, the whirr of the slot machines, and the rattling of dice."

"Well, I kinda had my heart set on a patriotic honeymoon."

"I had a rather different conception. But, if you don't like Reno, hows about Pismo Beach?"

"What's there to do in Pismo Beach?"

"This is our honeymoon you know."

"So what's that got to do with it?"

"Honeymooners usually want to spend their honeymoon in a quiet, secluded place."

"Why?"

"Don't you know about the birds and the bees?"

"Oh, do they have an animal sanctuary in Pismo Beach?"

"No, but then we're not going to Pismo Beach."

"We're not?"

"No, we're going to see all them patriotic places before the liberals sell them to the commies."

"Sigh. Ain't love swell?"

"Yeah. Swell."

SANDY BROWNLEE

Miss April 16th through the 30th, Sandy Brownlee, a transfer student from Wisconsin State University at River Falls, is an education sophomore. She would like to teach language in high school.

Miss Brownlee has been on Donaldson's Teen Board and is currently attending modeling class. She hopes eventually to work for the House of Dior, Oleg Cassini, Rudi Gernreich, or the House of Barney (a local firm).

Sandy enjoys art shows (not movies), skiing, and ballet. Miss Brownlee describes her ideal date as intelligent, not necessarily good-looking, and a fellow who is able to communicate. She didn't specify any topics. A topic of interest, important to our readers is the following set of dimensions: 8.65×10^5 microns, 3.73×10^{-12} astronomical units, and 0.1147 (perches)$^{1/3}$.

Professor Algebra's Garden

The other day Professor Algebra had several friends in to see his garden, of which he is justly proud. In a rather small space he had developed several new strains of tomatoes and at the same time had grown a large variety of flowers of such quality that they had been awarded many blue ribbons.

As would be expected, everything about Professor Algebra's garden has an integral length in feet. The garden proper is a square surrounded by a paved walk on each side. These four walks are all different widths (all widths of the walks and sides of the garden proper are, as said before, an exact number of feet). There is a sundial in the center of the narrowest walk, the next wider walk is one foot wider, the next still another foot, and the widest is still one more foot wider. The entire lot, gardens and walks included, is again a perfect square with sides an exact number of feet in length.

If the area of the entire square lot is six-hundred-twenty-one more square feet than the area of the square garden, how wide is the strip of walk on the side opposite the sundial?

This is the third of a series of problems which have been appearing in the *Technolog* during Winter and Spring Quarters. Answers may be obtained from *Gopher* salesmen who will be easily identified. Students may also obtain the answers, and buy their *Gophers*, at the *Technolog* office, Room 2, Mechanical Engineering Building.

*Copyrighted. Oswald Jacoby and Wm. H. Benson, *Mathematics for Pleasure*, McGraw-Hill Book Co., Inc., New York, 1962.

ELECTIONS

TECH COMMISSION

The following one-year positions on Tech Commission, the I.T. Student governing board, are now available.

Members-at-large:

Sophomore	*one position*
Junior	*one position*
Senior	*two positions*

TECHNOLOG BOARD

The Minnesota Technolog Board two year positions are available.

APPLY Rm E-133

DEADLINE WED., APRIL 28, 4:00 pm

FILING FOR ST. PAT

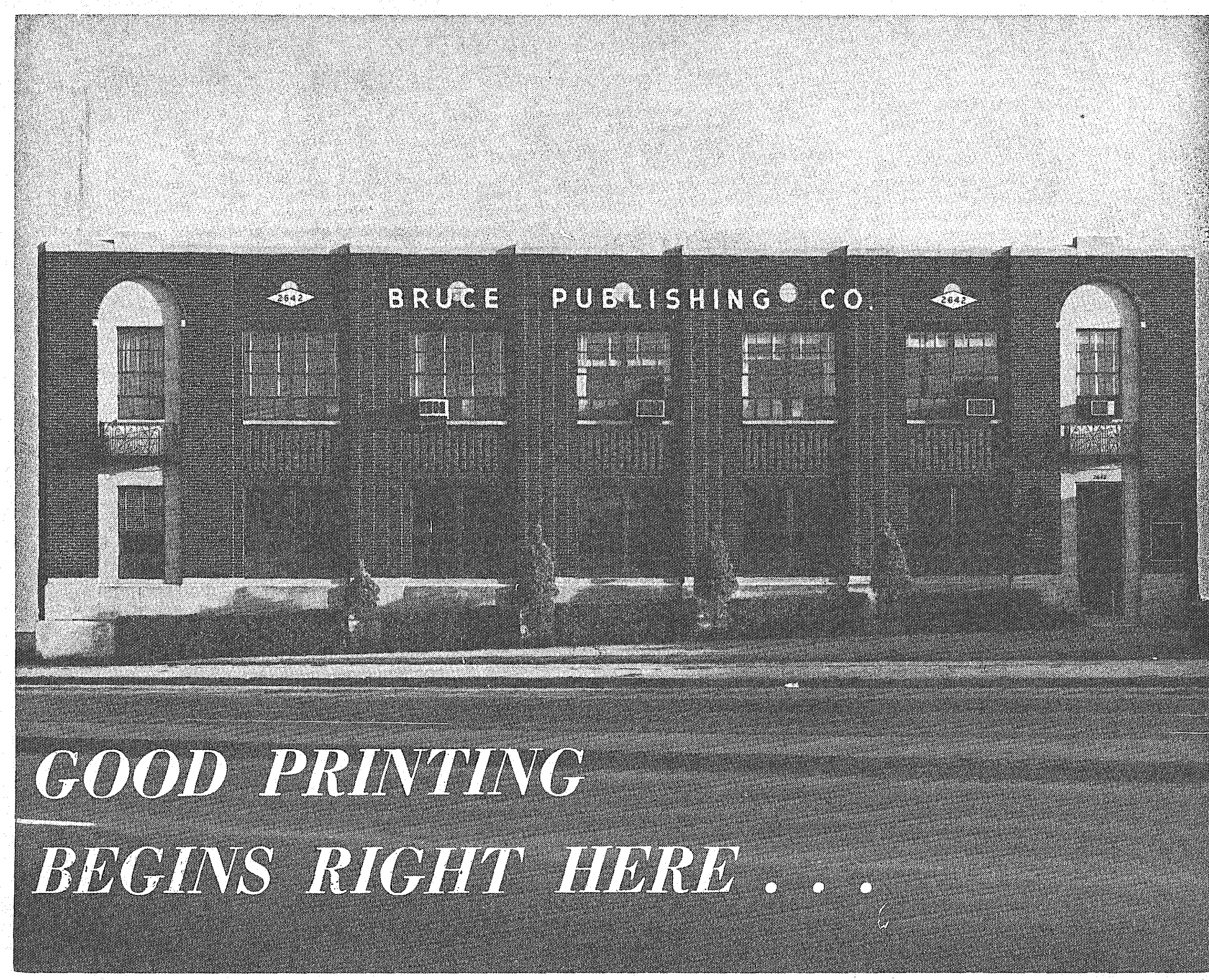
Anyone qualified for the honor of being crowned St. Pat on E-DAY should file in 133 Main Engineering before 4:00 pm, Friday, April 23.

Qualifications:

1. *Must be an I.T. SENIOR*
2. *Must have made outstanding contributions in I.T. extra-curricular activities.*

MSA

All parties interested in applying for the I.T. positions in the Minnesota Student Association should apply in Rm E-133 by Wed., April 28, 4:00 pm.



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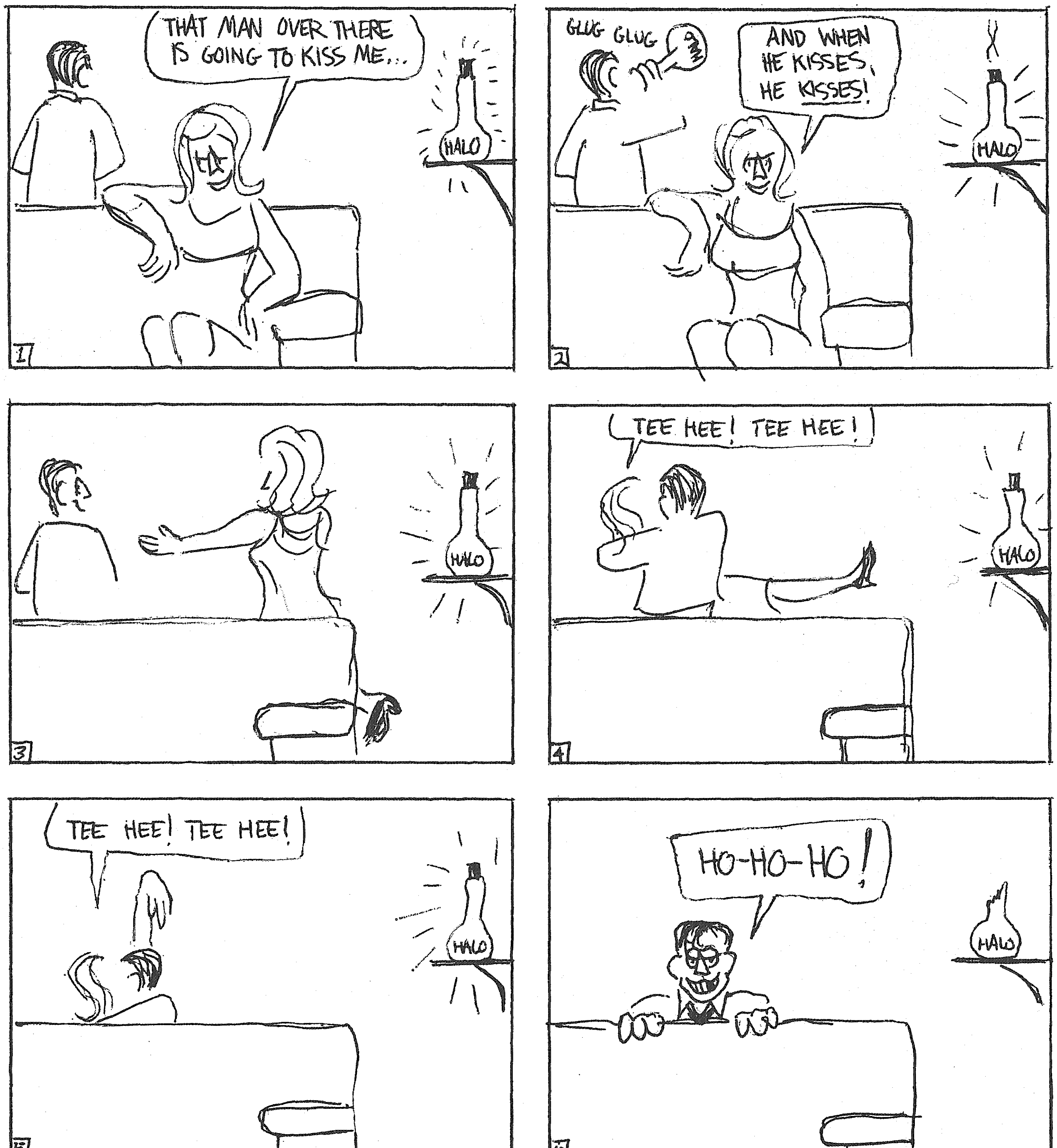


SAWDUST From the Log

Larry: "I saw a policeman chase a crook through a store."

Harry: "Did he catch him?"

Larry: "No, he stepped on a scale and got a weigh."

• • •

Good advice is—don't give any.

• • •

A cadet staggered into the Latin Quarter one night and in a loud voice yelled, "When I drink, everybody drinks!" He summoned everyone to the bar — the musicians, hatcheck girls, waiters, and guests. Everybody took a drink. When he finished his whiskey, he yelled again, "When I take another drink, everybody takes another drink." Once more everyone gathered around the bar. They even called in the taxi drivers, doormen, and a cop from the corner. When he finished that one, the cadet took a dollar out of his pocket and slapped it on the bar. "When I pay," he screamed, "everybody pays."

• • •

Coed: "Do you think I'm conceited?"

M.E.: "No, why?"

Coed: "Girls who are as good looking as I am usually are."

On examining the man's luggage, the customs officer discovered a full bottle of whiskey. "I thought you declared you had only wearing apparel in this baggage?"

"Sure and that's true," replied the traveler. "That's my night cap."

• • •

Friend of ours got a telegram lately which certainly gave him a thrill. The message read:

"Married Bessie yesterday in Miami. Going to Tampa with her tonight."

• • •

"I've been married four times. Do you think I'm a loose woman?"

"No, dearie, just a busy-body."

• • •

"Where you goin', Clem?"

"Town."

"What'sa matter with the wheelbarra?"

"Broke."

"Who broke it?"

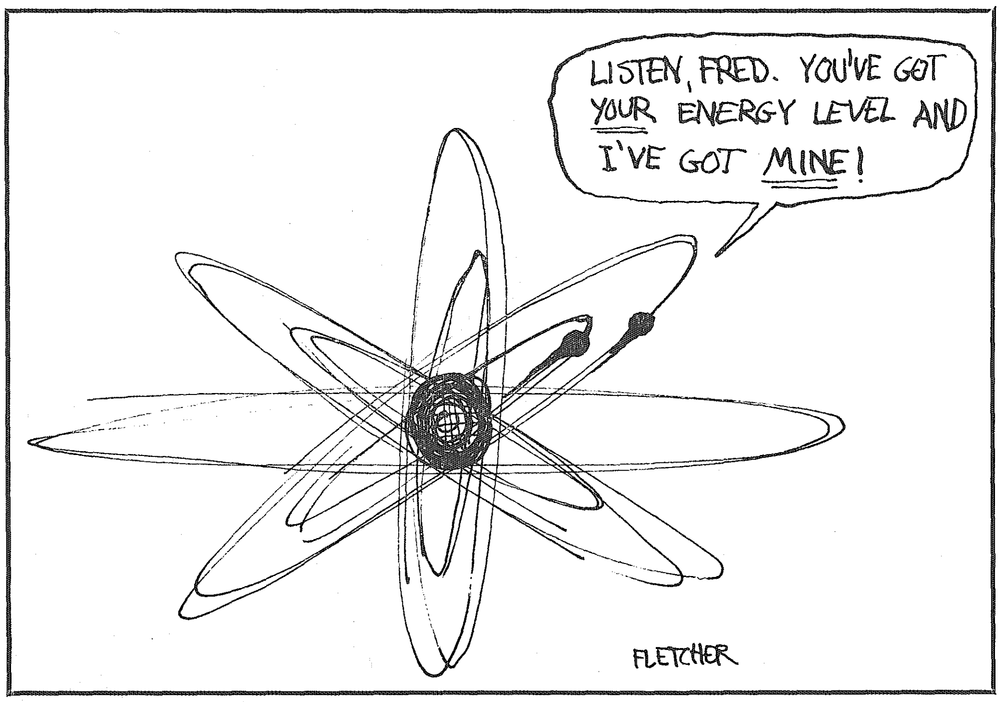
"Hired man."

"Same hired man got your daughter in trouble last month?"

"Yep. Clumsy, ain't he?"

• • •

I drove my car with one hand and my girl friend wild with the other.



Two co-eds were discussing their favorite subject: men. "If I came home and found an Engineer in my apartment, I wouldn't know what to do!" gasped the Freshman. "You could give him forty-eight hours to get out," replied the Senior.

• • •

An old maid is a gal who knows all the answers but is never asked the question.

• • •

A beatnik ran a red light, the cop pulled him over and said, "Didn't you see that red light?" The beatnik replied, "Like man, I didn't even see the house."

• • •

A Texan had a small farm with just a few sheep. One day his wife, while dyeing some bedspreads blue, had a little lamb fall into the bucket of dye. A passing motorist saw the lamb with the blue fleece and bought it for $50. So the Texan figured he had a good thing going and colored some more lambs which brought big profits.

"Pretty soon," he recalled, "I was coloring them pink, blue, yellow, and green and you know—now I'm the biggest lamb dyer in Texas."

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Famous Last Words

"God help those who do not help themselves."

"Marriage is love parsonified."

"Early to bed and early to rise makes a male healthy, wealthy, and dead."

"Don't trust first impulses—they are always good."

"Better belly burst than good liquor be lost."

"All men are equal after you make them."

"Brevity is the soul of lingerie."

"The reason for much matrimony is patrimony."

"To reach the source, you have to swim against the current."

"Women should be obscene and not heard."

"A new groom sleeps keen."

"Man has only two primal passions; to get and to beget."

"Familiarity breeds contempt—and children."

"One man's folly is another man's wife."

"Abstinence makes the heart go wander."

"Virtue is insufficient temptation."

"When I drink I think; and when I think I drink."

"Many a girl has gotten into trouble by obeying that boyological urge."

"A lie in time saves nine."

"A woman is never too old to yearn."

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ENGINEER'S BOOKSTORE
Main Engineering

This is one of our mechanical engineers making a mistake

They are to wed in June, and the guy had better shut up before she gets miffed. A gal has every right to resent the implication that the betrothed outpoints her in understanding of sewing and fabrics and what's good or bad about them. Even if it's true. Which it is. We have made him a pro at it.

It is our crafty intent to stop at nothing in our efforts to make garments or fabric furnishings that carry our identification tag (as for KODEL Fiber) so pleasing to the ultimate buyer in every way that she will attribute the satisfaction all to the fiber and look for that tag evermore. This means we put mechanical engineers, chemical engineers, chemists and—yes—physicists to work freshening up the technology of dyeing, knitting, weaving, sewing, and the other elderly arts practiced not by us but by our customers' customers.

As in all the other industries in which we participate and for which we seek scientific and engineering recruits—photography, information retrieval, aerospace, plastics, graphic arts, x-ray, chemicals—there is much to challenge the intellectually ambitious in satisfying the common yearnings of mankind for adornment of the person and the home. Past technical accomplishments in fibers and fabrics, weak by comparison with what can be anticipated when fresh, better informed minds pitch in, have sufficed nonetheless to create the present affluence where there is plenty of money on hand to do what smart people will tell us to do. All we need are more smart people.

Drop us a line. From polymer theory to workable yarn and from workable yarn to clothes on the back, rugs on the floor, and curtains on the windows extends a long row of assorted disciplines and aptitudes.

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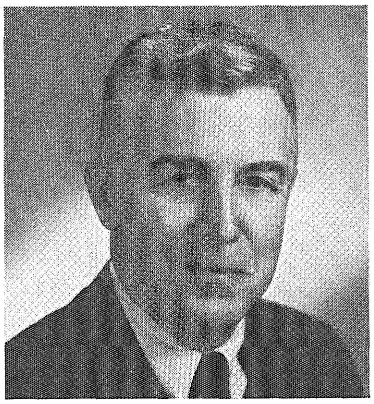
Should You Work for a Big Company?

An interview with General Electric's S. W. Corbin, Vice President and General Manager, Industrial Sales Division.



S. W. CORBIN

■ Wells Corbin heads what is probably the world's largest industrial sales organization, employing more than 8000 persons and selling hundreds of thousands of diverse products. He joined General Electric in 1930 as a student engineer after graduation from Union College with a BSEE. After moving through several assignments in industrial engineering and sales management, he assumed his present position in 1960. He was elected a General Electric vice president in 1963.

Q. **Mr. Corbin, why should I work for a big company? Are there some special advantages?**

A. Just for a minute, consider what the scope of product mix often found in a big company means to you. A broad range of products and services gives you a variety of starting places now. It widens tremendously your opportunity for growth. Engineers and scientists at General Electric research, design, manufacture and sell thousands of products from microminiature electronic components and computer-controlled steel-mill systems for industry; to the world's largest turbine-generators for utilities; to radios, TV sets and appliances for consumers; to satellites and other complex systems for aerospace and defense.

Q. **How about attaining positions of responsibility?**

A. How much responsibility do you want? If you'd like to contribute to the design of tomorrow's atomic reactors—or work on the installation of complex industrial systems—or take part in supervising the manufacture of exotic machine-tool controls—or design new hardware or software for G-E computers—or direct a million dollars in annual sales through distributors—you can do it, in a big company like General Electric, if you show you have the ability. There's no limit to responsibility . . . except your own talent and desire.

Q. **Can big companies offer advantages in training and career development programs?**

A. Yes. We employ large numbers of people each year so we can often set up specialized training programs that are hard to duplicate elsewhere. Our Technical Marketing Program, for example, has specialized assignments both for initial training and career development that vary depending on whether you want a future in sales, application engineering or installation and service engineering. In the Manufacturing Program, assignments are given in manufacturing engineering, factory supervision, quality control, materials management or plant engineering. Other specialized programs exist, like the Product Engineering Program for you prospective creative design engineers, and the highly selective Research Training Program.

Q. **Doesn't that mean there will be more competition for the top jobs?**

A. You'll always find competition for a good job, no matter where you go! But in a company like G.E. where there are 150 product operations, with broad research and sales organizations to back them up, you'll have less chance for your ambition to be stalemated. Why? Simply because there are more top jobs to compete for.

Q. **How can a big company help me fight technological obsolescence?**

A. Wherever you are in General Electric, you'll be helping create a rapid pace of product development to serve highly competitive markets. As a member of the G-E team, you'll be on the leading edge of the wave of advancement—by adapting new research findings to product designs, by keeping your customers informed of new product developments that can improve or even revolutionize their operations, and by developing new machines, processes and methods to manufacture these new products. And there will be classwork too. There's too much to be done to let you get out of date!

FOR MORE INFORMATION on careers for engineers and scientists at General Electric, write Personalized Career Planning, General Electric, Section 699-12, Schenectady, N. Y. 12305

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MAY 1965

What's down under the sea? Hostile submarines? New food sources? Biological wonders like the archaic coelacanth fish? ¶ In many ways, we know more about the surface of the moon than we do about the sea around us. The sea guards its secrets in darkness, with pressures that crush steel like an eggshell. Radio waves that put us in touch with the stars can penetrate less than 100 feet of its depth. ¶ Westinghouse scientists are helping to unravel the sea's mysteries by perfecting new precision instruments for measuring salinity, acoustics, currents, pressures, sea floor contours. ¶ Westinghouse was the first to develop centralized engine room control for oceanographic ships, a development that will help make hydrographic and oceanographic surveying faster and more accurate than ever before. ¶ New undersea propulsion methods under investigation at Westinghouse involve fuel cells, thermoelectric generators, thermionic converters, cryogenic propellants. Strange words, strange world. ¶ For more data concerning a challenging career at Westinghouse, an equal opportunity employer, see our representative when he visits your campus, or write L. H. Noggle, Westinghouse Educational Center, Pittsburgh, Pa. 15221.

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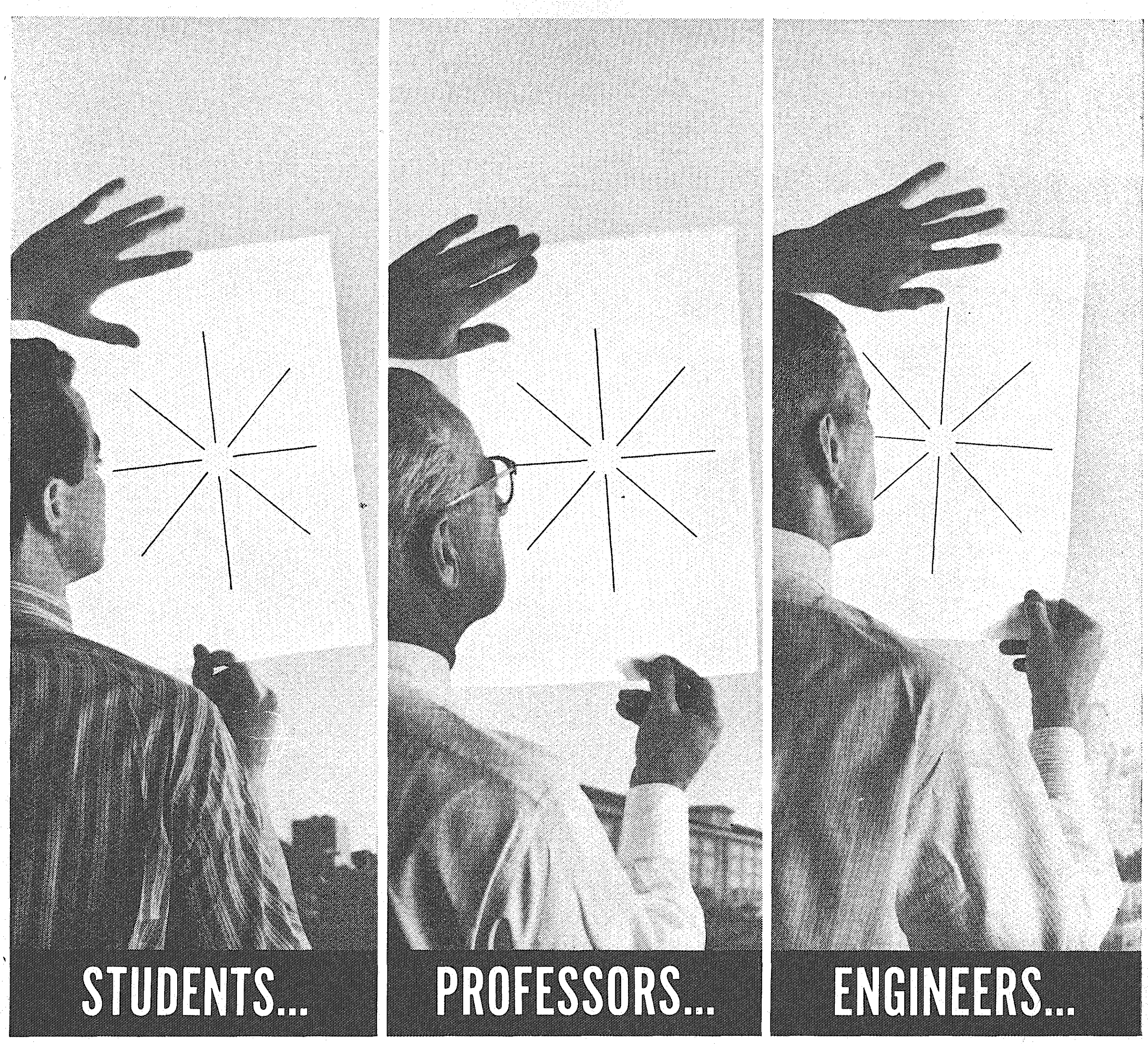

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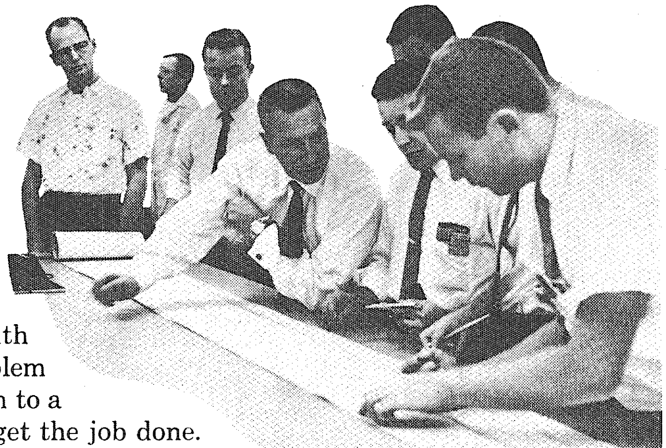

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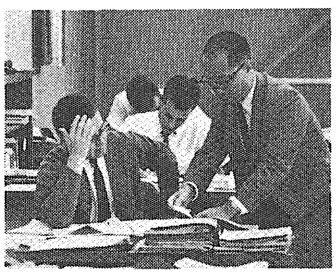

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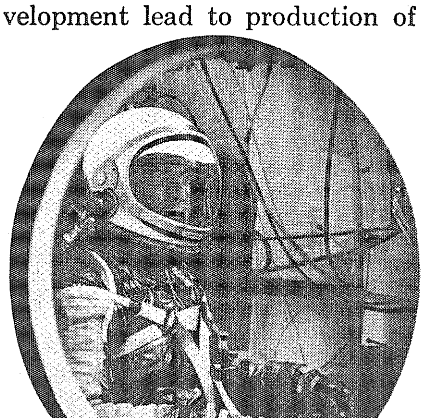

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Official Student Publication of the Institute of Technology, University of Minnesota

Cover: Faithful IT students gently toss Paul from the top of the Experimental Engineering Building.

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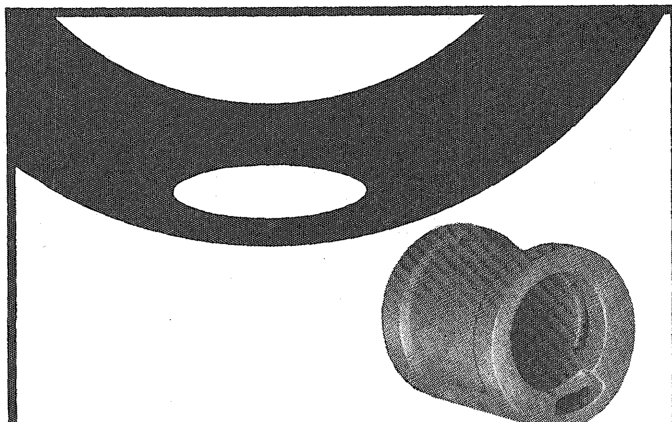
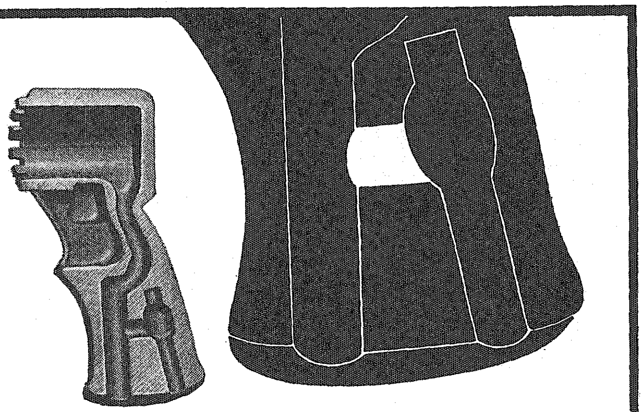
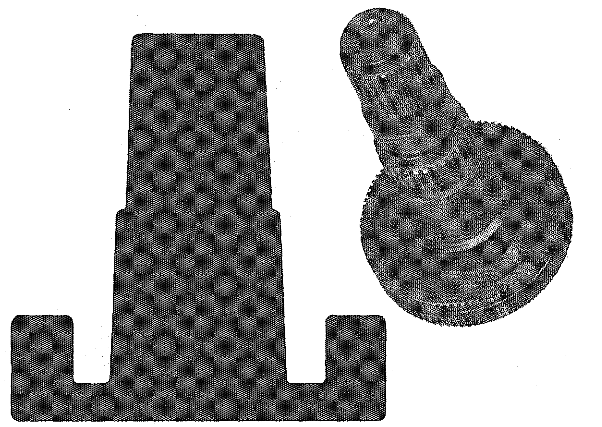
Unusual Shapes Cost Less To Produce When They are Malleable Castings.



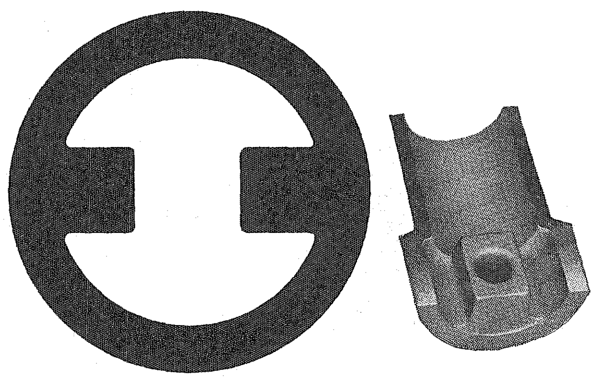
Elongated Holes
Round holes? Simple! Odd-shaped holes? Use Malleable! Here's a shape where casting is the only economical solution . . . and only Malleable provides both the strength and easy machinability that are needed. Excellent wear resistance on the inside of this air tool cylinder is achieved by hardening the 53004 pearlitic Malleable up to Rockwell 58C.



Blind Holes
Blind holes present a situation where the only practical manufacturing method is casting. This example shows a cross-section of the handle of a pneumatic impact wrench. Shell coring produces the holes with such accuracy that only a few finish machining operations need be performed.



Deep Grooves
Deep grooves are real money-wasters in other forming methods . . . but not in Malleable castings. In this transmission gear, the switch to pearlitic Malleable cut material cost 15% . . . cut machining cost 25%.



Internal Bosses
Here is a shape that can cause real problems . . . except when it's cast of Malleable iron. The interior cavity, two bosses and the holes through the bosses are formed with a shell core. This method cuts cost 75% compared to welding several components. The Malleable casting looks better . . . achieves closer tolerances.

There are many ways you can do a better job at less cost with modern Malleable castings. Our new brochure, "Design Criteria for Malleable Iron Castings", tells how.
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Editorial

How Not to Teach Engineering

There ought to be a better way to teach young engineers.

Engineering education today is heavily slanted toward drudgery. Schools are doing their best to cram more and more into the curriculum. The thinking seems to be running somewhat as follows. Engineers must know about all fields of engineering, not just their own (four courses in ME, three in CE, two in drafting, etc.). They need a broader outlook on social problems (four additional liberal arts courses). They need more theory (six semesters of math instead of four, two extra courses in physics).

Exams should be harder, and there should be more of them, professors seem to be thinking. Engineering is expanding so that each course must touch on a wider range of topics than it used to. So additional books are assigned beyond the regular text for the course. And watch out, there will be a question on the quiz on the outside reading!

At the end of this grueling regimen, a bright young engineer appears. Hand him a problem and he immediately begins to scribble out dozens of remembered formulas (most of them not applicable) and to comb through numerous books that he recalls touched on this subject. He doesn't take the time to think out the problem to see if there is an easy way to reach a solution. He's too afraid that somebody is going to ask him a question, and he'd better sound knowledgeable. (Remember those surprise quizzes!)

This growing trend toward shoehorning more and more into the curriculum, without wiping out some of the extraneous material already there, seems ominous.

Already it seems that each generation of new engineering instructors tries to make up for the struggle that *they* had to go through to get a diploma. The increasing amount of material gives them even more ammunition to do it with.

It is interesting to note that Albert Einstein struggled through an experience like this at the Swiss Federal Institute of Technology. He didn't comprehend easily, and his note-taking was disorganized. He couldn't get up enough interest to concentrate on the variety of subjects he had to take. If it weren't for the assistance of a more disciplined and organized student at the school who helped him out in cramming for exams, he probably would have flunked out. Einstein later revealed that his technical school experience had such a deterring effect that he lost his taste for scientific problems for a year.

Could it be that cramming as many details as possible into a student's head might not be the best way to train engineers? Is it possible that all the formulas that must be memorized to pass the exam really do not constitute the heart of the subject matter?

If at the end of his schooling, a student is able to face a design task creatively and with the information he needs, then our present system is working. If not, a new way must be found.

Robert Haavind

Guest editorial reprinted by permission from *Electronic Design*, February 15, 1965.

SEPARATION OF

by JAMES N. LANG, *M.E. '65*

The liquefaction and subsequent separation of gases is of interest to many industries. For example, the missile and space programs are dependent upon sources of oxygen, nitrogen, hydrogen and helium. The space effort uses approximately 2,000 tons of liquid oxygen per day. All manufacturing concerns which use welding processes require large supplies of oxygen, helium, argon, and carbon dioxide. The food industry uses large supplies of liquid nitrogen to fast-freeze perishables and to maintain low temperatures in transportation vehicles.

The separation and purification of gases constitute the major industrial application of low-temperature processes. Almost all commercial oxygen and nitrogen, as well as all neon, argon, krypton, and xenon are obtained by the distillation of air. The bulk of commercial helium is obtained from helium-bearing natural gas by a low temperature process. Low temperature processes have been used commercially to separate hydrogen from coke-oven gas and other sources of impure hydrogen. The low-boiling point components of natural gas—methane, ethane, ethylene and others—are separated and purified by low-temperature distillations. Also, a start has been made in the commercial production of deuterium by distilling liquid hydrogen.

To better understand the following ideas, the theoretical ideal process for separating gases should be considered. Semi-permeable membranes could be used for the separation of oxygen and nitrogen. If it is assumed that a cylinder with pistons at either end contains n moles of a mixture of which xn are nitrogen and $(1-x)n$ are oxygen and that the pressure existing is one atmosphere, then the ideal gas laws are applicable. The partial pressures of the two components will be xp and $(1-x)p$ respectively, where p is the total pressure. The problem is to determine the least amount of work required to separate the mixture into its two components. Suppose that one piston is permeable to nitrogen only and that the other is permeable to oxygen only. If the pistons are moved slowly together, the end result will leave pure nitrogen on one side and pure oxygen on the other. The result is attained at the expense of a certain amount of energy. This energy can be minimized if the process is considered to be isothermal. The work to compress the components from their original partial pressures to the final pressures can be given by:

$$W = -\int_{P_1}^{P_2} pdv$$

It can be shown that to separate one mole of air into pure oxygen and nitrogen at 25°C would require 10.65 calories. This is equivalent to 9.3 watt hours per lb of oxygen.

The practical methods of gas separation do not approach this figure; however, it is interesting to compare the practical results with the theoretical optimum. A power consumption of 550 watt hours per cubic meter of 98% oxygen is required for the Linde-Frankl low-pressure oxygen plant. This is 175 watt hours per lb, or about 5.3 percent of the theoretical optimum.

Although this appears to be far from the ideal, the low temperature process still is the most efficient so far discovered for separating the components of air. The process consists of cooling the air until it is partially liquefied and then sending the mixture of oxygen and

GASES

nitrogen through a rectifying column which separates the low-boiling nitrogen from the high-boiling oxygen.

The operation of a rectifying column depends upon the different vapor pressures of the components of the mixture being treated. Thus when there is equilibrium between the liquid and vapor phases of the mixture, the lower-boiling component concentrates in the vapor phase. Figure 1 shows a phase equilibrium diagram giving the relations between the liquid and vapor phases of such a mixture. The upper curve in the phase diagram is the dew-point curve, the locus of temperatures at which vapors at various compositions start to condense. The lower curve depicts temperatures at which boiling of liquids of various compositions starts. For a given temperature at equilibrium, then, the upper curve shows the vapor composition and the point at the same ordinate on the lower curve shows the liquid composition. It is obvious that a simple evaporation will cause a partial separation; the vapor will be richer in the lower-boiling point component and the liquid will be richer in the higher-boiling point component.

The rectifying column is a device for cascading the effects of a large number of evaporations. A typical column has a boiler at the bottom; a number of plates, each holding a layer of liquid through which the ascending vapor is caused to percolate; and a condenser at the top where a large fraction of the vapor is condensed. The liquid thus formed trickles down the column. The plate contains perforations about 1/40 inch in diameter, small enough so that the rising vapor prevents the liquid from running through. The liquid level rises on each plate until the excess spills over and down to the next plate. A "theoretical plate" would achieve the complete equilibrium indicated by the phase diagram, and the rectifying column is usually considered, for discussion, in terms of the number of equivalent theoretical plates. In the ideal case, the vapor leaving a given plate is in equilibrium with the liquid on the plate according to the phase equilibrium shown in Figure 1. Also, the liquid on the next plate above will have the same composition as the vapor below. This implies that there is a definite temperature difference between the two, a difference just sufficient to maintain equal vapor pressure above the trays of liquids of different composition. This critical temperature and composition difference between the liquids on adjacent theoretical plates can be explained thus. If the upper of the two plates being considered should tend to get cooler, extra condensation of the rising vapor will warm it. If an excess concentration of the higher-boiling point component warms the plate, the lower-boiling component in the rising vapor will dilute the mixture, increase its vapor pressure, and therefore lower its temperature.

Referring to Figure 1, assume that saturated vapor of composition *a* is admitted at the level indicated. After steady operating conditions have been reached, the liquid on the plate above will have the same compo-

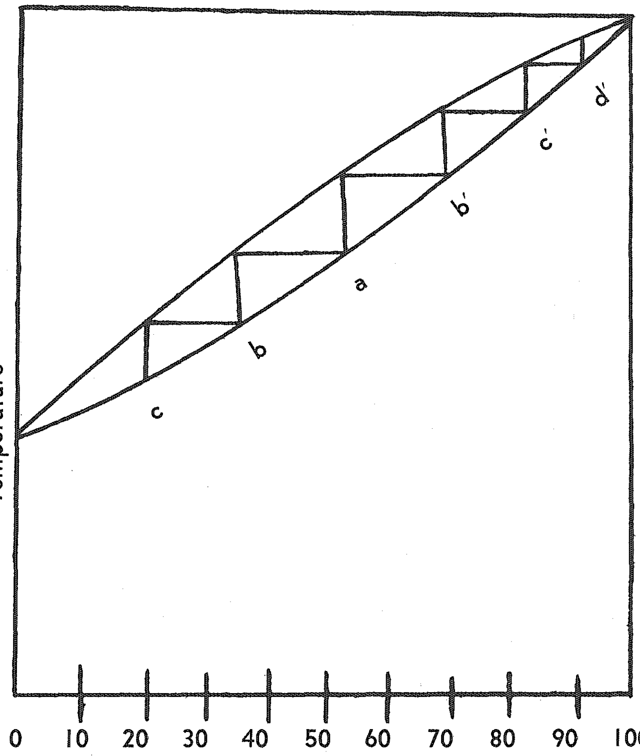

Fig. 1.
Liquid Vapor Phase Diagram

sition. The vapor above this next plate will have the composition of *b*, and so on. So, by adding more plates, we can approach as closely as desired to the completely pure low-boiling components. This same argument applies to the lower part of the column, going from composition *a* to *b'* to *c'*, etc.

The term purification denotes the removal of small amounts of objectionable components from the gas being processed. For example, water vapor and carbon dioxide are removed from air prior to liquefaction. In contrast to separation, the process which concentrates wanted constituents, purification removes and discards unwanted material.

Chemical methods of purification do not themselves involve low temperatures, but they are often used in purifying gases for liquefaction. Water can be removed by passing the gas over a dessicant, which takes up the

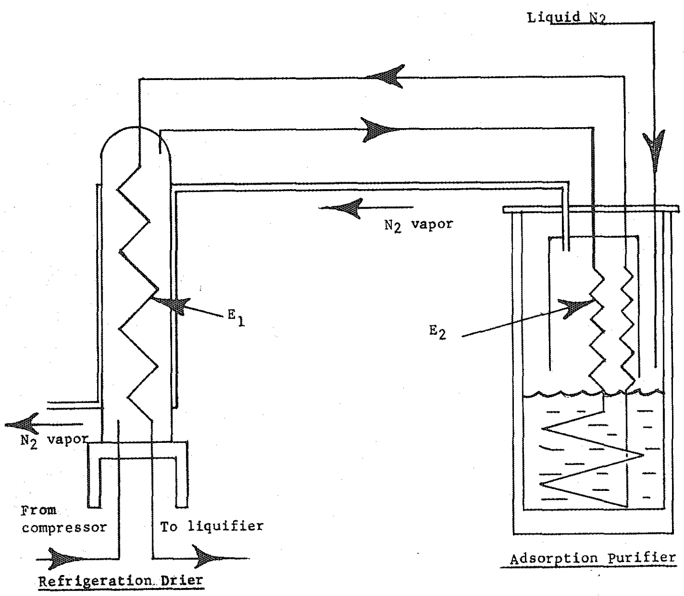

Fig. 2.
Refrigeration Purifier

water as water of crystallization. However, this method of drying has been replaced by other methods. The standard method of removing carbon dioxide from air has been to pass the air through a tower in which it is scrubbed with a countercurrent of a caustic solution such as sodium hydroxide. It is necessary to replace the caustic solution from time to time and this has prompted many plants to switch to refrigerative purifiers which require no replacements.

Oxygen is removed by having it react with the hydrogen to form water. Metallic nickel or palladium chemically deposited on an extended surface such as alumina is used as a catalysts to promote this reaction.

A hydrogen refrigeration purifier developed by W. F. Giauque is shown schematically in Figure 2. Here the refrigeration purifier is combined with a silica-gel adsorption purifier so that the liquid nitrogen which cools the silica-gel also provides the cooling for the purifier. Hydrogen at high pressure, containing water and oil vapor, enters the bottom of the strong insulated tube and passes through the heat exchanger E_1. The water and oil condense on surfaces of the progressively cooler heat exchanger tubes and drain away by gravity.

At a certain level the freezing temperature is reached (the "frost line") and from there up the water is deposited as ice. The thickest deposit of ice forms at the level where the freezing temperature is just reached because the amount of water vapor in equilibrium with the hydrogen decreases rapidly at lower temperatures. From the top of the purifier the hydrogen goes to heat exchanger E_2, where it is further cooled, and then flows through the silica-gel purifier, where nitrogen and other volatile impurities are removed. The returning pure hydrogen, still at high pressure, flows up through the heat exchanger E_2 and cools the incoming streams. The hydrogen then returns through the small tubes of heat exchanger E_1 and provides the cool temperature to condense the moisture on the outside of the tubes. The cold nitrogen vapor is routed through a third passage of heat exchanger E_2, and through tubes wound on the outside of the purifier.

After operating for some time the accumulation of ice begins to seriously restrict the passages and cause the pressure difference across the purifier to increase. At this time the hydrogen can be diverted to a second purifier while the first purifier is warmed until all of the ice melts and drains away.

In the process called adsorption, a layer of gas (having a thickness of one or more molecules) is condensed on the surface of a solid. Van Der Walls forces between the molecules of the solid and of the gas are believed to be the mechanism which causes adsorption. The molecules of the first layer are attracted most strongly and the amount adsorbed increases greatly as the temperature is lowered toward the condensing temperature. The heat of adsorption in the first layer is usually much greater than the ordinary heat of condensation of the gases, but becomes of the same order of magnitude when the number of adsorbed layers becomes large. There are certain substances, notably silica-gel, alumina-gel, and charcoal prepared from dense organic materials, that have a very porous structure, the pores being generally submicroscopic in size. Their effective surface areas are enormous, as much as several hundred square meters per gram, and they will adsorb large quantities of gas. Both the pore size and the total area of the pore surfaces play a part in determining the amount of a given gas that will be adsorbed at a given temperature and pressure. Adsorbents of this type are very useful in purifying gases because a gas near its condensation temperature is adsorbed very strongly. Thus, charcoal at 77°K will adsorb and remove nitrogen from helium or hydrogen. Figure 3 shows a qualitative representation of the concentration of nitrogen on hydrogen gas passing through an adsorption purifier.

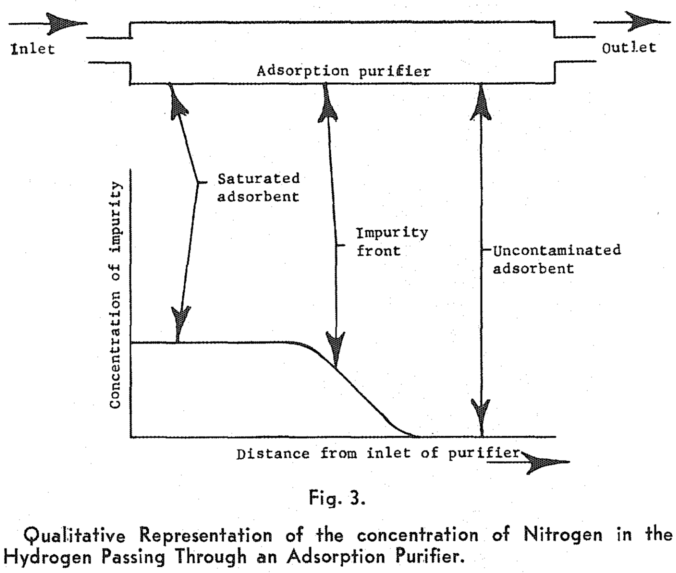

Fig. 3.
Qualitative Representation of the concentration of Nitrogen in the Hydrogen Passing Through an Adsorption Purifier.

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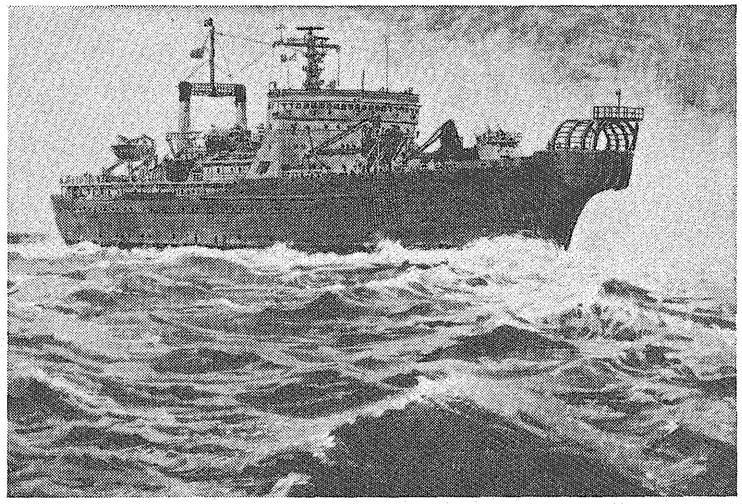

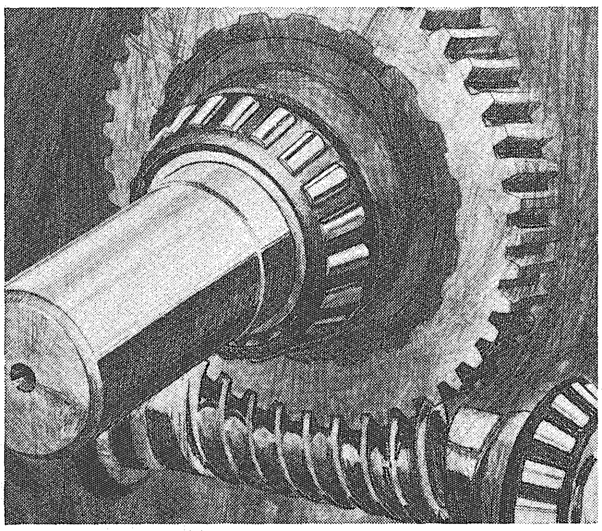

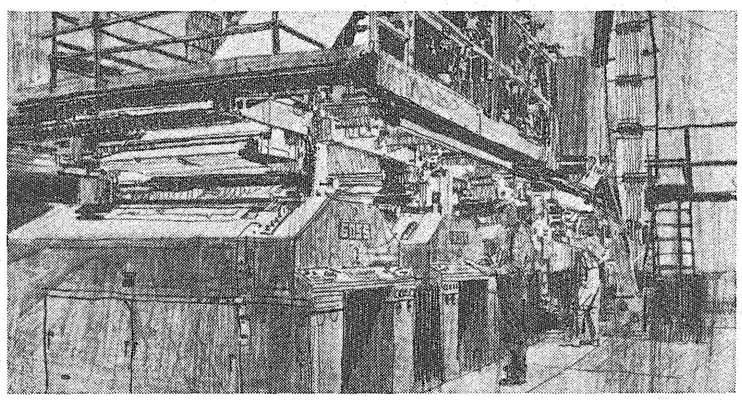

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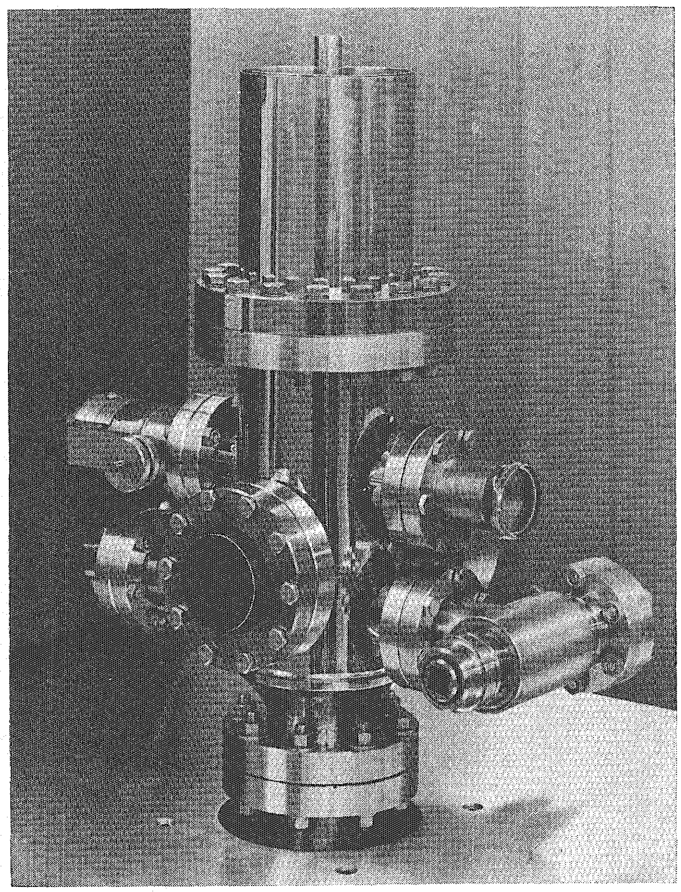
WHAT'S NEW *in Engineering*

edited by STEVE LINDFORS, *Physics '67*

Atomic Spy

The world's most powerful research microscope—the first that enables scientists to see atoms—was introduced recently at the 13th Annual Physics Show of the American Institute of Physics.

This microscope, which can discern objects as small as one-hundred millionths of an inch, will provide a whole new spectrum of information for physicists, metallurgists, chemists, and many other scientists, possibly even biologists and medical researchers. For example, scientists may be able to learn why metals rupture in missiles



and underwater vehicles, and more about the atomic structure of living matter.

More specifically, they will be able to study surface phenomena such as adsorption, catalysis, initial stages of oxidation, as well as surface irregularities, including grain boundaries, dislocations and vacancy complexes.

The only limitation for use of the microscope now appears to be that the specimen under study must be able to withstand intense electric fields, of the order of 100,000 kilovolts per centimeter. However, an improved version of the new microscope may be able to handle materials which ordinarily would not be thought of as capable of withstanding such an intense field.

To prepare the sample for this microscope, a wire two-thousandths of an inch thick is etched down to an ultra-thin needle point. The temperature of this sample is reduced to the temperature of liquid hydrogen (minus 258F.) to reduce atomic motion.

This cold specimen is then put in a high electric field so that charged particles aimed at the specimen will reflect from it. An inert carrier gas, such as helium or neon, is transformed to positively charged ions which are brought into the electric field. These ions are repelled by the atoms on the surface of the specimen. Thus the ions are thrown back at the fluorescent screen, where they depict the sample. A vacuum is maintained in this system so that no extraneous atoms will interfere with a true reflective path.

Earth-Maid Newspaper

An entire daily newspaper could be transmitted to the moon and reproduced from a single 8 by 10 inch film with absolute fidelity and resolution. Such a system could be used for transmission to ships at sea, aircraft, or even that sometimes longed-for desert island. New developments by the Du Mont Laboratories Divisions of Fairchild Camera and Instrument Corporation in the field of fiber optics (minute glass rod light pipes) have opened up completely new methods for highest quality facsimile transmissions and reception either on film or on the face of cathode ray tubes similar to television picture tubes.

Our astronauts are not yet on the moon, but if sports enthusiasts are among them, the very light-weight devices possible through new fiber optics shape converters would give them all the details and conjecture of basketball, football, baseball, or chess. And the female astronaut would keep up with the newest recipes and would have her skirts at the right length when she returned to earth.

In actual practice, the fiber optics shape converter, using a light source, scans the newspaper page or photograph and converts the intensity and configurations of light into electrical energy. This energy is then transmitted through the air or over cables to a receiver which incorporates a second fiber optics shape converter. The energy received by the receiver can either be used to portray a picture on a television screen or reconverted to optical energy and directed through the second fiber optics shape converter to expose photographic film.

TV From Coal, Not New York

At the Westinghouse Research Laboratories a standard television set is operating directly from a handful of powdered coal. Research engineers are using the experiment to demonstrate an experimental 100-watt fuel cell system which converts gases from the coal directly into electricity.

The gases extracted from the coal by the reactor are mainly hydrogen and carbon monoxide, which form when steam and carbon dioxide react with the hot coal in the unit. The gas mixture then flows to the fuel cell battery.

The experimental system consists of a fuel cell battery having 400 thimble-size fuel cells, plus a chemical reactor for producing volatile gases from the coal fed into it. Both the reactor and battery operate at high temperature—1800 degrees Fahrenheit.

In the battery, the gases flow upward through the pipe-like stacks of fuel cells. Here they make contact with the negative terminal (cathode) of the combination of cells. At the same time, heated air passes upward around the outside surface of the cells, where the positive terminal (anode) is located. Electrons are removed from the anode surface by the oxygen in the air. These electrons attach themselves to the atoms of the oxygen molecules, forming negatively charged ions. The ions move through the solid electrolyte and collect at the negative electrode. Here they combine with atoms

of the fuel gases, freeing the electrons that were picked up at the anode terminal of the cell. Such a movement of electrons constitutes an electric current.

To maintain its 1800-degree temperature, the fuel cell battery is housed in a heated oven. Cell systems of several kilowatts will generate enough heat to maintain this operating temperature without the aid of an external heat supply.

Concrete Becomes Magnet

Commuters someday may be riding over an elevated "magnetic" highway in cars without wheels. The concept of such a future wheel-less transportation system has been advanced by engineers of Westinghouse Electric Corporation.

The system would float the vehicle magnetically and drive it with an electric motor that has no rotating parts. Thus, the magnetic highway would take over the two basic functions of the wheel in transportation systems—supporting the vehicle and transmitting the power needed to make it move.

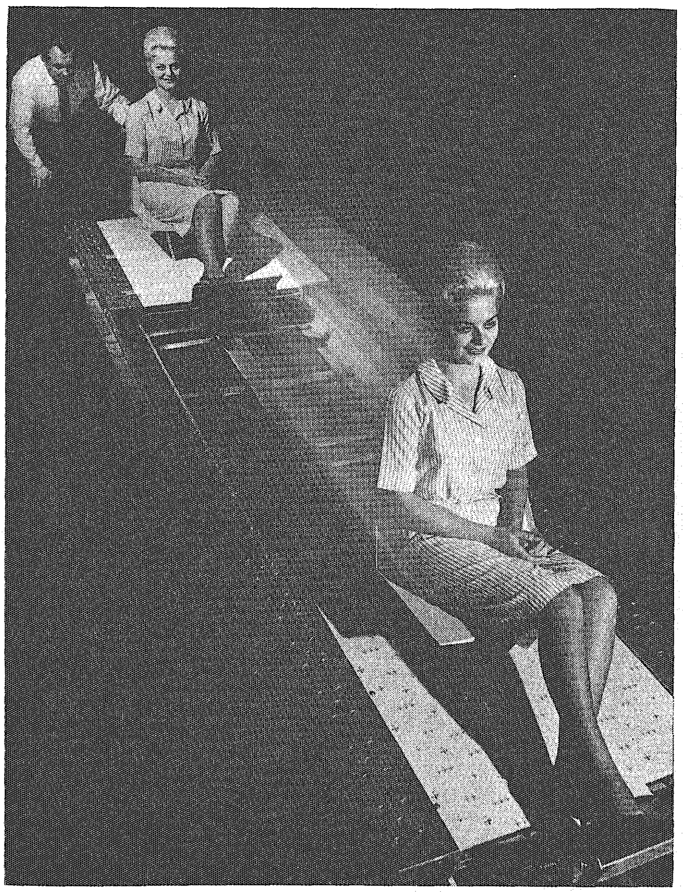
To demonstrate the principle of the magnetic suspension system, a small, one-passenger vehicle has been constructed at the Westinghouse Research Laboratories.

The laboratory test vehicle is supported by strong, ceramic-type permanent magnets placed lengthwise along the underside of the vehicle. Similar magnets, of the same polarity, form a double track beneath it.

Since magnets of like polarity repel each other, the experimental car floats about one-fourth of an inch above its magnetic track. There is no physical contact and, therefore, no friction between the vehicle and its magnetic rails. The vehicle simply "rides" on a layer of air.

Magnetic suspension would provide vehicles with excellent riding qualities; it would reduce propulsion power requirements; it would eliminate noise; and it would push land travel above 150 miles per hour.

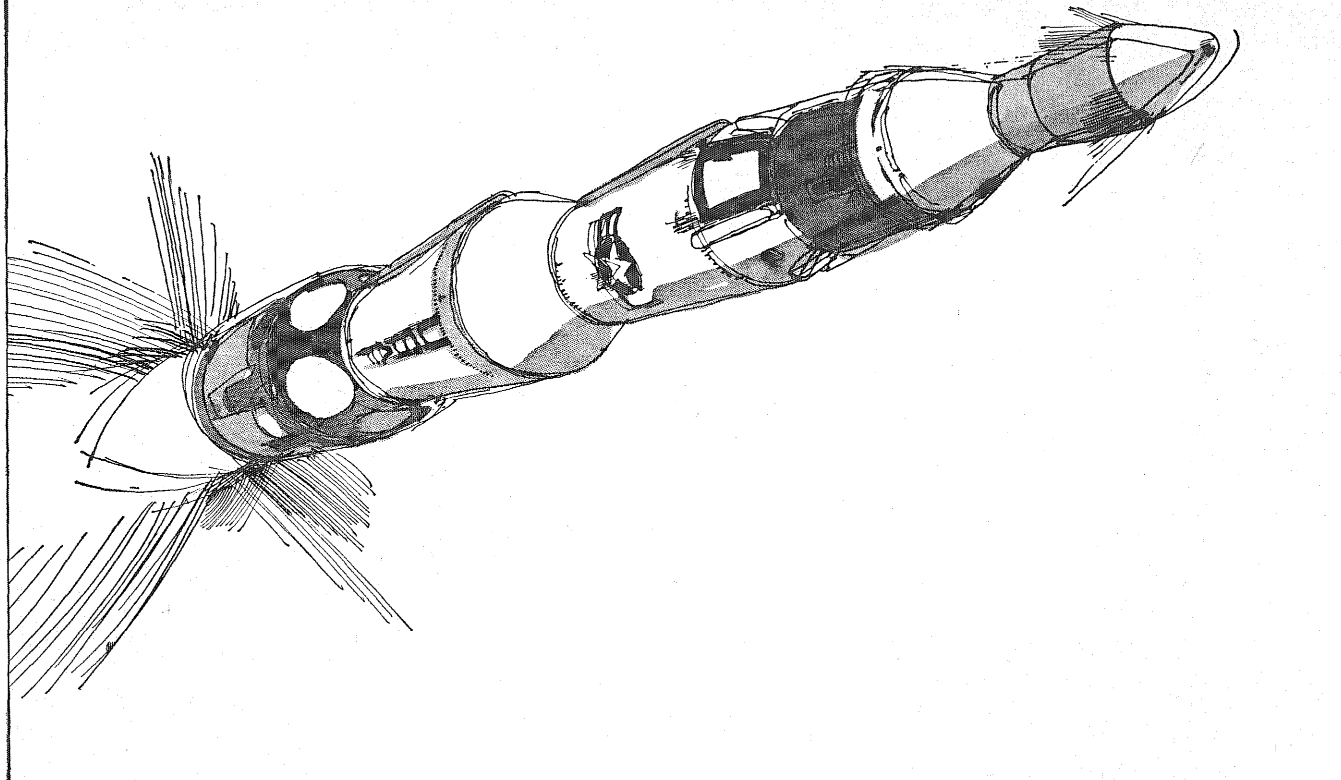
In a full-scale system, the vehicle would likely be suspended from overhead, instead of being supported



from below as in the laboratory test model. The magnetic suspension and electric drive thus could more easily be shielded from the weather.

The stator, which is the stationary part of any electric motor, would be stretched out lengthwise and would be mounted on the overhead roadway structure. The rotor, which ordinarily is made to rotate, would also be constructed in linear form and would be mounted atop the vehicle, directly beneath the stator. Electricity, flowing in the stator, would drag the rotor and the attached vehicle ahead, for the same reason that it spins the rotor in a convention electric motor.

In accompanying photo, Westinghouse secretary, Adrianne Tomasic, rides a small test vehicle which demonstrates how transit cars of the future will be magnetically "floated."



College graduates do key work right away on the Aerospace Team.
Lt. Gregory Risch, aeronautical engineer from Notre Dame, varsity swimmer, missile test expert, tells how you can be part of it.

(Lt. Risch, B.S. '62, did extensive undergraduate work in aerodynamics, helping to construct one of the country's largest and most successful smoke tunnels. He has played an important part in the operations of the test range at Cape Kennedy.)

What's the best way to become an Air Force officer?

I wouldn't want to call any one way the "best" way. We count on getting top-quality officers from all our sources. First, there's the Air Force Academy. I received my commission through Air Force ROTC. Many colleges and universities will soon be providing two-year AFROTC programs that you can apply for during your sophomore year. Then, for the college graduate, there's Air Force Officer Training School—OTS.

Who's eligible for Air Force OTS?

Any college graduate, male or female, or a college student within 210 days of graduation, is eligible to apply. Who the Air Force will take depends on what the particular needs are at the time. Those with scientific or engineering degrees can usually count on receiving the first openings.

Does the Air Force have jobs for nonscience majors?

There are quite a few jobs in nontechnical fields such as administration and personnel. And it is not essential that prospective pilots or navigators have backgrounds in the sciences. However, since the Air Force is one of the world's leading technological organizations, a keen regard for science is important.

What sort of work do young Air Force officers do?

Important work. An Air Force career gives young people the opportunity to do meaningful work right from the start. That's the thing I like best about it. I'm only a couple of years out of college, but already I'm working on a vital project in an area that really interests me. In other words, I'm getting to *use* the things I studied in college. My education is paying off, both for me and for the United States.

What are the possibilities for advancement?

They're plenty good. The Air Force believes in giving its young officers all the responsibility they can handle. That's not only good for you, it's good for the Air Force. It gets the best-qualified people into the top jobs where they can contribute most to our defense effort.

How long am I committed to serve?

Four years from the time you receive your commission. If you go on to flight school, four years from the time you're awarded your pilot or navigator wings.

Where can I find out more?

If there's an Air Force ROTC unit on your campus, see the Professor of Aerospace Studies. If not, contact the nearest Air Force recruiting office. It's listed in the white pages of the telephone book under "U.S. Government".

United States Air Force.

How about a friendly game of cards?

Watch out for our Gene Wollaston, though. He stacks the deck. In fact, he's already stacked 80 decks—of computer cards—to build a mathematical model to solve important refinery problems. With his special skills, Dr. Wollaston helps determine proper product yields and properties from key refinery operations. The final result should be an improved product—at a tremendous saving of time and money. (Once the model is built, the cost of solving a problem is as little as $3.00.)

So, as a card player, Gene's helping to take the gamble out of running a refinery. No mean accomplishment for a chemical engineer two years out of Illinois Institute of Technology.

You're not a card player? Don't worry. As long as you're looking for a meaningful challenge, your opportunity may be here at American Oil. We're also experimenting with fuel cells, spatial environment, and rust protection in car engines—to mention a few of our diverse fields of interest. Some of them may interest you, whether you're in Engineering, Physics, Chemistry, Mathematics, or Metallurgy.

You can find out by writing for more information. To J. H. Strange, American Oil Company, P. O. Box 431, Whiting, Indiana.

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SPLINTERS From the Log

by DAVID E. ENGEN, *Pol Sci '67*

The six-year-old had received a detailed lecture from his father on the facts of life, the birds, and bees, and simple biology. Papa leaned back at the end of the recital and said, "Now if there is anything else you want to know, don't hesitate to ask me, son."

The boy pondered a minute, then gravely asked his father, "How come they put out the *Saturday Evening Post* on Wednesday?"

• • •

Kool-Aid: A charity for Beatniks.

• • •

"She's a new girl with us and just fresh from the country so we'll have to show her what's right and what's wrong," said the engineer to his assistant.

"Very good sir," replied the assistant, "you show her what's right."

• • •

Conscience gets a lot of credit that belongs to cold feet.

• • •

Young girl at the perfume counter, after looking at My Sin, Breathless, and the other lurid names: "Have you anything for a beginner?"

• • •

Angry wife: "One of the ducks you were out shooting yesterday called and left her number."

• • •

"Son, I know a man who doesn't drink, smoke, or chase women and he just celebrated his 100th birthday."

Small son: "How?"

• • •

Men do make passes at girls who wear glasses . . . it all depends on their frames.

• • •

A father was trying to point out the advantages of a good clean life to his son.

• • •

The dean of women at a very well known university recently began a speech to the students with these memorable words:

"The president of the University and I have decided to stop petting on campus . . ."

A Shevlin Hall dietician was heard complaining about the tastes of students. "Monday they liked it; Tuesday they liked it; Wednesday they liked it. Now all of a sudden, on Thursday, they don't like it!"

• • •

Sign over bar in a saloon: We accept resignations from Alcoholics Anonymous.

• • •

Goliath: "You are the meekest, shyest, puniest thing I ever saw. What are you stooping over for?"

David: "I'm getting a little boulder."

• • •

There's one consolation: if a girl doesn't like her own figure, she can always lump it.

• • •

Small boy to father: "Here's my report card and one of yours I found in the attic."

• • •

Who composed this sorority toast? "Here's to the land we love, and vice versa."

• • •

Strip poker is a game that begins according to Hoyle and ends according to Kinsey.

• • •

If a gal wants to wear slacks, she'd better make sure that the end justifies the jeans.

• • •

Overheard in Frontier Hall:

"Is she frigid? She thinks sex is just a German number."

• • •

Girl (in very dark car): "Take your hand off my knee. No, not you. YOU!"

• • •

The zipper is the undoing of the Modern girl.

• • •

Some girls are cold sober—others are always cold.

• • •

From Mankato State comes word of a new student organization called Students Anonymous. If you get a strong desire to study, call them, and they'll send someone over to drink with you.

Poor Benny was afraid of dying. No matter how much he tried to get used to the idea, he knew that someday he would have to die, and the thought of it terrified him.

So Benny sought out one of the most famous physicians in all of the world and told him that he would pay for all research expenses and would throw in one million dollars to boot if the doctor could find some way that Benny could live forever. Well, the doctor studied and studied, and finally came upon an old African ritual that promised eternal life. It consisted of merely drinking one quart of goose grease and hog fat, and promising simultaneously never to shave or get a haircut again. Naturally Benny jumped at this chance for eternal life, but the doctor warned him to be sure NEVER TO SHAVE OR CUT HIS HAIR, because if he did, he would turn into a Grecian urn.

And so, Benny went along with all the rules of the bargain, and for 200 years lived very very happily (and very very hairily). But as luck would have it, when Benny was two hundred and twenty years old (that restless age), he fell in love with a charming young girl who fell in love with him, and they planned their wedding date.

But this girl had a mind of her own and demanded that Benny get rid of that "terrible mop of hair and that awful beard." Since Benny was so healthy, he couldn't imagine such a ridiculous thing as turing into an urn, so he immediately set to work at trimming and clipping his head of hair. Unfortunately, the doctor's predictions held, and in less than a minute, Benny was not Benny at all, but a small Grecian urn, covered with hair.

Moral: A Benny shaved is a Benny urned.

• • •

By the way, what's a Grecian urn, anyway?

Now that I think about it, I s'pose it all depends on what he does.

* * *

My girl friend and I argue—she doesn't like the way I feel about her.

• • •

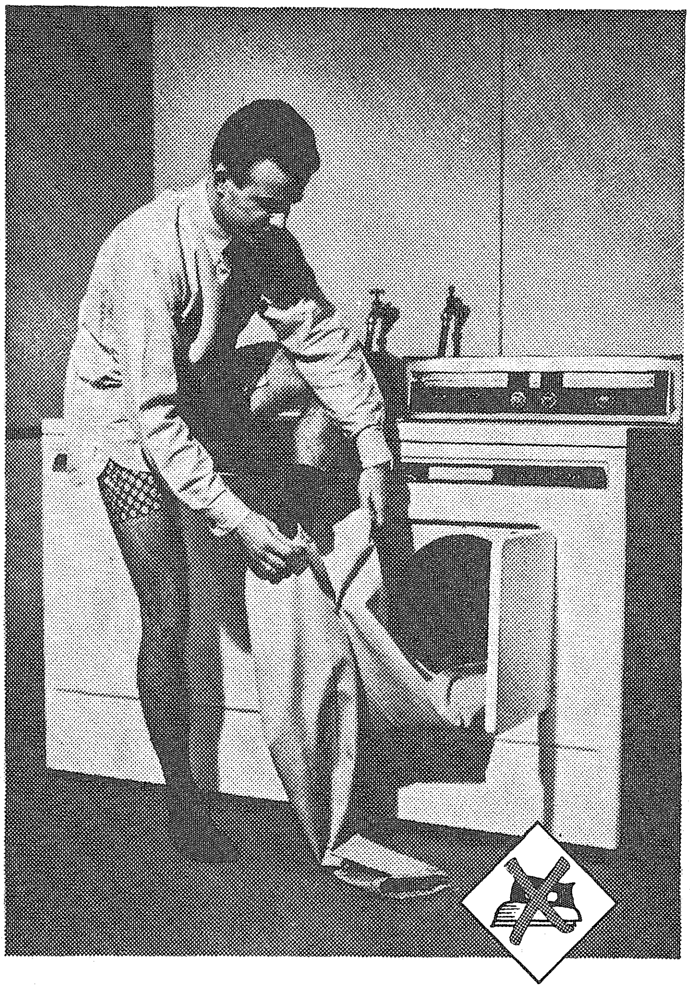
A lunatic was leaning out of the asylum and watching the gardener.

"What are you doing there?" he asked.

"I'm putting manure on the strawberries."

"I usually put sugar on them, but of course, I'm crazy."

Out of the dryer
...ready to wear!



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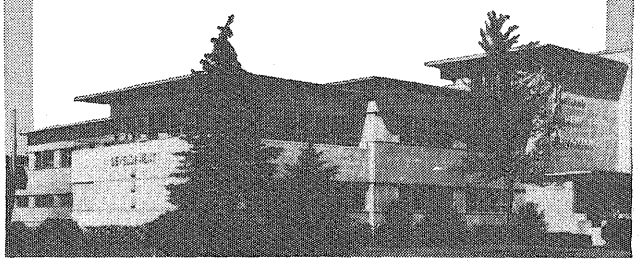

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MISS MAY

Photos by Gregory

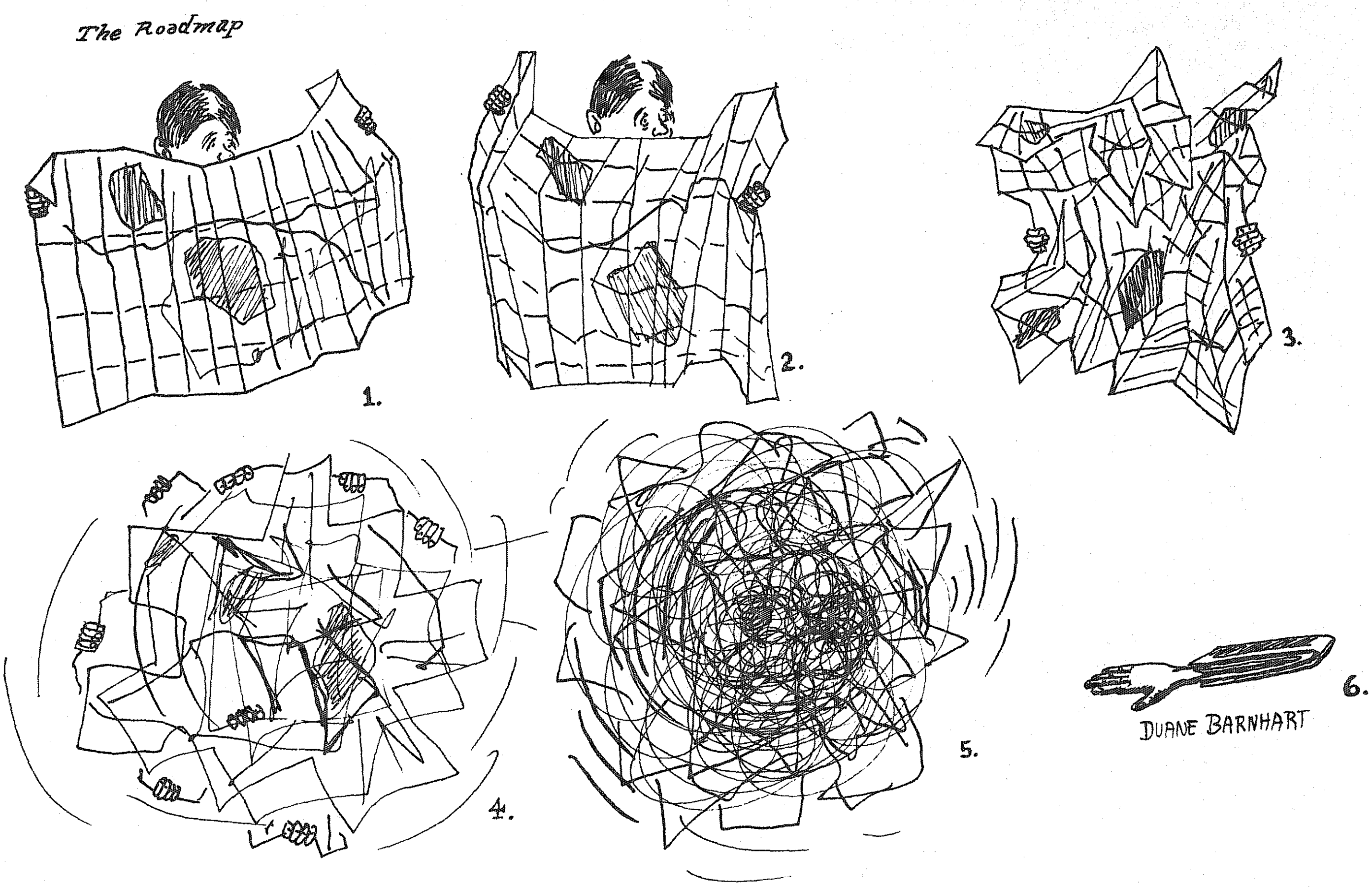
LESLIE MARSH

Miss Leslie Marsh, our contribution to bring out May flowers, is a graduate of Hopkins High (class of '63) and now a secretary with the Telex Corporation (acoustical products). Miss Marsh, however, does not have a quieting effect.

Miss Marsh enjoys water skiing, tennis, and outdoor sports in general. She loves fun, casual dates, but isn't wild about figs.

Leslie will soon be winging her way across the country (she's studying to become a stewardess) and serving coffee, tea, or milk. So fasten your seat belts and get ready to contemplate these numbers:

$$(1, 2, -2.33) \times (1, 36, -24.33)$$



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Lots of things are going on at Union Carbide. We're producing new alloys to re-surface equipment such as rock-crusher rolls and keep them in action longer. Other new alloys are helping the chemical industry stop costly attacks of acids and corrosives. And we've recently introduced some new silicone rubber compounds with greatly improved resiliency for use by the aerospace and automotive industries.

To keep bringing you these and many other new and improved products, we'll be investing half a billion dollars on new plant construction during the next two years.

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UNION CARBIDE

UP FRONT

by JEROME BRAUN, *Chem '68*

DR. JAMES HOLTE

Dr. James E. Holte is as interested in his students after graduation as he is now. This interest led him to become director of the University's Continuing Education in Engineering and Science Program. As director, he tries to correlate the needs of industry with the educational capabilities of the University.

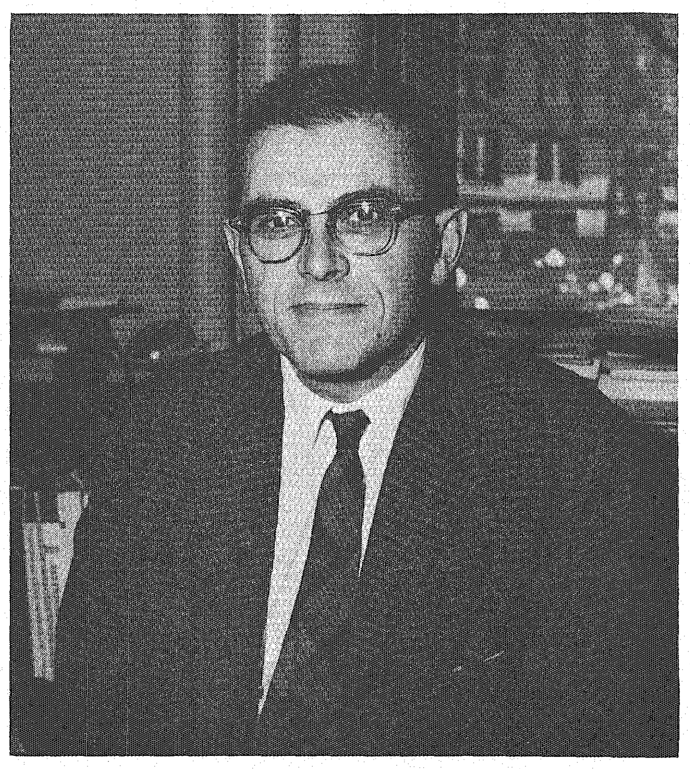
Dr. Holte was born in Grand Forks, North Dakota, in 1931. When he was twelve, his family moved to the Twin Cities where he attended Minneapolis South High School. He received his B.S. in 1953, his M.S. in EE (1955), and his Ph.D. in EE (1960)—all from the University of Minnesota. He presently teaches third year circuits courses EE 61-63, and is doing some research with microwave signal guidance.

This short, 5′5″, assistant professor who believes that "each program must be taylor-made to the individual," also finds time to enjoy woodworking, photography, and tennis. Lately, he, his wife, and their three children joined a health club where, among other things, he has taken up weight lifting.

Even though Dr. Stuart W. Fenton is Chairman of the Department of Chemistry, he is somewhat of an unfamiliar figure to most of the undergraduates in I.T. His time is spent almost exclusively managing the Department of Chemistry, doing research on the addition of oxygen to unsaturated organic compounds, and teaching organic chemistry at the graduate level.

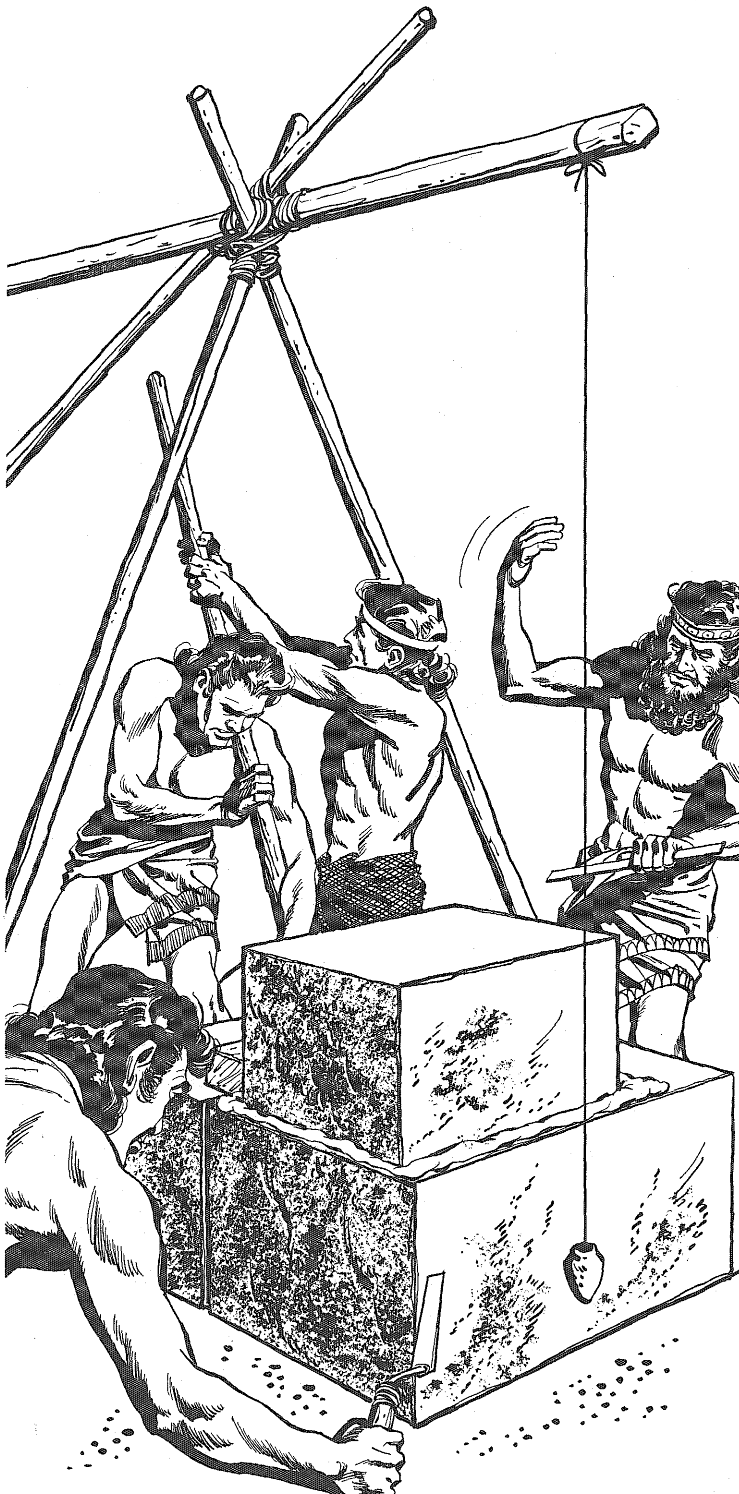
Dr. Fenton was born in London, Ontario, in 1922. He became interested in chemistry as he grew up in Ottawa. He then attended Queen's College in Kingston, Ontario, where he received his B.S. and M.S. degrees. His doctorate work in organic chemistry was done at Massachusetts Institute of Technology. A few years later, he joined the staff here at the University of Minnesota where he plans to remain.

Dr. Fenton is a member of several professional organizations of which the A.C.S., the A.A.A.S., and the Chemical Society of London are just a few. His leisure time is usually spent outdoors with his wife where they enjoy fishing, hiking, and racing his sailboat.



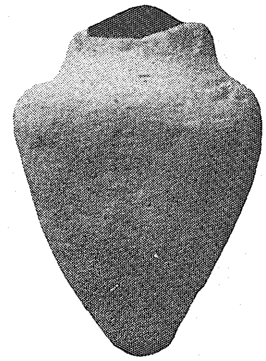
DR. STUART FENTON

"And we think we're modern"



DURING THE PAST HUNDRED YEARS, BUILDING TOOLS HAVE UNDERGONE SOME MAJOR CHANGES. TODAY'S TOOLS ARE INSTRUMENTS OF PRECISION..... EACH ONE DESIGNED TO DO THE JOB EASIER AND BETTER. BUT THERE'S ONE TOOL THAT HASN'T CHANGED IN OVER 5,000 YEARS..... IN FACT, EVEN IT'S SHAPE IS THE SAME AS IT WAS IN 3,500 B.C.

HOW DO WE KNOW THIS? BY THIS ANCIENT BABYLONIAN CLAY PLUMB BOB.



Students of the past have unearthed these clay plumb bobs in Iraq and in other parts of the world. With the help of this simple, yet accurate tool, Babylonians built some of the most magnificent structures of all times. Though the buildings have crumbled to dust centuries ago, the clay plumb bobs have withstood the test of time.

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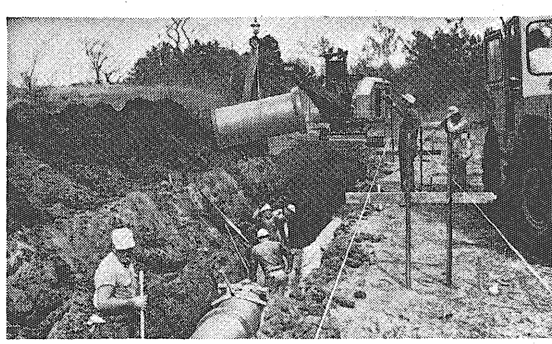

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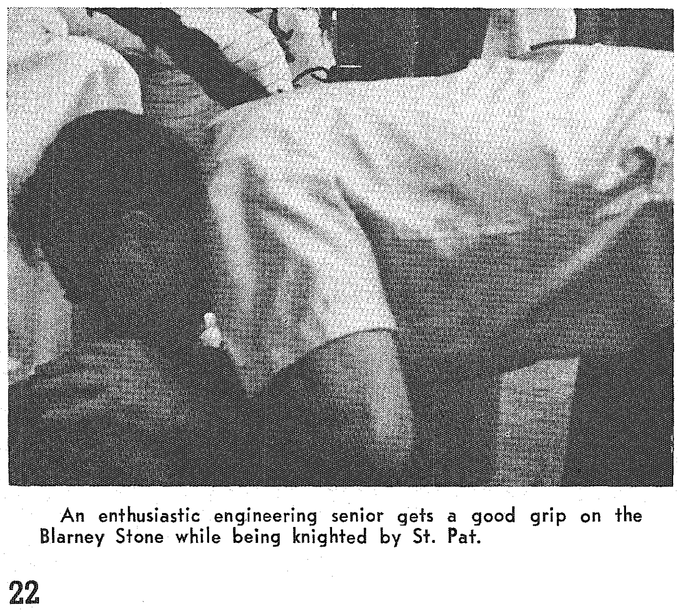
One of the fringe benefits of being St. Pat is being able to kiss Queen Colleen. This year's Queen is Jeanne Stine, a music education freshman sponsored by Triangle Fraternity. She is a member of Tri-Delta Sorority, University Chorus, and University Madrigal Singers. St. Pat for 1965 is Bob Nordstrom, a fourth-year electrical engineer. Bob is a member of Theta Tau, Eta Kappa Nu, Technical Commission, and Institute of Electrical and Electronic Engineers.

E - D

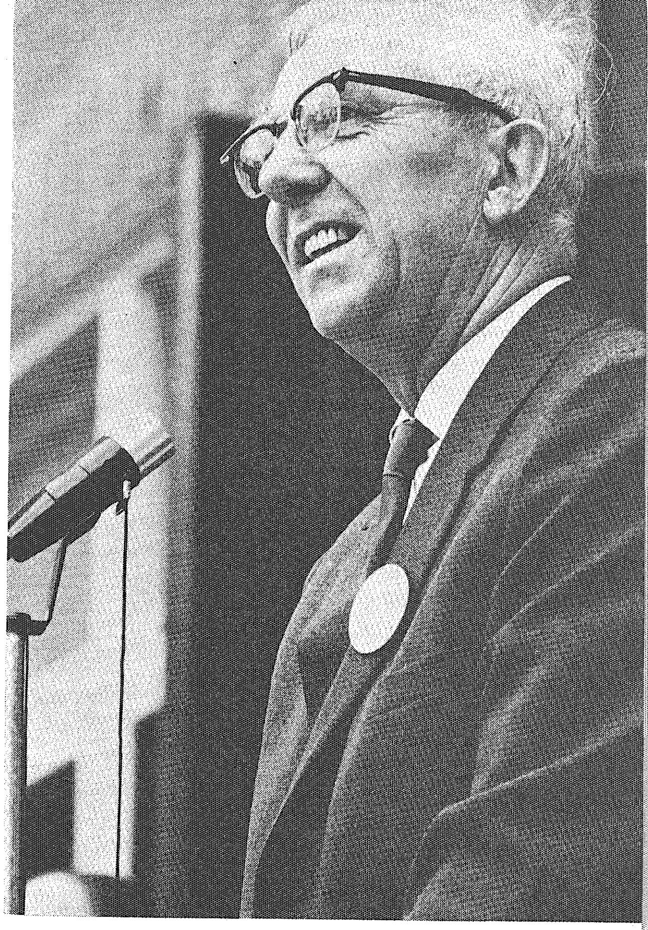
E-Day, accompanied by its usual *Blarney Castle* publications, picnic, queens, Blarney Stone, beer certificates, and brawl was celebrated for the 51st time here on campus. Of course, the traditional "Paul Bunyan kidnapping" event was a success but it may have been rather disastrous since Paul had an invitation to attend a dinner with Governor Rolvaag and the foresters the same evening. Fortunately, at least from the forester's point of view, he was able to attend both functions.

This year the shamrock was easily spotted by Jim Cheesebro with the help of the evidence provided by the "clear, unambiguous (!!??)" *Blarney Castle* clues. Jeanne Stine was crowned E-Day queen and was kissed, of course, by Bob Nordstrom, this year's St. Pat. The band at the brawl was especially conducive to increasing the number of marriages that occurred, hence, lots of people had fun until 2! . . . in case you aren't aware, the license expires at 2.



An enthusiastic engineering senior gets a good grip on the Blarney Stone while being knighted by St. Pat.

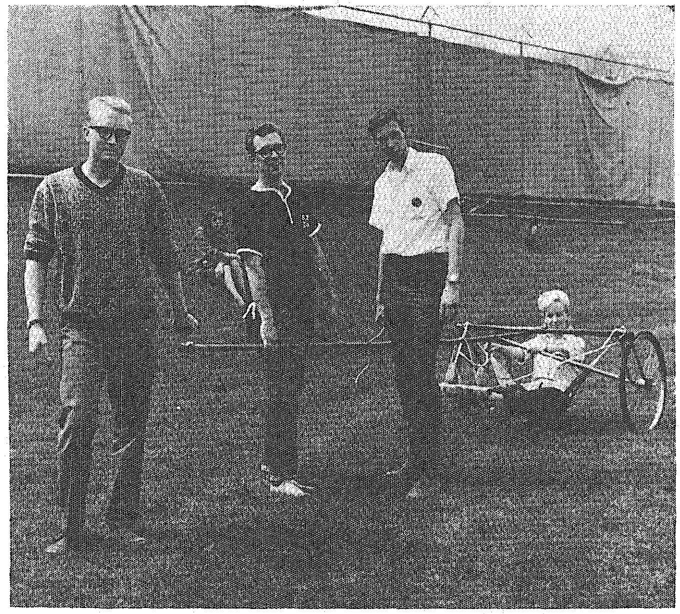
AY 1965



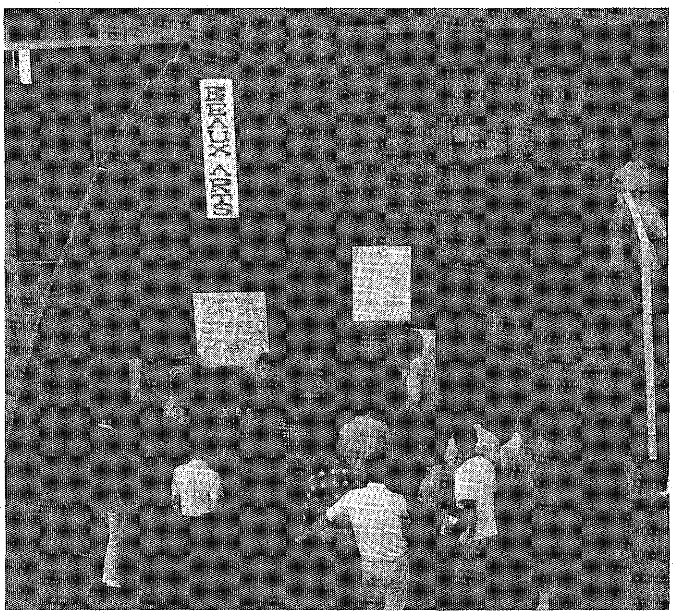
Dr. Ernst Eckert, recipient of one of the 1965 IT Distinguished Teaching Awards and the 1964-1965 Western Electric Excellence in Instruction Award.

Theta Tau First Place Float

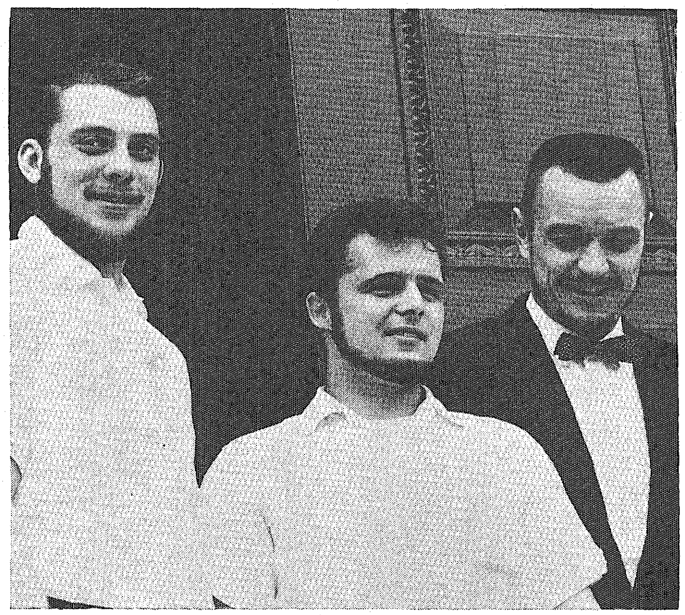
St. Pat, Bob Nordstrom and 1964 Queen Colleen, Cindy Barker



Kappa Eta Kappa Chariot with Horses and Driver

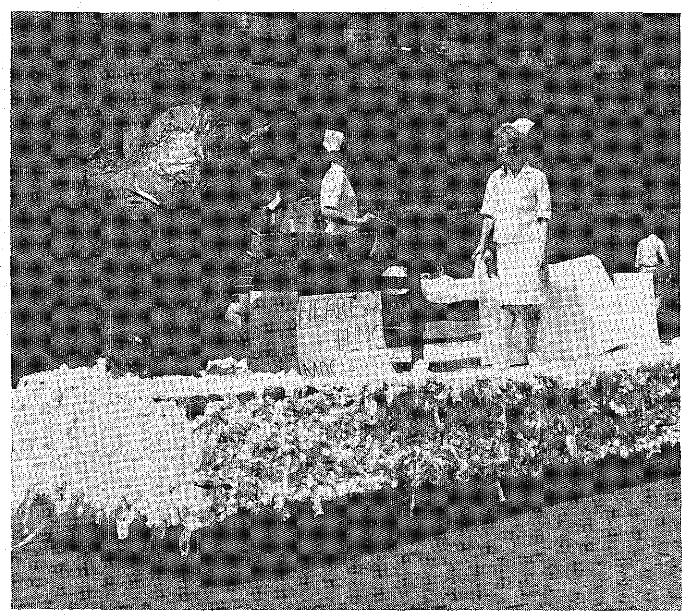


IEEE's First Place Open House Exhibit



First Annual Beard Contest Winners

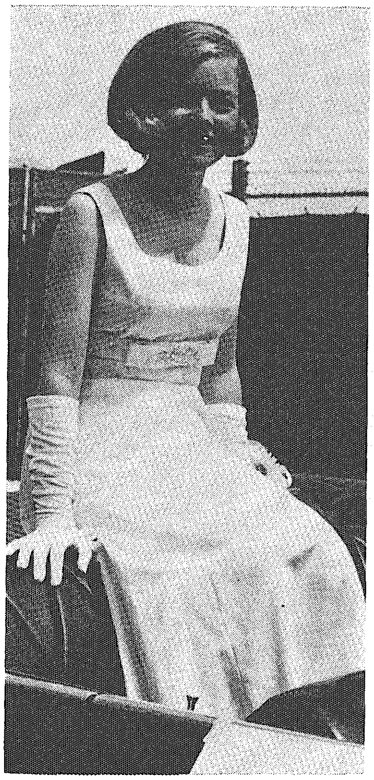
Plumb Bob and Friend



Kappa Eta Kappa Float

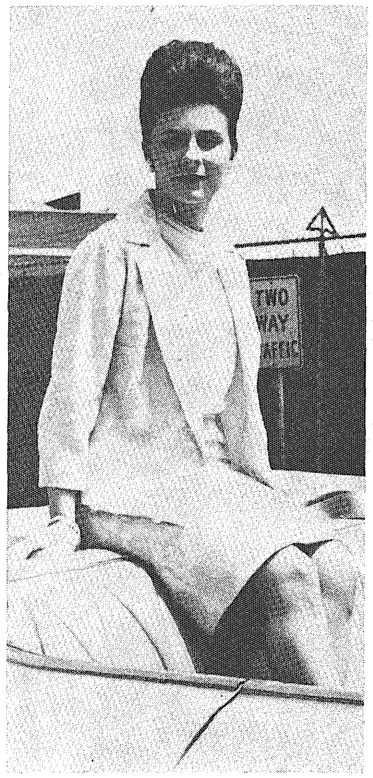
Pat Clemens,
AIIE Queen candidate

Jean LeVander,
KHK Queen candidate



Cathie Clemenson,
Theta Tau Queen candidate

Barb DeValerio,
Black Book Queen candidate



Tournaments, Parade, Open House, and All Participation Results

ALL PARTICIPATION

Societies	*Points*
1. IEEE	6089
2. ASCE	4283
3. MSPE	3682
Fraternities	
1. Theta Tau	8125

ALL TOURNAMENTS

1. Theta Tau
2. Alpha Chi Sigma
3. ASCE

BOWLING

1. Theta Tau
2. Alpha Chi Sigma
3. AIAA

High Individual:
Walter Brunner, Alpha Chi Sigma

BRIDGE

1. Theta Tau
2. AIAA
3. MSPE

CHARIOT RACE

1. Theta Tau
2. ASCE
3. Alpha Chi Sigma

GOLF

1. ASCE
2. Alpha Chi Sigma
3. AIAA

Low Individual:
Don Luka, Independent

PING-PONG

1. Alpha Chi Sigma
2. AIChE
3. Theta Tau

High Individual:
Herbert Franzen, Independent

SOFTBALL

1. Alpha Chi Sigma
2. Theta Tau
3. IEEE

TENNIS

1. ASCE
2. AIChE
3. AIME

High Individual:
Klaus Becker, ASCE

OPEN HOUSE

Societies

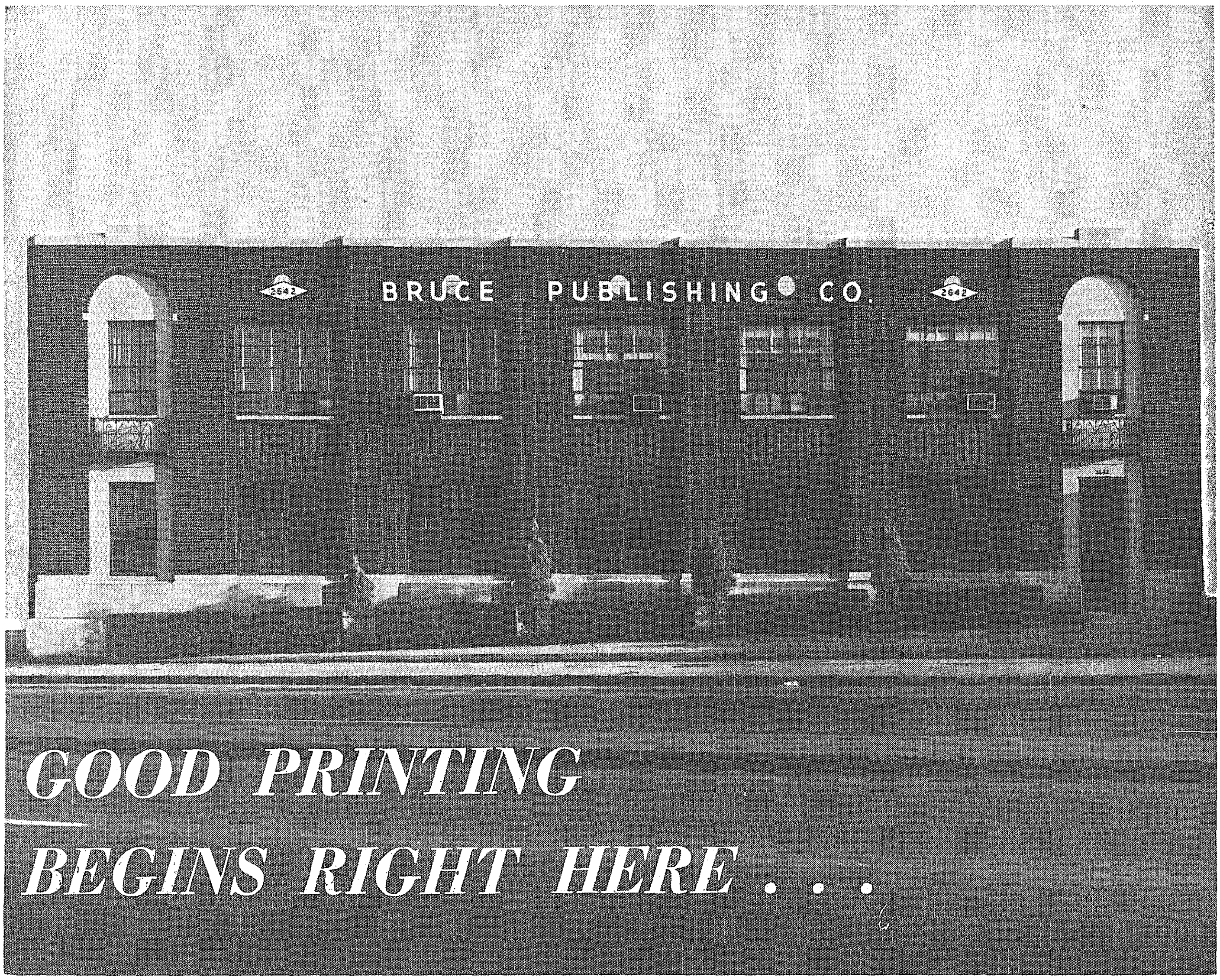
1. IEEE
2. AIIE
3. MSPE
4. AgE

Fraternities

1. Triangle
2. Alpha Chi Sigma
3. Theta Tau

PARADE

1. Theta Tau
2. IEEE
3. Kappa Eta Kappa



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Selectee: "They can't make me fight."

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• • •

"You were away without official leave," his superior barked. "Why?"

"Well, sir," the harassed private began, "my first day in the Army we were issued combs, and that afternoon all my hair was cut off. The next morning they issued us toothbrushes, and that afternoon the dentist pulled six of my teeth. The following morning, I was issued an athletic supporter. That's when I went AWOL."

• • •

A grammar grade teacher decided to do something different in class one day. She bought a bag of penny candy and blindfolded the students in the class. She brought three of them up to the front of the room and gave the first one a small chocolate bar. When the little boy was asked what he was eating, he immediately replied that it was a chocolate bar. This was fine, so the teacher gave the next one a piece of caramel candy, which was identified immediately. The third little boy received a candy kiss. When asked what he had, he didn't know. To give the little boy a hint, the teacher said that it was something that his mother gave his father before going to bed at night.

A voice from the back of the room said, "Spit it out! For goodness sake, Johnny, spit it out!"

Then there was the janitor who worked in the girls' dorm and was entrusted with a pass-key to every room in the building. The following week the dean ran across him and asked, "Why didn't you come around Friday for your pay, John?"

"What! Do I get wages, too?"

• • •

A costless and foolproof contraceptive has been developed: "No!"

• • •

The young couple drove away on their honeymoon blissfully unaware of the sign their friends had put on the rear bumper: AMATEUR NIGHT.

• • •

A guy called his girl one night and asked "Got anything on for tonight?"

"Yes," replied the chick, "and it's staying on."

• • •

A Scotchman and Irishman were on board a ship bound for Scotland.

The Scotchman, on catching sight of homeland, yelled, "Hurrah for Scotland!"

The Irishman, a bit riled, replied, "Hurrah, Hell!"

To which the Scotchman countered, "That's right, every man for his own country."

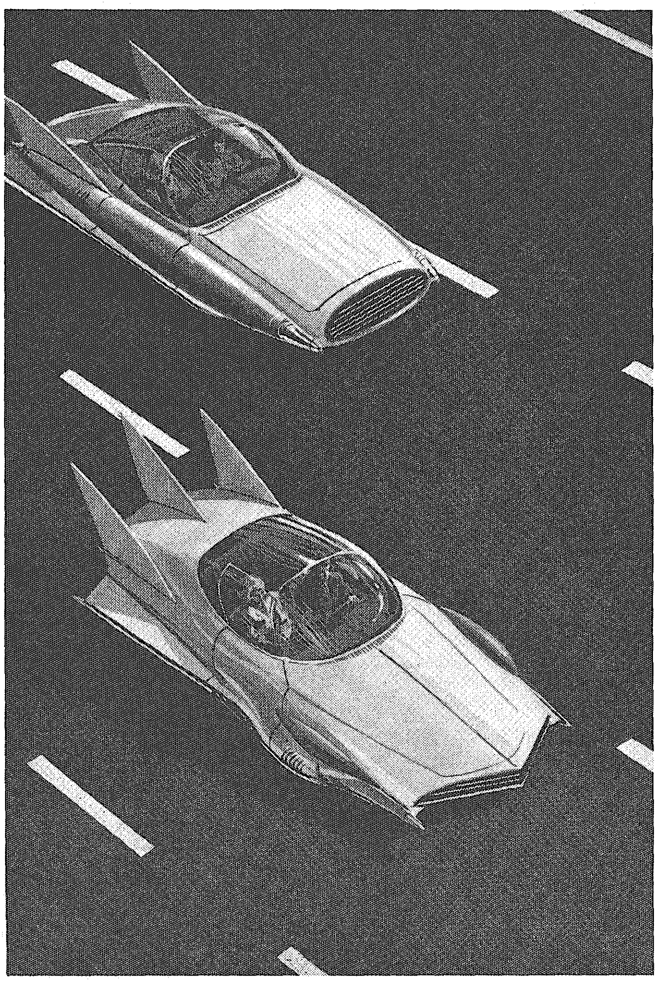
• • •

Freshman: "Say, why'd you go out with that sad-looking girl the other night?"

Forester: "Why not, she's one in a million."

Freshman: "Huh, how's that?"

Forester: "She agreed to go out with me."



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BRAIN TEASERS

by GERALD JOHNSON, *ME '67*

1. The two volumes of Gibbon's *Decline and Fall of the Roman Empire* stand side by side in order on a bookshelf. A bookworm commences at page 1 of volume I and bores his way in a straight line to the last page of volume II. If each cover is ⅛ of an inch thick, and each book without the cover is 2 inches thick, how far does the bookworm travel?

2. In how many zeros does 10,000! end?

3. A lottery sells ten tickets and offers three prizes. What is the chance of winning a prize with three tickets?

4. A rope ten feet long is suspended from points on two buildings equidistant from the ground. The distance from a straight line between the two points to the place of greatest sag on the rope is five feet. How far apart are the buildings?

Answers to March Brain Teasers

1. $2{,}015\pi$ sq. ft.
2. Only one weighing. Number the piles 1 through 10. On the left side of the balance place 1 coin from pile 1, 2 coins from pile 2 and so on until you place 5 coins from pile 5. On the right side of the scale place 1 coin from pile 6, 2 coins from pile 7, up to 5 coins from pile 10. By observing which side weighs more and by how much, you can now tell which pile is counterfeit.
3. Obviously, it depends on which way you cross it.
4. x=2.618 and x=.387.
5. The EE's by 3/2.
6. I have no cousin George!
7. John was 60 years old when he died.

Answers to May Brain Teasers

1. ¼ inch. When two volumes are in order, left to right, on a bookshelf, the first page of volume I and the last page of volume II are separated only by two covers.
2. 2,499 zeros.
3. 17/24.
4. The buildings are not separated at all, their walls meet.

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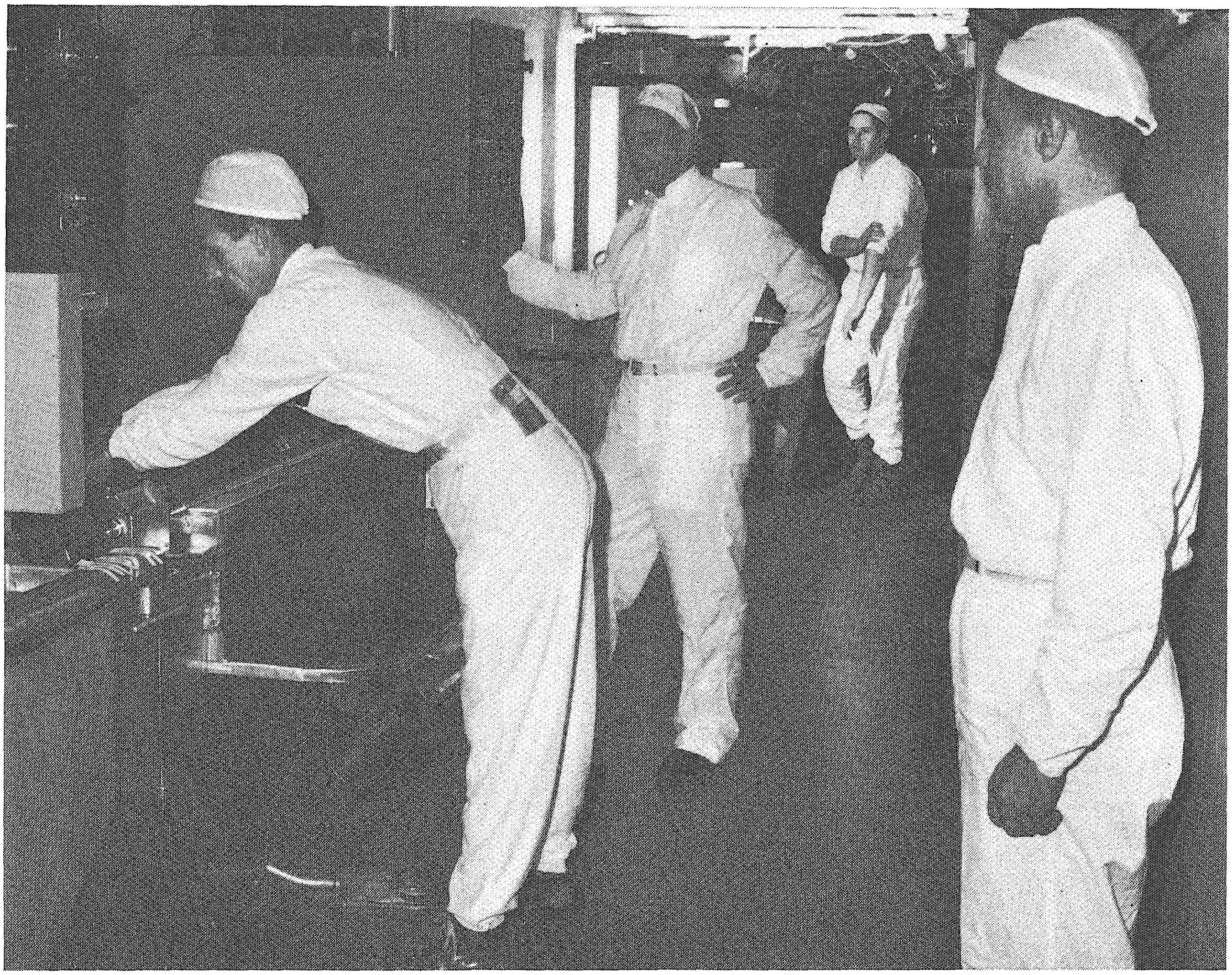
ENGINEER'S BOOKSTORE
Main Engineering



Art of creating photo-film manufacturing machines taught here

That's sure no professional ad model posing up in the foreground of the picture but a real pro of an engineer looking over his handiwork some six years after drawing the assignment.

The first three years he spent picking the best location for the thing with regard to capital cost, operating cost, and operating convenience. This means he actually put it together in a scant three years, which isn't bad, considering that it amounts to a huge integration of mechanical engineering, electrical engineering, chemical engineering, hydraulic engineering, instrumentation engineering, structural engineering, industrial engineering, and just about every other category of engineering in the catalog of a big college.

Of course, no college teaches men how to design and assemble a complex like that. You learn by doing. Not at every large company can you learn. Come to think of it, *is* there any other company whose production is of a nature and volume that demands such neat and thoroughgoing co-ordination of engineering disciplines?

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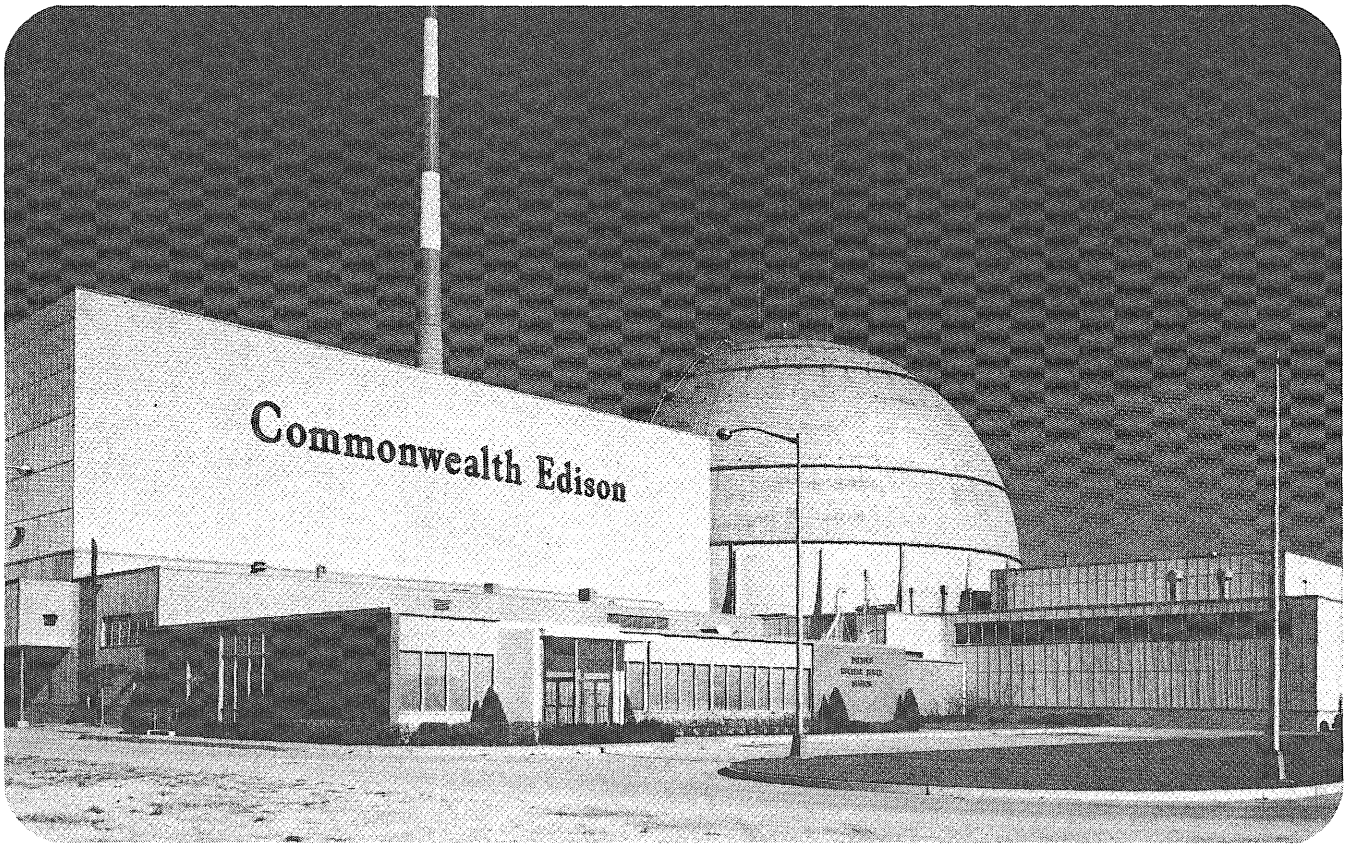
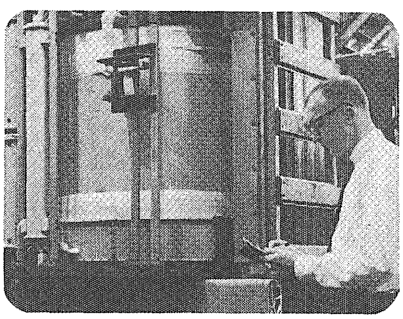
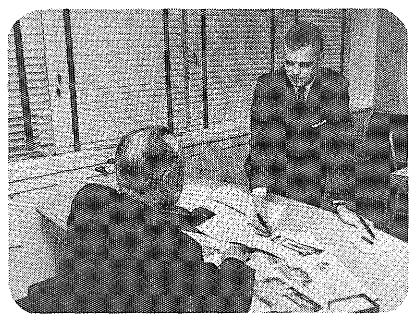


DRESDEN NUCLEAR POWER STATION—America's first full-scale producer of commercial electric power from the atom, rated 200,000 kw. Dresden 2, a 714,000-kw second-generation design is now being built—like the original—by General Electric.

ELWOOD P. STROUPE, MSChE, PURDUE '62 is a design engineer at the Atomic Power Equipment Department. He has contributed to the design of Dresden 2's reactor—heart of the system. He'll follow it right through installation.



RONALD F. DESGROSEILLIERS, BSEE, U.S. MILITARY ACADEMY '60 is on the Manufacturing Training Program at G.E.'s Power Transformer Department. Ron is a production foreman helping build massive transformers for Dresden 2.



WORKING ON THE SALE of Dresden 2's turbine-generator is William J. Mahoney, BMS, Maine Maritime Academy, '56. After serving four years in the U.S. Navy, Bill joined the Technical Marketing Program to help G.E. meet its customer's needs.

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