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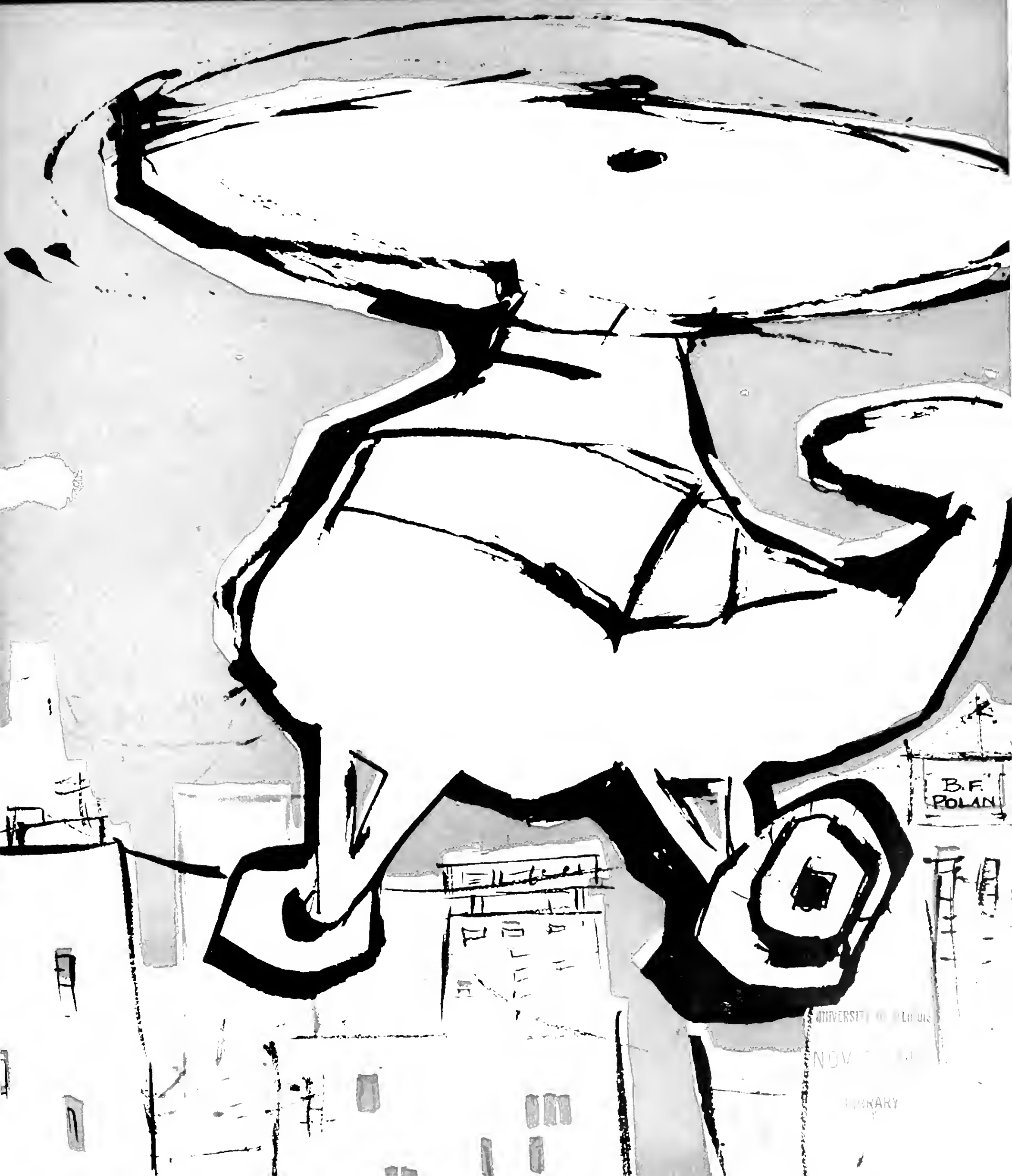
TECHNOGRAPH



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THE ILLINOIS TECHNOGRAPH

Volume 75, Number 1 **October, 1959**

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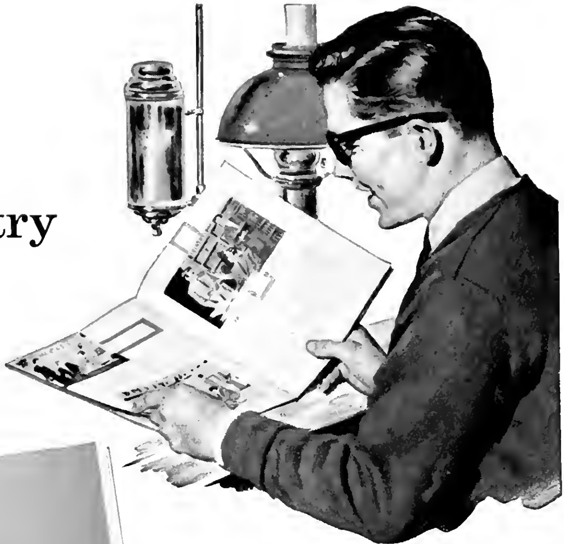
 Published eight times during the year (October, November, December, January, February, March, April and May) by the Illini Publishing Company. Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois, under the Act of March 3, 1879. Office 215 Engineering Hall, Urbana, Illinois. Subscriptions $1.50 per year. Single copy 25 cents. Publisher's Representative: Littell Murray Barnhill, Inc., 737 North Michigan Avenue, Chicago 11, Ill., 369 Lexington Ave., New York 17, New York.

Opportunities in the Petroleum Industry with Phillips



New brochure describes career opportunities at Phillips

This new booklet describes the unusually fine career opportunities at Phillips Petroleum Company—a growth leader among America's integrated oil companies. New projects and expansion programs at Phillips have created many attractive openings for young men in practically every phase of the petroleum industry.

At Phillips, the production of crude oil, the refining and marketing of automotive and aircraft fuels and lubricants continue to grow. Phillips is also in the forefront of the great boom in petrochemicals, sparked by a constant stream of new developments in synthetic rubber, plastics, carbon black, fertilizers and other chemical products originating in Phillips research labs. Less publicized Phillips projects include research, development and production programs in atomic energy . . . as well as uranium mining and processing. Phillips is also the number one producer-marketer of liquefied petroleum gas in the nation.

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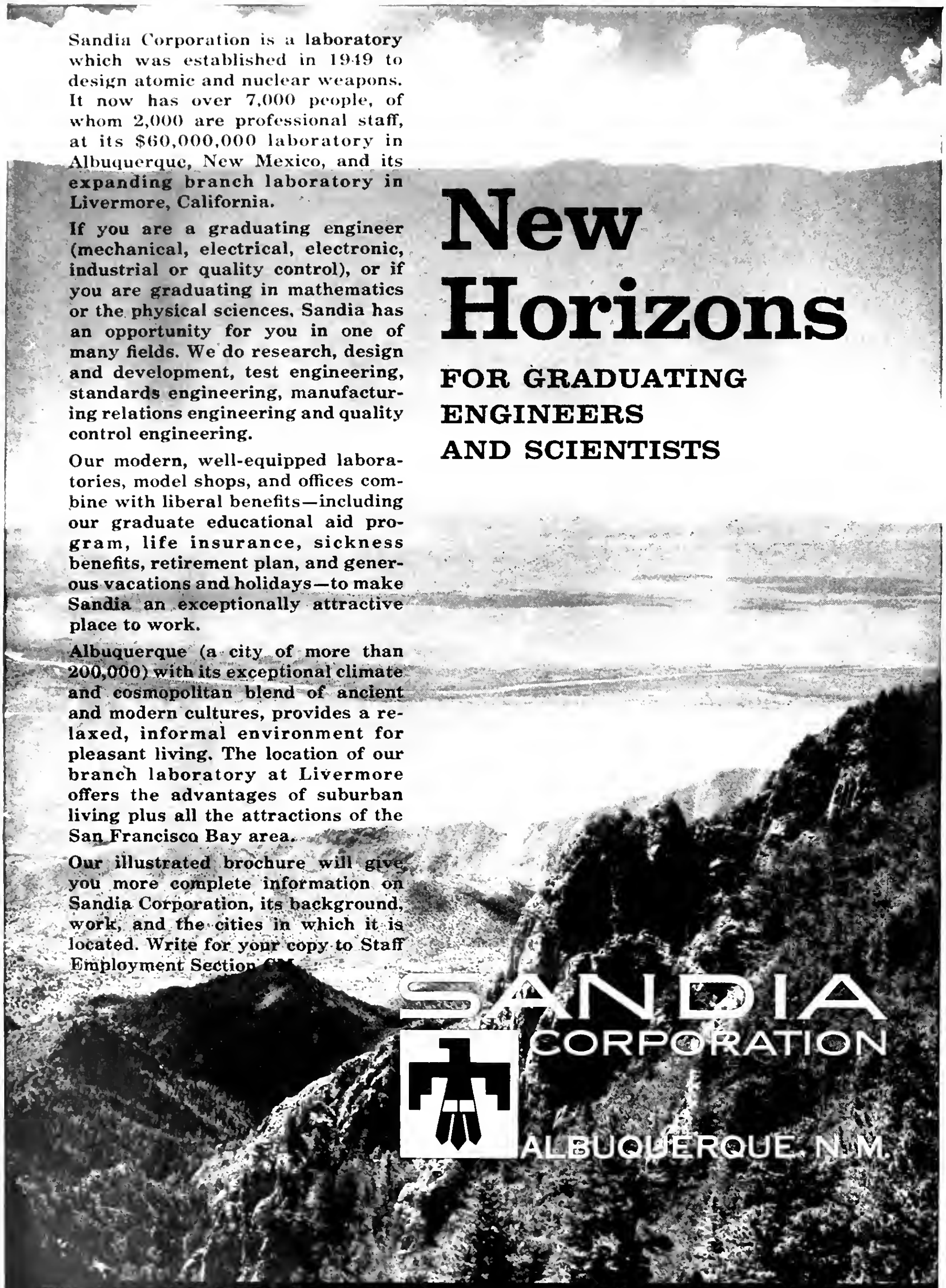

This photograph depicts the view from 10,800 feet above sea level at the crest of the Sandia Mountains, looking westward across the Rio Grande Valley and the northern limits of the city of Albuquerque.

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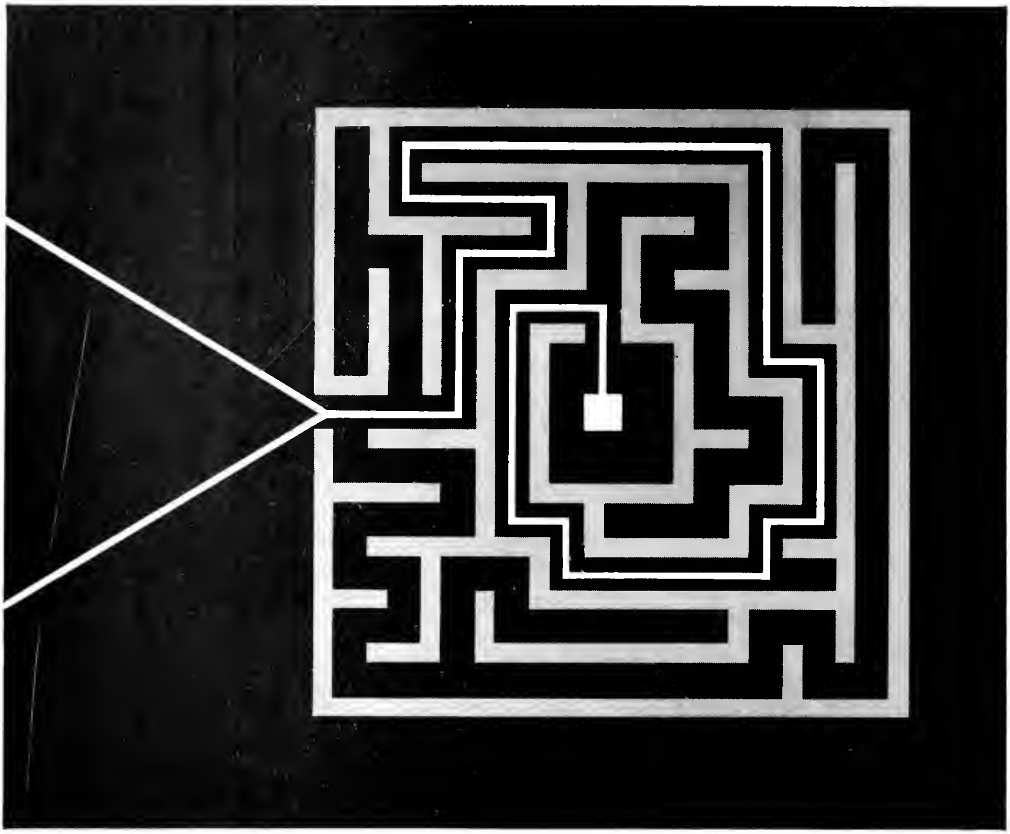

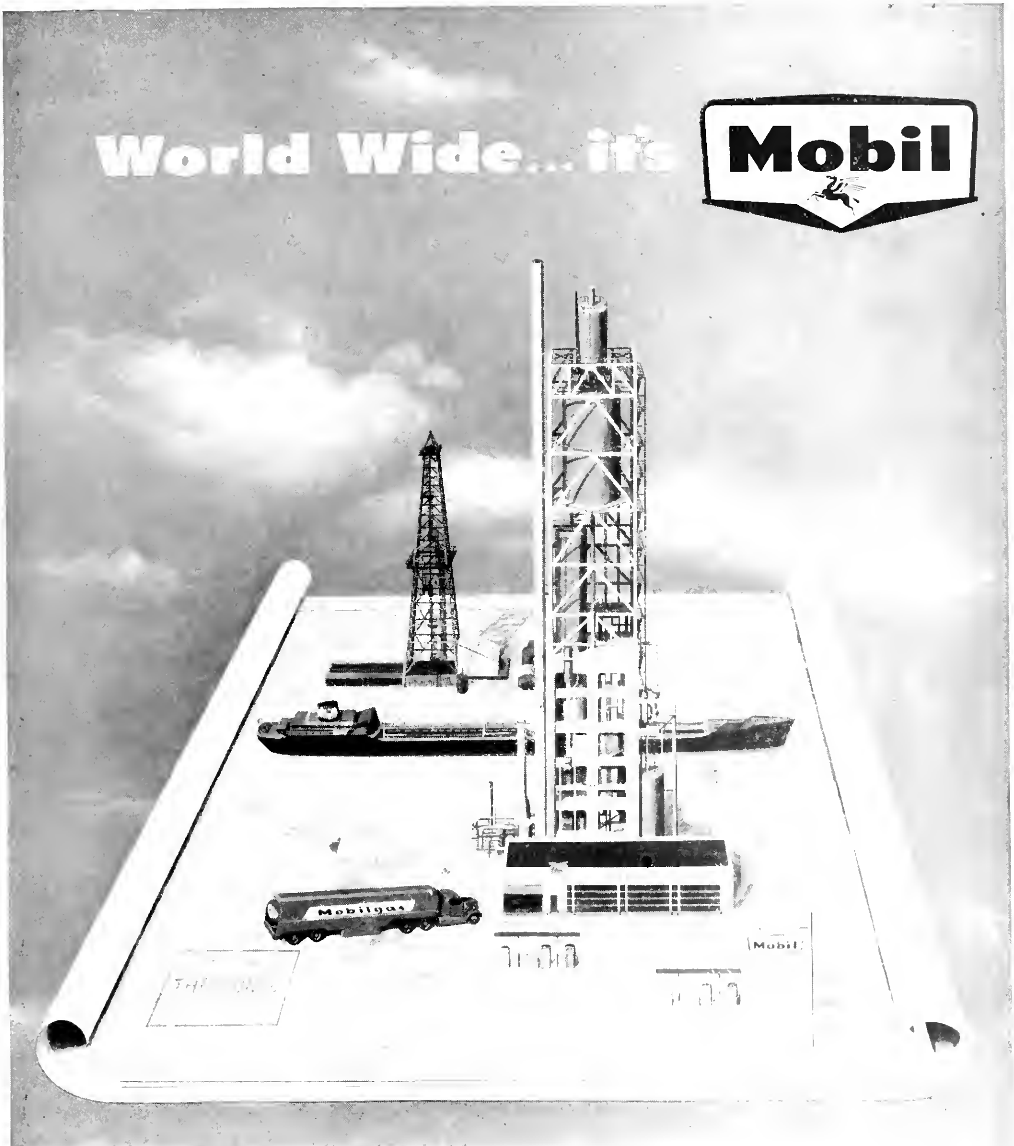
World Wide...it's
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Take It From Glick . . .

Picture Praf. Glick buried amid a maze of wiring and expensive equipment. He has a stack of notes and data sheets, a two-day growth af beard, and a budget of $200 thousand far his research project.

Halfway through one of the mast intricate steps af procedure in synchranizing his apparatus, Glick is tapped on the shaulder by a little guy with horn-rimmed glasses and a natebaok. Glick jumps in surprise and his setting is last. At least an hour has been wasted. Holding his temper as best he can, Glick gently removes the villian fram the premises.

A week later the episode is forgatten; however, the repercussions have not yet begun. It isn't until a year later that Glick gets his come-uppance. His budget for research is cut to such a figure that little work can be dane and his project is terminated.

With a certainty that the gads are against him, he goes to his directar and discovers that the budget was cut due to a lack of sponsors.

This little episode could ga on, however, it would be best to stop and ga back a way. Remember the little guy, with the glasses and the sneaky way about him? He was an engineering writer and it was his job ta publicize Glick's praject. Although his method af appraach was not the best, his purpase was, far with publicity, funds can be acquired for further prajects. Why is he necessary? Because mast people in research are too busy in their lab ta take time to tell others abaut their wark.

While this provides a livelihaad for engineers who ghost-write, it speaks poarly far thase who do the actual research. For the man with the clearest knowledge af a specific project is the research director himself. If he would not limit himself to the lab alone but include the field of writing, his reports as well as publicity releases would be af wider scope and interest.

All this centers around one point. Being an engineer or scientist daes nat exempt an individual from the necessity of expressing himself in written farm. We may joke all we like about Advanced Remedial Writing far Experts, (Rhetoric 200); however, in the final analysis the pen and the typewriter must be used to camplement the slide rule.

HELICOPTER CONTROL

By Edward Rollo

The purpose of this report is to explain, in a basic and general way, the accomplishment of successful helicopter flight. By successful flight is meant the unlimited ability of the helicopter to maneuver under all practical flight requirements. This must, of course, lead to an explanation of the physical control methods in the three planes of motion, and to an explanation of how the prime mover, the rotor, is controlled to accomplish stable motion in these directions. Since the aerodynamics and mathematics of rotor blade theory are rather complicated, it is the purpose of this report to present this material in a manner readily understandable to the layman. The proper references for those interested in a more detailed analysis are included in the reference section.

The general requirements of a helicopter are much the same as in conventional aircraft. This is, it must be able to produce thrust and lift and control these forces in six directions. The operator must be able to control the helicopter in a vertical, directional, lateral, and longitudinal maneuver along with combinations of these.

Vertical control or lift control is probably the easiest to accomplish since this can be obtained by throttle adjustments and pitch movements of the rotor blade much the same as thrust is controlled in a conventional aircraft propeller. Since the rotor blades are airfoils much the same as a conventional wing increasing the pitch is merely increasing the angle of attack of the blade which in turn increases the lift of the blade. Coupled with this increase or decrease in pitch there must be a proportional increase or decrease in rotor rpm. The increased angle of attack of the blades causes greater blade resistance tending to reduce the rpm thereby holding the lift force constant. (See Fig. I.)

Vertical control immediately introduces directional control. The turning rotor, which is rather large in comparison to the fuselage, creates a large torque on the drive shaft. This is in turn transmitted to the fuselage in a manner tending to rotate the whole fuselage in a direction opposite that of the rotation of the rotor. (See Fig. II.) This is in accordance with Newton's third law of motion, which states "for every action there is an equal and opposite reaction." Several methods of control have been developed, and four of

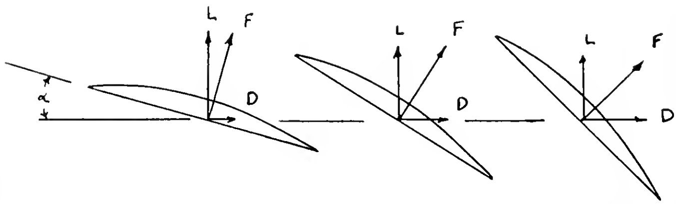


Figure I. As the angle of attack increases, the drag increases tending to slow down the rotor. Therefore, additional power must be applied to produce constant rpm and increase lift.

the most common are as follows: (1) mounting two counter-rotating rotors on the same axis (coaxial), (2) installing a vane in the slipstream, (3) tandem-type double mounting with counter-rotating rotors, and (4) the anti-torque rotor. These are all illustrated in Fig. III.

By far the most common method, particularly on small helicopters, is to

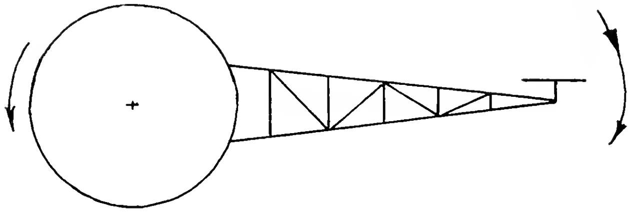


Figure II

mount a small rotating anti-torque propeller perpendicular to the plane of the rotor, at a given distance from the center of gravity, and precalculated to cause a moment equalizing the rotor torque. Directional control is then achieved by varying the tail propeller pitch. In low pitch the tail swings as if there were no counteracting moment, in medium pitch the fuselage remains stationary, and in high pitch the fuselage turns in the direction of the rotor. This is similar to the yawing condition in conventional winged aircraft. See Fig. IV.) The anti-torque tail rotor could be operated independently of the main rotor, but the simplest method is to drive it through a power take-off in the transmission of the main rotor at some fixed ratio of speed to the main rotor.

In order to complete the picture of directional control, it must be pointed out that although the tail rotor counteracts the torque of the main rotor, it also produces an unbalaced thrust force, which in turn is offset by a slight tilt of the main rotor. (See Fig. V.)

Rotor tilt on a small single-rotor type helicopter is necessary for lateral control and this motion is similar to the rolling condition on conventional winged aircraft. On a side-by-side type helicopter the thrust of either or both rotors can be adjusted to produce a pure moment in a lateral direction, (See Fig.

VI.) where as on a single-rotor type helicopter both a moment and side force are produced. This side force is not necessarily a hindrance since generally a lateral motion or roll proceeds motion intended in the direction of roll.

Longitudinal control is similar to pitch control in the conventional winged aircraft and is attained much the same way as lateral control. Fig. VII illustrates several methods of longitudinal control for tandem-and single-rotor helicopters. In (a) either the thrust of each rotor is adjusted or the rotors are tilted. In (b) rotor pitch is periodically increased at some part of the rotor path to create greater lift on one side of the rotor than the other. In (c) rotor tilt is the main control mechanism. In (d) the anti-torque rotor produces the pitching moment. In (e) a combination of rotor thrust and offset flopping hinges produce longitudinal control.

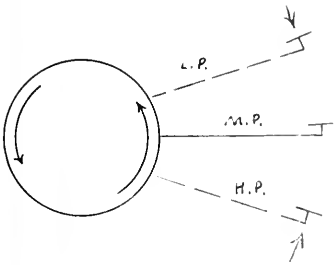


Figure IV

The ability to control the helicopter in each of the previous discussed maneuvers and directions must be put in the pilot's hands through some sort of control mechanism. A relatively simple illustration of the control mechanism linking the pilot and the helicopter is shown in Fig. VIII. The most coordinating and effective method of control is that found in a conventional aircraft, and for this reason they are adapted as closely as possible in a helicopter. As in a conventional aircraft, the control stick is located in front of the pilot and is used to control lateral and longitudinal motion. The pilot merely pushes the stick in the direction he wishes to go and the main rotor tilts in that direction. Rudder pedals are also provided in a helicopter for directional control. The pilot pushes the right pedal to go right and the left pedal to turn left. Pushing of the pedals increases and decreases the pitch of the anti-torque rotor, thereby allowing the helicopter to swing in the direction desired. The pitch lever or thrust control lever is operated by one hand while the control stick is operated by the other. Moving the pitch control up or down changes the pitch of the rotor blade, and upward motion of the stick produces increased lift and vertical ascent, whereas pushing the pitch control stick down produces decreased lift or vertical descent. A throttle control mechanism is located near the pitch control lever or is mounted on the pitch lever and is controlled by twisting the grip much the same as a motorcycle throttle control. In some helicopters the pilot merely controls either the pitch or the throttle and the other control is automatically adjusted for by rotor governors in order to maintain constant rotor speed.

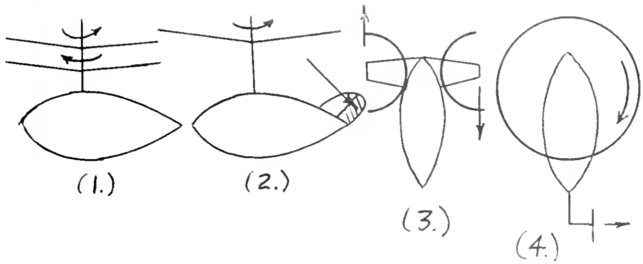


Figure III

In order to make the helicopter go in the direction desired, a force must somehow be produced in that direction. On other vehicles of motion such as the airplane, automobile, and the boat a way is provided by having a propeller in that direction, friction transmitting force in the desired direction, or again a propeller transmitting force in the direction desired. The famous "Juan De La Cierva" autogyro produced thrust in a forward direction with a separate propeller and engine provided for this function alone. But under these conditions, the aircraft becomes bulky and impractical in view of the competition from winged aircraft.

In a helicopter, in order to keep it as light and as simple as possible, a directional force must somehow be acquired from the lifting rotor. The best way to accomplish this is to tilt the path of the rotor blade tips (referred to hereafter as tip-path plane) and acquire a component of the thrust in the direction it is wished to go (See Fig. IX.)

This involves the controlling of unseen forces and moments and leads to an explanation of how the rotor itself is controlled.

In order that the helicopter be stable under all flying conditions and maneuvers, the rotor must be a very versatile piece of equipment and must be able to compensate for changing conditions. It must be controllable when tilted, in a cross wind, in forward flight, etc. For this reason the first thing to be controlled is the lift of the individual blades themselves. An example is as follows: suppose the rotor is operating at some counter clockwise constant speed and it is wished to go forward. Assume that so far no adequate way has been provided to do this, and the rotor and shaft must be tipped together. When the rotor is tipped forward from the pilot's seat, the blades coming into the left side have an increasing angle of attack and the blades on the right have a decreasing angle of attack. This causes a force greater on the left than on the right tending to roll the craft over.

This effect is also present in a cross wind where the blades approaching head on into the wind have greater lift than those retreating with the wind, and this same effect is also very noticeable in forward flight.

There are two basic ways to overcome this effect and allow control of the rotor. These were both mentioned earlier when lateral and longitudinal control were discussed. One way is to be able to periodically control the pitch of the blades and the other is to allow the blades to flap. Both methods have been adequately developed, but by far the more common method is to hinge the blades either at the shaft hub or at some short distance from the hub and allow them to flap. A hinged blade in rotation is in balance by the action of the centrifugal force and the lift of the blade. Since the blade is hinged (no moments can be transferred through a hinge) unequal lift forces cannot be transmitted to the helicopter body itself. This therefore eliminates the rolling effect due to tilting and wind conditions.

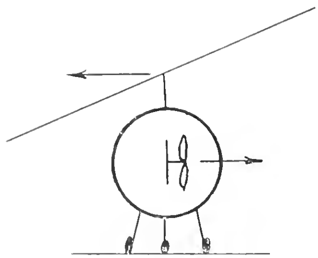
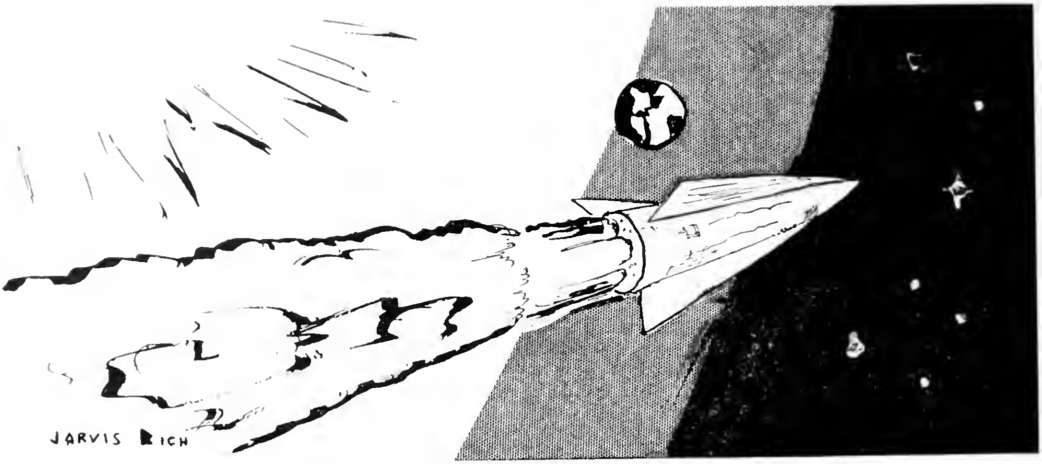


Figure V

(Continued on Page 41)



Relative . . .

By Dru Simms

Lane switched the radio-transmitter button off.

"Still no sound," he said to Clark, the other half of the rocket's crew. They exchanged grim looks.

A landing without contact with an earth base would be almost impossible. It seemed ironical that after their year of orbit around that now-far-distant dog-star, Sirius, they should come so close and yet fail.

Lane's thoughts turned to Gail, his girl—a year ago. He wondered if he would ever see her again. Or, if they did make it down, would she be waiting?

As it was planned, their trip—the first into another galaxy—was to have lasted six months. But, as they approached Sirius, something went haywire. All their instruments jammed. Their velocity meter registered the unbelievable speed of 93,000 miles per second, one-half the speed of light. At first they panicked but everything went smoothly. Time seemed to stand still. And since there was so much to be observed at this frontier of speed and space, they decided to extend their orbital journey to a year. There was no fuel problem as their sleek ship was powered by an inexhaustible source—nuclear power.

And now, back in the earth's atmosphere, every instrument was functioning properly except the radio.

They went through the deceleration process mechanically, knowing it was probably hopeless. Lane was again letting his mind wander to Gail when he heard a sputtering from the radio.

"Earth base Number Sixty to unknown rocket, altitude 81 miles, speed 25,110 mph. Please identify yourself. Over."

Lane looked at Clark, and grinned. They explained their situation as briefly as possible, then requested landing instructions. The earth-bound radiomen seemed confused but, after placing several calls, agreed to wait for further explanation until the ship landed.

Ten minutes before their scheduled landing, with their speed down to 4,500 miles per hour, everything was going well. From there on in it was routine.

A huge crowd was gathered by the time the two men crawled out of the hatch. Standing a little apart were several men in uniform, all strangers to Lane, and . . .

"Gail!" He ran toward her, but stopped short when she extended a hand and said politely,

"Mr. Roth! You look exactly like the pictures. You haven't aged a bit! Congratulations on making quite a stupendous space voyage"'

Lane looked at her blankly.

"Gail . . ." He began again.

"Mr. Roth, are you all right? I'm not Gail." She laughed lightly, "I'm sorry. Of course, you wouldn't know. I'm Jane, Jane Williams, Gail's daughter."

The impact of the words staggered Lane a step backwards.

"Daughter!" He echoed the word.

A frown puckered the girl's brow and she looked at him intently.

"Mr. Roth, how long do you think you've been up there in space?"

Lane looked up at the sky, then back at the girl. His answer came hesitatingly.

"One year." He straightened his shoulders. "How long . . .?"

She answered his unfinished question. "Twenty-three years."

PRINTED CIRCUIT TECHNIQUES

By Irvin McKittrick

Introduction

There is a common myth among many technicians and some engineers that printed circuits are nothing but a web of troubles holding components together. This is the result of coming in contact only with the problems and never with the processes. There have been considerable discussions between major electronic companies regarding the merits of printed circuit techniques. The controversy regards the problems encountered in servicing printed circuits after manufacture. I was recently involved in the production of a telephone multiplex equipment system which used printed circuits throughout. When testing and trouble shooting this system, which involved the use of over 1,000 printed circuit boards, I failed to find that I could agree with many of the complaints about servicing. For example, I found it much easier to check solder connections on the surface of a board rather than dig through a maze of wires, circuit tracing was obvious following conductors on the board, components were not hidden or hanging in air between terminal strips waiting to shake loose. In order to dispel this myth of troubles, let us look at some of the significant advantages of printed circuits and how these circuits are produced.

Engineering faces circuit problems in certain areas which no other system but the printed techniques can solve. How else can we reduce the size and weight of missile, satellite, and space-vehicle assemblies? What other system allows us even to approach the automatic assembly of equipment into replaceable units?

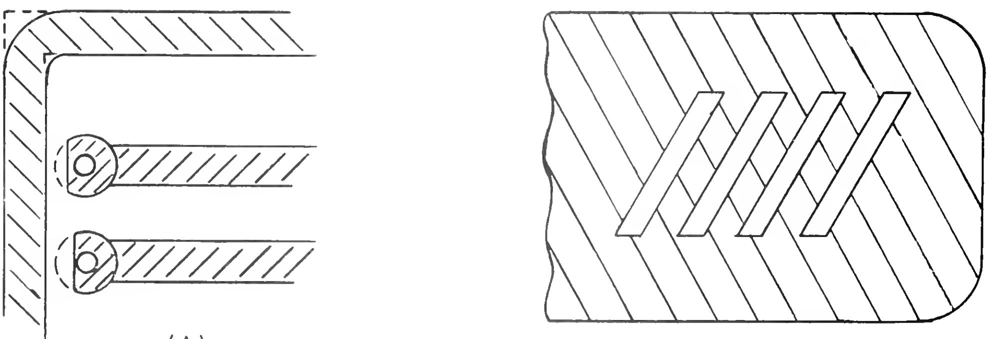
What a Printed Circuit Is

These are some of the far-reaching possibilities of printed circuits, which replace conventional hand-soldered wiring with conducting strips of copper bonded to a flat sheet of insulating base material, with conductors on one side and components mounted on the other. Actually the conductors are obtained by etching or eating away undesired sections of a foil coating which originally covered the board. Although silver and aluminum foils might be useable from a conductivity standpoint, copper is more readily available, lower in cost, and easier to solder. The component leads are passed through holes in the board and are all soldered at once by lightly dippling the conductor surface of the board into molten solder.

The term "printed circuit" is sometimes used to include both components and conductors, whereas printed wiring applies to conductors only. In this article it refers primarily to the wiring, with which components such as resistors, coils, and capacitors are connected. Once we have decided to design a given electronic circuit for printed production, the requirements for the circuit must be considered. Information on environmental conditions in which the unit will operate, maintenance requirements, and physical size of the equipment must be considered. Knowledge of these conditions will define design requirements.

Methods of Manufacture

There are two general systems of producing printed circuitry today. One adds metal to an insulated base, and the other removes a portion of a thin metal layer which has been bonded to the base. Current methods of the first system are vacuum processing, chemical deposition, die stamping, or molding. All of these additive methods require a considerable set-up cost and are ad-



(A) (B)

FIGURE 1

vantageous for particular applications to circuit problems. The removal, or subtractive process, is accomplished by etching unwanted material in an acid bath. The etched circuit is probably the most widely used form of printed wiring today. The circuit process is flexible, reliable, and easily produced, with new techniques adding to its present popularity. In order to produce an etched circuit board, three basic problems must be considered: circuit design, base material selection, and process selection.

Circuit Design

First, the circuit must be designed for printed conductors. Since every printed circuit board is different in all electrical and mechanical problems, a steadfast rule of layout cannot be given. For example, compare a board which is to be used in aircraft systems subject to vibration, temperature, and pressure changes with a stationary computer application which is temperature and humidity controlled. Therefore, each board must be designed to meet the particular requirements of the circuit involved. From the schematic diagram of the circuit, the components must be laid out on the board. Rather than actual components, plastic replicas of standard components are used.

Various arrangements of circuit components are then tried until the desired connections can be made with the minimum of crossed leads. This is largely a trial and error process, and each circuit design will pose new problems in crossover minimization. Ordinarily, cross over of conductors is necessary to produce the desired circuit. Sometimes this can be accomplished by using components, otherwise a wire strap is used on the component side of the board to make the necessary connections. The layout is done on tracing paper which is placed over an expanded underlay grid pattern of ten squares to the inch. This pattern may originally be two to seven times oversized, and is later reduced by photographic means. To allow uniform layout and a board which can be assembled by automatic machinery, all component mounting holes, except clustered ones such as tube sockets, are placed to fall on intersections of the grid pattern. The use of slotted or oblong holes for component or hardware mounting should be avoided if possible to reduce die cost. Non-circular holes can be used, but where there is a choice, cost considerations point toward round holes.

After the hole layout is decided upon and connections are sketched in, external circuit connections such as grounding systems and shielding can be added.

A complete ground system is necessary, since the usual metal chassis which often serves as a common ground has been eliminated. The ground system connecting such hardware as tube sockets and shields, also serves as shielding between conductors to reduce stray pickup.

Conductor width and spacing are dependent on current loads and breakdown voltage respectively. A 1/16" spacing, usually considered a minimum, is necessary for a 500V DC working level.

Figure (1) shows some of the layout principles which are used. When making 90° turns, the conductor should follow a smooth curve as in (A) to reduce the possibility of conductor damage in handling and provide a smoother solder flow path during soldering. The terminal connection or "land" need not be completed if spacing requirements are critical, as shown in the same figure. If a large area of shielding is required as in (B), a bar grid technique should be used to prevent blistering of copper during soldering.

When lower moisture absorption and increased insulation qualities are needed, a glass base material is necessary, of which Epoxy glass is the most widely used. This laminate has good mechanical strength plus excellent moisture and insulation qualities. The Teflon glass grade is excellent electrically but very expensive; it is used primarily in low-loss microwave applications.

Along with the electrical characteristics of these base materials, we must consider the demands of fabrication. Before final assembly, the board may have to be pierced, drilled, milled, routed, or sheared. The majority of the phenolic-base laminates are hot-punching materials, which means that the material must be raised above room temperature in order to be punched or sheared without cracking or chipping. Some cold-punch phenolics are available, but they are more susceptible to heat and sometimes warp under dip soldering. The glass-base materials present less of a problem in fabrication, in that they do not easily chip or crack, but are abrasive and cause higher tool wear than the phenolic-base materials. The copper foil may be obtained in several thicknesses, of which .00135 or .0027 inch are the most common. The thickness used is dependent on current capacity, which is decided upon when the circuit is designed. The foil is bonded to the base with heat and pressure. The bond strength or force in pounds required to pull back a 1" wide strip of the foil varies slightly with the different base materials. Most reputable manufacturers provide necessary information on the bond strength of their products. Standard tests are proposed by RETMA for adhesion of printed wiring if there is any question of quality or durability.

TABLE 1

NEMA Grade	Moisture Resistance	Insulation Resistance	Tool Wear	Mechanical Strength	Punch Ability	Cost Factor XXXP=1
P	Poor	Fair	Excellent	Good	Good	.7
XXXP	Good	Good	Good	Good	Fair	1
EPOXY GLASS	Very good	Excellent	Poor	Good	Fair	4
TEFLON GLASS	Excellent	Excellent	Poor	Good	Good	13

After the sketched layout is complete, it is usually traced on glass cloth and the conductor pattern is inked in. A tape system can be used instead of inking, but is less stable dimensionally and is ordinarily not used where close tolerances are desired. The tracing represents a master art work which can be photographically scaled to the required size, and then negatives can be produced to be used for one of the various processes of etching.

Base Material

The printed circuit base material is a special problem in itself. The laminate may be a paper or cloth-base phenolic, or one of various fiber-glass combination laminates, as shown in Table 1.

The NEMA type XXXP is the most widely used grade of material, having high insulation resistance and low dielectric losses. It is mechanically strong and low in cost. The low cost type P is used in models or prototype circuitry where good electrical properties and long life are not so important.

Process Selection

After the circuit has been designed and the base material selected, the final step is to select the process to be used in etching away the unwanted material. One popular procedure for etched circuitry involves a photo-resist system such as would be used by a photo engraver. Because it is expensive, this system is used principally for short runs or sample production. Normally, fifty boards would be considered an economical upper limit of this process. For production quantities in the thousands, an off-

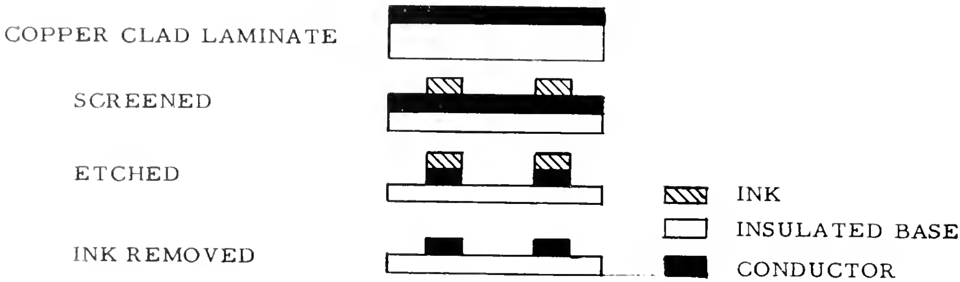


FIGURE 2

set printing procedure can be used with considerable economy. The large gap between the short run and full-scale production techniques is filled by the silk screen process. This will be explained in detail, as it covers the widest range of

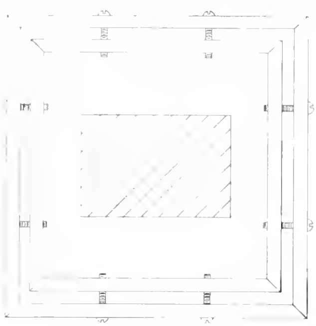


FIGURE 3
Dimensionally adjustable silk screen.

usage at the present time. First, for any process it is necessary to clean the board to obtain a bright surface. This can be done by using water, a good cleansing powder, and a rotary brush. The board is then rinsed and completely dried. To prevent warpage, the use of hot water in cleaning or warm air drying should never raise the board temperature above 150 F. The board is now ready to be printed with an acid resistant ink. Figure (2) shows a surface buildup view of the various steps in the silk screen process.

The circuit pattern to be used must be a negative, allowing the resist ink to cover the circuit conductor areas, while all other parts of the board are unprotected. The construction of a dimensionally adjustable silk screen is shown in Figure (3).

The screws on the sides allow the circuit pattern to be adjusted for correct position on the board. When the board is screened it must be held perfectly flat, usually by means of a vacuum plate specially designed for this purpose. The silk screen must be carefully handled to avoid damage. Even a pin hole in the wrong place can cause trouble. After screening, the board is ready for etching by ferric chloride or other bath. This will remove all copper not protected by the ink. Careful control of the time the board is in the etchant is important to prevent over or under etch. After the board has been etched, it must at once be thoroughly cleaned to halt the etching process. The cleaning procedure consists of a water rinse, a solvent rinse to remove the screening ink, and neutralization. The board is then dried and visually inspected before release for production.

Conclusion

A recent survey by the Institute of Printed Circuits found that the chief complaint about printed circuit boards in radio and television equipment was difficulty in pinpointing component failures. Other complaints were about accessibility and conductor lift during servicing.

In general, such service complaints have been the thorns in the side of printed circuits. Personal experience in the inspection, test, and repair of hundreds of boards used in multiplexing equipment leads one to believe this is largely a problem of education.

Although technicians are not prone to immediately accept changes in service techniques, the electronics industry is spending large sums of money on training. There is no doubt that care and common sense are still required in servicing printed circuits, though in the future disposable modules are likely, which would eliminate the need for repair. The nearness of this time will be determined only by how rapidly the art of printed circuitry can be advanced. The future holds many prospects for printed circuitry, but let us also consider the advantages over conventional wiring which it provides today.

Advantages

By use of printed circuits, metal chassis, brackets, terminal strips, and other hardware can be reduced if not completely eliminated. The RETMA Symposium on Printed Circuits mentions one radio which was re-designed to use printed circuit techniques. Hardware was reduced from 55 to 33 pieces, 21 of which were the same as used in the conventional receiver.

A mention of size reduction in the Symposium relates an assembly consisting of 18 tubes, 150 components, and associated hardware in a 50 Cu. inch package. Another example is that of a four tube amplifier compacted to 1″ by 2″ by 3″.

In his book on printed circuits, Lytel describes a printed circuit microwave receiver, the weight of which was reduced from 32 to 5 pounds. At the same time, costs were also reduced.

There are definitely important savings in the direct labor required to build a printed unit. Assembly and soldering can be done automatically, eliminating 80% of the hand labor involved.

The less evident savings come in other areas. Inspection and test procedures may cost 40% to 60% less. The drawing required is often reduced 50% over conventional wired circuits.

As an engineer, the next circuit device you produce, consider the three factors: cost, size, and weight. Consider them carefully and then consider the printed circuit.

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THE NEXT TWO

PAGES ARE PRESENTED

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OF THOSE INTERESTED

IN APPLIED SCIENCE

THE STAFF


SCIENCE in ACTION
BERNOULLI'S PRINCIPLE:
"THE PRESSURE OF A MOVING FLUID VARIES INVERSELY WITH VELOCITY CHANGES"
WHERE ARE THE LITTLE "B's" AT?
IMPENETRABILITY OF MATTER:
"NO TWO OBJECTS CAN OCCUPY THE SAME PLACE AT THE SAME TIME"
FLUID MECHANICS:
"PRESSURE IS DIRECTLY PROPORTIONAL TO THE DENSITY OF THE FLUID AND THE HEIGHT"
AND IF A BODY IS IMMERSED IN FLUID, THE PHONE RINGS!


NEWTON:
"FOR EVERY ACTION, THERE IS AN EQUAL AND OPPOSITE REACTION."
"A BODY IN MOTION TENDS TO STAY IN MOTION UNTIL ACTED UPON BY SOME EXTERNAL FORCE"
WHEN EXPERIMENTING, ONE SHOULD HAVE A FAIR IDEA OF THE RESULTS
AND A BODY AT REST, STAYS AT REST!
HIC


EQUILIBRIUM:
"TWO EXACTLY OPPOSITE CHEMICAL REACTIONS TAKING PLACE AT THE SAME TIME"
SOME ENCHANTED EV'NING YOU MAY SEE A STRANGER


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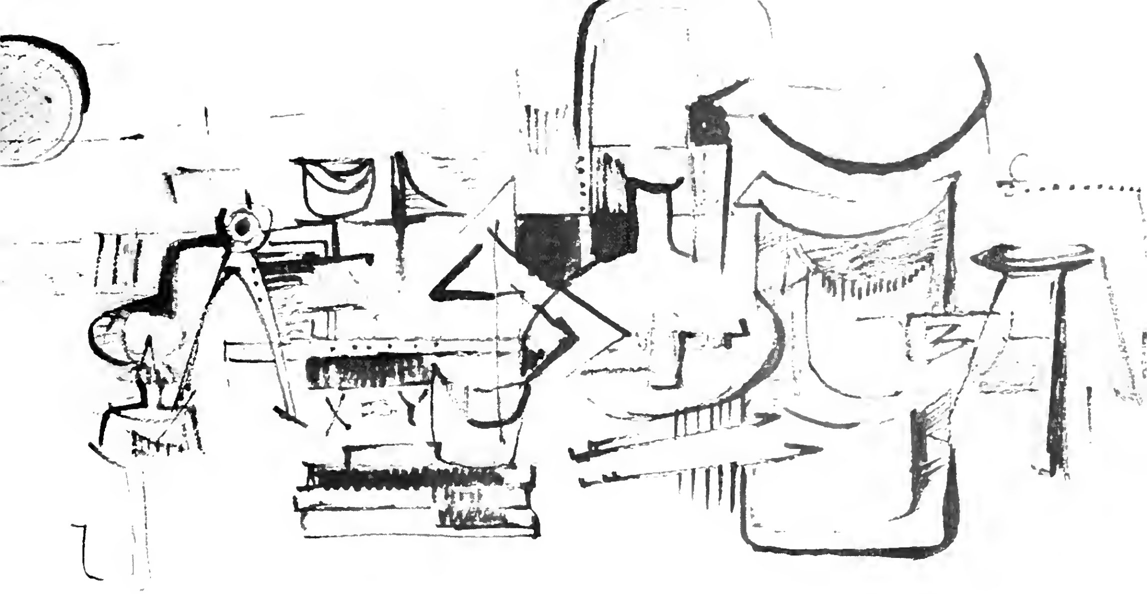

The Scientist as a Person

By Samuel Lenher

Editor's Note: Mr. Lenher is vice president and director of E. I. duPont de Nemours and Company.

* * *

The attention of the public recently has been directed, in an unusual degree, toward the American scientist. The launching of a Russian sputnik ahead of our own satellite has raised a question whether the United States may lag behind the Communists in research and technology. This in turn has led to an examination of our educational system, and we find issues in the political arena which previously had only been debated within the cloisters, relatively speaking, of education and industry.

Those of us who for some years have been occupied with the theme of this conference — research administration — have participated in an intensive search for an answer to the question of what kind of person, and what kind of training, will make a good scientist. It seems to me the time has come, now that the spotlight of public and political attention has been focused upon research, to reverse the field and examine what the scientist is like as a person.

The reason I think this might be timely is perfectly simple. We have considerable reason—for the most part empirical, it is true—to believe there is widespread misunderstanding of the scientist as a person. As a former chemist now engaged in management responsibilities, I of course recognize there is no litmus test to disclose exact shades of public opinion, nor have any scales been devised to weigh precisely what may be burdening the human mind. The evidence, however, of public confusion over the true nature of the scientist seems to me sufficiently strong to convince an average American jury, and that is enough to be alarming. I would like to cite some of this evidence.

In our modern society, the newspaper or magazine cartoon frequently is a revealing indication of what many Americans may be thinking. A popular magazine which has one of the largest national circulations published a cartoon a few weeks ago which is to the point. It portrayed a cocktail party with two guests in the foreground. The feminine guest was a type all too frequently encountered at such an occasion. Obviously she had just been introduced to a bewildered-looking individual with a mustache and goatee, a bald head with flowing locks below the neckline, wearing a string bow tie and wing collar, as well as a pince-nez. The lady was saying, "Oh, you're a scientist. I've always wanted to meet a genuine fathead."

Of course no one but a cartoon character would mistake an egghead for a fathead. But more seriously, a widely published article by a top writer for the Associated Press reports that "in the potboilers of movies and television, the basic research scientist almost invariably is: single-tracked, unworldly, misunderstood, ridiculed by everyone (except his faithful, tiptoeing wife who keeps trying to get him to eat a sandwich), self-sacrificing, a dedicated saint who was born with a vision only he can see, suffers hell pursuing it and—Eureka!—in the last two reels finally finds a cure for the monstrous plague, just when he was down to his last two test tubes."

Now I should add, of course, that the Associated Press did its commendable best to dispel such an impression of the scientist by giving the facts about a living, breathing, and intensely human and likeable research chemist at Yale University. Nevertheless, the fact that this great news service saw reader interest in such a story lends considerable weight to two academic surveys which indicate the public's image of the scientist, especially among young people, is alarmingly distorted.

A poll of high school students by Purdue University in 1956 found that 14 per cent thought there was something evil about scientists; 19 per cent said scientists are more likely than other people to be mentally ill; 20 per cent thought scientists have little regard for humanity; 34 per cent believed scientists cannot have a normal family life; 38 per cent thought scientists are willing to sacrifice the welfare of others to further their own interests; and 78 per cent felt science had its place but there are many things which can never be understood by the human mind.

No doubt many of you are also familiar with the study conducted by Drs. Margaret Mead and Rhoda Metraux for the American Association for the Advancement of Science, entitled "The Image of the Scientist Among High School Students." Here students in more than 120 high schools were asked to write essays on what they thought about science and scientists. Out of this came what the authors described as three images—the shared, the positive, and the negative. If only the first two had emerged, there would be no necessity for my discussion, but Drs. Mead and Metraux concluded that "this image in all its aspects, the shared, the positive, and the negative, is one which is likely to invoke a negative attitude as far as personal career or marriage choice is concerned."

As might be expected, there have been challenges to the validity of this conclusion. I have neither desire nor competence to enter that controversy, but I do feel very strongly that the negative image, and the extent to which it discourages young people from seeking scientific careers, is of very serious concern to all of us, and indeed, to the future welfare of the United States.

It may be true, as some authorities maintain, that our national problem today is not a shortage of scientists and engineers, but a lack of sufficiently good scientists and engineers. While this too may be debatable, there can be no argument that if we are to have true national security, and if we are to maintain and improve our standard of living in the face of population growth, depletion of natural resources, and industrialization of countries which hitherto have been agrarian, our technological progress will require a vast increase in the number of technically trained people in the generations just ahead. Equally important is the development of a wholesome popular attitude toward science and scientists.

For this reason, I think it is important to recite the negative image which Drs. Mead and Metraux feel will discourage young men and women from entering science, and I quote it in full:

"The scientist is a brain. He spends his days indoors, sitting in a laboratory, pouring things from one test tube into another. His work is uninteresting, dull, monotonous, tedious, time consuming, and though he works for years, he may see no results or may fail, and he is likely to receive neither adequate recompense nor recognition. He may live in a cold-water flat; his laboratory may be dingy.

"If he works by himself, he is alone and has heavy expenses. If he works for a big company, he has to do as he is told, and his discoveries must be turned over to the company and may not be used; he is just a cog in a machine. If he works for the government, he has to keep dangerous secrets; he is endangered by what he does and by constant surveillance and by continual investigations. If he loses touch with people, he may lose the public's confidence—as did Oppenheimer. If he works for money or self-glory, he may take credit for the work of others—as some tried to do to Salk. He may even sell secrets to the enemy.

"His work may be dangerous. Chemicals may explode. He may be hurt by radiation, or may die. If he does medical research, he may bring home disease, or may use himself as a guinea pig, or may even accidentally kill someone.

"He may not believe in God, or may lose his religion. His belief that man is descended from animals is disgusting.

"He is a brain; he is so involved in his work that he doesn't know what is going on in the world. He has no other interests and neglects his body for his mind. He can only talk, eat, breathe and sleep science.

"He neglects his family—pays no attention to his wife, never plays with his children. He has no social life, no other intellectual interest, no hobbies or relaxations. He bores his wife, his children and their friends—for he has no friends of his own or knows only other scientists—with incessant talk that no one can understand; or else he pays no attention or has secrets he cannot share. He is never home. He is always reading a book. He brings home work and also bugs and creepy things. He is always running off to his laboratory. He may force his children to become scientists also.

"A scientist should not marry. No one wants to be such a scientist or to marry him."

To call such an image unpleasant would only be redundancy. I might attempt to shatter it by describing some of my neighbors and former laboratory associates in Wilmington, but I'm afraid that would not be enough. So in an effort to get the facts about the scientist as a person, a personal research unit conducted a sociological study of about half of the 2,400 technically trained people who are engaged in research for the Du Pont Company.

A questionnaire asked them to list their family status, educational qualifications, and non-scientific activities in high school, college, and after leaving college. The anonymity of their replies was guaranteed, and the response was remarkable as such things go. More than 75 per cent of the questionnaires were answered and returned, contrary to the expectations of some of our research administrators. An analysis showed the responding group was typical of the company's scientific population as to age distribution and company service, although by chance we had a slightly higher representation of Ph.D.'s. There was no attempt to distinguish between those engaged in basic and applied research .

In the realm of vital statistics, 25 per cent are between the ages of 21 and 29; 61 per cent are between 30 and 44, and 14 per cent are between 45 and 65. They come from 44 of the 48 states, the District of Columbia, and 25 foreign countries. Thirty-four per cent come from the Midwest, 31 per cent from the Atlantic seaboard, and seven per cent from the Northeast. States with the highest representation are New York, Pennsylvania, Illinois, Ohio, Massachusetts, and Minnesota. (It is significant, in this connection, to note that the most recent census shows New York, Pennsylvania, Illinois, Texas, Ohio, Michigan, California, Missouri, and Massachusetts as the leading birthplaces for our population as a whole.)

The scientists received their education at 258 colleges and universities in the United States and 34 foreign institutions, with Illinois, Wisconsin, Massachusetts Institute of Technology, Ohio State, Cornell, Purdue, Minnesota, Delaware, and Michigan mentioned most frequently. Sixty-eight per cent have doctorate degrees, eight out of 10 in chemistry, as might be expected. Chemical engineering was next, with other fields of specialization including physics, other types of engineering, bacteriology, and biochemistry.

It is interesting to note that 19 per cent of them earned all their college expenses as undergraduates, while 69 per cent earned all their expenses for graduate work. Sixty-two per cent of the undergraduates and 89 per cent of the graduates earned more than half of their college expenses. The main source of income for the graduate students was from teaching, research, or both.

Now let's return to some aspects of

the image reported by Drs. Mead and Metraux.

"A scientist should not marry. No one wants to be such a scientist or to marry him."

In all 88 per cent of our scientists are married, compared to 85 per cent of the general adult population as reported by the census. Seventy-three per cent of their wives attended college. Although 15 per cent do not have children, the average number of children per family is slightly more than two, compared to one and one-half for the average American family. Three happy scientists who obviously don't spend all their time in the Du Pont laboratories are each blessed with seven children.

"His work may be dangerous. Chemicals may explode. He may be hurt by radiation, or may die."

Research deals with chemicals. The company operated the Hanford atomic materials plant during the Second World War, and now is operating at Savannah River plant for the production of atomic fusion and fission materials. Employees at all company research laboratories established an injury frequency rate of only one man injured in three million exposure hours during the last five years, which is 23 per cent lower than the over-all company rate in the same period. The latest available frequency rate for all American industry is one man injured in 160,000 exposure hours.

"He may not believe in God, or may lose his religion."

Our survey did not inquire whether scientists were church members, but approximately 75 per cent mentioned church in listing their activities. The latest Census lists only 61 per cent of the general population as church members. Whereas a survey of Protestant churches generally showed only one out of four members took an active part in church affairs beyond membership or attendance, 57 per cent, or more than one out of two, scientists reported such activity. Twenty-three per cent mentioned Sunday School teaching or supervision, 18 per cent church offices such as trustee or elder, 16 per cent membership in men's clubs, 16 per cent membership on church committees, nine per cent choir singing, and five per cent assistance to youth groups.

"He is a brain; he is so involved in his work that he doesn't know what is going on in the world. He has no other interests and neglects his body for his mind. . . . . He has no social life, no other intellectual interest, no hobbies or relaxations."

The survey showed 37 per cent of our scientists participated in 64 different civic activities. Nineteen per cent mentioned membership in community councils or associations, and seven per cent were in fund-raising groups. They hold or have held 136 positions of responsibility, such as president, vice president, board of governors, chairmen of committees, team captains, etc.

Only two per cent of the general population in the Wilmington area has participated in civil defense work compared to seven per cent of the scientists. Other points of comparison were unavailable, but there is reason to believe the participation of scientists in civic activities is considerably higher than that of other groups in the community.

When it comes to educational activities, about one-third of the scientists participate in the work of Parent-Teacher Associations. This is slightly higher than the figures for the general population in the Wilmington area. Twenty-two of the scientists surveyed were involved in district, state, or national PTA groups, while nine were members of Board of Education. About one in five is active in Boy Scout work, compared to one in 20 adults in the Delmarva Peninsula which includes Wilmington. Others are active in YMCA work. Twenty-one per cent are active members of fraternal organizations.

It is worth noting that an analysis of 600 completed questionnaires showed that 47 of the group participate in politics, 51 in military organizations, 20 in dramatics, 76 in purely social organizations, and 112 in miscellaneous groups such as stamp and camera clubs, an orchid society, the Delaware Society for Natural History, the American Association for the United Nations, etc.

When it comes to music, the scientists listed 54 different activities with 22 per cent participating in either vocal or instrumental groups both within and outside the company. I might interject here a personal recollection of a lively Dixieland jazz band known as "The Rhythm Doctors" because its members were Ph.D.'s engaged in research.

Few scientists can be said to neglect their bodies for their minds. Seventy per cent of them engage actively in 42 different sports, as anyone who visited a golf course in Delaware would quickly discover. Naturally—to the surprise of some of my tennis-playing friends—golf is the most popular, with bowling second. Tennis is third, followed by fishing, softball, swimming, hunting, basketball, and sailing.

Other favored leisure-time pursuits include gardening, woodworking, photography, bridge, dancing, and organized reading in some 34 different fields. The variety of such activities is amazing. To give you a sample of the variety of interests reported by various scientists, their returns mentioned cooking, collecting Civil War items, knitting, bird watching, archaeology field work, painting, sewing, tutoring, telescope building, writing, rocket design, music theory, sports cars, antique refinishing, electronics, hi-fi, chess, and learning languages.

Perhaps some of you may be wondering whether the collateral interests of scientists leave them much time for research. If so, let me quickly assure you they usually spend an eight-hour, five-day week in the laboratory, and do a lot of thinking about their work at home. Moreover, 72 per cent of them have published at least one paper in scientific journals, while 57 per cent have presented at least one paper before technical audiences.

"His work is uninteresting, dull monotonous, tedious, time consuming, and, though he works for years, he may see no results or may fail, and he is likely to receive neither adequate recompense nor recognition. He may live in a cold-water flat; his laboratory may be dingy."

Research is time-consuming, but few scientists find it dull. As one of them wrote on his questionnaire, "Most people don't appreciate the fact that science is a way of life. Frequently research problems become so engrossing that one can think of nothing else." Another said of his colleagues, "These scientists are among the most stimulating people in the world. They continually seek to discover something new, to improve something already invented, to learn the 'why' of various phenomena—always seeking, always learning. One must admire this attitude."

One out of four scientists decided upon his career before reaching the age of 15. The reasons included a strong personal interest in the field, courses in elementary or high schools, influence and encouragement of teachers or members of the family—and this may be a surprise—experience with home or toy chemistry sets.

The scientists were not asked whether they felt their salaries were adequate, but 43 per cent said they decided to go into industry because of its financial rewards. It is almost unnecessary to add that starting salaries, at least, for scientists in industry are much higher than those for young people who start life in other jobs. I know of no scientist around Wilmington who lives in a cold-water flat; in fact, one of the favorite sales arguments of the real estate agents is to mention that "this house was owned by a chemist—or engineer — so you know it is in good shape."

"If he works by himself, he is alone and has heavy expenses. If he works for a big company, he has to do as he is told, and his discoveries must be turned over to the company and may not be used; he is just a cog in a machine."

(Continued on Page 43)

Checking Einstein with

Purity Plus—*Hughes Products Division engineer checks semiconductor materials to insure purity.*

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an atomic clock in orbit

To test Einstein's general theory of relativity, scientists at the Hughes research laboratories are developing a thirty pound atomic maser clock *(see photo at left)* under contract to the National Aeronautics and Space Administration. Orbiting in a satellite, a maser clock would be compared with another on the ground to check Einstein's proposition that time flows faster as gravitational pull decreases.

Working from the new research center in Malibu, California, Hughes engineers will develop a MASER (Microwave Amplification through Stimulated Emission of Radiation) clock so accurate that it will neither gain nor lose a single second in 1000 years. This clock, one of three types contracted for by NASA, will measure time directly from the vibrations of the atoms in ammonia molecules.

Before launching, an atomic clock will be synchronized with another on the ground. Each clock would generate a highly stable current with a frequency of billions of cycles per second. Electronic circuitry would reduce the rapid oscillations to a slower rate in order to make precise laboratory measurements. The time "ticks" from the orbiting clock would then be transmitted by radio to compare with the time of the clock on earth. By measuring the difference, scientists will be able to check Einstein's theories.

In other engineering activities at Hughes, research and development work is being performed on such projects as advanced airborne systems, advanced data handling and display systems, global and spatial communications systems, nuclear electronics, advanced radar systems, infrared devices, ballistic missile systems... just to name a few.

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JUDY STEPHENSON

TECHNOCUTIE

Engineers, take note!

"All eligible bachelors are hiding out in engineering." October Technocutie, Judy Stephensan, has the engineers on campus pegged in this manner.

The 18-year-old, 5'2" saphomore in elementary education has definite ideas on men in her life. Judy thinks manners are one important requisite. She doesn't limit herself to one type of man; she likes varied personalities.

Judy's ideas on a nice date are dancing, movies or parties; but she definitely prefers lemonade to beer.

Originally from Lockport, Judy now lives at the Delta Gamma house on campus.

A thinking beauty, Judy made Alpha Lambda Delta last year as well as Star & Scroll Queen, Illio beauty, and the Sports Car Queen finals.

She likes waterskiing, bowling, sports cars, the Kingston Trio, chocolate ice cream and steak.

The best part, and the most profitable for all engineers is that Judy is open for dates. All eligible bachelors, call at the DG house.

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Tau Beta Pi Essay . . .

THE VIRTUES OF A PROFESSIONAL MAN

By Charles D. Grigg

Most young men of today eventually come to a crossroads or intersection, better known as high school graduation. Then they must carefully choose the direction in which to travel. Faced with this decision, the young man must examine a multitude of options; to continue his education, to begin in some type of employment, to join the armed forces, and numerous other choices all beckon to him.

What causes a young man to choose a field where professional performance is a necessity? In doing so, he must be well acquainted with the basic requirements that differentiate the routine worker and technician from the professional man. The essential criteria of the profession will allow a young man to decide whether he wants to work at a level of employment where professional performance is demanded.

The first criterion of professional performance is that it usually reflects a formal and somewhat standardized training. This does not mean that the profession can be entered only via special college training. However, it does mean that complete understanding of certain fields of knowledge is to be regarded as essential to the successful practitioner.

A large area of widely accepted standard practice is implied by professional performance. This means that certain techniques, measures, and methods have achieved widespread approval and acceptance.

The regular and formalized exchange of information and experience among practitioners is usually presumed in professional performance. These exchanges are facilitated in the professions by several methods. Professional associations and conferences, on local, regional, and national levels are utilized by participants in exchanging information and learning of new developments. Specialized periodic literature is used in which reports of research, experiment, and experience are spread throughout the field. This attitude of free exchange contrasts greatly with the old philosophy of patented procedures.

The most essential feature in facilitating this free exchange of professional information is undoubtedly the professional association. These associations are composed of individual practitioners and are controlled democratically by the members. The association prescribes standards of training, knowledge, experience, and skill which must be met by those who are admitted to membership.

Professional performance implies the knowledge of and familiarity with a continually growing field of professional literature. Such literature includes standard texts and specialized periodical publications, supported and maintained by members of the profession and providing a means of reporting research, experiment, and experience.

Continued research is always reflected by professional performance. Professional fields show continual change in theory and practice as a direct result of this research and the incorporation of research into current knowledge. This research receives from practitioners their active cooperation and participation as well as their continued moral and financial support.

Professional performance is guided by an accepted systef of professional ethics and a strong sense of public responsibility. The special responsibility arising out of their advisory and consultative function must be recognized by professional men. They can afford to be persistent in their concern for ethical considerations and the public interest, because their special knowledge insures a maximum degree of independence and security. They are employed for what they know. Therefore, the professional man can afford to be a "no man," rather than a "yes man," to a degree that is not to be expected of a non-professional employee.

The most important distinctive characteristic of the professional man is that suggested by the designation of "learned professions"—a continuing attitude of learning. The professional continually searches for new knowledge and a greater and more penetrating understanding in a lifetime spent in study and learning. His training is designed to urge upon him habits of continuous education. From this never-ending drive arises his interest in research, his participation in professional associations and conferences, his study of current literature, and his overall striving to improve his profession. This attitude of learning is the very essence of the truly professional man.

These are the basic criteria of professional performance, the creed of the professional man. It was earlier asked what causes a young man to choose a professional career. The basic purpose of a man's life—to leave the world a better place in which to live than when he entered it—is well supported by these criteria of the professional. There is little question that the professional man is an essential element in the continual enhancement of society.

HELICOPTER CONTROL

(Continued from Page 19)

This means that the blades merely flap up and down to always maintain a zero moment about the hinges. This flapping due to an unbalance of the lift and centrifugal forces also always tends to align the tip path plane perpendicular to the control axis when a tilt of the blades is desired. Since this balance tends to lag the tilt momentarily, a lag in the direction of motion is momentarily noticed.

One might conclude then that the problem of control of the rotor is solved. But if the helicopter were developed with vertical flapping hinges alone, during flight testing it would be observed that either the flapping motion was retarded or that forces were acting tending to snap off the blades in the in-plane direction. To the pilot this might remain a great mystery, but to the mathematician or engineer this action must remain an inherent part of the system as long as the blades are designed to flap vertically only. To understand this action a little knowledge of angular momentum is required. Angular momentum is a product of the mass of the blades M, the radius of the center of gravity squared R^2, and the angular velocity W. In other words it is MR^2W. This product always tends to remain constant, but as the blades flap up and down the distance from the blade center of gravity to the axis of rotation changes and something else must change to hold the MR^2W constant. Since the mass cannot change the angular velocity of the blades must change, and since the blades are rigidly mounted in the in-plane direction, this results in a whipping action on the blades with a tendency to prevent vertical flapping. It therefore becomes obvious that something else must be done to overcome this, and the answer lies in hinging the blades in the in-plane direction also.

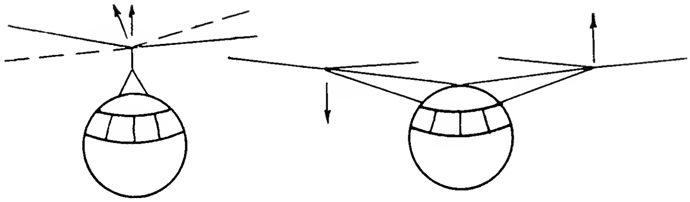


Figure VI

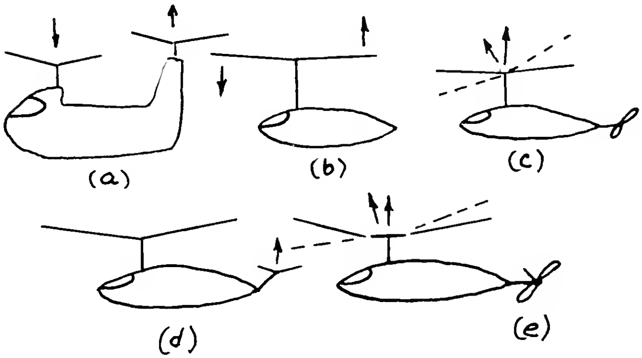


Figure VII

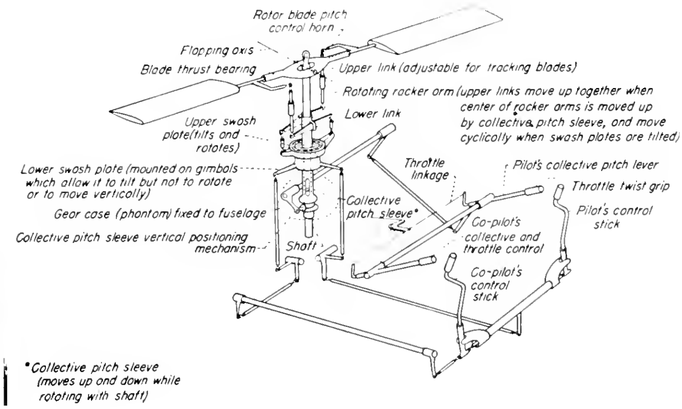


Figure VIII

Now as the blades flap up and down they can also speed up and slow down

Figure IX

to hold the angular momentum constant and the problem is solved. This is known as a full-flapping universally-mounted rotor.

This explanation was based essentially on a single-rotor type helicopter and examples of other variations were introduced. The basic control methods involved are best illustrated by the single rotor, with an anti torque rotor, but they are applicable to all helicopters. The main control requirements are therefore, (1) directional control, (2) pilot control and (3) rotor control; and these are essentially accomplished by (1) rotor tilt and anti-torque devises, (2) mechanical controls similar to those in conventional aircraft with an added pitch stick, and (3) the full-flapping universally-mounted rotor.

———1———

Weekend Chores Eased

Saturday afternoon is a good time for a game of golf, or pottering around the house, but it was not always that way. Back in 1924, a Pittsburgh oil company published a booklet in which it told the car owner what he would have to do every weekend to keep his car in shape and listed parts that must be oiled or greased by hand.

The Scientist as a Person

(Continued from Page 31)

I can't speak for the scientist who works alone, and certainly one of the major problems in our society today is to preserve the individuality and initiative of those who contribute toward a group effort. It is equally true that a scientist who is paid by a big company to do research and who makes a discovery is expected to give the company the benefit of that discovery. But let me add quickly—if the discovery provides a commercial opportunity for the company, the scientist shares commensurately in the rewards through a bonus system.

I have been hearing rumors and have read stories for years of inventions being suppressed or kept in a deep freeze by business firms because development might injure an existing business. No authentic proof of this has ever come to my attention. Certainly the intensity of competition today would make such a step unthinkable in the chemical industry. In our company, for example, nylon was developed and put on the market as soon as possible after its discovery although we knew it would hurt our rayon business. Further, we now have in addition "Orlon" acrylic fiber and "Dacron" polyester fiber which compete with nylon in many markets.

It is worth noting here that among those who have risen to top management, those who began in a research laboratory constitute 33 per cent of the members of the Executive Committee, 45 per cent of the general managers, 33 per cent of the assistant general managers, 54 per cent of the directors of production, 38 per cent of the assistant directors of production, 33 per cent of the directors of sales, and 27 per cent of the assistant directors of sales. In numbers, 43 of the 118 top posts are held by men who began as research scientists. In addition, all 24 of the directors and assistant directors of research in our various departments— posts which rank on the organization chart with the directors and assistant directors of production and sales—are of course scientists.

It seems to me these facts demonstrate the scientist is a most desirable citizen engaged in an essential and rewarding profession. Instead of being "squares" or hermits, they have about the same interests as other Americans. Perhaps because of their intellectual training, many scientists accept an even greater responsibility for civic and social obligations.

Above all, they are proud and independent individuals. Four out of 10 of those who responded to our questionnaire took advantage of an invitation to express themselves on what, if anything, should be done to alter the distorted concept of the research scientist. Their comments reflected opinions and personalities ranging all over the spectrum. Perhaps the extremes were these:

"Scientists are concerned with life, government, the arts, etc., outside their occupations. They are not necessarily mental giants nor is their work at all mysterious. They want to participate in the community. Their opinions warrant more consideration in the fields of government and social affairs." And on the other side:

"I feel very strongly that it is a great disservice to both science and the public to try to picture scientists as 'just plain folks' who happen to do research instead of selling soap. Practically all of the scientists I have known have been more or less peculiar—in general, the better the scientist, the older the man."

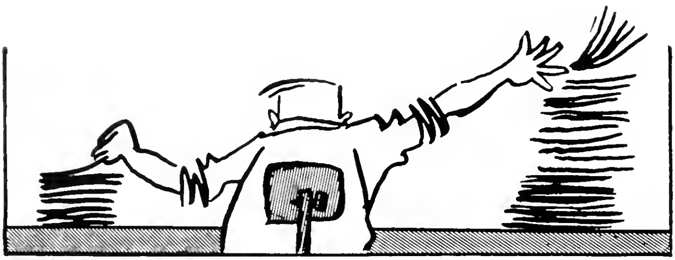
A final comment, it seemed to me, was an articulate expression of the way the scientist himself would like to be regarded. This one urged:

"Present true, creative scientists as they are: different from the ordinary people; all creative people are different from the ordinary public—it is what makes them creative. They should be respected because they are different, and thus contribute to the understanding of the world around us."

SEE PAGE 57

For An Important Bulletin

Skimming Industrial Headlines



Edited by Paul Cliff

Steel-Shod Russians

There was a time when Russians actually wore shoes with steel soles, American Machinist comments. This was in the 13th century, and the wearers were tribesmen who inhabited the lower Central Ural Mountains. The soles were an inch thick, and were grooved to prevent slipping. Being absolutely rigid, they had no give, and probably were uncomfortable. But they were economical. The shoes were passed from generation to generation, and never wore out.

Lockheed's F-104 Starfighter

How much flight is there in the thin, short and sharp wings of Lockheed's F-104 Starfighter?

Enough to carry it successfully through about 40 years of normal service.

California Division of Lockheed Aircraft Corp. put the sharp, thin wing through nearly 11,000 successive, 2-hour combat flights simulated during a grueling 3½-year-long fatigue test program.

In such tests, powerful hydraulic jacks repeatedly bend and twist the part to torture it and try to make it break.

In contrast to conventional methods which applied an unvarying pattern of forces in such tests, Lockheed for the first time employed a new flight-by-flight loading concept.

Simulating the rapidly changing pressures encountered by a combat F-104 from takeoff run through all phases of flight and back to landing, loads were applied in the sequence expected during each complete flight.

Researchers used two groups of special hydraulic jacks in the tests to create the load conditions identified with both subsonic and supersonic flight maneuvers.

The first structural failure occurred (finally) after 10,793 "flights" involving more than 1,000,000 flight-like load applications duplicating all phases of an actual operational mission.

Further, the engineers reported they found that even with 60 per cent of the wing-fuselage attachment rendered inoperable the wing continued to carry its design load.

World's Highest Dam

The Vaiont Dam across the deep, narrow gorge of the Piave River in Northern Italy will be the highest in the world when completed next year. The arched concrete structure, only 623 feet wide at the top will rise 870 feet from the river bed—over 100 feet taller than Mauvoisin Dam in Switzerland and 144 feet higher than Hoover Dam in Colorado.

Radio Station For $25

A tiny portable FM radio transmitter can be built from commercial parts costing only $25. The microphone-transmitter, powered by a standard transister radio battery, is about the size of a deck of bridge cards and has a range of about 200 feet—just right to serve as a portable public address microphone.

Tiny Screws Provide Headaches

Tiny screws have been providing king-sized headaches for space engineers and scientists. Thinner than a fine needle, they are vital components of the delicate instruments and controls in missiles and rockets.

Until recently, there were no standard screw sizes at those Lilliputian dimensions, and engineers had to design their own screws for every new instrument.

Now, a solution has been reached. A publication called "American Standard Unified Miniature Screw Threads," has been approved by the American Standards Association. It establishes a new thread series that will go a long way towards simplifying design of space-age instruments, as well as watches and other more down-to-earth miniature mechanisms.

The new publication establishes fourteen standard screw thread sizes, with a standard design that covers all of them.

Screws covered by this standard are so tiny that 75,000 of the smallest of them would fit in a thimble. The threads on these are invisible to the naked eye. The diameters of the screws range from one-hundredth (0.01) inch to six one-hundredths (0.06) of an inch.

Closed-Circuit Auction

The Army will auction a billion and a half dollars worth of surplus equipment this fall over a closed-circuit television network. Machinery, tools and supplies stored at depots all over the East will be put before bidders at large-screen TV setups in New York City, Boston, Philadelphia, Columbus, Chicago and St. Louis. Bids will be made and accepted via two way radio.

Burglar's Apprentice

The "jimmy," a short crowbar often used by burglars, was invented in the Middle Ages and got its name from burglars' apprentices, who were all called "James." When a bright crook invented the handy tool, he named his new helper after his old one, and the name stuck.

Moth Fighter

Compounds that are colorless, odorless and harmless to humans now protect textiles from attack by insects. Called metabolites, the compounds—differing only slightly in chemical structure from vitamins—upset the digestive system of larvae by causing embryonic starvation. Full-grown insects, however, recognize the difference between the compounds and real vitamin-bearing materials and make no attempt to approach fabrics treated with them.

New Source of Electrons

Electronic tubes of the future may some day be "transistorized," according to Westinghouse Electric Corporation scientists. It all depends on whether they can make practical use of an effect physicists have discovered recently by which it is possible to obtain a constant flow of electrons directly out of the surface of certain semiconductor materials.

The latest semiconductor to yield this unique flow of electrons is silicon carbide—a hard, crystalline solid best known for its widespread use in impure form as an abrasive in grinding wheels. The density of the electron flow or "emission" they find, is equal to that in the average electronic tube.

"In recent years, transistors and related devices have replaced conventional electronic tubes in a wide variety of modern electronic equipment," Dr. Clarence Zener, director of Westinghouse research, said in disclosing the new discovery. "By removing the most serious limitation of the ordinary electronic tube this discovery in semiconductors might reverse this trend and bring a new lease on life to the very device which semi-conductors seem destined to outmode."

An electronic tube functions by regulating the flow of a stream of electrons across a vacuum inside it. Conventionally, these electrons are obtained by boiling them out of a coated metal wire, or cathode, at high temperatures. Considerable electric power is required to supply the necessary heat, which then must be dissipated to prevent overheating of the tube itself.

"Applied successfully to a vacuum tube, this new method of electron emission from semiconductors would do away with this whole inefficient process," Dr. Zener declared. "One can visualize a tube in which the usual heated cathode is replaced by a small semiconductor crystal having a built-in 'junction' like that in a transistor. The crystal would consume a negligble amount of power and would yield electrons instantly and indefinitely when a small electric voltage is applied across it.

"Such a device would, in effect, combine into a single operating unit many of the inherent advantages of both semiconductors and vacuum tubes. It would result in what might be called a 'solid state' electronic tube."

The escape of electrons from silicon carbide accompanies the emission of visible light from the crystal. This visible light is a form of electroluminescence, and occurs when enough voltage is applied across the junction to cause breakdown, that is, loss of the junction's normal electrical resistance.

A possible electronic tube of the future being constructed and tested by Westinghouse.

When breakdown occurs, small blue spots of light appear in the crystal in the region of the junction. Electrons escape from these bright, light-emitting spots, especially from those located nearest the surface of the crystal. The spots are small, only about 50 millionths of an inch in diameter. From the spots the Westinghouse scientists have measured currents up to one millionth of an ampere, which indicates that the density of the electron flow is quite comparable to that from the cathode of a typical vacuum tube.

Although a millionth of an ampere is a small current by everyday standards, many of the more sophisticated electronic tubes of today, such as beam-type camera and display tubes used in television and military electronic systems, may use considerably less current than this. It is particularly interesting that this perfectly adequate flow of electrons originates from a tiny, pin-point source. Such a source would have many advantages in the construction of complicated tubes. It would simplify focusing of the electron beam and eliminate much of the complicated tube construction now employed for this purpose.

In view of the present-day emphasis upon minaturization of electronic equipment, elemination of the large, hot, power - consuming cathode would be a major advance in electronic tube development. The potential advantages of such a "solid state" have stimulated at the Westinghouse research laboratories further research on the electron emission from silicon carbide as well as a program aimed at making eventual use of the phenomenon in working devices, the Westinghouse scientists reported.

Boon For Motorists

Motorists in Tulsa will no longer have to stand around and stare at grease racks while waiting for their cars to be repaired. A soon-to-open Oklahoma service station will feature an air-conditioned lounge equipped with television for its customers.

Ultrafast Acting Anesthetic

Heinrich Gruber of Berlin, Germany, has been granted a patent for an ultrafast acting, short-term liquid anesthetic for intravenous injection based on a derivative of barbituric acid. (U.S. 2,839,447). By the addition of a suitable quantity of glycerine, the stupor usually induced by a barbituric drug is overcome and a patient is in full command of his faculties immediately on awakening and is "fit" after only thirty minutes. Presence of diethylether in the anesthetic formulation stimulates breathing and metabolism, thus expediting the decomposition of the drug in the body. The anesthetic is recommended for localized operations requiring a short period of time.

Five-Purpose Lamppost

New York City plans to replace its 120,000 lampposts with a five-purpose fixture. The new lampposts, now in the design stage, will provide street light-fire alarm boxes and street signs in a single installation. New York hopes ebentually to replace all of its 64 different types of ornamental lampposts with the new model.

FROM YOUR MECHANIC GET THE BEST

Precis

There are two ways to keep your car in perfect shape. One is to put it in dead storage. The other is to find a good mechanic and to stick with him.

The first solution doesn't make much sense. The reason we buy a car is to use it: for business, errands, fun. The only way to be sure that it will be ready to use when it's needed is to see that it gets consistent, expert care. And that's easy to do if you go about it the right way.

Unless you've worked with cars most of your life, you should trust your automobile to the professional of the business—your neighborhood mechanic. If you're not an expert, resist the temptation to save a couple of dollars by doing it yourself. One slip of the hand can ruin an expensive part. Poor adjustment of a vital function such as ignition timing can cost you money in poor performance, high gasoline consumption and reduced engine life.

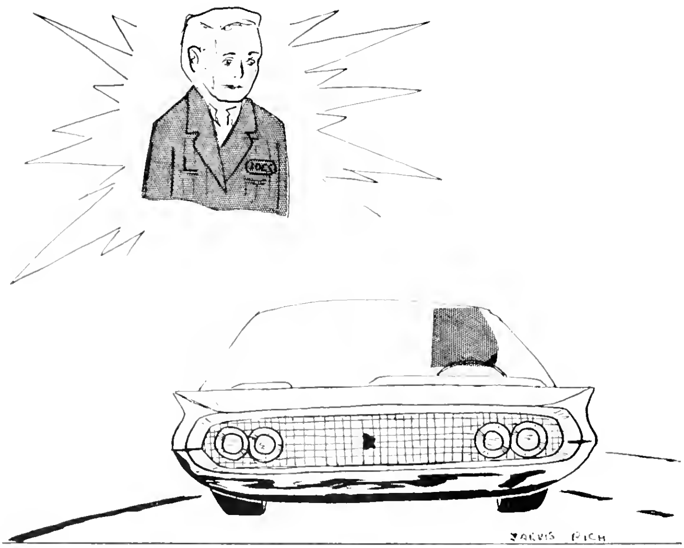
Pick a mechanic with a reputation for fair dealing and good work, and then stick with him. He's had rigorous training for his job. If he specializes in a particular make of car, he's probably attended training courses run by the manufacturer. If he repairs all makes, there's a good chance that he has had formal mechanical training in addition to a lifetime of working with cars, first as a teen-age hobby and later as his livelihood.

You'll find that most top mechanics keep up with the latest developments in the field by attending clinics run by parts and equipment manufacturers, such as American Brakeblok's famous brake service clinics. Other manufacturers keep them supplied with literature and service manuals covering every component of your automobile. In service stations these days you'll find such exotic equipment as oscilloscopes, exhaust gas analyzers and electronic dwell meters. They're a sure sign that today's mechanic is a specialist in a specialized job—keeping your complex automobile in perfect condition.

What can you do to get the most from your mechanic at the least cost? A number of things. First, tell him the symptoms, but don't try to do the diagnosis yourself. Give your mechanic the same credit for knowing cars that you give your doctor for knowing medicine. Let him do the diagnosis and treatment.

Ignoring this piece of advice can make it expensive for you. Take the case of the guy who was having trouble getting his late model V-8 to accelerate. It would hesitate and then lurch forward. Our friend had read an article on automatic transmissions, telling how a worn or slipping transmission band could cause that kind of trouble. So he instructed his mechanic to adjust the transmission and replace any worn bands. Since he was a guy that knew exactly what he wanted—and sounded like he knew what he was talking about—the mechanic followed instructions.

Two days later our hero got a healthy bill for parts and labor, and a guarantee that the transmission was now in top shape. But when he got out in traffic his car still hesitated and lurched. So he went to another mechanic. But this time he let the auto man do the trouble-shooting. Trouble: dirty carburetor. Cure: a thorough cleaning. Bill: a fraction of the cost of the transmission work. The unfortunate part of the story is that our friend is somehow convinced that the first mechanic was a sharp operator who took him for the price of an unnecessary transmission job.



Once you've found a mechanic you trust, keep him up to date on any symptoms of trouble. Let him listen to the engine perhaps give the car a short road test whenever you have a tune-up or grease job done. His trained eyes and ears will probably spot impending trouble long before it becomes serious, or expensive. He'll be glad to discuss your car with you and to recommend preventive maintenance that will keep your auto's condition up, and your repair costs down.

What about his charges? How do you know you're not being taken? Will he stand behind his work?

Relax. Although the automotive trade has a fringe of unethical operators—just as any other business does—the vast majority of mechanics and service station owners are honest. They're interested in building a following of regular customers, not in making a fast buck one step ahead of the Better Business Bureau.

Ask for an estimate on any job that's bigger than a tune-up. Most of the time you'll get a firm bid you can rely on. Occasionally, your mechanic will refuse a binding estimate until he's dug into the car. This perfectly legitimate; a lot of unexpected troubles can be hidden under the cylinder heads and oil pan. Just ask your mechanic to check with you before he does anything that will run into money.

Here's a money-saving tip. Whenever you have a repair job done, ask what other jobs can be combined with it. For example, a ring job, bearing replacement, and valve job can all be done together at a fraction of the cost of doing them separately. Ask your mechanic what else your car needs and whether it would be cheaper to have it all done together. There's not much satisfaction in having the engine torn down for one job, only to have it torn down again a few weeks later for something else.

Not satisfied with the results of your mechanic's work? Go back to him instead of trotting off to another serviceman. Talk it over. If he goofed, chances are he'll make it good. But remember that today's automobile is a complicated organism. Even if it has been put in top condition, an unforeseen breakdown can happen at any time.

In any case, the best protection against unexpected troubles and unbearable costs is to pick a good mechanic and to stick with him. He can be the best friend your car ever had.

* * *

THE COED

Between the sincerity of old age and discrimination of childhood there is a strange and uncanny age of the "coed." Coeds come in assorted sizes, weights, shapes and colors. They can be found everywhere —inciting panty raids, reading the latest edition of "Confidential," and bragging about that date with the campus hero they wish they could get.

A coed is exotic with mascara on her eyelashes, demureness in a sweater, and "The Future Homemaker" with a can opener. A coed is a composite—she is as funny as a train wreck, as modest as Lady Godiva, as subtle as a kick in the pants, has the taste of "pheasant under glass" and when she wants something, it is usually a date. Who else can talk more and say less. She is as cunning as a rattlesnake, as meek as a tiger, and as graceful as a giraffe.

She likes flattery, champagne, big cars, wedding rings, windy street corners, her roommate's clothes, and boys—anytime. She is leery of cheap dates, housemothers, western movies, hillbilly music, work, and other girls.

Nobody else can cram into one little billfold a complete picture album, five recent love letters, a box of Kleenex, her boy friend's car keys, eight safety pins, and a flashlight for emergencies on dates. After four long years of faithful companionship during which she has accumulated your ring, your letter sweater and your fraternity pin, you receive the two most heart-warming words in the whole world . . . "Dear John."

* * *

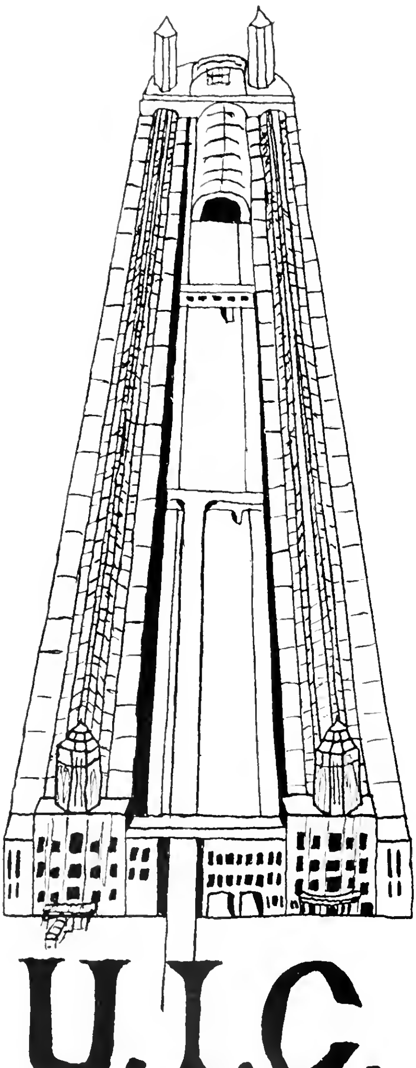
If young girls stay out late, drink, smoke and pet, men will call them fast —as fast as they can get to a phone.

MY SLIDE RULE

There are many like it but this one is mine.
My slide rule is my friend
And I shall learn to love it like a friend.
I will obey my slide rule.
When my stick tells me that 5x5 is 24.8,
Then by god, five times five is twenty-four point eight!
I will learn the anatomy of my slide rule,
Though I die in the struggle, I will use every side,
The black scale and the red, the inverted C and the inside out log,
The reversed A and the mutilated D.
I will master them all, and they will serve me well, they will!
I will cherish my slipstick and never shall profanity sear its long, graceful mahogany limbs.
My slide rule shall be my brother in suffering through long hours of midnight toil.
We will work together, my slide rule and I.
And on the great day when my slide rule and I have finished our appointed task and the problems are done and answers are right.
I will take that damn stick and have one hell of a fire, I will!

NAVY PIER STAFF

(1959 - 1960)



The Navy Pier column this month will be devoted to the introduction of the Pier staff. All returnees have three things in common; they are all nineteen, they are all in engineering, and they all like to write for TECH.

SHELDON ALTMAN is Navy Pier editor of TECHNOGRAPH. A graduate of Austin High school, he became active in the school concert and marching band. While in High school Shelly also played trumpet for a small combo. At present he is a fifth semester mechanical engineering student. As a staff member he has been both circulation and business manager. His contributions to the magazine were published quite frequently last year.

ARVYDAS TAMULIS came to the Pier from St. Ignatius High school. While there he deboted with the high school team. This experience has added to his creative skill as a writer; Arvy is also active in the Lituanica Club. He is a third semester engineering physics major.

MIKE MURPHY, is a graduate of St. Rita H. S. He is a third semester civil engineering student and is active in the ASCE. Mike contributed some fine material to the magazine last semester, including a competent report on Chicago's new exhibition center and the controversial filtration plant.

EILLEEN MARKHAM has come to us from Alverina H. S. A varsity debater, with high school experience in the same, she is the president of the UIC chapter of Pi Kappa Delta. Last years Navy Pier editorial was her work. Among her other interests are scouting (she's a Mariner leader), swimming (she's an instructor) and classical music (strictly a listener). Added note: Eillen is a third semester electrical engineering student.

IRVIN TUCKMAN, a third semester EE, has added his artistic talents to our group. While at Von Steuben H. S., Irv, won a Museum of Science and Industry contest for his design of a wind tunnel based on the Venturi Effect. His big writing assignment for TECH was co-editing the St. Lawrence Seaway report.

The *Technograph* staff wishes to correct a mistake in the May 1959 Navy Pier issue.

An article, "Central District Filtration Plant," was run minus the name of one co-author, Arnold Feinberg. We also wish to credit Mr. Feinberg with the photographs accompanying the article.

Used But Not Gone

by Olga Ercegovac

What happens to all that water that runs down the drain while you're waiting for it to get cold enough for that comparatively small drink? It runs down that drain into a sewer and mixes with wastes from other homes and industry. You probably don't feel very extravagant unless you live in a community threatened by a water shortage. If you have lived in California, you are probably more aware of such a situation.

California is having trouble because of its rapid decline in ground water and the intrusian of sea water. No one enjoys living in a community where he cannot feel at ease taking an extra shower on a muggy day or watering his parched lawn. Over conservation can be a trying thing. Why not re-use some of that precious water?

This question has been asked before, but even the American heritage of extravagance has been overworked. One California town sends a 2000 ton train of water (which we just spent a good deal of money on in the way of treatment) to transport only one ton of organic solids. And what's more—we throw away the train at the end of only one trip. In most common cases of well-treated sewage, one good burro could carry all that is required of a half a million gallons of water. The usual type of water provision plans take much time to get in operation. This is not the case with water and sewage reclamation.

First of all, what is sewage reclamation? There is no standardized definition, but it is usually considered as a purposeful upgrading of the quality of sewage. It is done with the intent of making it useable by agriculture, industry, or the public. Sewage reclamation may also be the actual utilization of sewage effluent which has undergone suitable treatment for some other reason. The term does not apply to treatment of sewage for the mere purpose of disposal. Nor does it apply to incidental reclamation achieved by dilution of sewage discharge into water courses for the purpose of disposal even though the water from the stream may be of suitable quality for beneficial use. Usually sewage receives minimum treatment just so it can be legally thrown away. This minimum is dictated by advancing standards of a growing population based on public health, aesthetics, and the rights of other water users.

Sewage reclamation has been in practice since 1930; but even in sections of the country where the water shortage is acute, sewage is disposed of with no reclamation. We have been slow to re-use waste water because of delays in technical, engineering, economic, psychological, and legal departments. Besides these, engineers and public officials tend to think of the collection, transportation, treatment, and distribution of water as one complete package; while the recollection, transportation, and re-treatment of the same water is considered an unrelated job of scavenging.

In 1930, Goudey demonstrated that highly treated sewage could be safely applied to ground water by surface spreading. In 1949 Arnold, Hedger, and Rawn found ground water recharged with treated sewage to be both technically and economically feasible. A general lack of interest in sewage reclamation delayed further scientific investigation. Until quite recently, it was believed that direct recharge of ground water was impractical because of clogging due to suspended matter in sewage effluents, and it was feared that pathogenic bacteria might travel long distances with moving ground water.

Even industry did not consider reclamation very seriously. Transporting the water back to potential users incurred large expense. Few cities were willing to tear up paved streets to lay new networks of pipe. Not only is it already crowded, but it is difficult to keep two separate water systems in one plant. Further inhibitions were due to the unknown economics of the situation. It is easier to mine out the existing ground waters than it is to reclaim sewage. Not too many people think of the long-term consequences to the natural resources. This all brought up the concept of water rights. Who would own the water that was recharged at public expense? What restriction could be placed on its withdrawal from an already over-pumped ground water basin? There was little interest in solving the problems that were connected with the whole concept. People want to go along for as long as they can get away with it.

It is too bad about the general lack of interest in sewage reclamation. Water supplied by reclaimed sewage could have well used more research. If present standards of nutrition are maintained, six million acres of newly irrigated crop land must be brought into full production by 1975. This land will lie in seventeen western states and need near three acre-feet of water per acre. This means we will need eighteen million acre-feet of water per year to make it useable. Going by a present census, we find that the total sewage flow is about three million acre-feet or one-sixth of the demand if the entire sewage flow can be reclaimed. Sewage reclamation is not sufficient to meet the irrigation demands, but these tremendous volumes of water can certainly help relieve the situation.

COMPARISON OF FRESH AND RECLAIMED WATER COSTS

location	*fresh*	*reclaimed*	*use*
Golden Gate Park California	$ 66	$ 21	lawn and shrub irrigation and ornamental lake
Grand Canyon Arizona	550	120	lawn irrigation
Los Alamos Mexico	92	24	power plant cooling water
Santa Fe Mexico	75	49	irrigation of golf course

cost is dollars per acre foot

Approximately half a billion gallons of water are wasted to the ocean each day after only single useage in California's two greatest centers of population. This is enough water to represent the combined yield of 350 12″ wells each producing 1000 GPM continuously. It is enough water to produce 7800 tons of steel daily at normal figures of 64,000 gallons per ton. Or this volume of water could irrigate 100,000 acres of land even if half of it were lost through evaporation during storage. Although it is not enough, this water can still go a long way.

Because most sewage effluent occurs in populated areas, this is where it is used. It can be used for industry, local irrigation, and domestic supply. The first two uses are most promising. Sewage reclamation water for domestic supply is hindered by aesthetic considerations as well as high costs for greater refinement. However, sewage effluent may be used by the public to recharge ground waters and thus become part of the water supply, or to irrigate parks and golf courses or even maintain recreational ponds. In some large cities, reclaimed sewage is used in peripheral agriculture or in maintenance of pasture land for dairy cattle not currently producing milk. Industry sometimes seems the more logical user. For over fourteen years the Bethlehem Steel Company has been using the sewage effluent of Baltimore for cooling blast furnaces, open hearths, rolls in rolling mills, wire drawing machines, quenching and granulating blast furnace slag and cleaning gases. This has been done at great savings to both the city and the company. Savings are common with the use of reclaimed water as can be shown by the attached table. Even when sewage is treated to meet public health standards, it can still compete with fresh water in cost. Most of the investigation of use of sewage effluent in the United States has been done by studies sponsored by the California State Water Pollution Control Board. The Board has found that the treated sewage can be applied to soil at the rate of one-half acre-foot per acre per day and that intestinal bacteria are removed from the liquid within the first four feet of travel through the soil. From another study sponsored by the Board, a practical method of recharging well operation by direct injection into ground water was developed. The public health safety of this procedure was also demonstrated. Bacterial travel with moving ground water did not exceed one hundred feet even though the settled sewage introduced carried away very high concentrations of organisms. The Board has confirmed the use of sewage effluent for irrigation in agriculture and for cooling water in industry.

The field of irrigation has been greatly influenced by the use of sewage effluent. When the practice was first begun, the economy of installation and operation usually resulted in too much sewage on too little land. Results were unfavorable and much of the practice was stopped. Much of the trouble was due to the fact that disposal was the primary object and the raising of crops and replenishment of ground water were secondary. New methods of using sewage effluent for irrigation emphasize conservation and agricultural utilization. This practice returns to the land as much as possible of the organic and fertilizing elements that have been withdrawn from the soil by harvesting foodstuffs. This results in superior growth of crops. The new technique uses a low rate of application over large areas of land integrated with planning of agricultural crops and requires proper maintenance and operation of all irrigation and agricultural devices.

When using sewage effluent for irrigation, some type of pretreatment is necessary even if it is just plain sedimentation. This removes coarse solids by thirty minute detention. Pretreatment advantages are: less wear on pumps, reduced sludge deposits in ditches and pressure sewers, prevention of poisonous product formation, no clogging of soil, and opportunity to rest the soil if outlet to a stream is feasible. With primary treatment the fertilizing value of the sewage effluent is lost as is the case with secondary treatment.

The irrigation methods used should be adapted to local farming practices, nature of soil, climatic conditions, topography, and the types of crops raised. The types of irrigation that can be used are spray, broad surface, ridge and furrow, flood, and subsurface. Drainage must be carefully watched at all times and the whole system of irrigation must be carefully planned.

At the present time irrigation with sewage effluents is carried on in two places in Arizona, seventeen in California, one in Nevada, four in New Mexico, and four in Texas. Industries using sewage effluents number seven in in Arizona, four in California, two in New Mexico, four in Texas, and one in Utah.

In the future it is predicted that reclamation plants will not be connected with treatment plants, and water reclamation will be carried on in its own right. At the present time there is only one plant that has been specifically designed for water reclamation alone. When ground waters are exhausted and people have to pay for transportation of water, the economic barrier to reclamation will be broken. There are only three sources of water suitable for ground water replenishment; runoff water, imported water, and reclaimed water. The technical and economic feasibility of water reclamation are sending our water back for re-usage.

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Bubble Mining

A Chicago company has patent applications in the U.S. and 31 other countries on a low-cost, "soap and bubble" method of recovering metals from sea water. Developed by a South African university professor, the method uses selected soaps to chase minerals to the surface when bubbles are blown through the water. The professor estimates it should be possible to get 600 tons of aluminum, two tons of uranium or 240 ounces of gold daily from the sea.

INVISIBLE POWER

by Gerald Wheeler

Sooner or later, every young engineering student is faced with the solution of problems involving power. We learn early in our freshman year that power is defined as "the rate of doing work." Work, in turn, is defined as "the product of a force acting through a distance in the direction of that force." After mastering these fundamentals, we proceed to solve innumerable problems without ever considering the source of power involved. We know that gasoline is used in our cars, coal or oil is used to heat our homes, and gasoline keeps our rooms well lit. But there is a new source of power rapidly becoming the most popular of all. That source—natural gas.

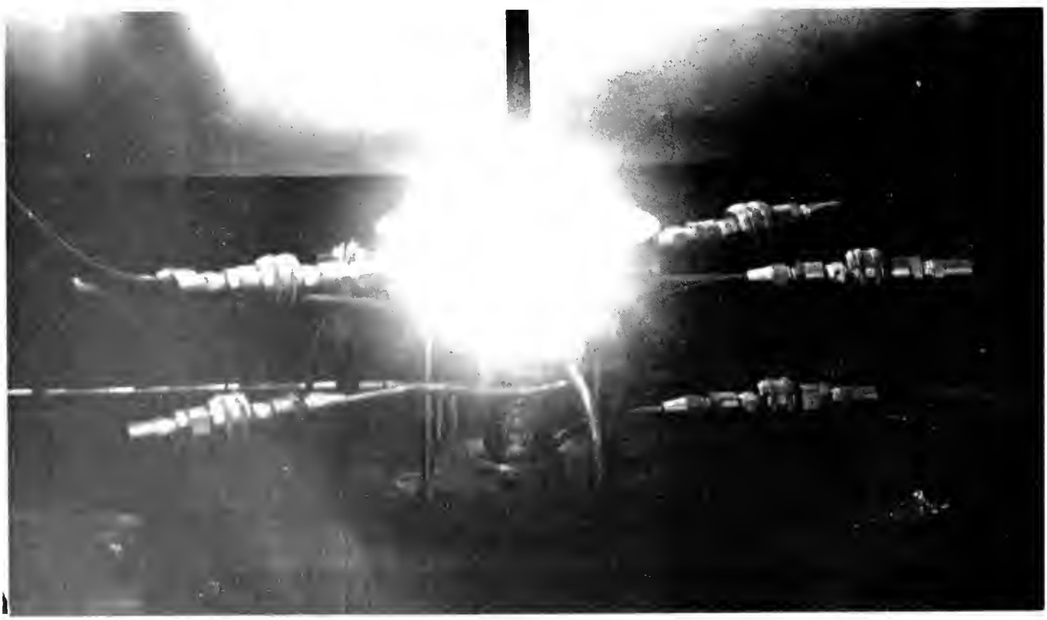
The statement "new source of power" must be qualified. It is new only in the sense that it has not been used commercially to any extent in the past. Actually, it is millions of years old. The ancient people referred to the constantly burning fires that escaped from earth fissures as "wild spirits" or holy altar fires." As late as 1934, natural gas was regarded as a nuisance by many oil men. Why has this source of energy suddenly become so popular in the modern home and industry?

Without knowing anything of natural gas, one might intuitively answer "economics." This is the primary reason. Although the gas has long been available, there has been no way of transporting it to the home or industry. If there were some way, the consumer would probably be willing to pay a little more for it considering that he would have no soot or waste products. But how? The answer was by pipeline. But of what shall the pipe be made? And how shall we lay the pipe across rivers, up mountains, and through swamps? Here was another case of the natural resources going to waste while man's industrial might grew strong enough to solve the many problems.

The first effort made to use natural gas publicly was in 1824, in Fredonia, New York. Hollowed out logs carried the gas from a 27 foot ell to two stores. This was all right for local use but hollowed out logs would certainly not be very practical as a piping system from Texas to New York. It was not until the 1920's that the steel industry had advanced to the point where thin walled pipes could be produced economically. Since pressure in the pipes often exceeded 700psi, great tensile strength was required. Meticulous research and development was carried out to the extent that present day finished pipe properties include an ultimate strength of 72,000 psi, yield point of 52,000 psi, and elongation of 22% in 2 inches. Once the pipes were made available, underground pipelines spread across the country from New Mexico to Vancouver and from Texas to New York. At the present time, natural gas pipeline mileage exceeds that of the railroads.

The size of the larger pipes is phenomenal. In fact, everything in the natural gas industry seems to be done on a grandiose scale. The "Big Inch" and "Little Big Inch" pipes running from Texas to the eastern seaboard are 24 and 20 inches in diameter, respectively. Pacific Gas and Electric Company's "Super Inch" from New Mexico to California is 34 inches in diameter. The "Big Buck" trencher, used to scoop out the bed for the Super Inch weighs 31 tons. Digging a ditch 44 inches wide and 5½ feet deep, it can provide a mile-long trench in one day.

Once the production of suitable piping was a reality, the problems facing the large gas companies were of a tactical nature. Specifically, how to go over the mountains and across the rivers? The pipeline could not be laid around the bottom of the mountain because of the possibility of landslide damage. By



laying the pipes straight up to the top and then down the opposite side, the moving earth rides along the side of the pipe. This mountain work entails step by step sweat labor. Distances traveled in these areas are measured in feet per hour.

Rivers are spanned according to their turbulence. If the river contains many rapids, shifting beds, and seasonal changes, chances are that the company will make arrangements to attach their line to a railway or highway bridge. If none are available, they may build a suspension cable of their own. Most of the lines, however, are sunk beneath the rivers. in this case, they are usually weighted down by large concrete sections.

By 1929, pipelines had been laid from the Texas Panhandle to Chicago, Detroit, Minneapolis, and Denver. But then the depression halted the building of more pipelines, for the cost of oil and coal fell so low that natural gas could not compete. During World War II, the price of gas and oil rose while natural gas regained its competitive position. Both private individuals and large industrial firms found that natural gas as a heating fuel provides ease of control and fuel uniformity. It was shortly after the war that the tremendous boom in the gas industry began. By 1953, over 315,000 miles of natural gas pipelines existed in the country.

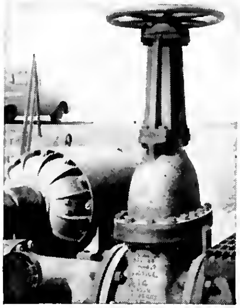
Accompanying the rapid rise in popularity was another problem. House heating during the winter created exceptionally high peaks in the use of gas. Companies in the Chicago area were sometimes using 15 times as much gas on a cold day as on a warm one. It seems that the only thing consistent about the weather is its inconsistency. Temperatures may range above normal during the cold months of one year only to average below normal the following year. The gas that is supplied to the domestic users is on tap from the southern oil fields. Since the velocity of flow through the pipes was only about 15 mph, a sudden cold snap could easily result in the demand for gas exceeding the supply. How then could the companies insure their users that they would not be caught short during the winter months? Perhaps larger pipes could be built that would supply a large metropolitan area through the bitter cold months.

A little thought will show that larger and more extensive pipes were not the answer. If the natural gas supply transported here by pipeline for the Chicago region were used primarily to serve house heating consumers in the winter months, the pipelines would, for the most part, lie idle in the summer and would be only partly used during the major portion of the year. At the present time, the situation is such that the unused gas of the summer season (that is, unused for domestic heating) is sold to industrial customers on a low-price interruptible or off-peak basis. In return for the lower gas rates, the industrial customer is subject to shutoff during periods of cold weather because domestic customers have a priority on the use of all the gas available. This settles the problem of summer use but might still result in an insufficient supply during the winter. Could we possibly store up the gas for emergency use? Various attempts were made to store the gas in cylindrical man-made tanks but the above-ground holders were found to be impractical from the standpoint of both capacity and cost. The problem was finally solved by storing up huge quantities of gas in worn-out oil and gas fields. Where the capacity of the largest above-ground storage tank is about 15 million cubic feet, the average capacity of 151 underground storage pools at the end of 1952 was more than 572 times as large.

The Chicago area, which is one of the world's largest natural gas consumers, unfortunately has no depleted oil fields nearby. For this reason it was necessary to undertake the "Herscher Dome" project. Geologists discovered that a large geologic trap (anti-syncline) in the region of Herscher, Illinois, contained a thick sandstone formation which was well adapted for the storage of great volumes of gas. It underlies approximately 15,000 acres, or nearly 24 square miles. In comparison to the 16 gas holders of the Peoples Gas Light and Coke Company now in operation in Chicago, which have a total capacity of 106 million cubic feet, the Herscher Dome has a 90 billion feet capacity.

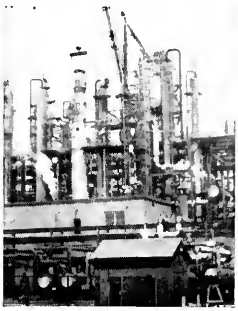
The problems now facing the gas industry are small indeed in comparison with those of the past. Every day more and more people are switching to gas for heating, cooking, refrigeration, and air conditioning. Although a prodigous amount of natural gas has been wasted in the past, the consumer need not worry about the supply being depleted in the near future. Proved reserves are three times as great as they were 12 years ago and 10 times greater than they were 30 years ago. Today's reserves are over 185 trillion cubic feet. Even today, more gas is being discovered than is being used.

Metal quiz... you might have to take one like it again when you design equipment. Try your hand at it now. But remember to take advantage of the help INCO can give you when really tough metal quizzes come your way in your future engineering jobs.



☐ **Refinery valve**—Needed: resistance to attack from petroleum products, thermal and hydraulic shock. Which alloy . . . ?

☐ **Turbojet afterburner shell**—Needed: strength plus corrosion resistance at high temperatures. Which alloy... ?

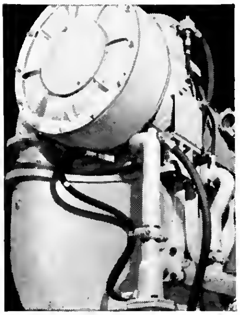


☐ **Recovery tower**—Needed: resistance to hot coke oven gases and aromatic chemicals, long service life. Which alloy... ?

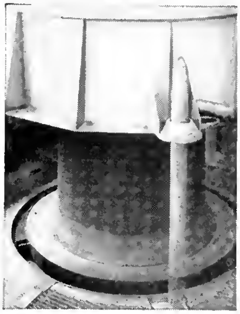
See if you can tell which of these nickel-containing alloys proved to be the answer to these problems. Put the right number in the right box.

1. Ductile Ni-Resist*
2. Nimonic "75"* nickel-chromium alloy
3. Nickel-aluminum bronze
4. Ductile iron
5. Monel* nickel-copper alloy
6. Inconel* nickel-chromium alloy
7. Type 316 chromium-nickel stainless steel

See answers below



☐ **Diesel manifold**—Needed: scaling and oxidation resistance at 1200°F, resistance to thermal shock. Which alloy ?



☐ **Heat treating retort**—Needed: light weight, ability to endure destructive heating-cooling cycles. Which alloy... ?

☐ **Ship's propeller**—Needed: lighter weight and resistance to erosion and salt water corrosion. Which alloy... ?

☐ **Regenerator pre-heater**—Needed: trouble-free service handling hot caustics, fabricating ease. Which alloy... ?

When you start to design equipment, you'll have to select the proper material to meet given service conditions... a material that might have to resist corrosion, or wear, or high temperatures, or a combination of these conditions.

Over the years, Inco Development and Research has gathered information on the performance of materials in many such problems. Inco's List "A" and List "B" contain descriptions of 377 Inco publications which are available to you, covering applications and properties of Nickel and its alloys. For Lists "A" and "B", write Education Services.

The International Nickel Company, Inc., New York 5, N. Y.

*Registered trademark

ANSWERS:
- Refinery valve... Ductile iron
- Turbojet afterburner shell... Nimonic "75"
- Recovery tower... Type 316 stainless
- Diesel manifold... Ductile Ni-Resist
- Heat treating retort... Inconel alloy
- Ship's propeller... Nickel-aluminum bronze
- Regenerator pre-heater... Monel alloy

INCO **Inco Nickel**

makes metals perform better, longer

BRAIN TEASERS

Edited by Steve Dilts

A certain farmer received an order for four crates (A, B, C, and D) of eggs. The order stated that the number of eggs in any two crates was to be a perfect square, and the number in whole four crates must also be a perfect square.

Now the farmer's problem is: What is the smallest number of eggs that can be put in the crates to fulfill these conditions—a different number being in each crate.

* * *

It's not exactly the time of year for fishing, but here is a fish story.

A man caught a shark and when boasting about it, he would only say that the head was 14 ft. long, the tail was as long as the head and one-quarter of the back while the back was as long as the head and twice the tail. Find the length of the fish.

* * *

If you are thinking ahead of spring vacation and are planning to take a trip, this teaser should provide some useful figuring.

A car makes three trips all of equal length. The speed in miles per hour of the second trip was three times the speed of the first trip, and the speed of the third trip was double that of the second trip. If the average speed of all trips was 30 m.p.h., find the speed of each trip.

* * *

A man, who had three sons passed away. In his will he directed that his total cash should be divided among them, except for a gift to the local hospital. He had a mathematical turn of mind, and after the will was made, he had worked the matter out and found that if he made the hospital gift to his eldest son, he would then have as much as the other two sons. But if he had given it to the second son, he would then have twice as much as the other two, while if he had given it to the youngest son, he would have three times as much as the other two. Now, if the man left a total of $1800, can you calculate how much each son and the hospital received as their share?

Three sailors come upon a pile of coconuts. The first sailor takes half of them plus half a coconut. The second sailor trakes half of what is lift plus half a coconut. The third sailor also takes half of what remains plus half coconut. Left over is exactly one coconut which they toss to the monkey. How many coconuts were there in the original pile? If you will arm yourself with 20 matches, you will have ample material for a trial-and-error solution.

* * *

BULLETIN

U. of I. scientists announced, deadline night, that preparations had been completed for launching a satellite into orbit. The *Technograph* was to be in on the project, they said, but they refused to release any further details.

* * *

A brain-teaser that calls for deductive reasoning with little or no numerical calculation is usually labeled a logic problem. Of course such problems are mathematical in the sense that logic may be regarded as very general, basic mathematics; nevertheless it is convenient to distinguish logic brain-teasers from their more numerous numerical cousins.

* * *

The most frequently encountered type is sometimes called by puzzlists a "Smith-Jones-Robinson" problem after an early brain-teaser devised by the English puzzle expert Henry Dudeney. It consists of a series of premises, usually about individuals, from which one is asked to make certain deductions. A recent American version of Dudeney's problem goes like this:

1. Smith, Jones and Robinson are the engineer, brakeman and fireman on a train, but not necessarily in that order. Riding the train are three passengers with the same three surnames, to be identified in the following premises by a "Mr." before their names.

2. Mr. Robinson lives in Los Angeles.

3. The brakeman lives in Omaha.

4. Mr. Jones long ago forgot all the algebra he learned in high school.

5. The passenger whose name is the same as the brakeman's lives in Chicago.

6. The brakeman and one of the passengers, a distinguished mathematical physicist, attend the same church.

7. Smith beat the fireman at billiards.

Who is the engineer?

For readers who care to try their luck on a more difficult Smith-Jones-Robinson problem, here is a new one devised by Raymond Smullyan, now working for his doctorate in mathematics at Princeton University.

1. To celebrate the Armistice of the First World War, three carried couples had dinner together. The following facts relate only to these six, and only their first and last names are involved.

2. Each husband is the brother of one of the wives; that is, there are three brother-sister pairs in the group.

3. Helen is exactly 26 weeks older than her husband, who was born in August.

4. Mr. White's sister is married to Helen's brother's brother-in-law. She (Mr. White's sister) married him on her birthday, which is in January.

5. Marguerite White is not as tall as William Black.

6. Arthur's sister is prettier than Beatrice.

7. John is 50 years old.

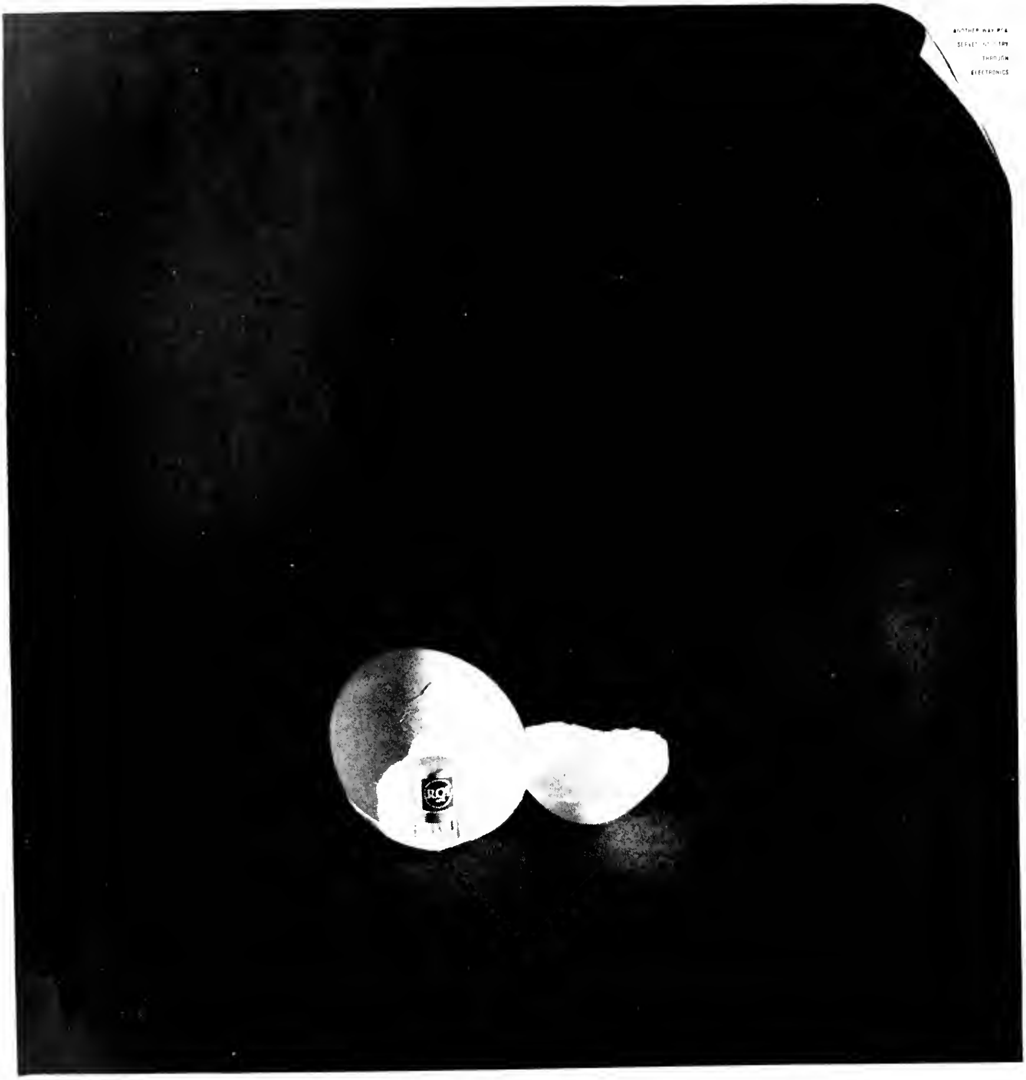
What is Mrs. Brown's first name?

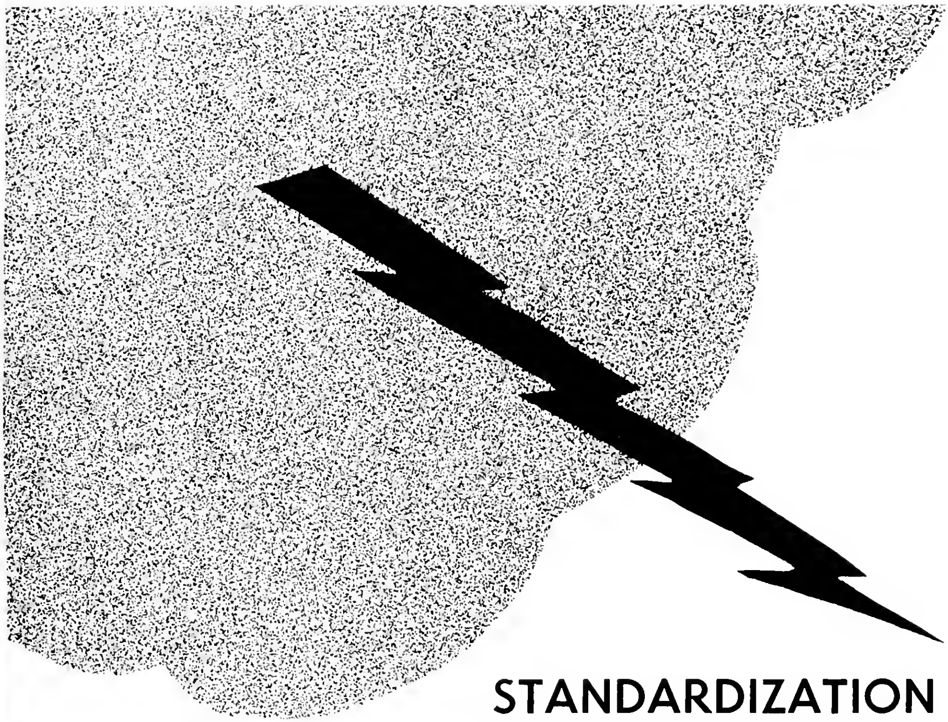
* * *

Three men—A, B and C—are aware that all three of them are "perfect logicians" who can instantly deduce all the consequences of a given set of premises. There are four red and four green stamps available. The men are blindfolded and two stamps are pasted on each man's forehead. The blindfolds are removed. A, B and C are asked in turn: "Do you know the colors of your stamps?" Each says: "No." The question is then asked of A once more. He again says: "No." B is now asked the question, and replies: "Yes." What are the colors of B's stamps?

* * *

The answers will appear next month for these teasers.





STANDARDIZATION

"The American economy could save at least $4 billion a year if all those who neglect standardization would now get wise to it," a group of engineers at a dinner observing National Engineers Week were told.

The speaker was Cyril Ainsworth, Deputy Managing Director, American Standards Association.

"Unless you are thinking in terms of the national budget, this seems like an awful lot of money going down the drain," he continued. "As our industrial economy moves into the space age, becoming larger and more complex, the waste is likely to increase, if we don't make some radical changes in our standardization procedures."

The knives, forks and spoons of our table cutlery are similar in size and shape to their counterparts all over the world. Their standards evolved through a slow process of elimination until the most acceptable shapes and sizes emerged. Practically all other tools throughout man's pre-industrial history were standardized by this same process of evolution, custom and preference.

This evolutionary process of standardization proved much too slow after the industrial revolution got into full swing. It took almost 200 years to develop and agree upon a workable safety code for steam boilers. Before it became available, boiler explosions were one of the most serious causes of loss of life and damage to property.

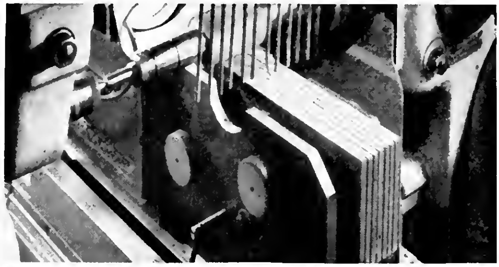
"In our budding space age, the nuclear reactor is comparable to the steam engine in the early industrial revolution. It's obvious that we can't wait almost 200 years for workable safety standards for nuclear reactors. Of course, individual nuclear reactors today are constructed with all possible safety features, but what is really needed are generally applicable safety standards for all nuclear reactors," Mr. Ainsworth pointed out.

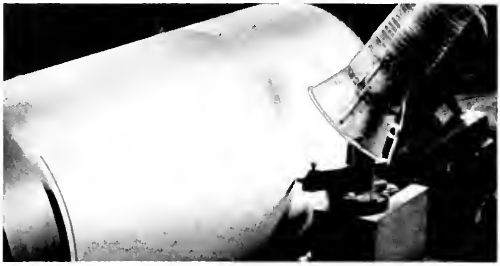
Unfortunately, American industry does not understand and subscribe as thoroughly as it should to the idea of standardization, said Mr. Ainsworth. It is best understood on the engineering level and in the purchasing office. However, the money needed to carry on standards work has to be authorized by management, treasurers, or in many cases, by contribution committees. Since these executives often are uninformed about the value of standardization and have other problems foremost on their minds, they often fail to understand the connection between long-range standards and future benefits.

"Let me give you an example," said Mr. Ainsworth. "The nuclear standards program initiated under ASA procedures costs about $25,000 a year to administer. This is small change compared to the multi-million dollar investments needed to develop nuclear power. Yet it is difficult, or almost impossible, to collect this amount fully! This in spite of the fact that the leading technical experts of every industry with an interest in this program are represented on the working committees. Financial support of ASA is too often handled as a contribution, much as a donation to the community chest. Such support is a sound business expense from which untold benefits are obtained."

The solution, said Mr. Ainsworth, is in education. Once basic research was viewed with suspicion. Today enlightened management knows its value. Standardization has not yet reached this stage of acceptance. Management is still reluctant to pay for standards projects that have no apparent direct relation to current production. Yet there is enough evidence that some of the greatest money savings have come from the long-range standards projects affecting all industry. Industrial safety standards are a case in point. They have reduced a fantastic toll in human lives and financial cost in lost manpower and production to an absolute minimum.

To all the combined advantages of Synthane Laminated Plastics ... add one more big plus—**MACHINABILITY**





There are many reasons why plastic laminates such as Synthane are well regarded. They offer—in combination—resistance to heat, wear, chemicals, oil, water; light weight; excellent dielectric properties and mechanical strength; dimensional stability. On top of all these, however, is the one property that makes Synthane practical—Machinability.

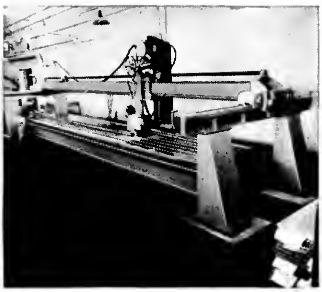
This means that whatever your application you may obtain parts of Synthane in the form desired and at a reasonable cost whether you require one or a million.

How Machinable is Synthane?

Synthane laminates are easy to machine, using ordinary wood or metal working machinery with only a few modifications of method. As an example, here are some standard machining operations readily performed on Synthane:

Shearing	Screw Machine Operations
Band Sawing	Planing
Circular Sawing	Shaping
Drilling	Punching
Tapping	Broaching
Fly cutting	Shaving
Milling	Sanding
Gear cutting	Grinding
Turning	Boring
Turret Lathe Operations	Tumbling
	Buffing

Practically all of these operations can be handled on standard machines, many with standard cutters. But the nature of the material, being softer and more resilient than metal, and being laminated and a poor heat conductor, often makes the



Sawing long lengths. One of the numerous special tools whose advantages are available when Synthane fabricates the material.

use of cutters with special rake and clearance, operating at special feeds and speeds, desirable.

The successful machining of Synthane laminates is aided by proper design of parts for ease of machining. A Synthane booklet: "Design Hints for Laminated Plastics*" adequately covers design recommendations.

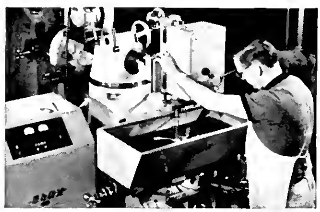
It pays to let Synthane machine laminated plastics for you

Although Synthane laminated plastics are easy to machine, it will usually pay you to have us handle the machining for you for these reasons:

1. All of our equipment is especially designed or adapted for the fabrication of plastics.
2. We are constantly developing new, faster, and more economical methods of machining Synthane laminated.
3. We make all of our own tools, dies, fixtures and jigs, quickly and economically.
4. We relieve you of all production worries: machining errors, rejects, waste, mistakes in dimensions or tolerances, and delays in delivery.
5. Because we combine manufacturing and fabrication in one location, we can maintain high quality control while solving difficult machining problems. When necessary, we can even modify the properties of a given grade of material to meet special requirements.

*Booklet available upon request.

For further information, write Synthane Corporation, 13 River Rd., Oaks, Penna.



Metal disintegration, a fast, economical way Synthane uses to produce or revise dies.

SYNTHANE

CORPORATION, S OAKS, PENNA.

Laminated Plastics for Industry

Sheets, Rods, Tubes, Fabricated Parts
Molded-laminated, Molded-macerated

Begged, Borrowed, and . . .

Edited by Jack Fortner

Guided Missile	Das Sientifiker Geschtenwerkes Firenkrakker.
Rocket Engine	Firenschpitter mit Smokenund Schnorten.
Liquid Rocket	Das Skwirten Jucenkind Firenschpitter.
Guidance System	Das Schteerenwerke.
Celestial Guidance	Das Schruballische Schtargazen Peepenglasser mit Komputerattachen Schteerenwerke.
Pre-Set Guidance	Das Senden Offen mit ein Pattenbacker und Finger Gekressen Schteerenwerke.
Control System	Das Pullen-und-Schoven Werke.
Warhead	Das Laudenboomer.
Nuclear Warhead	Das Eargeschplitten Laudenboomer.
Hydrogen Device	Das Eargeschplitten Laudenboomer mit ein Grosse Holengraund und Alles Kaput.
Management	Das Ultzerenbalden Groupe.
Engineering	Das Aufguefen Grupe.
Project Engineer	Das Schwettennoudter.
Windtunnel	Das Huffenpuffen Grupe.
Computing	Das Schlidenruler Grupe.
Structural Test	Das Pullenparten Grupe.
Security	Das Schnoopen Bunche.
Contract Administrator	Das Tablegepaunder Grupe
Planning	Das Schemen Grupe
Nuclear Research	Das Whizkidden Grupe
Facilities	Das Daskgeschoven Bunche.
Support Equipment	Das Garterbelten Grupe.

* * *

Engineer on telephone: "Doctor, come quick! My little boy just swallowed my slide rule."

Doctor: "Good heavens man I'll be right over. What are you doing in the meantime?"

Engineer: "Using log tables."

Boarder: It's disgraceful, madam. I'm sure two rats were fighting in my bedroom last night.

Madam: What do you expect for $25 a month? Bull fights?

* * *

EE: "What are you doing with that on your sweater? Don't you know that you're not supposed to wear it unless you've made the team?"

She: "Well!!!"

* * *

The psychiatrist was testing the intelligence of a hopeful candidate for discharge from the asylum.

Doc: "What would happen if I cut off your ear?"

Joe: "I couldn't hear."

Doc: "And if I cut off the other ear?"

Joe: "I couldn't see."

Doc: "Why?"

Joe: "Because my hat would fall over my eyes."

* * *

Sorority Girl: "We're going to give the bride a shower."

Frat man: "Swell! Count me in. I'll bring the soap."

* * *

A bathing suit—like a barbed wire fence—is designed to protect the property without obstructing the view.

* * *

Said the rooster as he put the ostrich egg in front of the hen: "I'm not complaining, but I just want you to see the kind of work they do in some places."

* * *

"Hey, Dad, I'm home from school again."

"What the devil did you do this time?"

"I graduated."

* * *

"Professor," said the engineer in search of knowledge, "will you try to explain to me the theory of limits?"

"Well, John, assume that you have called on a pretty woman. You are seated at one end of the divan and she is seated at the other. You move halfway toward her. Then you move half of the remaining distance toward her. Again you reduce the distance separating you from her by 50 per cent. Continue this for some time. Theoretically, you will never reach the girl. On the other hand, you will soon get close enough to her for practical purposes."

* * *

Now go back and read the rest of the magazine!

illinois

november · 25¢

TECHNOGRAPH


52965

MEMBERS OF ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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THE ILLINOIS TECHNOGRAPH

Volume 75, Number 2 **November, 1959**

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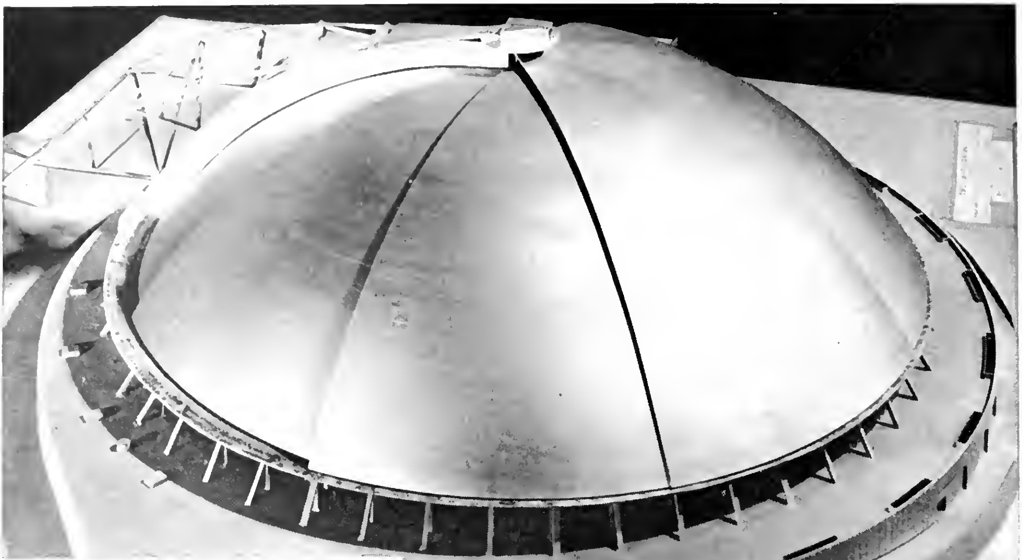
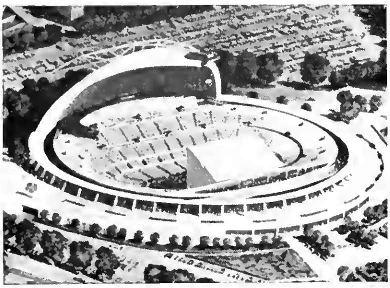
Cover . . .

Abstract art can often be as confusing as some of the abstract thinking in science. Yet, if the end result is something worth appreciating then the project is a success.

Barbara Polan has donated an example of abstract art for this month's cover.





All-weather auditorium in Pittsburgh will be covered by a 415-foot diameter Nickel-containing stainless steel dome. Largest of its kind in the world, the dome will protect an audience of more than 13,000.

For Pittsburgh's new auditorium...

A "push-button umbrella roof" of Nickel stainless steel ...the roof design of tomorrow

Here's the first of a revolutionary new type of roof design, destined to introduce a new concept in building.

A simple concept, but a daring one. The domed roof of a building is divided into eight sections which nest together when opened. Push a button, and six of these sections glide quietly together around an outside track.

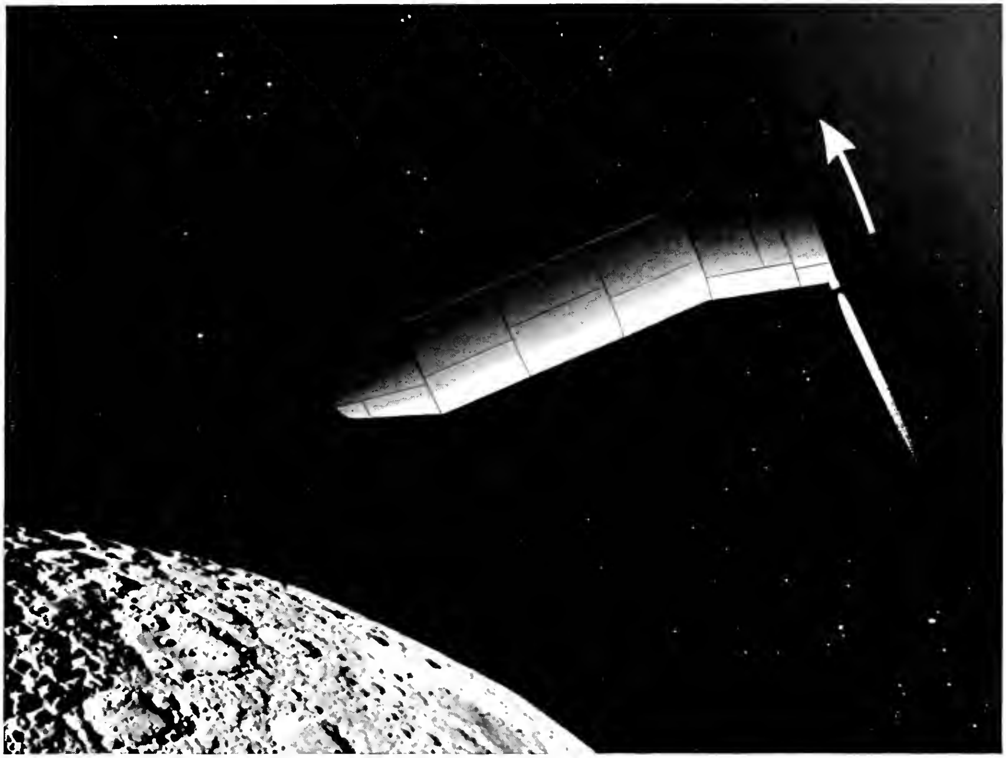
In Pittsburgh's new all-weather auditorium, the push-button umbrella roof can be closed at the first sign of bad weather without disturbing the show. In private homes, a roof design like this could bring the beauty of nature right into the home.

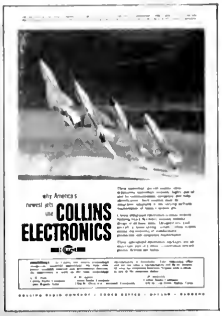
But what material is lasting enough for a dome like this? Architects and designers of the auditorium looked into all types of materials. They selected Nickel-containing stainless steel. They selected Nickel stainless because it has the best combination of properties for this purpose. For example it is one of the most weather-resisting, corrosion-resisting metals.

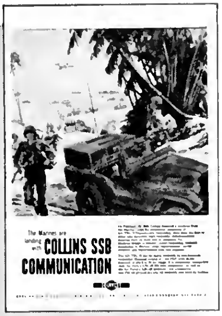
Naturally, this is just one example of how designers are taking advantage of the unique properties of Nickel-containing metals. In the future, however, you may be designing a machine—not a spectacular all-weather push-button roof. You might need a metal that resists corrosion, or wear, or high temperatures. Or one that meets some destructive combination of conditions. Here, too, a Nickel-containing metal could be the answer.

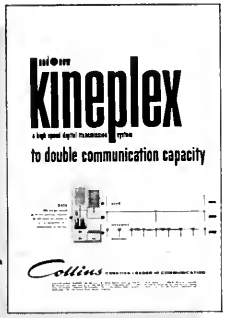
But, whatever your field of study, in the future you can count on Inco for all the help you need in metal selection. Right now, if you'd like to get better acquainted with Nickel Stainless Steel, why not write Inco for "Stainless Steel in Product Design." Write: Educational Services, The International Nickel Company, Inc., New York 5, N. Y.

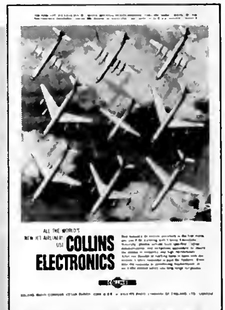
INCO **Inco Nickel** *makes metals perform better, longer*











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Collins needs engineers and physicists to keep pace with the growing demand for its products. Positions are challenging. Assignments are varied. Projects currently underway in the Cedar Rapids Division include research and development in Airborne communication, navigation and identification systems, Missile and satellite tracking and communication, Antenna design, Amateur radio and Broadcast.

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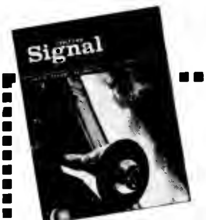

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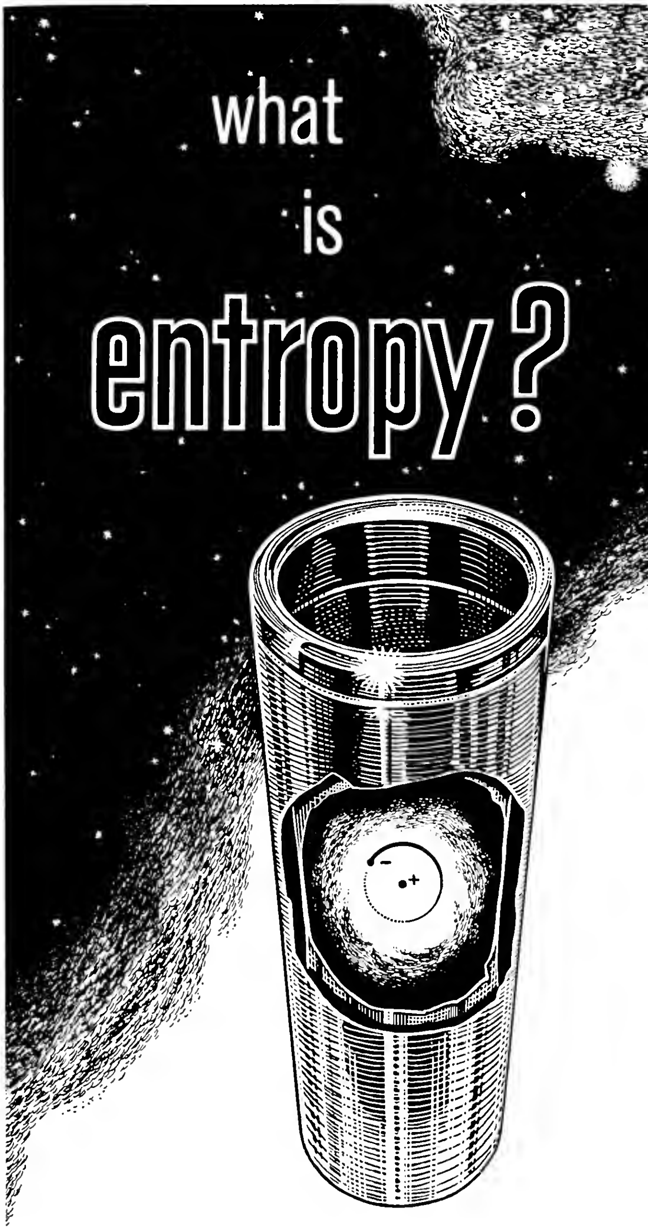

Heat lost except at absolute zero?

A measure of disorder?

A statistical probability of state?

The gradient of a scalar?

Macrocosmic phenomenon or microcosmic, too?

The fundamental concept of entropy is involved in many phases of our technology. Hence we have a fundamental need to know everything we can about its significance. This knowledge is critical to our work of energy conversion.

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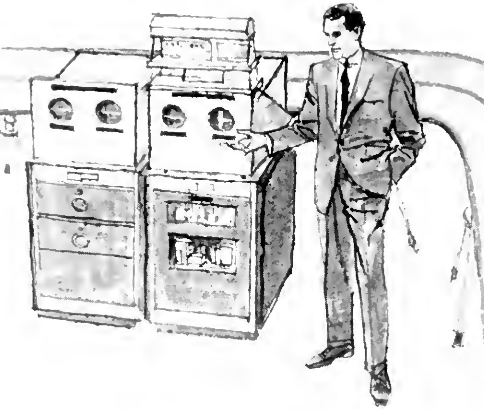


Leonardo da Vinci...on experiments

"I shall begin by making some experiments before I proceed any further; for it is my intention first to consult experience and then show by reasoning why that experience was bound to turn out as it did. This, in fact, is the true rule by which the student of natural effects must proceed: although nature starts from reason and ends with experience, it is necessary for us to proceed the other way around, that is — as I said above — begin with experience and with its help seek the reason.

Experience never errs; what alone may err is our judgment, which predicts effects that cannot be produced in our experiments. Given a cause, what follows will of necessity be its true effect, unless some external obstacle intervenes. When that happens, the effect that would have resulted from the cause will reflect the nature of the obstacle in the same proportion as the obstacle is more or less powerful than the cause."

—Notebooks, circa 1500

THE RAND CORPORATION, SANTA MONICA, CALIFORNIA

A nonprofit organization engaged in research on problems related to national security and the public interest

To the Seniors . . .

On this campus in years past there were many traditions. The bench at the southwest corner of the Union Building was for Seniors only. It was a privilege reserved for those who had gone through registration week for three years and had come back for more. They had sweated their hour exams and probably done poorly on some of them, but at least they were still around.

No one knows better than an engineer the work that lies behind a person in his senior year, and he should also realize the work that lies ahead. He soon finds that the senior year is more hurried than ever.

But while all the seniors seem to be working as hard as each other and striving for the same ultimate goal, they lack something best described as **espirit de corps.** I speak of a feeling for their fellow classmates as well as the school which has given them as much education as they are willing to obtain.

There used to be another tradition on this campus. Every male student would say hello to every other male student, regardless of whether he knew him. Obviously, with the growth of our campus this is impossible; however, the engineering campus could incorporate something of this nature.

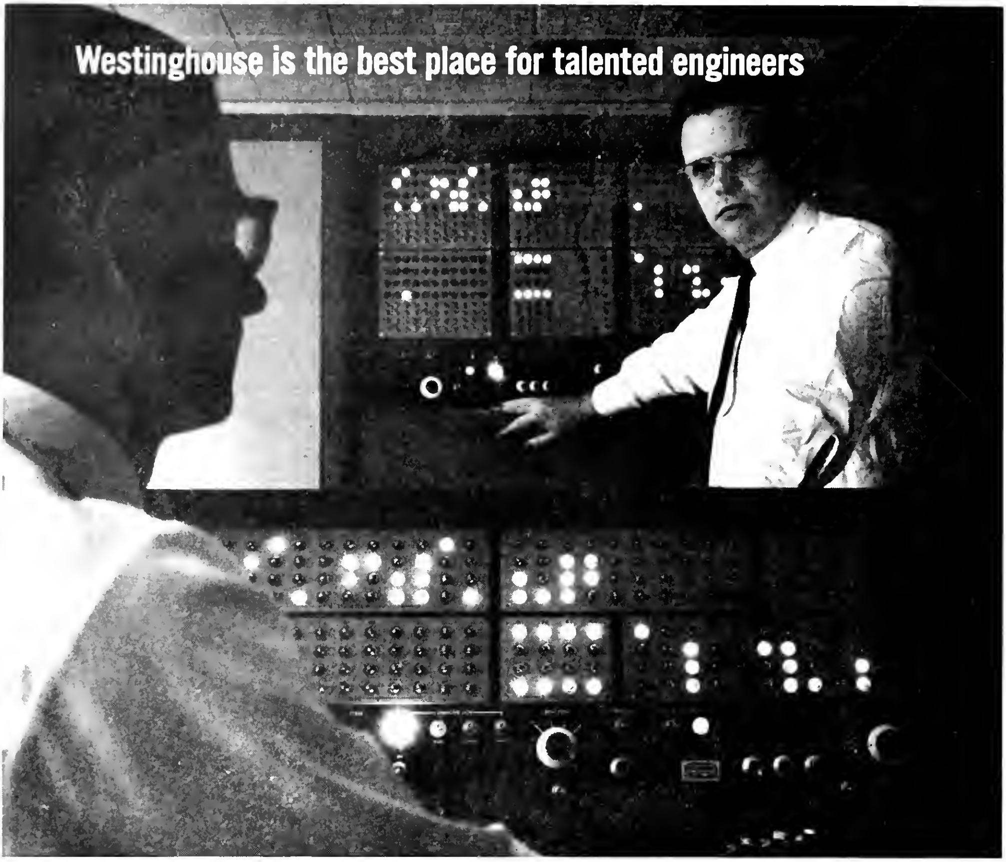
Another idea is that of a special shirt or hat for the seniors. If this seems silly, then look at the U. S. Army which has as standard a uniform as could ever be wished on a person, and yet some students wear parts of it to class (and rather proudly I suspect).

The solution to the problem may be something much simpler. Forget the whole idea. "We're seniors. We'll be out soon, so why bother?" The point is just that. We will be out soon, and what have we got to show for it besides the ability to analyze an engineering problem?

Industry is looking for a person with a touch of the "gung-ho" in him, and the willingness to let it show.

Why not let it show now, while you are in with a group of men who are doing and wanting the same things you are? Let it show some, and you as well as the school will benefit by it.

—WDP



Westinghouse mathematicians Burnham Moffat and Dr. Richard Durstine check on an electronic computer working out solutions to a heat transfer problem for the company's Atomic Power Division.

The Mathematics Department helps you to use high-speed computers to solve your problem

The Mathematics Department helps Westinghouse engineers take advantage of modern methods of mathematics and new developments in this field. If new techniques are needed to use a digital computer for solving an engineer's problem, these men will develop them.

This department, the second of its kind in American industry, is staffed by 15 Ph.D.'s, 3 M.S.'s, and 6 B.S. mathematicians. Among other accomplishments, it is credited with developing OPCON, an electronic brain for optimizing control of processing systems. OPCON won for Westinghouse the 1958 Industrial Science Achievement Award of the A.A.A.S.

Supporting the work of about 150 other mathematicians with operating divisions, the Mathematics Dept. is actively studying industrial logistics (called OR or Operations Research by some), fatigue of metals (pioneering work using statistical techniques), equipment and system design, and a variety of other challenging problems.

The young engineer at Westinghouse isn't expected to know all of the answers. Our work is often too advanced for that. Each man's work is backed up by specialists—like the men in this Mathematics Dept. Even tough problems are easier to solve with this kind of help.

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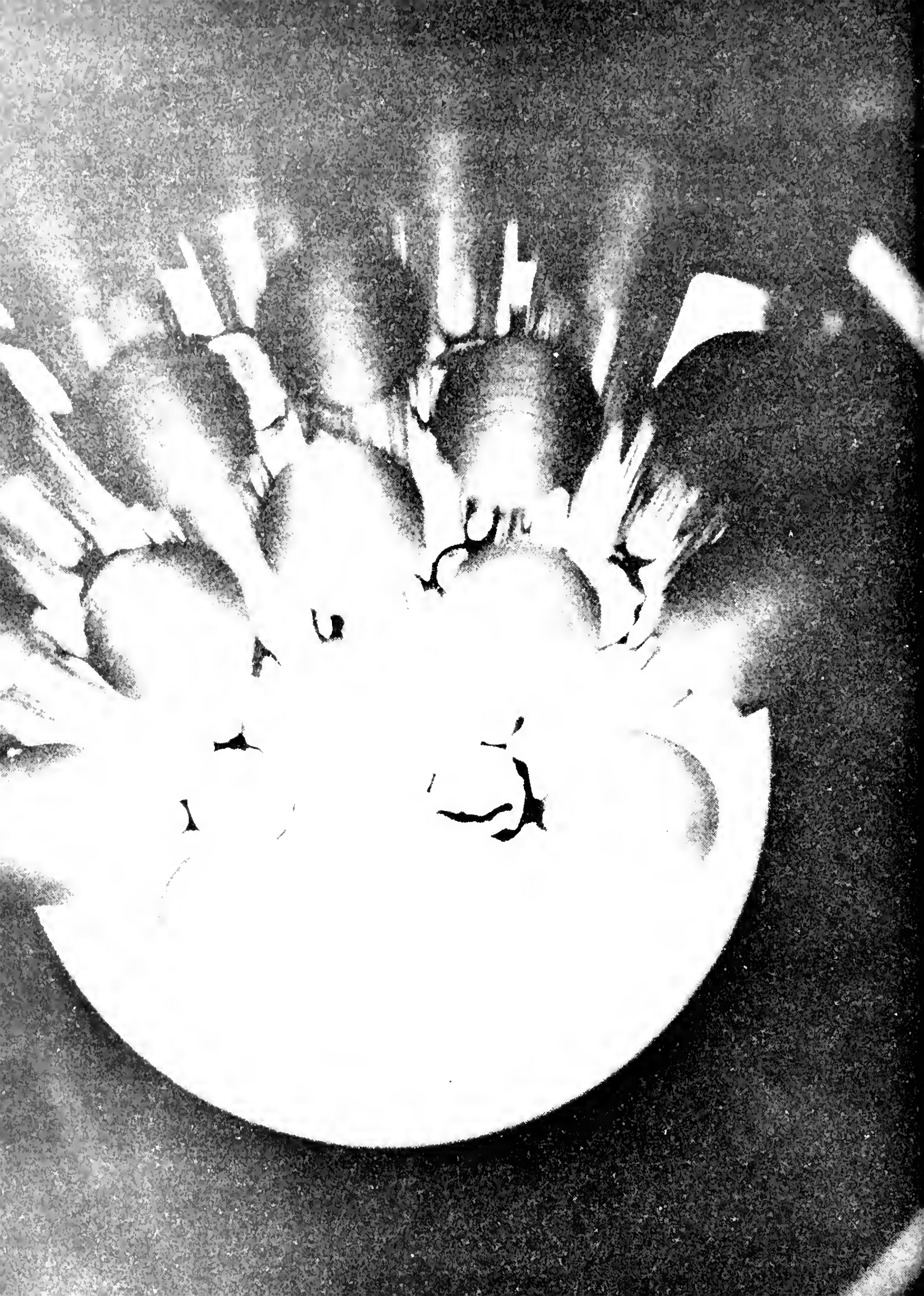


Ceramics and Nuclear Engineering

By Jim Blome

There is a great need for new materials that can be used in atomic reactors. These materials must be capable of withstanding not only high temperatures, but also corrosive environments and radiation damage. A few of the ceramic materials that have been used for this work will be discussed along with the problems that arise from their use.

There are a variety of special conditions on materials used in the construction of a reactor. The core of a thermal reactor must be made up of elements having a low probability for capturing neutrons. The bulk of the core must be of light elements in order to slow down the neutrons for the atomic reaction. This eliminates most of the elements from consideration. The control rod which is inserted in the core must be made of elements having high neutron capture probabilities. The particle shield which is around the core must absorb neutrons without the emission of gamma radiation. The radiation shield which goes around the particle shield must be very dense to absorb the harmful radiation that is emitted.

The effects of bombardment of fission products, neutrons, beta particles and gamma radiation, called radiation damage, place still another big restriction on the material that is to be used in the construction of reactors.

Extracting the heat which is produced in the reactor is done via a coolant which gives rise to corrosion problems never thought of at normal temperatures.

The ceramists and metallurgists have done a remarkable job in meeting the difficult materials requirements of reactors.

Ook Ridge

Two types of research reactors are operated at Oak Ridge National Laboratory. One is a graphite moderated, air-cooled, natural uranium reactor; the second is a water-cooled and moderated, enriched uranium reactor.

The graphite reactor was first built as a pilot plant for the Hanford plant, but since 1944 has been used as a research reactor. There are three ceramic materials used in this reactor: graphite, concrete and glass (in the form of glass wool). Together they make up the bulk of the reactor.

The size of the graphite core is 24x24x24 ft., and is entirely surrounded by a concrete shield seven feet thick. The graphite is fitted together from blocks 4x4x48 in. in size which are keyed to prevent shifting. About 600 tons of graphite are built into the reactor. The shield is composed of three layers of concrete; a one foot thick wall of standard concrete on the inside and outside and the five feet in the center which is filled with a special concrete containing barytes to increase the density, thus making the shield more effective in absorbing gamma rays. The concrete also contains haydite (an expanded clay material) to give the structure a high water content and thus make the shield more effective. The water has the property of absorbing neutrons. The mass of uranium in the reactor is 54 tons and is formed into cylinders commonly called slugs. These slugs are 1.1 in. in diameter by 4 in. long and are enclosed in aluminum jackets. The aluminum "can" is to prevent oxidation of the uranium.

Approximately 90,000 c.f.m. of cooling air is filtered through coarse glass wool filters and through channels in the graphite. After flowing through the channels and thus removing the fission heat from the uranium slugs, the air is taken through a long duct of concrete to a filter house. Here the air is filtered again through glass wool fibers and special paper filters which remove all particles above one micron in diameter. This process is very important since some of the slugs rupture and put radioactive fission products in the air. The air is drawn from the filter house by two 900 h.p. centrifugal compressors and is discharged at the top of a 200 ft. stack. The stack is necessary because of radioactivity in the cooling gases. The radioactive part of the gas is largely Argon-41. Fortunately, this does not have a very long half life (about 100 minutes) and the radioactivity decays before the gases reach the ground level.

Another factor which limits the kind of material that can be used in reactors is radiation. In some ceramic materials the low temperature thermal conductivity is appreciably decreased by radiation. Nearly all of the electronic properties of the nonmetals are altered by bombardment of fission products.

Although the present state of knowledge in the field of radiation damage makes it hard to give a complete picture of the best materials to use, two things seem to be most important in radiation stability. The most stable materials are those which are ionic and which have a high symmetry. Experience with graphite indicates that, if it is necessary to use anisotropic materials, the best results will be obtained with small particle sizes and a minimum of preferred orientation.

Urania

In view of the fact that UO_2 is a very important ceramic material used in reactors, a short summary of some of its physical and chemical properties will now be discussed. Uranium dioxide has been used as a reactor material for fuel elements both in bulk and granular forms. Uranium dioxide is a dark brown material in powder form. Its crystal structure is the face centered cubic CaF_2 type, the uranium ions occupying corners and faces.

The melting point of UO_2 is stated by most investigators to be about 2800°C and sintering has been noted at temperatures as low as 1400°C. Some furnace walls, after sintering, have been colored and radioactive, indicating the volatility of UO_2. If BeO is present it becomes even more volatile.

Some of the chemical reactions with uranium that have been noted are:

With Carbon—UC_2; U_2C_3

With Hydrogen—No reaction up to melting point.

With Oxygen—UO_2; U_4O_9; U_3O_7; U_2O_5; U_3O_8

With Oxides—Solid solutions with ThO_2 & ZrO_2

With Silicon—USi

With Aluminum—UAl_4; UAl_3

With Columbium—Solid Solution at 1000°C containing an unknown phase.

Urania is formed into many shapes by

←

Ceramic systems are being considered as fuel element material here at Atomics International, a division of North American Aviation, Inc.

such ceramic fabricating processes as: cold pressing, slip casting, extrusion, and hot pressing. Urania bars and pellets, for example, are made by pressing UO_2 powder plus a few per cent dextrose or wax binder in a steel die at 10,000 psi. All of these forming methods are common to the ceramic industry and much work has been done by ceramists on nuclear fuel.

Crucibles, cylinders and other hollow thin wall shapes are made by slip casting a water-urania mixture, plus HCl as a deflocculant, in an ordinary plaster mold. This method of forming ceramic materials has been used by manufacturers for many years, although different deflocculating chemicals may be used in different casting slips.

Refractories

In the reactors which use uranium as a fuel there is a need for special shaped fuel components. Some of the refractories which have been used for casting and melting this metal are Magnesium Oxide, Calcium Oxide, Thorium Oxide and Aluminum Oxide. These special molds and crucibles are formed by slip casting and dry pressing, just as are many other ceramic products.

In slip casting alumina, a very fine powder of it is used along with bentonite, ball clay and distilled water. A one-eighth inch wall thickness can be attained in about one minute in a plaster mold. Alumina can also be dry pressed using a modified polyethylene glycol or binder.

Some ceramic bodies which are made for nuclear applications need special consideration in their preparation. Bodies made of urania must be fired in a partial vacuum or in some other inert gas atmosphere, because urania upon heating in the presence of oxygen converts to U_3O_8 causing a destructive volume increase. It has been found that bodies containing 30 percent urania and 70 per cent thoria (by weight) can be fired in the air by adding UO_2 to the thoria, thus producing a solid solution, with no flagrant volume change. This product has become more popular because of the ease of firing.

A higher temperature reactor has been proposed using more ceramic materials. This reactor would make for more efficient production of power. With the fuel, moderator and breeder planket in ceramic form and gas as a coolant this reactor could operate at higher temperatures and could be more efficient according to the Carnot cycle. The Carnot cycle asserts that the efficiency of a heat engine is increased if the spread between the temperatures of the incoming and outgoing gases can be increased. The high temperatures attainable (above 1000 C) in a ceramic reactor would make this increase in efficiency possible.

Applications

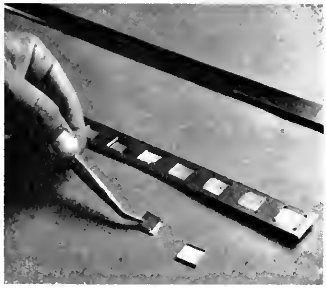
It is said that much of our nations electrical supply will soon come from atomic energy. This is especially probable in regions where there is little natural supply of power like water or coal. Atomic power plants today provide light for the homes of less than 200,000 Americans. In three years, however, that total should soar to about 2,000,000. It has been predicted that 20 per cent of our electrical power will come from nuclear sources by 1980.

On July 21, the first American-built nuclear-powered merchant ship was christened at Camden, N.J. and there are others now in the building stage. Nuclear power has also made history in the able hands of the United States Navy. There is no other source of power that could have driven a submarine thousands of miles under the polar ice cap.

By 1962, the Air Force hopes to have nuclear-powered airplanes and a few years later commercial planes of this type may be in the test stage.

Mines being worked with nuclear power equipment and trains of nuclear design have been predicted by the middle 1960s.

Ceramics will have a strategic role in power reactors of many types in years to come. There will be many problems involved in adapting ceramic materials to the various conditions under which they will be used in nuclear reactors but, if progress in this field continues as it has, these problems will be taken in stride.



Physical ceramists at Atomics International investigate inter-particle relationships of refractory oxides.

Main Research Building at Oak Ridge National Laboratory

MATHEMATICS FOR THE SPACE AGE

By Dean H. L. Wakeland

On October 4, 1957, a new age was born when the Russian satellite Sputnik orbited the earth and shocked many Americans into the realization that Russia's space technology had not only equaled but surpassed American space technology. Immediately cries rang from all corners of the United States for the causes of our failure in the space program. One area which was immediately singled out as a great weakness was our educational system. More emphasis was placed on mathematics and science in education than ever before.

However, the high schools in the State of Illinois were several years ahead of the space program in their planning for better mathematics programs. In 1950 the College of Engineering proposed a change in the mathematics requirements for entrance into college and the Illinois high schools immediately began to upgrade their mathematics programs. A brief review of entrance credits presented by the freshmen in the College of Engineering from the years 1952 through 1959 indicates the planning and achievement made by Illinois high schools.

Freshmen in the College of Engineering come primarily from Illinois high schools and therefore the entrance credits they present indicate the college preparation available in Illinois. In 1950 the mathematics entrance requirements for the College of Engineering were one and one-half years of algebra, one year of plane geometry, and one-half year of solid geometry. At that time approximately sixty per cent of all entering freshmen met these requirements. In 1953 the College of Engineering raised its mathematics requirements to two years of algebra, one year of plane geometry, one-half year of solid geometry, and one-half year of trigonometry. In 1956 the one-half year of solid geometry was dropped as a requirement in hopes that high school students would replace solid geometry with the study of advanced mathematics. Since the latest change in 1956 the entrance requirements have remained at three and one-half years of high school mathematics.

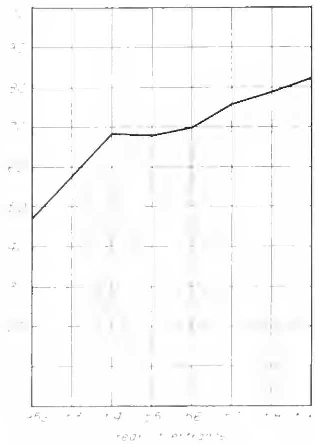
The response of the Illinois high schools to this upgrading of college entrance requirements has been extremely gratifying. The graph below indicates the continued improvement in the preparation of high school students. In 1952 only 47% of the students entered with three and one-half years of mathematics including trigonometry. That figure has now risen to 82.2% and continues to rise each year. An even sharper contrast is shown in the comparison of students having had four years of high school mathematics. In 1952 only 27% of the freshman class had four years of high school mathematics, whereas, in 1959, 70% had four years of high school mathematics.

Illinois high schools have also added college level courses to their offerings during the past ten years. In 1952 only a few of the engineering freshmen presented college credit in algebra or trigonometry, but in 1959 nearly 15%, of the class did so. In addition, an increasingly larger number of students are entering the College of Engineering each year with college credit in analytic geometry and integral or differential calculus. In 1959 twenty-six engineering freshmen were placed in the first course in calculus and 5 in the second course in calculus.

The alumnus who complains "students aren't as good as when I was here" would be enlightened if he were to review the statistics of each new incoming class. The quality of the engineering freshmen class continues to improve each year. In 1952, 59%, of the incoming freshmen came from the upper thirty per cent of the high school class, whereas, in 1959, 66%, came from the upper thirty per cent. Likewise, the Engineering freshmen in 1959 offered more entrance credits in areas other than mathematics than any class before them.

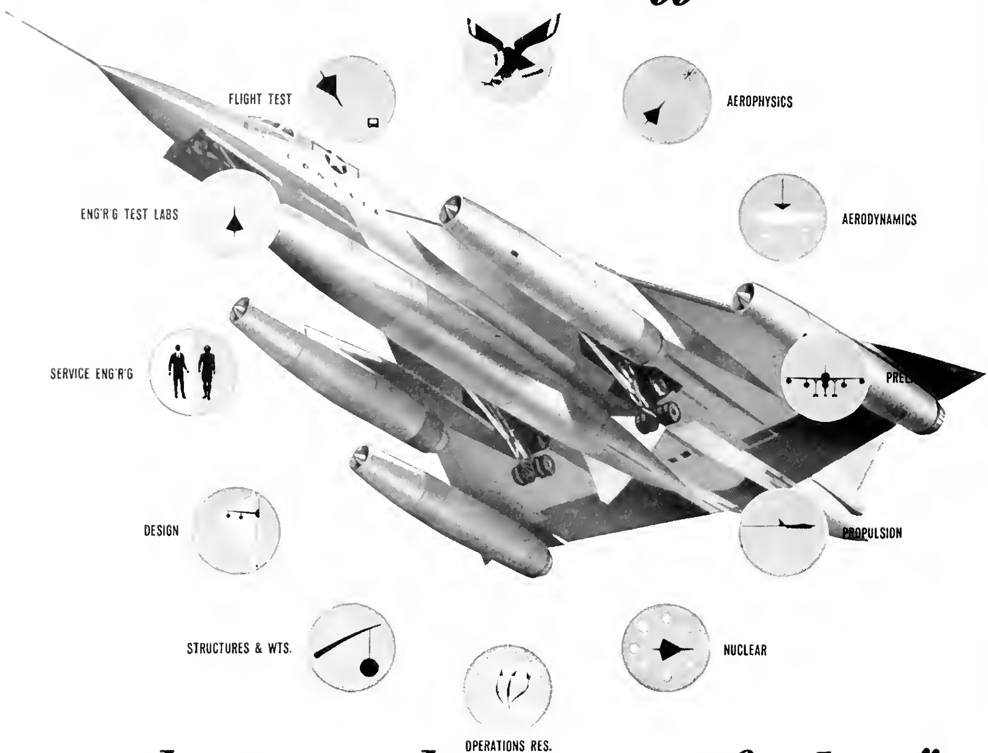
It seems that engineering freshmen can always find many things to be corrected in the high school from which they came, but seldom do they realize the good points of their high school background. The high schools in the State of Illinois are to be commended for their high standards and continued progress in making their mathematics program one of the strongest in the nation. Studies and improvement programs are being carried out in other educational areas and a comparison might show similar progress.

The College of Engineering is again studying its entrance requirements in areas other than mathematics and there is a possibility that other entrance requirements will be changed in the future. The fundamentals of mathematics as in any other educational area, have not been changed by the so called "Space Age," but the excellence required in educational areas is definitely higher than ever before. Illinois' high schools not only have realized this fact but had instrumented programs to meet their new challenge before Sputnik was fired.



Percent of the Engineering Freshmon Class presenting $3^1{}_2$ years of high school mathematics.

"Best individual effort...



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Tau Beta Pi Essay . . .

LANGUAGE *and* LEADERSHIP

By Tom Gabbard

As the world grows smaller, the opportunities for United States industries to exploit the world's resources are becoming increasingly advantageous. Many industries have already taken the giant step into world-wide operations. The oil industry is a prime example. In respense to these new opportunities, our oil industries have established operations in South America, Africa, and Asia.

This movement abroad has created a great demand for engineers who are willing to work in these foreign lands. However, the supply of men who are qualified to take these jobs has been very limited. The limitation is the inability of American Engineers to speak another language. It is well past the time to remedy this situation. Until high schools begin to fulfill this need more satisfactorily, our universities need to install an effective program to teach our engineers how to speak to the nationals of other lands.

In all of the educated foreign countries of today there is some program of dual language instruction. Many young students learn to speak two or three languages before they are even in high school. This accomplishment seems like a miracle to us. However, the achievement is very real. Many American educators have realized this fact and are encouraging programs for primary schools. However, these programs are still in the experimental stage. It will be many years before these schools are turning out students who are bilingual. I met a good example of just what we should strive for when I visited Brazil last summer. I stopped a young man of about fourteen years of age on the street and asked for some assistance. The boy apologized for not being able to speak English very well. He said that he had only been studying it for three months. However, he asked if perhaps I could speak Portuguese, Spanish, or French. I very humbly apologized to him and asked him to try his English.

If the American universities had men like this young Brazilian for students, they would have no problem. As it is, we are not likely ever to approach this criterion for many years. The universities must revise their curriculum in order to satisfy this crying need. It may be hard for many people who have never thought of traveling abroad to realize that this problem is important. However, these people will one day be awakened. Two of this country's most eminent engineers visited Paris this summer for a world conference and were brought face to face with this very problem. Since the conference was held in France, it was assumed by everyone except our engineers that the official language would be French. As the conference progressed, it became apparent to everyone that these two men were being left completely out of the discussion. When this situation was discovered, the official language was changed to English. This unfortunate situation caused a great deal of embarrassment for our representatives. Similar situations may also cause much ill feeling toward our country.

In many of our universities, the engineering students waste much time each semester taking survey courses that are of little value to them. This time could be spent in learning to speak foreign languages. With the new techniques for training that have been developed, a student should have no difficulty in learning a language well while in college. Such a program would lend emphasis to the programs of the secondary and primary schools. Students in college preparatory curricula would realize the need to increase their talents.

The engineer of today must be a man of many talents. He is being called into the fields of management, of sales, of administration, and of leadership. As life becomes increasingly mechanized and work becomes increasingly technical, the leadership is going to become the most important aspect of the profession. If the engineer is not fully capable of meeting this challenge, our country will soon lose its position as the world leader. We can not long retain our position if we cannot speak to, or understand the customs of, our friendly neighbors. In this age engineering is tantamount to leadership, and leadership is paramount in success. We must prepare ourselves for these responsibilities.


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TECHNOGRAPH LAUNCHES SATELLITE

As Recorded by George Carruthers

On October 21, 1959, members of the *Technograph* staff, in cooperation with the college of engineering, placed the world's first cat-carrying vehicle, Katnik 1, into orbit around the earth and later brought it back safely.

This tremendous achievement was the result of over a year of top-secret work. In fact only a few bearded Cossacks caught the squeal before the Cat's meow was broadcast around the world. Cat lovers were overjoyed although they were at first concerned about putting a cat and dog in the same space.

The rocket, built wholly on campus, had a small launching vehicle. This first stage was powered by a new and radical means of propulsion developed at the University of Illinois. A hydrogen-oxygen-carbon chain produced by means of a catalyst of heat and smoke was bonded in such a manner as to produce a new high energy fuel—H-O-O-C-H.

The power of this combination as a propellant was discovered a few years ago by a couple of chem e's doing unsponsored research. They had decided to keep the results of their experiment secret; however, hearing of the need for such a fuel for the project, they threw their caution to the wind. During the first test run, the thrust of the Atlas Vernier engine used in the first stage was nearly doubled.

The second stage of the two-stage vehicle was also powered by a high- energy propellant. However, two full professors worked on this stage, so a solid propellant was used.

The engine section of the first stage, which was assembled by the aero department, weighed only 100 pounds complete with shell and pumps. This phenomenally low figure surprised even those who planned the stage. Upon checking, it was found that someone had forgotten to install the engine. This hiked the weight to 175 pounds.

About the same time, the question came up as to the type of research to be carried out with the proposed satellite. A faculty member in the home economics department suggested inclusion of one of his pastries aboard the satellite so that the University could claim the world's first "pie in the sky." However, this idea was rejected because of lack of space, weight considerations and the added complications necessary to eject the pie into orbit.

The biology department suggested an animal experiment for study of space medicine. They thought of using mice. However when a cat wandered into the lab, they changed their minds and sent the cat instead. Besides supplying useful medical data, sending the cat enabled the department to resume their experiments with rodents.

The satellite proper which housed the cat was mounted atop the solid-propellant second stage, which in turn was mounted on a spin-stabilization turntable just above the guidance system of the first stage. (see diagram)

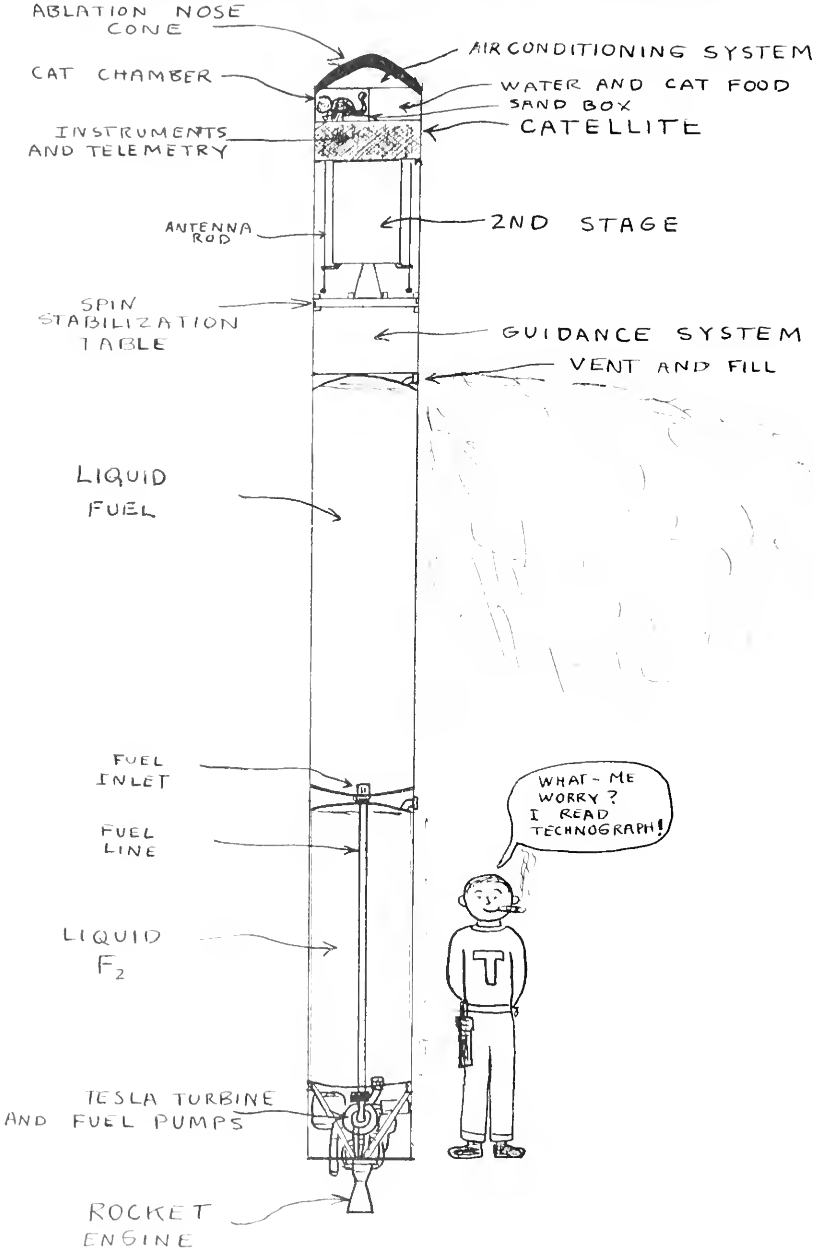
Housed in the satellite were air, water, food and a sandbox for the cat. Also on board were time-lapse cameras loaded with color film, radio telemetering devices and recovery equipment which included a radio beacon and dog repellent. The electronic equipment including the entire guidance system of the rocket vehicle was completely the work of students and faculty members of the electrical engineering department.

Design of the vehicle and catellite

(Continued on Page 29)

TECHNOGRAPH staff makes last-minute adjustment on rocket

U. of I. "KATNIK" SATELLITE ROCKET



Flunkout I is placed in satellite

(Continued from Page 27)

was carried out by sections of G.E. 100.

Working on the assumption that new blood was best for a project such as this, the students were given incentive by hearing strains from "They said it couldn't be done . . ."

Construction of the vehicle was begun late in September in the aero lab. By the middle of October, construction and preliminary tests were completed.

The tests came through with only one hitch during a static test of the first stage—it blew up. But muttering "back to the drawing board," the workers gained new incentive and the stage was completely rebuilt. The rest of the tests and the launching of the vehicle were then placed in the hands of the Technograph staff. They were considered dispensible.

While the tests went on, arrangements were made to track the vehicle. Members of the U. of I. Astronomy Club volunteered to track the vehicle visually, using binoculars and small telescopes confiscated from students in back of a women's housing unit.

It was planned to launch the vehicle in a north-south direction so the cat would be in the Van Allen belt of radiation for as short a time as possible. The planned perigee was to be 120 miles and the apogee 400 to 600 miles. This would allow the second stage and catellite to orbit the earth from 10 to 30 times before drag caused them to fall into the earth's atmosphere. The second stage would burn up, but the catellite would be recovered.

On the night of the launching, the Astronomy Club was notified that countdown was in progress. All planes at the airport were grounded and the Civil Air Patrol was notified to keep planes out of the area. At 1:17 a.m. on the morning of the 21st, fueling began. Preflight checkouts were completed with only two holds, once when a crew member walked up to the hydrogen fueling truck smoking a cigar, and once when it was discovered that a mouse had gotten into a compartment of the catellite near the one occupied by Flunkout, the cat. This mistake caused quite a commotion over the microphone in the second stage as would be expected.

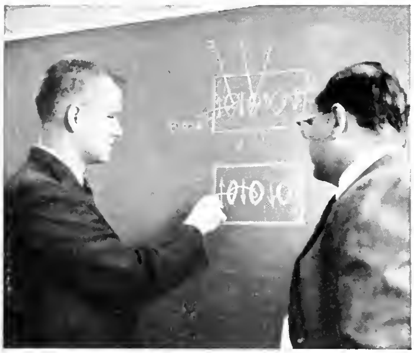
At 3:45 a.m. the countdown reached the final ten seconds. All was clear, so at X minus zero the firing signal was given. The ignition button was pushed. The rocket simply sat on the pad. "Missile does not lift," was the word. Disappointment showed on the faces of all present; it seemed certain the shot would have to be scrubbed. Just then, one of the crew members walked in with a sheepish grin on his face. He stammered, "I'm uh sorry, fellows. I er-uh forgot to put the batteries in."

The project boss went into action. There was a thud of shoe leather against denim. The crew member sailed through the door in a parabolic arc and plopped down at the base of the launching pad.

(Continued on Page 42)

Product Development at IBM

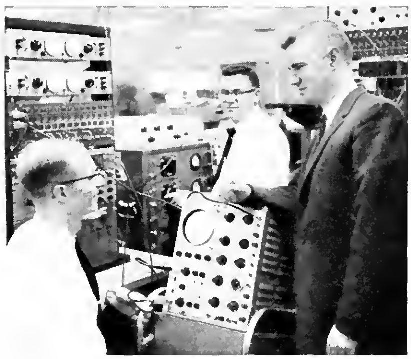
IBM Engineer Richard R. Booth
explores electronic frontiers
to develop new, faster and
larger storage devices
for tomorrow's computers.



Computing time cut from six months to one day

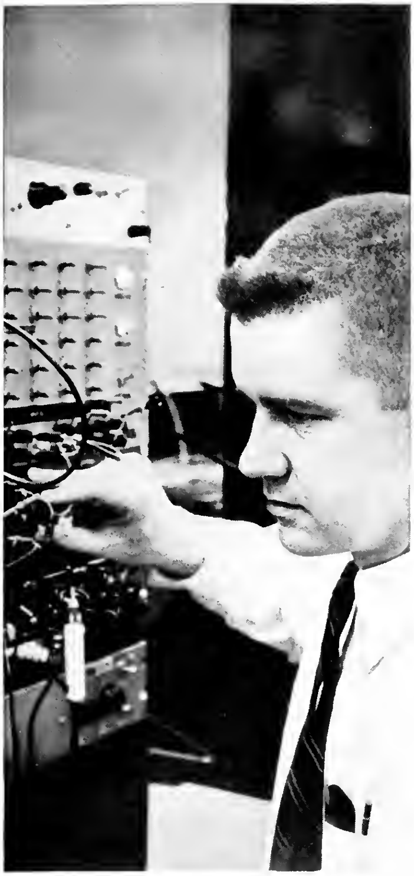
"My job is to design and develop new, high-speed storage devices for a powerful new computer that will perform, in one day, operations requiring six months on present equipment," said Dick Booth as he began a typical day recently. A product development engineer at the IBM Laboratories in Poughkeepsie, N. Y., he started his morning with a conference on a product of great interest to him: a magnetic core storage device with a nondestructive read-out feature. For an hour, he discussed with circuit design engineers the logical devices needed for the register—such as magnetic core drivers and sense amplifiers. Should such devices not be available, the group would work on designs for new ones.

Dick Booth next met with members of the Magnetic Materials Group to establish specifications for the magnetic core memory elements to be used in the register. He also discussed with the group the development of equipment to test the memory elements. "This magnetic core register is based on an original idea of mine," he explained. "When you have a worthwhile idea, you will be given a free hand in proving it out, backed by IBM's resources — plus the assistance of skilled specialists."



Increasing responsibility

At 10:30, Dick Booth reviewed the status of the entire project with the two engineers, two technicians, and one logic designer who make up his team. "My present position is staff engineer," he explained. "It's the second promotion I've had since I joined IBM three years ago with a B.S.E.E. degree from the University of Illinois. I know that there are plenty of other opportunities to move ahead. Furthermore, parallel advancement opportunities exist for engineers in either engineering development or engineering management."



Preparing for the future

In the afternoon, Dick Booth went to the 704 Computing Center to supervise some complex precision computations. "You see how quickly the 704 arrives at the answers," he said. "The computer being developed is expected to multiply more than 500,000 fourteen-digit numbers a second and add them at the rate of one million a second. The computer may be used for design computations for reactors, as well as calculations of satellite behavior. Of course it should have hundreds of other applications."

At 3:30 P.M., Dick Booth attended a weekly class on Theoretical Physics that lasted until 5:00. Afterward, he commented, "You know, IBM offers excellent educational opportunities both in general education and for advanced degrees. One of the engineers in my group has just received his Master's degree from Syracuse University, after completing a postgraduate program given right here at the IBM Laboratory."

A chance to contribute

As he was leaving for the evening, he said, "Yes, I'd recommend an IBM career to any college graduate who wants to exercise his creative ability. IBM will appreciate his talent and he'll have the opportunity to work with specialists who are tops in their fields. I doubt that he'd be able to find a more sympathetic and stimulating atmosphere. Furthermore, he'll have the added incentive of contributing to vitally important projects . . . projects that will take him to the frontiers of knowledge in computer electronics."

* * *

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No Hipsters These

By Bob Westerbeck

He pressed the Minister of Destruction's urgent button. The screen focused, faded, and came into focus again. "Priority, Sir. I suggest you alert the planet for eventual attack, preparedness condition one—Sir! Did you get my message?"

"Sorry, 94, I had to plug my translator in. This blasted English! Yes, it's as we thought; the missiles are coming from earth. They're very crude all the same, hardly enough to warrant preparedness condition one. Are you sure you're not losing your touch, 94?"

"On the contrary, Sir, my faculties were never keener. I believe that Mars or the Jupiter moons want us to believe the missiles are from earth. They hope to lull us into complacency, into the belief we have nothing to fear for a century or two. At an unsuspected moment, they'll disguise their disintegrator missiles as harmless earth missiles and destroy us before we realize the danger."

"An interesting possibility 94, but what makes you so sure the missiles are launched by enemies disguised as earthmen and not by earthmen themselves?"

"As you know, Sir, I frequently visit the fraternal organizations on a planet for information. The inhabitants seem more talkative in such an atmosphere. Accordingly, I spent an hour in a place called Tony's Cellar Club in one of the larger cities here on earth."

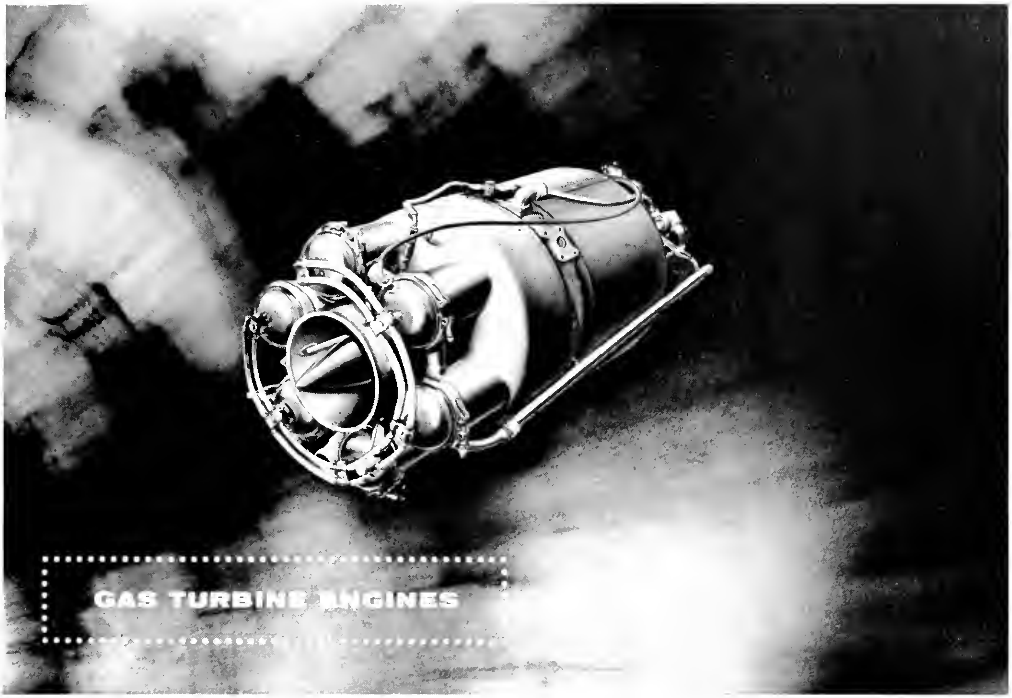
"Yes, yes, 94. Get on with it! I have an execution scheduled shortly."

"Yes, Sir. It was very close and warm inside, and the light was very bad. The atmosphere was full of smoke from what they called cigarettes. There were three earthlings manipulating musical instruments called a horn, a set of skins, and a bass. The music was appallingly primitive, and the earthlings seemed to be in a high state of barbaric passion. They swayed, clapped their hands, had glassy eyes, and seemed hypnotized in general. There were various couples at tables who embraced each other periodically in their ardor. I assume they still reproduce their race physically, a sure sign of inferior cultural evolution. Also, their language has not progressed to the point we had thought. For instance, I asked an earthling what the title of the music was. He told me not to be square, that it was a session, and that it was real crazy. Well, Sir, it appears that the earthlings worship insanity, which is what crazy means. More significantly, I think, I had not assumed the geometrical square form, which would indicate the earthling was having hallucinations."

"Is that all, 94?"

"No, Sir, there's more. This earthling asked me if I dug the music. I thought perhaps if I humored him, I could draw him into my confidence. I told him I didn't because I had no shovel. He laughed loudly, for no apparent reason, and told me I was a gasser. I must confess I was a little offended. We certainly have more humane methods of execution than gas. Well, Sir, he said I fractured him, even though I hadn't so much as touched him. He called a few more earthlings over, and said he wanted them to meet a real square. I was a little shaken at this point. I thought perhaps I had inadvertently assumed the square form. I looked over my entire form, and it was that of an earthling. It seems that they were all metally unbalanced, Sir. He then told me I was cool, man, cool. It must have been a rare lucid moment for him, since he recognized my form for that of a man. Well, I told him I wasn't cool at all, on the contrary, I told him I was very hot. The whole group went into hysterics at this point, probably at some prearranged signal I didn't catch. I presumed they were working themselves into a savage orgy of some sort, so I left and came back to the space sled and contacted you. That's all I have to report, Sir."

"Very good, 94. It appears quite obvious that the earthlings are themselves incapable of developing missiles. No further verification will be necessary in view of the conclusiveness of this report. The planet's strategic position as a shield for our enemies poses a serious threat to our civilization. I will take the appropriate steps now that we know nothing important will be lost.



• The small gas turbine is an important aircraft support item used primarily for starting jet engines and providing on-board auxiliary power. The high compressed air and shaft outputs for its small size and weight mark it as an important power source for common commercial use. AiResearch is the largest producer of lightweight gas turbines, ranging from 30 H.P. to the 850 H.P. unit pictured above.

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—Photos by Dave Yates

Technocutie . . .

JUDY COSME

Technograph's November Technocutie is a girl that likes to go to Kam's jam sessions and one that would like to learn more of the songs here on campus.

Judy Cosme, a freshman in Home Economics, thinks parties are fun. Also high on her list of date ideas are going to the movies, out to eat or dancing. Other things she likes to do are swim and ice skate. Sweater and skirt type dates are best to her thinking.

More than jazz or Dixieland, rock 'n roll is Judy's favorite type of music.

Judy says she doesn't get on the engineering campus much, and that she doesn't know much about engineering. When asked about Einstein's theory of relativity, she replied, "What's that?" Perhaps there is an engineer that would be willing to explain.

The things that make a fellow rate with her are clean-shaven faces and promptness on dates. Judy likes men's clothes especially the new Continental pants that are becoming popular. She says she has seen some sharp dressers on campus, but not all fellows quality. Sweaters and slacks are the clothes she likes on a fellow. She would rather not see a fellow in Bermudas.

This semester Judy is living in LAR. She said she heard about the water-fights U. of I. is famous for and thinks it would be "neat" to have one.

Judy's favorite foods are the fattening kind; but she also likes steak, candied apples and pretzels with her favorite beverage.

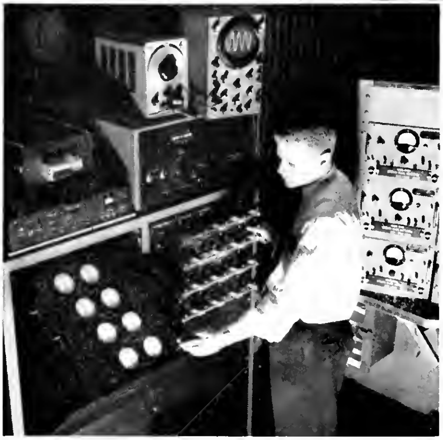
Judy emphatically says that girls are not at college to catch a man. She admits that there may be some who are but that they are the exceptions. Her reasoning is to take into account the number of girls that do graduate and get jobs. Also she feels that if a girl weren't here to go to school, she would take only easy courses and courses that she likes.

Judy likes school although she thinks it is hard. Because she has a hard time writing, freshman rhetoric scores low with her.

Typically female, Judy likes the hen sessions at LAR. It is easy for her to talk study time away.

Judy would like to date engineers, and she has no preferences as to type.

engineers



Automatic systems developed by instrumentation engineers allow rapid simultaneous recording of data from many information points.

Frequent informal discussions among analytical engineers assure continuous exchange of ideas on related research projects.

Under the close supervision of an engineer, final adjustments are made on a rig for testing an advanced liquid metal system.

and what they do

The field has never been broader
The challenge has never been greater

Engineers at Pratt & Whitney Aircraft today are concerned with the development of all forms of flight propulsion systems—air breathing, rocket, nuclear and other advanced types for propulsion in space. Many of these systems are so entirely new in concept that their design and development, and allied research programs, require technical personnel not previously associated with the development of aircraft engines. Where the company was once primarily interested in graduates with degrees in mechanical and aeronautical engineering, it now also requires men with degrees in electrical, chemical, and nuclear engineering, and in physics, chemistry, and metallurgy.

Included in a wide range of engineering activities open to technically trained graduates at all levels are these four basic fields:

ANALYTICAL ENGINEERING Men engaged in this activity are concerned with fundamental investigations in the fields of science or engineering related to the conception of new products. They carry out detailed analyses of advanced flight and space systems and interpret results in terms of practical design applications. They provide basic information which is essential in determining the types of systems that have development potential.

DESIGN ENGINEERING The prime requisite here is an active interest in the application of aerodynamics, thermodynamics, stress analysis, and principles of machine design to the creation of new flight propulsion systems. Men engaged in this activity at P&WA establish the specific performance and structural requirements of the new product and design it as a complete working mechanism.

EXPERIMENTAL ENGINEERING Here men supervise and coordinate fabrication, assembly and laboratory testing of experimental apparatus, system components, and development engines. They devise test rigs and laboratory setups, specify instrumentation and direct execution of the actual test programs. Responsibility in this phase of the development program also includes analysis of test data, reporting of results and recommendations for future effort.

MATERIALS ENGINEERING Men active in this field at P&WA investigate metals, alloys and other materials under various environmental conditions to determine their usefulness as applied to advanced flight propulsion systems. They devise material testing methods and design special test equipment. They are also responsible for the determination of new fabrication techniques and causes of failures or manufacturing difficulties.

SOUSED *for* SCIENCE

RESEARCH INTO THE EFFECTS OF ALCOHOL

By Jerry Jewett

On September tenth, of this year, three men appearing for the Traffic Short Course given by the College of Law in connection with the University of Illinois Traffic Court Safety Conference consumed liquor in the interests of science to demonstrate graphically to the assembled officials the affects of alcohol on the driver.

These men, one a justice of the peace, forty-two year old Judge Robert Brown, another, L. James Strif, a former naval officer and present junior in the College of Law, and Harold Stainer, a big two-hundred pound reporter for the Decatur Review, sat down before the round of tests to enjoy a lunch of either a hamburger or ham sandwich with coffee or milk. *After this in less than fifty minutes*, the men drank the previously determined amount of liquor.

Judge Brown had nine shots of one-hundred proof bourbon mixed with coke, James Strif drank straight five ounces of one-hundred proof Old Grand Dad, and Harold Stainer consumed six cans of beer in the alloted time. Immediately following this, the men were put through a battery of tests given by Professor Borkenstein of the University of Indiana and State Trooper Walter Ziel. These tests had been administered once before the men began their drinking bout. The tests included a Breathalizer test to measure alcohol in the blood stream, the Canadian Dot test to measure concentration and reaction, a depth perception test, and a reaction test which measured reaction speed and errors in decision making.

The results of these tests showed that in ability to concentrate, Judge Brown and James Strif deteriorated at the same rate of fifteen per cent. Brown deteriorated one-hundred forty-seven per cent in depth perception; Strif, three-hundred eighty-five per cent; and Stainer, one-hundred eighty-nine per cent. In glare recovery Judge Brown went down one-hundred forty-five per cent; James Struif, eleven per cent; and Harold Stainer one-hundred eight-nine per cent. However in errors, Brown made one-hundred sixty per cent more after drinking; Struif, two-hundred seventy-five per cent more; and Stainer, one-hundred sixty-six per cent more.

These tests were designed as a demonstration to determine the efficiency of chemical tests, for it was hoped that this information would help the judges, justices of the peace, magistrates, and attorneys to detect people too drunk to drive.

In this state, a person must have over fifteen hundredths per cent alcohol or over fifteen parts of alcohol per ten thousand units of blood to be guilty of drunken driving. Between five and fifteen hundredths, a person may be arrested for drunken driving but conviction is hard unless further evidence is presented.

In addition to determining the efficiency of chemical tests, this experiment also showed that the light social drinker is more of a menace than the completely drunk individual. Someone with over fifteen hundredths per cent alcohol in his blood stream may actually be safer on the road than one less drunk. The completely inebriated person compensates for his drunkenness by going very slowly so that other drivers know he's coming. The person with fewer drinks feels he can do anything and travels at lethal speeds of seventy or eighty miles per hour. These people feel that they are driving better than they ever have before, but really many of their decisions may be incorrect even if their reaction time is just as fast. The test proved that the three guinea pigs could make decisions just as rapidly as before drinking, but their percentage of errors increased remarkably after the drinks. These men only had eight hundredths per cent of alcohol in their bloodstream; so although they were not legally presumed drunk, they would have been a menace on the highway.

Robert Stainer pointed out a few little-known fallacies and truths about drinking which the tests proved. For one thing, one shot of one-hundred proof whiskey equals in alcoholic content one twelve ounce can of beer, and a man weighing two hundred pounds can have two drinks for every one a

(Continued on Page 40)

SOUSED FOR SCIENCE . . .

(Continued from Page 38)

one hundred pound man has. Thus the alcohol rate in their blood stream will be kept even. The tests also proved that drinking a fifth of bourbon in over twenty-four hours will leave a person sober but consuming it in sixteen hours or less will make one drunk. Taking one drink an hour, a person's body burns the alcohol as fast as it is being absorbed, but taking two drinks an hour one is being burned up and the other is being stored. Eating before drinking will help somewhat because alcohol is absorbed into the blood more quickly on an empty stomach. That one last cup of coffee for the "road" will not help at all. Neither garlic nor onions will change the effectiveness of the Breathalizer test.

Between seventy to eighty per cent of the major traffic accidents involve at least one driver who has been drinking too much. It is felt that the social drinker, if he realized his potential deadliness, would be more careful about driving when he has been drinking. Even though over fifteen parts of alcohol per ten thousand units of blood indicate conclusively that a driver is drunk, a driver with less than this concentration of alcohol may be far more dangerous.

System for Safe Flying

A new instrument flying system enables a pilot to judge his altitude, ground speed and compass heading. The system, demonstrated on a helicopter, promises safe all-weather flying for airplanes and helicopters.

Fast Highway Painter

The Delaware State Highway Department uses an electronically controlled highway striping machine that can apply solid, broken or edge lines at speeds of 12-to-15 miles per hour. Built into a light truck chassis, the unit carries its own supplies of white and yellow marking paints and reflective glass beads, and can be applied by one man.

Brain Surgery Will Cut Food Bill

Medical researchers are looking for the part of the brain that controls the appetite. If they find it, a surgeon will be able to cut the food bill.

Hula Hoop Craze

The current world-wide craze for hula hoops—which range in price from around sixty cents to a sophisticated mink-covered hoop for $100—has put hoop sales to around $35 million, reports Chemical Week.

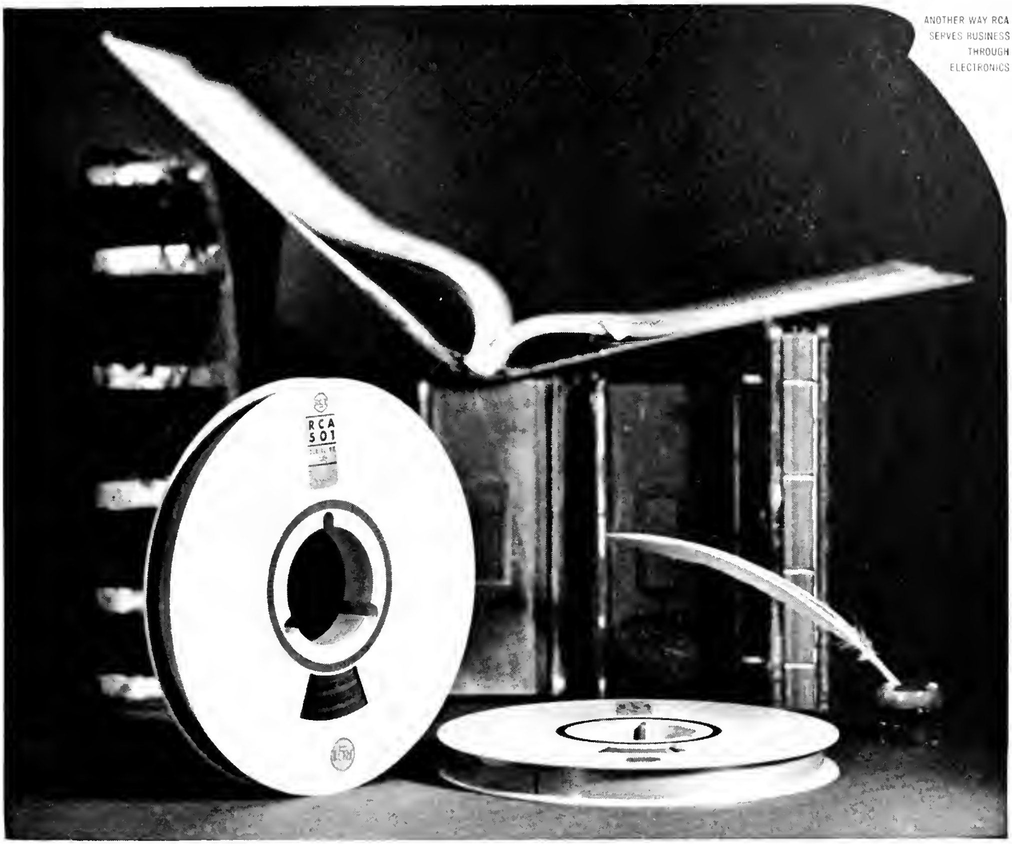
Farm Equipment Industry Big Consumer of Iron

A comparatively new metal that bridges the gap between steel and ordinary cast iron, ductile iron gained a foothold in the farm equipment industry last year when about 12,000 tons were consumed. During the current year some 27,000 tons of ductile iron castings will be used in plows, listers, hay balers, cotton and corn pickers, harvesters, threshers, small tractors and other farm equipment. The farm equipment field is only one of many in which ductile iron has found widespread use.

The materials being replaced by ductile iron in a wide assortment of components include gray iron, pearlitic malleable iron and steel forgings and castings. Ductile iron castings are also being used in original designs which in the past would have been weldments for forgings.

Ductile iron is gaining the ascendancy over ordinary cast iron especially in the case of rotating parts. With farm machinery being designed to handle ever heavier duties at continually increasing speeds, greater strength and ductility than that offered by gray irons are required. The need for a stronger material at a price much lower than other engineering materials of similar strength is being met by ductile iron.

ANOTHER WAY RCA
SERVES BUSINESS
THROUGH
ELECTRONICS



RCA Electronics creates the "501" to streamline the paper work of business—it reads, writes, figures and remembers on tape

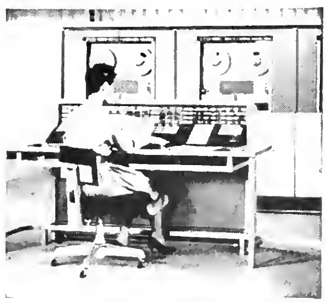
Much of today's traffic jam in paper work is being eliminated by electronic data processing. But to build a system that would be practical and economical for even medium-sized organizations was a job for electronic specialists.

To solve the problem, RCA drew on its broad experience in building computers for military applications and combed its many laboratories for the latest electronic advances that could help. The result was the RCA "501" high-speed electronic data processing system—the most compact, flexible, and economical ever built. It is a pioneer system with all-transistor construction for business use.

The "501" cuts out paper work bottlenecks for many government agencies and businesses, from stock brokerage firms to public utilities, banks, insurance companies, and steel mills.

It "remembers" millions of letters, numbers, and symbols that are "read" onto its magnetic tapes by such things as punch cards and paper tapes. In a fraction of a second, it can do thousands of calculating, sorting, and comparing operations—and checks each step. Finally, it writes such things as bills, reports, payrolls in plain English at 72,000 characters per minute.

This economical and practical answer to an acute business problem is another way RCA Electronics is helping to simplify the growing complexity of business.



RADIO CORPORATION OF AMERICA

Technograph Launches Satellite . . .

(Continued from Page 29)

Two minutes later, the countdown had recycled and was again in the final ten seconds. "3, 2, 1, Zero!"

A burst of blue-white flame shot out from the base of the rocket. As the rocket built up thrust, it remained locked tight to the pad by the special restraining arms. When the project boss was satisfied that the engine was working properly, he ordered, "Let her go!"

The restraining arms snapped back from the rocket, and with a tremendous roar the vehicle lifted slowly off the pad and climbed upward. The glare of the exhaust was so intense that it lit up the surrounding countryside like daylight, much to the dismay of numerous co-eds.

The rocket gained speed and altitude quite rapidly and began to tilt toward the north. At this time a group of student members of the Chicago Rocket Society were alerted to watch for the vehicle as it passed over Chicago. At X + 167 seconds the rocket vehicle was travelling horizontally with a velocity of some 10,000 mph, 105 miles above Harvey, Illinois. At this instant, the first stage burned out and the second stage took over, boosting itself and the catellite to orbital velocity of 18,000 mph.

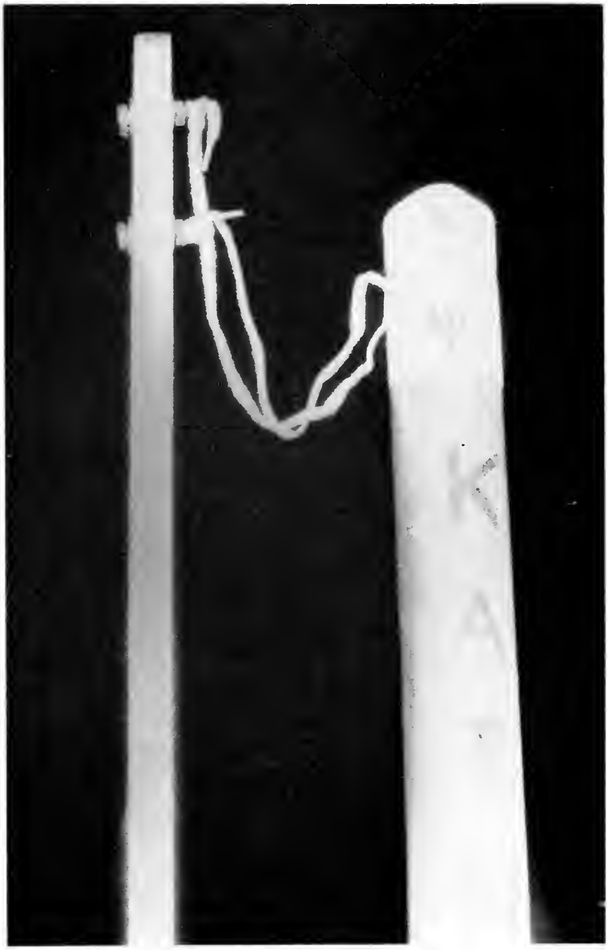
The catellite then separated from the second stage and both were in orbit.

The second stage firing was clearly visible from to the naked eye; the exhaust flame appeared brighter than Venus.

At first the crew worried that the catellite might not orbit because the perigee was only 105 miles instead of the planned 120 miles, but they soon forgot their worries.

In the meantime, the first stage which had separated from the second just south of Chicago, was beginning its re-entry trajectory. It had been planned that the first stage would re-enter over Lake Superior, 600 miles north of the University. However, because of the somewhat low perigee (caused by a malfunction in the guidance system) the first stage landed in the outskirts of the town of Cascade, Michigan, just iland from the shore of Lake Superior.

The flaming rocket smashed into a highway about thirty feet from a parked whisky truck. The impact set off a detonation of the highly explosive liquids stored in the truck. This spread to similar supplies of explosives in a tavern nearby. The truck driver and tavern owner stopped sampling supplies and headed for a bomb shelter



X minus 10 seconds . . . Katnik I just before launching. Frost on the missile is due to the sub-zero liquid, HOOCH, stored inside.

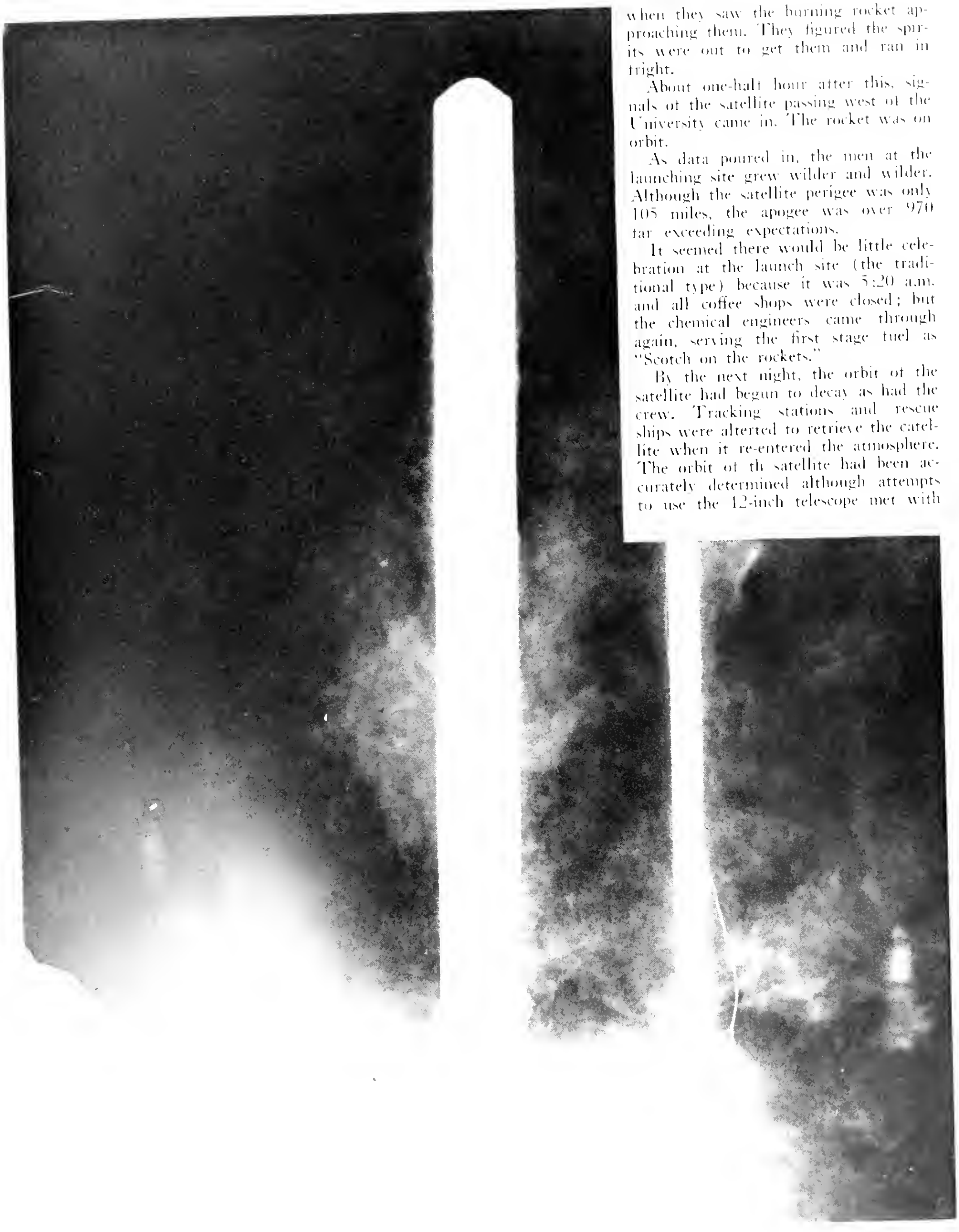
when they saw the burning rocket approaching them. They figured the spirits were out to get them and ran in fright.

About one-half hour after this, signals of the satellite passing west of the University came in. The rocket was on orbit.

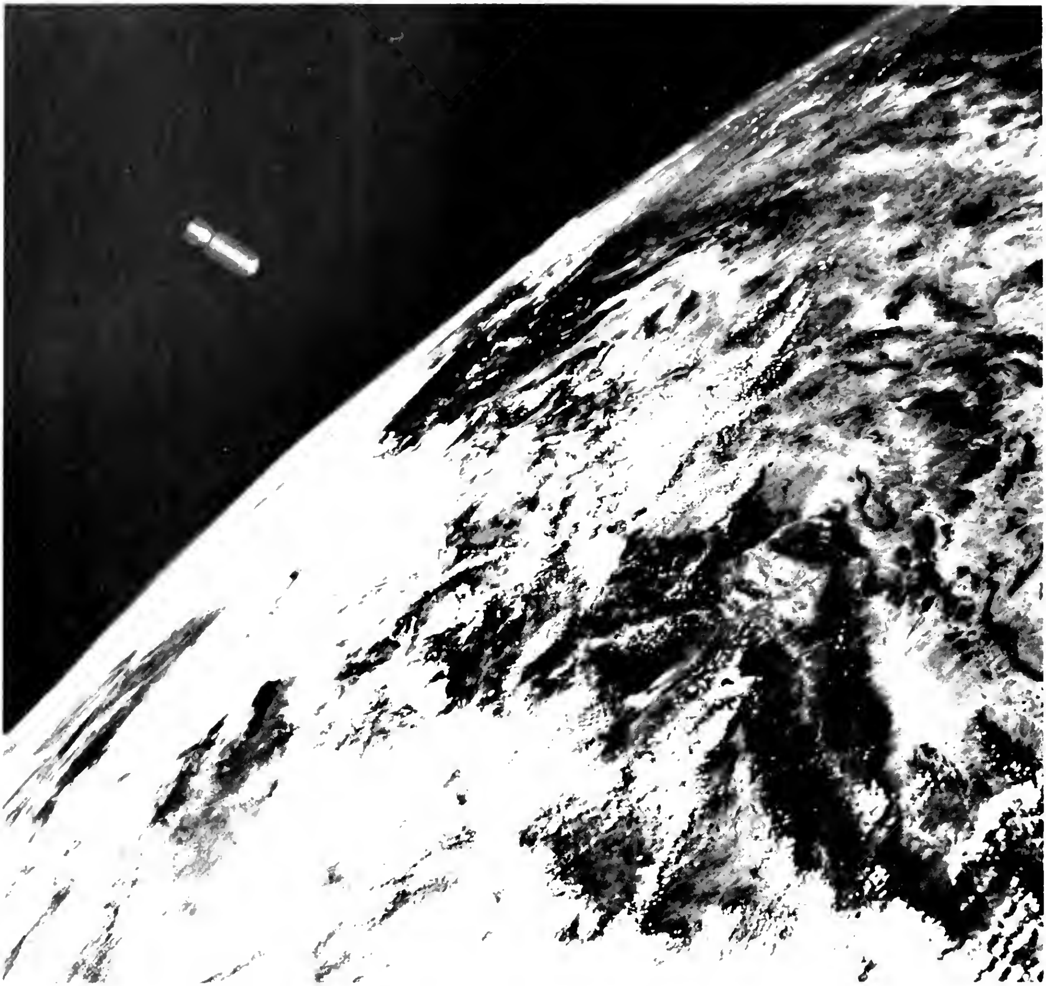
As data poured in, the men at the launching site grew wilder and wilder. Although the satellite perigee was only 105 miles, the apogee was over 970 far exceeding expectations.

It seemed there would be little celebration at the launch site (the traditional type) because it was 5:20 a.m. and all coffee shops were closed; but the chemical engineers came through again, serving the first stage fuel as "Scotch on the rockets."

By the next night, the orbit of the satellite had begun to decay as had the crew. Tracking stations and rescue ships were alterted to retrieve the catellite when it re-entered the atmosphere. The orbit of th satellite had been accurately determined although attempts to use the 12-inch telescope met with



Katnik blasts off on historic flight to place world's first cat-carrying space vehicle into orbit



Above: One of the few existing photos of the catellite in orbit. Seen in the bockground is the moon.

difficulty. A bald eagle had built its nest on the main lens.

On the 16th orbit, the second stage re-entered the atmosphere south of Los Angeles. As it reached the city limits, it caught fire and fell into the set of a new Hollywood movie, "The Return of Jesse James." The producer and director of the film plan to incorporate the unscheduled scene into the movie by a slight revision of the script.

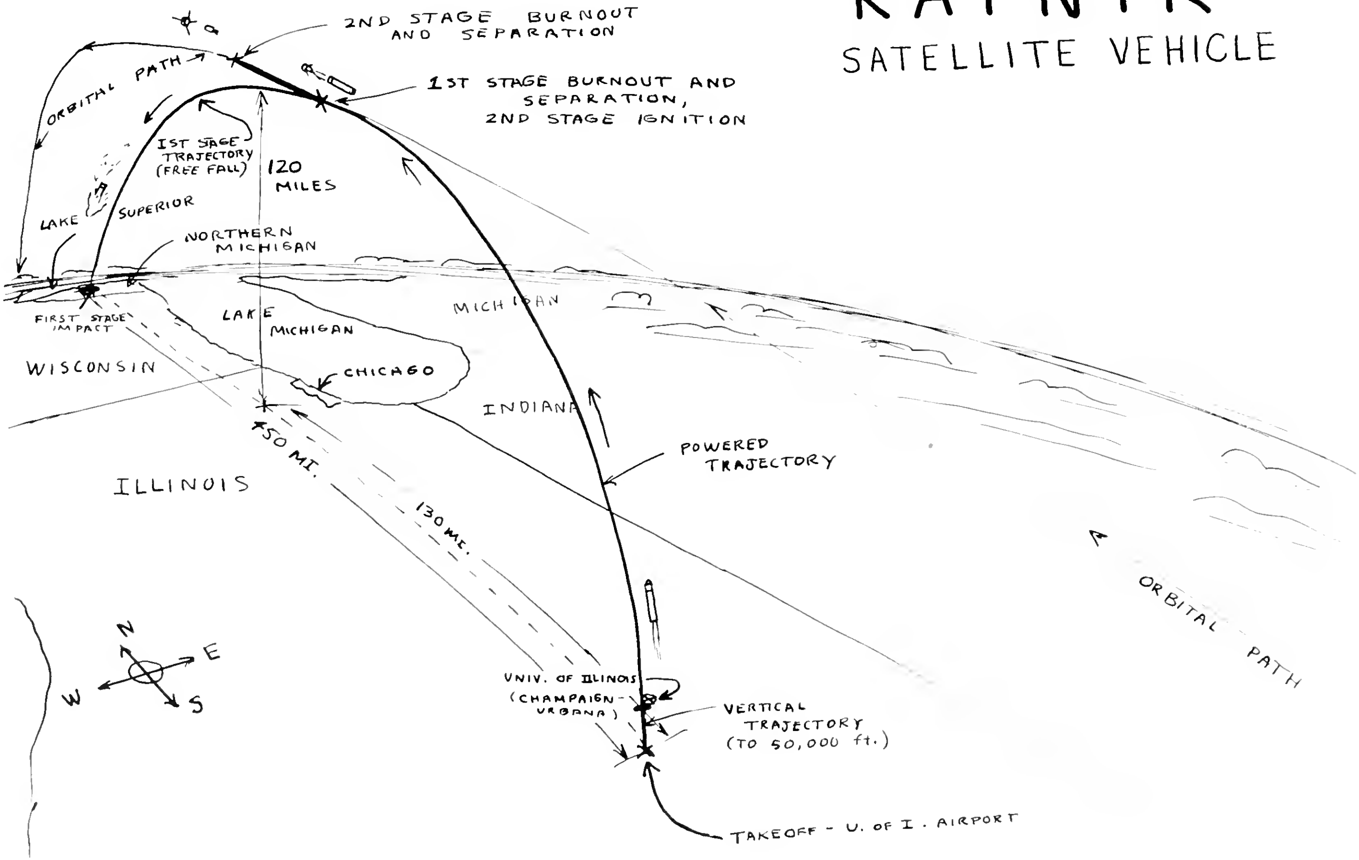
The catellite re-entered the atmosphere just off the Aleutian Islands on the next orbit. Rescue ships were alerted, and the cat and vehicle were recovered intact the next day. When the chamber was unlocked, it appeared that the cat had been reduced in size. One of the ship's crew pointed out that the cat had merely given birth to a kitten. (He was a family man, himself).

The cats are now being studied by the biology department to determine the effect of radiation, prolonged weightlessness and the affects of outer space on litter size.

All University departments were pleased with the success of the flight with one exception. The University Security Division charged the Tehnograph office with violating the fireworks statute. The staff members didn't sweat it; one of their former editors who now is a janitor in the Pentagon, was able to have the charges dismissed.

As for the future, another rocket similar to this one will be orbited about the Moon. It is to be noted, however, that there will be no mice on the flight since the Russians have discredited the cheese theory. (Besides, Flunkout II, has top priority.)

FLIGHT PATH PLAN "KATNIK" SATELLITE VEHICLE



HUGHES MASTERS FELLOWSHIPS. The Hughes Masters Fellowship Program offers unusual opportunities for academic training leading to a master's degree . . . and, in addition, provides each fellow with practical experience in the professional field of his choice.

Approximately one hundred new awards will be made by Hughes in 1960 to qualified applicants who possess a bachelor's degree in science or engineering. Additional awards are open to qualified applicants interested in business administration and education.

Hughes conducts extensive research and development in the scientific and engineering fields. While working for Hughes, fellows may be assigned to such areas of Research & Development as: microwave devices, parametric amplifiers, masers, infrared search and track systems, microminiaturization, antenna arrays, simulation methods, propagation, data handling, human factor analysis——and to a variety of engineering areas such as guided missiles, weapons control systems and systems analysis.

A selected group of award winners will be offered a **FULL STUDY PROGRAM.** Participants in this program will receive fellowships th permit them to attend an outstanding university on a full time bas during the regular academic year with a substantial stipend.

Other award winners will be assigned to the **WORK STUDY PROGRA** and will attend a university sufficiently near a facility of the Hugh Aircraft Company to permit them to obtain practical experience, a professional field of their choice, by working at the company pa time each week. An appropriate stipend will also be awarded.

After completion of the Master's Program, fellows are eligible to app for HUGHES STAFF DOCTORAL FELLOWSHIPS.

The classified nature of work at Hughes makes eligibility for securi clearance a requirement.

Closing date for applications: January 15, 1960.

How to apply: Write Dr. C. N. Warfield, Scientific Education, Hugh Aircraft Company, Culver City, California.

Hughes Fellowship Programs


BFP

TEACHING INTERNES

By Bill Andrews

Quietly getting under way this semester here at the University of Illinois is a new intern program for prospective engineering teachers. This program is being carried out in the departments of Mechanical and Electrical Engineering under the sponsorship of the Ford Foundation. The pilot program will, over a period of four years, involve a total of thirty graduate engineering students, each of whom will participate for four semesters. Each fall, beginning this fall, there are to be ten students starting the program, five from the Department of Electrical Engineering and five from the Deparment of Mechanical Engineering. (This fall, because one of the accepted applicants dropped out of the program too late to be replaced, there are only nine. Next year there will be eleven starting the program.) In the course of each intern's two years he will work toward his Master of Science Degree, which he will obtain after three or four semesters, in the former case continuing work toward his doctorate in the final semester of his participation in the program. In addition to a half to two-thirds academic load, the graduate students are involved in two other phases of this program designed to prepare him for a teaching career. He gains teaching experience through a phase in teaching plan which softens the transition from student to teacher. He also actively participates in a series of seminars on a wide variety of subjects. Each student receives an annual stipend of $2,000 to defray the cost of living at the University.

This program was envisioned about two and a half years ago as a reply to a problem posed by the provost of the University of Illinois, Gordon N. Ray: How is your department going to insure an adequate supply of instructors for the anticipated increase in enrollment? This was passed by Dean William L. Everitt of the College of Engineering to Professor Seicho Konzo, Chairman of the College's Graduate Committee. The ideas worked out by Professor Konzo are essentially the program now under way. It was decided to submit the plan to the Ford Foundation, which had shown recently an interest in the problems of engineering education. They suggested a few minor changes in the plan, such as including students in only two departments rather than throughout the college of engineering, and then approved the program. All this took only about six months. However, it was still too late to get started the fall, 1958, semester, so it was begun this fall.

The selection of the interns began last year with the notification of the various colleges of engineering across the country of the program. By the closing date for applications, February, 1959, the College had seventy-five applications for the ten available positions. The successful applicants were notified in March and reported here to begin this September. Among the considerations in selecting the candidates were scholarship (A "B" average or standing in the top twenty per cent of his graduating class was required to be considered.), three letters of reference from engineering instructors, and a real interest in the engineering teaching profession. An attempt was also made to distribute the scholarships so that a large number of schools would be represented. (The nine men presently enrolled in the program represent eight universities, with only the University of Alberta represented twice.) Although the program is primarily intended for those just receiving their B.S. degree, consideration is also given recent graduates now serving in industry or teaching.

It should be noted that the University of Illinois does not stand to gain from this program directly in terms of available teachers. This is because of a clause in the program that none of the men completing the program will be offered positions at the University of Illinois for a period of five years, and then only upon application by the student. The purpose of this program is not to augment the teacher supply for the host school.

The graduate work done by the students is not appreciably affected by the nature of the program. The foreign language requirements of the Ph.D. are anticipated by the students and courses taken to meet them. Other than these, most of the courses taken are advanced engineering courses. This phase of the program occupies approximately three-fifths of the student's time, the remainder divided between the two unique phases of the program.

The teaching intern concept of the program is one of the real innovations. Here the student first learns teaching from observing outstanding instructor experts, grading papers, working with laboratory groups, and finally, in their final semester in the program, taking over an actual class, giving it with a minimum of supervision from the college staff. Each student is assigned an instructor as his advisor. This instructor has been chosen by the department for his particular teaching abilities. Thus avoiding the shock of being handed a book and being told he has sixteen weeks to cover this material, which is rather discouraging to a prospective teacher, the intern is phased into actual teaching in gradual steps. In some cases it is felt that the student is qualified to go directly into laboratory work, so that a number of students are now, in their first semester in the program, actually working with lab sections.

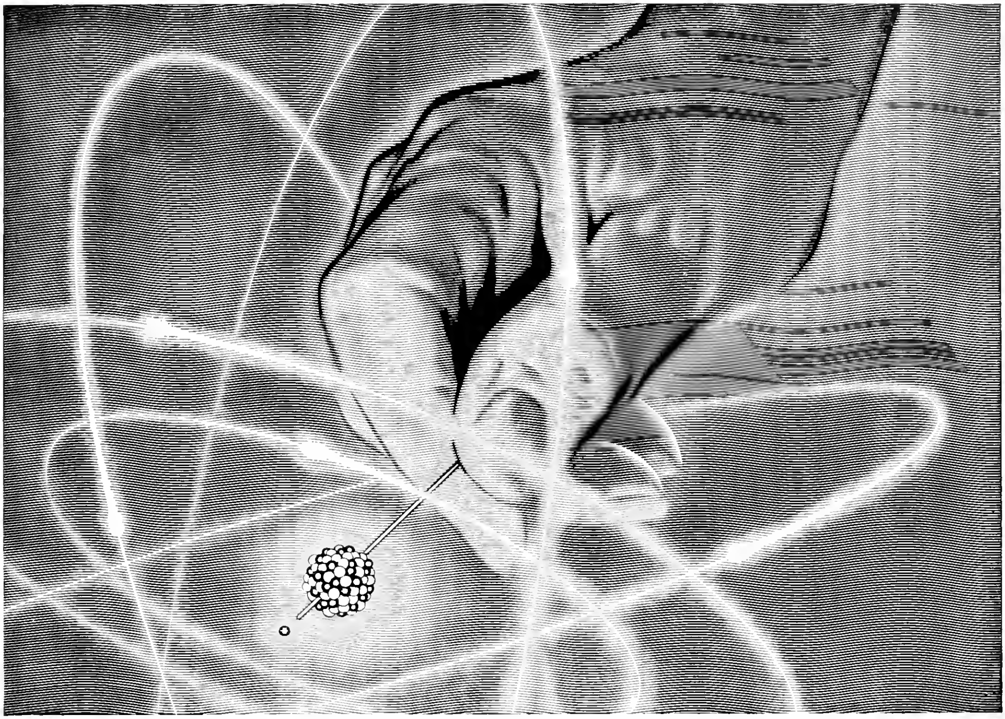
The final phase of the course is a series of weekly two hour seminars. These will require a certain amount of outside reading on the part of the interns in preparation, and a great deal on the part of the particular intern who is conducting each. The variety of subjects projected suggests the variety of purposes indulging them. Some are highly practical in teaching the students certain subject material, classroom psychology, and information about testing methods. Others will be of more broadening value. These will cover such diverse subjects as jazz, sociological problems, and fine arts. In addition to the actual information which is available through these seminars, the students get invaluable experience in group dynamics and general class handling. Each of the students will be chairman of one or more of these seminars and, at other times, recorder-reporter, who must prepare a summary of the proceedings. He gets opportunities to observe how individuals are "drawn in" to the discussion and how to think on his feet.

Preparing for teaching through this pilot program are nine men with only a desire to teach engineering in common. They come from Canada and Oklahoma, Kansas and the Bronx, up-state New York and suburban Chicago. One thirty-five year old intern is the father of three while another is twenty-one. Their interests run from Thermodynamics to Microwave Communications. Of the nine, five are ME's, three EE's, and one, Gordon Anderson, has transferred to the department of physics and is working under the program in this department.

It is the hope of the department that this program will prove itself worthy of its expectations and eventually spread to other universities. The shortage of engineering instructors is particularly serious in the smaller engineering schools where there are relatively few graduate students who can handle classes themselves, and who are likely to stick with their alma mater as a teacher. It is thus a responsibility, the bigger of engineering colleges to help meet this demand.

Perhaps an indication of the students' impressions of the program thus far can be drawn from the opinion of Ed Yellin:

"The projected program, and the manner in which it has thus far been implemented, certainly indicate that those of us in the program will be both psychologically and educationally prepared to enter the engineering teaching profession."



. . . a hand in things to come

Probing the atom...for you

The boundless energy of the uranium atom means a brighter future

Every day brings the benefits of atomic energy closer to our daily living. It presents a whole new field of exploration for scientists all over the world.

A longer, healthier life is hopefully ahead as radiation is helping doctors learn more about the basic processes of life by revealing how certain elements are put to work by the body. The controlled rays of the atom are also being used to pin-point malignant tissues for subsequent treatment. And radiation studies of how plants absorb nutrition from sun and soil are showing the way to improved food supplies.

These are but a few of the vital jobs being done by radioisotopes—radioactive materials created in atomic reactors at Oak Ridge, Tennessee . . . the great atomic energy center operated by Union Carbide for the U. S. Atomic Energy Commission. The people of Union Carbide will continue their pioneering research in atomic energy—and in the vital fields of alloys, carbons, chemicals, gases and plastics—to bring you a brighter future.

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UNION CARBIDE

...a hand in things to come

Magnetic Pump for Reactor Produced

The world's largest permanent magnet is scheduled to work in America's Atomic Energy Program. It will help pump liquid sodium in a breeder reactor to be operated by the Argonne National Laboratory for the Atomic Energy Commission. To be known as the Experimental Breeder Reactor $$ (EBR-II), this reactor will produce electrical power on the Argonne Idaho Divis'on site at the National Reactor Testing Station near Idaho Falls, Idaho.

The magnet weighs 1720 pounds, and is made of Alnico V material. The overall dimensions of the magnet are 52½ by 36 by 10 inches. It has a gap length of 16½ inches and a gap volume of 1584 cubic inches.

The magnet was checked in a 3000 hour test at temperatures up to 750 degrees F prior to its being put into service at the Argonne National Laboratory.

The huge permanent magnet will help in the pumping of the highly radioactive sodium at elevated temperatures.

The pumps operate without moving parts. This is achieved by the interaction between a current passing through the sodium at right angles to a strong magnetic field. This interaction produces a force in the sodium when directed through a closed piping system serving as a continuous supply of liquid sodium.

STATEMENT REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION

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1. The names and addresses of the publisher, editor, managing editor, and business managers are:

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Editor, Dave Penniman, 215 Civil Engineering Hall, Urbana, Illinois;

Business Manager, Roger Harrison, 215 Civil Engineering Hall, Urbana, Illinois.

2. The owner is: the Illini Publishing Company, a non-profit corporation.

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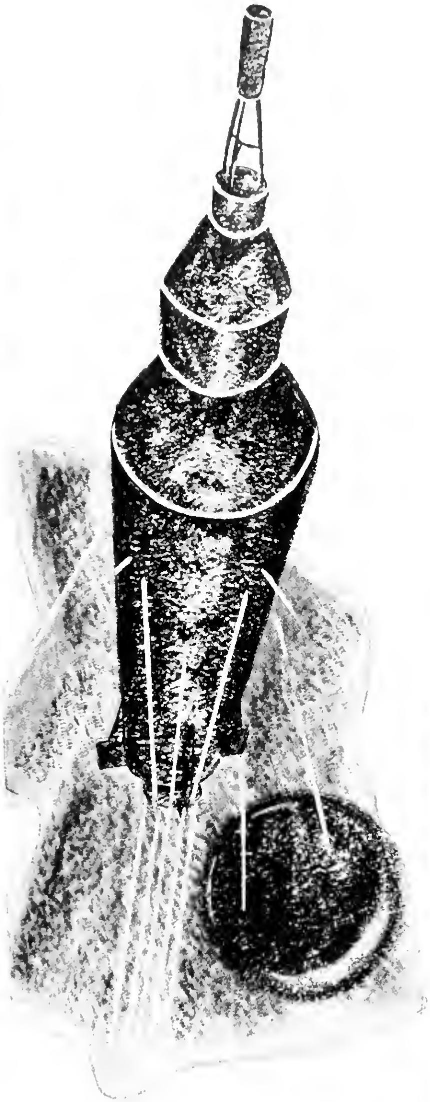
Roger L. Harrison, Business Manager.

Sworn to and subscribed before me this 10th day of October, 1959.

(SEAL) H. E. York.

(My commission expires Dec. 30, 1963)



The Campus at Night . . .

WHAT THE CAMPUS LOOKS LIKE

AFTER THE SHADES ARE DRAWN

AND THE CAT PUT OUT

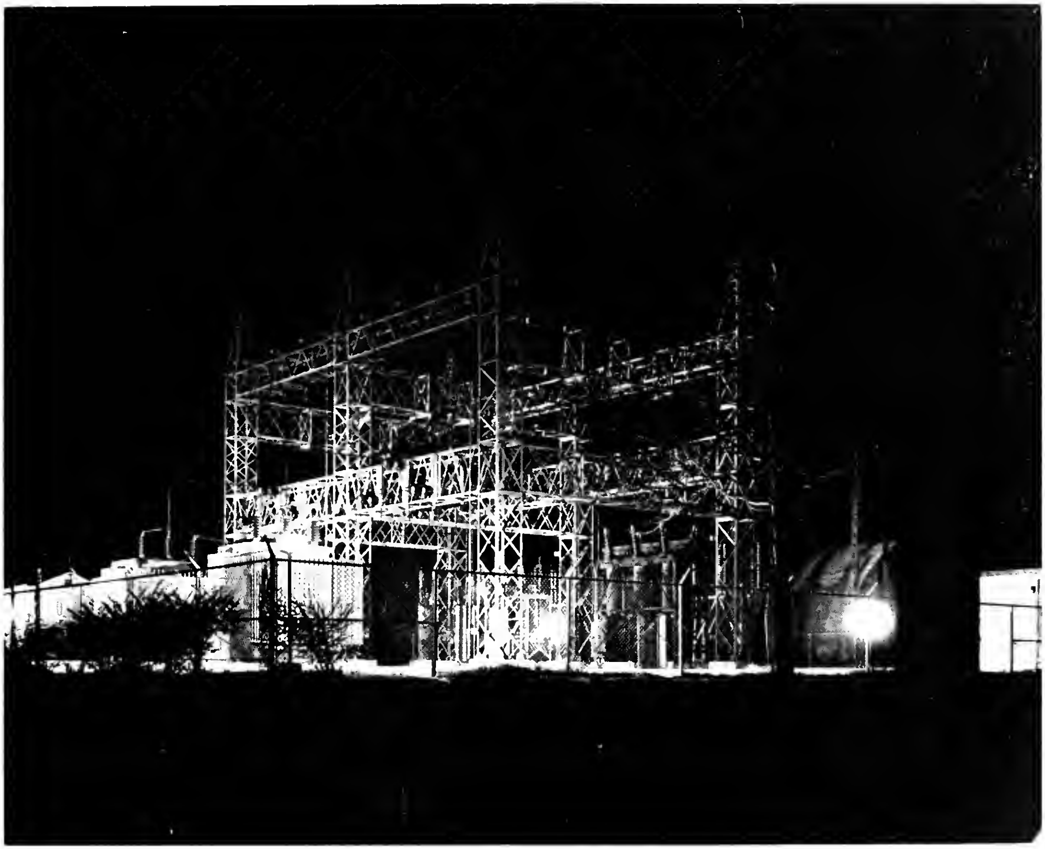
LOOK FAMILIAR?

AT LAST!

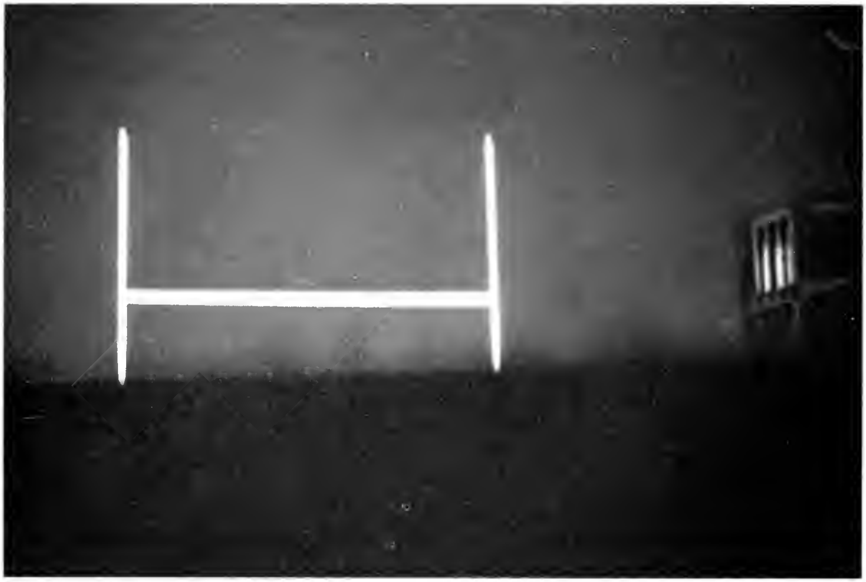
MIDNIGHT GRIND AT MRH

AND AT BEVIER HALL

POWER PLANT (M.E. 263 PROVING GROUND)

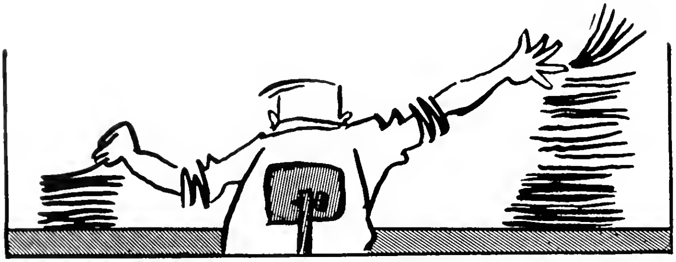


E.E. COMES THROUGH!



LATE FOR THE GAME

Skimming Industrial Headlines



Edited by Paul Cliff

Sputtered Resistors Make High Component Density Possible

Sputtered thin-film resistors, formed from refractory metals such as tantalum and titanium, may be one of the more important developments in microminiature electronics. Such resistors can be produced on glass or ceramic bases in lines as narrow as 1 mil (0.001 inch), spaced 1 mil apart, thus producing extremely high resistance in a small area.

Research in sputtering, an old technique in which ionized gas molecules bombard a cathode, dislodging atoms of metal which then redeposit on nearby surfaces, has been conducted at Bell Laboratories for several years.

The newly announced miniature resistors owe their success to a high precision masking process, which makes it possible to produce the thin films in specifically restricted locations. An expendable copper mask is used for this operation.

In producing a resistor, an over-all thin film of copper is first deposited onto the ceramic or glass base, for example, by sputtering. Then, the desired pattern is etched into the copper surface by standard photoetching techniques, leaving the bare substrate exposed. Tantalum, other refractory metals, or electrically useful alloys are then deposited onto the etched copper pattern, and the whole unit placed in an etching bath. The copper with its overlay of tantalum is removed, leaving behind only the tantalum which was in direct contact with the bare surface. Since the masks are extremely thin, fine detail is possible. Also, since the sputtered materials adhere to the substrate itself, support considerations are not necessary and complex patterns can be produced.

"Goer"—New Military Transporter

A new type of off-road transport vehicle, capable of delivering military supplies across-country to widely dispersed, fast moving units of the atomic age Army, is being manufactured by Le Tourneau - Westinghouse.

The giant rubber tired machine, dubbed the "Goer" for its "go-anywhere" mobility, is a strict departure from conventional Army trucks and transporters. Instead of following the historic pattern of being a military development which might one day be adapted to civilian use, it is essentially a "plowshare hammered into a sword." For the most part, Goer design principles and components have been adapted from those which have given mobility, agility and durability to commercial earthmoving machines in the United States since before World War II. The Goer's two-wheel prime mover; articulated, wagon-type electric steering; high ground clearance; springless suspension, rugged, simple power train; and six foot-tall rubber tires are all common to modern earthmoving equipment.

Two Goer prototypes—a 5,000-gallon fuel tanker and 15-ton cargo carrier negotiated a series of rugged rough-terrain problems which proved impossible for a fleet of conventional Army trucks and transporters. Fully loaded, the Goers climbed slopes, threaded their way between boulders, scaled a vertical wall, skimmed over a sand trap, snaked their way through whip-deep mud pits and topped the whole performance off by swimming across an inland lake.

New Copper Paste for Screen Printing

A new method for producing printed wiring directly on ceramic basis without the use of adhesives has recently been developed by Bell Telephone Laboratories. The basis of the new process, which uses standard silk screening techniques for forming the pattern, is a specially formulated copper-bearing paste. Following the printing of the desired pattern on the ceramic base, the piece is fired in a two-step process, resulting in a clean, durable pattern with excellent electrical characteristics.

In present methods of production, a sheet of copper foil is usually bonded to the ceramic or plastic base with an adhesive. The desired pattern is then produced by one of several methods usually involving the removal of undesired material. The bond of the copper to the base thus is dependent on the strength of the adhesive. Often, it fails during subsequent processing operations, such as soldering or assembly.

With the new process, a paste is prepared from a finely ground mixture of copper oxide and a special glass frit, blended with a standard silk screen printing vehicle. The paste is used to print the pattern on the ceramic, and the "card" is heat-dried to remove solvents. After drying, the card with its pattern is fired in air at 750°C for twenty minutes to burn off the printing vehicle. This operation leaves a non-conducting copper oxide pattern, ready to be reduced to metallic copper.

The second firing operation is conducted at 850°C for thirty minutes, in a controlled atmosphere containing hydrogen, nitrogen, and oxygen. The hydrogen in the atmosphere reduces the copper oxides to metallic copper, while the oxygen prevents reduction of other oxides in the system and promotes good wetting of the glass frit and the ceramic. Without the oxygen present, a poor bond results.

Rechargeable Nickel-Cadmium Batteries

A versatile selection of compact, rechargeable, sealed nickel-cadmium cells and batteries designed for battery-operated devices requiring high energy has been introduced by Burgess Battery Company.

The hermetically sealed construction of the new units, eliminating routine maintenance and the addition of liquids required by earlier nickel-cadmium batteries, represents a major advance in secondary battery technology.

Burgess will market individual cells in eight sizes, as well as a range of multiple cell batteries in numerous voltages. The individual cells, rated at 1.25 volts, include six button-type units ranging from a finger-tip sized cell only four-tenths of an inch in diameter to one slightly larger than a silver dollar. Long-lasting single-cell batteries in penlight (AA) and standard flashlight battery (D) sizes also are available.

A virtually unlimited variety of multiple cell nickel-cadmium batteries could be designed from the cells to fill the widely varying requirements of industrial product designers and electronic engineers.

Development of a unique conductive silver wax inter-cell connection makes possible broad flexibility for nickel-cadmium battery designs. A dab of silver wax on the positive and negative sides of each cell permits cells to be connected in series merely by being stacked in a column. The ability of the wax to mold itself to any contour between the cells assures a permanent inter-cell connection which will not break even under rugged handling.

Recharging will restore the new nickel-cadmium batteries to peak operating efficiency hundreds of times. Response of the cells is equally good to either a slow or fast charge. The nickel-cadmium batteries are not affected adversely by long idle periods either in a charged or discharged state, and they operate in a temperature range of 0 to 115 degrees F.

In tests, engineers have demonstrated how the normal life of nickel-cadmium batteries can be extended many times by recharging before they discharge more than one-half of their capacity.

Winners of Highway Bridge Design Announced

Award winners of the $44,000 Steel Highway Bridge Design Competition sponsored by U. S. Steel's American Bridge Division were named.

Top winner in the professional classification was Allan M. Beesing, structural design engineer with James J. MacDonald, Buffalo, N. Y., consulting engineer. He was awarded $15,000 for his entry.

First award in the student classification went to a joint entry submitted by Niels Gimsing and Hans Nyvold of Copenhagen, Denmark. Both men were students at the Technical University of Denmark. They will share $4,000 for their entry.

The competition, conducted under the auspices of the American Institute of Steel Construction, Inc., required entrants to design a steel bridge to carry a two-lane crossroad over a modern four-lane highway. It was open to professional design engineers and college engineering students anywhere in the world.

Winning entries were selected on the basis of originality of design, utilization of the properties of steel, economy, and appearance.

According to A. J. Paddock, president of American Bridge Division, the selection of the particular problem featured in the competition is especially appropriate to the construction of America's 41,000-mile interstate and defense highway system over the next 15 years. It is estimated that more than one bridge will be required for each mile of the high speed highway network.

Beesing's top-award design is a graceful welded steel girder structure which bridges, in a single span, a four-lane divided highway. The skillful combination of carbon and high strength steels and design innovations permits the abutments to be moved back from the shoulders and eliminates the need for a center pier.

The Gimsing-Nyvold entry is a welded two-span frame bridge designed for mass production and requiring minimum field erection. Construction work is reduced to a few riveted or bolted connections.

Four of the 15 awards were made to foreign entries. Two went to student entries, the other two being awarded to professional entries.

w It as the consensus of the judges after completing their work that the professional entries were outstanding and indicated that they represented a lot of thought and effort. As for the student entries, they commented: "future of bridge design is in good hands." They were surprised and delighted at the quality of work turned in by students, one saying, "This is better than I could have done in my college days, which means better students today and speaks well of educational advances."

Compact Cathode Ray Tube Produced

The development of a newly designed, compact "Wamoscope"—a cathode ray tube capable of presenting microwave frequency information directly on its screen—was announced by Sylvania Electric Products Inc.

Dr. Robert M. Bowie, vice president Sylvania Research Laboratories, said the new tube, which was developed for use in advanced electronic systems applications, does not require a solenoid, a bulky focusing structure requiring an external source of electric current. The "Wamoscope" is only slightly longer than conventional television picture tubes.

The improved "Wamoscope" operates over a frequency range of 2 to 10 kmc, and will be particularly important in high-resolution ralar applications, Dr. Bowie said. The new tube has a signal coupler incorporated within the tube envelope and "spot size" has been improved to 160 lines per inch at the center of its 10-inch screen.

Stainless Steel Pump for Yankee Atomic Electric Plant

Shown at Westinghouse Electric Corporation's atomic equipment department, a 16,000-pound canned motor pufmp volute is being made for the Yankee Atomic Electric Company's 134,000-kilowatt nuclear power plant at Rowe, Mass. The finished canned

motor pump, which will be hermetically sealed, will be over 11 feet high and will weigh 39,000 pounds. Along with three other units, the canned motor pump, rated at 1600 horsepower, will circulate radioactive water at 496 degrees F through the nuclear reactor system at a rate of 23,700 gallons per minute at a system pressure of about 2000 pounds per square inch. There will be an 80-psi pressure rise across the pump. Both the rotor, or rotating part, and stator, or stationary part, of this type of pump are encased, or "canned," in metal. Water being circulated flows through the space between the rotor and the stator, thus acting as a coolant and lubricant.

Skin-Diver Patrol

Skin divers patrol submarine cables of an electric utility company. The divers are able to check the cables at a rate up to two miles per day in depths up to 40 feet and one-half mile per day in deeper water, where decompression is required after 35 minutes' exposure.

Could this be a picture of you tomorrow? In the fall of 1958, it was Jack Carroll, principal speaker at the opening of Electronic Associates' modern new plant in Long Branch, N. J.

Jack Carroll *(right)* discusses the new equipment he has just seen during a visit with Henri Busignies, President of ITT Laboratories *(center)* and Anthony Pregliese, ITT Public Relations.

Cash Prizes!

FOR

BRAINTEASERS

The TECHNOGRAPH will award $5 to each of the winners of the monthly brainteaser contests which will begin with this issue. The winner will be the person who turns in the greatest number of correct answers to the TECHNOGRAPH office in 215 Civil Engineering Hall. If there is a tie, the prize will be given to the entry with the earliest date. The deadline for entries this month is December 10th.

BRAIN TEASERS

Edited by Steve Dilts

A group of airplanes is based on a small island. The tank of each plane holds just enough fuel to take it halfway around the world. Any desired amount of fuel can be transferred from the tank of one plane to the tank of another while the planes are in flight. The only source of fuel is on the island, and for the purposes of the problem it is assumed that there is no time lost in refueling either in the air or on the ground. What is the smallest number of planes that will insure the flight of one plane around the world on a great circle, assuming that the planes have the same constant ground speed and rate of fuel consumption and that all planes return safely to their island base?

* * *

What is the radius of the largest circle that can be drawn entirely on the black squares of a chessboard with squares that are two inches on a side?

* * *

An amusing parlor trick is performed as follows. Ask spectator A to jot down any three-digit number, and then to repeat the digits in the same order to make a six-digit number (*e.g.*, 394,394). With your back turned so that you cannot see the number, ask A to pass the sheet of paper to spectator B, who is requested to divide the number by 7.

"Don't worry about the remainder," you tell him, "because there won't be any." B is surprised to discover that you are right (*e.g.*, 394,394 divided by 7 is 56,342). Without telling you the result he passes it on to spectator C, who is told to divide it by 11. Once again you state that there will be no remainder, and this also proves correct (56,342 divided by 11 is 5,122).

With your back still turned, and no knowledge whatever of the figures obtained by these computations, you direct a fourth spectator, D, to divide the last result by 13. Again the division comes out even (5,122 divided by 13 is 394). This final result is written on a slip of paper which is folded and handed to you. Without opening it you pass it on to spectator A.

"Open this," you tell him, "and you will find your original three-digit number." Prove that the trick cannot fail to work regardless of the digits chosen by the first spectator.

* * *

Two missiles speed directly toward each other, one at 9,000 miles per hour and the other at 21,000 miles per hour. They start 1,317 miles apart. Without using pencil and paper, calculate how far apart they are one minute before they collide.

* * *

The answers will appear next month.

* * *

Here are the answers to last month's brain-teasers.

1. A = 10430
   B = 3970
   C = 2114
   D = 386
2. 93 feet
3. 1st trip = 15 m.p.h.
   2nd trip = 45 m.p.h.
   3rd trip = 90 m.p.h.
4.

Eldest	\$ 75
2nd	\$375
3rd	\$525
Hospital	\$825

The answer to the coconut problem is fifteen.

The most convenient device for solving the first logic problem is to use a matrix with vacant cells for all possible pairings in each set. One cell is needed for pairing names with jobs, and another is needed for pairing names with cities. Each cell is marked so as to show whether or not the combination is possible.

Premise 7 eliminates the possibility that Smith is the fireman, and Premise 2 tells us that Mr. Robinson lives in Los Angeles. Premise 3 and 6 inform us that the physicist lives in Omaha, but he can't be Mr. Robinson nor Mr. Jones (who has forgotten his algebra). Mr. Smith is therefore the physicist, and Mr. Jones must live in Chicago.

Premise 5 now permits us to identify the brakeman as Jones. Since the fireman can be neither Smith nor Jones, Robinson must be the fireman, and Smith must be the engineer.

The second logic problem left unanswered last month is best handled by three matrices: one for combinations of first and last names of wives, one for first and last names of husbands and one to show sibling relationships. Since Mrs. White's first name is Marguerite (premise), we have only two alternatives for the names of the other wives: (1) Helen Black and Beatrice Brown or (2) Helen Brown and Beatrice Black.

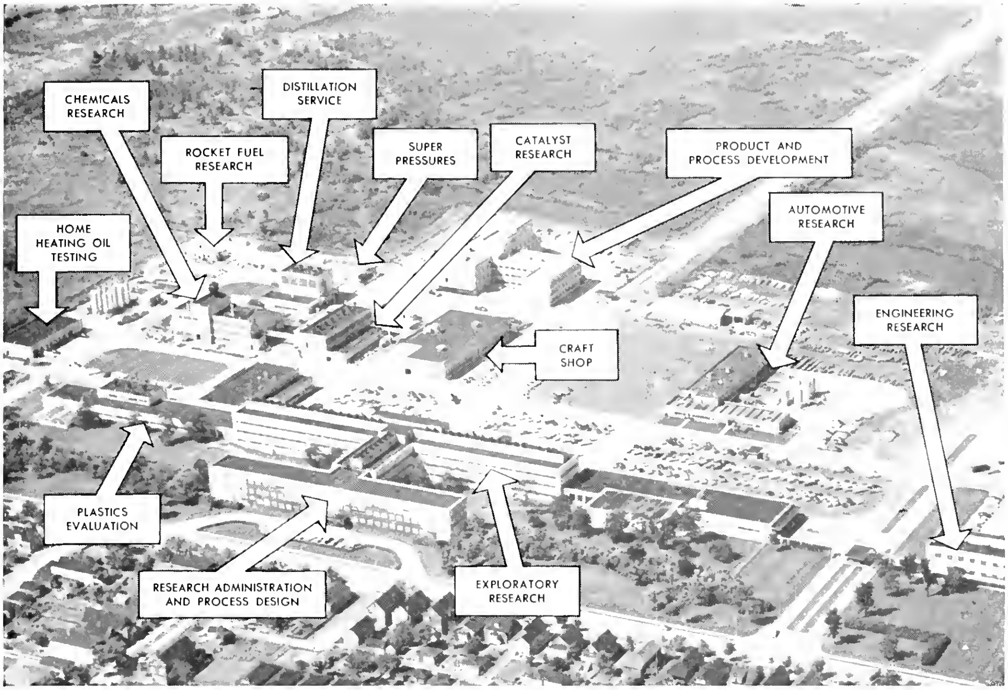
Let us assume the second alternative. White's sister must be either Helen or Beatrice. It cannot be Beatrice, because then Helen's brother would be Black; Black's two brothers-in-law would be White (his wife's brother) and Brown (his sister's husband); but Beatrice Black is not married to either of them, a fact inconsistent with premise 4. Therefore White's sister must be Helen. This in turn allows us to deduce that Brown's sister is Beatrice and Black's sister is Marguerite.

Premise 6 leads to the conclusion that Mr. White's first name is Arthur (Arthur Brown is ruled out because that would make Beatrice prettier than herself, and Arthur Black is ruled out because we know from premise 5 that Black's first name is William). Therefore Brown's first name must be John. Unfortunately premise 7 informs us that John was born in 1868 (50 years before the Armistice), which is a leap year. This would make Helen older than her husband by one day more than the 26 weeks specified in premise 3. (Premise 4 tells us that her birthday is in January, and premise 3 tells us her husband's birthday is in August. She can be exactly 26 weeks older than he if her birthday is January 31, his on August 1, and there is no February 29 in between!) This eliminates the second of the two alternatives with which we stated, forcing us to conclude that the wives are Marguerite White, Helen Black and Beatrice Brown. There are no inconsistencies because we do not know the year of Black's birth. The premises permit us to deduce that Marguerite is Brown's sister, Beatrice is Black's sister, and Helen is White's sister, but leave undecided the first names of White and Brown.

In the problem of the stamps on the foreheads, B has three alternatives: his stamps are (1) red-red, (2) green-green, or (3) red-green. Assume they are red-red.

After all three men have answered once, A can reason as follows: "I cannot have red-red (because then C would see four red stamps and know immediately that he had green-green, and if C had green-green, B would see four green stamps and know that he had red-red). Therefore I must have red-green."

But when A was asked a second time, he did not know the color of his stamps. This enables B to rule out the possibility that his own stamps are red-red. Exactly the same argument enables B to eliminate the possibility that his stamps are green-green. This leaves for him only the third alternative: red-green.



This huge research center at Whiting, Indiana, is only part of Standard Oil's research facilities. A recently completed technical service and quality control laboratory, not shown here, is the largest laboratory of its kind in the country. In addition, large research laboratories are operated by several affiliates.

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THE SIGN OF PROGRESS .. THROUGH RESEARCH


SPACE AGE
CHALLENGE?

Begged, Borrowed, and . . .

Edited by Jack Fortner

Engineer's Glossary

It is in process—So wrapped up in red tape that the situation is almost hopeless.

We will look into it—By the time the wheel makes a full turn, we assume you will have forgotten about it also.

A program—Any assignment that cannot be completed by one telephone call.

Expedite—To confound confusion with commotion.

Channels—The trail left by inter-office memos.

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

Consultant, Expert—Any ordinary guy more than 50 miles from here.

To activate—To make carbons and add more names to the memo.

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

Under consideration—Never heard of it.

A meeting—A mass mulling by master minds.

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

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

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

Re-orientation—Getting used to working again.

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 ugly rumor originally.

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

* * *

Three tourists were standing on a street corner in North Africa. They were an Englishman, an Arabian, and an American. Just then a beautiful woman walked by. The Englishman said, "By jove!" The Arabian said, "By the prophet." The American just shifted his chewing gum and said, "By midnight!"

A meek little man walked into a barroom and ordered two drinks from the burly bartender. He drank one of the drinks and poured the other into his shirt pocket. After about ten rounds of this procedure the bartender says, "Pal, why are you pouring the other drink into your shirt pocket?"

The little man jumped up into the bartender's face and snarled, "Mind your own business, you big bum, or I shall come over the counter and whale the fire out of you." About that time a blurry-eyed mouse stuck his head out of the man's shirt pocket and said, "That goes for your damned cat, too."

* * *

During the recent California drought everything was so dry that the trees were going to the dogs.

* * *

Professor Lewellyn Rubin looked toward the next green, waggled his driver confidently, and declared, "That's good for one long drive and a putt." He gave his club a mighty swing, blasted up about two inches of sod, and managed to get the ball about three feet from the tee.

The caddy stepped forward, handed him his putter, and suggested, "Now, for one helluva putt."

* * *

Did you ever hear the story about the farmer who was milking a cow on the side of a mountain? He slipped and fell and would have gone down 500 feet if he didn't have something to hang onto . . . the poor cow saved him but the neighbors thought it was an air raid.

* * *

"The editor just hanged himself."
"Have they cut him down?"
"Not yet. He isn't dead."

* * *

Little Jack Horner
sat in a corner
Crib notes under his eye.

He opened his book
And took a quick look,
And now he's a Tau Beta Pi.

* * *

Pop Robin returned to the nest and proudly announced that he had made a deposit on a new Buick.

Three football players at different schools had flunked their classes and were dropped from the team. They got together and talked about their misfortune. The man from O.U. said, "That calculus was just too damn much." The man from S.M.U. said, "It was trig that got me." The guy from U. of I. said, "Did yourse guys ever hear of long division?"

* * *

Statistics show there are three classes of coeds—the intellectual, the beautiful, and the majority.

* * *

Two be-bops while traveling in Russia, saw a guy being flogged in a public square.

"I don't dig the beat," said one, "but that sure is a crazy drum."

* * *

Two old ladies were enjoying the music in the park. "I think it's a Minuet from Mignon," one said.

"I thought it was a waltz from Faust," said the other.

The first went over to what she thought was the board announcing the numbers.

"We're both wrong," she said when she got back. "It's a Refrain from Spitting."

* * *

He was a rather undersized freshman at his first college dance, but despite his smallness and bashfulness he was sure of himself in his own way. He walked over to a beautiful and over-sophisticated girl and said, "Pardon me, Miss, but may I have this dance?"

She looked down at his small size and lack of fraternity pin and said, "I'm sorry, but I never dance with a child!"

The freshman bowed deeply and said, "Oh I'm sorry, I didn't know your condition."

* * *

U. of I.! What a football team!! What an attack!!! Even their breath is offensive.

* * *

A woman is getting older when she begins to worry more about how her shoes fit than her sweater.

* * *

Now go back and read the rest of the magazine!

One of a series*

Interview with General Electric's Charles F. Savage Consultant—Engineering Professional Relations

How Professional Societies Help Develop Young Engineers

Q. Mr. Savage, should young engineers join professional engineering societies?

A. By all means. Once engineers have graduated from college they are immediately "on the outside looking in," so to speak, of a new social circle to which they must earn their right to belong. Joining a professional or technical society represents a good entree.

Q. How do these societies help young engineers?

A. The members of these societies—mature, knowledgeable men—have an obligation to instruct those who follow after them. Engineers and scientists—as professional people—are custodians of a specialized body or fund of knowledge to which they have three definite responsibilities. The first is to *generate* new knowledge and add to this total fund. The second is to *utilize* this fund of knowledge in service to society. The third is to *teach* this knowledge to others, including young engineers.

Q. Specifically, what benefits accrue from belonging to these groups?

A. There are many. For the young engineer, affiliation serves the practical purpose of exposing his work to appraisal by other scientists and engineers. Most important, however, technical societies enable young engineers to learn of work crucial to their own. These organizations are a prime source of ideas — meeting colleagues and talking with them, reading reports, attending meetings and lectures. And, for the young engineer, recognition of his accomplishments by associates and organizations generally heads the list of his aspirations. He derives satisfaction from knowing that he has been identified in his field.

Q. What contribution is the young engineer expected to make as an active member of technical and professional societies?

A. First of all, he should become active in helping promote the objectives of a society by preparing and presenting timely, well-conceived technical papers. He should also become active in organizational administration.
This is self-development at work, for such efforts can enhance the personal stature and reputation of the individual. And, I might add that professional development is a continuous process, starting prior to entering college and progressing beyond retirement. Professional aspirations may change but learning covers a person's entire life span. And, of course, there are dues to be paid. The amount is graduated in terms of professional stature gained and should always be considered as a personal investment in his future.

Q. How do you go about joining professional groups?

A. While still in school, join student chapters of societies right on campus. Once an engineer is out working in industry, he should contact local chapters of technical and professional societies, or find out about them from fellow engineers.

Q. Does General Electric encourage participation in technical and professional societies?

A. It certainly does. General Electric progress is built upon creative ideas and innovations. The Company goes to great lengths to establish a climate and incentive to yield these results. One way to get ideas is to encourage employees to join professional societies. Why? Because General Electric shares in recognition accorded any of its individual employees, as well as the common pool of knowledge that these engineers build up. It can't help but profit by encouraging such association, which sparks and stimulates contributions.

Right now, sizeable numbers of General Electric employees, at all levels in the Company, belong to engineering societies, hold responsible offices, serve on working committees and handle important assignments. Many are recognized for their outstanding contributions by honor and medal awards.

These general observations emphasize that General Electric does encourage participation. In indication of the importance of this view, the Company usually defrays a portion of the expense accrued by the men involved in supporting the activities of these various organizations. Remember, our goal is to see every man advance to the full limit of his capabilities. Encouraging him to join Professional Societies is one way to help him do so.

Mr. Savage has copies of the booklet "Your First 5 Years" published by the Engineers' Council for Professional Development which you may have for the asking. Simply write to Mr. C. F. Savage, Section 959-12, General Electric Co., Schenectady 5, N. Y.

*__LOOK FOR__ other interviews discussing: Salary • Why Companies have Training Programs • How to Get the Job You Want.

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TECHNOGRAPH

THE ILLINOIS TECHNOGRAPH

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December, 1959

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Cover . . .

Who knows what lurks on the cover of the TECHNOGRAPH? Barbara Palan does. She again deals with an abstract theme, as last manth, but has added a second calor.

CAUTION
RADIOACTIVITY

Westinghouse Metallurgists, Dr. M. J. Fraser (foreground) and Dr. H. W. Weart, prepare to photograph a molten alloy sample as one step in the determination of liquid-solid interfacial energy. These direct experimental measurements are the first of their kind ever attempted.

The Metallurgy Lab helps when you need a new alloy to make your idea practical

The Metallurgy Lab helps Westinghouse engineers solve problems involving the need for special alloys and other new materials. If an engineer's idea requires a new kind of material to withstand high temperatures or one with unusual magnetic or thermoelectric properties, the men in the Metallurgy Lab may be able to develop it for him.

This laboratory, one of the largest of its kind in the country, uses both basic and applied research to come up with a spectrum of new materials with a variety of properties. One typical activity is the development of alloys of high melting point metals like tungsten, tantalum and niobium for use in reactors. Another is a study of deformation and fracture, which will add to the store of metallurgical knowledge engineers in other departments can call on to solve their specific problems.

The young engineer at Westinghouse isn't expected to know all of the answers. The work we do is often too advanced for that. Instead, each man's abilities and knowledge are backed up by that of specialists like those in the Metallurgy Laboratory. Even the toughest problems are easier to solve with this kind of help.

If you have ambition and real ability, you can have a rewarding career with Westinghouse. Our broad product line, decentralized operations, and diversified technical assistance provide hundreds of challenging opportunities for talented engineers.

Want more information? Write to Mr. L. H. Noggle, Westinghouse Educational Department, Ardmore & Brinton Roads, Pittsburgh 21, Pennsylvania.

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Better Things for Better Living . . . *through Chemistry*

From the Editor's Desk . . .

What do you know?

One of the most well used and least meaningful greetings on this campus is, "What do ya know?" An answer such as, "Not much, how about you?" is the inevitable return to this rhetorical question.

What **do** you know? Many theoretical concepts and practical ideas have been made evident during your time at this university, but one phase is left up to you. You must find out about You.

How well do you know yourself? It is a very discouraging thing to find that, after four years of college, knowledge of oneself is lacking. Time is scarce, and thinking required on numerous subjects; however, time should be spent on yourself, also.

Do you know yourself well enough to realize your limitations and your strong points so you do not spend a great amount of time on something of little interest to you? If the things of little interest include your studies, then some serious thinking should be done concerning your goals.

Knowing yourself is not an easy thing to do and requires a type of thinking that is far more analytical than any mechanical problem, because the mechanism (you) is variable in almost every respect. The reasons for these variations are vital things to know, yet no book, person, or editorial can define them for you. If success (which also should be defined by you personally) is ever to come, some thing must be spent in regarding yourself. Stop to think of your goals, even amid the bustle of this campus. Then the next time someone says, "What do you know?" you can answer that question to yourself at least.

WDP

The Free Piston Engine

By Dick Nordsieck

Introduction

In the past, the field of aircraft power has been divided into two main categories, gas turbine type engines and reciprocating engines. These have been developed almost entirely separately, and each is now nearing or past the point of diminishing returns from its development.

The turbine type power plants, including such engines as the turbo-jet and the turbo-prop have been developed to the point where increased efficiency will necessitate higher turbine inlet temperatures and thus require better alloys for turbine blade materials. Metallurgists feel that they have reached their peak in a turbine blade which will withstand 1800 F. Furthermore, the efficiency of a turbine type power plant, at its maximum, is only 35%, and this occurs at the top speed of the engine.

On the other hand, the reciprocating engine is limited with respect to power by the maximum allowable bearing pressures and hence an upper limit is placed on combustion chamber pressures. Granted the efficiency of a reciprocating engine is creditable, but it would be highly desirable to have more power without sacrificing efficiency.

From the previous observations, it might seem that a combination of the two, turbine and reciprocating engine, would just compound the limitations, and so it would, if some ingenuity were not employed. It will be the purpose of this report to present just such an ingenious combination of these, two of the oldest forms of power plant.

The free piston gas generator turbine is a hybrid engine, combining the advantages and eliminating most of the disadvantages of both the gas turbine and the reciprocating engine. The engine is composed of two major parts, the gas generator and the turbine assembly. The free piston gas generator is basically a pressure-charged, two-cycle, opposed-piston, crankless diesel engine of variable stroke and compression. It is evident, since the engine has no crankshaft, that its power cannot be transmitted directly. Rather, the purpose of the free piston gas generator is to supply high pressure exhaust gases to a turbine assembly placed in its exhaust system. Because the gas generator employs reciprocating pistons to perform its task, the hybrid engine is not regarded as a true gas turbine by many people, since a gas turbine normally utilizes only rotating parts.

History

The first patent on a free piston engine was held by Doctor Buchi, a Frenchman, in 1905, but the gas generator was not built and run in its modern form until 1925 when the Marquis R. P. de Pescara of Spain built an engine which he hoped would power a small helicopter. As it turned out, his engine was more successful as an air compressor, and Pescara decided to develop it along these lines. Just prior to World War II several small companies in Europe began to work on the gas generator turbine combination, and by 1940 a 750 kilowatt set was in operation in the Alsthom factory in Belfort, France. During this time Alan Muntz and Co. of Hounslow, Middlesex, held a Pescara license and also did development work on behalf of the Admiralty. The outbreak of the war interrupted French development. When they over-

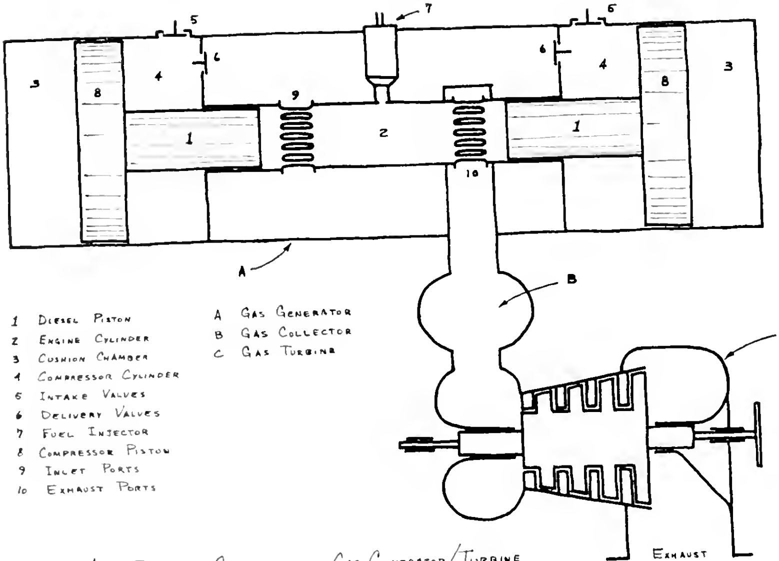


Fig 1 Inward Compressing Gas Generator/Turbine

ran Europe, the Nazis were able to capture the gas generator designs, and subsequently some German submarines were equipped with free piston air compressors. In 1943, the U. S. Navy captured one of these submarines, and became very interested in the gas generator turbine combination as a power plant for marine use. The General Machinery Corporation of America conducted extensive research work on marine installations for the Navy. This work is continued today by the same company under the name of Baldwin-Lima Hamilton.

Some other firms now developing free piston power plants include General Motors Corporation and Ford Motor Company, both working under Pescara-Muntz license. In 1956, General Motors exhibited the Firebird I, an experimental car powered by a free piston engine, and, in 1957, General Motors built a 6000 hp marine free piston power plant installed in the Liberty ship William Patterson. Also in 1957, Ford rolled out the Ford Typhoon free piston gas generator turbine powered tractor which exhibited excellent characteristics for the farmer's purpose in that it produced its maximum torque at heavy load.

Components and Principles of Operation

The closest simulation of a free piston gas generator would be obtained from an opposed two cylinder diesel engine with a turbine placed in its exhaust system. The primary differences are that in the free piston engine there is only one combustion chamber and no crankshaft or connecting rod.

Figure 1 shows the locations and identities of the various parts and will be referred to frequently during the explanation which follows.

Beginning with the pistons at their extreme outward positions, known as the "outer dead points," air which has been admitted to the compression cylinders (4) through the inlet valves (5) is compressed through valves (6) to approximately 50 p.s.i. by the inward motion of the pistons. The valves (6) prevent the return of this air to the compression cylinder. Depending on the power loading on the generator, the pistons will be at a certain variable distance apart and the compression pressure may be as high as 900 p.s.i.

At a predetermined point in the stroke, fuel is injected into the cylinder through injectors (7) of conventional design suitably spaced around the combustion chamber (2). Combustion is spontaneous and the two pistons are driven apart, *opening first the exhaust ports* (10) *and then the scavenge-intake ports* (9). The exhaust gases, considerably cooled and diluted by the pressurized scavenge air, travel at about 80 p.s.i. through the damping chamber (B) and thence to the turbine (C). The purpose of the damping chamber is to smooth out the impulsive exhaust discharge before delivery to the turbine. When the exhaust reaches the turbine, pulse frequencies are low enough that there is no risk to turbine blades. The fundamental frequency of the main pressure waves in the exhaust gas is of the order of 10 c.p.s. compared with a natural frequency of about 1000 c.p.s. for the blades in the first stage of a large turbine.

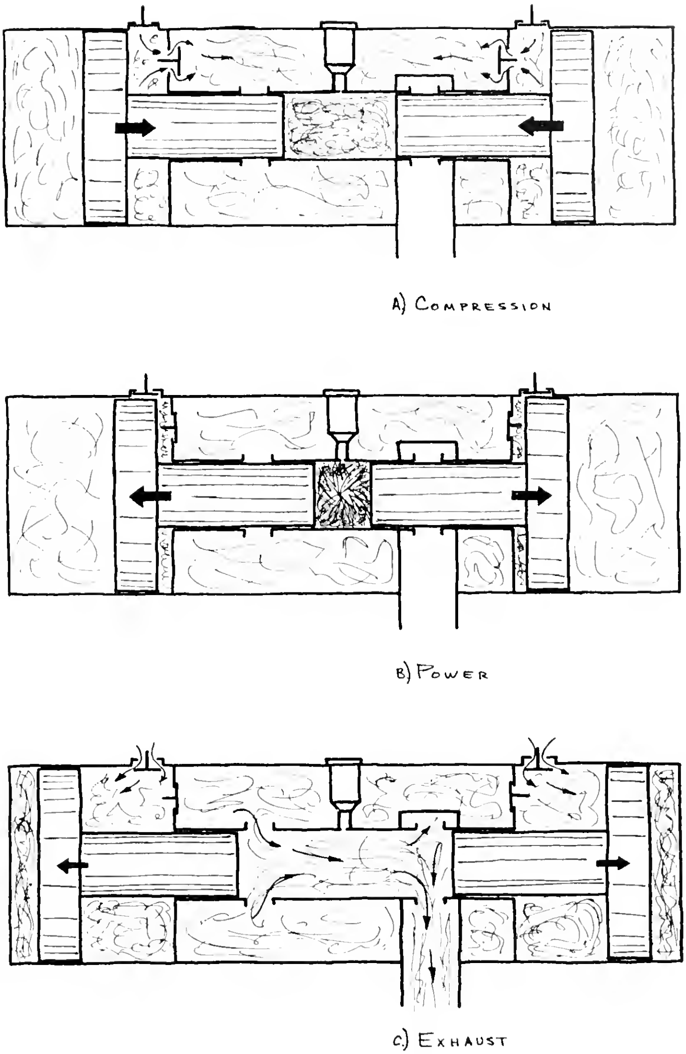


Fig. 2 The Cycle

Gases reach the turbine at about 900 F., and after expansion through the turbine, exhaust to the atmosphere at approximately 450°F. The turbine itself acts as an exhaust silencer and the noise level is about the same as a diesel engine running at the same speed, but no high frequency noises such as valve clatter are present.

As the piston continues outward, it compresses the air trapped in the cushion cylinders (3), exchanging the kinetic energy of the piston for potential energy in the compressed air. The re-

(Continued on Page 14)


CHINA
U.S.S.R.
ALASKA
EUROPE
GREENLAND
CANADA
AFRICA
U.S.A.

(Continued from Page 11)

turn of the pistons is effected by this energy stored in the cushion cylinders and the amount of energy stored depends upon the amount of fuel injected on the previous stroke, so the stroke of the engine varies by virtue of the quantity of energy stored in the cushion cylinders. It now becomes evident that as extra fuel is injected, more energy is stored and, on the inward stroke, the pistons will come closer together giving higher peak pressures and more power. For any given constant load, there will be an equilibrium condition and the stroke will become essentially constant.

It should be noted here that any difference in pressures between the cushion cylinders would result in a difference in piston return energies and out of phasing of the pistons. These differences in pressure which might result from variations in cylinder and piston ring wear are neutralized by two devices. First a balance pipe is provided between the cushion cylinders, which also serves as a guide rod, and second, the pistons are synchronized by means of a light rack and pinion mechanism. (See Fig. 3). This synchronizing gear only supports small forces and is not a power transmitting device.

The air valves used are normally of the flat disc type. Experiments with the reed type of valve showed that they were more efficient, but more reed type valves were necessary for the same installation and breakage was high due to vibrations, resulting in increased maintenance requirements.

Due to high combustion chamber temperatures, it is necessary to cool the piston crowns and this is done quite simply and neatly by a telescoping double channel pipe which projects up the center of each piston from the outer end and squirts cool oil on the underside of the piston crown. The oil is supplied by the center tube and returns via the outer channel to be recooled. Cooling is provided for the cylinder walls in the conventional manner by water jackets around each cylinder.

Injection of fuel into the cylinder is effected by a compressed air chamber on the injection pump and is initiated by a trip usually located on the synchronizing linkage, thereby utilizing the piston position to time the injection correctly. Of course, the quantity of fuel injected is controlled by the operator.

There are several methods for starting the free piston gas generator. The method used will generally depend on the size and type of the installation but all the methods require that the operator be able to control the final position of the pistons when the engine is shut off after use. The usual method of stopping the generator is by opening a valve on the balance pipe to bleed air from the cushion cylinders gradually until there is no longer enough air compressed in the cushion chamber to return the piston to the center of the cylinder. This leaves the pistons near the outer end of the stroke. Another method of stopping the generator is to simply shut off the fuel, but this does not insure the operator's knowledge of the pistons' final positions.

One starting method involves, first, closing the valve on the balance pipe and then suddenly feeding highly compressed air into the cushion cylinders via another valve or the balance pipe. This drives the pistons together, and combustion is usually instantaneous so that a full load can be taken up immediately.

The other method employed utilizes a ratchet starter on the synchronizing linkage which pushes the pistons outward compressing the air left in the cushion cylinders. The starter releases suddenly and the pistons fly inward to start combustion which is, again, almost instantaneous.

Three controls over the operation of the free piston gas generator are available to the operator. As was previously mentioned, he can meter the fuel to the combustion chamber to control the power output of the generator. A relief valve is provided so that the operator can stabilize the scavenge chamber pressure to that of the cushion chambers to insure a constant speed, or the operator can control the cushion chamber pressure to increase or decrease the load on the generator as is done in the case of stopping.

The turbine drive used with a free piston gas generator differs little from an ordinary axial flow gas turbine except in one important respect. Since the temperature of the gases at the inlet is never more than 1000 F., it is not necessary to use special high temperature alloys in the turbine blades. They can be made of stainless steel instead.

A single or multi-stage turbine may be employed as the installation requires, and the gases can be directed to perform a variety of tasks. As is depicted in Fig. 4(A) full power may be obtained by directing all the gas through the main turbine, or, as shown in Fig. 4(B) the gas may be diverted through a reverse turbine to provide a type of reverse gear as might be needed in an automobile or an aircraft. Also, if needed, the gases could be exhausted ahead of the turbine in an emergency or when no motion is required.

Thermodynamic Comparison

It is advantageous, at this time, to compare the expansion cycles employed in the diesel engine, the open cycle gas turbine, and the free piston gas generator turbine in order to obtain a better understanding of the thermodynamic features and the efficiency of the free piston engine.

In a diesel engine all the expansion of the exhaust gases takes place in the cylinder in which combustion also occurred. Here the expansion is limited by the highest compression ratio and peak pressures which can be tolerated by considerations of bearing stresses, usually the primary limiting factor.

The open cycle gas turbine obtains its power by using all the expansion of the gases in the turbine section, which means that the exhaust gases reach the turbine at temperatures in the neighborhood of 1800°F. directly from the combustion chamber. Part of the work produced by this expanding gas must be used to drive the compressor unit, but due to present design limitations, the

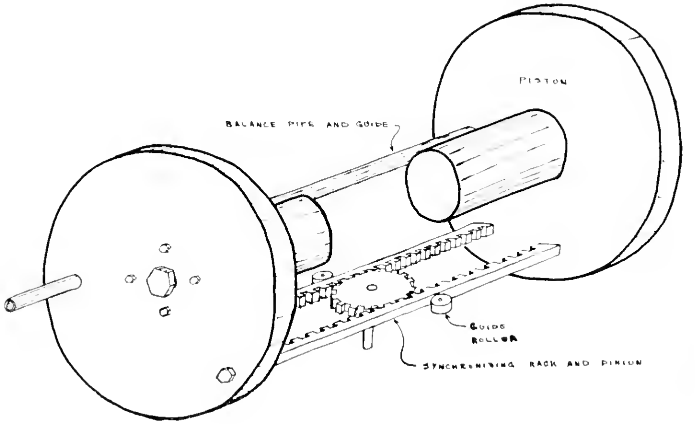


FIG. 3 SYNCHRONIZING LINKAGE AND BALANCE PIPE

pressure ratios achieved there are generally quite low. Consequently, although a large amount of heat can be applied to the compressed air, in practice, much of the compressed air is used to dilute the combustion gases in order to protect the combustion chamber and the turbine blading.

In the free piston engine, part of the gas expansion takes place in the combustion cylinder and the rest occurs in the turbine section. Therefore the combustion cylinder is not exposed to abnormally high mean effective pressures although its scavenge air is at a much higher pressure than in a conventional diesel engine, and also the gas turbine is not subjected to excessive temperatures. These gas temperatures can be lower for an equivalent amount of work in the turbine since the work of compression has already been done independently in the gas generator.

Comparisons of Different Free Piston Principles

Although the Pescara or inward-compressing type of gas generator, which has been discussed so far, was favored during French development, some variations on the original design have evolved in an attempt to improve on it. Some authorities claim that the inward-compressing type has some disadvantages because when a large amount of fuel is injected into the cylinder, the clearance at the inner end of the piston increases proportionately as does the clearance in the compressing cylinder. This causes the volumetric efficiency of the engine to decrease with increasing load.

In the generator pictured in Fig. 5(A), compression of the scavenge gases takes place on the outward stroke of the pistons. This outward compressing generator eliminates the disadvantage discussed above in that its volumetric efficiency increases as the piston is driven further out by larger fuel charges.

Another interesting design is shown in Fig. 5(B). Here compression takes place alternately on both the inward and outward piston strokes, hence its name, the double-acting generator. The major drawback of this design is that it is too efficient. It compresses too much air so that the diameter of the compressing pistons must be decreased, making it difficult if not impossible to attach a synchronizing linkage.

It appears that, taking into account size, wearing surface area and simplicity of design, the Pescara design is still the most efficient type.

Advantages and Disadvantages

At the present time, the known advantages of the free piston gas generator turbine far outnumber its disadvantages.

Compare peak pressures of approximately 900 p.s.i. attainable in a free piston gas generator to those of 500 p.s.i. in a conventional diesel engine due to bearing load limitations. Its high compression allows the engine to operate efficiently on any clean burning fuel from peanut oil to high octane gasoline, which results in lower fuel costs. Combining this with the fact that the free piston gas generator affords lower fuel consumption than either the conventional diesel engine, long noted for its efficiency, or the open cycle gas turbine, the result is much improved economy.

As was previously mentioned, exhaust gases reach the turbine section at temperatures under 1000°F., eliminating the need for critical materials in turbine blades as occurs in the conventional gas turbine, and thereby lowering initial costs.

Due to its symmetrical construction, the free piston engine is inherently balanced, and only slight vibration is present caused by the inertia of its pulsing exhaust. Its symmetrical nature also renders the free piston gas generator insensitive to thermal distortion due to changing load, and it is thought that the engine can be safely started cold and brought to full power within two minutes.

The free piston engine can accelerate faster than any conventional gasoline engine, and, being of simpler construction, it has fewer high precision com-

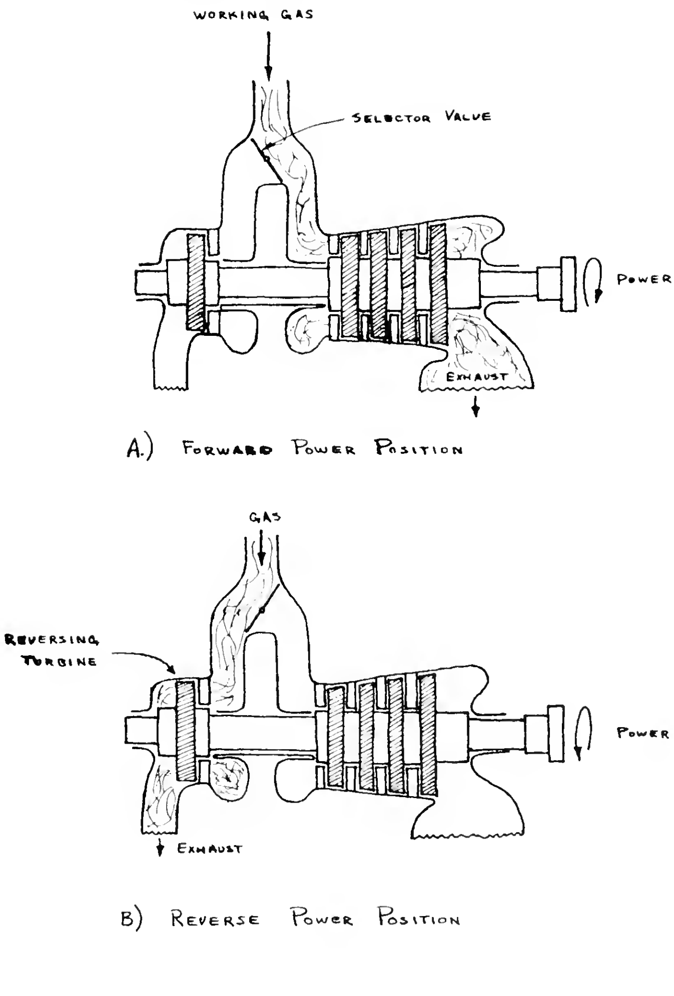


Fig. 4

ponents and fewer wearing parts. A great deal of cylinder wear is eliminated in a free piston generator, since there is no side thrust imparted by connecting rods as in conventional gasoline or diesel engines.

Finally, the free piston engine is of relatively light construction. Aircraft engineers have estimated that a free piston power plant applied to an airplane might weigh less than one pound per horsepower which equals the ratio achieved in today's best radial engines, but these radial engines require three times the weight in fuel.

To date the only real disadvantage to the free piston gas generator is that it is still prone to some of the troubles encountered in other piston type engines such as piston ring and cylinder wear.

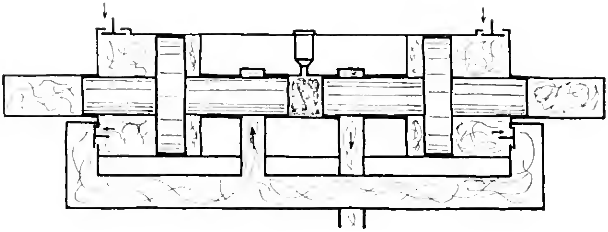
Applications

Considering its excellent efficiency, relatively light weight, simplicity and power characteristics, it would appear that the free piston gas generator turbine could be advantageously utilized as an aircraft power plant.

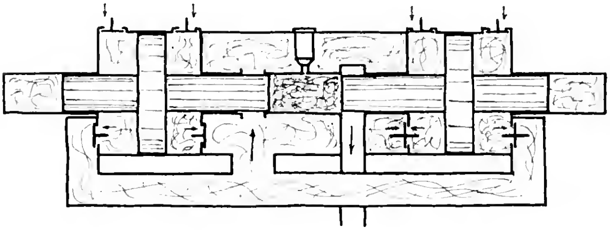
In a 1949 Research Memorandum the N.A.C.A. compared the performances of several similar transport aircraft powered by different types of power plants, including the piston type gas generator engine, turbo-jet, turbo-prop, compound engine and turbo-supercharged reciprocating engine with variable-area exhaust jet nozzle. The gas generator employed was a conventional diesel engine which drove its own compressor directly off the crankshaft and supplied its exhast gases to tuurbines to drive the propellors. Tests were carried out at turbine inlet temperatures of 1400 and 1800 F. for the turbo-jet, turbo-prop and gas generator engines, and flight speeds investigated were in the subsonic region. The comparison was based on the pay-load ton-miles per hour of operation per ton of take-off gross weight.

"The relative merit of the piston-type gas generator engine based on this comparison was found to increase as the flight range increased. The performance of the piston-type gas generator engine was found to exceed the performance of the other engines at all flight speeds investigated for flight ranges greater than 1600 miles at a turbine-inlet temperature of 1400 F. and for flight ranges greater than 2000 miles at a turbine-inlet temperature of 1800 F."

It is evident from this report that, since a conventional diesel gas generator engine outperformed its competitors, a free piston gas generator turbine could surpass them even further by virtue of its forementioned advantages over the conventional diesel engine. For a free piston engine powered transport aircraft, excellent range and efficiency characteristics should be available coupled with 500 m.p.h. cruising speeds.



A Outward Compressing Generator



B. Double - Acting Generator

Fig. 5

A possible configuration of this aircraft would have the gas generator (s) located within the fuselage or the wing roots with the gas turbines housed in the wings, thus relieving some of the structural problems involved in mounting complete engines on the wings.

The free piston gas generator turbine is also suitable for use in electrical generation, railroad engines, marine power plants and automotive propulsion.

Conclusions

Before any new power plant goes into production, good, sound engineering reasons must be presented which support its usefulness and ability to perform the required tasks. The fact that it runs and is as good as other present day products is not sufficient. It must go further, surpass current machines and incorporate additional features which will make it attractive to both engineer and consumer.

In the opinion of this author, the free piston gas generator turbine meets these qualifications and he hopes that he has demonstrated this fact here. It would seem foolish to pass up an opportunity for real progress in the field of propulsion with the argument that "the tried and true old timers" are the best.

In summing up, there is hardly a place where fuel is converted into energy that this new engine won't find application. It is more versatile than the diesel, three times more economical than the open-cycle gas turbine and cheaper than the steam plant. If properly exploited the free piston engine could have quite as large an impact on all our lives in the second half of the twentieth century as the conventional internal-combustion engine had during the first half.

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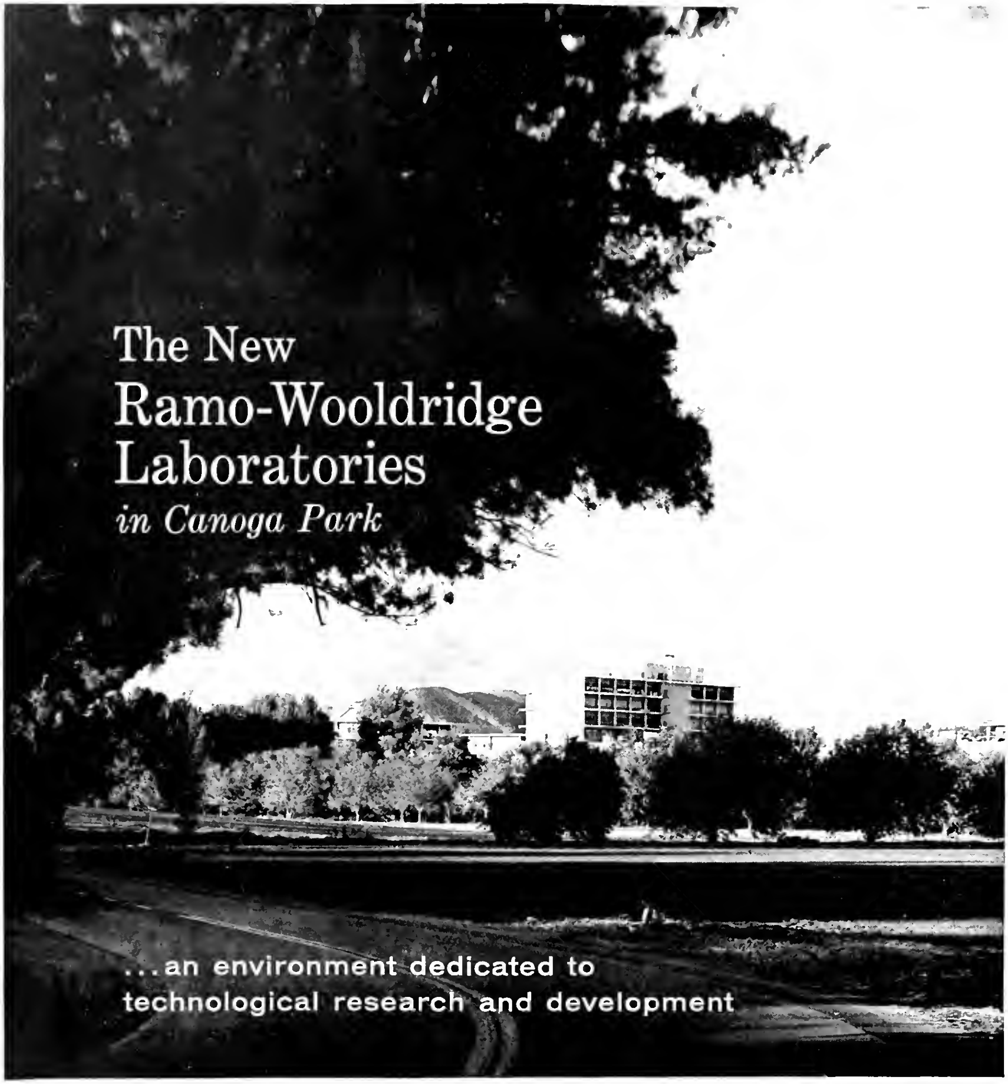

The new Ramo-Wooldridge Laboratories in Canoga Park, California, will provide an excellent environment for scientists and engineers engaged in technological research and development. Because of the high degree of scientific and engineering effort involved in Ramo-Wooldridge programs, technically trained people are assigned a more dominant role in the management of the organization than is customary.

The ninety-acre landscaped site, with modern buildings grouped around a central mall, contributes to the academic environment necessary for creative work. The new Laboratories will be the West Coast headquarters of Thompson Ramo Wooldridge Inc. as well as house the Ramo-Wooldridge division of TRW.

The Ramo-Wooldridge Laboratories are engaged in the broad fields of electronic systems technology, computers, and data processing. Outstanding opportunities exist for scientists and engineers.

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The Dean Speaks —

HOW GREAT IS THE UNION?

By Dean H. L. Wakeland

New engineering graduates are often shocked and surprised to find that an engineering union exists in the company organization in which they have been employed. Few colleges and universities inform engineering students of the existence and influence of engineering union. Even fewer prepare them for the professional status and responsibilities that they should accept when they enter engineering practice.

How great are the unions which represent engineers at present? For years engineering societies have attempted to determine the number of engineering unions and members but only recently has any reasonable estimate been published. In July, 1958, the National Society of Professional Engineers reported in their publication "The American Engineer" the first compilation ever made of the unions representing engineering and technical employees. Present estimations (depending on whether union or engineering society estimates are used) places the number of engineers in the United States between 300,000 to 500,000. Of these, the unions represent 40,000 or about 10% of all engineers. Only 30,000 of the engineers represented by unions are dues paying members. It is also commonly believed that many of these 40,000 members called engineers are technicians, draftsmen, rod-men and other sub-professional personnel.

Most of the 29 engineering unions are located on the East or West Coast of the United States with only a few being located in the Mid-West or South. The largest number are found in the aircraft and electronics industries, although railroads, oil industries and governmental groups are also included. In nearly every case, the union has been an outgrowth of a large employment situation where individuality is not easily maintained. Normally a combination of factors — poor management practices, failure of the engineer to grow professionally and desire of labor unions to control all labor—has led to an organized union.

Perhaps we should review for a moment the aims of unions as contrasted to professional organizations. The union has nearly always existed for the purpose of achieving gains—many times selfish gains—for a limited number of persons. These gains—normally better working hours and conditions, higher wages, greater benefits—are not always peacefully achieved. Conversely the professional organizations have promoted integrity, expertness, common public welfare, ethical practices, responsibility and fair dealing in individual services. The aims of the professional are to provide services which will benefit most of the people concerned providing these services are not based on self gain to the professional. A contrast of these aims should illustrate that unionism and professionalism are incompatible.

Walter Reuther has boasted publicly many times that some day he will bring the engineers into the big, happy, labor family. Basically the unions present attitude towards engineers is no different than 30 years ago when the late Matthew Woll, the long time vice president of AFL said, "The trouble with you engineers is that you picture yourselves as professional men. Actually, you are just hired help." In recent years a number of engineering unions have been organized which give lip service to professional status, ethics, integrity, public welfare, and would have the members believe that they are a part of a high level union which operates in harmony with professional aims.

However, the records of these modern unions expose their aims and methods of operations. In the final analysis the old stand-bys — strikes, closed shop, payroll deduction of dues, and union power —are used. Some engineers have suddenly found themselves classified in the same area as draftsmen, stenographers, sub-professional workers and any others that were easily organized. Others have found that they have degraded their own status and raised the status of others through unionism. In several instances the modern union has been voted out after a few years of trial. In most cases the engineers feel their professional status is jeopardized. Yet we must realize that a number of engineering unions still exist.

Thus, the answer to the new engineering graduates' question, "How Great is the Union?" is not a short and concise one. We know that about 10% of all engineers are unionized and that only a small percentage of the graduates are faced with this question. But any engineering graduate facing this situation should evaluate the implications and working conditions under such an arrangement before accepting employment. The basic questions that he must answer are "Do I Want a Union?" or "Do I Want a Profession?" for I personally believe that they are incompatible.

Tau Beta Pi Essay . . .

Where Have You Built Your Floor?

By George C. Kuhlman

The Nijo Palace located in the city of Kyoto, Japan, is a living reminder of the feudal era in that country's history. Within the palace a large audience room can be found where the Shogun or ruler met his visitors some four hundred years ago. The room is divided by having half of the floor three feet higher than the rest. Upon this elevated portion sat no one but the Shogun. The reason? He wanted to show that he was above all others because of the position he held in life. The United States has been built on a different and well known system. The floor where our leaders now stand is the same that we tread upon. With our very way of life based on such a principle, we still find some people, who because of their position or occupation, are ever trying to raise the statami (floor mat found in the homes of Japan) beneath them.

Today the young engineer, who is about to enter the world of business, finds opportunities in his future which no person dreamed possible, a few years ago. His big problem is not where to find a job, instead it is which one to accept. He finds that opportunities for future advancement show overwhelming promise. The wages at which he starts his position are unprecedented where compared to other walks of life.

The entire world today is placing more emphasis on the engineer and the things he does than ever before. A great deal of the future political control of the world has been placed on the engineer's ability or inability to produce a variety of goods. It lies not only in the production of machines of destruction, but in the things that better the living standards of the population as well. The young engineer, in most cases, understands the responsibility placed upon him and strives toward more understanding of his work.

Along with this ability to acquire a job, to receive high wages, and the world wide importance of his job comes one bad aspect. This I am sure is found in a substantially large portion of young men. It is the idea that his line of work is just a little better or of more importance than someone else's. This feeling is not the young engineer's fault. It is, shall I say, an occupational hazard which would have happened to any young man, regardless of his training, had the emphasis been placed upon him.

The outcome of this feeling, which is but a human interpretation of importance, could have a profoundly adverse

effect upon our young men. They may tend to rebuild the floor beneath themselves at a little higher elevation. This will eventually affect the feeling of the people the young men come in contact with and will arouse a dislike for the young engineer. Such a dislike is surely not wanted by the new engineer nor is it wanted by those who have been in the profession for a long time.

I am sure that if such a thing does happen to these men they will eventually realize their mistake and correct it. This will come with age and a broader understanding of life. In the meantime though, the actually unwanted but unrealized attitude will have already made its mark upon them.

There may be some controversy on the part of the reader as to whether a slight swelling of heads is occuring on our newly graduating engineers. Isn't it only a natural reaction to think in terms of greatness when emphasis is placed upon the things you do? Isn't it even more natural when this emphasis is backed up by wage earning possibilities we all know are present today. This I called earlier an occupational hazard. Still, there is one thing that is adding to this feeling of superiority and does not come under any of the headings listed above. This is the distinction made between the engineer and the non-technically educated person by people who have an overwhelming influence over our younger men and women. If they are correct in making such a distinction, then the schools of engineering throughout our land are making a terrific mistake. This mistake being the placing of more and more non-technical subjects into the engineering student's curriculum. This is done not to gain full proficiency in such subjects but to place more understanding at the reach of the engineer about the things that other people do, the things the engineer must know and understand so he may live and work with his neighbors.

Let us not stop placing such emphasis on our engineer or any other person as long as they deserve such emphasis. Let us though at the same time increase the understanding between the engineer's work and the non-technical man's. The engineer when in the world of business is only as good as the advertiser, the salesman, the banker or the numerous other men whom he works with. If this one point is stressed enough it will surely be conveyed and a lot of misunderstanding and unhappiness prevented. Let us lower that floor for the young men before it is nailed too firmly. Put it at the point where one's self pride begins and the inflatedness leaves off.

The young engineer today must not only be well versed in his own profession, but it is his duty to know and take part in civil as well as functions of private organizations in community life. He will come in contact with men of every conceivable walk of life. He must work at a variety of things with these other men and do so on the same patch of ground. He must not, for the good of his own way of life, attempt to make himself seem at a higher elevation. Every other man our young engineer works with, whatever position or walk of life he may be in, plays just as important a role in life as the man with the slide rule.This I am sure has been said before, but repetition is often the best means of conveyance. Here then is the point that the young engineer must absorb and not hear and forget. Men must stand on the same level as all other men to be able to understand, work, and live with one another.

If we look once more at the interior of the Nijo Palace in Kyoto, we find a strange yet not surprising thing built within its walls. Every board that was placed on the floor of that palace had a squeak put into it. You find it impossible to move a foot in silence. Each movement brings forth the cry of the marauding blue jay. The people of that country call it the palace of ten thousand canaries, but to my ear it was not the chirp of the gentle songbird.

Unprecedented Need for Engineering Teachers

Delegates for the national convention of Tau Beta Pi, the honor society for outstanding American engineering students, returned to their campuses from Purdue University ready to tell the story of the "unprecedented" need for new teachers in the nation's engineering colleges.

At least 1,000 new engineering teachers will be needed each year through 1967, according to a report by representatives of the American Society for Engineering Education at the Tau Beta Pi meeting. "And events of the next 20 years will give the nation's engineering teachers new importance and status," Dr. Harold L. Hazen, Dean of the Graduate School of the Massachusetts Institute of Technology and chairman of ASEE's Committee on the Development of Engineering Faculties, said at the convention.

Only the most able and creative of America's engineering students can fill the demands of engineering teaching, according to Dean Hazen. He advised would-be teachers to continue their education into residential graduate work. "Experience indicates that if you enter full-time employment when you graduate," Dean Hazen said, "the chances that you will ever enter teaching are small."

"On the other hand, if you choose graduate study you are adding to your assets in a very substantial way, independent of whether you eventually enter industry or education.

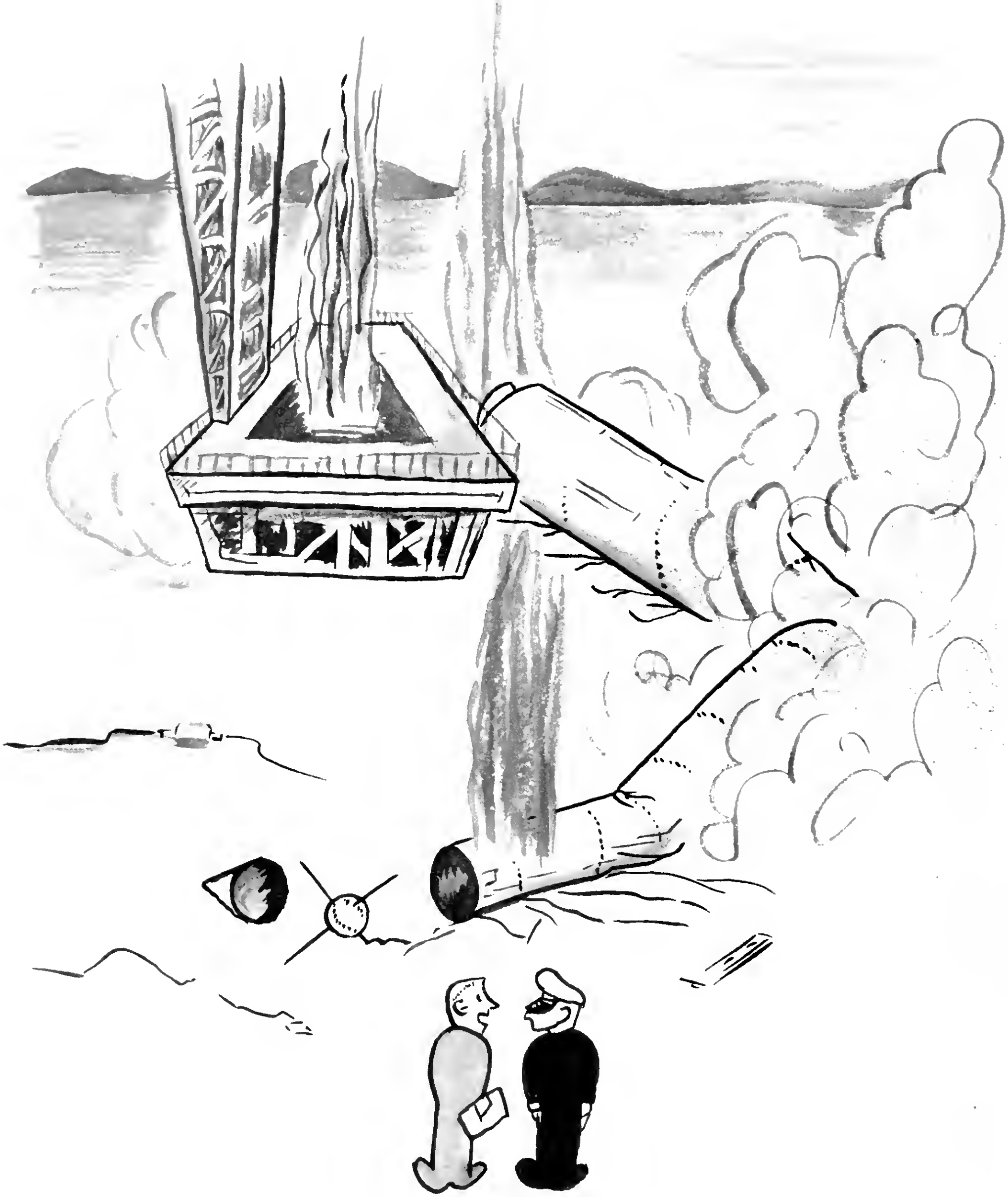
"During the past six years, the nationwide production of engineering doctorates has been steady, at about 600 per year. Of these 200 to 300 go into teaching. Our need for engineering teachers is roughly four times the number of doctorates now in prospect. We must have many more, and more of them must enter education."

Speeds Assembly Method

Set screws, used in the manufacture of products, are automatically carried 15 feet or more by air pressure through a flexible tube to a new air gun driver developed by a New England firm. Operating rate of this portable machine is up to 2,000 screws an hour, depending on torque setting, screw depth, operator proficiency and fixturing.

Hove you ever been pinched for going too fast?"

"No, but I've been slapped."



"Well sir . . . we do have a few bugs to ircn out!"

SLIDE RULES ANONYMOUS

By Jeri Jewett

Engineers beware! The slide-rule carrying coeds on your campus are uniting. For the first time, this semester the few woman engineers at the University of Illinois are banding together to help each other. These girls with their sponsor, Professor Wilson, are trying to gain membership in the Society of Women Engineers. At present, they are on probation.

The national organization of the Society of Women Engineers is primarily a professional one for graduate woman engineers and women with equivalent engineering experience. These groups have developed out of various industrial and educational centers where substantial numbers of woman engineers were located. Organized meetings have been held since 1949 and the organization was incorporated in the District of Columbia early in 1952.

The Society is trying to get more women engineers by informing the public of the availability of qualified women in this field and by fostering a favorable attitude in industry to these women. The Society also tries to contribute to their professional advancement.

Of primary importance is the fact that the Society is encouraging younger girls with aptitudes and interests in this field to enter the engineering profession. It also is helping to guide their educational program. Besides this, the Society encourages its members to belong to other technical and professional engineering societies.

In carrying out these aims, the Society has a Public Relations Committee which helps secure public recognition of the achievements of women engineers. The *Newsletter of the Society of Women Engineers* tells what the women in various sections are doing plus giving articles of interest to these women.

To interest young women in this field, the Professional Guidance and Education Committee finds out information about the various fields, the programs offered by accredited colleges, and scholarships available to engineering students.

Yearly, a national Convention is held for all interested members. The program includes panel discussions and addresses by prominent speakers, and a banquet at which the SWE award is presented to the woman who has made a significant contribution to engineering.

The Society is divided into three grades of membership: Member, Associate Member, and Student Member. Naturally the girls at the U. of I. are trying to become Student Members, but upon graduation they will become full-fledged Members. When this chapter is chartered, it will join the two other student chapters, one at Purdue and one at Drexel.

The girls here, following the example of the Society, are being urged to join their individual engineering societies on campus. At the meetings the girls have speakers and then get together to talk over specific problems and help each other with homework. These girls also go into the high schools to tell girls interested in engineering not to give it up just because of the small number of women enrolled in that college at present.

The chapter here has about ten girls representing most of the different phases of engineering. Barbara Kozub, a pretty junior in Industrial Engineering, is the chairman of the group and her assistant is secretary-treasurer, Lucille Kowalski.

Well, boys, you had better watch out or these coeds carrying tackle boxes will be beating you at your own game. The Society of Women Engineers seems to be accomplishing one of its main goals, for most of the girls are freshmen. Good luck girls; keep up the good work.

engineers

Automatic systems developed by instrumentation engineers allow rapid simultaneous recording of data from many information points.

Frequent informal discussions among analytical engineers assure continuous exchange of ideas on related research projects.

Under the close supervision of an engineer, final adjustments are made on a rig for testing an advanced liquid metal system.

and what they do

The field has never been broader
The challenge has never been greater

Engineers at Pratt & Whitney Aircraft today are concerned with the development of all forms of flight propulsion systems—air breathing, rocket, nuclear and other advanced types for propulsion in space. Many of these systems are so entirely new in concept that their design and development, and allied research programs, require technical personnel not previously associated with the development of aircraft engines. Where the company was once primarily interested in graduates with degrees in mechanical and aeronautical engineering, it now also requires men with degrees in electrical, chemical, and nuclear engineering, and in physics, chemistry, and metallurgy.

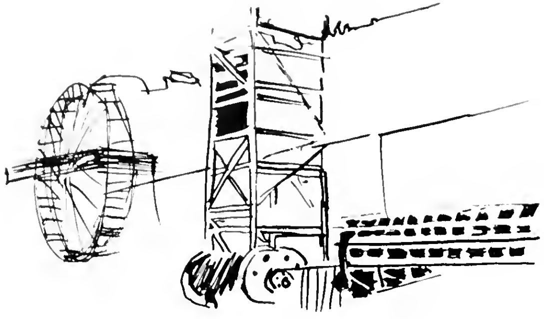
Included in a wide range of engineering activities open to technically trained graduates at all levels are these four basic fields:

ANALYTICAL ENGINEERING Men engaged in this activity are concerned with fundamental investigations in the fields of science or engineering related to the conception of new products. They carry out detailed analyses of advanced flight and space systems and interpret results in terms of practical design applications. They provide basic information which is essential in determining the types of systems that have development potential.

DESIGN ENGINEERING The prime requisite here is an active interest in the application of aerodynamics, thermodynamics, stress analysis, and principles of machine design to the creation of new flight propulsion systems. Men engaged in this activity at P&WA establish the specific performance and structural requirements of the new product and design it as a complete working mechanism.

EXPERIMENTAL ENGINEERING Here men supervise and coordinate fabrication, assembly and laboratory testing of experimental apparatus, system components, and development engines. They devise test rigs and laboratory setups, specify instrumentation and direct execution of the actual test programs. Responsibility in this phase of the development program also includes analysis of test data, reporting of results and recommendations for future effort.

MATERIALS ENGINEERING Men active in this field at P&WA investigate metals, alloys and other materials under various environmental conditions to determine their usefulness as applied to advanced flight propulsion systems. They devise material testing methods and design special test equipment. They are also responsible for the determination of new fabrication techniques and causes of failures or manufacturing difficulties.



THE HISTORY OF ENGINEERING

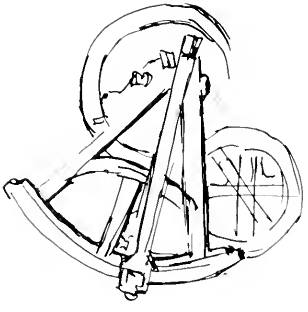
By Gren King

One of the main problems facing the engineer today is overcoming the stigma of a stereotyped personality. The engineer in fiction and in people's minds is a shy, withdrawn person satisfied with being introverted. Unfortunately many engineers are typified by this stereotyped idea. A graduate, having taken only science and math, is ill-equipped to face the world of today. Personal insecurity and uncertainty are the main causes of a scientist's withdrawal from humanity.

There is no need for this insecurity and uncertainty. Several courses designed to promote an interest in the field of the humanities and social studies are offered to engineering students at the University of Illinois. An engineer who has taken several humanities courses has the ability to talk to anyone about almost any subject.

One of the newer courses is one fairly important to engineering. After a course in Engineering History (GE 220), an engineer is able to answer most questions concerning past science. In History of Engineering, the interrelation of science, politics, religion, and commerce, past and present, is covered in detail. Past discoveries, accomplishments, and a history of man's attempt to alter his environment all give the student a better understanding of the "taken-for-granted" things of life.

The study of Greek and Roman civilizations seems unimportant to an engineer until he realizes that the roots of modern science are embedded in these cultures. Each person is encouraged to further study history and philosophy by the teachers of this course. A student profits from the knowledge and mistakes of the past. A greater interest in engineering subjects and social studies promotes better marks, and these better marks improve the chances for a job upon graduation. When an employer has to choose between two job applicants, he is bound to choose the one who has taken a broader field of subjects.



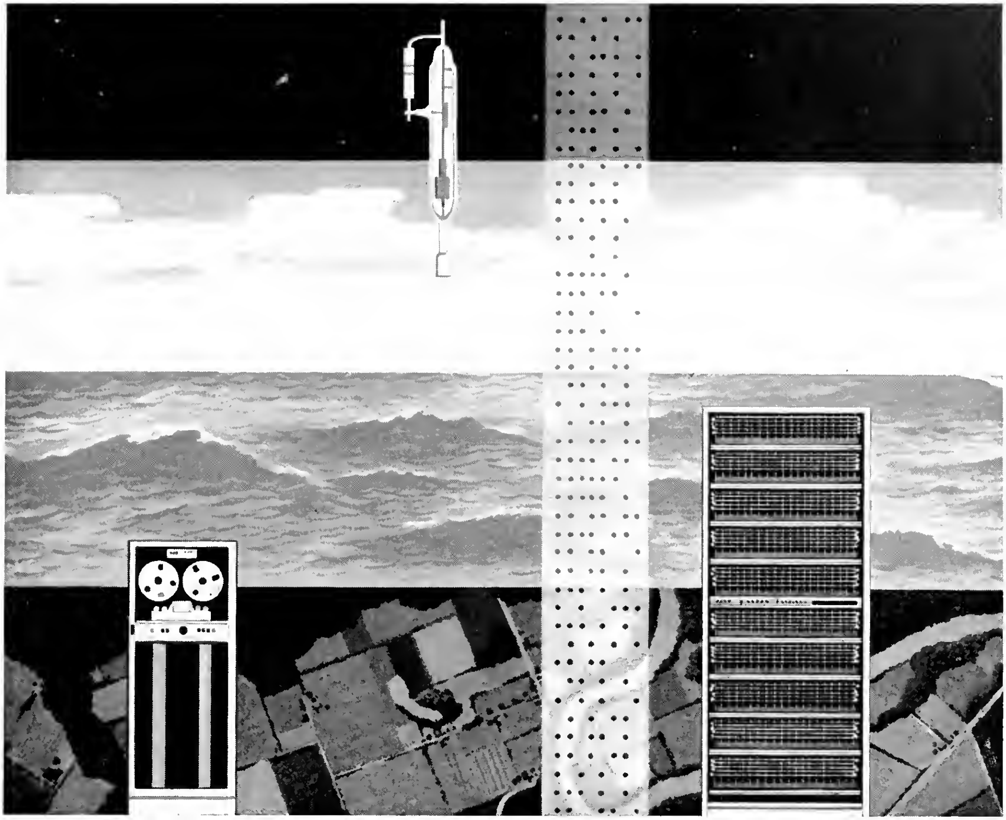
After graduation, a person who has taken social science courses has greater chances of success. He is able to face competition and join the social life his job offers. GE 220 and other social science courses offered to the engineer broaden the chances of promotion and raises in salary.

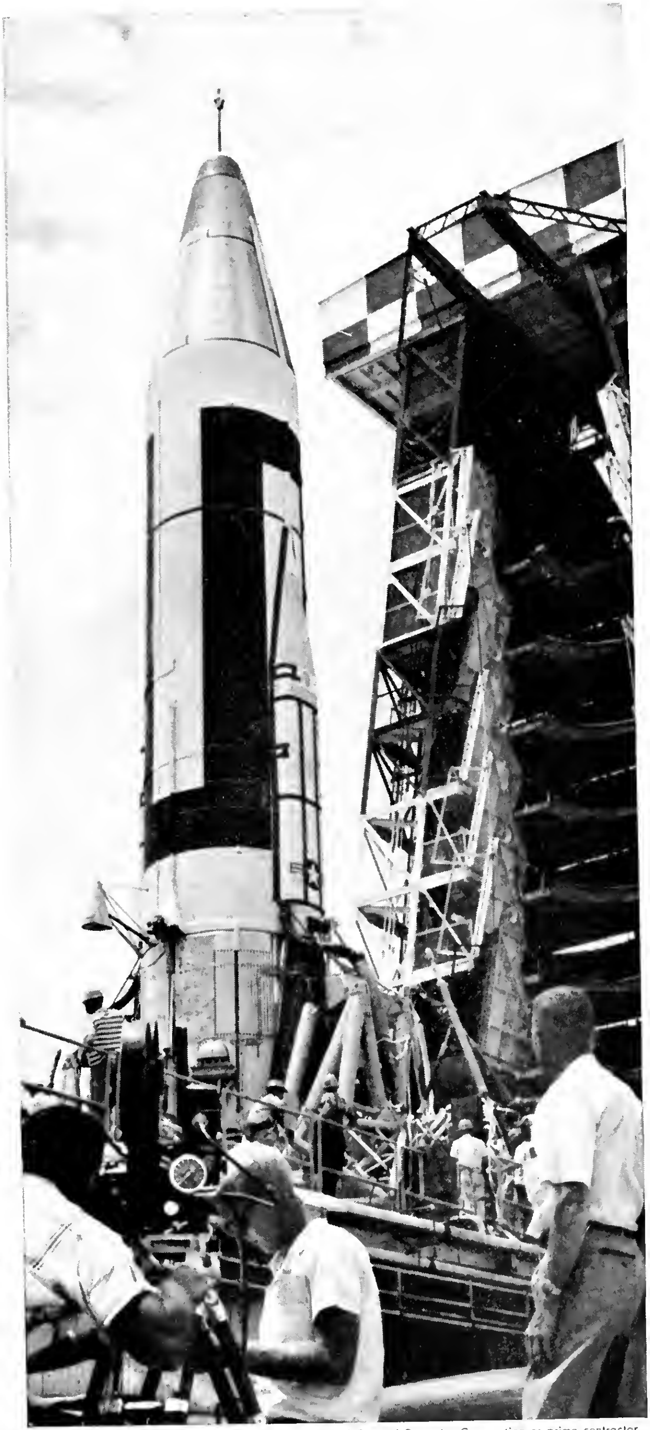
Interest in the world outside the laboratory is stimulated. The scientist realizes the need to help in fields only vaguely related to engineering. He tries to improve the schools to which his children go, the community, and the church to which he belongs. He begins to realize the need for his services. Local

politics indirectly influence science and engineering by influencing appropriations to schools. An engineer who has entered life on an enlarged political, religious, and social scale helps science.

Ninety per cent of government appropriations are concerned with science or engineering projects; yet, only ten men in either house of Congress have any scientific background. Therefore, people having both scientific and general education are desperately needed in government jobs. People having taken social science courses plus their engineering courses can be beneficial to the government.

All engineering students should at some time in their years in school take Engineering History. The course is open only to juniors and seniors because a general knowledge of engineering is necessary to receive the full value of the course. Professor Dobrovolny says that the History of Engineering correlates comprehension of scientific matters and the heritage rightfully belonging to engineers to give the engineer a more well rounded background.





Atlas missile, built by Convair (Astronautics) Division of General Dynamics Corporation as prime contractor.

Basic Research at IBM

A day at the laboratory

IBM scientist Gerald Burns studies ferroelectrics to improve understanding of their basic properties.

A basic research project

"I'm using nuclear resonance to explore ferroelectrics," says IBM scientist Gerald Burns. "We're trying to discover how the ions in a ferroelectric crystal are arranged, and why and how they change position and structure with temperature changes. Ferroelectric crystals have a reversible spontaneous polarization . . . that is, they can be polarized in either of two directions, and, by the application of an electric field, polarization can be reversed."

How did Gerry Burns come to work on this problem? "I started this particular research project because it was related to other work I had been doing and I felt it would prove challenging and rewarding. Little is known about what goes on in a ferroelectric crystal—or why. Our basic objectives are to find out *what* and *why*.

"At the planning stage, the project seemed to offer a great research potential, but none of us was sure how long the project might last or what its ramifications might eventually be. It's a good example of the basic research done at IBM."

One of the eight scientists in the Ferroelectric Research Group, 26-year-old Gerald Burns began a recent day by setting up equipment for the first daily run.

"The experiment is conceptually quite simple," he explained. "A ferroelectric crystal is placed in the tank circuit of an oscillator, between the pole pieces of a large electromagnet. The sample is surrounded by a dewar so that the temperature can be accurately regulated. Then the magnetic field is slowly decreased. When the field reaches certain values, the nuclei in the crystal absorb energy from the oscillator. The trick is to detect this absorption which is quite small. Runs at various temperatures are made, and the temperature dependence of this absorption is studied.

After setting up the first run, Gerry Burns met with the head of his group. Together, they discussed the temperature dependence of the nuclear quadrupole resonance coupling constants. Several helpful suggestions were made.

Gerry Burns then talked with chemists who grow the crystals used in the experiments. They discussed possible variations in the crystal-growing method and considered the growth of other crystals in order to broaden the experiments.

Early in the afternoon, he attended a seminar conducted by a visiting professor on the subject of the atomic structure of solids. Each week, several such seminars on a variety of technical matters are given.

After the seminar, Gerry Burns returned to set up another run at a different temperature. He also talked to a technician about building a new piece of equipment to be used in future experiments.

Photos by Dave Yates

Technocutie . . .

ELLEN BROCKWAY

December cutie of the month is vivacious Ellen Brockway, junior in Art from Downers Grove, Illinois. On campus she lives at Alpha Phi sorority, where she serves as house chaplain. This office reflects Ellen's taste for good literature, intelligent conversation (from the speaking as well as the listening side), and speech work. In the latter category, the readers will note her appearances in several University Theatre Workshop plays.

On the lighter side, this 5'4" brunette has an enthusiasm for life and all her activities within it. Her friends see her laughing whole heartedly and livening up any situation in which she finds herself. Among her avocations are bicycle riding and painting.

You can find Ellen running from the Architecture Building to the house to activities at any hour of the day. Among her activities is Angel Flight, women's campus branch of the Air Force. Some of you may have seen her in the 1959 Dolphin Queen Contest.

Say hello the next time you see her. She'll love it!

The Forgotten Law

By Momo Iko

"Stop fiddling up there and hit something. These newsmen are beginning to gall," said gray-haired Doc.

A laugh came over the radio and Jack Hardin answered his counselor of 11 months, "Patience, doc. We've been aiming for that blasted moon for 25 years, a few more hours won't kill us."

Ten minutes later, 100 million radios voiced his remark and 80 million Americans smiled at this cocky man who for eleven months was the star of this unearthly project. Kids all over the country were in a state of delirium. Buck Rogers was fact now. Eleven months of accelerated hell was paying off.

At two o'clock, April 25th, Jack Hardin stepped into the Z-30, grinning broadly. The engines' explosive thrust propelled the ship off the firing table with a roaring bellow, and in a minute the ship was out of sight. Now, one day after the take-off Hardin non-chalantly made small talk with his friend.

"Doc, you were right. There was absolutely nothing to panic about. I had the jitters at first, but now I have a feeling that everything's going to work out great. Just think, Doc, I'll be the first human being ever to go to the moon." He wrinkled his brow in amusement. "Damn Buck Rogers, for once, I'll be the hero in my family. When you really think of . . ."

Commander Willis strode into the control room and cut the conversation short. He picked up the mouthpiece. "Hardin, this is Willis. You're scheduled to hit target in 15 minutes. Buckle in, double check your equipment and relax. We'll make contact with you 10 minutes after you land. Remember, Hardin, relax and don't worry."

"I won't sir. Really . . . You worry too much . . . sir."

Willis motioned Doc over. "Keep the talk light."

Doc nodded in assent and sat down at the radio. "Hey Jack, remember to make your first words from the moon witty. This wild world will love you." A long silence ensued.

Then a voice registered through the vacuum, "Doc, tell me . . . " Hardin's voice jerked. A loud jolt and a strangled sound leaped over the radio. Both men stiffened. They waited; 5 minutes, 10 minutes, 12 minutes. Willis flicked the switch. "Hardin, come in. Do you hear me? Come in." His face looked haggard as he turned to Doc.

"Maybe," Doc said, "maybe he's still unconscious; give him time," but his face was twisted in fear.

Ten more minutes went by and in the interior of the Z-30, Doc's disbelieving voice pierced through the radio static. "What went wrong. God, what could have gone wrong." Jack Hardin's dead form was stiffening.

"We have to do it now," said Willis.

"No," screamed Doc, but the lever was pulled and the Z-30 exploded into dust again.

Buck Rogers was still a fairy tale.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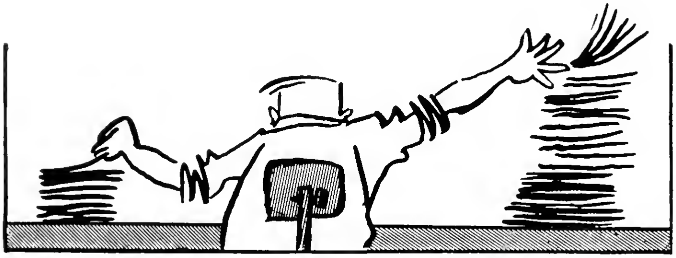

Edited by Paul Cliff

Two Advances in Fluorescent Lamp Design

Two dramatic concepts in fluorescent lamp design have been announced by the Westinghouse lamp division.

Where the fluorescent lamp has traditionally been a tube with a base at each end for electrical contact, Westinghouse has unveiled a fluorescent tube with a base on a single end. Since the lamp does not require wiring and sockets for both ends, it can be mounted in one socket much like a conventional incandescent lamp.

Dr. R. M. Zabel, manager of research and engineering, said that while single-ended fluorescent lamps have been under study for several years in the laboratory, a recent breakthrough achieved by Westinghouse researchers makes it possible to build a practical single-ended lamp of high efficiency.

The second advance announced by Westinghouse consists of a U-shaped fluorescent lamp, which shares many of the advantages of the single-ended fluorescent tube since all electrical connections are at one end.

U-shaped fluorescent lamps have an efficiency equal to or greater than conventional fluorescent lamps. Also, U-shaped lamps are only half as long as lamps of comparable wattage.

Dr. Zabel reported that although the company has not set a date for marketing either lamp, the company's commercial engineers are working with architects, designers, and lighting fixture manufacturers to determine the scope of applications to which the lamps might be put.

Some of the immediate uses which can be foreseen for the new lamps, include fluorescent installations above diffusing plastic or glass ceilings, decorative lighting in restaurants, bars, and amusement parks, showcase lighting, street lighting, signs and displays, school lighting, and for unusual effects in lounges, reception rooms, halls and lobbies.

New Test Instrument Described

A new automatic instrument is providing greater accuracy and reliability in measuring the viscosity of photographic emulsions at Kodak Park Works.

Kodak scientists described the instrument as a "rolling ball viscometerer."

The viscometer consists of a precision glass tube, mounted in an inclined position in a temperature-controlled water bath, the scientists said. The tube is filled with the liquid to be measured, and a steel ball, with a variation in size of less than 6/100,000 of an inch, is dropped into it.

The time taken by the ball to travel the distance between two magnetic coils that surround the tube near the top and bottom is a measure of the viscosity of the liquid, they explained.

Since the ball is steel, changes it causes in each of the magnetic fields start an electronic clock when the ball passes through one field and stop it when it enters the other. The time of passage is thus measured very accurately.

The Kodak researchers said the viscometer is easy to operate and has given accurate, reproducible results.

Ground Broken for United Engineering Center

Herbert Hoover, representing 300,000 members of 18 major engineering societies, broke ground for the 18-story United Engineering Center at United Nations Plaza. The ceremony was attended by an estimated 500 people.

Mr. Hoover was assisted by a freshman engineering student from Hawaii, Jerry Fujimoto, representing the engineers of the future.

In remarks just before he turned the first shovel-full of earth at the site of the new Center, Mr. Hoover called the occasion "an event of national importance. The engineering societies in our country comprise a great army of over 250,000 creative minds covering almost every branch of the profession."

The United Engineering Center, scheduled for completion in mid-1961, will house the headquarters of major engineering societies and joint engineering groups. Their members, Mr. Hoover said, "are the foundation of security in our defense and the increase of the standards of living and comfort for our people."

"The purpose of this great building is to facilitate these goals. It will play a great part in American life. It will serve all mankind," he concluded.

The Center has been made possible by contributions from industry and from thousands of individual engineers. Plans for the Center have been eight years in the making. To date, more than 500 companies have contributed nearly $5 million, and some 56,000 engineers have added another $3 million.

When completed in 1961, the Center's 180,000 square feet of office area will be occupied by the following groups:

American Society of Civil Engineers
American Institute of Mining, Metallurgical and Petroleum Engineers
The American Society of Mechanical Engineers.
American Institute of Electrical Engineers
American Institute of Chemical Engineers
American Society of Heating Refrigerating and Air-Conditioning Engineers
Illuminating Engineering Society
American Institute of Consulting Engineers
American Welding Society
American Institute of Industrial Engineers
Society of Women Engineers
The Municipal Engineers of the City of New York
United Engineering Trustees, Inc.
Engineering Societies Library
Engineering Foundation
Welding Research Council

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Engineering Index

Engineers' Council for Professional Development

Engineers Joint Council

Transparent Silicone Potting Compound

A new silicone potting material that permits visual and instrument checking of individual parts within a potted assembly is now on the market produced by Dow Corning Corporation, Midland, Michigan.

This material cures in place to form a resilient, protective mass that retains its outstanding dielectric properties and moisture resistance over the wide temperature span of below −60 up to 200 degrees C.

No damaging stresses are exerted on delicate parts by this material either during or after curing.

Potted circuits can be traced visually, and test probes can be accurately directed to connections by simply inserting them through the gel. Dielectric Gel "heals" itself immediately when test probes are removed.

Electronics Cut Road Costs

Georgia's Highway Department credits electronic equipment with a fourteen-month savings of $229,681 and 140,257 man-hours in earthwork design. On bridge computations, savings add up to $100,000 and the time of 13 engineers.

Stepping Transistor Made of Interconnected Elements

A p-n-p-n semiconductor element that can serve as the basic building block of a silicon stepping transistor has been described by Bell Telephone Laboratories. It has potential application to digital computers, pushbutton dialing, and telephone switching.

The four-terminal device acts as a pulse-controlled on-off switch. It may be used as a basic stage in building up certain logic circuits in digital computers, such as for counting and decoding. By using one element to drive two others, versatile decoders can be made.

A more complex device, which is fabricated from a single piece of silicon, can also perform these logic functions. As a prototype arrangement, a stepping transistor with four stages—or elements—has been made.

The stepping transistor, as fabricated on a single piece of silicon, performs the function of a complex circuit. Hence it is referred to as a "functional device." The concept of a functional semiconductor device is a promising approach to microminiaturization.

The gas stepping tube utilizes the bistable voltage-current characteristic of a gas discharge for its operation. Unidirectional transfer of voltage between its electrodes—one anode and several cathodes—is obtained by the nonsymmetrical geometry of the latter's construction.

The stepping transistor utilizes a p-n-p-n transistor as the bistable element. The design of the structure results in a bistable voltage - current characteristic between a single common electrode and a set of multiple electrodes. Nonsymmetrical geometry is employed to obtain a unidirectional transfer of voltage.

Also, unlike the gas stepping tube, close proximity between stages is not basically required in the stepping transistor. This is why stepping transistor elements comprising single four-terminal stages can be separately encapsulated and connected externally.

Defense Dome 'Sees Red'

"Irtan" optical material forms a dome for the nose of an infrared-guided missile. The new material transmits radiation efficiently up to 8 microns in the infrared. It is especially resistant to

Irtan optical material finds job as nose cone for heat-seeking missiles.

cracking due to thermal shock when a missile reenters the earth's atmosphere. To the eye, objects viewed through the dome appear rose-colored because of Irtan material's transmission of the red portion of the visible spectrum.

Salavaged 7 Billion Pounds of Aluminum Since 1948

Through research and advancements in the art of aluminum smelting during the past decade, a total of more than 7 billion pounds of scrap aluminum has been salvaged, processed into alloys and returned to American industry for a wide variety of uses.

It is predicted that, through expanding knowledge of metallurgy, more than 15 billion pounds will be returned to the nation's aluminum users during the next 10 years.

Comparable in every way to alloys made with primary aluminum, the smelters' alloys are converted into castings for the automobile industry, appliance manufacturers, business machines and a host of other end use products.

The conservation and re-use of scrap aluminum has literally saved the U. S. economy billions of dollars, the Institute stated. It pointed out that, without the salvage of 7 billion pounds since 1948, American users, in duplicating the output with virgin aluminum, would have forced to:

Import 13 million tons of bauxite.

Ship the bauxite to the U. S. in 1300 voyages at 10,000 tons per trip.

Ship to plants 10 million tons of alumina, coke, pitch, cryolite, soda ash, and other ingredients.

Construct additional facilities to process the metal into ingot form.

Consume 67 billion kilowatt hours of electrical power—an amount equal to all electricity generated in the U. S. in about a five-week period.

As the principle users of aluminum scrap, the aluminum smelting industry has been chiefly responsible for the preservation of the value of the scrap as a useful commodity and kept it from becoming an unwanted, indigestible drag on the nation's economy.

New Plan for Disposal of Radioactive Waste

Disposal of radioactive wastes by using sandstone layers thousands of feet under the earth's surface as an ion-exchanging "water softener" was suggested at the 32nd annual meeting of the Federation of Sewage and Industrial Wastes Associations.

Low-level radioactive wastes now are dumped into streams. A growing problem is developing as amounts of these increase. Another unsatisfactory disposal is in buried tanks.

The engineers propose pumping the water-carried wastes into sandstone layers below any danger of contaminating ground water, oil, coal, or minerals.

In passing through the sandstone, radioactive wastes would be deposited in manner similar to deposition of minerals in a water softener. The purified water would return to the surface through a second well at a distance.

Gravy Fender-Offer

Stain-repellent ties are now being made by one company. The ties are guarded against both water and oil stains and common dirt.

UIC

NEWS FROM THE NAVY PIER

In and Around Chicago

Chicago area steel producers now are racing old man time. With the steel strike recessed, the ore boats are bringing ore in as fast as possible to lay in winter stockpiles.

Meanwhile, area plants have called back 90,000 steelworkers who haven't received a paycheck for four months. U.S. Steel Corp., the nation's largest producer, expects shipments to reach near capacity within a few weeks.

Spot shortages may develop during the winter which probably will be sidestepped by costlier rail deliveries. However, with good weather the Great Lakes shipping season can last into the middle of December. Then the waterways will be ice-locked until about April. Navy Pier, housing the Port of Chicago (and the Chicago branch U. of I.) is hoping for good weather to extend the shipping season.

At Navy Pier

Overheard: Instructor to class — "Some professors run through courses like express trains. Only trouble is, they're the only ones riding."

New Courses Added

New courses added to Chicago curriculum include math 341, Differential Equations; math 346, Complex Variables and Applications; and M.E. 221, Mechanics of Machinery. With these and other courses, some Navy Pier engineers can remain in the city for five or six semesters.

ASCE Meeting

The U.I.C. student chapter of the American Society of Civil Engineers played host to Melvin E. Amstutz, a member of the Illinois State Board of Examiners for Professional Engineers. He gave an informative talk to members of all the engineering societies.

Amstutz began his lecture by briefly reviewing the history of the National Society of Professional Engineers. He explained how the organization was formed in 1934 for the purpose of advancing the profession of engineering. The society's membership soon spread across the country. State chapters of the N.S.P.E. were formed. Illinois was one of the first. Soon there were city and county chapters being formed and today membership numbers between 50,000 and 60,000. There are state chapters in each of the 50 states with approximately 400 local chapters.

Amstutz went on to enumerate the unceasing activities of the N.S.P.E. today. The society constantly is striving to protect the rights of Professional Engineers. These rights include that of the freedom of an engineer to practice without joining a union. This has been one of the most important achievements of the society. Union officials constantly have opposed legislative action which would protect the engineer. It has been mainly through the efforts of the society that these laws have been passed. Another act which the society was instrumental in helping to pass was that of declaring engineering a profession. It constantly has endeavored to have state

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Navy Pier

(Continued from Page 41)

laws passed which would require all engineers to be registered. There is such a law in Illinois which not only forbids anyone to call themselves professionals unless registered but also defines the term engineer.

Amstutz then further discussed the engineer by talking about how a person goes about becoming a Professional Engineer. He explained that a test is given to the prospective engineer as soon as he completes his education. This is referred to as Engineer in Training exam and deals basically with the material covered during one's college years. After a period of time has been spent in actual practice, another exam is given which measures the amount of knowledge acquired from on-the-job experience. Upon passing both exams the applicant becomes a professional engineer. Amstutz said that many companies are adopting the policy of hiring only registered engineers and more probably will do so in the future.

Academic Profile

Two students are standing in the halls, slide rules at their hips. It is early spring.

"Say Bill, do you know where there are any summer jobs available?"

"Yeah, sure. I just got one from Prof. Walraven."

And so it goes, lines of engineers shuffle to Prof. Walraven's office in search of jobs. Prof. Walraven has contact with more than 250 engineering companies that request student employment.

This is only one of the functions of Prof. Walraven who is chairman of the 101 drawing courses in the G.E. department. In addition to his academic duties, he is the University representative to A.S.E.E. (American Society of Engineering Education). In this capacity he is able to study the engineering programs of other schools and compare the Chicago program to theirs.

Prof. Walraven was born in Southern Illinois. He received his Masters at the U. of I. and started his doctorate. He went into industry so he could bring practical experience to the classroom.

In writing *General Engineering Problems*, a lab manual, Prof. Walraven and a co-author presented practical engineering problems to the students in an academic manner.

Prof. Walraven, a family man, has three children. He admits he has little spare time, but when he can, he turns to technical writing.

BRAIN TEASERS

Edited by Steve Dilts

NOTE: Due to the unavoidable delay in the printing of the November issue the Brain Teaser contest will begin this issue. Dead line for entries will be Jan. 15th.

A gang of boys made a raid on the Perkins orchard and came back with a quantity of apples, which were then pooled and divided equally among them. Michael said he thought it would be fairer to share by families instead of by individuals. As there were two Johnson brothers and two Fairbanks brothers, redivision by families would have increased each share by 3 apples. With the argument at its height, along came Fred, who, being the oldest of the gang, was appealed to as arbiter. Fred decided that it would be unfair to share by families. Furthermore, he pointed out, he himself would certainly have participated in the raid, to the great increase of bouty, had he not been detained by a compulsory engagement with a rug-beater. But as head of the gang he was entitled to a share. Fred had a way of winning his arguments, so each boy contributed one apple to him, making equal shares all around. How many apples did the boys gather?

* * *

Prove that at a recent convention of biophysicists the number of scientists in attendance who shook hands an odd number of times is even. The same problem can be expressed graphically as follows. Put as many dots (biophysicests as you wish on a sheet of paper. Draw as many lines (handshakes) as you wish from any dot to any other dot. A dot can "shake hands" as often as you please, or not at all. Prove that the number of dots with an odd number of lines joining them is even.

* * *

Smith, Brown and Jones agree to fight a pistol duel under the following unusual conditions. After drawing lots to determine who fires first, second and third, they take their places at the corners of an equilateral triangle. It is agreed that they will fire single shots in turn and continue in the same cyclic order until two of them are dead. At each turn the man who is firing may aim wherever he pleases. All three duelists know that Smith always hits his target, Brown is 80 per cent accurate and Jones is 50 per cent accurate. Assuming that all three adopt the best strategy, and that no one is killed by a wild shot not intended for him, who has the best chance to survive? A more difficult question: What are the exact survival probabilities of the three men?

* * *

An unlimited supply of gasoline is available at one edge of a desert 800 miles wide, but there is no source on the desert itself. A truck can carry enough gasoline to go 500 miles (this will be called one "load"), and it can build up its own refueling stations at any spot along the way. These caches may be of any size, and it is assumed that there is no evaporation loss. What is the minimum amount (in loads) of gasoline the truck will require in order to cross the desert? Is there a limit to the width of a desert the truck can cross?

* * *

The most popular problem ever published in *The American Mathematical Monthly*, its editors recently disclosed, is the following. It was contributed by P. L. Chessin of the Westinghouse Electric Corporation to the April, 1954, issue.

"Our good friend and eminent numerologist, Professor Euclide Paracelso Bombasto Umbugio, has been busily engaged in testing on his desk calculator the 81×10^9 possible solutions to the problem of reconstructing the following exact long division in which the digits were indiscriminately replaced by *x* save in the quotient where they were almost entirely omitted.

```
           8
XXX ) XXXXXXXX
        XXX
         XXXX
          XXX
           XXXX
           XXXX
```

"Deflate the Professor! That is, reduce the possibilities to $(81 \times 10^9)^0$."

Because any number raised to the power of zero is one, the reader's task is to discover the unique reconstruction of the problem. It is easier than it looks, yielding readily to a few elementary insights.

The answers will appear next month.

* * *

Here are the answers to last month's brainteasers.

Four airplanes will do the trick. One solution:

Planes 1, 2, 3 and 4 take off together. After going 1/6 of the distance around the earth, planes 1 and 4 transfer half their remaining fuel to planes 2 and 3. As 2 and 3 continue for another 1/6 of the way, planes 1 and 4 return to base. Plane 3 now transfers its fuel to 2.

* * *

If you place the point of a compass at the center of a black square on a chessboard with two-inch squares, and extend the arms of the compass a distance equal to the square root of 10 inches, the pencil will trace the largest possible circle that touches only black squares.

* * *

Writing a three-digit number twice is the same as multiplying it by 1,001. This number has the factors 7, 11 and 13, so writing the chosen number twice is equivalent to multiplying it by 7, 11 and 13. Naturally when the product is successively divided by these same three numbers, the final remainder will be the original number.

* * *

The quickest way to solve this problem is to run the scene backward in time. A minute before the crash the 9,000 mile-per-hour missile is clearly 150 miles from the meeting point and the 21,000 mile-per-hour missile is 350 miles from the same point, making the distance between them 500 miles.

Begged, Borrowed, and . . .

Edited by Jack Fortner

A very rich deposit of oil was discovered on the farmer's land. Immediately he rushed into town to purchase a new car. An obliging salesman showed him a sleek roadster selling for $5,000.

"I am prepared to pay cash," said the farmer. "Will I get a discount?"

"Why certainly," replied the salesman. "We will give you a 10% discount on a cash purchase."

Not being confident on his ability as a mathematician, the farmer said he would think it over and return later.

He walked into a restaurant and over his coffee tried to figure what his discount would be, but to no avail. Finally in desperation he turned to the waitress and asked, "If I gave you 10% of $5,000 how much would you take off?"

Blushing prettily, the waitress whispered, "Would my earrings bother you?"

* * *

M.E. Problem Test No. 2

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

* * *

The engineer returned home one night at a late hour, and finding difficulty with his equilibrium, made considerable noise in the hallway. Suddenly there was a sound of crashing glass which awakened his wife.

"John," she called, "What's the matter?"

From downstairs came a low mumble, "I'll teach those goldfish to snap at me."

There are those who claim that silk isn't the best thing in the world, but most people will agree it is about the nearest thing to it.

* * *

She was a gorgeous girl,
And he was a loving male.
He praised her shape in English,
French, Italian, and Braille.

* * *

Prof.: "Why don't you answer when I call your name?"

ME: "I nodded my head."

Prof.: "You don't expect me to hear the rattle all the way up here do you?"

* * *

The fellow and girl charged around a corner and bumped smack into each other. They stepped back, apologized and started up again. But they both dodged in the same direction and bumped once more. Again they started up, bumped and apologized. This time the fellow stepped back, raised his hat and gallantly remarked, "Just once more, cutie, then I really have to go."

* * *

Mottoes:

Freshman Girl: "Mother knows best."

Sophomore Girl: "Death before dishonor."

Junior Girl: "Nothing ventured, nothing gained."

Senior Girl: "Boys will be boys."

* * *

Freshman: "What does 'Fantasy' mean?"

Senior: "A story in which the characters are ghosts, goblins, virgins, and other supernatural beings."

* * *

Two Wacs returning late one night got into the wrong barracks—those of the enlisted men. One lost her head and ran: the other remained calm and collected.

* * *

Then there was the chemical engineer who died from drinking shellac. The boys all said he had a good finish.

ENGINEERS CORN TEST

Connect 20,000 volts across a pint. If the current jumps it, the product is poor.

If the current causes a precipitation of lye, tin, arsenic, iron slag, or alum, the whiskey is fair.

If the liquor chases the current back to the generator, you've got good whiskey.

* * *

The origin of the expression, "hurrah for our side!" goes back to the crowds lining the streets when Lady Godiva made her famous sidesaddle ride through the streets of Coventry.

* * *

Some girls are cold sober.
Others are always cold.

* * *

During mock maneuvers an army commander ordered a notice to be displayed on a bridge stating: "This bridge has been destroyed by air attack." But to his chagrin, he noticed through his field glasses that a foot regiment was crossing the bridge despite his orders. He sent his adjutant to the officer in charge post-haste to find out how he dared to defy his orders. An hour later the adjutant was back. "It's all right, sir," he reported. "The troops are wearing signs saying 'We are swimming'."

* * *

Two enterprising young men on a train decided to make the acquaintance of the young lady across the aisle from them. Said the first gentleman, "My name's Peter, but I'm no saint." Added the second, "My name's Paul, but I'm no apostle." Replied the flustered young lady, "My name's Mary and I don't know what to say."

* * *

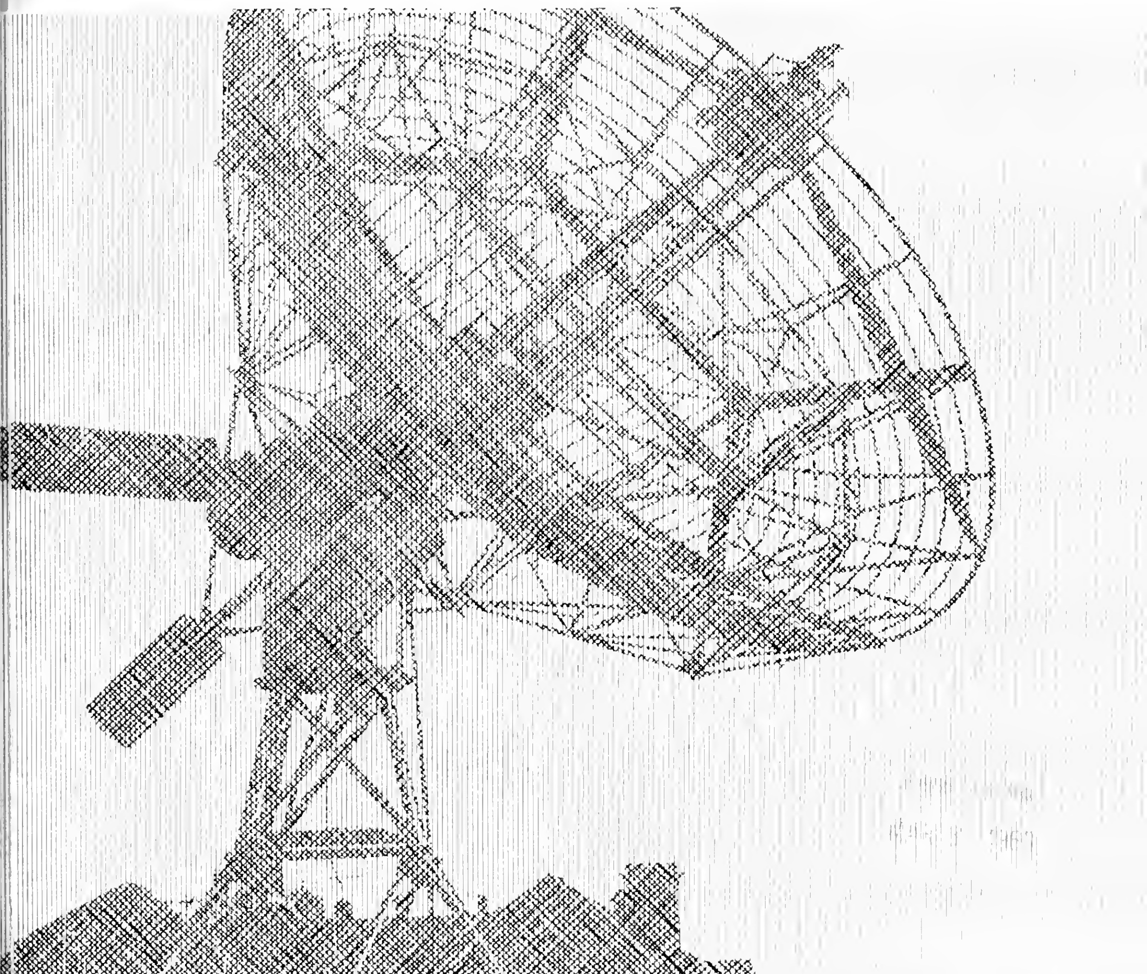
"She isn't my best girl—just necks best."

* * *

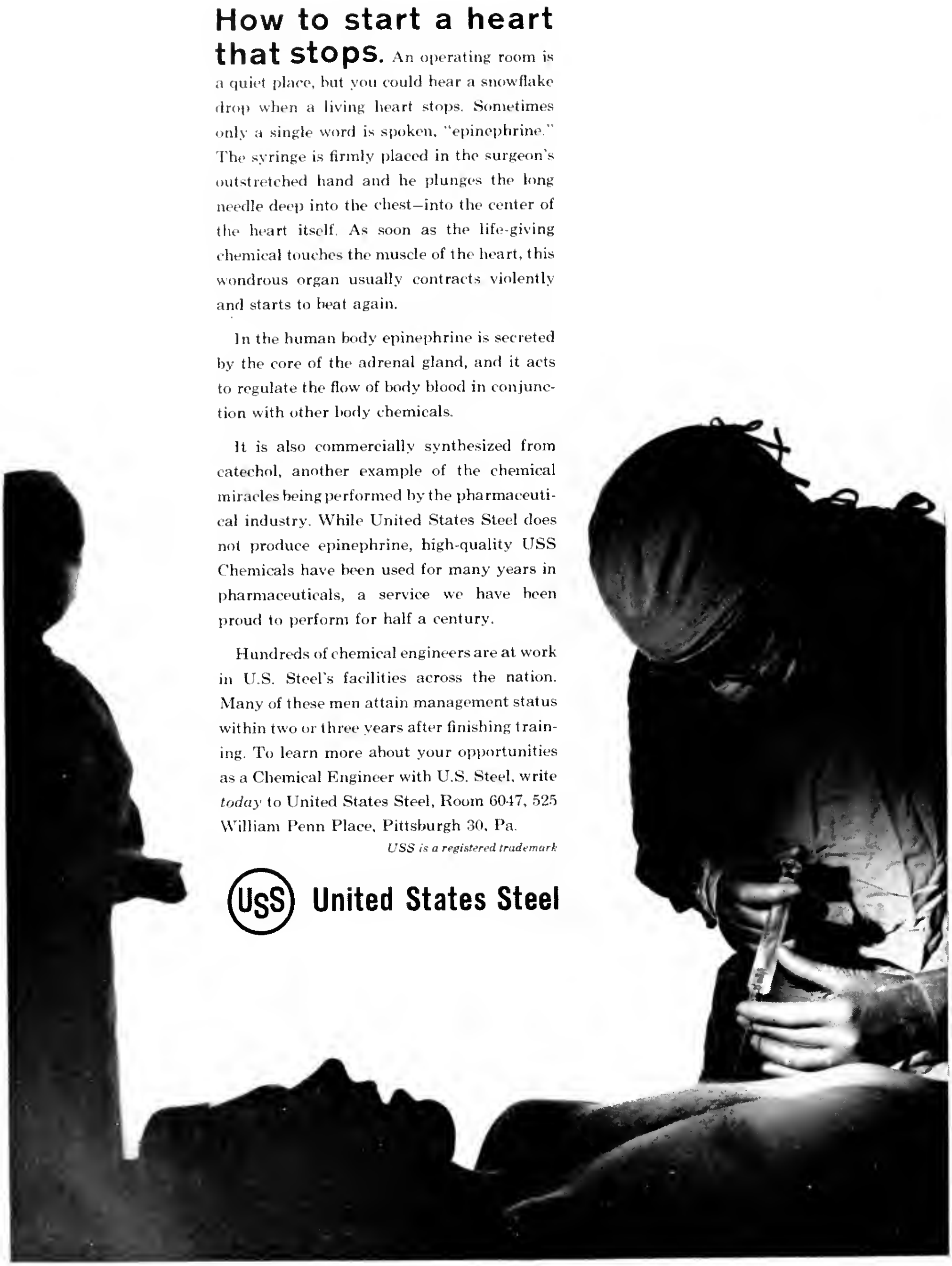
Bus driver: "All right back there?"

Feminine Voice: "No, wait till I get my clothes on."

Then the driver led a stampede to the rear and watched the girl get on with a basket of laundry.



ENGINEERING OPEN HOUSE


How to start a heart that stops.
An operating room is a quiet place, but you could hear a snowflake drop when a living heart stops. Sometimes only a single word is spoken, "epinephrine." The syringe is firmly placed in the surgeon's outstretched hand and he plunges the long needle deep into the chest—into the center of the heart itself. As soon as the life-giving chemical touches the muscle of the heart, this wondrous organ usually contracts violently and starts to beat again.
In the human body epinephrine is secreted by the core of the adrenal gland, and it acts to regulate the flow of body blood in conjunction with other body chemicals.
It is also commercially synthesized from catechol, another example of the chemical miracles being performed by the pharmaceutical industry. While United States Steel does not produce epinephrine, high-quality USS Chemicals have been used for many years in pharmaceuticals, a service we have been proud to perform for half a century.
Hundreds of chemical engineers are at work in U.S. Steel's facilities across the nation. Many of these men attain management status within two or three years after finishing training. To learn more about your opportunities as a Chemical Engineer with U.S. Steel, write *today* to United States Steel, Room 6047, 525 William Penn Place, Pittsburgh 30, Pa.
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THE ILLINOIS TECHNOGRAPH

Volume 75, Number 4 January, 1960

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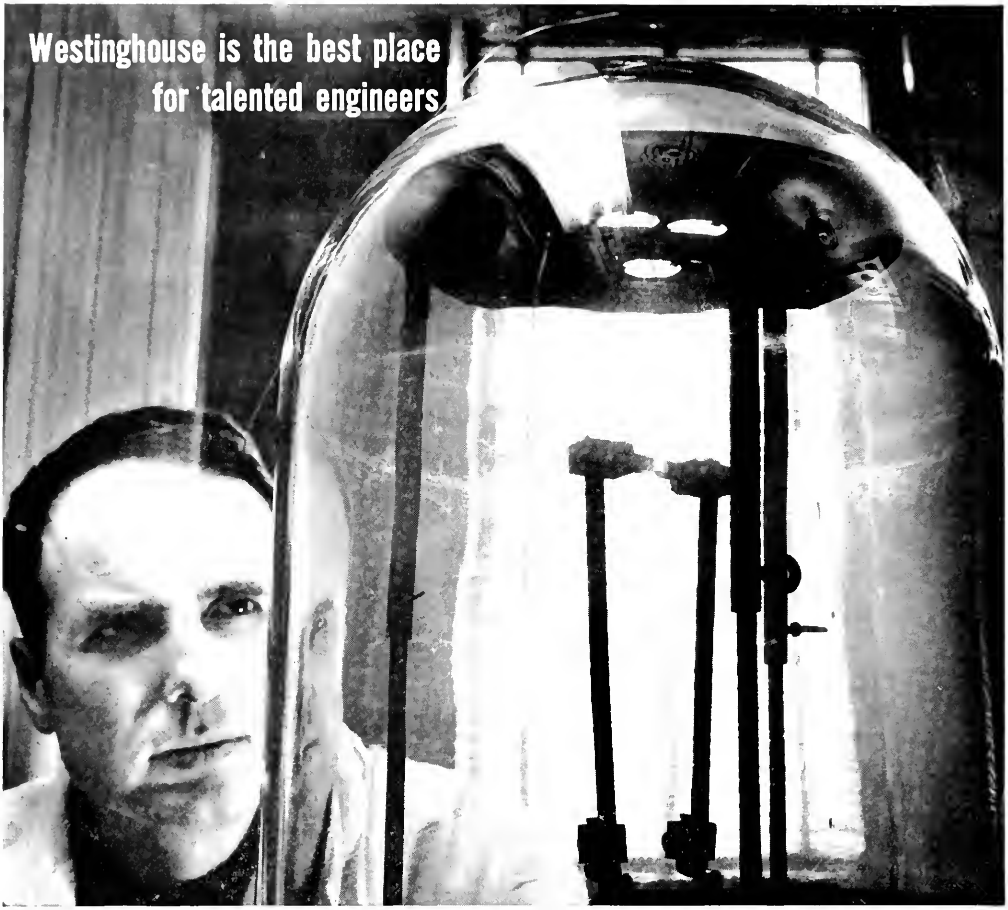
Cover . . .

The cover this month done by Phil Weibler will also be the OPEN HOUSE poster for this year. Phil is doing all the art work for the Open House publicity campaign.



W. J. Burnham of Westinghouse's Electronics Lab controls the evaporation of germanium metal in a low pressure atmosphere. The germanium smoke collects on a glass disk producing a thin film semiconductor of the type to be used in telemetering systems.

Is a semiconductor film the answer? Ask the men in the Electronics Lab

The Electronics Laboratory helps the Westinghouse engineer use the latest tools in the electronics field and works to develop new ones for his special projects. If a Westinghouse engineer needs a new semiconductor film for a satellite telemetering system, or a highly sensitive tube for a new kind of TV camera, he can call on this group of experts for help.

The lab is currently doing work with infrared imaging devices, molecular electronics, sound transmission in water and air, parametric amplification of microwaves, plasma physics, thermionic power conversion and light emission. Nearly all of its work is in support of engineers and scientists in other departments of the company.

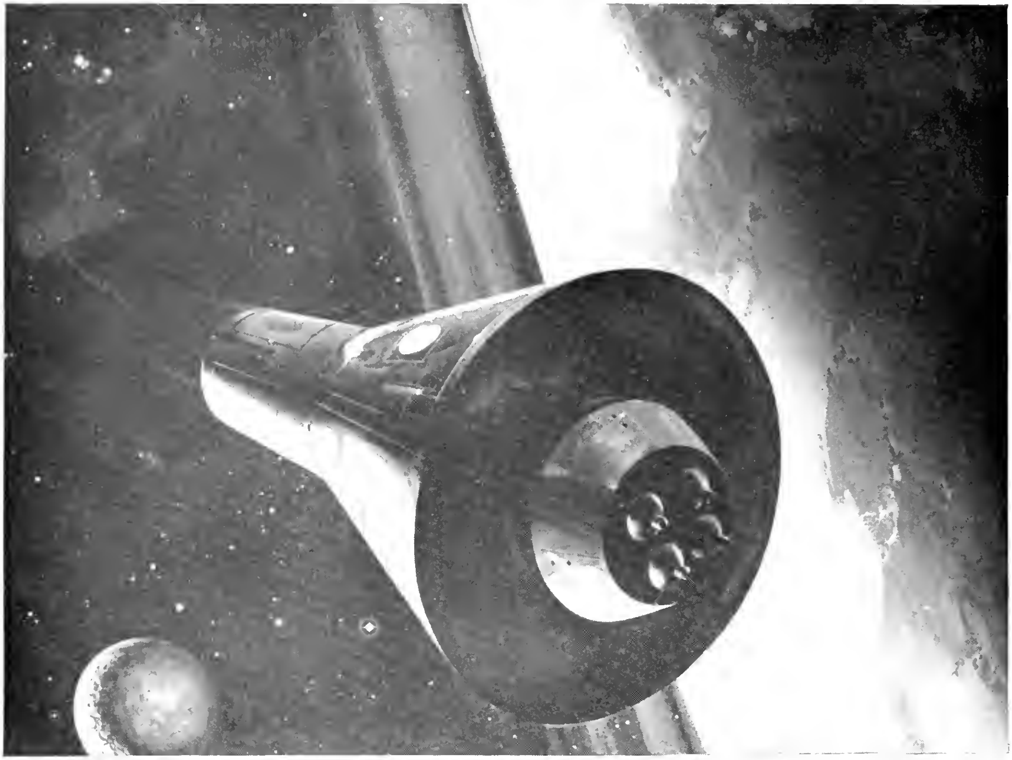
At Westinghouse the young engineer isn't expected to know all the answers. Our work is often too advanced for that. Instead, each man is backed up by specialists, like those in the Electronics Lab.

If you have ambition and real ability, you can have a rewarding career with Westinghouse. Our broad product line, decentralized operations, and diversified technical assistance provide hundreds of challenging opportunities for talented engineers.

Want more information? Write to Mr. L. H. Noggle, Westinghouse Educational Department, Ardmore & Brinton Roads, Pittsburgh 21, Pennsylvania.

YOU CAN BE SURE...IF IT'S

Westinghouse



DOW is tomorrow-minded

plant . . .

Take just one for-instance: Plaquemine. Some five hundred acres of Louisiana sugar cane country once. Stately oaks and magnolias. Today they're still there. But growing harmoniously with them are the vivid contemporary colors of the new plant—the Dow reds and greens, gleaming whites, Confederate gray, businesslike black. They blend in with the oaks and magnolias to provide one of America's most modern and distinctive plant vistas. Along with the forward-looking products and the people who produce them, this tomorrow-minded Dow plant is a part of the new face of the new South.

Plaquemine is located in one of the nation's fastest-growing concentrations of chemical manufacture. This now bustling Evangeline country offers abundant natural resources, an excellent network of transportation, good accessibility to great and developing markets and communities. And, perhaps most important of all—Old Man River—the limitless Mississippi, with its never-ending source of fresh water and its gate to the ocean-going trade routes of the world.

Today's Plaquemine is a symbol of Dow's tomorrow-minded growth—at one of the fastest rates in the industry. To keep pace with its output of products, new and old, Dow plants are building nationwide. Says the Chairman of the Board of Directors: "We build in boom times to keep up with the demand; we build in slump times for the future." And Dow continues to build its plants, products and people always with tomorrow in mind.

If you would like to know more about the Dow opportunity, please write: Director of College Relations, Dept. 2425FW, THE DOW CHEMICAL COMPANY, Midland, Michigan.

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN DOW

A new dimension in

bubble blowing

This plastic bubble protects the antenna of a radically new aerial three-dimensional radar defense system.

Sensitive to the inadequacies of conventional radar systems, engineers at Hughes in Fullerton devised a radar antenna whose pointing direction is made sensitive to the frequency of the electromagnetic energy applied to the antenna. This advanced technique allows simultaneous detection of range, bearing and altitude...with a single antenna.

Hughes engineers combined this radar antenna with "vest-pocket sized" data processors to co-ordinate antiaircraft missile firing. These unique data processing systems provide:

1. Speed—Complex electronic missile firing data was designed to travel through the system in milliseconds, assuring "up-to-date" pinpoint positioning of hostile aircraft.
2. Mobility—Hughes engineers "ruggedized" and miniaturized the system so that it could be mounted into standard army trucks which could be deployed to meet almost any combat problem—even in rugged terrain.
3. Reliability — By using digital data transmission techniques, Hughes engineers have greatly reduced any possibility of error.

Result: the most advanced electronics defense system in operation!

Falcon air-to-air guided missiles, shown in an environmental strato chamber are being developed and manufactured by Hughes engineers in Tucson, Arizona.

Reliability of the advanced Hughes systems can be insured only with the equally advanced test equipment designed by Hughes El Segundo engineers.

Other Hughes projects provide similarly stimulating outlets for creative talents. Current areas of Research and Development include advanced airborne electronics systems, advanced data processing systems, electronic display systems, molecular electronics, space vehicles, nuclear electronics, electroluminescence, ballistic missiles...and many more. Hughes Products, the commercial activity of Hughes, has assignments open for imaginative engineers to perform research in semiconductor materials and electron tubes.

Whatever your field of interest, you'll find Hughes diversity of advanced projects makes Hughes an ideal place for you to grow...both professionally and personally.

ELECTRICAL ENGINEERS AND PHYSICISTS

Members of our staff will conduct

CAMPUS INTERVIEWS

MARCH 10 and 11, 1960

For interview appointment or informational literature consult your College Placement Director.

HUGHES

The West's leader in advanced ELECTRONICS

HUGHES AIRCRAFT COMPANY

Culver City, El Segundo, Fullerton, Newport Beach, Malibu and Los Angeles, California
Tucson, Arizona

COME AND SEE US

Get a Student's — Eye View of Engineering

W. L. EVERITT

Dean, College of Engineering

Engineering is more a way of life than a way of making a living. Hence, it is difficult to explain in succinct terms just what an engineer is or what he does. One somewhat facetious definition has it that "an engineer is someone who knows whether a thing will work before it is built—any fool knows afterward." Such a definition shows why *mathematics* is so important as an engineering tool, but does not begin to tell the whole story: how an engineer must work with people as well as with energy and materials, how he must predict and then fulfill the needs and desires of his fellow men, so that his product must meet socially desirable objectives—will both work and be wanted. No definition can make clear how the engineer must dream as well as produce, or how he fits into our modern economic system so indispensably that many people think he, more than the members of any other profession, will determine the future of mankind.

As a contribution to career guidance, the College of Engineering at the University of Illinois is most anxious to present engineering as a possible profession for the consideration of high school students in the state, the group from which members of this and all other professions must be drawn. Such a presentation is made in a variety of ways, and in cooperation with other groups who have similar objectives. For that reason, we publish numerous booklets (such as our *Careers in Engineering*), we arrange (on invitation) for speakers at Career Days in high schools, and we support national organizations such as the Engineers' Council for Professional Development in their information efforts.

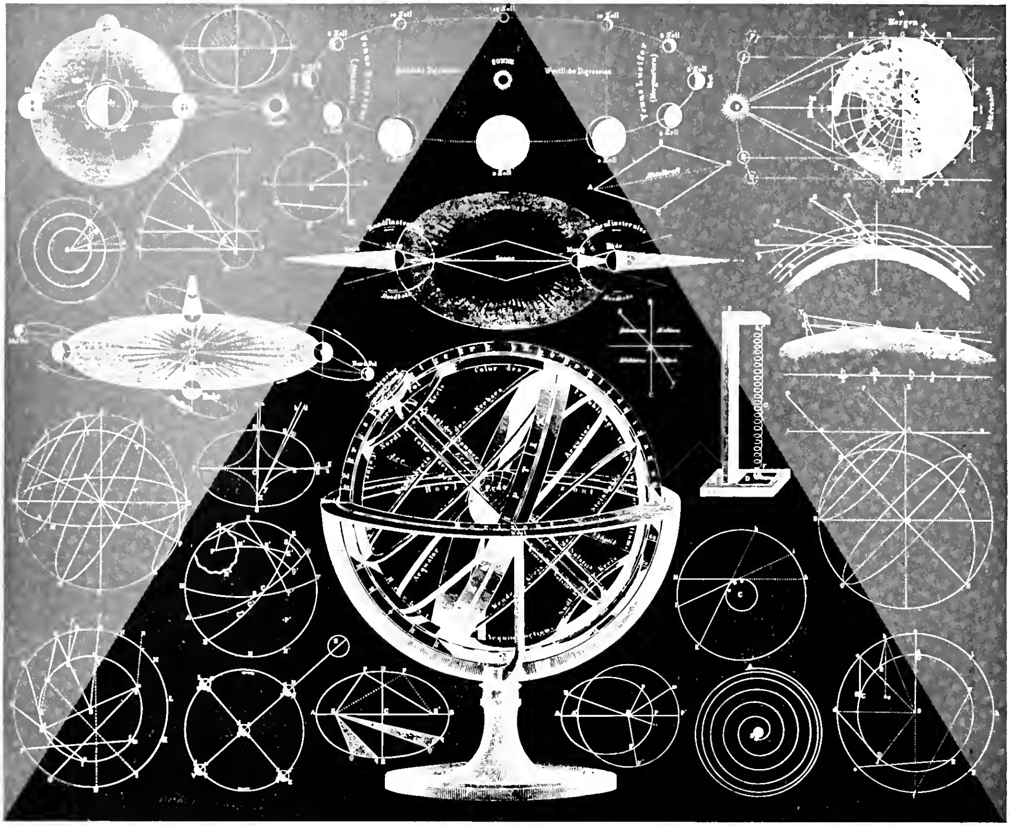
However, nothing can convey a message of interest and hospitality quite as well as a person-to-person contact. We are, therefore, always glad to have high school students or parents come to Urbana or to the Chicago Undergraduate Division at the Pier to talk with our staff or to see our physical facilities. But once each year, in mid-March, we suspend classes so that students and faculty together can make a special concerted effort in displaying our whole College and its facilities for our visitors. This is our Engineering Open House, to which this issue of *Technograph* is dedicated to give the high schools preliminary information.

During the two days of March 11-12, we will have many interesting demonstrations, and almost everything laboratory-wise will be going at once. You may talk to students and faculty advisers as well as see equipment in operation. Our Tau Beta Pi Honor Society even has a textbook roundup and will give interested visitors a scholarly, curricular point of view to balance the entertaining features in the laboratory areas. I myself find it a good time to learn more about engineering, to see our new facilities in operation, and to be pleasantly surprised by the new ways our students have found to present their own special fields and projects.

I must admit that such a short, overall tour-visit can hardly convey to you a deep and broad understanding of engineering in terms of the philosophy I expressed in the opening paragraph—sometimes this takes years for even a practicing engineer to grasp in shaping his own attitudes toward life. But I hope that such an observation of engineering education in action may help lay the foundation so that by combining it and other means high school students can find an answer to the critical question: Is engineering the right career for me? We are also, of course, anxious to have vocational advisers and other members of the high school faculties, as well as school administrators, parents, and the general public come to see us.

If you wish, we can make arrangements to have you talk individually with one or more members of our faculty. In this connection, it would be helpful if you would write ahead so that we can plan appointments; but if your plans are uncertain until the last minute, come anyway and let us know when you get here. While I will not be in my office all the time (I, too, want to see what is going on), you can reach me or members of my staff through my secretary in Civil Engineering Hall, Room 106.

May I extend, on behalf of our students and staff, a warm invitation to come to our 1960 Engineering Open House at Urbana on March 11 and 12 to see a leading Engineering College on parade.



Some pollen isn't to be sneezed at

...it may be clue to oil!

What a 500-million-year-old spore looks like magnified.

One of nature's most closely-guarded secrets is being unraveled today by the painstaking efforts of research scientists working with clues millions of years old, some dating back as far as 500 million years.

Scientists feel certain that vast supplies of oil lie undiscovered beneath the earth's surface. Only a few scattered and skimpy clues to its whereabouts exist. Fossils of plant and animal life are among the most important. But with the skill of an expert, nature has covered the trail well. In many areas, the better known fossils can't be found!

Constantly searching for new clues, science "detectives" in the laboratories of Pan American Petroleum Corporation, a Standard Oil affiliate, have turned to the invisible pollen and spores that fill the air to the discomfort of hay fever sufferers. (Spores are similar to pollen and also can cause hay fever symptoms.) But these pollen and spores no longer peril allergy victims, for they have been embedded in rock for millions of years.

These microscopic traces of plant life form the missing link, telling scientists the same story they normally get from the larger plant and animal fossils. Because of this new study, extensive areas, once passed over, have been opened to re-exploration. Scientists expect new oil discoveries will be made.

As the result of such trail-blazing research work America's proved underground oil reserves have grown larger, prices have remained reasonable, and America has been assured an adequate supply to keep its defenses strong.

WHAT MAKES A COMPANY A GOOD CITIZEN?

Responsibility for the future is inherent in good citizenship. One way a company can discharge this obligation is through research aimed at expanding America's resources and assuring future generations the benefits we enjoy today.

This is not a florist shop. It's a petroleum laboratory, and the plants are used to help find clues to oil deposits. Here Dr. A.T. Cross compares pollen of today's plants with fossil pollen that is more than 120 million years old.

1959

STANDARD OIL COMPANY

STANDARD

THE SIGN OF PROGRESS...
THROUGH RESEARCH

The Dean Speaks —

The Importance of Communication in Engineering

By Associate Dean Stanley H. Pierce

Some people mistakenly believe that the acquisition of an education in technical subjects alone is sufficient to become successful in engineering. Although there may be isolated instances in which an individual has had a moderate degree of success with a purely technical education, it certainly is not to be recommended to prospective engineering students.

Freshmen at Illinois have often heard me say, "You will never be successful in engineering by just filling your head with technical information. You may have excellent ideas for new designs and technological improvements, however, they will not be useable unless you can communicate them to someone else by means of the written or spoken word. Courses in rhetoric and speech will be as important to you and your career as any technical subject you may take. Study these courses as hard as you would study mathematics or physics."

There is an old saying that "hindsight is better than foresight." What do engineering graduates have to say about this area of communication in engineering? They can look back on their college education and evaluate it in light of their present engineering experiences.

Professor Herman A. Estrin of the Newark College of Engineering wrote an interesting article on this subject in the November 1959 issue of *College English*, published by the National Council of Teachers of English. He asked several hundred alumni of his college the question, "What advice would you give a freshman concerning the study of English in an engineering curriculum?" Permission has been granted to include the answers to this question in the Technograph. There is a wealth of sound advice in the fourteen points, summarized by Professor Estrin below, which are applicable to both engineering and non-engineering students.

1. Approach English as you would any task. Work as hard at it as you need, to become proficient. English is governed by rules and laws as are all technical studies. Learn and use them.

2. Utilize every opportunity to write; and in writing, practice conveying ideas clearly and concisely.

3. Treat English at least as importantly as any technical course and get as broad and comprehensive an English background as possible.

4. Become proficient in expressing yourself on paper. Develop the habit of writing all decisions, since industry tries to avoid verbal orders.

5. Learn the fundamentals of grammar well. Learn how to present ideas, to put important things first, and to eliminate the irrelevant.

6. Learn to write technical papers and learn to read them. Learn how to organize and present a technical report verbally through use of charts and graphs. Above all, learn how to spell! Misspelled words create the same impression as gravy stains on a necktie.

7. Concentrate particularly in acquiring the ability to write clear, concise letters and articles. Master completely not only grammar forms but also rhetoric. Become thoroughly able to think and speak on your feet.

8. Treat English I as you would Physics I or Chemistry I. *The pen displaces the slide rule as an individual advances in engineering.*

9. Pay close attention to the assignments. Advancement in business (including greater remuneration) can be achieved only by people who can express their thoughts and desires in a manner that will make them be listened to by others. This can be accomplished only by speech or composition.

10. Use your teacher harshly as your critic. English is a subject as important as any of the rest, and you cannot afford the luxury of letting the teacher set the pace.

11. Take English, but study *communication*. This, more than any other quality which you may possess, will set the rate and extent of your professional advancement.

12. Learn sentence structure and write intelligently. I think that men should be made to read other men's compositions and reports to see how miserably most people write.

13. Do not consider English as a secondary subject. It can be more valuable than any technical course. More responsibilities given to a person in his job usually mean more administrative functions—resulting in less slide-rule work and greater need for effective English to communicate ideas and policy.

14. If you do not succeed in mastering Engineering, be certain to obtain a mastery of English. *For in the end it will be one subject you will need more than any other during your lifetime.*

Newsflash: Washington, D.C., 5:45 A.M. The Plexus, carrying the first man to Mars, was just launched from Cape Canaveral. Confusion and excitement reigned. Paul Getz, the passenger, was sent off amid chaos. His family received countless telegrams of congratulations. All America was restless and proud.

At 9:10 a.m. a report came in from Salina, Kansas, that the Plexus had failed, and had landed on the outskirts of the corn growing community. Apparently it had made less than one orbit of the earth before landing. Thus far there were no signs of Getz. Instructions were broadcast for no one to enter the Plexus under any circumstances. Government officials wanted first hand observation in order to determine the cause of failure.

Scientists and technicians in charge of the project were flown immediately to the site. Swiftly but cautiously two men entered the ship. Although externally the appearance was identical to the Plexus, the interior revealed a more advanced knowledge of inter-spacial travel. The instrument panels were labeled in unreadable hieroglyphics. The investigators were frightened and confused. Why? How?

Both ran from the spaceship like scared children. By this time, a crowd of curious spectators had gathered, restrained by armed military police. However, the attention was not on the metal tube, but a man dressed similarly to Getz, ready for space travel. From the crowd were hurled threatening questions, but the man would make no reply. He looked neither Mongoloid, nor Oriental, nor Caucasoid. He was different. Indescribably different . . . Bewildered, the men fought their way through the crowd to the nucleus of Army officials, told them the phenomena of the instrument panels and stared at the space-clad stranger.

The research center in Washington was alerted to the freak experience in Kansas. More experts were flown in. By now, most of the American public was aware. Tension stretched tighter and tighter as time passed with no concluding results.

Intense inspection of its mechanical properties led to the assumption that the origin of the ship was Mars. Mileage was approximate. The fuel tank, half empty, contained exactly the amount estimated for the Plexus.

With this new store of information, officials again turned their attention to the stranger. His attempts to communicate were unintelligible, his facial expressions grotesque. Fear of the unknown roused the mob to violent outbursts of nervous energy.

A small boy dodged his way through the crowd, pointing his toy tommy gun at the foreign intruder. "A . . . a . . . . . . a . . . a . . . aaaa . . ." Terrified by the strange noise and insulted by the nervous laughter, the stranger grabbed the child, shaking him and stamping the plastic gun to pieces. From the turbulent crowd, men sprang forward and freed the child. The space visitor was mauled, beaten, bruised and left bleeding on the ground. The distraught Army officials rushed him to the nearest hospital where he was given little chance to live. He made several attempts to communicate, but exhaustion defeated him each time.

Washington, D.C. 1:30 a.m.: communication was established with Getz. The feeble message decoded:

"I am in captivity until the Martian is returned. Earth depends upon HIS safety."

As this message was being relayed to Kansas, news of the stranger's death was being relayed to Washington.

—By Cynthia Patterson

What are the Odds?

From PRECIS

How long will you live?

What are your chances of winning the Irish Sweepstakes? Of drawing a perfect hand at bridge? Of acquiring a mate, if presently unattached?

No one can tell you for certain, of course, but the mathematical experts who spend their lives doping out the laws of chance can do almost as well: they can tell you the odds.

What, for example, are the mathematical chances of your living to a ripe old age? According to annuity tables worked out by insurance actuaries, the odds are that a twenty-year-old man will live 54.23 years longer; a girl of the same age can expect 59.43 additional years of life.

Once you reach 30, the odds say you will survive another 44.61 years if you are a man, another 49.70 if a member of "the weaker sex." At 40, figure on another 35.15 (or 40.11) years; at 50, you're odds-on to hang around for 26.23 (36.81) (twelve-months) more.

Men of sixty are favored to survive till 78; women of the same age are good bets to reach 82. Once you've achieved 70, the odds say you'll survive past 80, giving the men 11.86 more years and women 14.18.

But lest you become over confident and do something silly—like 80 miles an hour—remember that your chances of accidental injury this year are about 1 in 17, and that accidents are the primary cause of death from age 1 to 44!

Unfortunately, your chances of accidentally striking it rich are much, much slimmer. The odds against any single ticket winning the Irish Sweepstakes? A sad 60,000 to one.

According to information supplied by Facit, Inc., creators of precision-made Swedish business machines, even greater are the odds against your drawing a royal flush at poker: 649,739 to one. On four of a kind, they drop to 4,164. The odds on getting a flush are only 508 to one against you, and a straight comes even easier at t254 to one.

You can easily figure your chances of a straight or a flush by counting the number of cards that will do it against the number of cards remaining in the deck. It's 47 to 8 on the first, 47 to 9 on the second.

You have 4 chances in 47 of drawing an inside straight — a bet hardly worth taking unless the table is likely to contain, at the very least, 12 times as much money as you're likely to wager. And then you may lose because an inside straight can be beaten.

How about bridge? The odds against a perfect hand — all 13 cards of the same suit — are a ridiculous 635,013,-599,599 to one. *But* few card players stop to think that the odds against their picking up any specified hand—including that awful one that Fate dealt you last night—are exactly the same as the odds against holding thirteen spades.

Has a whole table ever held perfect hands at one deal? Yes—and it happened quite recently—just this past April. The lucky players: the Duke of Marlborough and some aristocratic pals at a London bridge table. The odds against this particular mluke, as computed with the help of a Facit calculator, were 53,644,737,765,488,792,-839,247,440,000 to one!

But if you think those odds are high, just try to calculate the odds against the Facit, or the Odhner ading machine —or any other precision machine—making a mistake. The odds against such a boner are infinite!

Often called a gamble, marriage, too, has computable odds. At the age of twenty, a girl has nine chances in ten of marrying at some time during her life. At 25 she has 78 chances in 100 of marrying, by 30 her chances are 55 out of 100, a year later she has an even chance, and by 32 the odds are slightly against her 46.4 chances in 100 of becoming a Mrs.

A man of 30, on the other hand, has 72 chances in 100 of finding a wife, and the odds don't begin to work against him till the age of 35, when he has slightly less than one chance in two of marrying. (A woman of the same age battles three to one odds against finding a mate.) There are 31.7 chances in 100 that a man of 40 will wed; one chance out of five that a woman of the same age will marry.

What are the chances of wedded bliss including a set of twins, triplets, quadruplets or quints? Though multiple births *do* tend to "run in families," the theoretical odds against any expanctant mother giving birth to twins are 90 to one. The odds against her producing triplets are 9,000 to one, 900,000 against quadruplets and 90,000,000 against repeating the accomplishment of Papa and Mama Dionne!

But surely you can count on a fifty-fifty chance of getting a boy (or a girl if you want one)? Not quite; Actually the ods are very slightly in favor of having a son. One hundred and five boys are born for every 100 girls. Doctors know that the very young mother (teens and early twenties) is even more likely to produce a son.

The law of averages has no inflnence in determining the sx of a child—or any other issue in doubt. No fallacy has cost more people more money than the "lightning doesn't strike twice in the same place" myth. It's even cost lives! The chances of getting "heads" on a coin toss, no matter how many "heads" have rolled before, is always one in two.

And many soldiers in World War I found, to their cost, that a newly made shell-hole was no safer a refuge than a trench which had not been previously hit. It's true that the chances of two shells striking exactly the same spot are very small. But after the first one has hit, the chance that a second one will strike the same place is no smaller than the chance that it will strike any other point on the battlefield!

But if you avoid shell-holes, tire blowouts and roulette tables, your own chances of survival couldn't be better.

Getting the jump in a card game can mean hurdling tremendous odds. You have only one chance in 649,739 of drawing a royal flush in poker, one in 4,164 of getting four of a kind. But the odds against a perfect bridge hand—635,599,599 to one—are no higher than the odds against getting any specified hand in the deck! (Figures and drawings from Facit, Inc.)

Using more complex methods of doping out life expectancies, statisticians have come up with figures that would make anybody flip. The average citizen of 20 is odds-on to survive at least another 54 years. At 30, he's favored to live another 44 years, the 40-year-old can expect another 35 years of life, men of 50 are odds-on to survive past 75. And the outlook for women is even better!

STEPPING STONES TO SPACE

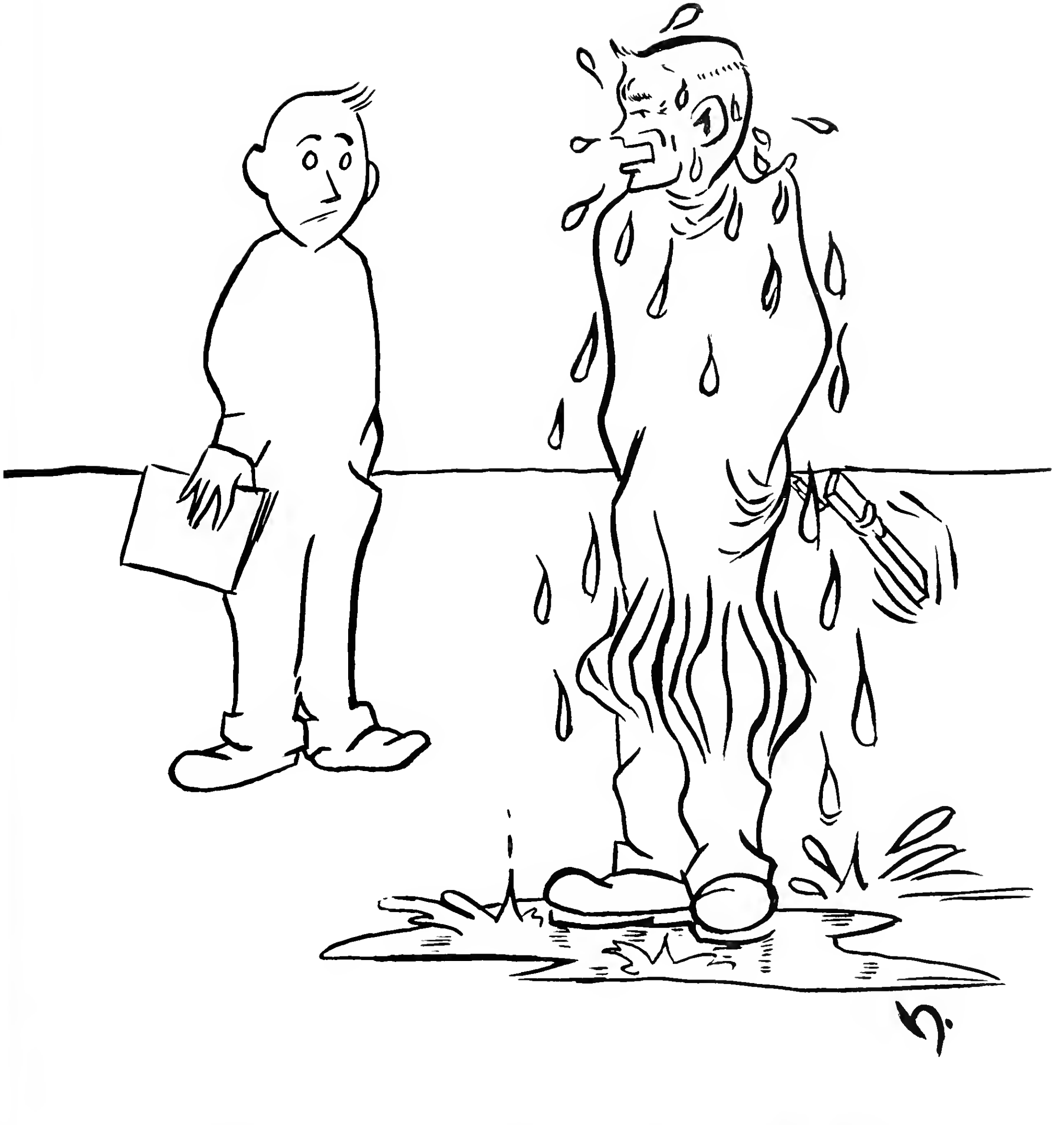
Just as the satisfactory recovery of an orbital vehicle signals the success of a space project, you, as a professional engineer, will in time enjoy increased prestige in your company and community, a high standard of living, and personal pride in the knowledge that your contributions have advanced the art of aeronautical and space technology.

At McDonnell—a large number of relatively young engineers are already enjoying the hallmarks of success mentioned above. You, too, can write *your* success story with us by taking advantage of McDonnell's Stepping Stones to Space.

Learn more about our company and community by seeing our Engineering Representative when he visits your campus, or, if you prefer, write a brief note to: Raymond F. Kaletta
Engineering Employment Supervisor
P.O. Box 516, St. Louis 66, Missouri

Illustrating McDonnell's youthful and dynamic management is John Yardley, age 34, Project Engineer-Project Mercury. John received his BSAE from Iowa State in 1944, and his MS Applied Mechanics Degree from Washington U., St. Louis, in 1950.

McDONNELL *Aircraft*



"SWEATING MY PHYSICS FINAL? WHY--NO! WHAT MAKES YOU ASK THAT?"

Special Section on

ENGINEERING OPEN HOUSE

March 11 and 12

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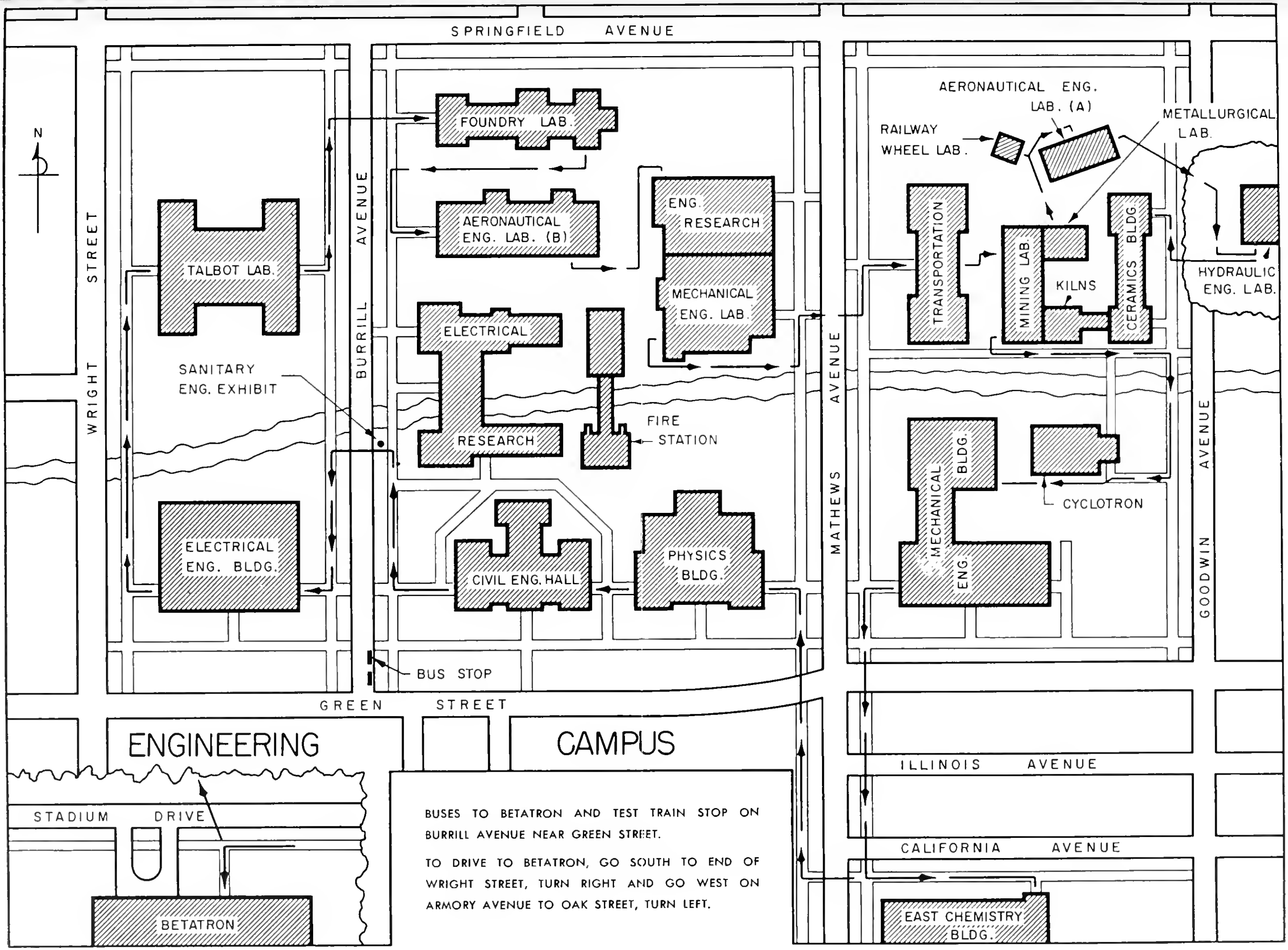


SPRINGFIELD AVENUE
N
WRIGHT STREET
BURRILL AVENUE
MATHEWS AVENUE
GOODWIN AVENUE
GREEN STREET
ILLINOIS AVENUE
CALIFORNIA AVENUE
STADIUM DRIVE
FOUNDRY LAB.
AERONAUTICAL ENG. LAB. (B)
TALBOT LAB.
ENG. RESEARCH
MECHANICAL ENG. LAB.
ELECTRICAL RESEARCH
FIRE STATION
SANITARY ENG. EXHIBIT
ELECTRICAL ENG. BLDG.
CIVIL ENG. HALL
PHYSICS BLDG.
BUS STOP
AERONAUTICAL ENG. LAB. (A)
RAILWAY WHEEL LAB.
METALLURGICAL LAB.
TRANSPORTATION
MINING LAB
KILNS
CERAMICS BLDG
HYDRAULIC ENG. LAB.
MECHANICAL ENG. BLDG.
CYCLOTRON
EAST CHEMISTRY BLDG.
ENGINEERING
CAMPUS
BETATRON
BUSES TO BETATRON AND TEST TRAIN STOP ON BURRILL AVENUE NEAR GREEN STREET.
TO DRIVE TO BETATRON, GO SOUTH TO END OF WRIGHT STREET, TURN RIGHT AND GO WEST ON ARMORY AVENUE TO OAK STREET, TURN LEFT.

AERONAUTICAL ENGINEERING

Aerodynomics

Aerodynamics is the field of aeronautical engineering which deals with the determination of the flows past a body immersed in a fluid medium, and the forces and moments which they produce on the body.

To aid in the study of aerodynamics, laboratory experiments are conducted and the results are employed in solving associated problems. The shock tube which will be on display in Aero Lab B generates a shock wave which moves past a model, producing flow velocities up to 20 times the speed of sound for very short durations of time. By photographing the model during this period with a high speed camera, valuable data is obtained. The smoke tunnel, also on display in Lab B, enables the engineer to study low speed flows past wing sections at various angles of attack. This is accomplished by injecting parallel streams of smoke into air passing over an airfoil which in turn trace the path of the air stream lines. The analog computer provides solutions of flight regime problems by means of circuit balancing. Such problems would be extremely difficult to solve without the aid of this valuable electronic device.

Students also study aerodynamics through individual research. Two examples of this are the working models of a helicopter and a ground-effect vehicle which will be demonstrated for Open House visitors. These devices are employed in examining the phenomena of hovering and vertical take-offs and landings. Through such research will eventually come airliners which are capable of landing on a football field and still travel in level flights at supersonic speeds from city to city.

Aircroft Structures Display

Once upon a time when Sir Barnstormer and his steed, the Biplane, were champions of the air, the primary problem of aircraft structural engineers was to design an aircraft structure whose strength was superior to the air loads supplied to it. Loss of material strength due to vibration and high temperatures was unheard of.

Today however, as aircraft speeds creep past mach 5, such as in the X-15 rocket airplane, the "structures man" is required to become well versed in structural problems whose complexities were not even imagined.

Flutter, or vibration, not only of controlled surfaces such as ailerons and elevators but also of wings and fuselage panels, plagues the modern aircraft structural engineer. In our wind-tunnel, Lab A, we will have an airfoil section installed which demonstrates the phenomena of flutter.

Structures can no longer be analyzed only as single strength systems. Due to heat addition from air friction temperature rise and material properties are impaired. To combat strength losses due to these temperature rises, we can:

a. use a heavier structure

b. use improved materials

c. employ a combination of steps a and b.

The last alternative is usually the necessary one. In Lab B we will have a display of some of the high temperature problems and their solutions.

In addition to the displays in these relatively new fields, a Baldwin Testing Machine will be used to exhibit the torsional failures of columns loaded in compression. Photoelasticity and its use in explaining stress fields will be demonstrated.

Samples of aircraft honey-comb structures and some small parts will also be shown.

Aircroft Propulsion

Did you ever hear of a bladeless turbine? Well, believe it or not, the Aero Department will have on display a Tesla turbine, which extracts power from high-pressure air, gas or steam using nothing more than a series of plain flat steel discs. The friction of the gas passing over the disks rotates them at a high speed, thereby providing power with greater simplicity and far less weight than any conventional gas turbine.

Invented by Nikola Tesla in 1913, this device is now being developed by the department for use in light aircraft. Because of the lack of blades, the turbine can produce much more power per pound and can operate at higher temperatures; and at the same time it is far cheaper and simpler than the bladed gas turbine. It will be demonstrated in Aero Lab B.

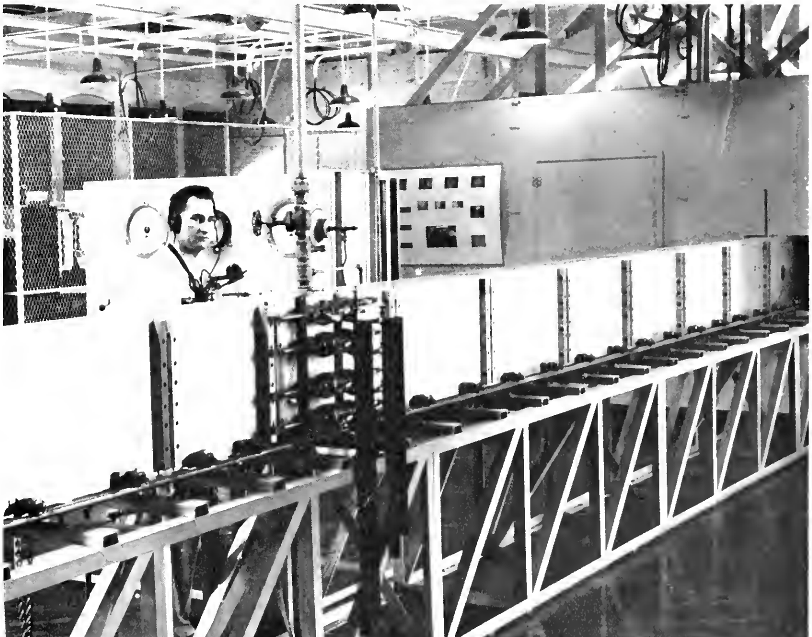
Aero Lab A will sound like Cape Canaveral when our working model rocket motor is demonstrated. Using hydrogen and oxygen for fuel, this motor works on the same principle as those used on our biggest missiles.

Also demonstrated in Lab A will be a plasma jet generator, a propulsion system of the future. Creating a jet hotter than the surface of the sun, the plasma generator can produce up to ten times as much thrust per pound of fuel as the conventional chemical rocket engines. The plasma generator also is the power source of the hypersonic wind tunnel which subjects models of ballistic missiles and space vehicles to the extreme temperatures they will encounter on re-entering the atmosphere from outer space. You will see an actual model of a missile nose cone melt like butter before your eyes.

On display in Aero Lab B will be an actual working model of a ramjet engine. Also there will be full-scale cutaway displays of turbojet, pulsejet and rocket engines.

The plasmo-jet in operation

Praf. McCloy and Prof. Yen are shown operating the Tesla turbine



Shown above is the shack tube which is used by the Aeranautical and Mechanical Engineering Departments far research. A rapidly expanding gas travels the length of this tube creating shack waves which may be studied.

AGRICULTURAL ENGINEERING

Engineering, an essential in agricultural progress, is the theme for the Agricultural Engineering Open House display of 1960. By use of actual machines, models, and displays the Illinois Student Branch of the American Society of Agricultural Engineers will present a few of the projects and products of engineering research.

Agricultural Engineers will feature the newest method of transportation developed by man, the "Aeromobile." The aeromobile developed by Dr. W. R. Bertelsen, Neponset, Illinois, powered by a 75 H.P. engine rides on an air cushion free of the surface of the ground moving at speeds up to 40 miles per hour. The engine drives a fan that provides the air cushion that the aeromobile rides on. Steering is provided by flaps or fins that control the flow of air and determine the direction of travel for the machine. The inventor reports that the machine will travel over water, hover over a field or move in any direction at will. The machine may enable many new kinds of agricultural applications to be developed with transportation over wet fields, swamps and bogs becoming possible. See it at the Agricultural Engineering Open House Exhibit.

Agricultural engineering consists of four divisions, each embracing the work being done in four great areas of agriculture. These are the divisions of power and machinery, soil and water, farm structures and farm electrification.

The power and machinery exhibit will be high lighted by the presence of a "fuel cell" tractor, a research project of Allis Chalmers Co., which utilizes a greatly different method of producing power than found in conventional farm tractors. The fuel cell instantly converts chemical energy to electrical energy in the form of direct current. The chemical energy providing the fuel is a gas mixture which is largely propane.

Although this is a research tractor, it is of commercial size and will pull a two-bottom plow. The main advantage of the engine is its efficiency in the range of 60-70 per cent, whereas the best diesel engines are about 40 per cent efficient.

Another feature of the power and machinery exhibit will be a tractor equipped with an automatic guidance system. This system is capable of completely guiding the tractor as it goes through the field. The only effort required of the operator is that which is necessary to turn the tractor at the end of the field.

Also included in the exhibit will be cutaway views of automatic and conventional tractor transmissions as well as a corn planter test stand which shows the working mechanisms of a modern farm corn planter.

The soil and water area will have a field tile flow line demonstration. By the use of colored dyes added to the water flowing through a glass faced sand tank, the flow lines of water to a subsurface drainage tile can be observed. This model allows the comparison of actual flow patterns with those derived from theoretical analysis.

Another demonstration will consist of a portable water channel and scale models of various water control structures. The use of these models for the hydraulics of various designs may be observed as well as the variations in capacity for various flow conditions.

The soil and water division will also feature several other interesting exhibits. One of these will be a sprinkler-type irrigation set-up showing how the rate of application of water may be varied through the use of various size nozzles and direction of spray. The second model display is that of soil erosion control structures. These plastic models are of flumes, V-notch spillways, and dams with drop-box inlets. There are also enlarged photographs of field conditions where these structures are being used.

The third division is that of farm structures. The increasingly widespread use of steel construction will be shown by a complete farmstead model. This model shows the use of steel buildings in a typical beef and swine operation.

Another model present will be that of a machine to test trusses of all types. This machine allows accurate laboratory determination of the effects of loads on the various types of trusses which are used in farm buildings.

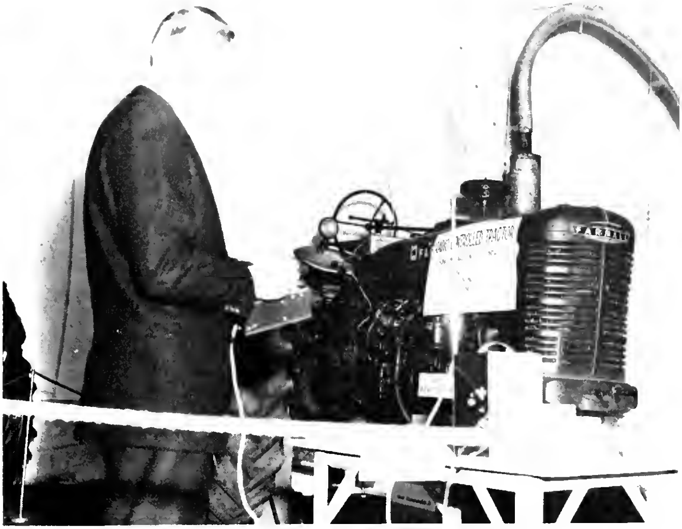
The fourth division is that of farm electrification where there is very much interest in feed processing and handling. This will be illustrated by a model of a completely automatic live tock feeding system. Such a system is capable of mixing the desired ration and then delivering it to the animals in the correct amount at the desired time. This is truly the start of "farm automation."

The extent to which electricity is put to use on the farm is well brought out by a model farm layout. Operational electric devices on the model show how electricity is used to reduce labor.

Of much interest to many, especially swine producers, will be the display of electric floor heating. A concrete slab is cast around a layout of electrical heating cables which results in a floor for which the temperature may be controlled.

For a first-hand view of some of the many advances taking place in Agricultural Engineering be sure to stop at the tent housing the previously described exhibits. You'll be glad that you did!

This student is shown spraying dust into a tractor air cleaner to test the effectiveness of various filters.



The radio-controlled tractor above will be demonstrated at this year's Open House.

This air tent will house all the Agricultural Engineering displays. It is supported by air blown from a crop dryer.

CERAMIC ENGINEERING

The world in which we live, the life we lead is one made possible through the development and use of ceramic products. Ceramics is technically defined as: "non-metallic, inorganic materials which require the use of high temperature in their processing." But what does ceramics mean to me—what does ceramics mean to you?

Ceramics is the foundation of our homes; the bricks, fibreglass insulation, and plaster in the walls, the windows, the sanitary facilities, the ceramic coated ranges, washers and bath tubs, the dishes, the glassware, the mirrors, and even the light bulbs. But this list is only the beginning. The television set has a ceramic picture tube and many small ceramic electronic parts. Outside the home the impact of ceramics still heavily influences our lives. The streets upon which we walk, the sewers we need, the buildings we admire—the beauty of our community is due in a large extent to ceramic products.

Ceramics though, has a more subtle function in our everyday lives. Without ceramics, there would be no automobiles, no silverware, no airplanes—no steel because ceramic materials line the inside of the blast furnaces in the steelmaking processes, and practically every other furnace in existance. Other materials simply cannot withstand the temperatures required in today's manufacturing processes. Almost every article we possess either has within itself or has been manufactured using ceramic materials or products. With a small insight into the products at our disposal and the processes used in their manufacture we can easily see that our world is truly—a ceramic world!

But what about the future? It, too, will be a ceramic world. There will be ceramic structures for space vehicles, ceramic rocket engine parts, ceramic nuclear fuels, high temperature ceramic electronic components, fabrication of ceramic components for atomic piles and many other products that now seem only like the wildest of dreams. How is the ceramic engineering curriculum preparing for tomorrow so that we all may have a better today?

Ceramic engineering is taught in a curriculum which maintains a sound engineering basis in mathematics, chemistry, physics, applied mechanics and engineering design with electives in social science and humanities. On this base the study of high temperature reactions and equilibria in the processing of nonmetallic, inorganic raw materials is expanded to apply to the problems of a wide variety of the process industries. In particular is the "ceramic industry;" ie., glass, refractories, porcelain enamel, structural clay products, abrasives whitewares, electrical components, cements, etc. This may include, however, the mineral processing activities of any industry in which high temperature technologly is employed.

With the advent of the nuclear era, supersonic travel and missiles, the field of ceramic engineering has become even more important. These new endeavors have made necessary training in the high temperature disciplines, in electronic ceramics and in similar allied fields.

Opportunities for professional development for engineers with a ceramic background are almost unlimited. The broad training received in ceramic engineering leads the graduates to positions of responsibility in fundamental investigations and research on materials, product development, process development and supervision, quality control, manufacturing administration, or sales and technical service in the use of raw materials, mineral products, and processing equipment. Those engineers with particular aptitude for engineering design have an opportunity for employment in fields where a knowledge of the engineering properties of materials at elevated temperatures is of paramount interest, such as industrial furnace design, aeronautical and space applications, or nuclear and conventional power plants.

The future ceramic engineer, in short may be a high-temperature materials specialist in a modern engineering team devoted to research, development, operation, or sales in a world that has needed and used ceramics from the ancient aqueducts and roads of Rome to the spectacular advances of the space age. This world is truly a ceramic world; and a glimpse of it may be obtained at the 1960 Engineering Open House.

Determining the temperature of a porcelain enamel smelting furnace by means of an optical pyrometer.

An hydraulic press is used to form dry shapes of ceramic materials in a study of desirable dies and pressure relationships.

CHEMICAL ENGINEERING

Persons touring the East Chemistry Building during the 1960 Engineering Open House will be shown some of the processes and equipment used every day in the industrial world. The majority of the processes are located in the four-story Unit Operations Laboratory and are of proportions approximating the size of pilot plants which are simply scaled-down, fully-operating models of the commercially-employed units. The design and operation of the pilot plant is generally the last important step in the sequence of events which often starts in a chemist's test tube and which may or may not result in the full-scale operation of a chemical plant. Pilot plant work thus constitutes a very important and challenging phase of chemical engineering.

The tour of the "Unit Ops Lab," as it is called by those closely associated with it, will consist of demonstrations and explanations of gas absorption, distillation, filtration and radiochemistry. Exhibits not in the main laboratory include a temperature measurement display, a Chem-Magic show, and a series of films showing the chemical engineer applying his talents in industry.

The gas absorption display, more commonly called "Chem-Pop," consists of a long, clear, packed column which contains uncarbonated popade. The carbonating gas carbon dioxide, is then bubbled through the column and is absorbed by the liquid, thus producing a refreshing drink of sparkling Chem-Pop as well as demonstrating the process of gas absorption.

This bomb is used to obtain extremely high pressures. Variations in pressure are detected by the defraction of light rays passing through the high pressure area.

Another clear plastic column is employed to visually exhibit the distillation process. A solution of two liquids of different boiling points, one of which is colored, is heated and thus vaporized. The vapor phase, consisting initially of both components, is forced up through the distillation column which, by means of tower trays and a uniform temperature gradient gradually separates the two vapors. In this particular two component separation, one component (the lower boiling of the two) goes out the top of the tower as a vapor while the other condenses and flows back down through the column.

The apparatus used to demonstrate filtration is called a continuous vacuum rotary filter. A slurry of colored calcium carbonate in water is fed to the bottom section of the slowly rotating, cloth-wrapped drum. The water is then sucked through the cloth by virtue of a partial vacuum drawn on the inside of the drum, leaving the sludge or filtrate adhering to the cloth. The filtrate is later removed by releasing the vacuum and scraping the drum. This type of filter has found widespread use in many separation processes.

The radiochemistry exhibit is intended to explain the operation and applications of geiger counters and other instruments and equipment utilized in experimental work and in radioactive chemical tracer techniques.

The temperature measurement display, located in the instrumentation laboratory on the second floor, will include a more or less chronologically based arrangement of the many devices used by chemical engineers to measure and control that very important process variable, temperature. The display contains a rather extensive number of instruments, ranging from the simple mercury thermometer to devices as complex as the optical pyrometer and the self-balancing potentiometer type temperature recorded and controller.

Intended both to balance the tour of the scientific and engineering aspects of chemical engineering and to give the possibly travel-weary visitor a chance to relax for a few minutes, are the Chem Magic show and the films. These are both performed periodically and will prove to be entertaining as well as educational.

Another unique feature of the Chemical Engineering Department's Open House Program is the use of a group of guides, whose purpose is to lead the visitors through the building and displays and to answer their questions on the subject of chemical engineering.

Fermentation apparatus in chemical engineering enables biochemistry students to study all types of biological action.

CIVIL ENGINEERING

Have you ever thought of the miserable, lowly civil engineer, out in the rain and cold, shouting four-letter words at the laborers to encourage them to work a little less slowly? Have you ever thought of how frustrated he must be when rain washes out his new road; or when the foundations upon which he was going to place his new building suddenly sink into the ground for no apparent reason; or when a flood rises to tear away his new and beautiful bridge? If you have ever thought about this miserable, lowly engineer, you have probably become convinced that you don't have to be crazy to be a civil engineer, but it helps.

You may have looked in open-mouthed awe at a news film of a rocket launching and decided that you would have to be a rocket engineer. Or, you may have taken a tour through nuclear reactor facilities, such as Argonne National Laboratories, and decided that there was no other field worth considering except nuclear physics. Then on your way home, you passed a location where a new road was being constructed. Amid the dust, noise, and confusion, you saw a man who appeared to be encased in dirt from head to toe. This, you guessed, was a civil engineer. But after all, who would want to work in conditions like that? How can a grimy civil engineer compare to a distinguished scientist in a white coat working with complex equipment?

If you have ever thought of these things, you have been thinking of the wrong person. The true civil engineer is a combination of construction boss, on-the-spot computer and catalogue of engineering know-how, designer, and public relations man. He is constantly trying to find new and less expensive means of achieving important goals.

The civil engineer's college education provides a complete back-ground in technical subjects and in areas which will help the engineer to communicate with his fellow man. The Department of Civil Engineering at the University of Illinois is acknowledged as one of the finest in the country. There are many prominent citizens of this country who spent many of their college hours in Civil Engineering Hall at the U. of I. The quality of the graduates, however, is only a reflection of the quality of the faculty.

At the 1960 Engineering Open House the student civil engineers plan to demonstrate how they go about developing this complete background to aid them in their future fields of endeavor. They will show how known principles are applied and how new theories are proven. If you are interested in the world about you, do not bypass the informative displays of the civil engineers.

The traditional civil engineer

Have you ever watched a building being constructed and wondered what was going on? You will be able to see the whole process from the initial cost estimates to the laying of the last brick. If you decide to pursue this phase of civil engineering, you will not only receive instruction in the efficient use of heavy construction equipment but also in labor relations and in the economics of engineered construction.

Most of you either are or soon will be drivers. The design and construction of the highways upon which you drive is another of civil engineering's many phases. The proper method of timing traffic through a town will be demonstrated. There will also be a model of a modern traffic interchange. This type of structure will become more prevalent as the interstate highway system nears completion. There will also be examples of student-prepared highway designs. These show the amount of material which a student highway engineer masters during his years of study.

In recent years, you have no doubt read of the many floods that have occured in the United States. While these flood have caused much damage, the amount of such damage is slight when compared with the additional damage that has been prevented by the hydraulic engineer. The students of hydraulic engineering show in model form just how a flood is prevented. Flood control is just one small part of the main interest of hydraulic engineers which is the control and efficient utilization of water, our most abundant and most misused national resource.

Closely associated with the hydraulic engineer is the sanitary engineer. After water is made available to a population center, it must be made fit for human consumption. The student sanitary engineers plan to show the advances in their field through the use of a model water purification system. The job of water purification is almost the direct opposite of the other task of the sanitary engineer which is the disposal of industrial and human waste. The difficulties of this task have been greatly increased because of the general use of radioactive material in some industries. Some ways in which these difficulties are overcome will be of interest to all.

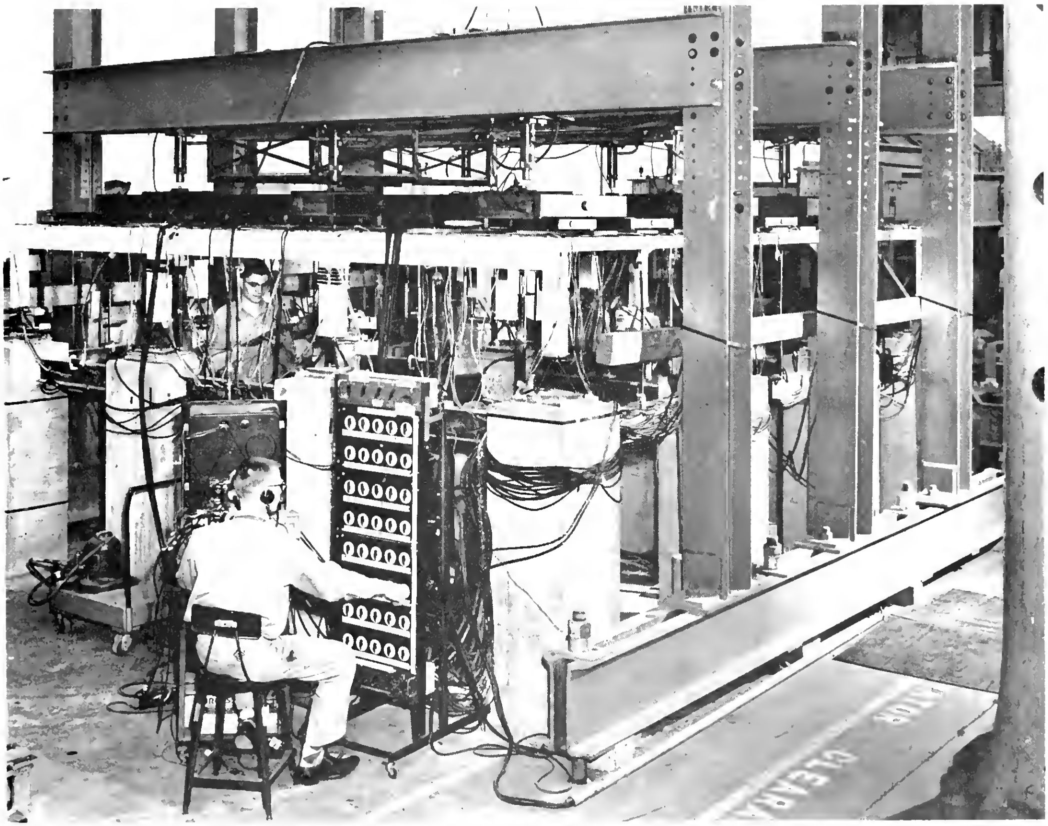
The most impressive means of mass transportation is the railroad. As the years go by, the efficient use of the railway systems becomes more of a problem to the railway engineer. The use of modern equipment and better methods of planning are two solutions to the problem. Methods of planning will be shown through the use of models. Full-size modern equipment will be demonstrated on a nearby siding. This may be your only chance to see the inside of a diesel locomotive.

The most basic but at the same time the most complex phase of civil engineering is the study of structures. Most of the other phases are in some way concerned with structures. Highway and railroad bridges, dams, and filtration plants are all structures. Many examples of the various types of structures will be shown in model form. You will get an opportunity to see structural research in action in the crane bay of Talbot Laboratory. Since all structures must eventually carry their loads to the earth, the types of foundations become important. Some of the spectacular foundation failures in the past will be depicted.

The various parts of a structure must fit together accurately. The lengths and widths of the parts are known, therefore the entire length and width of the structure must be accurately fixed upon the earth's surface. The process by which this is done is called surveying. You will see the most advanced types of surveying instruments which can measure heights to one thousandth of a foot and angles to the nearest 5 seconds. Surveyors are also concerned with making maps of the ground surface.

If you have any questions as you go through the displays, feel free to drop into the lounge to discuss them with the faculty and students present.

It is hoped that you now realize that the civil engineer is not just a scientist, but a scientist that must see his work bringing about some improvement in modern living.



THE MODERN CIVIL ENGINEER

ELECTRICAL ENGINEERING

This year's Electrical Engineering Open House will feature, in addition to some new projects, the most popular displays of previous years. As in the past, students will assemble and present the displays. Rather than depend upon outside exhibits and or elaborate permanent apparatus within their department, the majority of the E.E. displays are projects constructed from common electrical components by the E.E. students. These exhibits often prove to be the most interesting from the spectators' viewpoint.

An incentive provided by the college of Electrical Engineering for new and interesting displays is a method whereby a student may receive credit for devising and constructing a worthy exhibit. If an E.E. has plans for a new project, the student submits his ideas to a member of the faculty. If the faculty advisor deems the project economically and, of course, electrically feasible, the student may register for one hour of credit in E.E. 271, a course which exists for a variety of occasions. A requirement for the credit is a paper written by the student, which describes the exhibit. Many of the popular displays of previous years were the product of E.E. 271.

This electronic package is an artificial neuron used in a biological computer

Among the new displays to be presented at this year's Open House are a number guessing game, an electronic humidity control, and a light-bulb control. In the number guessing game, the participant chooses a number between one and 32, and by answering four yes-no questions, the correct number will be shown on the machine. The electronic humidity control is a device which automatically turns a dehumidifier on or off, depending upon the amount of humidity in the surrounding air.

The light-bulb control should prove to be one of the most mystyfying, although relatively simple, displays of this year's Open House. A box showing two switches is connected to another box exhibiting two light bulbs with only a single wire between them. By employing a system of rectifiers (property of which allows the passage of current in only one direction) unseen to the spectators, each switch can turn its respective light bulb on or off through this single interconnecting wire.

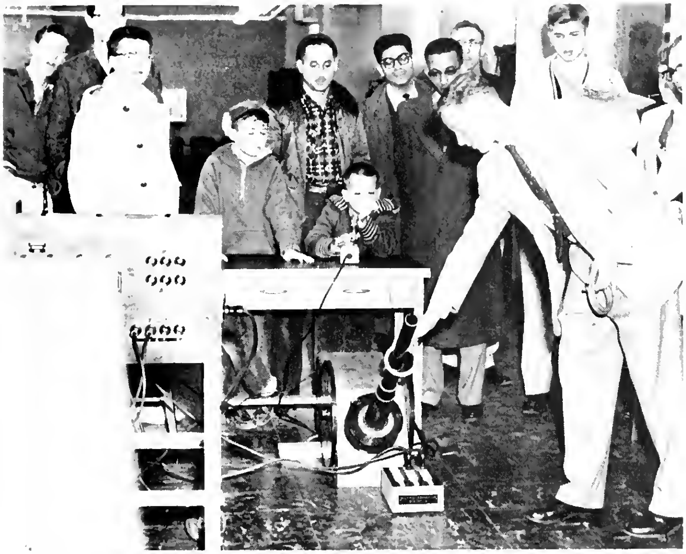
Several projects involving the use of a cathode ray oscilloscope will be presented. With an oscilloscope patterns generator, many interesting traces are generated on the screen of the scope. An exhibit seemingly created for the species of beings known as knob-twisters is the smiling scope face. A face is traced out on the oscilloscope screen which can be made to smile or frown by the turning of knobs. Another spectator participant display is the ghost writer. A small electric pencil that makes no physical contact with the oscilloscope can be used to write on the screen of the scope.

Familiar displays which have appeared at previous Open Houses include the Van-de-Graff generator, which displays 100,000-volt electrical discharges; a high current demonstration, in which a hacksaw blade is heated and melted in a few seconds by the use of merely six volts; the electromagnetic cannon, a repulsion effect produced on a non-magnetic ring which "shoots" at a target; a Jacob's ladder, where a high voltage spark climbs up two parallel wires; electronic Tic-Tac-Toe, in which a spectator tries to beat the computer (the computer always wins or ties); Data-Fax, a demonstration of how photographs are sent long distances over wires; a sonar exhibit, which measures the distance from the EE building to an adjacent building by the use of sound waves; the kissometer, a device measuring a couple's romantic potential through oscullations; the educated duck, an electronic "duck" trained to move toward various light sources; a remote controlled ball two feet in diameter which rolls around on the floor through the commands of a radio control system.

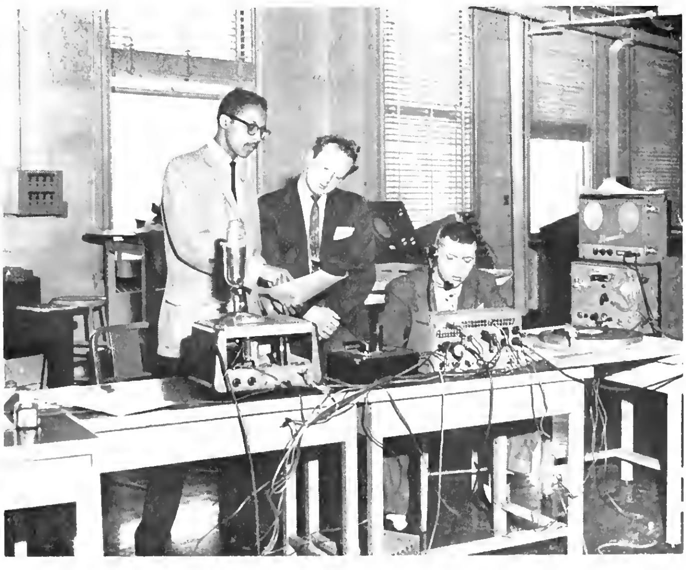
There are also several special displays from local organizations. One of these is WPGU, the student operated carrier-current radio station on the campus. During open-house weekend, WPGU will be broadcasting "live" programs from a room in the Electrical Engineering Building.

Another university organization which will provide a display is the Synton Radio Club, the university amateur radio club. Its members will exhibit and demonstrate its equipment by attempting to contact other "Hams."

Other demonstrations will be given by the State Police, who will show how speeders are trapped by radar; WILL-TV, the University of Illinois TV station, which will have a TV camera in the building; and the EE department radar set, which will show the surrounding terrain on a small screen.



The electromagnetic cannon being "loaded" with a non-magnetic ring.



Students with radio station WPGU broadcasting from the E.E. Building during Open House.

General Engineering

The General Engineering Department will have its exhibit in the Transportation Building. General engineering offers professional training for several careers, including engineering journalism, engineering sales, engineering management and engineering geology.

A spectacular exhibit will be the operation of a new system of copying machines. These machines utilize the latest techniques of microfilming and dry processes of reproduction. Incorporating the latest electronic control mechanisms, these devices have revolutionized the art of reproducing engineering drawings. Microfilming original drawings, mounting individual microfilms into aperture filing cards, and automated copying produce drawing prints of variable size. While the print is being made, the operator observes an enlargement of the drawing on a viewing screen. Distribution, revision and filing of drawings are greatly facilitated. In addition to the microfilming processes, other types of all-electric reproduction machines will be displayed.

An engineer is well-advised to know the legal aspects of his field. A display will explain the legal problems encountered in acquiring property and in making contracts for engineering projects. The correct procedures for obtaining a patent will be shown in detail.

History of engineering encompasses the technological accomplishments of all time. A panorama will present one aspect of man's progress, transportation. Included will be illustrations of prehistoric dugouts, clipper ships of the last century, present day jet airliners, and future designs of atomic space ships.

For people in research and in design, graphics has an important application to problems involving repeated formulae. Uses of various slide rules, nomographs and alignment charts, logarithmic and other graph paper will be demonstrated.

Engineering drawing is a universal means of communication between engineers and scientists. It is perhaps the major application of geometry in the science of mathematics. The engineer and draftsman have many mechanical aids for drawing. Demonstrations will illustrate the use of the pantograph, ellipse machine, lettering devices, axonometric projection boards, airbrush, zipatone and other special equipment for making drawings. Visitors may enjoy using some of these devices.

Descriptive geometry has many applications in science and engineering. In one instance, it is applied to the earth science dealing with the structure of the earth's crust and the formation and development of its various geologic layers. Special geological problems and their solution by means of descriptive geometry, signs and symbols used in geology, and applied isometric and oblique projections are among the illustrations to be found in this display.

An important purpose of the General Engineering Department is teaching the elements of engineering graphics. Many types of drawing will be displayed, including machine drawings, freehand sketches, axonometrics, perspectives and shadow projections. Limit dimensioning and tolerancing for interchangeable assembly are stressed. Special applications are portrayed in such fields as geology, heating and ventilating and architecture.

The University of Illinois Foundation has applied for a patent on a device which implements a new drawing system. The device consists of a lucite quadrangle of special shape which operates within an equilateral triangular frame. By use of the device, the new drawing system automatically projects between top, front, side and isometric views. A plastic three-dimensional model will convey the geometric theory of the new system, and the quadrangle will be demonstrated.

Throughout the Transportation Building, students will be stationed to help answer questions and to explain the displays. In addition, the staff of the General Engineering Department will be on hand to provide information on specific career opportunities for the graduate in general engineering. The students and staff of the department extend a cordial welcome to one and all. We look forward to meeting you.

Students working on aircraft drafting and lofting in General Engineering 203

Circle and ellipse drawing machine being demonstrated to visitors of last year's Open House.

The various views of two intersecting cones are demonstrated by plastic pieces in the orthograpic and isometric planes.

engineers

and what they d

The field has never been broader
The challenge has never been greater

Automatic systems developed by instrumentation engineers allow rapid simultaneous recording of data from many information points.

Frequent informal discussions among analytical engineers assure continuous exchange of ideas on related research projects.

Under the close supervision of an engineer, final adjustments are made on a rig for testing an advanced liquid metal system.

Engineers at Pratt & Whitney Aircraft today are concerned with the development of all forms of flight propulsion systems—air breathing, rocket, nuclear and other advanced types for propulsion in space. Many of these systems are so entirely new in concept that their design and development, and allied research programs, require technical personnel not previously associated with the development of aircraft engines. Where the company was once primarily interested in graduates with degrees in mechanical and aeronautical engineering, it now also requires men with degrees in electrical, chemical, and nuclear engineering, and in physics, chemistry, and metallurgy.

Included in a wide range of engineering activities open to technically trained graduates at all levels are these four basic fields:

ANALYTICAL ENGINEERING Men engaged in this activity are concerned with fundamental investigations in the fields of science or engineering related to the conception of new products. They carry out detailed analyses of advanced flight and space systems and interpret results in terms of practical design applications. They provide basic information which is essential in determining the types of systems that have development potential.

DESIGN ENGINEERING The prime requisite here is an active interest in the application of aerodynamics, thermodynamics, stress analysis, and principles of machine design to the creation of new flight propulsion systems. Men engaged in this activity at P&WA establish the specific performance and structural requirements of the new product and design it as a complete working mechanism.

EXPERIMENTAL ENGINEERING Here men supervise and coordinate fabrication, assembly and laboratory testing of experimental apparatus, system components, and development engines. They devise test rigs and laboratory setups, specify instrumentation and direct execution of the actual test programs. Responsibility in this phase of the development program also includes analysis of test data, reporting of results and recommendations for future effort.

MATERIALS ENGINEERING Men active in this field at P&WA investigate metals, alloys and other materials under various environmental conditions to determine their usefulness as applied to advanced flight propulsion systems. They devise material testing methods and design special test equipment. They are also responsible for the determination of new fabrication techniques and causes of failures or manufacturing difficulties.

Special Feature . . .

THE BETATRON

Contrary to popular belief, the future engineers, physicists, and chemists who work on the betatron at the Physics Research lab do not wear white coats and look like part of the machines they are associated with. These are just average men with an above average aptitude and intelligence in their chosen fields; science and research.

The first betatron was completed on July 15, 1940, by Professor Donald W. Kerst, working at the University of Illinois. This gets its name from two Greek symbols "beta" used scientifically to indicate high energy electrons, and the suffix "tron," meaning an instrument for. The betatron is an instrument for producing high-energy electrons. This first machine produced 2½ million-volt x-rays and was used primarily for research.

A year later, this same professor built a 24 million-volt machine which is now being manufactured by Allis-Chalmers Manufacturing Company. This machine is the most useful in industry and medicine, for machines with less voltage don't penetrate as far for industrial uses and the larger ones produce tiny particles of matter which interfere with the picture. The betatron can reveal flaws in thick metal castings and forgings and can check the assembly of complicated mechanisms within metal housings to determine the condition without taking it apart. Flaws as small as 1/16 inch deep and 5/1,000 inch wide can be seen in metal 20 inches thick and photographic plates may be placed away from the object, enlarging the picture so that flaws up to 1/1,000 inch wide may be seen. This property was first used by military forces when the first betatron was produced commercially. It was used to check internal mechanisms of military equipment before shipping and to try to find cavities in the explosive filling of large shells.

In medicine the 2½ million volt machine is good for treating skin cancer while the 24 million volt one can penetrate deeper. The 24 million volt betatron is especially useful in the treatment of cancer because, instead of using x-rays which may pass beyond the cancer into healthy tissue, it can produce a high-energy beam of free electrons which will go very little beyond the cancer. The x-ray beam, because of its high energy, has a very sharply-defined edge which is of utmost importance when cancer is near a vital organ.

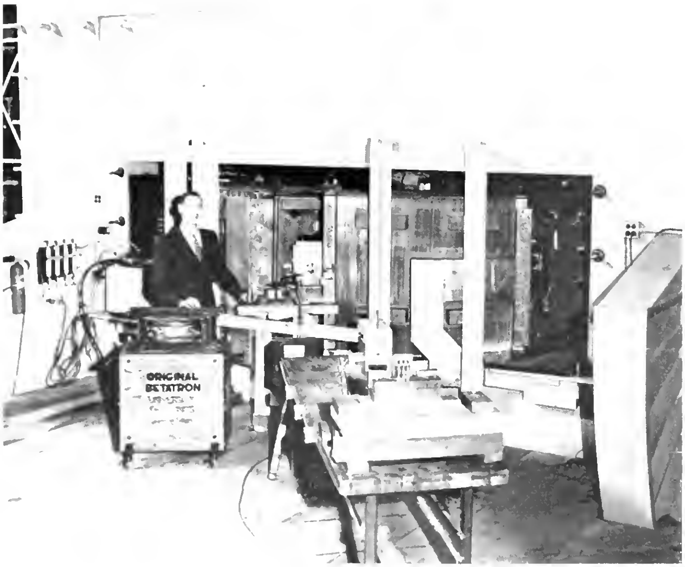
Ten years after the second betatron a 340-million-volt machine was designed and built under Professor Kerst's direction. This betatron had such drastic refinements of design that if the original 2½ million-volt betatron (two feet square) had been built this way it could have come from a machine the size of a tiny matchbox.

This big betatron is used at the present solely for research. It is used to check theories and to provide numbers from which new theories can be made. This is basic or pure research without a product involved as contrasted with research and development which is striving to perfect something or find something with a product.

As my guide said, the hardest job of the men working on the betatron is explaining to the taxpayers who eye askance the huge sum of money necessary for research and maintenance that the machine will not develop a "super bomb" or new nuclear weapon. They have a hard time explaining that all the machine does is give a set of numbers from which scientific research may be continued. One man jokingly said that the only product is a few hard-earned Ph.D.'s from working and research on the betatron.

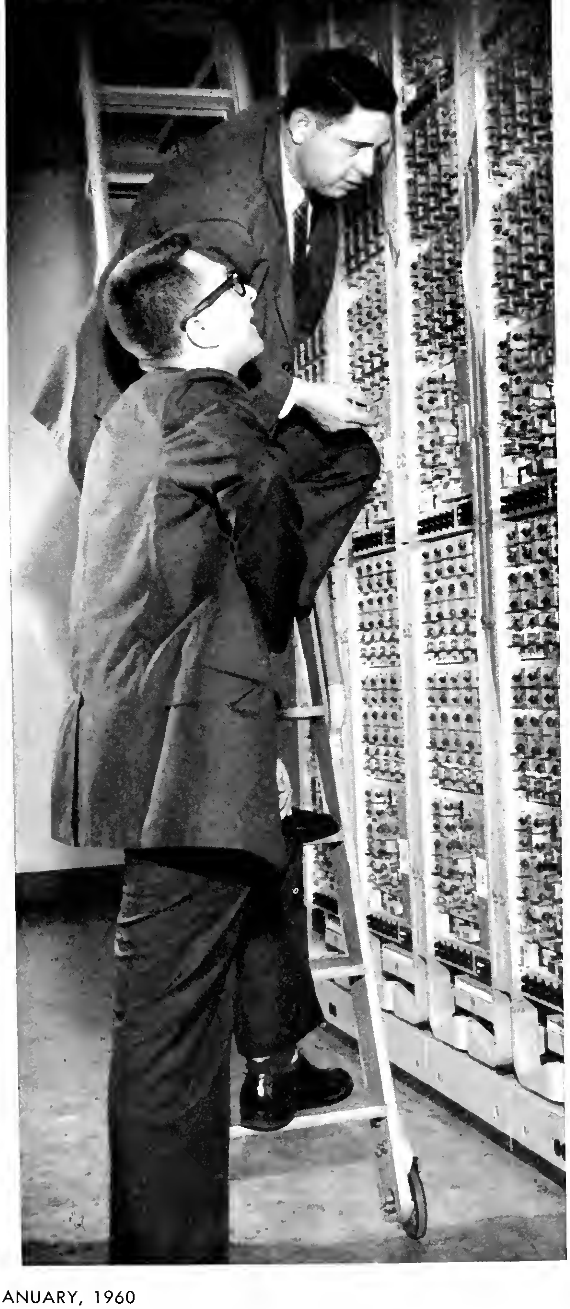
At the Research Lab the betatron is "big business." In connection with it is a machine shop and a glass shop to make pieces of equipment needed, a radiochemistry lab, experimental preparation rooms, and control rooms, a well equipped stockroom and several offices. The boys at M.R.H. can testify to the fact that the betatron requires plenty of energy, for at various times all the lights in the residence halls blink six times a second while the machine is charging up. Many varied ways of insuring safety from excess radiation are in effect.

In the atomic age in which we live perhaps the betatron at this school will conduct the research which will be the key to the future.



And it's still growing!

MEET BURNELL RICHARDSON AND DICK MASLOWSKI



They're transmission engineers with Michigan Bell Telephone Company in Detroit. Burnell graduated from Western Michigan in 1951 with a B.S. in Physics, spent four years in the Navy, then joined the telephone company. His present work is with carrier systems, as they relate to Direct Distance Dialing facilities.

Dick got his B.S.E.E. degree from Michigan in 1956 and came straight to Michigan Bell. He is currently engineering and administering a program to utilize new, transistorized repeater (amplifier) equipment.

Both men are well qualified to answer a question you might well be asking yourself: "What's in telephone company engineering for *me?*"

SAYS DICK:

"There's an interesting day's work for you *every* day. You really have to use your engineering training and you're always working with new developments. Every time Bell Laboratories designs a new and more efficient piece of equipment, you are challenged to incorporate it in our system effectively and economically. For example, I have been working on projects utilizing a newly developed voice frequency amplifier. It's a plug-in type—transistorized—and consumes only two watts, so it has lots of advantages. But I have to figure out where and how it can be used in our sprawling network to provide new and improved service. Technological developments like this really put spice in the job."

SAYS BURNELL:

"*Training* helps, too—and you get the best. Through an interdepartmental training program, you learn how company-wide operations dovetail. You also get a broad background by rotation of assignments. I'm now working with carrier systems, but previously worked on repeater (amplifier) projects as Dick is doing now. Most important, I think you always learn 'practical engineering.' You constantly search for the solution that will be most economical in the long run."

There's more, of course—but you can get the whole story from the Bell interviewer. He'll be visiting your campus before long. Be sure to sit down and talk with him.

BELL TELEPHONE COMPANIES

INDUSTRIAL ENGINEERING

The Industrial Engineering Division of the Department of Mechanical Engineering is engaged in three main areas of research: (1) the problems encountered in metal cutting, (2) use of computors, and (3) the new predetermined time systems used in establishing work standards. Each of these phases is being actively carried on by both the instructional staff and the graduate students in the division.

Prime physical evidence of this research in the form of apparatus, is evident in the machine tool laboratory and in the methods-time laboratory.

This year the Industrial Engineering Department has tried to bring new concepts and ideas into its displays developed for Open House. The program will consist of five different areas.

The first of these areas is linear programming and statistics, which will consist of three different exhibits. A random sampling display will be the first exhibit demonstrating the theory of probability. This exhibit consists of a random selection of a number of balls from a box containing different colored balls. The probable number of each color of balls has been predetermined for a random sample, thus deciding whether to accept or reject the whole lot.

The next item is tolerance build-up and control consisting of a series of wooden blocks of different sizes (simulating parts) stacked as an assembly process. The differences in sizes of the blocks will demonstrate how tolerances can build up an assembly and is an example of statistical quality control. Another feature in this area is the IBM 610 Automatic Decimal Point Computor. This machine is mainly used for scientific and engineering calculations. It is a desk model computor combining keyboard, wire panel and paper tape programming with printed output. The 610 has a 84 word magnetic drum memory, each word consisting of 31 digits and a sign. Programming and calculations for a few typical Industrial Engineering problems will be illustrated.

The second area is motion and time study. An electric peg board is being used to show the advantages of motion and time study. Pegs are inserted in several different ways, with each time recorded. The audience may participate to see if they can match a predetermined time standard.

There will also be a display showing different equipment used in motion and time study, plus wall charts used by Industrial Engineers.

Plant layout and material handling is the third area. The first exhibit in this area consists of a display using electrically operated valves and an air cylinder to move an object through a maze demonstrating new concepts in material handling. Another materials handling display features a three foot high model of a man lifting a load. The mechanical model man first lifts a load the wrong way and then performs the correct method of lifting a load. A scale model of a plant will also be on display showing some of the principles of plant layout.

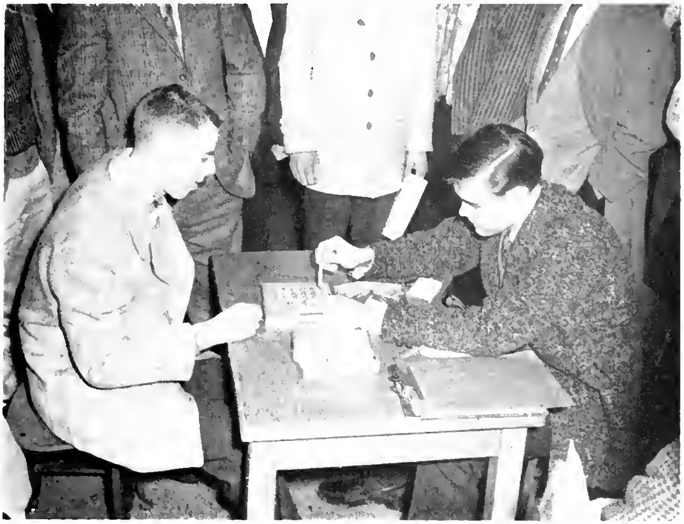
The fourth area is safety. The first exhibit in this area will show the principle of fume control. This display points out that gas fumes are heavier than air and can travel down pipes, elevator shafts, and stairways to be ignited in other parts of buildings. The second display consists of a model factory set up with saw dust and a candle burning in it. A bellows blows air into the model causing the dust to circulate and finally explode, demonstrating how dust explosions are caused. Another exhibit shows different types of protective equipment consisting of safety and fire-fighting-equipment.

A safety goggle endurance display is also being featured this year. A hydraulic device drives a spike into a safety goggle lens showing the protection a person receives when wearing safety glasses. Two more displays demonstrate the principles of guards and safety devices on equipment such as a saw and jointer guard and a punch press guard.

The last area is tool design. Several displays have been set up to show the different types of tools used in tool design. A punch press die model will also be shown and operated.

The students and instructors of the Industrial Engineering Department believe that this year's exhibit is one which will grasp the interest of every visitor. A great deal of time and effort has been expended on the various projects and displays for the sole purpose of illustrating the many facets of engineering's youngest field.

Time and motion study utilizes many modern devices to improve output and save labor. Shown here is a camera recording the procedure used in an assembly process.



This peg board demonstrates that even in such a simple operation as inserting pegs in a board there is a right, i.e., faster way to operate.

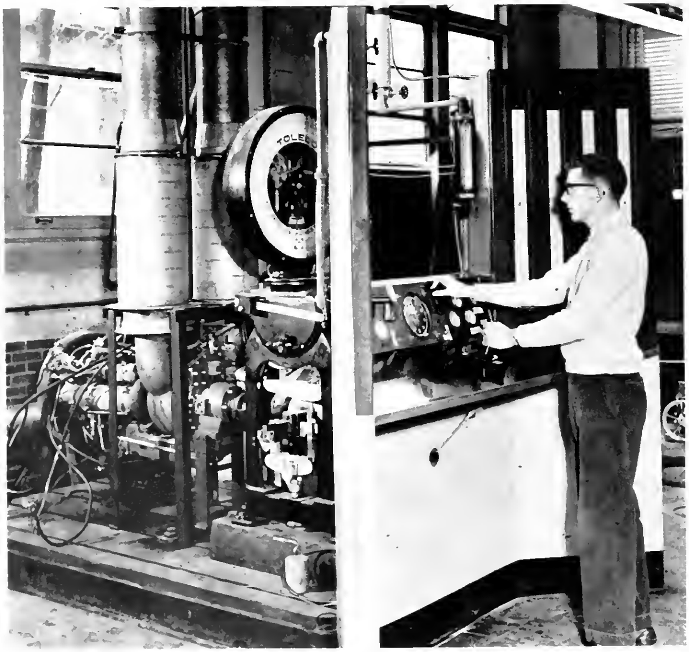
This is part of the exhibit on protective equipment for personal safety in industry.

MECHANICAL ENGINEERING

This year, as in the past, the Mechanical Engineering Department will feature demonstrations and tours of its laboratories and equipment. During the time a student spends as an undergraduate in Mechanical Engineering, he will at one time or another operate many of the different pieces of equipment that are on display. These machines will give the undergraduates some practical experience in the application of the theory that he receives in the classroom.

In the internal combustion laboratory, a visitor will see diesel, gasoline, and gas turbine engines mounted on test stands. The performance characteristics of these engines can be found by much the same procedure as is used in industry. The gas turbine only recently installed, may be of interest because much work is being done in industry and here at the University with idea of applying it to passenger cars, busses, trucks and other vehicles.

In the heat treatment of metals laboratory, you can see how steels can be treated in different processes to obtain a variety of desired physical properties. Under microscopes the different structures and components in treated steels can be observed and studied. The high temperature electric and gas furnaces here are similar to those used in industry but on a smaller scale. The metal working laboratory will give you a chance to see many of the various machine tools used in metal cutting such as lathes, mills, grinders and planers. Also there will be demonstrations of research and student experiments in metal cutting and tool problems.



A student is shown conducting a performance test on a gas turbine in the Internal Cambustion Laboratory. This is only one example of the displays which visitors may observe at Engineering Open House.

A welding laboratory will be open with demonstrations of various welding techniques given by students.

In the mechanical engineering laboratory various forms of steam equipment such as turbines and engines will be on display. Also air compressing units, centrifugal fans and air conditioning equipment will be in operation.

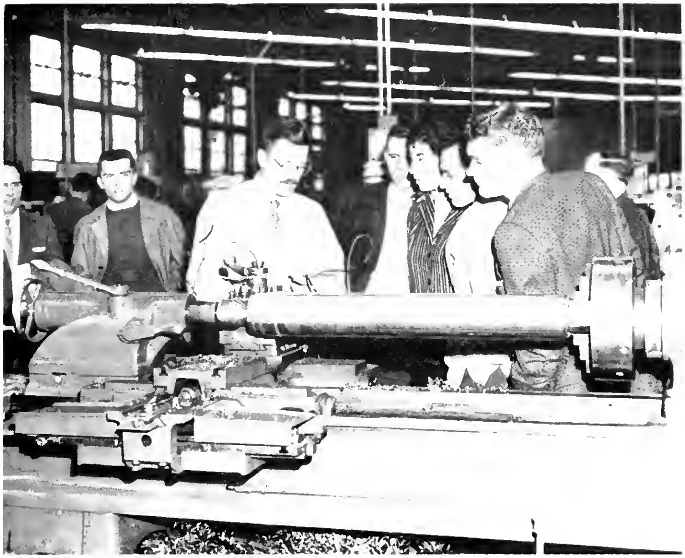
In the foundry, there will be demonstrations of the steps required in the making of castings. The making of molds, cores, and the pouring of metal can be seen here also.

The mechanical engineering student honorary, Pi Tau Sigma, will prepare an exhibit which explains the mechanical engineering curriculum. Some textbooks used by the student and a complete list of the courses of study will be found in the Mechanical Engineering Lounge.

There are many fields open to graduates in mechanical engineering and the student branch of the American Society of Mechanical Engineers will have a display to show some of them.

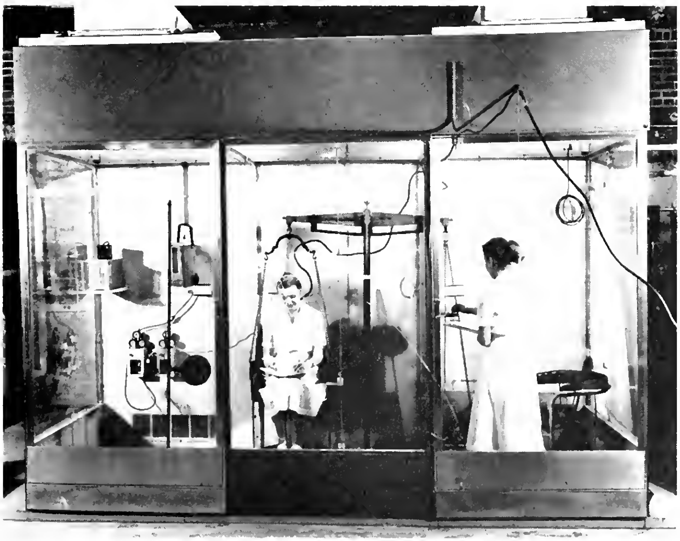
A new display this year will be the physical environment laboratory. Here you can see the equipment and techniques used in research on the effects of temperature and relative humidity on the comfort of humans.

There should be many things that you will find of interest in the Mechanical Engineering Department and we hope you can take advantage of this year's Open House to see them.



Professor Turkovich demonstrates some of the equipment used in metal cutting research to a group of interested visitors.

Professor E. L. Broghamer instructs a Mechanical Engineering student in the use of an analog computer to solve a problem in stress analysis. This machine will be on display during Open House. →



In this "isolation" booth humidity and temperature are controlled so that human comfort in relation to types of clothing and atmospheric conditions may be studied.

METALLURGICAL ENGINEERING

Of the 98 naturally occurring elements, 70 are metals. The metallurgical engineer is concerned with metals, and he has a large storehouse to work from. To date, the metallurgist has found commercial uses and applications for less than half of these 70 metals, so he has a long way to go. But he has progressed far in many fields of application of metals. For example, titanium was very precious 15 years ago but today it is used commonly in aircraft. Metallurgy has progressed remarkably for the short time it has been in existence but there are many avenues open for investigation. Metallurgy, now a basic science consisting of mathematics, chemistry, and physics, is concerned with two main purposes—the procuring and adaption of metals to satisfy human wants.

The Open House exhibit for the Metallurgical Engineering Department has increased the number and scope of exhibits this year in order to show the major areas of metallurgy today, and to show some recent advances in the field. Our displays this year will show how metals are extracted from their ores, how they are cast, how corrosive conditions affect them, how temperature affects them, and how they are formed by mechanical means. The total number of exhibits this year is twenty; they are briefly described below:

Steelmaking Exhibit: This display shows steel production from sources of ores to finished products.

Metal casting: Aluminum ashtrays will be cast at periodic intervals and will be distributed to visitors.

Metals Under the Microscope: This display shows what some of the more common metal products look like under the microscope. It also shows the steps necessary to prepare a metal for observation under the microscope so that its structure can be determined.

Photography in Metallurgy: Photographic equipment is used in metallurgy to get permanent records of metal structures. Some examples are shown.

Thermocouple Demonstration: This display shows how temperatures can be measured by means of a combination of two dissimilar metals.

Phase Changes in Steel: Phase changes in steel are shown by expansion of a specimen as it is heated to high temperatures.

Heat Treatment of Steel: This display shows the changes in properties of steel as it is subjected to high temperatures and different cooling rates.

Cold-Cadmium Robber-like Alloy: This display is an example of one of the research projects in progress in the Metallurgy Department. The alloy displayed can be made to behave like a piece of rubber or like a piece of putty.

Crystal Models of Metals: Atoms are arranged in metals to form various crystal structures. Many models will be shown.

Galvanic cells: The four displays are all examples of electro-metallurgical phenomena and show the relationship between electricity and metals, corrosion in action, electroplating, electropolishing.

Metals quiz: The visitor trys to match the correct metal with a certain property or application, and can determine his metal I.Q.

Display of metals: This is a new display this year which shows over forty of the metals in use today along with their price and relative abundance.

Question and answer booth: Here the visitor can obtain literature and answers to questions about specific displays and metallurgy in general and the educational opportunities at the University.

Movies: Three or four short duration films about metallurgy will be shown.

Rolling mill demonstration: This display will show how metals are reduced to foil.

Brittle fracture in metals: This is a new display which will show the effect of temperature on the impact strength of steel. A steel will change from a ductile to brittle nature as the temperature is changed a few degrees.

Zinco—the wonder metal: This display shows how a metal which has been quenched in cold water heats up again in a person's hand.

These processes and phenomena are understood by the metallurgical engineer to some extent, but there are many answers that are still needed. To obtain these answers much research has to be done. Some important questions which are outstanding today and which are receiving attention through department research investigations are:

Why do some metals and alloys undergo an abrupt change from ductile to brittle behavior over an extremely small temperature interval?

What effects will irradiation such as that from a nuclear reactor have on the properties and life of a metal?

What is the mechanism by which alloys such as steel are hardened?

How do high temperatures, such as those encountered in missiles, affect metals and alloys, and how long will materials last under these conditions?

How can one predict the behavior of alloys from a knowledge of their pure components?

What can be learned about metals and alloys by examining them under the optical and electron microscopes.

How does continuous stressing such as that occurring in automobile axle affect the properties and life of a metal?

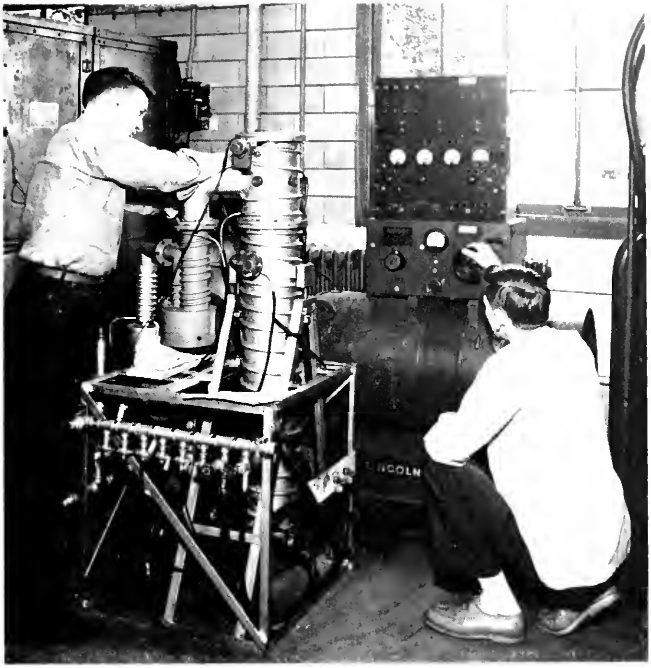
What is the mechanism through which metals are attacked by corrosion? Why do metals become harder when they are deformed?

Are there better processes for refining and producing metals more economically?

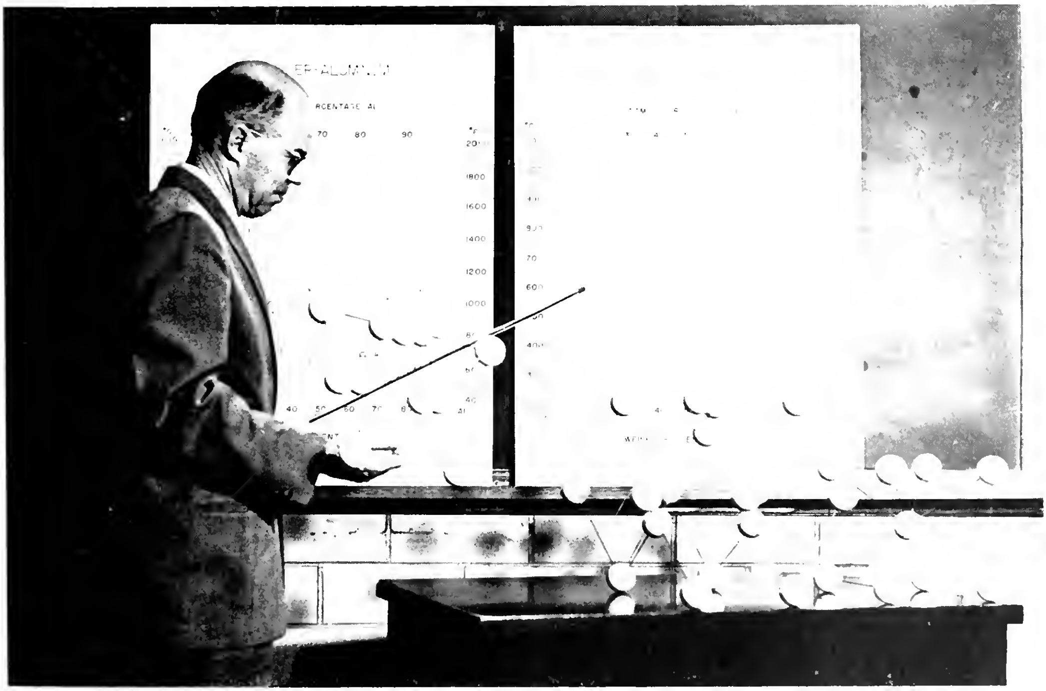
These problems are but a few of the ones now confronting the metallurgist in his work. In time, these problems will be solved, but new ones will continually arise. The metallurgist therefore must always be around to solve these problems; but, more important, he is needed to produce and adapt metals for today.

In our exhibit we are attempting to show metallurgy today—what the field encompasses and what the function of the metallurgical engineer is. We also are going to give the public a glimpse into the future of metallurgy.

The present-day opportunities in metallurgical engineering are practically limitless. The field of metallurgy is wide open and in great need of trained personnel. Adequate and extensive training in metallurgy and metallurgical engineering is available at the University of Illinois and many other colleges and universities. Metallurgy is a field where one can engineer and utilize his creative ability to the fullest, and find extremely interesting and satisfying work.



Students adjusting high vacuum furnace in metallurgy laboratory.



Shown above is a teaching model which is used to illustrate the crystalline structure of the atom array in copper-alloys.

MINING and PETROLEUM ENGINEERING

Mining Engineering

The history of the mining engineering curriculum dates back to the beginnings of the University of Illinois. The initial report of the Committee on Study of Course and Faculty provided for courses in mining engineering. However, there was little mechanization in mining then, and mining engineering education was slow in catching on. It was not until the beginning of this century that the Department of Mining Engineering was re-established by action of the General Assembly. A newly constructed mining laboratory was occupied in the fall of 1912. Compared to other departments in the College of Engineering, the Department of Mining has remained relatively small with the advantage of small classes and close contact between instructor and students.

Mining engineers are engaged in producing and processing primary wealth from the earth's crust and as long as industry uses minerals to manufacture everything from nylon stockings to atom bombs there will be careers for engineers in the mineral industries. About 1/10th of all gainfully employed persons in the United States are connected with the mineral industries. Many foreign enterprises are staffed by engineers trained in the United States, and they add greatly to these figures.

Mining engineers are concerned with finding mineral deposits containing fuels, ores, and non-metallic minerals for the building and for the chemical industries. The first steps are to explore the size and to evaluate the richness of such finds; to determine whether profitable mining is possible, and to choose a method for extracting, recovering, and treating the mineral. Engineers also design and select the processing equipment, purchase components and supervise the erection of the plant, and operate both the extraction and treatment facilities.

A surprisingly large percentage of mining graduates enter the administrative and marketing phase of the mineral industries. Others occupy themselves in related fields—production and use of explosives, the manufacture, sale, and servicing of equipment such as crushers and grinders, drills, hoists, cutting and loading machines, mechanical miners pumps ventilating fans, locomotives and mine cars or belt conveyors, and safety equipment.

Some mining men, of course, cover the whole range of this kind of activity, while others confine themselves to a single aspect or specialty. Other people, who work most closely with mining engineers are geologists and geophysicists, civil engineers, chemists, eletrical and mechanical engineers, and finally metallurgists.

The Mining Department of the University of Illinois has all the facilities to prepare the student for the work basic to his profession, but this is by no means the only work.

There are other areas of instruction for the graduate student working toward his master's or doctor's degree. This phase is closely related with research in mining, which often is carried out in cooperation with other agencies on the campus such as the University of Illinois Engineering Experiment Station, the State Geological Survey, and others. Students from all corners of the globe come for advanced work in the Mining Department, which has a worldwide reputation. Research is done in many areas of mining. In geophysical prospecting, such physical characteristics of rock as gravity, magnetic attraction, resistivity to electric current, radioactivity, and speed of transmitting vibrations are a few of the things which can be measured accurately by delicate instruments. Measuring the speed with which vibrations are transmitted through rock strata, has been particularly successful in locating oil-bearing formations thousands of feet below the earth's surface.

Some fundamental research in a completely new field called "rock mechanics" tries to find out what happens to rocks when drilled, blasted or crushed and ground as in preparation plants. Drilling research ranges from blasthole drilling to oil well drilling to tunnel boring machines and continuous miners. In blasting research, the blasting effect of commercial explosives is investigated to determine the useful energy formed under controlled conditions.

Closely related is the study of the failure of mine roof and of mine pillars, and the design of underground openings to make them safe.

In the field of mine ventilation, electrical and anemometric gages for the measurement of the flow of air in closed ducts have been developed. Methods for economically reducing air losses in mine ventilation are studied.

Another wide field of mining research is in ore beneficiation and coal preparation. Latest work deals with the utilization of Illinois coal, its adaptation for making metallurgical coke, etc.

In mine administration the use of modern statistical concepts and the applicability of mechanical and electronic computers is being investigated.

Examples of the work done by the mining department at the University will be on display in the Mining Laboratory and in the Ceramics Building during Engineering Open House.

Petroleum Engineering

Oil and natural gas occur filling the pore spaces of various sedimentary rocks usually at considerable depth, and frequently in association with "connate" water.

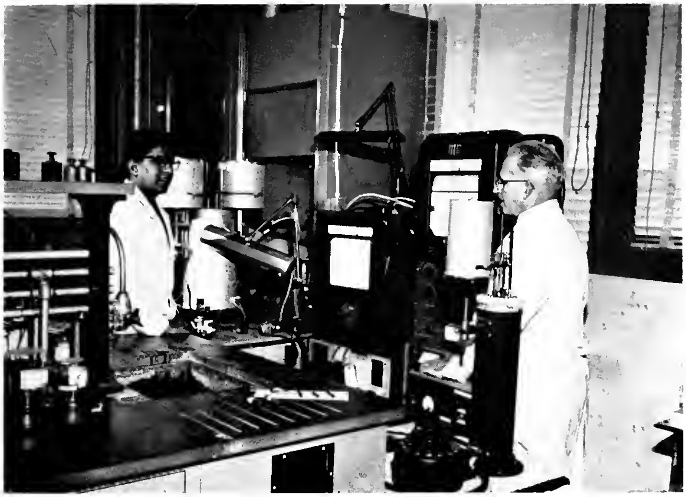
Petroleum engineering is concerned with the problems of drilling wells to the oil bearing horizons and then getting the oil (or gas) from these beds to the surface. Actually it is difficult to recover more than about 50% of the oil originally in the rock and in many instances as much as 80% of the oil originally present may be left in the reservoir at the end of the primary production process. Much of the current research in petroleum engineering is concerned with ways and means of increasing the total yield of oil by the use of "secondary recovery" methods. Confronted with the two possibilities of increasing oil production, either that of finding new fields, or that of getting more oil out of known fields one can see that the latter is the more attractive proposition since naturally the more easily located oil has already been found (and produced and sold) and exploration is becoming both more expensive and more difficult.

Of the secondary recovery methods now in use, that of "water flooding" is widely used in Illinois (as well as other states); in this method water is pumped through an injection well and as it sweeps through the reservoir rock to the producing well it pushes oil ahead of it. The amount of extra oil that can be recovered by this method depends on quite a lot of factors, for example whether the oil or the water wets the rock surface, very extensive research is being carried out in both university and industrial laboratories on the question of increasing yields from water floods.

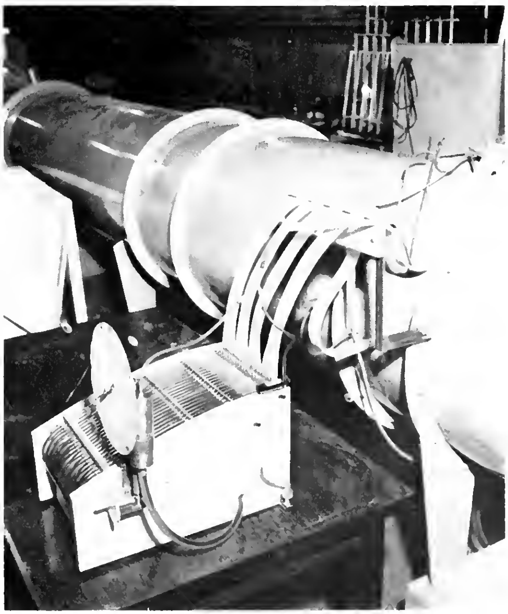
A more recent and very attractive method of increasing oil production by secondary recovery methods is that of the "fire flood" whereby oil is ignited underground so that by burning some of the oil the rest is heated and driven towards the producing wells. The heated oil flows more freely since it is more fluid when hot, and the gases produced during the combustion act to drive this heated oil out of the reservoir.

Another source of supply for oil lies in possible fields located at great depths below those currently known, the problems of drilling to these great depths include the behaviour of materials at the high temperatures and pressures such as exist deep in the crust.

The Open House exhibit will illustrate methods of determining how well the oil flows through a rock, how much is in the rock, how "electric logs" can tell the content of oil and water in the formations at depth, and methods of displacing oil by water and gas.



Graduate laboratory for Mining Engineering students.



New type velocity guage used for measuring ventilation currents. Specifically, this instrument manometrically takes the square root of 20 numbers, averages them, and multiplies the result by a constant depending upon the psychrometric condition of the air. This guage was developed in the mining department.

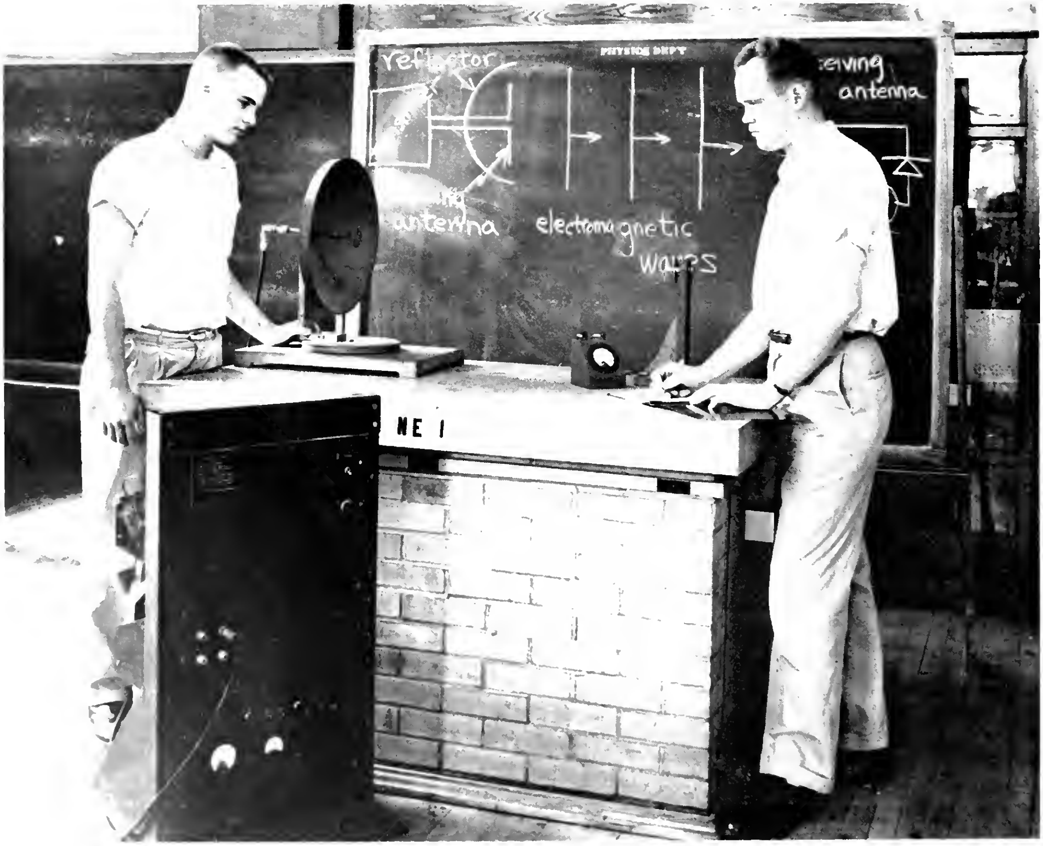
PHYSICS DEPARTMENT

During the 1960 Engineering Open House physics students will demonstrate some of the equipment used to teach physics at the University. These exhibits will be located on the first floor of the physics laboratory.

Room 100 will be devoted to the subject of mechanics, which describes the motion and behavior of bodies as small as nuclear particles and as large as the stars. In the past few years, the news of earth satellites and missiles have made us more conscious of the laws of motion and have given us popular examples of bodies which continue to move indefinitely in the absence of friction. These laws have always been somewhat unsatisfactorily illustrated in the classroom because the drag of friction slows things down. New apparatus used by the physics department makes use of thin films of gas as bearings of such low friction that the motion is almost undisturbed. No longer does the teacher have to make excuses for discrepencies between theory and experiment because of annoying friction.

New demonstrations this year, also in room 100, include a small model merry-go-round which illustrates some interesting properties of circular motion and an apparatus which demonstrates the laws governing projectile motion and ballistics.

Exhibits of high and low temperature phenomena will catch the interest of visitors entering room 112. A new geyser has been made of glass so that one can see more clearly how this interesting phenomenon takes place. Other exhibits include tanks of liquid nitrogen used to show what happens to materials



Two students study the phenomena of sending and receiving electro-mognetic waves at very low temperatures. One example is a lead bell that rings, but visitors will have to stop in to learn about the others.

The nuclear physics exhibit this year will be located in room 112 and will include a model of the famous "Van Allen Belt" of radiation high above the earth. The production and detection of cosmic rays and radioactivity will also be demonstrated.

A series of demonstrations pertaining to the field of optics will be located in room 119 of the physics laboratory. These will include a smoke box demonstration of geometrical optics, demonstrations of wave motion and interference, and the Land two-color process of photographic color reproduction.

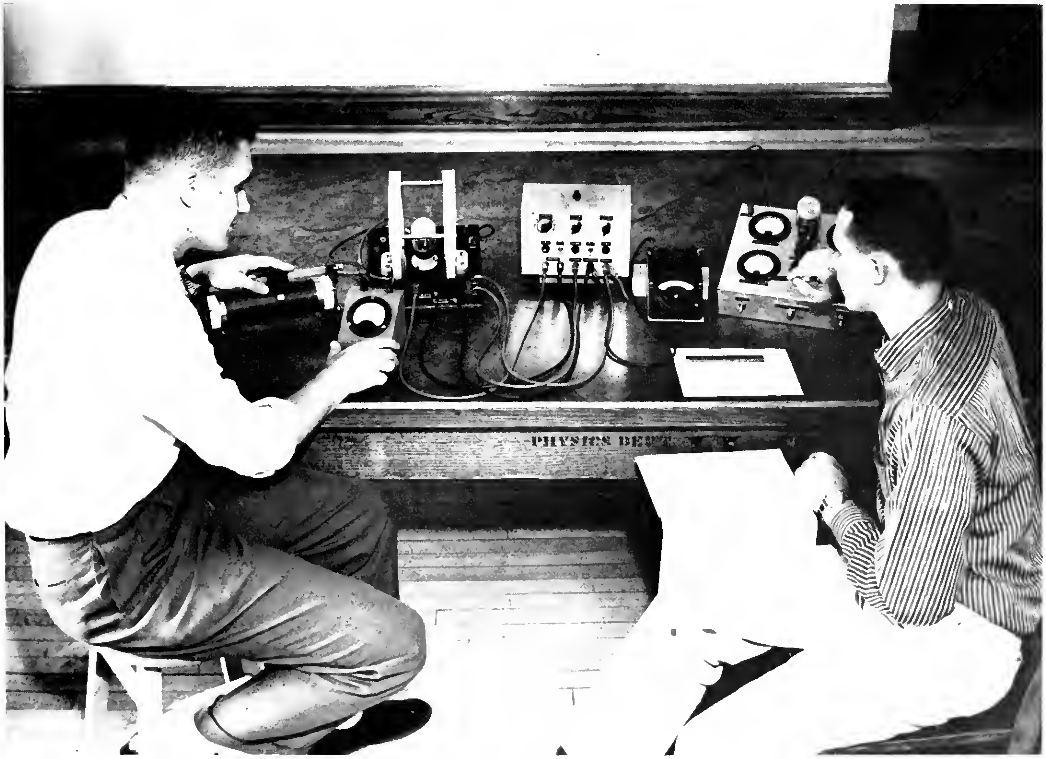
Geometrical optics, including the study of simple and complex lenses, can be demonstrated quite clearly with a smoke box. A smoke box consists merely of a reasonably air-tight container with one side made of clear glass. Some sort of smoke generator is used to fill the volume of the box with smoke. Since the smoke particles reflect light, thin rays of light propagating through the box can be seen throughout their entire length. Several of these smoke boxes will be on exhibit during the Open House. Lenses of various sizes and in combinations of two or more will be used to show how light rays are refracted and focused. One of the smoke boxes will have a small container of water inside it. Beneath the water surface, a source sending rays of light at various angles will show the effects of refraction on the rays at the interface of water and air.

Demonstrations of wave motion and interference will include diffraction gratings, the Michelson interferometer, and the Fabry-Perot interferometer.

The Land two-color process of photographic color reproduction illustrates some interesting facts about the eye and how we see colors. It was previously thought that three colors called the primary colors are necessary to form complete color. Recent experiments by Edward Land have shown that the eye does not need three colors, but that only two are necessary for full color images to appear. By simultaneously projecting on a screen two carefully prepared black and white transparent slides, each through different color filters, a full color image appears. This process will be used to take two photographs of a group of colored objects and, shortly thereafter, demonstrated that full color is obtained by projecting the slides on a screen.

The cyclotron, housed in the nuclear radiation laboratory, will be open to the public this year. The cyclotron and other experimental apparatus in the lab are used by graduate student sand faculty for experimental work in nuclear physics.

The betatron research and development program is housed in the physics research laboratory. The staff of the lab, as in past years, will conduct a guided tour of the building. Faculty and graduate students at the lab are engaged in the study of nuclear phenomena produced by X-rays and electrons from the 340 MEV betatron and the 22 MEV betatrons.



Engineering sophomores in a physics laboratory determining the relation between the charge and mass of an electron by measuring the deflection effects of electric and magnetic fields on a beam of electrons in a vacuum tube.

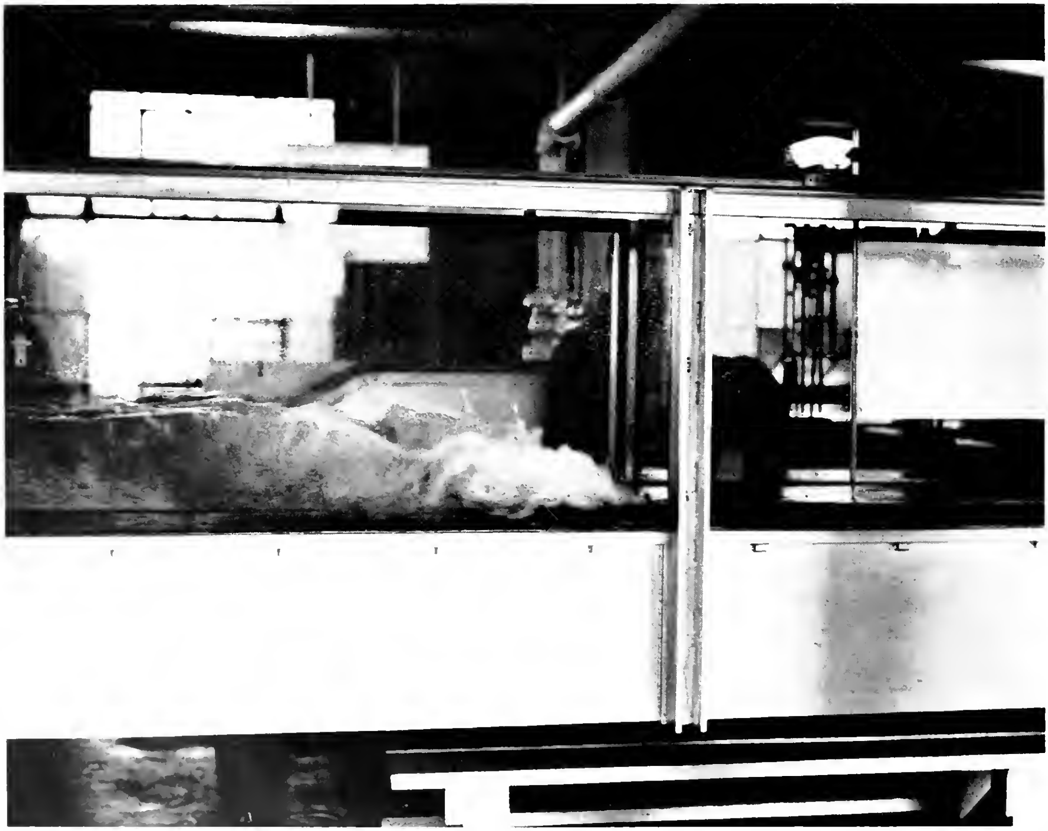
THEORETICAL AND APPLIED MECHANICS

This year the displays of the Department of Theoretical and Applied Mechanics, located in Talbot Laboratory will include the demonstration of a current research project which studies the behavior of a missile as it leaves water and enters the air. As the missile leaves the water it is photographed by a movie camera, and by analyzing the photographs the action of the missile can be determined. This display will be presented in the basement of the fluid mechanics laboratory every hour on the half hour.

In the crane bay a three story tall testing machine will be used to fracture large concrete cylinders. These cylinders usually tax the machine to almost its full capacity of 3 million pounds load. When fracture does occur, it happens with explosive quickness resulting in an exciting spectacle. The demonstration of the machine will occur every hour on the hour.

On the west end of the first floor of the building the entire fluids laboratory will be open to visitors. Some of the many operating displays in fluid mechanics will be water turbines, a pump that carries water from the basement to the first floor by means of water clinging to a rope, and the hydraulic jump (where flowing water suddenly jumps from fast, shallow flow to deep, slower flow in order to overcome resistance in the chanel).

On the second floor of Talbot Laboratory, exhibits will show methods for determining the mechanical behavior of solid materials. By allowing polarized light to pass through a clear plastic specimen and observing the resulting fringes of color, the distribution of stresses in that specimen can be obtained. This useful method, call photo-



A hydraulic jump occurring in a glass-sided flume located in Talbot Laboratory.The hydraulic jump is an important phenomenon since, as indicated, the extreme turbulence will erode a stream bed where it occurs. Spillways of dams and other hydroulic structures must, therefore, be designed so the jump appears in a concrete-lined section of the channel.

elasticity will be demonstrated along with the uses of sensitive strain gages which indicate by electrical means how much a specimen has stretched. These gages are so sensitive that they can detect the stretch in a 3 inch diameter brass bar 3 feet long when it is touched by your finger. Also shown, will be examples of mechanical vibrations. When a machine such as a car engine undergoes sudden loads mechanical vibrations result. Modern vibration measuring instruments and models which demonstrate a few of the basic ideas in the study of mechanical vibrations will be in the display. Tests showing the behavior of steel bars when they are pulled in tension and twisted in torsion will be performed continuously during the Open House. In the torsion test the visitors may actually run the test by cranking an arm which twists the steel bar through a gear reduction. Many people are surprised when they see how many times a steel bar can be twisted around before it breaks. A machine which tests small concrete cylinders in the same way as the big machine in the crane bay will be operating and there will also be a machine which demonstrates the effect of high temperatures on steel under load.

The third floor of Talbot Laboratory contains the fatigue of metals laboratory. Here, actual research projects which study the effects of repeated loading and fracture of metals will be shown. One of the research projects now in progress is concerned with the behavior of the metal in the Polaris missile.

This concrete cylinder has just been shattered by the 3 million pound testing machine whose base is shown at the right.

ENGINEERS IN THE ARMED FORCES

Army Ordnance Carps

The role of ordnance will be portrayed in the exciting exhibit which the Army Ordnance Corps has prepared for this year's Engineering Open House.

Displays which will exhibit the Army's achievements over the past years will include models of Nike anti-aircraft rocket installations. The Nike-Ajax is deployed all over the country today.

There will be mock-ups of the Army's satellite-carrying missiles, and back on the earthy side, we will display the complete line of close support missiles which are used in the field today. Other weapons on display will be the "81" and the "57" mortars and a variety of small arms.

Models of the new Army weapons will be available, together with an explanation of the engineering which goes into their design.

You will also have an opportunity to hear of the many advantages of a career in the U. S. Army. There will be skilled personnel on hand to answer any questions you may have.

Be sure to visit the Army Ordnance display when you come to this year's Engineering Open House. Your visit should be entertaining and enjoyable.

Signal Corps

In the new concept of Atomic Warfare, the United States Government relies on three principles to enable it to defeat the enemy. These are mobility, firepower, and communications.

The main responsibility for communications rests with the Signal Corps. To implement its goal of a solid net of mobile communications covering any size unit of troops in an area, the Signal Corps and civilian manufacturers have developed a number of specialized pieces of equipment. A few of these means will be on display at the 1960 Engineering Open House to give spectators a small view of some of the equipment necessary to complete the needed communications of the Army.

Several radios will be set up so the spectators can operate them and get a better knowledge of the equipment used by the service. The best known is the small individual set called the AN PRC-6 or "walkie-talkie." In addition to the "walkie-talkie's" capability of being easily carried and operated, it can, if necessary be used to broadcast teletype signals as will be done at Open House. This particular set-up is not normally used by the Army; however, it is typical of the usefulness and versatility of government equipment.

In contrast to the small one-man radios shown, several large, multi-unit radios, normally set up in trucks, will also be on display. These will be tuned to local commercial stations to show that military radios operate on the same principle as do civilian radios. The rugged construction and other special devices will show the difference between the two types. Military radios both broadcast and receive. This is but one facet of their versatility.

Although radio is the primary means of communications other supporting means are necessary. This includes wire communication composed of telephone and teletype.

Several teletype machines will be on display. Spectators can send and receive between two of these. This will demonstrate its speed and usefulness. Another set will receive a national press news service to show again, the similarity to civilian installations. This wire equipment is generally more stable than radio but is not as mobile.

Other wire equipment to be shown include telephones and switchboards.

Some other equipment widely used by the Signal Corps, but not shown, will be long range telephone and radio equipment, photography, television and electronic computers.

Speedy, reliable communications is a must for a modern army. The Signal Corps provides this with fast, accurate equipment employed in highly mobile situations.

Army Engineer

The mission of the infantry division engineer battalion in the attack is to assist the forward movement of the division by general engineer work. The disposition of all available engineer troops and equipment, both organic and supporting, is determined by the division engineer to accomplish this mission according to the scheme of maneuver established by the division commander.

The engineers accomplish this by performing various duties during the attack. Some of these general duties are: engineer reconnaissance, collect data for improvement of existing maps, removal and construction of obstacles, maintenance of supply routes and lines of communication and the construction and maintenance of bridges to be used during the attack. It is the division engineer's responsibility to see that there are engineer units with the front, flank and rear guards.

The location and maintainence of the main supply route (MSR) is another important duty of the engineer. Supply routes must be kept open at all cost to maintain the forward motion of the attack. These routes must be kept clear of mines and also road work must be done to keep the routes in shape for their intended traffic. Also the engineers are responsible for the supply of water.

The engineer is responsible in transporting troops across rivers. This is accomplished by means of assault boats, foot bridges, ferries, and bridges. Careful planning must go into river crossing operations and the engineer plays one of the more important parts in these operations. Planning may be started 50 miles before the river is reached by the attacking force.

The engineer is an important factor in the attack whether his job is removing obstacles in the advance or constructing obstacles in the retreat. Much of the success of the attack depends upon the engineer's accomplishments.

NROTC

The U. of I. NROTC's exhibit for the 1960 Engineering Open House is located in rooms 152 and 154 in the Mechanical Engineering Building, first floor. Consisting mainly of displays concerning deelopments in aircraft control, guided missiles and missile guidance, and Naval ordnance, the exhibit represents many of the latest advancements in naval warfare.

A moving cockpit simply demonstrates manual aircraft attitude control. Visitors may sit in the cockpit and move the control stick, which actuates servos that cause the cockpit to pitch and roll realistically. The device is similar to a Link trainer, but less complicated.

A small-scale skeleton aircraft frame is mounted with a spinning gyroscope connected to its control surfaces. The frame is pivoted and may be easily moved to show the movements of the control surfaces caused by the gyro. The display's purpose is to demonstrate the principles of gyro control in aircraft.

A continuously - running projector shows a sound film on the Sidewinder, one of the Navy's new air-to-air missile. The film is in color, and explains the guidance principles of the heat- seeking missile. The Sidewinder is shown in flight, and runs on target drones.

Numerous static displays feature new developments in Naval Ordnance, and include models of the *Nautilus* and the *Patrick Henry*, a new ballistic missile submarine. Also shown are scale cutaways of mines, bombs, depth charges, and a new torpedo employing a homing device to actually hunt its target.

Midshipmen will be on hand to conduct the exhibit and answer questions.

ANOTHER WAY RCA
SERVES BUSINESS
THROUGH
ELECTRONICS

Princeton, N. J.: Today the area around this historic educational center is one of the country's foremost communities of scientific research.

RCA Electronics helps build a new capital of science at Princeton, N. J.

Explorers once looked for new opportunities beyond the mountains and the oceans. Today, our frontiers are somewhere out in space or deep inside the atom. The modern explorer is the research scientist. He seeks new ideas, new knowledge.

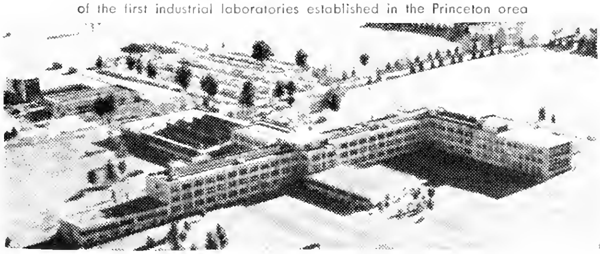
Research has been an important activity at RCA ever since it was founded in 1919. And eighteen years ago many scattered operations were united in the RCA David Sarnoff Research Center, which set the pattern for a new capital of industrial research at Princeton, N. J. Here, RCA provided gifted men with fine facilities—and created a climate in which research thrives. Since then, many other institutions dedicated to research in a variety of fields have been erected in the area.

From RCA's vision has grown a reservoir of scientists and research men whose achievements put electronics into service on an ever-broadening front, and with such success that RCA means electronics—whether related to international communications, to the clearest performance of television in color or black-and-white, radio and stereophonic music or to national defense and the electronic conquests in space.

RADIO CORPORATION OF AMERICA

RCA

The RCA David Sarnoff Research Center, dedicated in 1942, was one of the first industrial laboratories established in the Princeton area



—Photos by Dave Yates

technocutie . . .

BARBARA KOZUB

January's Technocutie belongs to the engineers at the University more than any other Technocutie in a long time. Barbara Kozub, majoring in Industrial Engineering, is a junior at the University. Called Bobbie by her friends, she says she picked engineering as a career because it was a challenge. Barbara says she wanted to be in the business field, but liked the combination of business and science that industrial engineering offers. To her, the field offers a right balance between the two.

When Barbara graduates, she would like to work in a big plant (preferably one in chemicals, foods or clothing) and do production supervision. She says she wants a lot of people around her all the time to work with as well as doing engineering problems.

Barbara says the students she works with all seem polite and lots of fun; they are very friendly, rather nice and mannerly. She says she doesn't know what they think about having a girl in their classes, but outwardly they are friendly. Teachers' attitudes vary, Bobbie says. Some of them are wonderful towards a girl; others will try to embarrass a girl; and still others just ignore her. Most of them she feels are very good, however.

Industrial engineering courses, economics and physics are Barbara's favorite courses although she admits physics 106 was hardest for her. "The subjects best liked and hardest sometimes go hand in hand." Barbara enjoys the challenge of tackling a hard course. She admits she often lets an easy course slide and therefore gets the worst marks in them.

Bobbie is one of the women trying to get the Society of Women Engineers started. She is chairman of the group who are trying to get more women engineers interested in the society. The girls also plan to write to high school girls who write to the Dean of Women about engineering, and they will tell them the advantages and disadvantages of engineering for women.

Although she doesn't have much spare time in the school year, Barbara is also a freshman advisor at LAR and a member of SIES. She says she likes to listen to Johnny Mathis, Doris Day and instrumental mood music to relax. She does not like modern jazz.

She admits she likes food: salads, fried chicken, steaks and chops well done top her list. She prefers coffee or cokes to beer.

Barbara's pet peeve concerning men is the conceited variety, the egotistical men not interested in others. She thinks people on the whole should be interested on others, as she herself is interested in people.

Another of Barbara's peeves are people who let themselves be dominated by social pressures of campus life and who don't relax and act natural. She feels engineers are more sincere than some of the men on the other side of campus.

If she could be doing anything she wanted, Barbara would like to be working at an interesting job where she could serve a useful purpose and have lots of friends and work with a lot of nice people.

Ageneral education is important for engineers, Barbara feels, because everything an engineer does take is technical and not all of it is necessary. She wishes it were possible to substitute LAS courses for these. She feels most engineers know where they will major and therefore some of the courses could be more general.

Bobbie is not sure just where she will be working in Open House, but she will be helping in some industrial engineering display. She thinks Open House is good each year. She says it is possible to learn more in one day of Open House than in one year of classes. A student there can see what courses he will be taking will be like and what other engineers are doing.

About the idea of a stereotyped female engineer, big and muscular, Barbara says the girls in the Society are sharp, and that type of woman can be found in any field, not just engineering.


PORTER

Tau Beta Pi Essay . . .

The Responsibility of the College

By Richard W. Sievers

Today's highly trained space-minded engineering student receives an education that equips him to live in a functioning society composed principally of technicians or other engineers. He is completely at home in a conversation encompassing such topics as Newton's Equations, Ohm's Law, Kirchoff's Law and a host of other allied subjects that are of interest mainly to other engineers. His only hope of surviving a conversation in a mixed group containing non-engineering students is for him to shift or limit the discussion to areas in which he may make knowledgeable contributions. These areas are admittedly small. They do not usually include such topics as art, music, literature, or in many instances, even current events. His political knowledge is chiefly composed of tinted accounts that appear in local newspapers telling of the exploitation of the public or crafty politicians.

From these observations it would seem that the engineering student is not receiving a sufficiently broad education while at school. It would seem that his technical education, either by his own choosing, or by college requirements, should be augmented by a greatly increased amount of subjects in such fields as Economics, Political Science, Art, Literature, Music, and the Humanities. It should be the responsibility of the college to insure that the engineer, at the time of his graduation, is fully qualified to meet his own responsibilities to society.

The engineer has a two-fold responsibility; to industry, and to all forms of government from the local to the national level. The foremost of these is probably to industry. It is here that the skills and talents that have been developed in our engineering schools are called upon and have been proven adequate. The engineer could not help in producing the maze of complicated hardware and gadgetry that has become the stock-in-trade of American engineering. His productivity is second to none. He seems to have an infinite capacity for finding the solutions to a great variety of difficult problems.

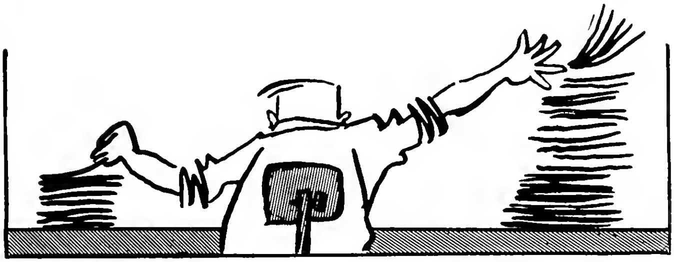
One of the major problems facing the engineer is one that has confronted him ever since the invention of the first wheel. This problem is the control, for useful rather than destructive purposes, of all of the findings and creations that evolve from the ingenuity of engineering. With the advent of blasting powder, man was able to increase his productivity by having the powder with which to clear land. His ability to destroy was also increased by the application of this power to muskets and cannons. The Industrial Revolution produced new production machines which we consider to be indispensible to our present way of life. Mass-production, made possible by mechanization of the industries, has allowed the production of merchandise to be of such a volume that an abundance of goods and services are available to everyone. These same mass production methods are also used to mass-produce rifles, bullets, tanks, planes, and even warships. This again brings with it the problems connected with control.

These same problems of control are experienced when the engineer meets his second responsibility; that responsibility that is directed toward government.

With the ratification of the Constitution of the United States in the latter part of the eighteenth century, the citizens of the United States were granted the privilege to choose, through elected officials, the governmental policies to be followed. This same process of choosing those to represent us in the government by free elections is still followed today. It is up to the individual to become familiar with the mechanics of our government and to give support in order that our government may be truly the "People's Government." The community leaders, who may well be engineers, must be people who are educated in the functions of good government. It is up to all individuals to realize the full importance and necessity of having a multi-party political system with full-time politicians to operate them. It is, however, up to these same individuals to determine the capabilities and potentialities of these systems and politicians, and to offer their support and leadership to insure their election. It is up to the engineer, as a community leader, to arouse community interest and to provide community leadership in order that the control of the government be in the hands of all people.

In order that the engineer may have the ability to provide adequate leadership, he himself must first have been schooled in governmental theory. This can most easily be effected by a furtherance of his college training. Yet, the engineering student is granted only a minimum of time that he may devote to non-technical subjects. Is this fair to either the student or to the community in which he later lives? Should not the colleges recognize that this facet of an engineering student's education is also important and initiate measures which would correct this condition? Even though the student engineer, offered lucrative starting salaries in industry, will not of himself take the extra time to fortify his education with more non-technical subjects, the educational institutions must insist that this be done. They should require non-technical courses to insure that the engineering student, as a potential leader entering into community activities after graduation, be qualified to offer guidance and leadership in order that our government "of the people" may continue to be just that.

Skimming Industrial Headlines



Edited by Paul Cliff

New Stereo Speakers

Four new General Electric "Stereo Classic" speakers have been introduced by the audio products section of the Company's radio receiver department, according to an announcement by S. J. Welsh, marketing manager for audio components.

Model 1201B, a 12-inch wide-range speaker priced at $19.95, will serve as an effective economical basic speaker for any stereo or monophonic high fidelity system. It has a recommended amplifier rating of 5-25 watts (continuous power rating), frequency response of 48 to 13,000 cps, power rating of 25 watts, and Alnico 5 magnet weight of 14.5 ounces.

Also priced at $19.95 is the Model G-504 tweeter speaker, a 2¾-inch direct radiator tweeter speaker, styled for surface mounting if desired. It provides maximum dispersion of high frequencies in all directions for truer stereo effect, with frequency response of 1200 to 16,000 cps. Model G-504 has a 100-degree dispersion, both horizontally and vertically, power rating of 30 watts, and Alnico 5 magnet weight of 6.8 ounces.

Model G-502 dual-cone 12-inch speaker features a specially treated cloth edge suspension for improved low-frequency response with greater linearity and new binding post terminals for easy connection. It has a special auxiliary "whizzer" cone for high frequency performance and a recommended amplifier rating of 5-25 watts (continuous power rating). Model G-502, priced at $34.95, has frequency response of 30-16,000 cps, power rating of 25 watts and Alnico 5 magnet weight of 14.5 ounces.

Priced at $59.95 is Model G-503, a dual coaxial 12-inch speaker, with specially treated cloth edge suspension for better low frequency response plus a new combination electro-mechanical and L-C crossover network for smoother transition. An extra-long aluminum base voice coil provides greater linearity and fine tone under varying climatic conditions. With a recommended amplifier rating of 5-30 watts (continuous power rating), Model G-503 has frequency response of 30-16,000 cps, 100-degree dispersion, crossover frequency of 2,000 cps, power rating of 30 watts (Integrated Program Material), and Alnico 5 magnet weights of 14.5 ounces for the woofer and 6.8 ounces for the tweeter.

Supersonic Circuit at Tullahoma Nears Completion

Largest of the 22 wind tunnels and test cells at the U. S. Air Force's Arnold Engineering Development Center in Tullahoma, Tenn., is the propulsion wind tunnel comprised of a transonic unit now in operation and a supersonic circuit nearing completion.

The propulsion wind tunnel—one of the three major laboratories at the Center—is powered by the world's largest rotating machine. Built by the Westinghouse Electric Corporation, the machine is over 480 feet long and develops 216,000 horsepower. It concludes the world's two most powerful synchronous motors, each rated 83,000 horsepower, and two smaller "starting" motors of 25,000 horsepower each. The four motors, which were built at the Westinghouse East Pittsburgh, Pa., plant, are connected in tandem to drive two huge compressors: one a three-stage unit for the transonic circuit; the other an 18-stage unit for the supersonic circuit. The compressors were built at the Westinghouse Sunnyvale, Calif., manufacturing division.

The transonic circuit at the Center has been conducting aerodynamic and propulsion tests for nearly three years, and it soon will be joined by its associated supersonic tunnel. Tests have been conducted on more than 30 of the major weapon-system projects of the United States government, including the USAF Titan, Snark, GAM-72 and Bomarc missiles, nose cones for all intercontinental ballistic missiles, the Navy's Polaris, the Army's Juniper and the National Aeronautics and Space Administration Mercury "man-in-space" project.

Picture Freezer for TV Editing

A video picture freezer which instantly stops TV picture action and holds the frozen image on its screen for as long as ten minutes is now available from the industrial systems division of Hughes Aircraft Company.

The new Hughes storage monitor is equipped with a five-inch Hughes Tonotron tube, which can display a continuous television picture, and "freeze" the action at any desired time.

The Hughes storage monitor has a varied range of applications, including:

1. Video tape editing. The monitor can be used as a key unit in the design of advanced video tape editing systems.

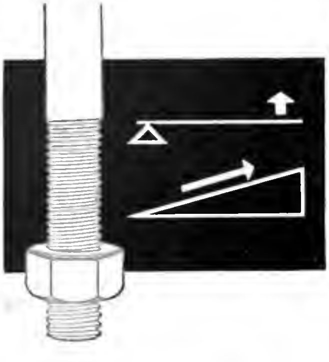
2. Surveillance. Closed-circuit TV surveillance in industrial plant protection, as a deterrent against shoplifting, and as an aid in general law enforcement.

3. Sports. Quick determination of pertinent actions in sporting events by providing an instant frozen picture of race finishes, winners, accidents and rules infractions.

4. Teaching. Closed-circuit "on the scene" TV classroom instruction. Ideal for capturing pertinent moments in medical and dental operations and demonstrations, thus permitting elaboration by the lecturer.

5. Fluoroscopy. Capable of storing images where short-burst fluoroscopic X-ray techniques are used, further aiding in reducing patient irradiation dosage. Image available for immediate examination.

The Hughes storage monitor can be connected directly to a closed circuit television camera, video tape recorder or other video signal source, the company said. The device will monitor the pic-



ture until the store switch is manually or automatically actuated. This instantly freezes the action, until normal picture action is again started by using the monitor switch. The unit is available for table or rack mounting and multiple units can be set up to freeze a number of sequential action frames.

Larger License Plates

License plates on 70 million American motor vehicles will be bigger, brighter, and easier to read if states apply research findings reported to the Highway Research Board by three engineers from the University of Illinois.

They told about a two-year study on license legibility sponsored at the university by Charles F. Carpentier, Illinois Secretary of State. Recommendations for Illinois plates have been reported to him.

They recommended the national size of license plates, 12 by 6 inches, be lengthened to 14 by 6.

For quick accurate identification under normal daylight conditions at 125 feet or farther they recommended no more than six identification characters on the plates.

For states with fewer than 1,000,000 vehicles the easiest read system is straight use of numbers. For larger states they found the best system two letters and four numbers, which provides for 6,000 vehicles. All letters should be together at beginning or end of the series, they said.

Bigger characters for state names or abbreviations and for year numbers were recommended to make this information legible at least 65 feet away.

Recommendations were in line with finds that licenses have two functions: to identify the vehicle, and to show the owner has complied with registration laws.

Under these finding slogans and emblems would go off the plates. The engineers reported, "The advertising and publicizing of the state by means of slogans or symbols is not a function of license plates."

Two plates—one front and one rear—were found necessary to best accomplish the purpose of licenses.

Rounded open-style numbers and letters were recommended for best legibility, with letters slightly larger than the the numbers, and with selection of high-contrast colors for the plates.

Reflectorization of license plates was discussed and it was said that this increases night legibility by 28 per cent.

"There appears no appreciable difference in legibility of various types of materials used," he said, however, "considerations other than legibility, have an important bearing on choice of reflectorizing material." Factors he listed are visibility, durability, ease of cleaning, all-weather performance, manufacturing requirements, and cost."

Effect of reflectorized plates on vehicle collisions is not definite, he said. Additional data are needed.

A Home Away From Home

How will space specialists keep a man comfortable in a space ship if they can't load the vehicle with tons of air conditioning equipment to change temperatures or put its occupant in a temperature-adjustable space suit?

The answer is to try to design the space vehicle to operate at a constant "shirt sleeve" temperature, said senior research scientist J. E. Janssen, Minneapolis-Honeywell Research Center. He added however that this is easier said than done. "How do you calculate the temperatures, if no one's ever been there?"

Conditions in space differ from earthly ones, said Mr. Janssen, and the ways that the skin has of helping to keep the body comfortable on the ground may not be available to it among the stars.

For one thing, since the force of gravity is so much lower in space than on earth, the air that carries off heat and moisture from the body won't be moving nearly as fast. If some means is not provided for moving the cloud of carbon dioxide and vapor from around the space man, he won't be very comfortable. But velocities will have to be kept fairly low, because high air movement has a fatiguing effect.

Even more important, formulas indicate that air temperature variations inside the vehicle have less effect on the occupant than the "mean radiant temperature" of the ship. Mr. Janssen defined "mrt" as, roughly, the surface temperatures of an enclosure, like a space ship, which gives off the same heat as a body in the actual environment. For every degree that "mrt" varies, a 3.2°F change is necessary in the air at atmospheric pressure to compensate for it. The big job will be control of "mrt," he said.

From the data he gathered, Mr. Janssen went on, comfortable atmosphere in a space ship in given conditions would be about 67 F. This would compare to an earthly environment of 70°F and 82.2 skin surface temperature.

But, he indicated, these formulas are only the beginning. They will help a man stay alive while hurtling through space, but only when he comes back can exact ones be worked out.

At the same session of the ASME meeting, a new space age word that may soon be a standard part of the language was defined.

The word is "clo" and, according to J. W. McCutchan, associate professor of engineering at the University of California, a "clo" is that quantity of clothing that will maintain a comfortable heat balance for a man sitting at rest in a room with a 70° temperature, less than 50° humidity and air movement of at least 20 feet per minute.

Professor McCutchan said that crews of supersonic airplanes need at least 3 or 4 clo for complete protection in case they have to bail out in arctic territory. The problem is that an impossibly low cabin temperature is required if the men are to wear that much clothing in comfort.

The solution may lie in ventilated clothing, continued Professor McCutchan. This type of garment, which has built-in vents among its other attributes, is a sort of substitute for air conditioning and allows the air to circulate through clothing more freely.

Suits of this type have already been designed, but crewmen must wear with them an anti-exposure suit, flying suit, woolen underwear, gloves, wool socks and rubber boots.

The perfect solution to the problem has yet to be found.

Street Of Gold

Although many Europeans erroneously believed that the streets of America were paved with gold, there actually was one saturated with the metal. Located in San Francisco in 1848, it contained so many specks of gold that some people picked it out as a means of making a living. How the gold got there is a mystery, but some say miners who lodged at the United States hotel lost tiny grains enroute from the leaky canvas bags they carried.

TV For Towser

Television advertisers are reported flirting with subliminal messages again—this time aimed at dogs. The trick would be to transmit supersonic barking, which a dog can hear but a man can't, along with a picture of a dog-food can. The viewer's dog would bark in answer and the viewer, presumably would rush out to buy the food.

Labor-Snaring Lottery

An appliance company in labor-short West Germany holds Saturday lotteries to keep its workers on a six-day week, reports International Management Digest. The firm offers a lottery of 20 prizes—including its own refrigerators and washers—plus free beer and sandwiches in addition to overtime pay, to employees who report for work on Saturdays.

BRAIN TEASERS

Edited by Steve Dilts

This elegant puzzle dates back to 1739. For historical interest, I give it in the original dress which seems to have imposed the English currency on the Netherlands. I hasten to state that all an American needs to know about this currency is that a guinea contains 21 shillings.

Three Dutchmen and their wives go to market, and each individual buys some hogs. Each buys as many hogs as he or she pays in shillings for one hog. Each husband spends altogether 3 more guineas than his wife. The men are named Hendrick, Elas, and Cornelius; the women are Gurtrun, Katrun, and Anna. Hendrick buys 23 more hogs than Katrun, while Elas buys 11 more than Gurtrun. What is the name of each man's wife?

* * *

Can you rearrange the integers from 1 to 49 so that all rows (horizontal and vertical) plus the two major diameters add up to 175 per summation? Just for a start—

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	32	33	34	35
36	37	38	39	40	41	42
43	44	45	46	47	48	49

For a "bonus point," the first row is as follows:

30 39 48 1 10 19 28

Now you know how many rows there are and the placement of seven numbers, so go to it!

* * *

The following puzzle, due to Dudeney, is given because the method of solution is useful for an entire class of digital problems.

If we multiply 571,428 by 5 and then divide by 4, we get 714,285, which is the same as the original number with the first digit transferred to the end.

Can you find a number that can be divided by 5 and multiplied by 4 in the same way—by transfering the first digit to the end?

Of course, 714,285 would serve if we were allowed to transfer the last digit to the head. But the transfer must be made the other way—from the beginning to the end.

Eight men entered the tennis tournaments at Hillcrest. The tournament was played in three consecutive days, one per day, and no match was defaulted. The first and second round matches were stipulated to be two sets out of three, while the final was three sets out of five. A spectator who was present on all three days reports the following facts from his observations:

1. Eggleston never met Haverford.
2. Before play began, Gormley remarked jocularly to Bancroft, "I see we meet in the finals."
3. Chadwick won a set at love but lost his first match.
4. Although 140 games were played, the losers won 43.

When the pairings were posted, Abercrombie said to Devereau, "Do you concede, or do you want to play it out?"

6. On the second day, the first round of losers played bridge, and the same table gathered on the third day with Eggleston in place of Abercrombie.
7. Bancroft won nine games.
8. Franklin won 32 games.
9. The first score of the tournament was a service ace by Gormley at which Eggleston shouted, "Hey, I'm not over there!"

Who won the tournament? Whom did he beat and by what score?

* * *

The answers will appear next month.

Here are the answers to last month's brainteasers.

* * *

Because two people are involved in every handshake, the total score for everyone at the convention will be evenly divisible by two and therefore even. The total score for the men who shook hands an even number of times is, of course, also even. If we subtract this even score from the even total score of the convention, we get an even total score for those men who shook hands an odd number of times. Only an even number of odd numbers will total an even number, so we conclude that an even number of men shook hands an odd number of times.

* * *

In the triangular pistol duel the poorest shot, Jones, has the best chance to survive. Since his two opponents will aim at each other when their turns come, Jones' best strategy is to fire into the air until one opponent is dead. He will then get the first shot at the survivor, which gives him a strong advantage. Computing the actual survival probabilities is somewhat tricky, but I have the assurance of several experts that Jones, who hits his target 50 per cent of the time, has a survival chance of 47/90; Smith, who is 100 per cent accurate, comes next with a chance of 27/90 or 3/10; and Brown, who is 80 per cent accurate, is last with a chance of 16/90. Perhaps there is a moral of international politics in this somewhere.

* * *

The following analysis of the desert-crossing problem appeared in a recent issue of *Eureka*, a publication of mathematics students at the University of Cambridge. Five hundred miles will be called a "unit;" gasoline sufficient to take the truck 500 miles will be call a "load;" and a "trip" is a journey of the truck in either direction from one stopping point to the next.

Two loads will carry the truck a maximum distance of 1 and 1/3 units. This is done in four trips by first setting up a cache at a spot 1/3 unit from the start. The truck begins with a full load, goes to the cache, leave 1/3 load, returns, picks up another full load, arrives at the cache and picks up the cache's 1/3 load. It now has a full load, sufficient to take it the remaining distance to one unit.

Three loads will carry the truck 1 and 1/3 plus 1/5 units in a total of nine trips. The first cache is 1/5 unit from the start. Three trips put 6/5 loads in the cache. The truck returns, picks up the remaining full load and arrives at the first cache with 4/5 load in its tank. This, together with the fuel in the cache, makes two full loads, sufficient to carry the truck the remaining 1 and 1/3 units, as explained in the preceding paragraph.

We are asked for the minimum amount of fuel required to take the truck 800 miles. Three loads will take it 766 and 2/3 miles (1 and 1/3 plus 1/5 units), so we need a third cache at a distance of 33 and 1/3 miles (1/15 unit) from the start. In five trips the

(Continued on Next Page)

BRAINTEASERS . . .

(Continued from Page 79)

truck can build up this cache so that when the truck reaches the cache at the end of the seventh trip, the combined fuel of truck and cache will be three loads. As we have seen, this is sufficient to take the truck the remaining distance of 766 and 2/3 miles. Seven trips are made between starting point and first cache, using 7/15 load of gasoline. The three loads of fuel that remain are just sufficient for the rest of the way, so the total amount of gasoline consumed will be 3 and 7/15, or a little more than 3.46 loads. Sixteen trips are required.

Proceeding along similar lines, four loads will take the truck a distance of 1 and 1/3 plus 1/5 plus 1/7 units, with three caches located at the boundaries of these distances. The sum of this infinite series diverges as the number of loads increases; therefore the truck can cross a desert of any width. If the desert is 1,000 miles across, seven caches, 64 trips and 7.673 loads of gasoline are required.

* * *

In long division, when two digits are brought down instead of one, there must be a zero in the quotient. This occurs twice, so we know at once that the quotient is x080x. When the divisor is multiplied by the quotient's last digit, the product is a four-digit number. The quotient's last digit must therefore be 9, because eight times the divisor is a three-digit number.

The divisor must be less than 125 because eight times 125 is 1,000, a four-digit number. We now can deduce that the quotient's first digit must be more than 7, for even times a divisor less than 125 would give a product that would leave more than two digits after it was subtracted from the first four digits in the dividend. The first digit cannot be 9 (which give a four-digit number when the divisor is multiplied by it), so it must be 8, making the full quotient 80809.

The divisor must be more than 123 because 80809 times 123 is a seven-digit number and our dividend has eight digits. The only number between 123 and 125 is 124. We can now reconstruct the entire problem as follows:

```
          80809
     ----------
124 | 10020316
       992
       ----
        1003
         992
        ----
         1116
         1116
```

The answer to the last problem was 72 apples.

Sun Checks Radar

The sun, long a navigational aid, now can be used to check the accuracy of search-and-height-finding-radar antennas in a new technique. The method uses the steady radio signals emitted by the sun as known and accurate reference points and permits testing and adjusting of antennas in active service at field sites for the first time.

Perfume Discourages Fido

Meter readers for an electric utility firm in Texas have found that spraying a cheap perfume with a water pistol will discourage menacing dogs. While perfume spraying is not a positive preventative for dog bites, it does show promise of substantially reducing the number of attacks suffered by meter readers.

'Fantastic' Steel

The Russians claim to have developed a process by which steel can be fabricated to resist the "fantastic" loads of nearly two million pounds per square inch. Soviet scientists report that the process "succeeds in moving atoms of matter so close together" that virtually no space exists between them.

Thor Statistics Soar

To handle one squadron of Thor missiles (15 launching emplacements) requires ten miles of piping, 2,500 miles of wire, 1,500 meters, 3,000 panel light assemblies, 50,000 resistors and potentiometers, 50,000 capacitors, 5,000 relays and enough electricity at peak output to supply a community of 25,000 homes.

Electronic Nightstick

Watchmen's nightsticks have gone electronic. A new model has a built-in transmitter that actuates an electronic alarm system. A button at the top of the stick sets off a signal, enabling a watchman to sound alarm instantly without going to a fixed box. The signal can be used to operate any burglar alarm or other device.

River Lights Aid Planes

Neon lights are being spaced on transmission-line spans across rivers to alert airplane pilots who often follow rivers when fog cuts visibility. These lights already have been installed at Columbia and Mississippi River crossings. Similar installation are planned by utilities for eastern rivers.

Convenient Location

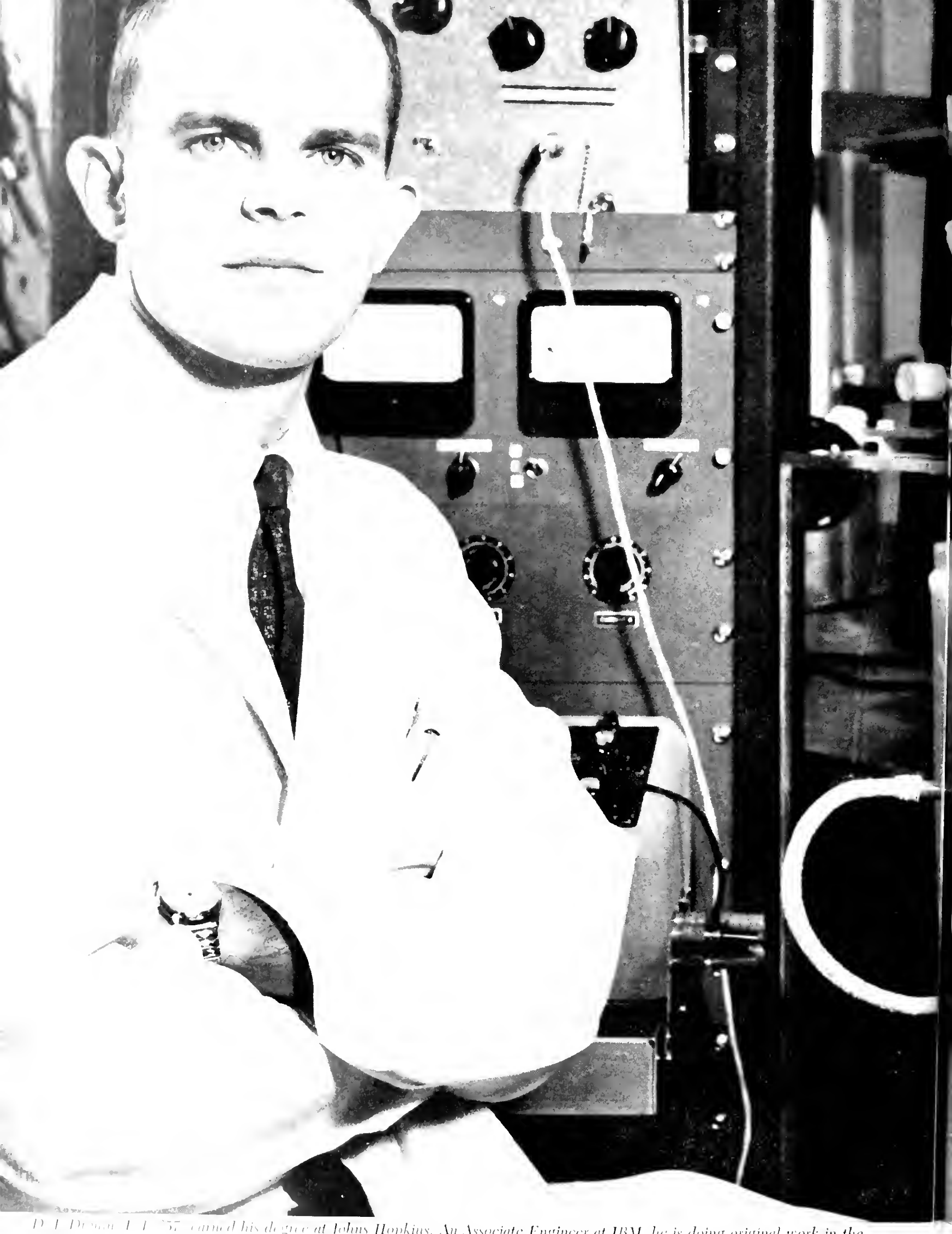
Frankfurt, Germany, will have a restaurant sitting on top of 14,000 tons of malt and barley. A circular restaurant for 160 persons, several smaller rooms for 40 diners each, and a roof garden with a capacity of 150 persons is being built at the top of a brewery tower. In addition, there will be a beer hall on the ground floor.

Fast Winter Starts

Motorists can keep their automobile batteries warm this winter and increase starting power 35 per cent at 32 degrees Fahrenheit with a new heating element that is said to maintain battery temperature at 60 degrees F., even in an unheated garage. A lead-in cord is attached to the unit for connection to a line from the regular house current.

Cheaper Clothes Coming

A new acrylic latex plastic may permit clothing such as suits and dresses to be made from low-cost, longer-wearing nonwoven fabrics. Nonwoven fabrics treated with the latex are easier and cheaper to make, are stronger and can be washed or dry cleaned often—two processes that rapidly ruin nonwovens treated with conventional materials.



D. I. Dr[illegible] E.E. '57, earned his degree at Johns Hopkins. An Associate Engineer at IBM, he is doing original work in the design and testing of thin film circuits. Two of his ideas in this field have been filed upon for patents.

HE'S WORKING TO GIVE OLD METALS A NEW FUTURE

The metals now being utilized in thin film development have been known and used for centuries. But dormant within these metals has been their quality of superconductivity at extremely low temperatures. Only when researchers were able, with great ingenuity, to create certain relations between metals and changes in their basic structures, could these superconducting qualities be utilized. But much remains to be done at this moment, especially in the application of thin metallic films to practical working devices.

Development Engineers at IBM are at work daily on the problem. They envision the replacement of today's electronic logic elements with modules of amazing responsiveness, durability, and simplicity. The extremely small size of these modules and their low power requirements will be important factors in shaping the electronic systems of the future.

Closely allied on this work are engineers of practically every specialty. Only by bringing the talents and abilities of people of many fields to bear on the unique problems of thin film development, will progress be consistent with objectives. Engineers at IBM expect to obtain these objectives, and once they are obtained, to set new ones.

If you think you might be interested in undertaking such truly vital and interesting work, you are invited to discuss your future with IBM.

Our representative will be visiting your campus soon. He will be glad to talk with you about the many opportunities in various engineering and scientific fields. Your Placement Director can give you the date when our representative will next visit your campus.

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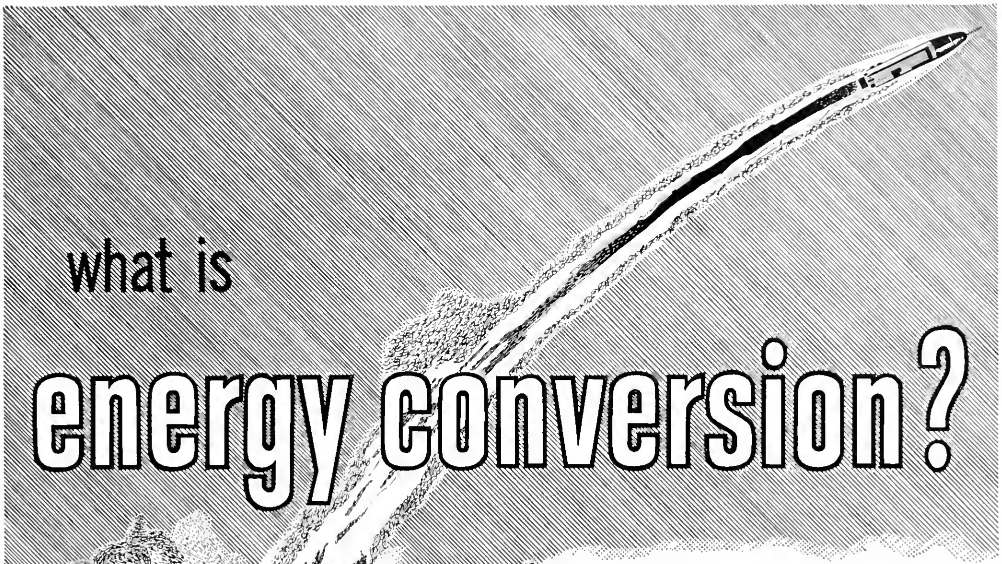
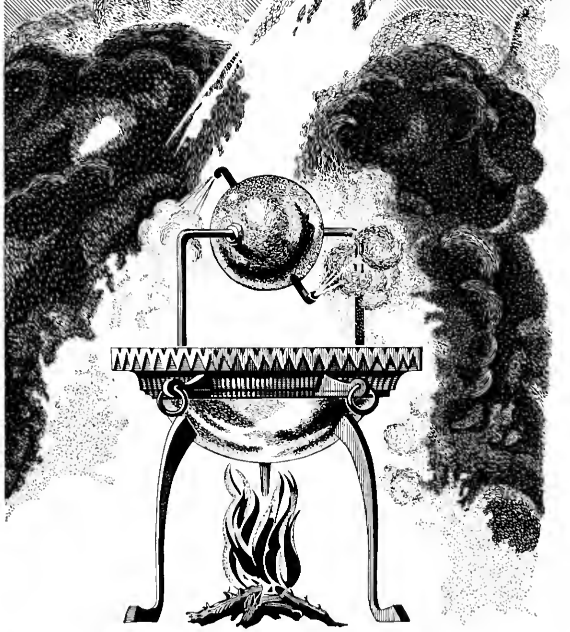
For further information about opportunities at IBM, write, outlining your background and interests, to: *Manager of Technical Employment, Dept. 844, IBM Corporation, 590 Madison Avenue, New York 22, New York.*





A method of doing work?
A change of state?
Regimentation of random motion?
Organized degradation of matter?
Is it reversible?

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Begged, Borrowed, and . . .

Edited by Jack Fortner

Did you hear about the engineer that thought he was a big gun just because he finished every week with a report?

* * *

Any of you guys hear about the engineer who didn't buy any Christmas seals because he couldn't afford to feed them?

* * *

Prof.: "Are you troubled by thoughts that you might flunk out of engine school?

E.E.: "No, I rather enjoy them."

* * *

1st M.E.: "You cuttin' machine design Friday?"

2nd M.E.: "Nope, I can't. Need the sleep."

* * *

A well-known zoology professor was unwrapping a parcel before his class which, he explained to his pupils, was a fine specimen of a dissected frog. Upon disclosing two sandwiches, a hard-boiled egg, and a banana, he was very surprised and exclaimed, "But surely I ate my lunch."

* * *

The guy was doing his best, leading a goat with one hand, carrying a cane with the other, and loaded down with a laundry basket on his back and a chicken under his arm.

His girl hesitated when they came to the woods, saying, "I'm afraid to walk with you in there. You might try to molest me."

"How could I?" the guy assured her. "Look at all the stuff I'm carrying.

"But you could put the chicken under the laundry basket, stick the cane in the ground, and tie the goat to it."

* * *

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."

* * *

The wild crowd has a new game going. Three guys rent a hotel room and each brings a quart of Old Screech with him. They sit and drink for an hour, then one of them gets up and leaves. The other two have to guess which one left.

The Southern father was introducing his family of boys to a visiting governor.

"Seventeen boys," exclaimed the father, "and all Democrats — except John, the little rascal. He got to readin'."

* * *

And then there was the condemned golfer who asked the hangman, "Mind if I take a couple of practice swings?"

* * *

Men are as honest and truthful as women — that's why women are so suspicious of them.

* * *

Freshman: "What does 'Fantasy' mean?"

Senior: "A story in which the characters are ghosts, goblins, virgins, and other supernatural characters."

* * *

A patient of an asylum who had been certified cured was saying good-by to the director of the institution.

"And what are you going to do when you go out into the world?" asked the director.

"Well," said the ex-nut, "I have passed my bar examinations, so I may try to work up a law practice. Again I had quite a bit of experience with dramatics in college, so I might try my hand at acting."

He paused and thought for a moment.

"Then on the other hand," he continued, "I may be a teakettle."

* * *

Two engineering students were taking calculus for the first time and while waiting for the instructor to arrive, they took a quick perusal through the book. One of them came across the integral tables in the back of the book.

"Tell me," he asked his friend, "can you read that?"

"No," replied his friend, "but if I had my flute with me I could play it."

* * *

It's quite simple," explained one of the seniors in EE, "to hook up an electric power circuit. We merely fasten leads to the terminals and pull the switch. If the motor runs, we take our readings. If it smokes, we sneak it back and get another one."

* * *

Wine, women and song are getting to be too much for me; guess I'll have to quit singing.

Two lunatics were playing a little game.

"What have I got here?" asked one, his hands cupped.

"Three Navy Patrol bombers," said the other.

The first looked carefully into his hands, "Nope."

"The Empire State Building?"

"Nope."

"The Philadelphia Symphony Orchestra?"

The first one looked into his hands again and said slyly, "Who's conducting?"

* * *

Been doing quite a bit of research on the origin of old sayings and phrases, and think I've stumbled upon the beginning of that great old cheer, "Hoorah for our side!" I guess it was first heard on the day Lady Godiva rode side saddle through the streets of Coventry.

* * *

A man went into the Army, and, right after induction, he went to see a doctor.

"What's wrong with you?" asked the doctor.

"Well, I just got in the Army, and look at the uniform they gave me! The pants are just the right length, the sleeves are just right, and the hat fits perfectly, and the shoes are also perfect."

"Well?" asked the doctor.

"My problem is this," said the inductee. "Am I deformed?"

* * *

A college senior entered a professor's office one morning and said:

"Last night, professor, your daughter accepted my proposal of marriage. Fully realizing the importance of the step, I have called upon you to see you and inquire if there is any insanity in your family."

The professor looked up over his glasses and surveyed the young man in silence for a moment, then sadly nodded his head and remarked:

"Yes, yes. There must be."

* * *

"Get up!" commanded the Irish cop.

"I can't offisher," replied the Scot. "Two men ha' got me down."

"Nonsense!" snorted the policemen. "I don't see any men holdn' ye down."

"They are too," insisted the reclining one. "Their names is Haig and Haig."

One of a series*

Interview with General Electric's Charles F. Savage Consultant—Engineering Professional Relations

How Professional Societies Help Develop Young Engineers

Q. Mr. Savage, should young engineers join professional engineering societies?

A. By all means. Once engineers have graduated from college they are immediately "on the outside looking in," so to speak, of a new social circle to which they must earn their right to belong. Joining a professional or technical society represents a good entree.

Q. How do these societies help young engineers?

A. The members of these societies—mature, knowledgeable men—have an obligation to instruct those who follow after them. Engineers and scientists—as professional people—are custodians of a specialized body or fund of knowledge to which they have three definite responsibilities. The first is to *generate* new knowledge and add to this total fund. The second is to *utilize* this fund of knowledge in service to society. The third is to *teach* this knowledge to others, including young engineers.

Q. Specifically, what benefits accrue from belonging to these groups?

A. There are many. For the young engineer, affiliation serves the practical purpose of exposing his work to appraisal by other scientists and engineers. Most important, however, technical societies enable young engineers to learn of work crucial to their own. These organizations are a prime source of ideas — meeting colleagues and talking with them, reading reports, attending meetings and lectures. And, for the young engineer, recognition of his accomplishments by associates and organizations generally heads the list of his aspirations. He derives satisfaction from knowing that he has been identified in his field.

Q. What contribution is the young engineer expected to make as an active member of technical and professional societies?

A. First of all, he should become active in helping promote the objectives of a society by preparing and presenting timely, well-conceived technical papers. He should also become active in organizational administration. This is self-development at work, for such efforts can enhance the personal stature and reputation of the individual. And, I might add that professional development is a continuous process, starting prior to entering college and progressing beyond retirement. Professional aspirations may change but learning covers a person's entire life span. And, of course, there are dues to be paid. The amount is graduated in terms of professional stature gained and should always be considered as a personal investment in his future.

Q. How do you go about joining professional groups?

A. While still in school, join student chapters of societies right on campus. Once an engineer is out working in industry, he should contact local chapters of technical and professional societies, or find out about them from fellow engineers.

Q. Does General Electric encourage participation in technical and professional societies?

A. It certainly does. General Electric progress is built upon creative ideas and innovations. The Company goes to great lengths to establish a climate and incentive to yield these results. One way to get ideas is to encourage employees to join professional societies. Why? Because General Electric shares in recognition accorded any of its individual employees, as well as the common pool of knowledge that these engineers build up. It can't help but profit by encouraging such association, which sparks and stimulates contributions.

Right now, sizeable numbers of General Electric employees, at all levels in the Company, belong to engineering societies, hold responsible offices, serve on working committees and handle important assignments. Many are recognized for their outstanding contributions by honor and medal awards.

These general observations emphasize that General Electric does encourage participation. In indication of the importance of this view, the Company usually defrays a portion of the expense accrued by the men involved in supporting the activities of these various organizations. Remember, our goal is to see every man advance to the full limit of his capabilities. Encouraging him to join Professional Societies is one way to help him do so.

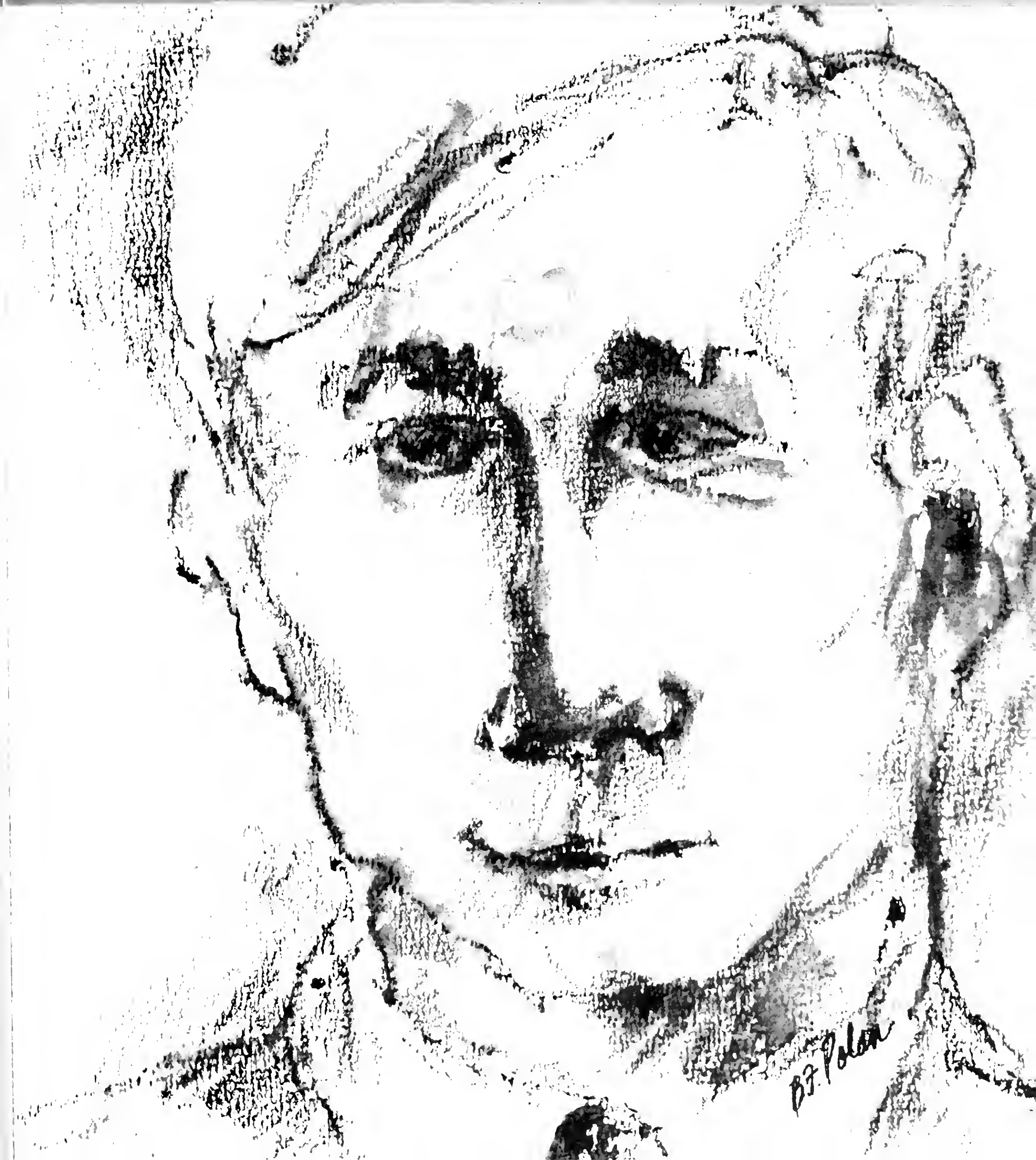
Mr. Savage has copies of the booklet "Your First 5 Years" published by the Engineers' Council for Professional Development which you may have for the asking. Simply write to Mr. C. F. Savage, Section 959-12, General Electric Co., Schenectady 5, N. Y.

*__LOOK FOR__ other interviews discussing: Salary • Why Companies have Training Programs • How to Get the Job You Want.

GENERAL ELECTRIC

ILLINOIS TECHNOGRAPH

February · 25¢



THE ILLINOIS TECHNOGRAPH

Volume 75, Number 5 — February, 1960

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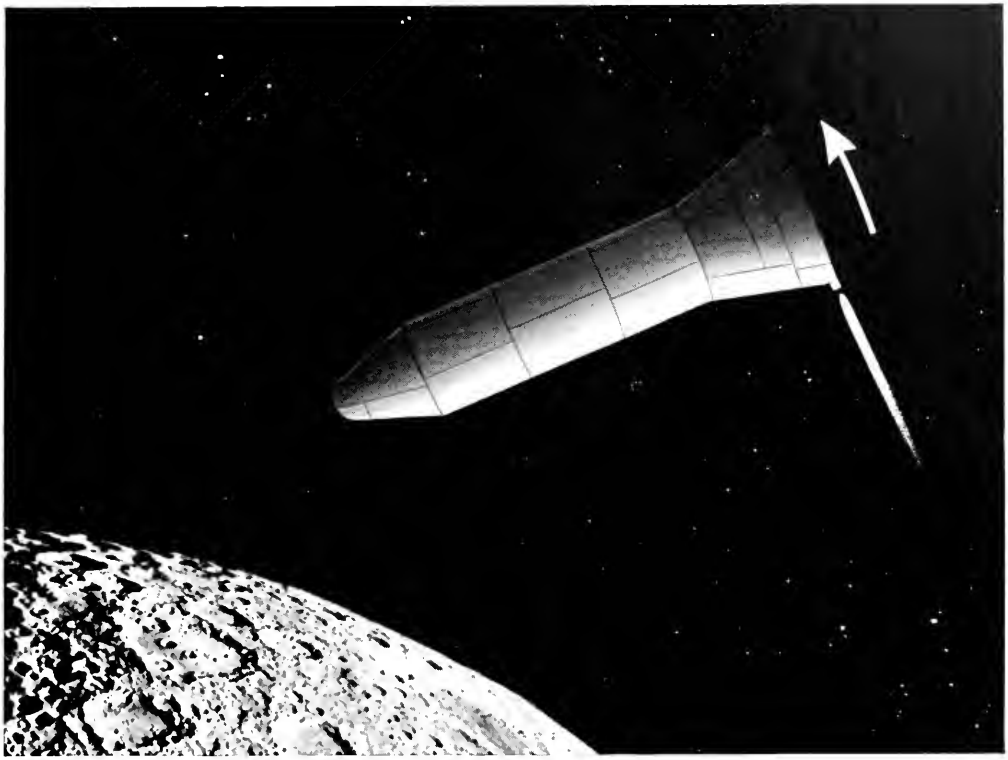
Cover . . .

Pictured on this month's cover is a "pensive young man" studying engineering who might someday become a writer also. For more about engineers in the writing field turn to page 14.
—Barbara Polan



HOW TO MAKE A "LEFT TURN" IN OUTER SPACE

(and the "right turn" toward a gratifying career)

Like the dimensions of the universe itself, the future of space technology is beyond imagination. The frontiers of space will edge farther and farther from us as engineering and scientific skills push our knowledge closer to the stars. Bendix Aviation Corporation, long a major factor in America's technological advance, offers talented young men an outstanding site from which to launch a career.

In the field of controls alone, for example, Bendix (which makes controls for almost everything that rolls, flies or floats) has developed practical, precision equipment for steering and controlling the attitude of space vehicles. It consists of a series of gas reaction controllers (actually miniature rockets) which are mounted around the satellite. Individually controlled by a built-in intelligence system, they emit metered jets of gas on signal whenever it is necessary to change the orientation of the satellite.

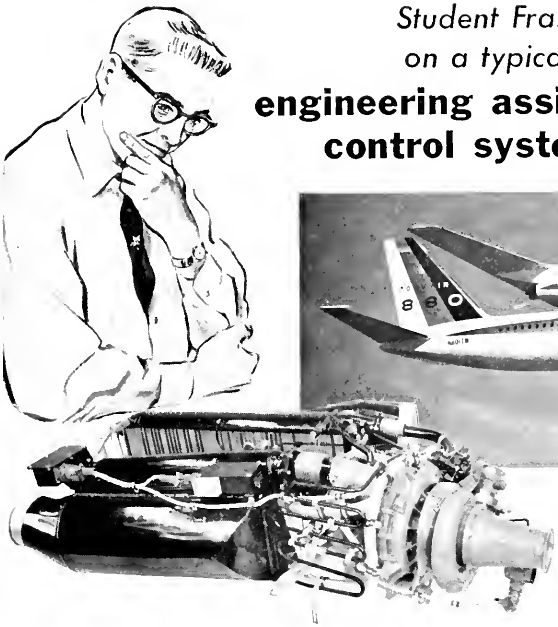
The development of this unique control equipment is but one of the many successful Bendix projects involving knowledge of the outer atmosphere and beyond. Bendix, a major factor in broad industrial research, development and manufacture, is heavily engaged in advanced missile and rocket systems and components activities. These include prime contract responsibility for the Navy's advanced missiles, Talos and Eagle.

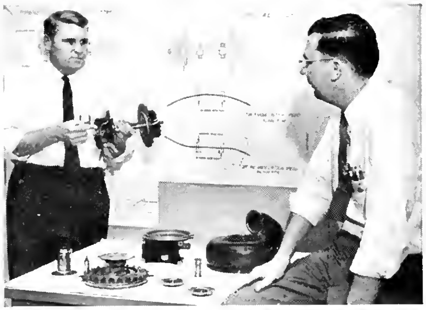
The many career opportunities at Bendix include assignments in electronics, electromechanics, ultrasonics, computers, automation, radar, nucleonics, combustion, air navigation, hydraulics, instrumentation, propulsion, metallurgy, communications, carburetion, solid state physics, aerophysics and structures. See your placement director or write to Director of University and Scientific Relations, Bendix Aviation Corporation, 1108 Fisher Bldg., Detroit 2, Mich.

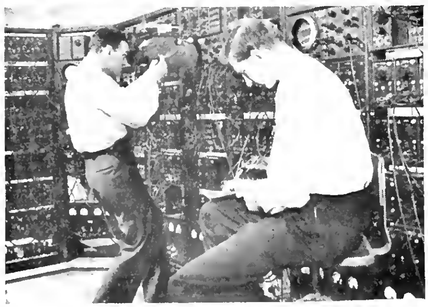
A thousand products — Bendix AVIATION CORPORATION Fisher Bldg., Detroit 2, Mich. — *a million ideas*

Student Frank G. pictures himself on a typical Hamilton Standard

engineering assignment: environmental control system for Convair 880







ENGINEERING EXCELLENCE of Hamilton Standard equipment is reflected by the selection of its air conditioning and pressurization system for the new Convair 880 jet. Frank G. readily sees the variety of engineering applications involved and learns that he would, as an engineer, participate in its development in one of the following groups:

DESIGN ENGINEERING—Where the engineer, using technical skills in *aerodynamics, thermodynamics, heat transfer, vibration, servo mechanisms* and *electronics*, creates a working concept of the product to meet rigid specifications of performance, weight, size, reliability, cost and safety. Engineers shown at right are discussing stress analysis problems of the turbo compressor rotor system.

ANALYSIS ENGINEERING—Where the engineer, acting as a consultant in applied research, derives and evaluates data on *performance, structures, vibration* and *reliability*. In addition, Frank G. finds that close liaison is maintained with project and design engineers, who incorporate this information in the development of the product. Such machines as the Philbrick Analog Computer, shown at right, facilitate compilation of technical data.

PROJECT ENGINEERING—Where the engineer's prime responsibility is coordinating all activity from design through qualification testing. Frank G. discovers this means "shirt sleeve" work at laboratory test facilities, verifying product specifications with analysis and design groups, working with experimental technicians and contact with customers and vendors. Electronic temperature control pictured at right, was developed by our autonomous Broad Brook Electronics Department.

For full color and illustrated brochure "Engineering for You and Your Future" write R. J. Harding, Administrator—College Relations

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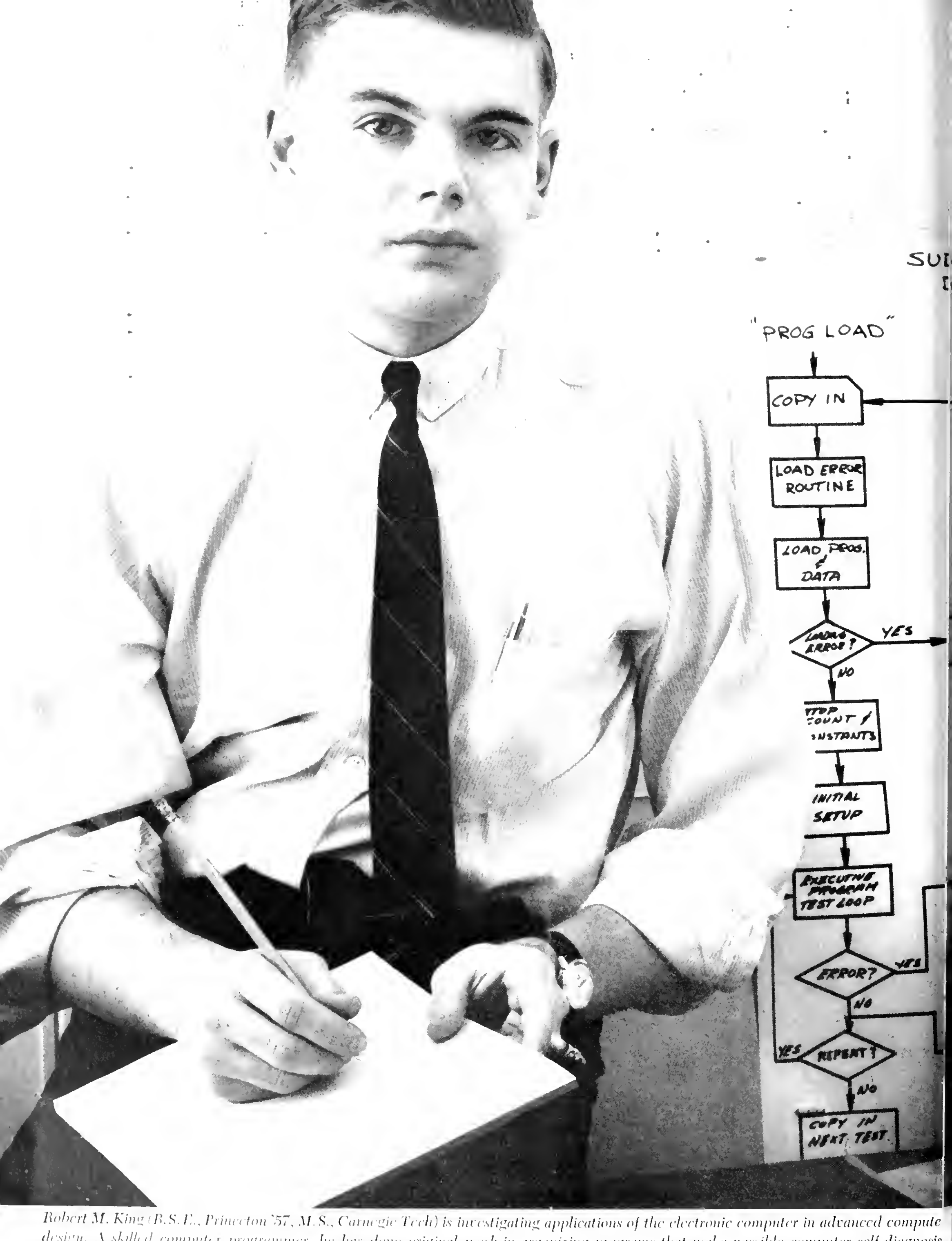
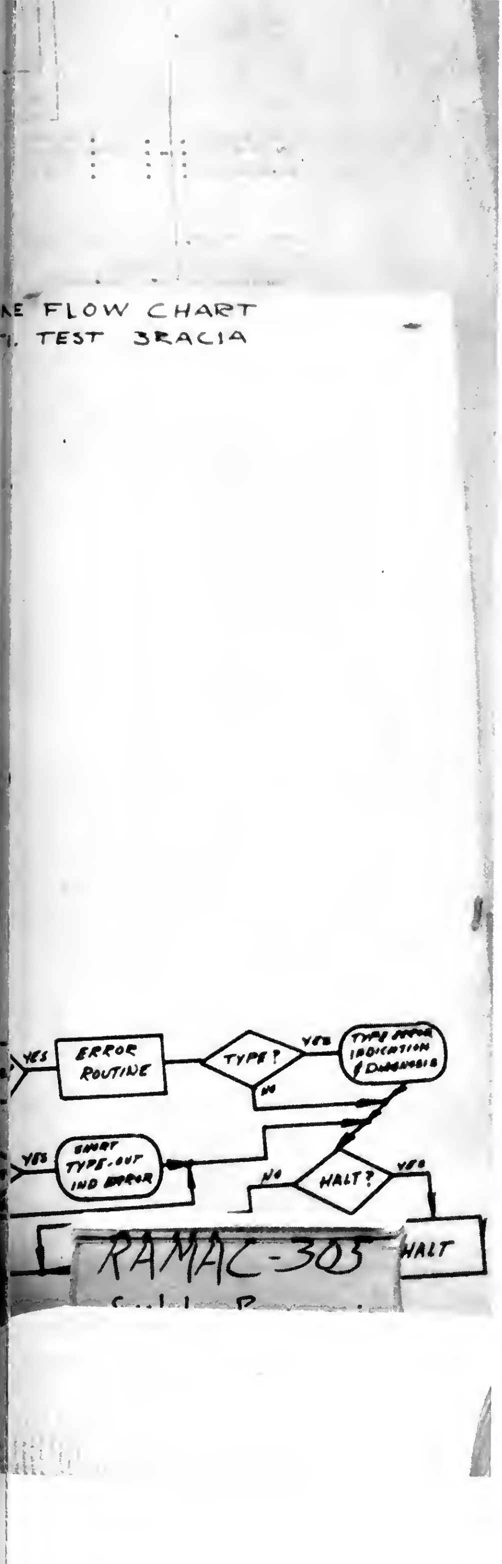


Robert M. King (B.S.E., Princeton '57, M.S., Carnegie Tech) is investigating applications of the electronic computer in advanced compute design. A skilled computer programmer, he has done original work in organizing programs that make possible computer self-diagnosis


FLOW CHART
TEST
YES
ERROR ROUTINE
TYPE?
YES
NO
YES
HALT?
YES
HALT
RAMAC-305

William Whewell...on mind and matter

"...these metaphysical discussions are not to be put in opposition to the study of facts; but are to be stimulated, nourished and directed by a constant recourse to experiment and observation. The cultivation of ideas is to be conducted as having for its object the connexion of facts; never to be pursued as a mere exercise of the subtlety of the mind, striving to build up a world of its own, and neglecting that which exists about us. For although man may in this way please himself, and admire the creations of his own brain, he can never, by this course, hit upon the real scheme of nature. With his ideas unfolded by education, sharpened by controversy, rectified by metaphysics, he may *understand* the natural world, but he cannot *invent* it. At every step, he must try the value of the advances he has made in thought by applying his thoughts to things."

—*Philosophy of the Inductive Sciences, 1847*

THE RAND CORPORATION, SANTA MONICA, CALIFORNIA

A nonprofit organization engaged in research on problems related to national security and the public interest

Room for One More

If you have taken a look at the table of contents, you will have seen that this issue leans heavily toward the engineer as an individual. We have included two essays and several articles concerning human interest and human factors that must be considered in your professional future.

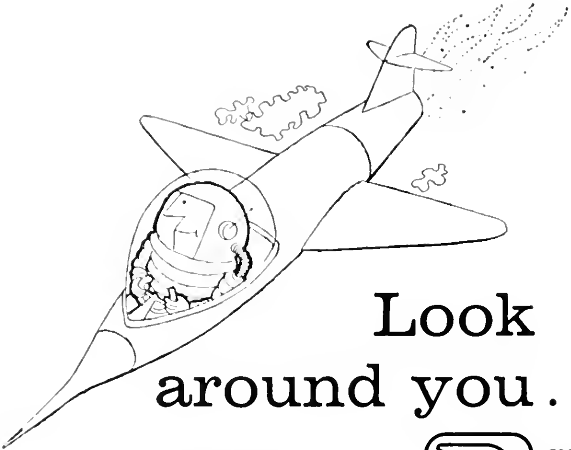
These articles, we hope, will whet your interest in yourself. You must think of yourself as a unique person with ideas and feelings of your own. If you are a senior and have started interviewing, you will begin to realize the pitfalls open to you. Conformity is an easy rut to travel. The men interviewing you represent companies which in essence are strange new worlds. One of these unknown worlds contains a place for you: a rut if you make it so.

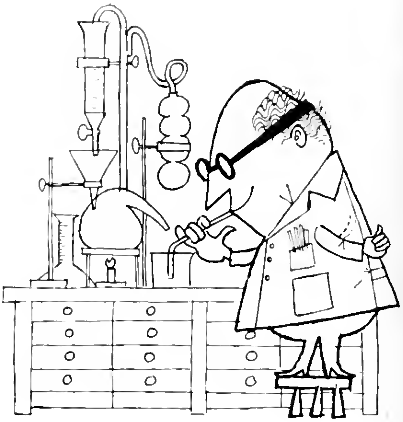
In your first effort to fit into the company you may find conformity the easiest method. Questions such as: "Should I join the company country club? Should I stock up on the 'tailored look' suits?" may become more important than you think now. Sure you've been a self-made man and grown a beard, or gone beat for a month, but these are very weak memories to cling to when you become part of an organization.

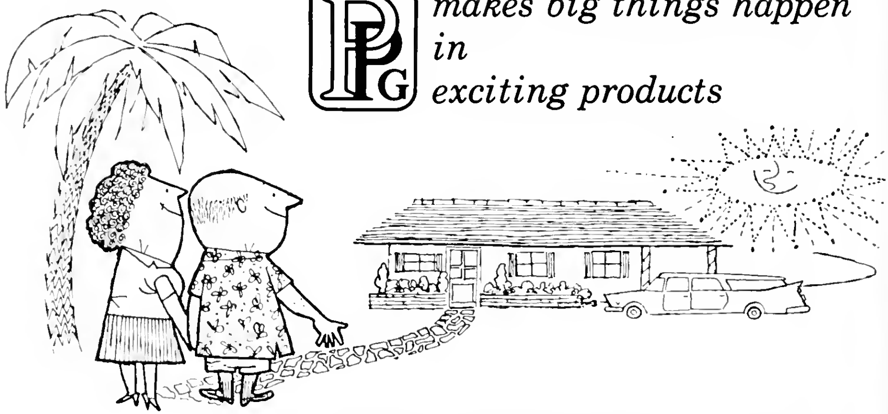
Conformity of the mind is the real danger for which to be on the alert. You have come from college relatively unspoiled in that your mind is still pliable. You should be alert for new areas of knowledge and grasp at new facts, but don't grasp at the first pattern of operational procedure.

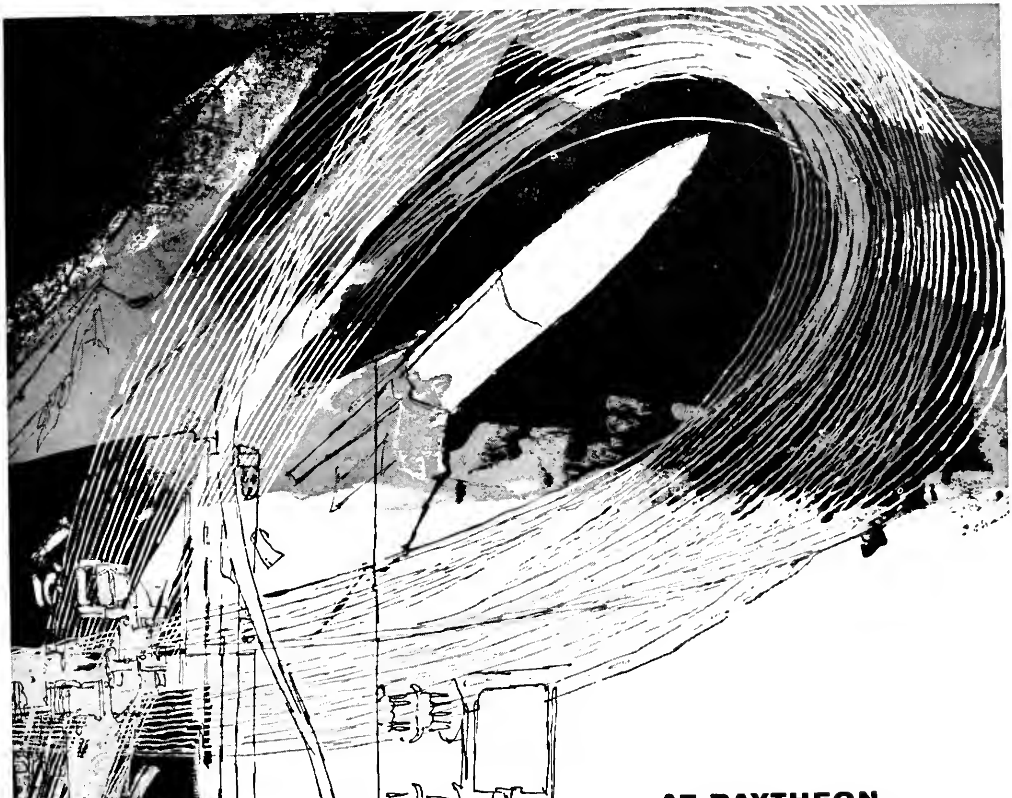
This may fit you into the cocktail club at noon and the poker club at night, however it will stifle your chance of **making room** in the true professional field of engineering. There is no niche for you there; you have to make a place for yourself.

WDP









WANTED:

Engineers Who Can Write

By Verne Moberg

Industry needs engineers who can express themselves.

And the student engineer can most profitably spend the little spare time available during his undergraduate years by learning to write. He may even double his income.

Why is it, then, that the earmark of engineers on the Illinois campus is that they can't write or speak well?

Who knows?

But the truth is, engineers both in industry and on college faculties insist that self-expression is almost *the* important skill student engineers need to learn. And they *can* learn to write—which is a first step in communication—with only a little effort through concentrating on some basic principles, staying awake in rhetoric class and getting in some practice writing.

You don't believe that you can learn to write or need to do it? First let's see what professional engineers have to say about the need for expression.

John Isaacson, manager of college relations at the IBM Product Development Laboratory, Poughkeepsie, N. Y., who was interviewed at Illinois this fall, says that the way an idea is expressed is almost as important as the idea itself.

"If you can't communicate, you may as well give your ideas away. We'd have to hire two people instead of one."

The people who communicate, Isaacson says, are the ones who make the grade in tangible rewards, "prestige, responsibility and the dollar," as well as intangibles (pride of a job well done).

G. H. Duff, Westinghouse central Illinois branch sales manager, Peoria, agrees. About 85 per cent of the Westinghouse personnel in management posts began as engineers who were able to put across their ideas effectively.

And here's how engineering college faculty rate communication skills.

According to Prof. T. J. Dolan, head of the U. of I. Department of Theoretical and Applied Mechanics, "The principal job of an engineer is to sell his ideas and to sell himself. If he can't do this, he may as well give up trying to be a professional engineer."

Other engineering educators say communication skill is more important for the engineer than for a man in pure science, because he must sell his ideas to all kinds of people—politicians, economists and businessmen of all kinds, including other engineers.

Yes, they care. And like girlfriends, instructors want to know *you* care—even about the little things.

One professor in the T. & A. M. department even confides that concise, straightforward presentation ought to be just as important as technical mastery to a student who wants high grades on his papers. Instructors are human too, and they're naturally impressed when you turn in a paper that says what you mean in crisp, clean language.

All right, so they all care. But exactly how much is the big payoff.

Louis N. Rowley, editor and publisher of "Power," technical magazine of McGraw-Hill Co., Inc., declares that, "other things being equal, skill with words and speech will add anywhere from \$50,000 to \$200,000 to an engineer's lifetime earnings."

Prof. G. M. Sinclair, research director of the T. & A. M. Fatigue Laboratory, calls Rowley's guess conservative. Effective communication skill, he says, will probably double an engineer's lifetime income.

Estimates vary, but all professionals agree, the dollars increase.

Of course, an engineer can get a job without knowing how to express himself, according to Isaacson.

"But he'd better be Einstein," he warns quickly. "He'll have to make up to the company what it's paying another man to interpret him. Einstein could communicate his more complex theories to very few men. But that was Einstein. The ideas most engineers come up with every day aren't that good."

If you know you're no Einstein, but still think engineers at Illinois don't have to learn to write, don't go near Prof. JoDean Morrow in the T. & A. M. department. "People like that are second-rate technical clowns," he feels. "Either you have professional pride or you don't."

So you want to be an engineer? So you'd better learn to write. If you'll put down that slide rule, you can start right now.

The first thing to keep in mind is that language, like a beautiful bridge, is a functional structure. It is designed to carry across ideas with economy and grace. The best technical writing, like the finest literature, is short and sweet.

As engineers, you have a headstart here over students in liberal arts because you're used to thinking in this strictly organized, functional way. So when you're designing, molding and refining the parts of language, which are paragraphs, sentences and words, always remember these basic principles.

1. All the parts must be there, or communication won't take place.

2. All the parts must be functional; useless parts just get in the way and slow up understanding.

3. The structure (paper or literary work) with the fewest parts works the best and lasts longest.

Before you begin to formulate what you have to say, put these in mind and you'll have an overall frame to simplify your thoughts.

In producing good writing you'll concentrate on three basic processes: designing, molding, and refining your thoughts, or as rhetoric teachers will say, organizing, writing and reviewing (correcting and or revising). Each one is important, and none can be left out—not even in an impromptu theme for rhet class. If, at any one of these three stages, you discover that preparation at an earlier stage was faulty or incomplete, go back to it and start from there. The stage you are in will be the most important when you are in it.

First comes design. As soon as you have a topic, narrow it down. Usually in factual writing, the more words that are in your title, the smaller your subject becomes and the more specific and meaningful will be the things you say about it. Next choose a thesis—a complete sentence which expresses your general topic in its subject and the particular slant you're taking on it in the predicate—and write it down. Now decide on your purpose and your scope and write them down. Now stop.

Take a look at your audience. Who will be reading your paper? Engineering professors? Rhetoric instructors? Other professional engineers? Find out who they are, learn as much as you can about their likes and dislikes regarding the subject and, more important, know what they *can* and what they *will* read.

Robert Gunning says in his book, "The Technique of Clear Writing," that technical writing is due for a Copernican revolution. Over four hundred years ago the Polish astronomer said that the earth orbited around the sun not *vice versa*. It's about time now, says Gunning, that engineers centered their thoughts on the reader, not on themselves.

So after you've noted the aspects of your topic you'll want to cover, organize them in a pattern most agreeable and appropriate to your reader. For engineers this will generally mean a logical structure of deductive reasoning. That is, in your paper as a whole you'll state your main points and then show why they're true. For instance, you might start like this:

1. The moon is a spherical mass moving around the earth.

A. Newton said so.

B. The Russians say so(they saw its backside).

C. Walking home last night, your girlfriend agreed that the moon is a spherical mass moving around the earth (Maybe your word choice gave her that headache?)

Or you might use a time or space sequence of relating the main points in descriptive writing.

In any case, jot down the main ideas in outline form and then ask yourself, "What questions would an intelligent reader ask about my topic that I haven't covered?" Then fill in the blanks.

Another important factor to consider about your reader is the suitable level of language. In what situation are you addressing this person? At the college level, you will probably need to use a professional tone. This means you will stick to business and tell what happened in the most direct, objective way possible. You will not relate the experiment to your instructor or employer in the same way that you would tell your roommate, "A very funny thing happened to me in met. lab today . . ."

At the same time you don't want to strain yourself to sound "scientific" by trying to pull intellectual wool over anybody's eyes. Make it your goal to *express* what you know, not to *impress* the reader. If you can express yourself well, naturally the audience will be impressed.

Now, are you organized? All right, get it down in black and white.

Here's where the streamlining really comes in. You'll want to weigh and test everything to find the best combination of parts in each of the three functional units of expression—paragraphs, sentences and words.

The largest and simplest unit is the paragraph. As you know, it's a group of sentences tied together to give logical support to a larger section of the paper. Make sure this thought unit carries through one idea and, if possible, arrange the specific ideas at the beginning and the end of the paragraph so they will naturally flow from the preceding and to the following ideas.

Engineers who think they don't need to learn to write are second-rate technical clowns.

Next: sentences. Keep them short. Of course, at times, when you want to vary the pace of your thoughts, you'll add some compound, or maybe even complex sentences.

If sentence structure leaves you in the dark, check a grammar book to get the facts. While you're at it, save yourself much pain in rhetoric classes by learning these general punctuation rules:

1. Almost always use a comma after an introductory dependent clause.

2. Almost always use a comma before the "and," "but," "or" or "nor" which joins two main clauses.

The rare exception occurs when the sentences are unusually short or closely related. Be safe—use the comma—and usually you'll be right.

Now that you're familiar with the terms, here's the main point. You can give your ideas weight by placing them properly. A main clause always carries the most important idea; a dependent clause, a less important one. If two ideas rate equally and are closely related, put them in a compound sentence with either a coordinating conjunction ("and," "but," "or" or "nor") or a semicolon to separate them.

Another major factor in sentence structure which can add or take away from the emphasis you want to put on your ideas is the order of the sentence elements. Unlike many other languages, English has a traditional order for parts of the sentence and that is, subject-verb-object. One, two, three; Mary loves John. If you want to put across your idea quickly and clearly, follow this order. Don't change it without one of these two good reasons: 1) The sentence sounds stilted and completely unnatural, or 2) Your sentence patterns need variation. Most important, subjects and verbs belong together, and if you can help it, don't separate the two with irrevelant words.

Likewise, modifiers—either words or phrases—belong as close as possible to elements which they complement. When your date comes down the stairs on the night of the big dance with a gorgeous new dress, you don't wait till next year to tell her about it. In the same way, readers forget what you're talking about when you tag on a modifier at the end of the sentence that refers to a word at the beginning. If you write, "The alloy melted quickly that was nitrided at 100F." you're talking nonsense. Place the modifiers right after the elements and make sense.

Finally, let's look at words, the most basic units of meaning. Once more, search for the simple, specific, familiar, concrete terms and you'll communicate faster. With the wealth of $64,000 words engineers have in their technical language, you can't afford to fog up the reader's mind with any more non-technical syllables than necessary. So keep it short.

Since most of our short, brisk words came from the Anglo-Saxon ancestral tongue of the English language, and not the Romance languages of southern Europe, you'll to well to favor them over words of Latin, French or Spanish background.

For instance, use "come" instead of "approach" and "great" instead of "immense." The most sparkling literature in English has been composed chiefly of these words and they can help you too. In his major works, Shakespeare drew 90 per cent of his words from the Anglo-Saxon, Milton used 81 per cent and the Bible (three gospels), 94 per cent. You might not outdo these best sellers, but your paper will at least be read.

A word about word choice: say what you mean. If possible, don't say the same thing so often that your reader is bored; find synonyms to express it in a different light. Sometimes, of course, there's no more than one word for the thing you are talking about. So, for your instructor's sake, use it — it can't be helped.

One engineering professor is now recovering from a severe case of amnesia because a student in his paper refused to call an extensometer an extensometer after the first reference. The worried man searched the lab for weeks to find the other "expansion gage cage," "metallic gift-wrapped measuring device" and "deformation quantifier" which the student talked about.

Certainly the rhetoric teacher is right when he says don't bore the reader with the same term over and over; do find synonyms. But the great sin, he'll tell you, is repetition of ideas. The same word will do twice if it's the only one that fits. In engineering a spade is a spade. Likewise, an extensometer is an extensometer, and your reader will be lost if you call it anything else.

A last word on verbs: if at all possible, keep them active, not passive. When the verb is in the active voice, the subject does the acting, but with a passive verb, the subject is acted upon. This becomes much clearer through example.

Passive: The yield point was lowered by cooling the metal.

Active: Cooling the metal lowered the yield point.

Often in technical writing the personal approach, involving "I" and other personal pronouns, is left out in order to show the objectivity and reproducibility of the results. Usually this involves the passive, but it can be avoided with effort.

For example:

Don't Use: That method of testing was dispensed with to reduce argon consumption.

Do Use: A new method of testing reduced argon consumption.

As Robert Gunning says, "The need to be impersonal is not the need to be inhuman. Some writers shun the first person so much they wouldn't use 'we' to refer to the human race."

But for best results keep both the subjective and the passive elements from your writing.

Shakespeare was lucky, most engineers will think. It was not until after his time, or about 1700, that scholars began to concentrate on rules of grammar. During the eigtheenth century about 250 books were published in effort to establish "correct English."

But writing is easier with rules than without, and they can help you organize your writing. Become familiar with them if you can, but see them as they make up the overall picture, not just as a set of facts. Remember, no rule is infallible. Break any one if necessary to say exactly what you mean.

Now your paper is down in black and white — it's written. But it's not complete until after the final process of refining your thoughts.

Go back and look at your work again. Have you used the best words available

Take a look at your audience. Know what they can and what they will read.

in every case? "The difference between the right word and the almost-right," said Mark Twain, "is the difference between lightning and the lightning bug."

Would analogies or comparisons, facts, examples or quotes brighten your material? Finally, are there any questions left unanswered? Fill it out and tighten it up.

Then check out the spelling and punctuation. You've been learning the rules since grammar school. Just apply them.

Or maybe you never really learned the rules. Prof. Morrow from the T. & A. M. Department claims a four-page handwritten paper turned in to him contained a record 136 misspelled words. Those odds are almost 1:4! Wood you be annoyed if you had too read a paper with that many mispelled words? Naturally.

Save yourself a lot of time for the rest of your professional and private life and learn the simple, logical principles now. Then you won't waste time looking them up each time you're in doubt.

Some words you'll misspell over and over out of habit. List them, learn to spell them correctly and make a real effort to memorize them. Never be afraid to use a dictionary.

As for punctuation, yes, learn the rules. They'll tell you non-restrictive clauses and phrases (ones that aren't essential to the meaning of the sentence) are set off on both sides by commas. And learn the placement of quotation marks in regard to other punctuation. It's simple:

1. Always place periods and commas inside the quotation marks.

2. Always place colons and semicolons outside the quotations.

3. Place exclamation points and question marks inside or outside quotation marks, according to which unit of thought they're meant for.

To punctuate reference paper footnotes and bibliographies, see a style sheet in any good modern English text. Generally the elements of the references are listed in the descending order by which you would locate them in the library, i.e., title, volume, page, etc.

Now, if everything's correct, you can take the last step. Read your paper aloud. Does it flow or does it stumble? Make the repairs. The smoothness of your writing will be the last X factor, for once you've mastered the basics, it's your style that will win your audience. When you have reached the point at which you feel you're "just talking along"—with the proper degree of formality or casualness, of course—then you have succeeded; your reader will wish he could write that well. The paper is done.

Writing is a long but logical process and with practice, you will take these necessary steps automatically. And you may not believe it, but all this can be done while you're studying engineering if you'll accept these challenges.

1. View every written assignment as a chance to improve your skill in self-expression.

2. Pay attention to your rhetoric instructor. He knows the best way to teach you one of the most important skills you can master.

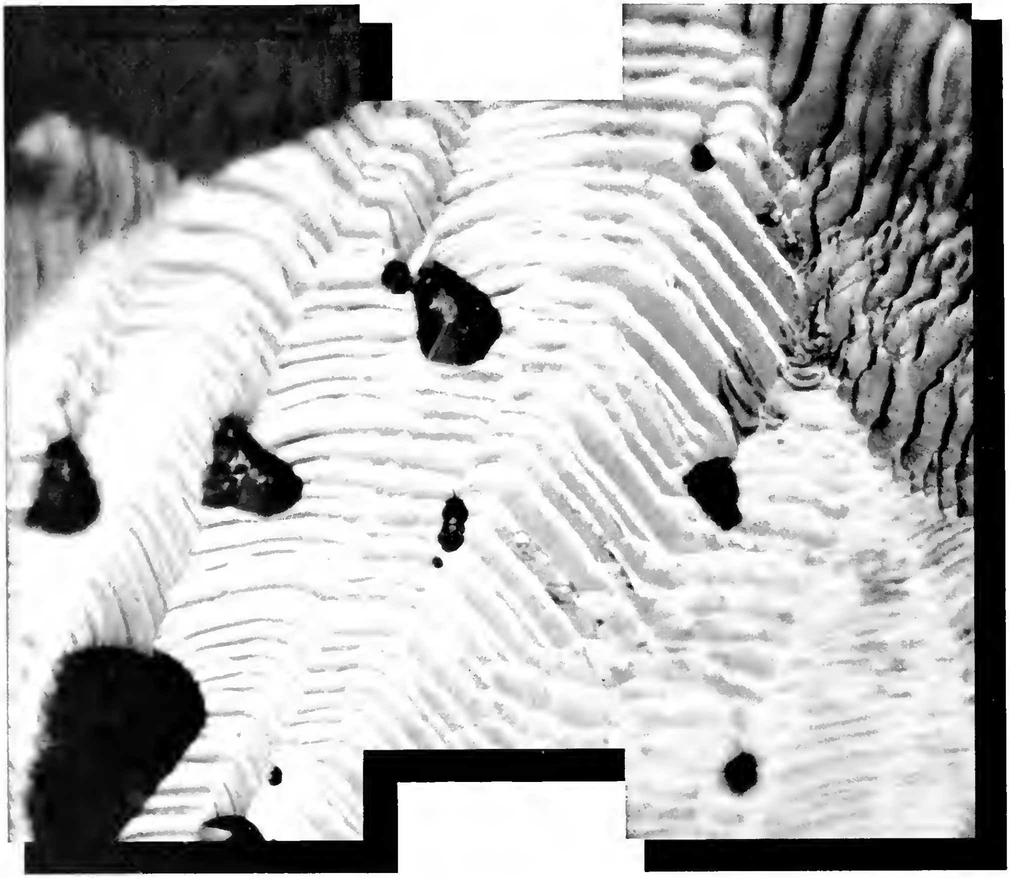
3. Try to fit in courses in public speaking, expository writing and business letter writing. Learn how to sell yourself and your ideas.

4. Take time out for an extra-curricular activity which requires you to communicate.

5. Write. Write as much as you can. Write letters to your parents, letters to your girlfriend, letters to the editor. Write it down. Take pride in the way you express every thought.

All set? Congratulations. You've overcome the greatest barrier in learning to communicate—the desire to do it.

The industry that



HUMAN CAPABILITIES *and* SPACE FLIGHT

By Milton Haefner

Introduction

In recent years, a frequently asked question has been, "Is it possible to put a man into space?" From a technical point of view, the answer to this question would be yes, a man can be put into space.

However, man is designed to exist within a comparatively limited environment. Due to his chemical and structural composition, he can tolerate only relatively small changes in this environment. Therefore, the question of putting a man into space is largely a question of whether or not man is capable of surviving in space. Looking at Figure 1, it can be seen that many of man's physical limitations and tolerances fall outside of the range of conditions which exist in space. From this, it is evident that if man is to survive in space, he must either adapt to his new environment or change the environment.

It is impossible to present here all the problems which must be faced and solved before man can enter into his new environment, space. Two important factors, however, which must be taken into consideration are man's tolerance to stress caused by acceleration and man's reaction to lack of weight both of which must be encountered if man is to accomplish space travel. Another consideration is the internal environment which must be maintained in the space vehicle if man is to continue to function efficiently. Decompression and radiation problems must also be taken into account when studying the possibility of survival in space. A less often considered aspect of the problem of man in space is the psychological-social problem which will be encountered due to confinement inside a small container.

Acceleration

These and other problems will now be considered in more detail. Due to the method by which man will be propelled into space, it is inevitable that he will be subjected to high acceleration forces. There are two factors which will greatly affect man's ability to tolerate this force. These factors are the position of the man relative to the direction of the acceleration and the duration of time for which the acceleration will last.

It has been calculated that during take-off of a three-stage orbital rocket,

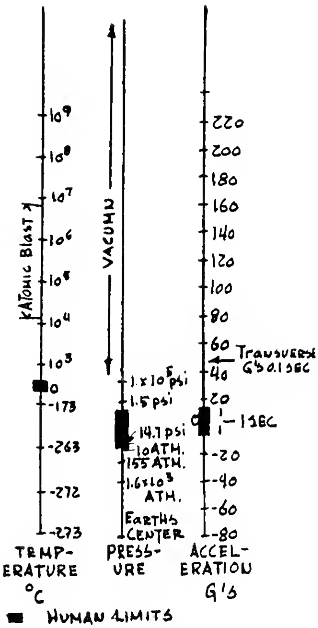


Figure 1: Man in the Physical World

the passenger will be subjected to accelerations ranging from 3 G's for 10 minutes to 10 G's for 3 minutes. However, these are not the only acceleration forces which will affect the pilot of a space vehicle. For instance, in a turning maneuver at high velocity, normal accelerations as high as 40-50 G's may be experienced. These accelerations can, of course, be reduced by increasing the turning radius of the maneuver while holding the velocity of the vehicle constant (see Figure 2).

Consider now how a man's tolerance to acceleration varies with the direction and duration of the force. When man is in the upright position, with the acceleration acting along his longitudinal axis, he has the lowest tolerance to acceleration. Refering to Figure 3, it can be seen that an acceleration of three G's sustained for a duration of one to two minutes would cause black-out. The cause of this condition is that the blood pressure is not great enough to overcome the added weight of the blood, and the blood then drains away from the eyes. Unconsciousness soon follows black-out.

There is, however, a significant increase in tolerance to acceleration when the subject is placed in a supine or prone position. The only difference between the supine and prone positions is that supine refers to lying face up while prone refers to lying face down. Again refering to Figure 3, it is seen that at ten G's acceleration, man's tolerance limit is now about three hundred seconds or five minutes. At an acceleration of three G's, a man's useful tolerance limit would be about six thousand seconds or one hundred minutes.

From the acceleration point of view, it then appears that the tolerance limits of man will not cause too serious an obstacle in the problem of sending man into space.

Weightlessness

Weightlessness is perhaps one of the most difficult orbital conditions to reproduce under laboratory conditions. There are only two ways in which it is possible to simulate this gravity-free condition. One of these ways is to place a body in a state of free-fall, and the other is to transport a body in an air-

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Turning Rate deg/sec	Radius Mi.	Time Min	G's ft/sec²
3.0	80	1.0	35.6
2.0	120	1.5	24.0
1.0	240	3.0	12.0
.5	480	6.0	6.0
.25	960	12.0	3.0

Figure 2: Normal Accelerations Due To Turning Rates

craft which is describing a parabolic arc. Both of these methods of simulating the gravity-free condition have the obvious disadvantage that the time duration of the condition is too short to determine the effects of prolonged weightlessness.

There are, in general, two sides to the problem of weightlessness. The first is the more obvious physiological aspect, lack of muscular co-ordination and disorientation being two of the greatest factors.

Decrease in muscular co-ordination is expected to take place when the gravity free state is first experienced, but adjustment to this condition will probably occur within a relatively short time. This lack of muscular co-ordination is caused by the fact that man is normally accustomed to exerting a certain amount of muscular tension in order to accomplish some motion. However, in the weightless state, the same amount of force will result in more motion than is anticipated; the first attempts to compensate for this overexertion will result in decreased muscular co-ordination. The final answer to this question will not be known until an orbital vehicle is actually put into operation, because this alone will provide a gravity-free condition of sufficient duration for adjustment to take place.

Orientation depends on certain sensory organs, some of which depend on gravity for their stimulus, and, as a result, weightlessness will cause these gravity-sensitive preceptors to be ineffective. Nerve endings are one example of these preceptors; by indicating where the pressures due to weight are concentrated, they thereby indicate position. To clarify this statement, consider this example: if the soles of a man's feet detect pressure concentrations, he knows he is standing, while if the concentrations are distributed on his back, he knows he is lying face up. Another organ which aids the sense of orientation is the inner ear which again depends on gravity as a stimulus.

There is, however, one means of orientation which does not depend on gravity as a stimulus. This is visual orientation and it is believed by most authorities that this means of fixing one's position and motion with respect to the interior of the vehicle will largely overcome the effects of disorientation due to weightlessness.

In addition to the physiological problem, there is also the possibility of a psychological problem arising as a result of weightlessness. Since the first men to be chosen for space travel will be above-average physical specimens, there is the probability that they will also have an above-average interest in their bodies. There is a correlation be-

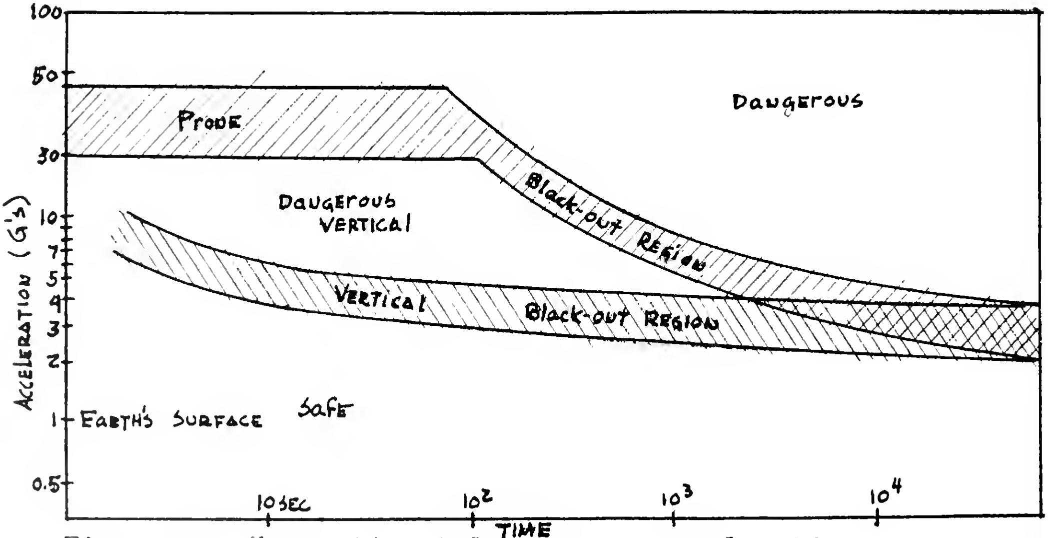

Figure 3: Human time-tolerance to acceleration

tween masculinity and physical attributes and as a result, lack of co-ordination may cause some concern as to loss of masculine traits. This may in turn cause some men to strive to regain their self-confidence by aggressive actions and bullying. Of course, in the close quarters of a space vehicle, this is intolerable.

Cabin Environment

If man is to survive and to continue to function efficiently in space, then he must be provided with an environment which, within moderate limits, will approximate that on earth. Pressure, temperature, humidity, and chemical composition of the atmosphere are the most important considerations in determining man's environment requirements.

There is a great deal of correlation between pressure and oxygen requirements. At sea level, 14.7 psi pressure with an oxygen content of 21 per cent is sufficient to provide man with needed oxygen supplies. However, as the total pressure of the atmosphere and the partial pressure due to the oxygen decrease, a greater percentage of oxygen is required. When the total pressure has been reduced to about 3.5 psi, 100 per cent oxygen is required to give the effect of sea level breathing. From a technical viewpoint, it is not feasible to consider a 100 per cent oxygen atmosphere and as a result, pressures considerably above 3:5 psi will have to be maintained. Ideally, sea level pressures would be desirable from the physiological standpoint, but the resulting pressure differential in space vehicles would provide serious structural difficulties.

The oxygen consumption rate of man depends on how hard he is working. Figure 4 gives some values of this consumption rate, a reasonable overall average being about 24 cu. ft. per day or 2 pounds per day. Corresponding to this oxygen consumption rate, about 21.6 cu. ft. or 2.5 pounds of carbon dioxide would be released per day.

It will therefore, be necessary to provide means of supplying oxygen and eliminating carbon dioxide. Since the first attempts at manned space flight will most likely be of short duration, the oxygen problem will probably be solved by storing a sufficient supply ahead of time. The carbon dioxide problem will most likely be solved by utilizing a chemical reaction which will absorb or decompose the carbon dioxide.

Temperature and humidity are also two important aspects of cabin environment. While man can withstand reasonable temperature extremes for a short period of time, it must be taken into account that man in space must be an efficient mechanism. In order for him to function properly for extended periods of time, provisions must be made to maintain a comfortable temperature-humidity level. The problem of heating due to friction will be accounted for by providing sufficient insulation and a possible heat sink. However, the amount of heat produced by the human body is approximately 3,000 cal. per day or about 12,000 B.T.U. per day. As a result, the same insulation which earlier protected the man may now cause him some discomfort if suitable air-conditioning is not provided. Perspiration will over a period of time, raise the humidity level if steps are not taken to prevent this. However, this can easily be overcome by use of chemicals which absorb moisture.

O_2 USED (PER day/MAN)		CO_2 RELEASED (/day/MAN)	
Cu. ft.	lbs.	cu. ft.	lbs.
19.2	1.59	16.8	1.9
21.6	1.79	19.2	2.2
24.0	1.99	21.6	2.5
28.8	2.39	26.4	3.0
33.6	2.75	31.2	3.6

Figure 4: Oxygen Consumption and Carbon Dioxide Release

Decompression

Most factors point to the desirability of employing a sealed cabin for manned space vehicles. However, in space this can cause a severe problem in the event of meteorite collision. While it has been calculated that the chance of collision with meterites of significant size is extremely remote, the problem must be considered.

Decompression means loss of pressures due to atmosphere and it is here meant to be a relatively fast loss of pressure. The physiological results of this decompression include hypoxia and decompression sickness.

Hypoxia, or oxygen starvation, is probably the more serious problem. Holes caused by meteorites would probably be of the order of one inch in diameter, and it has been calculated that with an initial pressure differential of 14.7 psi in a 500-cu. ft. cabin, hypoxia would occur in two minutes while total decompression would not occur for almost ten minutes. It can then be seen that the time it takes for hypoxia to occur would be the limiting factor when considering decompression effects.

Decompression sickness is the result of two things: lowered boiling points and gas expansion. From Boyle's Law it is known that as the pressure applied to a gas is decreased, the volume increases. Because of this, any gas which is trapped in tissues when decompression occurs will expand causing tissue damage. "Boiling of the blood" will also occur because the effect of lowering pressure on a fluid is to reduce the vaporization temperature. When the pressure becomes sufficiently low, normal body temperature becomes the boiling point of body fluids and bubbles will then form.

One possible solution to this problem is the use of emergency oxygen supplies which can be released to prevent decompression for a sufficient period of time for the crew to don pressure suits.

Radiation

Without the protection of the earth's atmosphere, which filters out most harmful radiation, man will be subjected to heavy cosmic and solar radiation.

Solar radiation, which is ultraviolet in nature, will cause severe sunburn and heating problems. Since man's first space ventures will most likely be accomplished entirely within the confines of the space vehicle, sunburn problems will perhaps cause some concern. It is hoped

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that the temperature control will be accomplished by making some areas of the vehicle radiation reflectors while other surfaces will absorb radiation.

Cosmic radiation is at present largely a matter of speculation. It is known that as altitude increases primary radiation (alpha, beta, gamma, etc.) also increases. It is believed that the effects of this radiation on man will be much the same as the effects of radiations which are found on earth. However, since heavy radiation shielding is impractical in space vehicles, the solution to this problem is not readily apparent.

Social-Psychological Problems

The most pressing psychological problems will be those of isolation and boredom. Once a space vehicle has been successfully put into orbit, there will be little for the crewman to do except for occasional monitoring of instruments. In addition, there will be physical restraints due to the restricted size of orbital vehicles.

Studies on the effects of sustained isolation and boredom indicate reduced intellectual capacities, emotional depression, and a tendency toward hallucinations. Of course, these conditions will be intolerable in prolonged space flights. There are however, various ways of overcoming, to a certain degree, the effects of isolation and boredom. Radio or television links with earth would greatly relieve the sensation of being separated from reality. Small games or problems which would present a challenge to man's intellect would also be of great help in relieving boredom.

As space flights increase in length and crews increase in size, the problem of inter-personality relations will be of interest. There is much truth in the adage, "Familiarity breeds contempt." Tests have indicated that even the best of friends can become enemies when subjected to each others company for 24 hours a day for extended periods of time. The solution to this problem is that enough room must be provided to assure each individual a certain degree of privacy. It has also been shown that personalities which are too evenly matched will not prove to be a good condition for extended periods of time. This brings up the possibility of mixed-sex crews because of the obvious personality differences. However, on flights of durations over a year's length, this could also produce some obvious difficulties.

Summary

While from a technical point of view, man in space is quite possible, physiological and psychological problems must also be taken into consideration before manned space flights are undertaken.

However, it would seem that most of these problems can be solved with present day engineering practices. It is hoped that satellite programs now in progress will shed light on some problems such as radiation effects and meteorite concentrations about which relatively little is now known.

With all problems taken into consideration, it is reasonable to make the statement "Man in space is possible."

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Motel Skyscraper

A motel building, 25 to 35 stories high and costing $18 million, is planned for downtown Fort Worth. Parking will be on the same floors as the rooms. The building also will include an auditorium seating 6,000 to 8,000 persons.

Help Wanted!

Positions are available on the editorial and production staff of The Illinois Technograph. Experience of this type is invaluable for personal satisfaction, job references, and development of creative skills. Applicants need not be engineering students. Interested persons may call the editor, Dave Penniman, at 2-4254 or leave their name at The Technograph office in 215 Civil Engineering Hall.

JOB OPPORTUNITIES OVERSEAS

The Myth and the Truth

By Judy Ondrla

Do you see yourself in a year or so with a degree in one hand and a suitcase in the other, boarding a transcontinental jet on the way to a job overseas? You have heard of fellows who graduate, join a firm and go to some ideal foreign country to represent that firm. You probably have thought, "What a setup! Get paid to travel! I'll have to find out about getting one of those jobs." And then perhaps your daydream went on to Italian wines or German beer or French women.

Lots of engineers dream of just the same thing. Mrs. Pauline Chapman, head of the engineering placement office, says each semester she is asked repeatedly about firms looking for men to relocate abroad and each semester she must tell many job hunters, there are NO opportunities for starting engineers overseas. The statement, of course, must be qualified. There are rare cases, but Mrs. Chapman and representatives of engineering firms who conduct interviews on campus prefer to take the absolute negative viewpoint because of the rarity.

There are two main reasons why a starting engineer is not sent overseas. One is economic, the other diplomatic.

Mrs. Chapman and a representative from Boeing Aircraft list the following reasons why few starting engineers have a chance for foreign employment. First of all, companies realize that recent graduates look upon an overseas job as a two-year paid vacation. They realize the engineer thinks of the job as a final "fling" before settling down to responsibilities of a wife, home and children. The companies know that the engineer doesn't want to work overseas more than two years. The engineers don't want to make a career of foreign work. It's a well-known fact that a person just starting with a firm cannot know everything he needs to know to represent the firm; therefore men with five or ten years' experience are much better investments. It's common sense to companies that they save money by sending an older, more settled and more experienced man overseas. Also most of the jobs available are top management positions that only experienced men are qualified to fill. Mrs. Chapman says she has talked with many company representatives on the subject of foreign employment. Almost every company, she says, wants at least five years' experience in the representatives; most ask for ten years.

Tied in with the economic savings mentioned above, the Boeing representative says that often an engineer who gets an overseas job doesn't want it for long. American firms overseas are mainly in countries like Saudi Arabia and South America. The Americans must lower their standard of living, and not many men can adjust. The men that do go over won't find large, clean homes with modern plumbing and refrigeration. The foods available aren't fresh vegetables or government inspected meats. He says most Americans, unused to the native diet, get sick when they eat the food.

The above are superficial reasons, however. The real reasons lie in the realm of diplomatic relations. When an American firm contracts with a foreign country to build a branch office in that country, the firm must agree to hire as high as 95 per cent native help. The remaining five per cent employed are, of necessity, Americans in a supervisory capacity. This again emphasizes the necessity of at least five years' experience.

Not only must 95 per cent of the employees be native, but there is an understanding between the firm and the government that as time passes, natives will be trained to take over these supervisory positions. The longer a company has been overseas, the smaller the need for American help.

Another source of native help to fill engineering positions overseas are the great numbers of men who come to the United States from a foreign country to get a degree. These natives, after receiving their degrees, go back to their homes. They will find any kind of job once they are home. These men literally sit around and wait for an American firm to open in the area. And these are the men that are hired. They are well-trained, qualified engineers. American firms can't afford to not hire these men; and the firm knows that these engineers are not just looking for a vacation. In most cases native engineers can be counted on as permanent help in that area.

One other strong reason for employing natives is the fact that it is just good business sense. Natives do a much better selling job to their own countrymen than any American could do.

Another main source of overseas engineering jobs is through the federal government. Tom Page, University representative in charge of placement with government agencies, says that an overseas job is not the first job an engineering graduate will get. He must first go through a training period. Government pamphlets on available jobs qualify openings for "mature, competent professional and technical specialists of recognized stature." These men are needed as "experts in the fields of engineering."

The closest a college graduate can get to a government overseas job is as a support specialist. Support specialists work with persons of recognized stature. But here, too, is a qualifier. These specialists must have "an excellent formal education (or its work equivalent) . . . and several years of professional work experience. . . ."

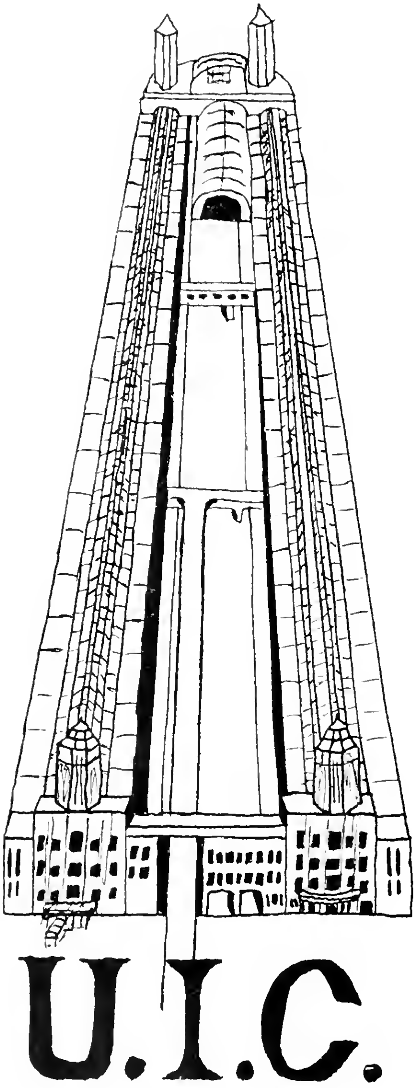
If you still want to go abroad, there are a few possibilities. Some of the national advertising of U. S. firms, published in *The Technograph* offers foreign opportunities. Look into these firms to find out what they are offering.

G. Brower, Boeing's representative, sees a somewhat optimistic future for overseas jobs, however. He feels that as industry develops overseas, so will job opportunities. There is a trend starting, he says, for companies to contract business in other countries. Several automobile and electronic firms are already setting up firms in Europe. Brower feels foreign aid and the United Nations' policies should bring some increase in jobs.

But the most practical thing is to resign yourself to at least five years' training here in the states. If you can prove yourself with your company, they may be anxious to send you as a representative.

Women in Engineering

By Eileen Markham



Have you noticed the shadow on engineering classes? What shadow?—that question is easy to answer if you've been reading the papers.

It seems that not enough women are entering the scientific professions. Statistics to prove this have appeared in almost all major news publications at some time during the month of December, 1959. So what?—the number of engineers, chemists, physicists and other technicians could increase by at least fifty per cent if the qualified women entered these fields.

Let's look at these facts rationally: *Do we need them?* Of all Russian engineers fifty per cent are women. (Russia has more engineers than the United States.) Less than one per cent of our engineers are women.

Do we need engineers? I'll leave that answer to your discretion. Just glance at the Sunday employment section of any major newspaper.

Can the women do the same work men are doing? With the exception of the jobs which involve heavy construction, engineering endeavors are not too physically demanding. The mental work can be done by any intelligent person with the proper training. And, since brains do not have sex, this can be achieved by a woman.

Oh! but, engineering is a man's field! Today it is. Tomorrow it needn't be. Girls may have to work harder to acquire those extra intuitive judgments which are part of a commonplace descriptive geometry situation. Yet, some of the world's foremost physicists and mathematicians were women. Even the men have produced no equal to Madame Curie who achieved two Nobel Prizes.

Why don't women enter engineering? Look at our own U. of I. Undergraduate Bulletin. The information on the engineering curriculum begins with a sentence about the training of "men" for engineering professions. For another thing, women are hesitant to enter the man's world. The competition is keen. It took over a hundred years for women to be accepted in medicine and law. (They are still frowned upon by many of their male contemporaries.) The same problem exists in engineering.

Surely, a more casual atmosphere exists in an all male class or place of work. But need this be reason for the instructor in a technical course to ignore or downgrade a woman student? These things have been known to occur. I, however, say NO to this treatment! Why? Because: We're needed! We're interested! We expect to earn our degrees and become qualified and capable members of an extremely vital profession. That is why we are engineers.

From the Pier . . .

SOLID ROCKET FUELS

By Mike Murphy

On the night of April 1, 1926, Dr. Jos. C. Patrick, a chemist and ex-physician, went into his laboratory to check on an experiment. Little did Dr. Patrick realize how important this experiment would be to the whole world. Dr. Patrick was trying to concoct a new type of automobile anti-freeze. Instead of finding a clear liquid which he expected, he found something that was dark and syrupy and having a smell like rotten eggs. Dr. Patrick viewed the experiment more or less as a failure. He used pieces of the unknown substance, which hardened upon cooling, for paperweights. In 1928 a man named Bevis Longstretch became interested in the substance which Patrick had named Thiokol, which is derived from the Greek words thio (sulphur) and kol (glue). It was found that Thiokol was impervious to petroleum and therefore could be used as an extremely efficient gasket for sealing gasoline tanks and other petroleum products containers. The two men searched for a place to open a factory but were refused many sites because of the sulphurous stench produced when Thiokol was processed. Finally they were able to set up a factory in Trenton, N. J. Business was generally poor but during World War II it improved because of the demand for gaskets for airplane fuel tanks. During the year 1941 the company made $89,000. It was not until after the war that the possibilities of Thiokol as a solid rocket fuel were investigated to any extent. Thiokol has been a leader in the field of solid fuels ever since that time. In 1958 the sales mounted to $2,000,000.

Solid fuels have definite advantages over liquid fuels. They can be pocketed into smaller spaces because of their high density and the fact that the oxidizer is built in. There are few moving parts in the combustion chamber which reduces the chance of mechanical failure. Solid fuels rockets are easier to transport and easier to fire.

On the other hand there are several disadvantages to solid fuels. Solid fuels rockets are relatively less powerful than liquid fuel rockets. There is a chance that the "grain" or charge may crack and thus expose more surface area. This condition will produce erratic flight resulting from velocity changes. Another disadvantage is the fact that solid fuels misses are hard to steer. These problems are rapidly being solved and the future of solid-fuels looks good.

Due to the extensive research in the field of rocket propellents many different types have been developed in the past few years. Most of the present day rocket fuels deliver in the neighborhood of 200 lbs. of thrust for each pound of fuel consumed per second but higher values are rare. One example of solid fuel having more thrust is one which Allegany Ballistic Laboratory has been working on and is reported to be about 285.

A term known as specific impulse is generally referred to when solid fuels are being compared. Specific impulse is the impulse per unit mass of a propellant expressed in units of pound seconds per pound. The final height reached by a missile is proportional to the square of the specific impulse.

In regard to solid fuels specific impulse can be found by multiplying the thrust by the time and dividing by the mass of the propellent. Another factor which enters into the computing of the specific impulse is the operating pressure in the combustion chamber, or the ratio of the nozzle exit area to throat area, and on the outside pressure. To achieve space flight with chemical propellants we need those that give the most energy per unit weight.

The specific impulse of most solid fuels has increased by about 70 pound-seconds per pound, but there is little hope of passing 300 since the energy of solid fuel is rather limited. Some double-base and composite solid blends offer the best possibilities of exceeding 250 pound-seconds per pound, but 245 will be the probable limit for standard carbon-hydrogen-oxygen-nitrogen types.

Some of the more important solid fuels are Ballistite, NDRC, and Cordite.

Ballistite can be safely stored at 120 degrees F; its ignition temperature is 300 degrees F, and its flame temperature is about 5000 degrees F. The cost of this material averages five dollars a pound, but the specific impulse of 210 and the exhaust velocity of nearly 7000 feet per second are higher than those of the cheaper materials NDRC and Galcit. The exhaust velocities of the latter are 5150 and 5900 feet per second, respectively.

NRDC stands for National Defense Research Committee and is a composite propellant, fuel and oxidizer separate. It costs only one dollar a pound, for specific impulse of up to 180 pound-seconds per pound. The flame temperature is, however, only about 4,000 degrees F., and the burning rate is relatively low.

Cordite and Galcit are usually made up of organic polymer fuel and inorganic nonplastic oxidizers.

High exhaust velocities from some solid fuels have been reported in the neighborhood of from 4,000 to 8,000 miles per hour. These fuels, for the most part, possess undesirable physical properties.

One property of a solid fuel which is important to know is its burning rate. This figure tells the weight or amount of propellent consumed per second per square inch. Most burning rates are between 0.2 and 2.0 inches per second.

In order to reduce the thickness of solid fuel rocket walls, the charge has a hole from top to bottom. This hole is generally star shaped. The purpose of this is to permit the charge to burn toward the wall of the rocket. This situation permits the use of thin wall construction. By varying the geometrical shape and size of the hole different effects in power and burning time can be had.

Today more and more missiles powered with solid fuel are appearing. A few of these missle are the Sparrow, the Falcon, the Sidewinder, the Genie, the Dart, which is used against tanks and the Rat, which swoops down on subs. Familiar to many in various American cities is the Nike-Hercules. The recent success of the Polaris is further proof of the potential use of solid fuel.

More from

NAVY PIER

on Page 30

THE OTHER ROLE OF THE ENGINEER

As Illustrated from Problems of Highway Engineering

By Robert M. Jones

Besides the technical procedures involved in an engineering design, the engineer must consider both public relations and the aesthetic appeal of the project, for they will affect the success of his design. Often, the acceptance of a project depends upon the effectiveness of the exchange of ideas the engineer has had with citizens and citizen groups during the planning stages of the design and, sometimes more important, how the finished project looks to the eye of the public.

The engineer's public relations responsibilities can be summed up in a few paragraphs.

First, he must be able to get along with the public; it is, in effect, his employer, whether he works for a government agency, for industry, or for a consulting firm assisting government or industry.

Second, he must plan carefully enough and far enough ahead that he can explain his actions at any stage any time. In the case of highway design, such explanations would include why he chooses a particular route, why his design provides for drainage of storms which are likely to occur at only five year intervals, or why he sets a particular design restriction, as far as he is empowered, on the speed and use of a given section of highway.

Third, he must be able to fare successfully under the fire of public comment and criticisms which accompany his decisions. Such discussion often comes from organized citizen groups and newspaper campaigns in a form which tends to put the engineer on the defensive. He may thus be caught between two factions of opinion, but must work his way out while satisfying both sides. Of course, he should have anticipated and been prepared to answer many of the arguments against his decisions. It must also be realized that some problems are incapable of solution without hurting someone.

In justifying the construction of a highway, for example, the engineer must concern himself with the economic benefits to the whole area under consideration. In doing so, he must weigh all possible highway locations in relation to whether they provide the best service both for the overall region and the specific area through which the highway passes. Often these considerations are in conflict; he must then work out an equitable compromise. For safety, one particular location might require a reduction in the speed limit over a section of bridges and curves. This is opposed to the desirability of a higher limit which provides rapid flow through the entire highway network.

Preventing or limiting truck traffic on a parkway can cause troubles for the communities through which the trucks must then pass. Eventually the truck traffic becomes such a problem that it demands a new highway to take care of trucks.

A recent case in New England, Connecticut, in particular, involved the Merritt Parkway and the Wilbur Cross Parkway which, for many years, formed parts of the only multi-lane highway between New York and Boston. These parkways were restricted to passenger car traffic, and, even with such a restriction, were crowded. At the time they were built, shipping by truck had not become as large an industry as it is today. After World War II, the industry blossomed with numerous heavy trucks to take care of the increased volume of shipping. These trucks were forced to travel on U. S. 1, the Boston Post Road, through the centers of towns along the northern coast of Long Island Sound and on deeper into the state.

The inevitable effects on these towns were traffic congestion, confusion, and inconvenience, plus destruction of city streets with accompanying increased taxes for residents.

The result of a concentrated campaign for a solution to the problem was the Connecticut Turnpike. It was especially designed for trucks, though passenger cars are allowed if they pay the tolls.

The need for a highway such as the Connecticut Turnpike should have been foreseen at the time the two parkways were designed. Even if it was, the rate of growth of the trucking industry was probably not correctly forecast. As a consequence, the volume of traffic at which more highway facilities would be built was reached at an earlier date so the engineer was caught short.

In the middle of the Connecticut Turnpike situation was the highway engineer. He was expected to make everybody happy with his solution to the problems of routing, alignment, curvature, sight distance, and related subjects. Everyone, as usual, expected a dream highway which would neither disturb the towns through which it passed nor evict people from their homes. Since this as obviously impossible, the "other role of the engineer" played an important part in the development of the Connecticut Turnpike. There, the route passes through some of the most heavily populated and wealthiest counties in the nation; in addition, these counties are some of the most beautiful and historic in New England. Thus, the usual pressures were multiplied.

The engineer must be most careful in his relations with the owners of the prospective site of a highway. He must be certain he does not needlessly destroy any of our country's heritage in the form of old houses, historic sites, fine trees or beauty spots, and other places of sentiment.

In this light, he must be able to account for each of his design actions, such as why he chose to put an elevated section of highway in a metropolitan section rather than skirting the downtown area by building through the cheaper land of the slums. He must be able to explain, in terms that the layman can understand, why alignment, sight distance, and volume of excavation dictated this choice rather than ignoring the honest questions of interested though perhaps irate landowners.

Aesthetic Design Important

Besides achieving a functional design, the engineer must consider the effects the project will have on the people it is meant to serve. Beauty should be included, for although it sometimes costs more, the favorable reactions of the viewing and using public are well worth the added expenditure. It must be remembered that the work of an engineer will last for many years and thus should be aestically pleasing.

Highway bridges, for example, could be perked up by using unusual shapes or combinations of concrete, steel, aluminum, and other materials. Or, extremely simple though aesthetically balanced masses could be used.

Since concrete requires surface grooves to arrest and contain cracks, good architectural use might well be made of these grooves. With little or no extra cost, the grooves could be ar-

(Continued on Page 30)

IN AND AROUND CHICAGO

By SHELDON ALTMAN

More Modernizing

A new government center costing 63 million dollars will get top priority soon as the next project in the comprehensive plan for modernizing Chicago's downtown area. The project will house local government and is to be built in the block bounded by Washington, Dearborn, Randolph and Clark.

In February the mayor, heading the public buildings commission, is scheduled for a report that will give the "ok" for the project.

The project will consist of two 18-story buildings, and will house courtrooms for Superior, Circuit, and Municipal courts and additional local government office space. The remainder of the block will be a parklike plaza, with such facilities as a skating rink in winter. This is just one of many projects that will renovate the downtown area. The Metropolitan Exposition center on 23rd street and the lake is well under construction.

The first building will be a federal government skyscraper in the half block along the east side of Dearborn between Adams Street and Jackson Boulevard. After this is completed and is housing the federal courts and offices, the present United States courthouse bounded by Adams, Dearborn, Jackson and Clark will be razed to make way for the second building.

A project for consolidating the railway terminals and building the University branch on these 130 acres is also under consideration.

Big Nuclear Shipment to Chicago

A 1350-pound shipment of nuclear emulsion, largest order of its kind and worth $100,000 has arrived at the University of Chicago from England. Prof. Marcel Schein, physicist, and his associates in Operation Skyhook, plan to use the emulsion in a new study of high-energy cosmic rays.

It will be sent aloft in two giant balloons off the West Indies. The emulsion is highly sensitive material and will replace photographic plates in the gondolas of the balloons. They will be "stacked" to give a three-dimensional "track" of cosmic rays.

First Full-Length Picture in 43 Years

Chicago is on its way to becoming the midwest's Hollywood. For the first time in 43 years a full-length feature has been produced in Chicago. All concerned with the production are Chicago talent. This includes the producer, director, actors and technicians.

In recent years many studios have been engaged in the production of industrial, educational, public service and Armed Forces training films. Some Hollywood scenes and some television dramas have been shot here, but the recent completion of "Prime Time" marks Chicago's first effort to emulate the old days of 1916 and Essanay Studios.

Between 1897 and 1916, long before the first camera turned in Hollywood, Chicago was a major producer of feature films. Essanay Studio had people such as Charlie Chaplain, Gloria Swanson, Wallace Beery and Tom Mix working for them.

The title "Prime Time" is based on the concept of youth as the prime of life and is concerned with the problems of youth. When the script called for specific locations the film-producers searched out locations bearing the correct names within the Chicago area. When a teen-age hangout called "Luiga's" was needed a pizzeria was used with that name. Nightclubs and taverns in the area were also utilized. This city may soon be renamed "New Hollywood."

At The Pier

Some more new courses have been added for the benefit of engineering students. These include Math 315, Linear Transformations and Matrices; Math 342, Differential Equations, an introducductory course in partial differential equations and Physics 281, Intermediate Atomic Physics; Physics 322, theoretical mechanics. M.E. 221 is again being offered. It was first offered last semester. This is all part of UI's expanding program.

THE OTHER ROLE OF THE ENGINEER

(Continued from Page 29)

ranged in pleasing geometric patterns.

The highway right-of-way also needs much attention. Its landscaping, including informative signs, must be integrated with the natural surroundings. All should be at least as good as if not better than the quality of the overall area.

Economy Versus Safety

The engineer must seek an economical solution, but in doing so he sometimes plays a deadly game. When getting fill material for a highway, as an example, he has to balance one evil against the prospects of another. Borrow pits, as the sources of fill material are called, can also be accident and health hazards. While the cost of hauling material from an area where excavation is already necessary is sometimes more than the cost of excavating from a nearby field, the engineer must consider the effects of his decision to open a borrow pit.

Usually with a borrow pit, a field is lost from farming or from prospective home or factory sites. The proper use of a borrow pit should be both to provide fill material and to improve the effectiveness of the surrounding in looks and use.

If a low spot is created, water will collect during storms, proving a hazard to children and grownups alike as accidents can always be associated with pools of water. The standing water presents a health hazard as it can harbor mosquitoes and other disease-carrying insects. Also, it can pollute drainage waters which in time pass through the possibly contaminated water of a borrow pit.

These situations are seldom, if ever, desirable. Besides being a danger to all forms of life, they detract from the beauty of the highway vicinity.

Responsibility Lies in the Engineer

In short, the engineer has a high level of social and aesthetic as well as technical responsibility for his actions. The demands upon him are manifold, and do not stop with a purely practical solution to his problems. He works with people, and for the community; he must therefore consider all the effects of his creation on those concerned.

If he does so, he will find his services more in demand and his leadership more respected and sought. The reason is simple: when people have something good and are happy with it, they will want more of the same. But if they are displeased, they will be reluctant to purchase more such services or to appropriate money for similar projects. Again, the engineer must always remember that his work will be exposed to the public for many years; thus, his professional reputation is at stake with every decision he makes.

The best way for the engineer to help people and to keep them happy is to be honest, to show the engineering reasons for his decisions, and to fulfill his real role—that of diligently striving to make every design as socially desirable, technically efficient, and aesthetically pleasing as possible for the public. Only in this way can the engineer fill his true position of intellectual leadership in our society.

engineers

Automatic systems developed by instrumentation engineers allow rapid simultaneous recording of data from many information points.

Frequent informal discussions among analytical engineers assure continuous exchange of ideas on related research projects.

Under the close supervision of an engineer, final adjustments are made on a rig for testing an advanced liquid metal system.

and what they d

The field has never been broader
The challenge has never been greater

Engineers at Pratt & Whitney Aircraft today are concerned with the development of all forms of flight propulsion systems—air breathing, rocket, nuclear and other advanced types for propulsion in space. Many of these systems are so entirely new in concept that their design and development, and allied research programs, require technical personnel not previously associated with the development of aircraft engines. Where the company was once primarily interested in graduates with degrees in mechanical and aeronautical engineering, it now also requires men with degrees in electrical, chemical, and nuclear engineering, and in physics, chemistry, and metallurgy.

Included in a wide range of engineering activities open to technically trained graduates at all levels are these four basic fields:

ANALYTICAL ENGINEERING Men engaged in this activity are concerned with fundamental investigations in the fields of science or engineering related to the conception of new products. They carry out detailed analyses of advanced flight and space systems and interpret results in terms of practical design applications. They provide basic information which is essential in determining the types of systems that have development potential.

DESIGN ENGINEERING The prime requisite here is an active interest in the application of aerodynamics, thermodynamics, stress analysis, and principles of machine design to the creation of new flight propulsion systems. Men engaged in this activity at P&WA establish the specific performance and structural requirements of the new product and design it as a complete working mechanism.

EXPERIMENTAL ENGINEERING Here men supervise and coordinate fabrication, assembly and laboratory testing of experimental apparatus, system components, and development engines. They devise test rigs and laboratory setups, specify instrumentation and direct execution of the actual test programs. Responsibility in this phase of the development program also includes analysis of test data, reporting of results and recommendations for future effort.

MATERIALS ENGINEERING Men active in this field at P&WA investigate metals, alloys and other materials under various environmental conditions to determine their usefulness as applied to advanced flight propulsion systems. They devise material testing methods and design special test equipment. They are also responsible for the determination of new fabrication techniques and causes of failures or manufacturing difficulties.

NEW ENTRANCE REQUIREMENTS FOR ENGINEERS

By Dean D. R. Opperman

September, 1963, has been approved by the Board of Trustees as the effective date for the new entrance requirements into the College of Engineering at the Chicago Undergraduate Division and at Urbana. These new requirements are the result of a year long study made by a group of engineering faculty men on the Urbana campus. Their recommendations were subsequently approved by the engineering faculty and the senate on the Urbana campus and by the engineering faculty and senate at the Chicago Undergraduate Division located on Navy Pier.

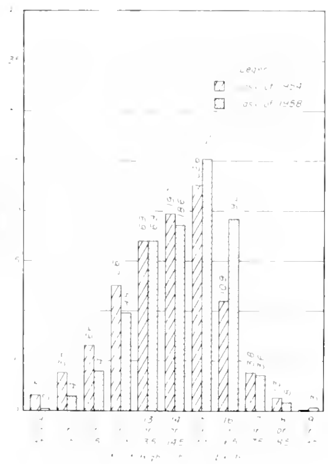
Many interesting facts were discovered in the study made by the Urbana faculty members.

Students entering the College in Urbana as new freshmen have been presenting more entrance credits than required by the College and the University. Further, the trend is for each succeeding class to enter the College better prepared than the class previous to it. A good example is found in mathematics.

In the fall of 1954, 70% of the entering freshmen presented at least 3½ units in mathematics. (A unit is one year of study in one course.) Four years later, in September 1958, the number of students presenting this number of credits climbed to 79%. Last fall, September 1959, the figure rose another 3% to 82%. We feel confident that this trend shown by prospective engineers to take more and more mathematics will continue in the future. The credit for the trend should be shared equally between the College of Engineering which has demanded more mathematics and the high schools which have responded with excellent college preparatory mathematics programs. Last fall several new freshmen received advanced placement in differential calculus and a few students received advanced placement and began their mathematics studies in integral calculus, the second semester calculus course!

Similar trends to take more subjects than required in high school have been shown to exist in other fields of instruction generally considered as college preparatory work. Increasing numbers of students are taking a full four years of English in high school, more foreign language, more science. The increases in all of these areas are noteworthy if we compare the class entering in 1954 with the class entering in 1958. The result of these stronger college preparatory programs is shown dramatically in the accompanying graph.

The University of Illinois requires a minimum of 9 units of college preparatory subjects of admission. The remaining 6 units required for admission may be in any area acceptable to the



Total units of high school subjects in foreign languages, the social sciences, mathematics, the sciences, and English, presented by freshmen entering in fall of 1954 and fall of 1958.

high school for graduation. This graph indicates that very few students entering in either 1954 or 1958 presented only a minimum of 9 college preparatory subjects. A large number of the students presented from 13 to 16 units of this nature, an impressive fact when 16 units is all that is required for *graduation* in many high schools. However, the most significant feature of the graph is the comparison between the classes entering in 1954 and 1958. Those students presenting smaller numbers of credits in college preparatory subjects are in the majority in the class of 1954. The class of 1958 came far beter prepared than the class of 1954 with respect to 15 through 19 or 19.5 units. Several conclusions can be drawn from the graph.

1. High school students are receiving better and better counseling each year with regard to programs of study that will prepare them for college studies.
2. At the present time, entering students are presenting far more "solid" subjects than required for entrance by the College of Engineering or the University of Illinois.
3. A student who minimizes college preparatory subjects in high school will be at a distinct disadvantage when paced in competition at the college level with students who have given thought to their high school programs and have chosen wisely the subjects they will need for their college work.

As a result of these rather intensive studies of the background of the students who entered in 1954 and 1948, definite recommendations were made, and approved, to strengthen the entrance requirements to the College of Engineering. These new entrance requirements, effective in September 1963, are as follows:

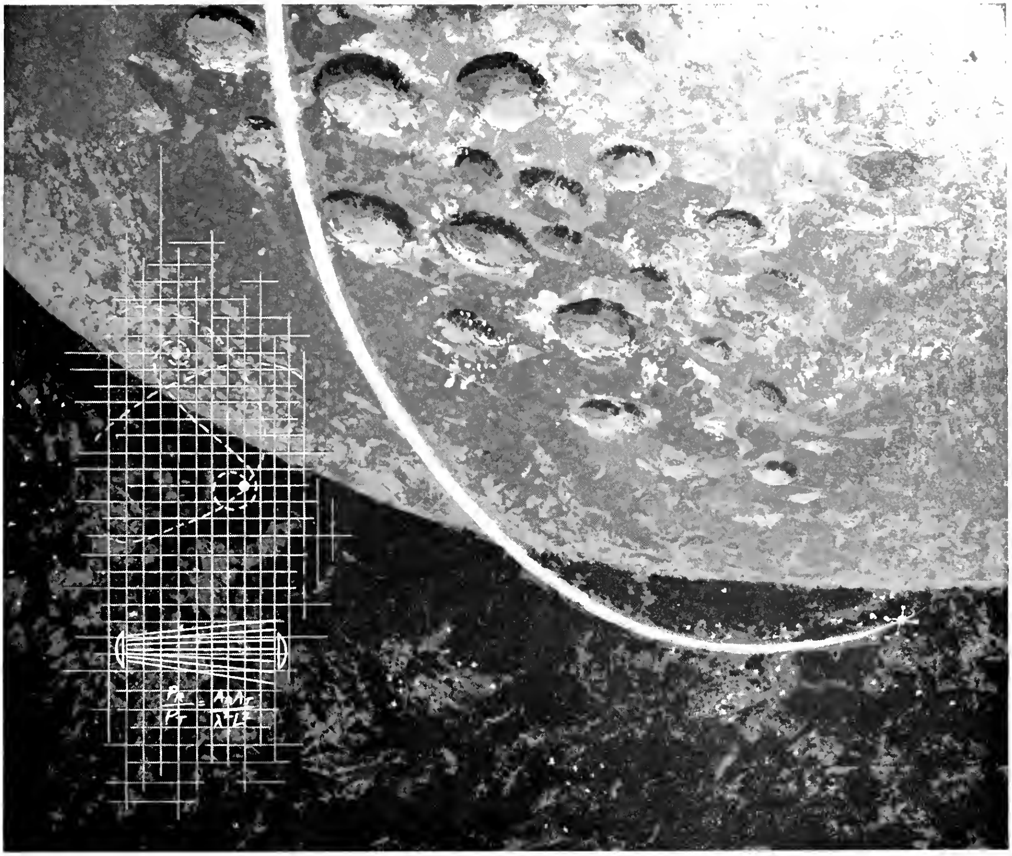
Subject	*Required Units*	*Recommended Additional Units*
English	3	1
Algebra[1]	2	
Plane Geometry	1	
Trigonometry	½	
College Preparatory Mathematics		as available
Science[2]	2	1
Social Studies	2	1
Language[3]	2	as available[4]

[1]Students who have only one unit in algebra and one unit in plane geometry may be admitted on condition that the deficiency is removed in the first year.

[2]Required science must include two units from physics, chemistry, and biology. Botany and zoology may be substituted for biology. General science may not be used as a required subject.

Required language must be two units in one language. Students deficient in language may be admitted on condition that the deficiency is removed during the first two years.

(Continued on Page 36)



What's ahead for you... after you join Western Electric?

Anywhere you look – in engineering and other professional areas – the answer to that question is *progress*. For Western Electric is on a job of ever-increasing complexity, both as the manufacturing and supply unit of the Bell System *and* as a part of many defense communications and missile projects.

These two assignments mean you'll find yourself in the thick of things in such fast-breaking fields as microwave radio relay, electronic switching, miniaturization and automation. You may engineer installations, plan distribution of equipment and supplies. Western also has need for field engineers, whose world-wide assignments call for working with equipment we make for the Government. *The opportunities are many – and they're waiting!*

You'll find that Western Electric is career-minded . . . and *you*-minded! Progress is as rapid as your own individual skills permit. We estimate that 8,000 supervisory jobs will open in the next ten years – the majority to be filled by engineers. There will be corresponding opportunities for career building within research and engineering. Western Electric maintains its own full-time, all-expenses-paid engineering training program. And our tuition refund plan also helps you move ahead in your chosen field.

Opportunities exist for electrical, mechanical, industrial, civil and chemical engineers, as well as in the physical sciences. For more information get your copy of Consider a Career at *Western Electric* from your Placement Officer. Or write College Relations, Room 200D, Western Electric Company, 195 Broadway, New York 7, N. Y. Be sure to arrange for a Western Electric interview when the Bell System team visits your campus.

Western Electric

MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

Principal manufacturing locations at Chicago, Ill., Kearny, N. J., Baltimore, Md., Indianapolis, Ind., Allentown and Laureldale, Pa., Burlington, Greensboro and Winston-Salem, N. C.; Buffalo, N. Y., North Andover, Mass., Lincoln and Omaha, Neb., Kansas City, Mo., Columbus, Ohio, Oklahoma City, Okla., Engineering Research Center, Princeton, N. J., Teletype Corp., Chicago 14, Ill. and Little Rock, Ark. Also W. E. distribution centers in 32 cities and installation headquarters in 16 cities. General headquarters: 195 Broadway, New York 7, N.Y.

(Continued from Page 34)

'It is recommended that additional credit be earned in the same language that was presented for entrance credit. However, if the two units of required language are Latin, additional credit should be in a modern language.

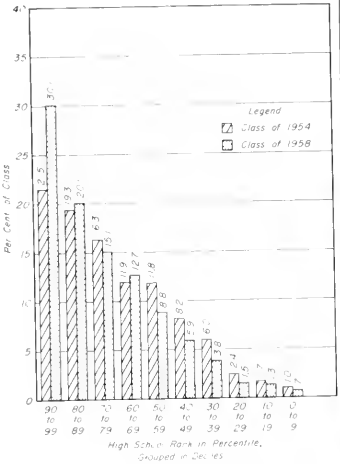
The mathematics and English requirements for admission have remained unchanged from what they were. The additions to the entrance requirements are two units of language, two units of social studies, and two units of science. Large numbers of students are already presenting two units of science and therefore this new requirement will not demand too much modification in the programs of the high school students. Over 80% of the students entering in 1958 presented two units of social studies although one or one and one-half units are required for graduation from high school. Therefore, a number of prospective students who intend to enroll here will be required to add one-half or one unit of social studies to their programs.

The requirement that will entail the most adjustment in high school programs is the new requirement in language. Over 55% of the students in 1958 presented 2 units of credit in language, but as the new entrance requirements indicate, this figure should rise to close to 100% by September of 1963. No student will be barred admission to our College because he does not have language credit since provision has been made to make up this deficiency during the first two years at the University of Illinois. However, the deficiency will mean that the student will have to add approximately one semester to the time normally required to earn his baccalaureate degree in engineering.

Increasing numbers of engineering students are continuing in college for graduate study after they have received their bachelor's degree. Everyone recognizes the value of foreign language in helping graduate students study more effectively. Since German, French, and Russian are the languages in which most of the significant technical literature is published, a study of one of these languages can be of immense value to an engineer. However, Spanish or other languages specified by the University may be used for entrance credits. Failure to study language before a student reaches the graduate level will only hamper his progress and delay his graduation with a master's or doctor's degree.

Another important reason for studying a foreign language is its contribution to the student's grasp of the meaning and structure of his own language. Many engineers have trouble communicating with other people, though their record is no worse than any other group of professional people. Foreign language studies will help the engineer write more effectively and, therefore, indirectly contribute to his future success.

One last item of significant information uncovered by the study should be brought to your attention. Though this information has no bearing on the new entrance requirements, it still should be of interest to students planning to go into engineering. The following graph, which indicates high school rank, shows that more and more students of engineering are coming from the upper half and only extremely small numbers are from the bottom quarter of their high school class. Larger numbers of students are coming from the upper ten per cent



Rank in high school class of freshmen entering in fall of 1954 and fall of 1958.

of their high school class each year. In September of 1959, 34 high school valedictorians were among the students entering engineering at Illinois!

It should be pointed out, however, that this garph shows nothing whatever as far as the success of these students in college is concerned. I firmly believe, though, that the prospective engineer should know that achievement in high school is an important indicator of success in later college work and this graph is one measure of achievement.

This article has not been written to inflate the ego of the present engineering students or to scare prospective students out of enrolling in engineering. However, e v e r y incoming student should realize the importance of a sound high school education. The new entrance requirements are designed to help prepare prospective students for the challenge and the thrill that will be theirs the day they first enroll in engineering.

Engineers who qualify to fill these chairs...

are on the road to filling responsible jobs with a growing company in a growing industry

● American Air Filter Company is one of the world's pioneers in the field of "better air." Starting 30 years ago as a manufacturer of air filtration equipment only, it has, through a planned program of product development, attained the unique position of being the one company in its industry that can take the complete over-all approach to the customer's air problems. In brief, this means supplying and coordinating all the proper products to filter, cool, heat, clean (control process dust), move, exhaust, humidify and dehumidify air.

"Better Air", while a big business today, is still in its infancy. Name any industry, any building type, and you have a present or potential user of AAF equipment. Other well-known trade names in the AAF family are Herman Nelson, Kennard and Illinois Engineering. At present, AAF operates ten plants in Louisville, Moline, Ill., St. Louis, Chicago and Montreal, Canada.

THIS KIND OF ENGINEERING DEGREE . . . ↓	. . . QUALIFIES YOU FOR THIS KIND OF JOB ↓
Mechanical	— *Engineering, Sales or Manufacturing*
Electrical	— *Engineering or Sales*
Industrial	— *Manufacturing or Sales*
Civil	— *Sales*

FORMAL FIVE-MONTH TRAINING COURSE

Your first job at AAF will be to complete a full five-month course in its technical training school. This is a complete and carefully planned course covering every phase of this business of better air and is under the direction of Mr. James W. May, a recognized authority on air handling problems and presently a member of the board of directors of ASHRAE. Classes, held in special, air conditioned quarters, are supplemented by field trips to visit AAF plants and observe on-the-job applications of equipment.

YOUR FUTURE IS ALL-IMPORTANT TO AAF

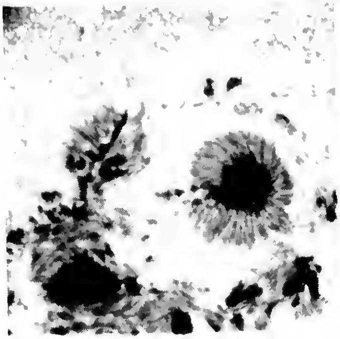
AAF prides itself on attempting to match the man to the job. During your training period you will have contacts with key company personnel. Your personal desires as to type and location of job are given every consideration. AAF is big enough to provide opportunities galore—small enough to never lose sight of the personal touch that adds satisfaction along with success.

A representative of AAF will be on your campus soon to interview students interested in learning more about the opportunities with this company. Consult your Placement Office for exact date.

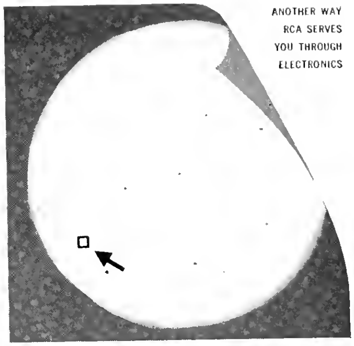
AAF **American Air Filter**

BETTER AIR IS OUR BUSINESS

Going up for "good seeing." Unmanned balloon-observatory starts its ascent to take sunspot photos. "Project Stratoscope" is a continuing program of the Office of Naval Research and the National Science Foundation.



One of the sharpest photos ever taken of sun's surface. It, and hundreds of others taken by stratoscope, may answer mystery of violent magnetic disturbances on earth.



Exact position of photograph in relation to the total sun surface is shown here. Plotting and photography of precise areas was made possible by airborne RCA television.

ANOTHER WAY RCA SERVES YOU THROUGH ELECTRONICS

RCA REPORTS TO THE NATION:

REMARKABLE NEW PHOTOS UNLOCK MYSTERIES OF SUN'S SURFACE

Special RCA Television, operating from stratosphere, helps get sharpest photos of sun's surface ever taken

Scientists recently took the first, sharp, searching look into the center of our solar system. It was achieved not by a missile, but by a balloon posted in quiet reaches of the stratosphere.

The idea was conceived by astronomers at the Princeton University Observatory. They decided that a floating observatory—equipped with a telescope-camera—would offer a stable "work platform" from which sunspots could be photographed free of the distortion caused by the earth's atmosphere.

But "Project Stratoscope" encountered an unforeseen and major obstacle on its initial flight. A foolproof method was needed for aiming and focusing the telescope of the unmanned observatory. Princeton asked RCA to help.

A special RCA television system was devised which enabled observers on the ground to view exactly what the telescope was seeing aloft. This accomplished, it was a simple matter to achieve precise photography—directed from the ground by means of a separate RCA radio control system.

The resulting pictures reveal sunspot activities in unprecedented detail. They provide the world with important information regarding the magnetic disturbances which affect navigation and long-range communications.

The success of "Project Stratoscope" is another example of RCA leadership in advanced electronics. This leadership, achieved through quality and dependability in performance, has already made RCA Victor the most trusted name in television. Today, RCA Victor television sets are in far more homes than any other make.

RADIO CORPORATION OF AMERICA

THE MOST TRUSTED NAME IN ELECTRONICS

The Inscription

By Helen Geroff

I boarded my ship and waved to the crowd outside. In five minutes, I would have to pull the lever which would release the rocket blast and take me off into the unknown. As I gazed out of the porthole, I saw the faces of my loved ones. They were proud of me, I was sure, but their haggard faces revealed the same fear that I had. Would we ever meet again?

I threw one last kiss and pulled the lever. The ship lunged forward and lifted me high into the sky. My fingers turned the panel dials almost automatically. My training had been long and exhausting, and now, I only hoped that I could remember everything.

As the moon came closer and closer into focus, I prepared to land. I radioed back to Earth that everything was functioning satisfactorily and that I would be checking in with them at regular intervals. My landing on the moon was very smooth. I made one last check of the panel controls, donned my oxygen mask, opened the ship's door, and set out.

I walked around collecting rock and dust samples for several hours. When I was almost ready to go back to the ship, I noticed a cave. I was getting tired, but I remembered hearing the scientists say that if man was ever to live on the moon, he would probably have to live under the ground, so I decided to look inside.

With pencil and note pad in hand, I began to explore the cave. I had not walked more than twenty yards when I came upon a man-made door, at least it looked man-made. On the door, a strange inscription was written in several languages. Excitement swelled inside of me. Here was something man had talked of finding but had never really hoped to find.

Moving as fast as I could, I ran back to the ship. With trembling hands, I tuned in the radio, focused the telescreen, and relayed my findings and the inscription to my superiors.

The commander's voice came over the radio loud and clear, "Stay where you are. We have called in some experts on languages, and they will translate the message if possible. You will hear from me again when we receive the translation. Over and out."

I waited anxiously for Earth's reply, but when it came, I found myself totally unprepared to receive such a message.

"This is Earth calling. The inscription reads as follows: 'The Earth will be blown to bits during their nuclear war. Any Earth-man reaching the moon before the start of the war will remain alive if he stays in this cave. A ship from Venus will pick up any possible survivors three days after Earth's destruction.' "

"Your orders are to remain in that cave. Russia has just declared war on the United States and . . ."

As I leaned closer to the radio, I heard a terrific explosion, and the voice died away.

— Photos by Dave Yates

Technocutie . . .

MARION HILLER

Bevier Hall and the school of Home Economics claim freshman, Marion Hiller, most of the time, but the engineers on campus claim her as their February Technocutie.

From Evanston, Marion calls Allen South her home on campus; but Saturday afternoon she lives at the Turk's Head listening to Hackenhull. An alternate on occasion is the Capital for the jam session.

Marion likes outdoor sports, tennis being her favorite with water skiing and sailing coming in second. But she also admits she is enjoying learning to play chess.

Sweets are Marion's favorite food. She laughingly admits she doesn't care for meals, but loves eating between them. Lobster tail rates high with her; milk is her favorite beverage.

Informal dates are the kind Marion likes most: movies, the beach in the summer, parties with close friends. She's always ready to dance.

Egotistical and unattentive men are Marion's pet peeve. She also rates low the type that call and say, "I'm here; come on down." A sense of humor in a fellow goes far with her.

Men's clothes are neat to score with Marion. In the winter she loves to see sweaters. She likes Ivy League clothes but would do away with the belt idea. Cotton slacks and wash pants instead of Levis are also a must.

With a millionaire's budget, Marion would travel; she would like to see the much-heard-about places, especially Russia.

Marion is not sure what she will do when she graduates perhaps go into retailing or textile research. In the meantime, she will study and have fun.

Problem: To find a job that will utilize your engineering training to the fullest possible extent, and reward you for a job well done.

Solution: Find a company that has a reputation for being the leader in its field. A company whose continued expansion is built on creative engineering of new products, new processes. A company with this background relies on its engineers for progress and rewards them accordingly.

At LINDE, the creative engineer will find this and more. As you probably know, LINDE is a major supplier of industrial gases to industry . . . you're probably familiar with them in welding; steel companies use them in refining metals; and they're essential to thousands of chemical processes. LINDE is also famous for its contribution in welding equipment, and its leadership in cryogenic (ultra-low-temperature) technology, and other new and fascinating products and processes.

A LINDE engineer, as a result of this progressive company thinking, enjoys several important advantages. Primarily, he works in a professional atmosphere, where highly specialized technicians are used to relieve him of bench work, drafting, and other detail work. And the engineer at all times enjoys privacy that is so greatly desired in engineering today.

But all these are discussed in a booklet that should be in your possession before you decide. Why not write for a copy today . . . no obligation. Ask for "Look to LINDE for Your Future." Address: Mr. J. J. Rostosky, Manager—Recruiting, Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York.

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UNION CARBIDE

The Thing That Couldn't be Done

By Stephen Lucas

Somebody said that it couldn't be done,
But he with a chuckle replied
That "maybe it couldn't," but he would be one
Who wouldn't say so till he'd tried.
So he buckled right in with the trace of a grin
On his face. If he worried he hid it.
He started to sing as he tackled the thing
That couldn't be done, and he did it.

—Edgar A. Guest

They said it couldn't be done; they said nobody could do it. Sounds familiar, doesn't it. "Gunsmoke" is interrupted at least three times a week by that catchy little phrase to which is added a plug for Liggett and Meyers L & M cigarettes. Most of us though are so worried about whether Matt Dillon will catch that week's varmit that we don't think seriously about the present implication of those twelve words — they said it couldn't be done; they said nobody could do it.

Throughout his brief presence on earth, man has attacked many problems which couldn't be done, and done them. One does not have to think too long to come up with such examples. Man was not made to fly and he certainly could not in a heavier than air machine; yet the Wright brothers did it. It was impossible for one person to talk to another many miles away; but Alexander Bell did it. A ship driven by a tub of boiling water — impossible, the people said; they were amazed when Fulton's *Clermont* did it.

That's very nice, you are probably saying to yourself, but I knew all this before. True, I say, this is not my point; my question is, can we keep the impossible jobs of today and tomorrow as our forefathers did? Can we, who are in colleges and universities of the United States, tackle the job that couldn't be done and do it? I am not sure we can, and I shall attempt to explain why and to offer a few suggestions on how we can remedy the situation of which I speak.

In *The Organization Man*, William Whyte takes several chapters to explain his views on the effect of education in turning out the organization man, the man who is happy to find his safe little niche in life and stay there away from the worries and insolvable problems of life. The Wall Street Journal, in an early March editorial, noticed that more employers wanted their prospective employees to have a wide and diversified

training. The editorial went on to say that presently colleges and universities were graduating tradesmen or human machines with the characteristic lack of drive and vocational interest that Whyte often observed. To come a little closer to home, Mrs. Frayn Utley, wife of Clifton Utley, well-known news commentator, and famous herself as a news commentator, last week at the annual professional journalism honorary banquet said, ". . . schools of journalism are not providing enough background education. They are turning out technicians."

What does all of this mean? What am I trying to say? I am saying that the universities and colleges are not turning out the thinking man, the man who has a wide and varied background in all or most fields, the man who when confronting a problem knows what to do when parts of the solution are not in his field, and the man who can and will tackle any problem because his mind has not been channeled and persuaded that the problem cannot be done. I am saying that the men and women graduated today are not the well-rounded men and women they believe themselves to be.

The three sources noted above are only a sample of the many persons, groups, and publications which cite the poor education being obtained in colleges and universities. It is relatively simple to say that something is definitely lacking in college education today; but, it is much harder to advance even a partial solution to this difficult problem. Before setting down suggestions, I should like to advance two statements: the first to explain what education should not be, and the second to generally outline what it should be.

The late Albert Einstein once remarked, "There is born into the minds of all men an intense curiosity and desire for knowledge, but for most people, this is soon educated out of them." And Vice President and Provost of the University, Gordon Ray, commented last year at the Men's Independent Association Awards Banquet that the aim of college education is not the amassing of information, but the enlarging of mental capacities to enable an individual to use the information he gained at college.

With these two statements in mind, let us see what could be done to actually educate, and not train, the people attending our colleges and universities. First, the undergraduate curriculum should consist of basic and general courses. A large amount of technical and specialized courses should only be taught in graduate schools. A possible solution to the old complaint about the narrowness of engineers would be to make engineering curricula of five year duration. The present trend of undergraduate engineering schools, which are most often accused of not offering a well-rounded course of study, is to continually keep adding more technical and specialized courses to the already overloaded undergraduate program. If the engineering school at this university were changed to a five year school, it is almost a certainty that the extra year would be composed almost entirely of more technical courses, although the main reason many educators and personnel directors in industry would want an extra year for engineering education is to add the lacking non-technical or liberal arts courses. Several of my instructors have mentioned that many of the present engineering courses were taught in graduate school when they went through their schooling. These courses have now pushed their way into the undergraduate's curriculum, often, I am afraid, at the expense of a non-technical or liberal arts elective. Some work should be definitely done in this area to stop the trend of technical specialization and turn it into a trend of education.

Second, several required courses in present or contemporary world events should be offered by colleges and universities to all of their undergraduates. A very noticeable trend in our nation at this time is the ignorance and disinterest of the people in world, national, and local affairs. This lack of interest and knowledge is quite evident in the campus counterpart — student government. Student Senate at this university has long admonished the student for his apathy in governmental affairs. Perhaps Student Senate could work in conjunction with the university in offering these courses in government and world affairs and use the university as a small model on which the students on this campus could practice and learn.

Third, a series of one course in contemporary, creative, or out-of-field writing should at least be offered and possibly be required in certain colleges. Tau Beta Pi recognizes the need for this type of practice and education in requiring as a pledge duty the writing of a non-technical essay of which this paper you are reading is an example. The recognition of this problem, however, does not necessarily bring about a solution. Those engineers elected into Tau Beta Pi do need this type of experience; but, surely the other people in engineering need this experience as much if not more than those persons actually participating as pledges. A course of this type should be required of all engineers, possibly a full year after Rhetoric 102. This program would be applicable to other colleges whose graduates also need a good command of spoken and written English in fields other than their own area of specialization.

Educators prominent in this area could certainly come up with more profound suggestions than those which I have offered; yet, I feel that these several suggestions expanded and fitted into the present educational system here are certainly needed in the light of comments similar to the ones previously advanced and to the readily apparent dissatisfaction of industry with present college graduates. With our present world becoming so specialized and technical, we must make sure that our college graduates do not become just a small cog or bolt in the great machine of American technology. Our college graduates must be educated, prepared to think and solve the complex problems of our day which cut across many fields and specialties. If we do not start to remedy this problem of education very soon, the bigger, impossible problems of our society might be approached as observed by this take-off on Edgar Guest's aforementioned quote;

They gave him the job that couldn't be done,
He smiled and went right to it.
He tackled the job that couldn't be done,
And found that he couldn't do it.

Pirate's Pirate

The theft and republication of books by Russia has long angered Western authors and publishers—and now the Soviets themselves are learning how it feels from the Red Chinese. The Chinese Communists have proved to be pirate's pirates by stealing and reprinting not only Western books but Russion texts as well.

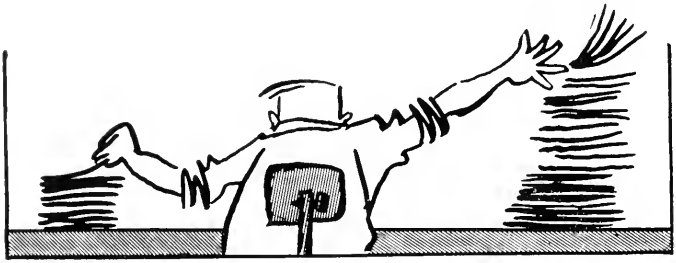
Melon On A Stick

Watermelon on a stick may be the newest national frozen confection fad next Summer if a Texas company is able to expand its opertaions fast enough. The company now ships chilled "melon squeezings" in 4,000 gallon tank trucks to dozens of creameries and other plants in its area for final processing.

Alcohol With Water Chaser

A slug of alcohol may play a significant role in bringing approximately 150-billion barrels of untapped U. S. oil to the surface. A professor of petroleum and natural gas engineering believes the alcohol slug, followed by a waterflood, may be one solution to the oil industry's secondary recovery problem.

Skimming Industrial Headlines



Edited by The Staff

Seven Tips on How to Get Better Results from Tape Recorder

Your daughter has such a sweet little voice that you simply must put it on tape. You do—and she sounds like a beatnik on a binge.

This can be avoided if you follow these seven hints on how to get better results from your tape recorder.

1. Avoid hand-holding the microphone. Mike stands, both floor and table models, are preferable. Don't place the microphone on the same table with the recorder or on a piano, radio or TV cabinet.

2. Make sure to record at the proper volume level. Too high or too low levels will create distortions.

3. Record the speaking voice at a speed of 3.75 ips. But it is advisable to record music, both vocal and instrumental, at 7.5 ips.

4. To avoid feedback, place the microphone so that the sound from the speaker is not directed toward it. Keep the mike away from audible hum fields such as those produced by fluorescent lamp ballasts and the like.

5. Keep tapes away from excessive heat and dampness, and do not store tape near electrical appliances or motors which may generate magnetic fields.

6. Do not wind the tape too tightly when you store it. Be sure the tape is wound evenly, and make sure to rewind at least once every six months.

7. Don't be afraid to experiment and make mistakes. One unique advantage of a tape recorder is that you erase mistakes simply by re-recording.

Survey on Engineering Writing Under Way

A survey to find what management is doing to help technical people communicate better is being made by the Technical Writing Improvement Society (TWIS). Underlying the survey is the desire to find why industry is not doing more to help their key professionals—particularly engineers — write better. The survey results are expected to show if the reasons are financial, lack of instructors, lack of books and other teaching materials, etc.

Questionnaires are being sent by TWIS to more than 1,000 of the country's top firms in all industries. The survey is being directed by John L. Kent, TWIS Executive Secretary. TWIS is a national organization of educators, trade journal editors, industrial writers and editors, and management people, founded in 1955.

In announcing the survey, Kent said that industrial management is one of the four factors which educators feel have a bearing on the quality of writing. The other three are (1) the engineer himself, (2) the editors who accept engineers' writing, and (3) the schools and colleges which have helped educate the engineer.

Results are to be published by TWIS this June.

New Repellents

A dust-repellent for paint and a water-repellent for clothing are promising new developments. The paint-protector is a colloidal silica preparation that "fills the pores of a paint surface to produce a slickness so total that there is virtually nothing for dirt to adhere to." The water-repellent treatment "withstood seven days of continuous 24-hour rainfall without showing any water penetration."

Mobile Lounge

Passengers at the now-abuilding Dulles International Airport outside Washington, D. C., will be ferried from terminal to planes in "mobile lounges." The vehicles will be self-propelled, have controls at both ends for travel in either direction, and be self-leveling to adjust to airliner door sills. Average passenger trek from car to plane will be cut from 1,600 to 350 feet.

Electronic Warehouse

A giant Milwaukee mail order house has slashed its two biggest costs—paperwork and physical assembly of orders—by an estimated $250,000 a year through automation. Two electronic computing systems used to sort and process orders have enabled a reduction of the firm's warehouse staff from 200 to 20.

Fish Finder

A Massachusetts electronics company has developed a portable depth and fish finder for use by sports fishermen in boats as small as dingies. The transistorized fathometer can operate off a portable battery or the battery of a power boat, has a depth range of 120 feet, and will pin-point both bottom depth and any intervening schools of fish.

New TV Tube

A pale green glow emitted by the radar screens is the only source of light in an airport radar room. All day, every day, observers in this darkened room scan the scopes to insure that air traffic is safely routed.

Without disrupting these vital operations, WDSU-TV, Channel 6, New Orleans, recently took its viewers into the radar room of the new Terminal Building at Moisant International Airport. The telecast from this darkened room was made possible by the use of General Electric's new super-sensitive television camera tube.

The event was one of a series of highly successful local "remote" telecasts using this type GL-7629 image orthicon for black-and-white for the first time in regular on-the-air service. WDSU-TV technicians were amazed by the ability of this tube, to pick up a usable picture in absolute minimum "existing light" conditions.

New Orleans' St. Louis Cathedral, on historic Jackson Square, was the site of another important telecast using this new image orthicon. WDSU-TV's traditional Christmas Eve telecast of Midnight Mass was marked by the best results ever this year. Understandably, the use of TV lights for this remote is out of the question. Engineering personnel were prepared to switch to a regular type 5820 tube if the light conditions in the Cathedral caused disturbing "burn-ins," or "highlights." However, no change was necessary; results were excellent.

The new tube also was used on a telecast from the Christ Church Cathedral, a location with very little available light. Again, the picture quality was far better than could be expected with the "5820" tube.

Still another "night-into-day" success story was chalked-up during the WDSU-TV coverage of the dramatic Democratic primary run-off on January 9, in which Jimmy Davis defeated deLesseps Morrison. A one-camera remote from the Jefferson Parish courthouse picked up reactions of crowds and candidates that were missed during first primary coverage using a regular tube.

WDSU-TV Chief Engineer Lindsey Riddle was well pleased with the results obtained with the new tube during the remote telecasts and studio experiments.

Radioactive Waste

The nuclear energy industry can develop in a rational way without being "bottle-necked" or "hamstrung" by trouble in disposing of radioactive wastes, an Atomic Energy Commission spokesman said.

Addressing a University of Illinois sanitary engineering conference that has "Radiological Aspects of Water Supplies" as its theme, J. A. Lieberman, chief, Environmental and Sanitary Engineering, AEC Division of Reactor Development, said:

"The management of radioactive wastes which includes their handling, treatment and disposal is a general problem whose thread runs through the complete fabric of nuclear energy operations. . . .

"In the peaceful day-to-day application of the benefits of nuclear technology, the disposal of radioactive wastes potentially represents perhaps the major 'non-beneficial' effect on the public and its resources.

"More money probably has been spent, and more scientific and technological effort concentrated on facilities, operations, and research with regard to this industrial waste than on any industrial contaminant we have known. At the present time at Atomic Energy Commission installations, there is an investment of approximately $200,000,000 in facilities for the handling, treatment and disposal of the wastes, while the estimated annual operating cost for these facilities is approximately $6,000,000."

Methods of keeping waste from having harmful effects center around two major concepts, "concentrate and contain" and "dilute and disperse."

Lieberman stressed that "the management of disposal of radioactive wastes is not a single problem with a single solution. It varies widely, depending upon the specific nature, concentration and quantity of radioactive materials involved, and on the specific environment in which it must be considered."

However, some methods which are being used with some effectiveness in varying kinds of situations include:

—Use of the "diluting power of the environment to some extent in handling low-level waste.

—"Conversion of waste to solids by one of several methods.

—"Storage of solids in selected geological strata with major emphasis on salt beds.

—"Disposal of liquids into geological strata—either deep wells or salt beds.

—"Disposal of liquids or solids into the sea.

"The conversion to solids and storage of these wastes in salt formations seemed to be the most favored possibility at this time," Leiberman added, referring to recent Washington hearings on the subject.

"Although one has to be very careful to distinguish between aspiration, reality and speculation in this field, it is our own strong feeling that the development program has thus far found solutions to some of the waste problems and at least indicated solutions to others."

The U. of I. Sanitary Engineering Conference is conducted by the U. of I. Department of Civil Engineering and Division of University Extension, with the Division of Sanitary Engineering, Illinois Department of Public Health. Proceedings will be published.

Milling During Transfer

Exhaust manifold castings can now be completely finished in a machine that not only saves floor space but permits simple alterations to meet part design changes. Designed and built by The Cross Company, Detroit, Mich., this machine mills all flange faces of manifolds while they are being transferred and does machining operations in both stations. Any change of the tailpipe flange angle — which usually changes with each new vehicle model — can be accommodated by changing the fixturing and the angle of just one head in one of the stations.

A two-position fixture, mounted on the shuttle, is loaded with two parts in the first station. One raw casting is clamped with the four exhaust port flanges up. A partially finished casting is turned end for end, rotated approximately 90 deg and clamped with the tailpipe flange up. The fixture locates the unmachined part on cast surfaces and will accommodate normal casting variations. The semifinished part is located by two milled surfaces and two drilled holes.

After the automatic cycle is initiated, the pallet moves to the second station. During the transfer, the parts pass under and are machined by three inserted-blade carbide-tipped milling cutters. The exhaust port flanges pass under a roughing and finishing cutter. Only one cutter is needed on the tailpipe flange since finish requirements are not as rigid because the tailpipe fits into a machined opening, directing the hot gases away from the gasketed joint.

In the second station, the tailpipe flange holes of the raw casting are drilled by an angular head. The same holes in the semifinished part are tapped by tools mounted on the same short vertical column as the milling cutters. With normal part design changes, it would only be necessary to change the angle of the tailpipe flange-drilling head. Because of standard component design, this is a compartively simple matter. Fixturing changes would depend on the angular change.

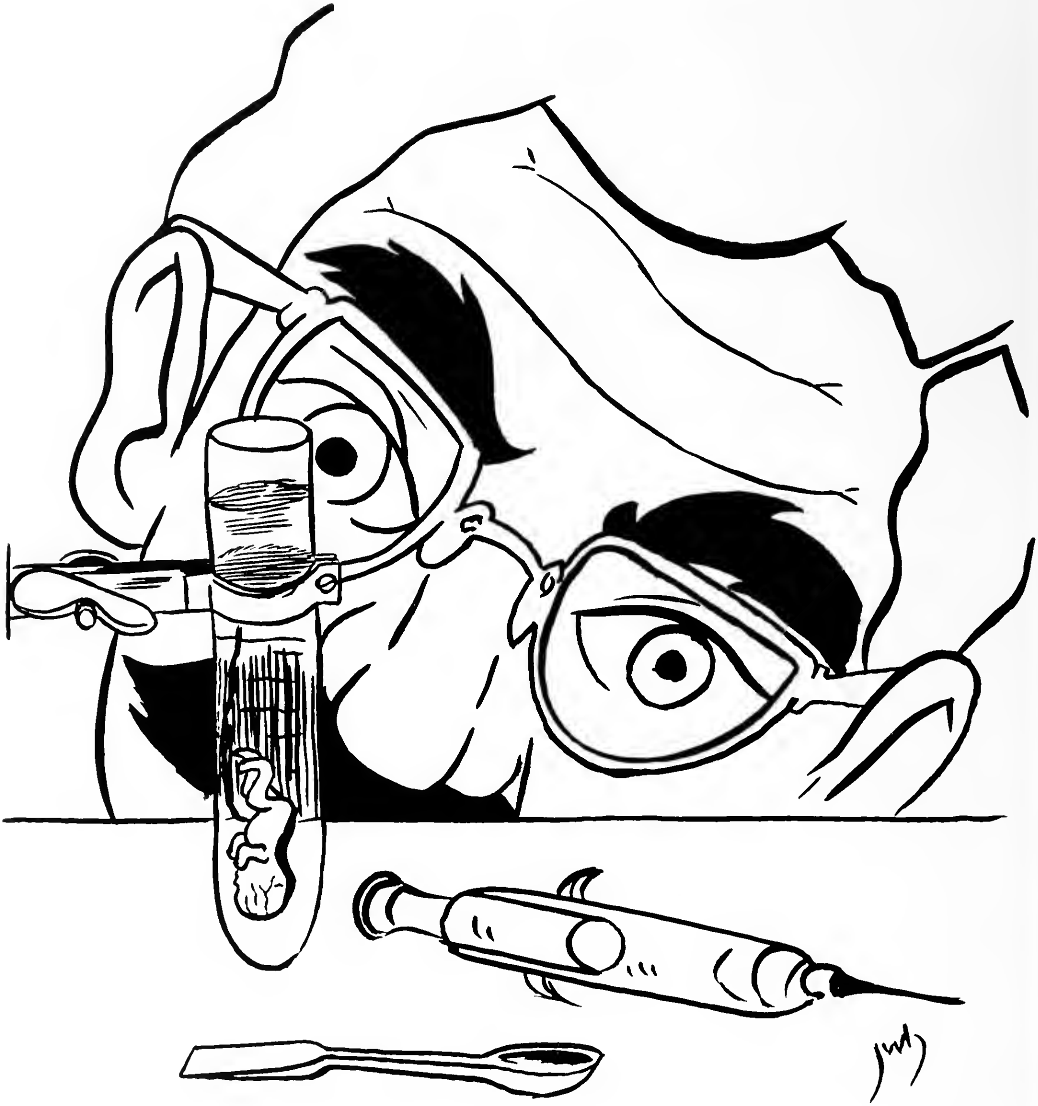
The parts are shuttled back to the first station in rapid traverse for the final machining operations. To prevent scuffing of the milled surfaces, the milling cutters are lifted about 1/8 inch during the period of the return movement.

In this station, the eight exhaust port flange holes of the raw casting are drilled and the central opening in the tailpipe flange of the semifinished part is finished with a two-step boring tool using carbide cutters.

At the end of this automatic cycle, the operator removes the finished part, transfers the semifinished part to the second fixture position and inserts a raw part in the first position. Each back-and-forth cycle of this machine produces one finished manifold and the production rate is 20 parts per hour at 100% efficiency while producing truck manifolds.

Space 'Bicycle'

Spacemen may spend a good part of their time pedaling. One researcher says a human passenger in a space vehicle could supply some of his own power by a pedal operated generator to save the weight and space used by other power sources such as batteries. In addition, it would provide a form of exercise and possibly help relieve tension.



"Fenton! Quick!"

. . . a hand in things to come

Reaching into a lost world

. . . *for a plastic you use every day*

Massive creatures once sloshed through endless swamps, feeding on huge ferns, luxuriant rushes and strange pulp-like trees. After ruling for 100 million years, the giant animals and plants vanished forever beneath the surface with violent upheavals in the earth's crust. Over a long period, they gradually turned into great deposits of oil and natural gas. And today, Union Carbide converts these vast resources into a modern miracle—the widely-used plastic called polyethylene.

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Polyethylene is only one of many plastics and chemicals that Union Carbide creates from oil and natural gas. By constant research into the basic elements of nature, the people of Union Carbide bring new and better products into your everyday life.

Learn about the exciting work going on now in plastics, carbons, chemicals, gases, metals, and nuclear energy. Write for "Products and Processes" Booklet H, Union Carbide Corporation, 30 E. 42nd St., New York 17, N. Y. In Canada, Union Carbide Canada Limited, Toronto.

UNION CARBIDE

. . . a hand
in things to come

BRAIN TEASERS

Edited by Steve Dilts

A familiar type of logic poser may be called the "colored-hat" variety after the following best - known example. Three men: A, B and C, are blindfolded and told that either a red or a green hat will be placed on each of them. After this is done, the blindfolds are removed; the men are asked to raise a hand if they see a red hat, and to leave the room as soon as they are sure of the color of their own hat. All three hats happen to be red, so all three men raise a hand. Several minutes go by until C, who is more astute than the others, leaves the room. How did he deduce the color of his hat?

* * *

Another class of popular logic puzzles involves truth-telling and lying. The classic example concerns an explorer in a region inhabited by the usual two tribes; the members of one tribe always lie, the members of the other always tell the truth. He meets two natives. "Are you a truth-teller?" he asks the tall one. "Goom," the native replies. "He say 'Yes'," explains the short native, who speaks English, "but him big liar." What tribe did each belong to?

* * *

When Professor Stanislaw Slapenarski, the Polish mathematician, walked down the down-moving escalator, he reached the bottom after taking 50 steps. As an experiment he then ran up the same escalator, one step at a time, reaching the top after taking 125 steps. Assuming that the professor went up five time as fast as he went down (that is, took five steps to every one step before), and that he made each trip at a constant speed, how many steps would be visible if the escalator stopped running?

* * *

An absent - minded bank teller switched the dollars and cents when *he* cashed a check for Mr. Brown, giving him dollars instead of cents, and cents instead of dollars. After buying a five-cent newspaper, Brown discovered that he had left exactly twice as much as his original check. What was the amount of the check?

* *

Brainteasers courtesy *Scientific American.*

The answers for these brainteasers will appear next month. The answers to last month's problems follow.

* * *

The amount spent by each individual is a square number, and the difference of the expenditure within each family is 63 shillings. The first step is to find 3 sets of squares that differ by 63. The required numbers are:

$32^2-31^2=63$
$12^2-\ 9^2=63$
$\ 8^2-\ 1^2=63$

The integers in the first column represent expenditures by the husbands; in the second column, by the wives. Now we have to pick the integers that differ by 23 and 11. It is easily seen that Anna (31) is the wife of Hendrick (32); Katrun (9) is the wife of Elas (12); Gurtrun (1) is the wife of Cornelius (8).

* * *

30	39	48	1	10	19	28
38	47	7	9	18	27	29
46	6	8	17	26	35	37
5	14	16	25	34	36	45
13	15	24	33	42	44	4
21	23	32	41	43	3	2
22	31	40	49	2	11	20

* * *

The required number is enormous, but it can be found by "brute force."

Since we do not know how many digits there are in the required integer, we will represent them by A, B, C . . . as read from right to life. Then the integer is one of form as follows:

(1.) $A+10B+100C \ldots +10^{n-1}Z$

where *n* is the number of digits.

Let us take A as the terminal digit to be transferred. When it is placed at the other end, the integer becomes:

(2.) $B+10C+100D \ldots +10^{n-2}Z$
$10^{n-1}A$

The stipulation is that (1.) is to be 4 5 of (2.). (Remember that the digits are represented in reverse of the way they are written.) Then—

(3.) $A+10B+100C \ldots +10^{n-1}Z=$
$4\ 5\ (B+10C \ldots +10^{n-2}Z+$
$10^{n-1}A)$

Clearing of fractions and expanding, we have—

(4.) $5A+50B+500C \ldots +5$
$(10^{n-1}Z)=$
$4B+40C \ldots +4(10^{n-2}Z)+$
$4(10^{n-1}A)$

Now collect the A terms on the right, all other terms on the left—

(5.) $46(B+10C \ldots +10^{n-2}Z)=$
$A[4(10^{n-1})-5]$

From (5) it follows that the right-hand member is divisible by 46. In other words we must find values for A and n such that—

(6.) $\dfrac{A[4 10^{n-1})-5]}{2 \times 23}$

will be integral. Since the expression in brackets is odd, it is not divisible by 2; therefore A is divisible by 2, and we can write—

(7.) A=2, 4, 6, or 8

Since A is not divisible by 23, the expression in brackets must be. The expansion of this expression for values of n 1, 2, 3 . . . gives 35, 395, 3995, etc. To find the first of these terms divisible by 23, set up a long division in form—

(8.) 23) 399 . . . 95(17 . . .
23
———
169
164
———
59 etc.

Bring down 9 from the dividend each time, until a remainder of 11 is reached, so that the final 5 can be brought down (since 115 23×5). This turns out to be a lengthy matter, but it is mere arithmetic. The smallest quotient obtainable is—

(9). 173,913,043,078,260,869,565

By taking A=2, we have the smallest integer that satisfies the conditions:

(10). 2,173,913,043,078,260,869,565

Three other answers can be obtained by setting A equal to 4, 6 and 8. In each case, as is seen from (6.) number (9.) has to be multiplied by half of A to make up the balance of the integer.

* * *

The minimum number of sets that could have decided the tournament was 15, totaling 90 games (4). One extra set was played in the first round (3), leaving one game to be accounted for. One set in the tournament must have been won by 7-5. Bancroft lost his first match by 6-4 and 7-5 (7.) Franklin reached the finals where he lost (8.)

Since he won the unique 7-5 set, his first-round opponent was Bancroft.

Other first round pairings were Abercrombie vs. Devereau (5), and Gormley vs. Eggleston (9). The remaining two entrants must have been paired: Haverford vs. Chadwick.

The winners in the first round were Haverford (3), Franklin (8), Eggleston and Devereau (6).

In the second round Eggleston did not meet Haverford (1), nor did he meet Franklin, for Franklin vs. Bancroft and Eggleston vs. Gormley were in different halves of the original bracket (2). Therefore, Eggleston met Devereau, and Haverford met Franklin. The winners were Devereau (6) and Franklin (8).

Devereau won the final match from Franklin by 6-4, 6-4, and 6-4 (8).

Gulls Plague City Dump

Gulls may force Duluth, Minn., to close its city garbage dump. The scavenging gulls, defying bombs, buckshot and thicker coverings of dirt, are considered a hazard to planes using a nearby airport. They have flown into jet intakes and collided with radar equipment.

Paint Kills Bugs

A paint that kills insects which alight on it recently has been developed. The paint is applied by conventional techniques. Insect-killing power is said to last as long as the paint itself.

Electronic 'Old Man'

New Hampshire's famous "Old Man of the Mountains," the natural rock formation that inspired Nathaniel Hawthorne to write "The Great Stone Face," is being protected from the weather by modern electronic equipment. Engineers have installed strain gages on the steel rods used to reinforce the stone face to measure shifts in the formation of the rock.

Belt Saves Roads

Old conveyor belts, which had been discarded by a mining firm, now are being used to protect the surface of a road from tractor-type machinery. The company's operations lie on either side of a black-top road and the old belts, laid across the road, prevent crawler-type machinery from damaging the pavement. However, the belting does not interfere with normal road traffic.

Rumpus Room Shelter

The latest twist in bomb shelters is a walnut paneled room designed to serve as a guest room, rumpus room or workshop when not being used as a shelter. It uses the basic design approved by the Office of Civil Defense Mobilization, but it adds such refinements as convertible sofas, vinyl floors, finished walls, a television set and cabinets.

Hat Radio

Latest idea in company communication is a two-way radio in a safety helmet which has a sound-cancelling microphone for effective transmission when surrounding noise level is high. The radio, about the size of a cigaret pack and weighing two pounds including two small batteries, has a 1,000-foot range.

Arctic Buildings Self-Rising

Two huge steel buildings that pull themselves up by their own bootstraps—in this case, built-in hydraulic jacks—are features of new Distant Early Warning Line construction in the Arctic. The two-story, 133-by-144-foot structures stand on "stilts" 19 feet above Greenland's ice cap and are raised by the jacks three feet each year. This keeps them from being buried by drifting and accumulating snow, which builds up on the cap one yard each year.

Steam Welding

Steam welding is the latest idea in shieded-arc systems—where gases usually are used to protect the weld from impurities such as oxygen—in the Soviet Union. Russian engineers say tests show that water vapor becomes a protective medium—providing a large quantity of moisture at the joint—that prevents weld porosity and improves over-all quality.

Robert K. "Buck" Moffett, University of Alabama '55, knows from personal experience the opportunities engineering journalism can offer. If you're interested in growing within your chosen field, he's the man for you to contact.

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Buck Moffett will cover as many colleges as he can in person. Ask your placement director when he'll be at yours. If he hasn't been able to get your campus on his itinerary, write direct. Tell us about your background, college record, outside activities and why you would be interested in a career in engineering journalism.

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Begged, Borrowed, and . . .

Edited by Jack Fortner

THE LIFE OF A JOKE

Birth—A freshman thinks it up and laughs out loud, waking two Sophomores in the back row.

Age 5 minutes—Freshman tells it to a Senior, who answers: "It's funny, but I've heard it before.

Age 1 day—Senior turns it in to a college magazine as his own.

Age 2 days—Editor thinks it's terrible.

Age 10 days—Editor has to fill magazine, so joke is printed.

Age 1 month—Thirteen college comics reprint it.

Age 3 years—Seventy-six radio comedians discover it simultaneously and tell it accompanied by howls of mirth from the boys in the orchestra ($5.00 per howl).

Age 10 years—Professors start telling it in class.

* * *

A motorist broke down in a lonely part of Illinois pork country and found refuge for the night in a farmhouse. The next morning, his breakfast was served a large bowl. As he ate he found that he was verrrry popular with a small pig which kept nuzzling him affectionately.

The farmer's explanation—"Wal, it ain't you the pig likes. It's jest that you're a-using his bowl mister!"

* * *

Salesman: "This model has a top speed of one hundred miles an hour and she'll stop on a dime."

Prospect: "What happens after that?"

Salesman: "A little putty knife comes out and scrapes you off the windshield."

* * *

The unusually high birthrate in a suburb near our city as recently explained. Every morning at 6:15 the express comes roaring through town blowing its whistle.

It's too early to get out of bed, and too late to go back to sleep.

* * *

The Technograph is a great publication
The school gets all the fame,
The printer gets all the money,
And the staff gets all the blame!

The Professor of English and the Instructor of Engineering were dining together in the Faculty Cafeteria. During the course of the meal the former spoke:

"I had a rather peculiar answer in class today. I asked who wrote the 'Merchant of Venice,' and a rather young freshman replied, 'Please, sir, it wasn't me!"

"Ha ha ha!" laughed the Engineering Instructor, "and I suppose the little rascal did it all the time."

* * *

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

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

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

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

"You ought to know," she replied, "you were in it."

* * *

A girl finished with her bath and was just stepping on the scales to weigh herself. Her husband returned home unexpectedly and entered through the back door. Seeing what his wife was doing as he passed the bathroom door, he exclaimed, "Well, dear, how many pounds today?" Without turning her head, she replied, "I'll take 75 pounds today, and don't you dare pinch me with those tongs."

* * *

Three eminent doctors were bragging among themselves one day. Said the first, "I grafted an arm on a fellow and now he plays tennis like a pro." Said the second, "I grafted a leg on a man and now he runs on the Olympic team." The third took the cake with, "I once grafted a smile on a jackass and now he is in Student Senate.

* * *

Some girls go in for necking—others go out for it.

* * *

Who was that lady you were obscene with last night?

A patient at a mental hospital who had been certified cured was saying good-by to the head psychiatrist.

"And what are you going to do when you get out in the world?"

"Well I may go back to U. of I. and finish my CE course. Then, I liked the Army before, so I may enlist again. He paused a moment and thought. "Then, again, I may be a teakettle."

* * *

He grabbed me by my slender neck
I could not yell or scream.
He dragged me to his bedroom
Where we could not be seen.
He threw aside my flimsy wraps
And gazed upon my form.
I was cold and chilly,
He was nice and warm.
He pressed his feverish lips to mine
I could not make him stop.
He drank my very life away—
I could not call a cop.
He made me what I am today—
Hated, used up, thrown away.
That is why you see me here—
An empty broken bottle of beer.

* * *

The eager relatives gathered for the reading of the will. It contained one sentence: "Being of sound mind, I spent every damn cent I had."

* * *

A wise man has observed that people who live in glass houses shouldn't. But then, they might as well—everyone knows they do.

* * *

A small boy leading a donkey passed a Marine camp. A couple of marines wanted to have some fun with the lad. "What are you holding on to your brother so tight for sonny?" said one of them.

"So he won't join the Marines," the youngster replied.

* * *

Student: Why didn't I make 100 on my history exam?

Prof: You remember the question, "Why did the pioneers go into the wilderness?"

Student: Yes.

Prof: Well, your answer, while very interesting was incorrect.

ILLINOIS TECHNOGRAPH

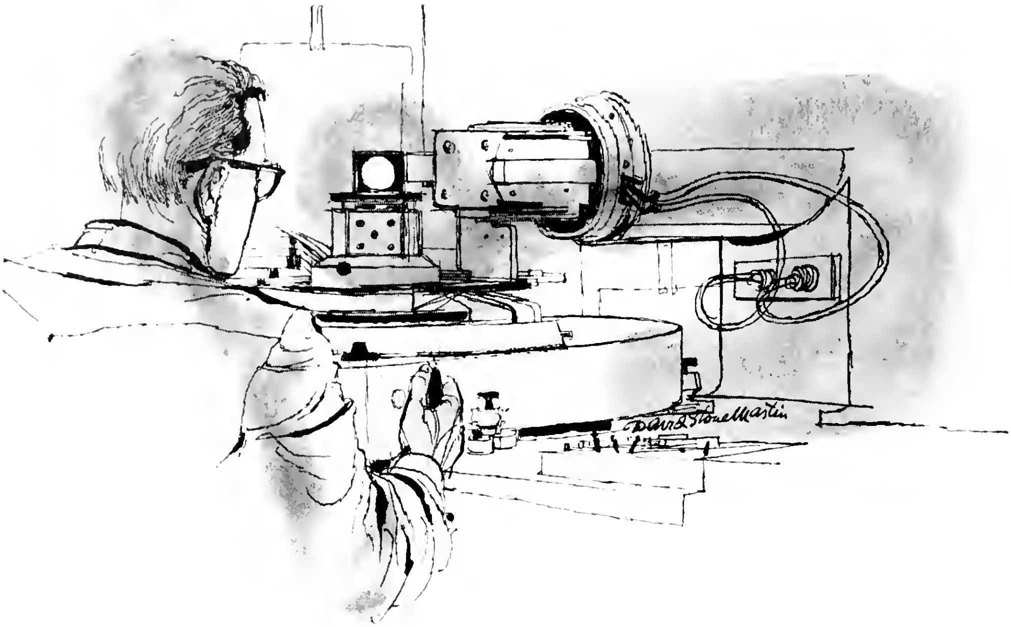
THE ILLINOIS TECHNOGRAPH

Volume 75, Number 6 March, 1960

Table of Contents

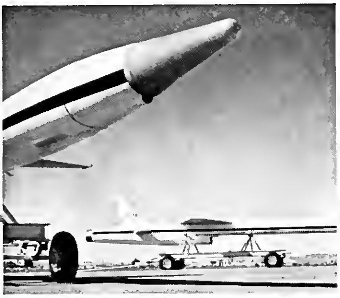
Cover . . .

During the eight months in which *Technograph* is published, contributions come from the Navy Pier branch. Last year an issue of *Technograph* was completely written and edited by Chicago engineering students. This *Technograph* is the second such issue. Again all contributions came from the Chicago branch of the University. The "Pier" students sincerely hope you enjoy this issue and hope to make it a yearly custom.

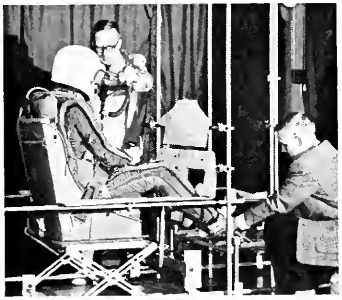


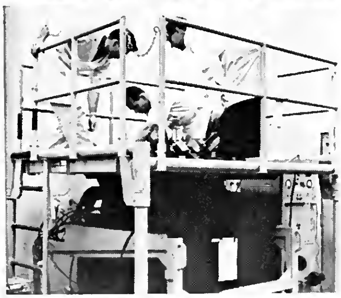
...NEWS IS HAPPENING AT NORTHROP

Take this 3-Minute Quiz to help you determine your future



1. *What part of the country has the best future for your type of work?*
2. *What part of the country offers an outstanding opportunity to enjoy your leisure?*
3. *Where can you work and still earn advanced degrees?*
4. *How important to you is the challenge of opportunity — and salary that matches your achievements?*
5. *Where can you work with outstanding men in your field?*





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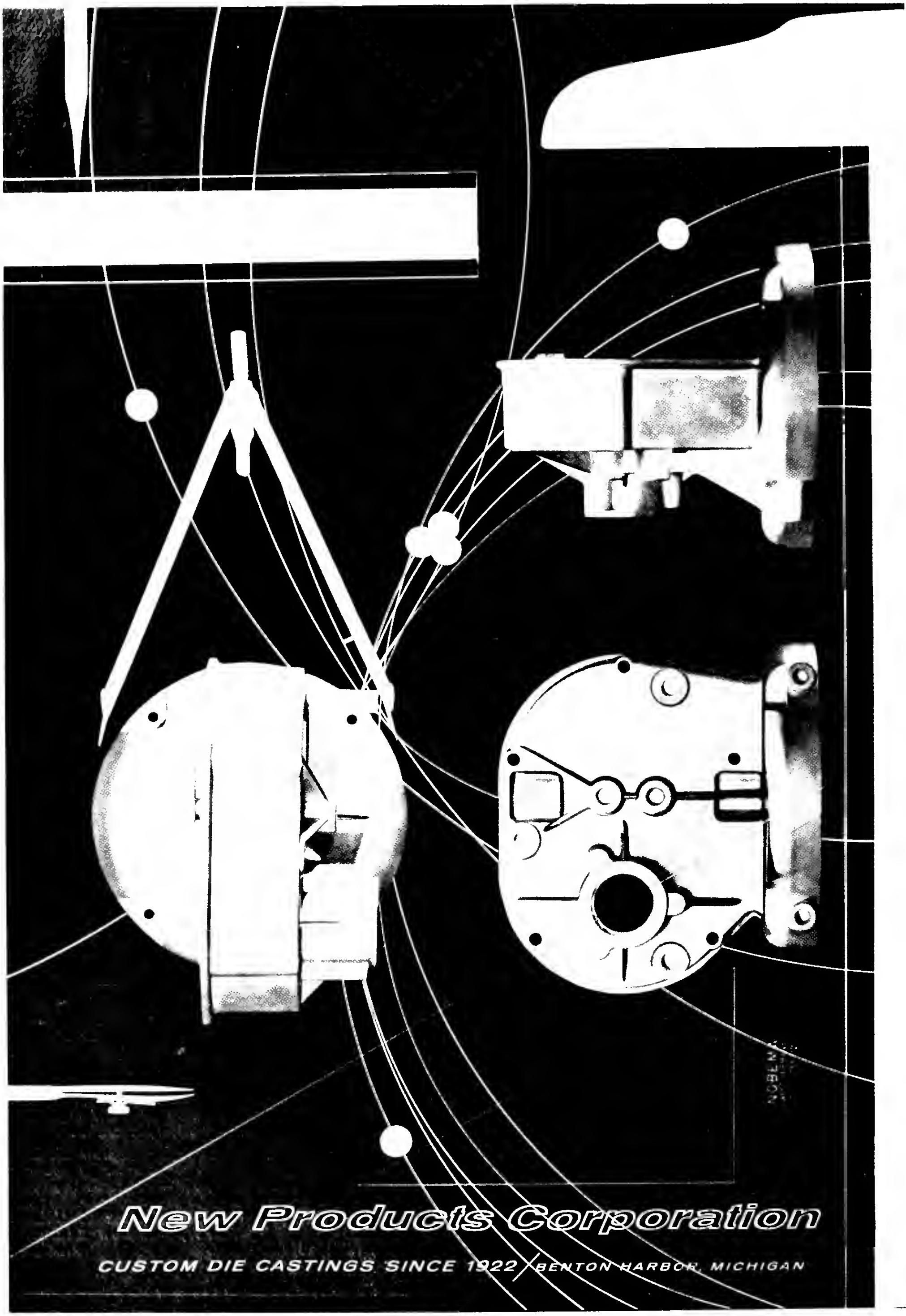
New Products Corporation
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The Widening Gap . . .

It becomes more and more evident to the sensitive engineering student as he advances in his undergraduate years, that there is a gap in the knowledge available with this type of education. The four-year engineering college seems to be producing more trained technicians and tradesmen than engineering graduates with university training.

There is certainly nothing wrong with an honest trade or a skilled technical ability, but the job of the university is to train men for responsible places in society and if possible instill a quest for learning and knowledge. How can this be done with the present "liberal" background available in engineering?

As the curriculum now stands it is very possible to go through four years of "education" without opening your mouth to express an opinion. Engineers come off the production line without a command of their native tongue, without the ability to communicate in writing, sometimes without even a rudimentary idea of the current world situation, and certainly without the more sophisticated attributes of a cultural background.

Certainly you can go through life without knowing what makes Beethoven or Shakespeare great, but you can also live without knowledge of the laws of thermodynamics. Each is important in its own way. However, a knowledge of both makes your education that much more complete.

What is the answer to this sorry situation? Many fine engineering schools have attempted to "humanize" their engineers by expanding the curriculum to five years. This is certainly a step in the right direction. It is much better than 13 hours of non-tech electives in 140 hours of credits.

Among the schools to make this step are MIT and Cornell, names familiar to most. The combined liberal arts-engineering program available at this university shows a progressive attitude at Illinois. However, to go a step further, it is the responsibility of the university to acquaint its students with their cultural heritage. This would force some to take "dem readin" courses and some even to "like dem readin" courses. We can delegate the responsibility of producing technicians and tradesmen to industry and trade schools.

—Sheldon Altman

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Pier Personalities . . .

AN INTERVIEW

with Ogden Livermore

Mr. Ogden Livermore, assistant professor in physics at the Chicago Undergraduate Division of the University of Illinois and a former advisor for *Tech* is one of the original stalwarts of the academic staff at our Lake Shore institution.

Born on November 17, 1899, Mr. Livermore has been interested in physics as far back as he can remember. His interest extends into the limitless practical applications associated with this science. His hobby as he calls it is "gagetry and gimmickry." In his youth he used to tinker around cars, and became familiar enough with them to invent a few accessories. His inventions include a radiator curtain and a hand operated thermostat for the car; both, he claims, made long before they ever came out on the market.

Professor Livermore

Professor Livermore who lives with his wife in Chicago's suburban Evanston has developed his hobby to include various household gadgets. One of Mr. Livermore's latest inventions is a special support for a ladder. The windows on his house are so tall that if a ladder were placed at the bottom, the top of the window could not be reached. This makes washing them difficult. He solved the problem by the use of his special brace. The brace enables the ladder to be placed at various heights on the window without leaning against the glass. Mr. Livermore very proudly sketched the brace and it's application for this reporter. His hobby has led to the construction of many of the lecture demonstration "toys" for the physics department.

Mr. Livermore received his B.S. in Chemical Engineering from Illinois in 1922. He also has received an M.A. from Northwestern in Education and studied physics and worked in metal research at I.I.T.

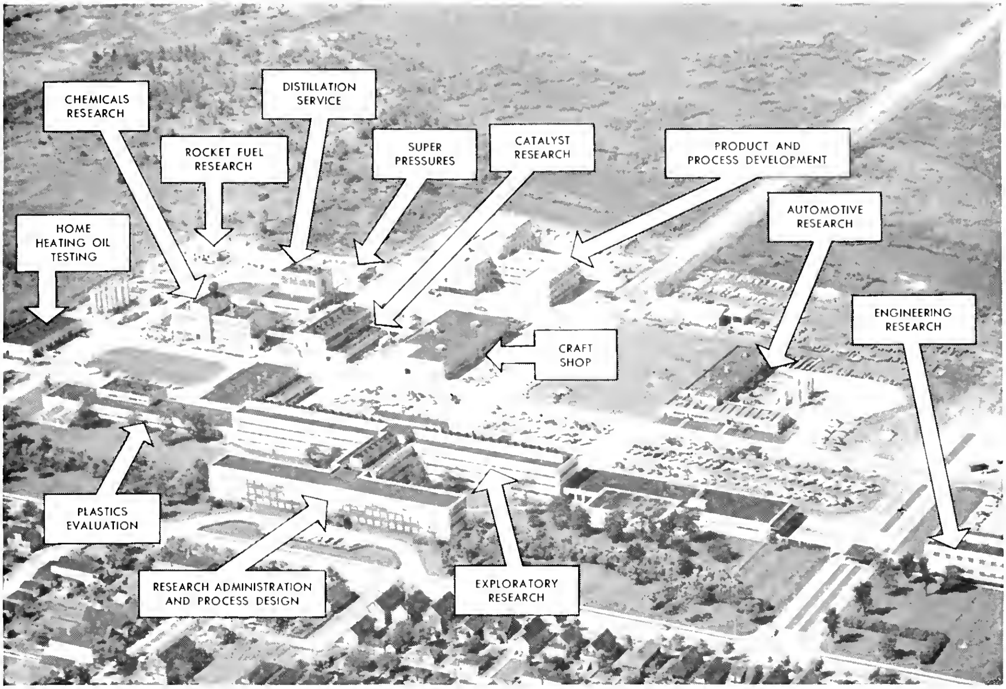
His teaching career started in 1937, and has covered everything from kindergarten up. Second graders are his favorites. He loves to talk with people and he finds that "the second graders are grownup enough to talk to, but not grownup enough to take offense."

Mr. Livermore came to the Pier in 1946 when it opened. He remembers when the teachers had to walk across a plank bridge that was over a gully of water in the corridor on the way to the lunchroom. That first year was a hectic one. Remodeling had not been completed yet and there weren't enough chemistry teachers to go around. Although he had been hired as a physics instructor, Mr. Livermore taught quant., qual., and beginning chemistry.

Mr. Livermore was the first sponsor for Tech. at the Pier, and ran it successfully for eight years. Because of his work on Tech the Dean of Women presented him with a handsome pin that he proudly wears. With the pin came a membership in The Activities Honorary Society.

When asked why he took up teaching his first words were "I like to show off." But this is very misleading. Mr. Livergood "likes personalities." He is the type of instructor who meets every one of his students individually. He takes a very personal interest in them and all their problems. His hobby has enabled him to reach students and help them to understand problems in physics. This helpfulness and unusual friendliness won him honorary membership in Omega-Beta-Pi, a pre-med scholastic fraternity at the Pier, and Phi-Eta-Sigma.

Professor Livermore feels that his term as an integral part of the Chicago campus has been, to say the least, an enjoyable one. He feels that our engineering school is one of the best. The only improvement that he can see would be the addition of a few more young ladies to boost morale and the decor (Amen).



This huge research center at Whiting, Indiana, is only part of Standard Oil's research facilities. A recently completed technical service and quality control laboratory, not shown here, is the largest laboratory of its kind in the country. In addition, large research laboratories are operated by several affiliates.

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THE SIGN OF PROGRESS...
THROUGH RESEARCH

U. S. and British Schools

By Arvydas J. Tamulis

Recently, much has been said about our educational system, and especially in comparison with the systems of other countries. No longer does the public of this country pose the question of whether Johnny can read, but their primary concern was whether Johnny can read better than Ivan. Lest I bore you with the much worn out question of our school system versus Nikita's little red school house, perhaps it would be of interest to note the comparison of the education a student receives in America as compared with his English speaking contemporary in England.

At the mention of education in Britain, one immediately thinks of the time-honored names of Oxford and Cambridge, and their outstanding positions as places of learning in the world. A notable fact to bring out here is that Britain, with a population of 51 million, has only 85,000 students in universities while the U. S., with a population of 178 million, has 3.4 million students in colleges and universities. Comparing the proportion of population to those attending universities, the U. S. places first, with Russia second, and Britain towards the bottom of the list as the 25th. In search of a reason for the small amount of students on the university level in Britain we must start at the beginning.

The British child usually starts in a primary school, a U. S. equivalent of public grade school, for children aged from 5 to 10. Between the ages of 10 and 11 a child takes an intelligence test known as the 11-plus. If he ranks among the top 25% of the students he is then admitted into what is called a grammar school, a U. S. equivalent of a junior and senior high school. This school is intended as a preparation for the university and is much more difficult than its counterpart in the U. S. If the child does not rank high in this 11-plus exam, he is then sent to a secondary modern school, a school stressing vocational training and his education ends at the age of 15 or 16. This is considered by many, even the Britishers themselves, as an evil in the educational system. At the age of eleven the future of the child is set. The mass of the British population is denied a higher education. The so called late developers, and others potentially good for college are turned aside. It is true that in such a way universities assure themselves of good material, but such a system hurts the country as a whole by letting other good material for college slip away not to speak of the injustice done to the child.

Now those that are admitted into these grammar schools find a tough curriculum awaiting them. This school is geared high to prepare the student for the university, eliminating the gap so apparent between our high schools and the college level school. In these schools the student must choose a field, either science or the arts, at about the age of 14 or 15. Then, if he shows a preference for the arts, a great emphasis is placed on language whereby he may take two or three languages. If a student prefers science at 15, at the latest, he takes up chemistry and physics. Then, usually at the age of 18, he may enter the university. All along the student is worked to capacity.

Without going deeply into the all familiar American educational system, the most glaring evil asserted by many educators is the gap created between high school and college. On the whole the colleges of this country attempt to keep the standards high and are raising them all the time in order that the completely educated man of the American system may hold his head high anywhere in the world. On the other hand the high schools attempt to take everyone and push them through the mill at the cost of lowering the standard. The trend in America is to follow the Dewey system of education which places the student in the center and around him builds the curriculum, the principles of education. If the student does not want any more mathematics above arithmetic and instead wants to substitute the proverbial basket-weaving course, so be it. While in England, as well as the other European countries, the principle of education, of learning, is placed in the center, and the student, if he wishes to advance in his studies, must adapt himself.

Which course is better to follow is hard to say. On both sides we have good points as well as bad. A happy medium may be called for, a system permitting the majority the chance at education, yet keeping the principles high so the system would not suffer.

Paris in Plastic

Spring has come in Paris—in a plastic wrapper. Parisian flower sellers have set up shop in transparent tents in the winter-swept city streets.

Stainless Steel Fuel Tanks

Tests are now being conducted on AM-355 stainless steel for use on special fuel containers for solid fuel rockets. It is a special, new type precipitation hardening stainless steel made especially for use in super-speed aircraft and missile parts which give the high strength-to-weight ratio to the fuel casings.

A Fable of the Barnyard

By Eileen Markham

Of late I have become convinced that the most valuable things are those taught us in our childhood. One of the most striking carry-overs of those pleasant days is the close corelation between the neighborhood park sand box and the foundry classrooms. Thus, I feel it might be of interest to us all if we were to go back and read some of the stories we read as children. But, I guess that might be a little boring as most of us have already read the same stories. So, I've written a new one—a fable that might be of interest to all of us. It is, as we know the typical fable to be, an animal story. May I present to you a TECHNOGRAPH *first:*

Once upon a time in the barnyard there was a horse and a mule. All their lives they lived the day by day way of the barnyard. Let's look at one such day.

Early in the morning the barnyard was in a state of complete quiet. Not a soul had stirred. The sun's rays began to penetrate the light streaked sky. And then we see a tired rooster begin to stir. As he slowly lumbered to the fence, his feathers perked up. Finally on the accustomed perch, his song began. The hen house awoke before the barn and then, at last, the lights in the house flickered on. In the barn the mule and horse paced back and forth waiting for their breakfast. (It was late again.) Impatiently the mule tried to open the feed bin lock with his teeth. Just as it started to give, the farmer's son came in with their meal. Afterwards their real day began.

Before lunch they didn't have much to do—just run and play in the sun. But then the children came out to play. So, the mule and horse gave them rides. The horse would stand still (as horses do) and wait for them to mount. Then he'd take them around the small paddock at a slow pace. That mischievous mule, however, used to stand still just until Teddy got half-way onto his back, then he'd begin to walk. He made a game of it. Thus, despite his lack of glamour (mules are ugly) he became his young master's favorite. It became almost a game, sometimes Ted and Joan would mount and ride him, other times they could not. He even did tricks (with some persuasion). All the while his friend the horse concentrated on his slow but beautifully uneventful ride along the path.

The obvious result was an extra lump of sugar for supper. Sometimes the mule would get another by taking it out of Joan's pocket. And the horse got his customary pat on the head in thanks for his dutiful task.

I could go on, but I think my point has been made. The individualist who strives to please can cope with more situations than the conformist. Hence the parallel in engineering. When we go out into the business world—maybe the straight "A" man who knows his subject backwards and forwards will get a higher starting rate. But, when we've

(Continued on Page 28)

STATE STREET LIGHTING

By Sheldon Altman

Chicago's State Street has done it again. It has regained the title of the most brilliantly lighted street in the world. The 74 lighting standards that accomplish this task spread for over seven blocks. Seventy poles extend from Lake Street south to Van Buren, accounting for 5,300 feet of lineal street area. Four more lights were added south of Van Buren in front of the Sears Roebuck store.

The poles are a basic tree design, having four curved arches growing from the tree "trunk." The pole also has three containers, 30 inches in diameter for the tree's flowers.

This standard was fabricated by Union Metal Company of Canton, Ohio and is composed of 17 major parts. The fabrication of the standards was a custom job. It required special mandrels for forming and specially selected plant personnel were used to hand bend the curved arms of the pole.

The central branch is of 5/16 inch steel. It tapers from 12 inches diameter at the bottom to eight inches in diameter at the top. The base of the standard is 34 inches in diameter at the ground line. The side walk luminaire is 24 feet above the ground; the two side mounts are 34 feet above the ground and the center mount reaches to 36 feet.

The lumenaire is now a standard General Electric flourescent lumenaire with special modifications. It is designed to accommodate 6 six foot power groove flourescent lamps.

The flourescent lamps are effected by temperature so that a self-enclosed air circulating system is incorporated in the luminaire. This is the first luminaire to be equipped with its own "air-conditioning" system. The air moving equipment consists of a centrifical blower driven by a unit bearing motor with a recirculating fan on the opposite shaft end of the motor. The motor is a shaded-pole type designed for long life and infrequent oiling.

In case of fan failure a thermostat cuts off the top two lamps to prevent overheating. The motor is controlled by a second thermostat which opens at 20 degrees F and closes at 40 degrees F.

A modification for State Street also consists of a special compounding of a plastic enclosing globe which makes the outline of the tubes during the daytime but provides for efficient light transmission during night operations.

One luminaire produces 55,800 lumens of light; each pole provides 223,200 lumens of light using the present lamp. When relamping is done the new double power grooved lamp will be used. This will raise each lumenaire's output to 62,000 lumens and each pole's output to 248,000 lumens. This will produce an average lighting intensity on the street of over 15 foot candles even though 20 per cent of the light is beamed upward on building facades.

Radio equipment is used extensively in the State Street lighting facilities. This is another first in street lighting. The system is operated by radio utilizing a 30-watt input transmitter broadcasting in the 27 megacycle band. The transmitter, located on the third floor of Carson Pirie Scott and Co., has astronomical time clocks which automatically turn on all four lumenaires at dusk, turn off the lower lumenaires at midnight, and turn the remaining fixture off at dawn. Separate time clock control is also provided for turning festoon lighting (such as that used of Christmas decorations) on and off. Manual push buttons are provided so that the system can be operated without use of the time clocks if desired.

There are actually two transmitters so that if one should fail the second can be utilized. The transmitter antenna is of the loaded dipol type and is approximately eight feet long.

The receivers are located in the bases of the poles. They are also equipped with an "air-conditioning" system. General Electric calrod heating units installed at the base of each pole maintain correct operating temperature for the radio receivers so that they will function under severe weather conditions.

Twenty-eight receivers are used and each receiver serves alternately two or three poles. If the receivers should fail to function the lights can be operated manually from the base.

To operate the radio broadcasting station a license was obtained from the FCC under their business category and it is renewed yearly.

The lumenaire reflector design provides for an upward component of light representing about 20 per cent of total light output. This was done to provide a cheerful atmosphere for the entire shopping area, both vertically and horizontally.

Each pole costs $7,500 installed. The city contributed $1,200 toward each pole, the balance being paid by the merchants on the street. The merchants' contribution was assessed on the basis of net front feet of store area along State Street on a six-year amortization basis. The city contribution is what a normal city light system would cost to install and maintain.

Every three months the poles are serviced. The lumenaires are cleaned, detective lamps are replaced, and instrument testing is performed on all radio equipment.

This unique lighting system has an output of nearly 3,300 lumens per lineal foot of roadway, three times the intensity of the next highest system.

It is interesting to note how this system came into existence. In the early 1920s the merchants of State Street decided that their street would have more than just the normal lighting facilities. They wanted a street that would be known around the world.

In cooperation with Commonwealth Edison and the best illumination engineers of the day they developed this system. On October 24, 1926, this system, owned and operated by the merchants, was put into operation as President Coolidge pressed a golden telegraph key.

But times change and a lighting system that is second to none in 1926 is far from that position within 25 years. It began to show signs of old age, and excessive maintainance costs combined with the fact that it was no longer the queen of streets again brought the State Street merchants together with a common bond. A new lighting system was again their mutual interest. What was needed was a light system that would:

1. Make State Street the brightest street in the world.

STATE STREET LIGHTING

2. Would be an artistic and functional achievement.

3. Yield a light which would not distort color (for display window purposes); increase glare or cause reflections in store windows; and one that would be up to date with coming illumination trends.

4. Would furnish building and upward illumination as well as street lighting.

These are pretty tough conditions for any light system to meet. Robert O. Burton, a Chicagoan with extensive experience in interior and lighting design, had his design selected from over 100 different designs studied in the two year planning of the renovated street. The simplicity of his form and its highly imaginative design, sets a lasting impression in illumination design.

The current system went into operation Nov. 13, 1959, (33 years after the first of the State Streets) giving Chicago another major civic achievement.

State Street taken the night of the opening ceremony, when the street had been blocked to traffic

CHICAGO'S MUSEUM OF SCIENCE and INDUSTRY

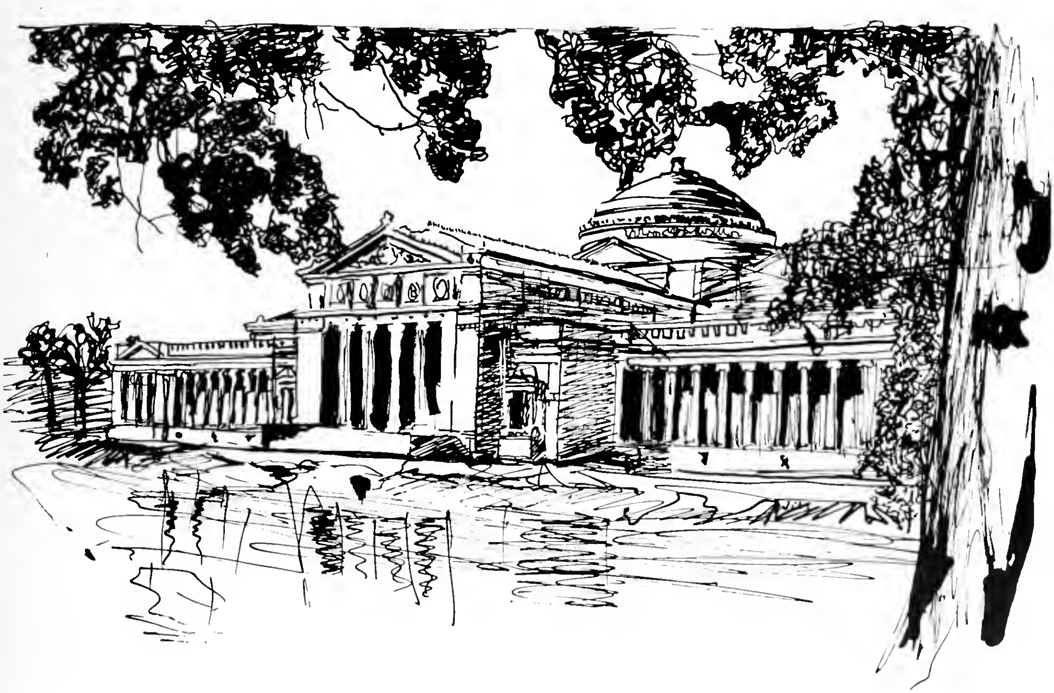
By Michael Murphy

Just west of the lakefront on 57th Street stands one of the most beautiful buildings in the world, Chicago's Museum of Science and Industry. The idea for a museum of this type was conceived by Julius Rosenwald, president of Sears, Roebuck and Co., being prompted by the inquisitiveness of his son, William. While Mr. Rosenwald and his son were in Germany in 1920, William was fascinated by the famous Deutsch's museum of science and industry. Rosenwald set out to found a museum like it in Chicago.

The site of the museum is the Fine Arts Building of the World's Columbian Exposition of 1893. The building was of Greek Classic style but with a modern layout. Many of the features of the fabulous structure were copied from the Erechtheion, one of the temples on the Acropolis, Athens, built in the 5th century, B.C. The original building was constructed of heavy brick walls with plaster coverings on the inside and outside. After the Columbian Exposition the building was used as museum which contained a collection of works which was mainly assembled from the Exposition. The name of the museum was the Field museum now known as the Chicago Natural History museum. In 1920 the Field museum left its slowly deteriorating building for a new home at its present location in Grant Park. Rosenwald decided to restore the building and to use it as the location for a museum of science and industry. He offered \$3,000,000 for its restoration and the south park district added another \$5,000,000 to this which was acquired through a bond. Later gifts by the Rosenwald family brought their total contribution to \$7,000,000.

The rebuilding of the structure consisted mainly of replacing the exterior of the building with Indiana limestone and interior with marble. All pillars which were originally iron were replaced with stone. The many skylights were replaced with domes of tile and copper. One striking feature of the exterior of the building is the 24 Caryatids which are supporting columns that have the form of draped female figures and are 13 feet tall. Reproductions of the sculptured panels which adorned the famous Parthenon ornament east and west pavilions. Some 350,000 cubic feet of stone weighing 28,000 tons make up the building. The structure contains 13,000,000 cubic feet of space and occupies 263,000 square feet (approximately six acres) of land. The floor space and exhibit space of the museum amount to 600,000 square feet and approximately 400,000 square feet respectively. The building consists of three pavilions. The central pavilion offers space for exhibits, offices, reference library, cafeteria, lunch rooms, kitchen, receiving room, and workshops. In the east pavilion can be found exhibits, studios, and storage space while located in the west pavilion are exhibits, and auditorium seating 1000 and a lecture hall seating 300.

The Museum of Science and Indus-



try is an educational institution, the purpose of which is to acquaint the general public with science and its application to industrial processes. An inscription in the Central Rotunda reads, "Science Discerns the Laws of Nature Industry Applies Them to the Needs of Man." An explanation of this inscription is thoroughly carried out by the museum.

When the museum first opened its doors in 1940 there were only a few exhibits scattered throughout the spacious building. This unimpressive atmosphere resulted in the museum facing a financial crisis. The trustees of the museum called upon Major Lenox R. Lohr to remedy the situation. Major Lohr who graduated from Cornell University was a member of the U. S. Army Corps of Engineers for twelve years. His work previous to being called upon by the museum trustees was that of general manager of A Century of Progress, the 1933-34 Chicago World's Fair and he also was president of the National Broadcasting Company.

Major Lohr's main objective was to remove the boring atmosphere generally associated with a museum. He reviewed the characteristics of other museums and settled upon some definite results. Smoking is permitted throughout the building and benches are provided for visitors who become weary.

Due to the tremendous cost of most exhibits which are worth viewing, the help of American industry was enlisted. As anyone can see the advertising which is accomplished by a company having an exhibit at the museum would more than pay for the cost of the exhibit. About fifty per cent of the exhibits are sponsored by industry. An exhibit by some organization is permitted by invitation only and then only under certain circumstances. Although the name of the company sponsoring the exhibit can be used freely in the exhibit no mention of excellence compared to other brand names is allowed. The company pays no fee for the space used but must pay for the complete construction and maintenance of the exhibit and for any demonstrators which are needed. Exhibits are kept for a period of three or five years depending upon agreement. If longer periods of exhibition are desired the company must agree to keep the exhibits up to date. One exhibit, that of the Bell Telephone Company changes thirty per cent of its material a year. The museum has about an equal number of its own exhibits. These include among other things a full scale operating coal mine, the captured German submarine U-505, a full scale model entitled "Yesterday's Main Street" and many more.

The majority of exhibits feature such things as life, motion, or visitor participation. It is this style of exhibit which mainly accounts for the large number of visitors to the museum yearly. In 1959 the number of visitors amounted to 2,547,231 which was a sizeable increase over the 516,848 people who visited the museum in 1940. In 1940 the average stay of a visitor was 55 minutes but in 1959 it was 3 hours, 12 minutes. People came from every state in the union and from the District of Columbia and many foreign countries.

The museum has an operating cost of about $800,000 a year. To meet this expenditure the museum has four sources of income — contributions from industry, income from securities, taxes levied by the park district and profit from admission to the submarine, coal mine, the Microworld and from the sale of souvenirs and from the cafeteria. Although Julius Rosenwald gave $7,000,000 to start the museum he left no endowment—believing each generation should provide for itself.

One industrial exhibit of particular interest is the B. F. Goodrich exhibit which features a "guillotine." The purpose of this guillotine is to show the strength of a tubeless tire. A 34 pound blade is dropped from a height of 30 feet onto the tire with the resulting force equal to that of a car traveling 60 miles per hour and striking a curb.

In the Radio Corporation of America exhibit visitors stand in front of color television cameras and see themselves on color receivers. The exhibits also show various phases of the science of color.

Another fascinating industrial exhibit is that of the International Harvester Company's simulated 160 acre farm. This exhibit is complete with model buildings, animals and people. An exhibit along similar lines is that of Swift and Co. The title of this exhibit is food for life and a farmer is employed full time to help maintain it. Every day 100 chicks are hatched in this exhibit and young ducks, lambs, and pigs are replaced about every three or four weeks.

General Motors exhibit "Motorama" emphasizes interchangeable assembly and its importance in modern industry. This exhibit tells the story of the first vehicles and traces their development through the years leading to modern luxury cars of today.

The Santa Fe railroad has an exhibit which delights everyone. It is an operating scale model of the whole Santa Fe railroad system extending from Chicago to California. Everything is shown in precise detail from the wheat covered plains of the midwest to the rich fruit producing Imperial valley of California.

The museum itself maintains a large number of permanent exhibits. Perhaps the most famous of these is a full scale, operating coal mine. After paying a small admission fee the visitors to the coal mine are led into an elevator and descend "600 feet" into the earth. Actually the elevator descends only a short distance but the slow motion of the elevator and the fast moving cables seen through the elevator give the appearance of a ride deep into the earth. This is followed by a ride on a small underground railroad of the same type used in actual mines. Next are demonstrations and lectures in various phases of coal mining.

Another popular permanent exhibit is that of the U-505 German submarine. This submarine which was captured by American Naval forces during World War II was brought to Chicago a few years ago as a memorial to the people who lost their lives while fighting German submarines. The sub was towed to Chicago through the Great Lakes and moved across the outer drive to its final resting place next to the museum. The visitors are first brought to a room which contains various articles such as log books, clothing and other objects found on the sub. Next the visitors enter the sub through its side and are lead through various compartments as the lecturer describes the sub's history and operation. The sub has been restored to a point where it is practically the same as it was during the years that it hunted for Allied shipping. As the visitors leave the sub they pass through a corridor which contains a periscope mounted in such a manner that the viewer can see out into the outer drive.

A must for every visitor is the exhibit entitled "Miracle of Growth." This exhibit was prepared with the assistance of the professional colleges of the University of Illinois. Pictures and diagrams serve to illustrate the process of human reproduction. This exhibit also contains a transparent plastic figure of a pregnant woman showing a full term fetus ready for birth. Another exhibit in the medical science section is "The Transparent Woman." As a demonstrator lectures concerning this exhibit various internal organs of the model light up. Other exhibits in this section of the museum are a 16 foot model of a human heart which can be entered. As a person walks through the heart a recording of an actual heart beat is heard.

All of the exhibits are created in such a manner so that the average person is able to clearly understand them. Many students in scientific fields have received their initial inspiration from a visit to the Chicago Museum of Science and Industry.

Raw Material Inventory for the Steel Industry

By Irwin E. Tuckman

The newspapers often carry stories as to the approximate inventories of the various producers of steel. They inform the public as to the importance of a stable supply in the warehouses, and the fact that if the supply dwindles prices rise.

But the steel companies have another inventory, an inventory that rises for about 8 months each year and falls the rest of the year. The public doesn't read about it, but it is harder to measure and much easier depleted than the warehouse inventory. It is one of the most important factors in the production of steel. This is the raw material inventory.

Near the blast furnaces of a steel refinery are mounds of iron ore, coal and limestone. These mounds appear to be small mountains and hills within the confines of the refinery. They can be compared to the pile of coal that was dumped in the alley for the heating of an apartment building. If that pile of coal were enlarged about six times it would be a very small mound in the stockpile of raw materials at a steel refinery.

To weigh the stockpile to find out how much there is, is out of the question. Yet by the use of engineering the tonnage can be measured with as little as one to two per cent error.

Most of the iron mined in this country comes from the Mesabi Range of Eastern Minnesota, the Clinton Range which runs from New York through the Appalachian Mountains to Alabama, and Wisconsin and Michigan. 79% of the ore comes from the Mesabi Range and the Lake Superior region.

The ore is transported down the Great Lakes on special barges to the furnaces located nearby. About 85% of all the iron and steel used in the United States is made in those states adjacent to the Great Lakes. In winter parts of the waterway freeze up, cutting off a major supply of ore. For only 8 months out of the year are the lakes navigable, and during this short time enough ore must be stored up to keep the furnaces going all year 'round. This time element is the reason behind the importance of knowledge of the inventory of the raw materials.

Formerly a crew of engineers used to go out to the stockpiles and measure the height of the mounds of raw materials. This operation took three to four weeks. Then they would spend about six weeks figuring the volume of the stockpile. From the volume and the density of the raw materials an estimate was made as to the number of tons of iron ore, coal for coke, and limestone available. An error of 8% was considered good. But an over estimation of more than 8% could throw the production schedule for a loop.

Several years ago a new method of aerial survey was introduced. It was new to the steel industry but old to the army. Originally used in World War II with 3-D photography, photogrammetry was able to obtain accurate details of enemy installations and industrial plants. Since then it has been used

(Continued on Page 26)

engineers

Automatic systems developed by instrumentation engineers allow rapid simultaneous recording of data from many information points.

and what they c

The field has never been broader
The challenge has never been greater

Engineers at Pratt & Whitney Aircraft today are concerned with the development of all forms of flight propulsion systems—air breathing, rocket, nuclear and other advanced types for propulsion in space. Many of these systems are so entirely new in concept that their design and development, and allied research programs, require technical personnel not previously associated with the development of aircraft engines. Where the company was once primarily interested in graduates with degrees in mechanical and aeronautical engineering, it now also requires men with degrees in electrical, chemical, and nuclear engineering, and in physics, chemistry, and metallurgy.

Included in a wide range of engineering activities open to technically trained graduates at all levels are these four basic fields:

Frequent informal discussions among analytical engineers assure continuous exchange of ideas on related research projects.

ANALYTICAL ENGINEERING Men engaged in this activity are concerned with fundamental investigations in the fields of science or engineering related to the conception of new products. They carry out detailed analyses of advanced flight and space systems and interpret results in terms of practical design applications. They provide basic information which is essential in determining the types of systems that have development potential.

DESIGN ENGINEERING The prime requisite here is an active interest in the application of aerodynamics, thermodynamics, stress analysis, and principles of machine design to the creation of new flight propulsion systems. Men engaged in this activity at P&WA establish the specific performance and structural requirements of the new product and design it as a complete working mechanism.

Under the close supervision of an engineer, final adjustments are made on a rig for testing an advanced liquid metal system.

EXPERIMENTAL ENGINEERING Here men supervise and coordinate fabrication, assembly and laboratory testing of experimental apparatus, system components, and development engines. They devise test rigs and laboratory setups, specify instrumentation and direct execution of the actual test programs. Responsibility in this phase of the development program also includes analysis of test data, reporting of results and recommendations for future effort.

MATERIALS ENGINEERING Men active in this field at P&WA investigate metals, alloys and other materials under various environmental conditions to determine their usefulness as applied to advanced flight propulsion systems. They devise material testing methods and design special test equipment. They are also responsible for the determination of new fabrication techniques and causes of failures or manufacturing difficulties.

(Continued from Page 23)

by engineers to survey land in the planning of highways.

By the use of photogrammetry a topographic map can be made. This map shows the configuration or shape of the land surface of any area with much detail. Due to the detail involved it is a map of small area as compared to a geographic map, and therefore is perfect for the stock piles. The map is made up of contour lines. On a steep slope the lines are close together and on a gentler one they are further apart.

There are four basic steps in the aerial inventory of a raw material stockpile.

I. The Plane

At a height of 1650 feet directly over the stockpile, a camera in the plane takes a series of photographs with a 55% overlap. When a matching pair of these photographs is projected on a screen a 3-D picture of the area is obtained. The scale used for measurement of a stockpile area is obtained by using known distances between markers.

II. The map.

The negatives of the photographs are used to make positive prints on glass plates. The pair of plates are put in a stereoscopic plotter, which projects them together on a small white screen. The two positives are each projected in different colors, one red and one blue. The plotter operator wears red and blue glasses similar to those used for viewing 3-D movies. The stockpile then appears in 3-D to the operator and he can distinguish the peaks and valleys as they actually are.

A bright dot is superimposed on the picture. The dot is controlled by the operator. He can adjust it to appear at any elevation. The dot is moved by a tracing table to which a pencil point is attached. By moving the dot along the pile so that it always touches the surface of the slopes of the mounds, the operator causes the pencil to draw a contour line at the bottom of the pile, and by moving up two feet with each successive line to the top of the stockpile an accurate topographic map of the pile is constructed.

III. Measuring the map.

A plainmeter measures square area within an irregular outline, and by its use the area of the stockpile is obtained.

With the counters set at zero the operator places the glass covered viewer on the first contour line. He follows the line with a dot in the viewer. After following the line through the map he procedes to the next elevation line and so on throughout the map.

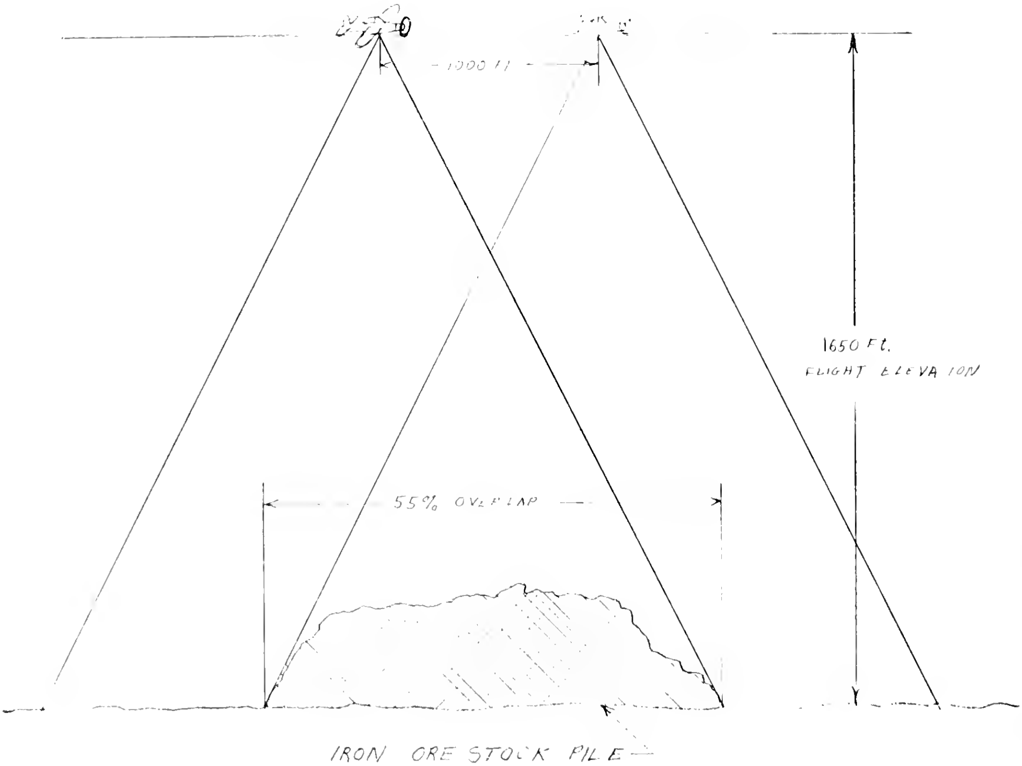
A dial registers figures as the viewer goes from elevation to elevation and around the map. The figures are then interpreted by means of a scale, giving an accurate tabulation of the area within the contour lines.

IV. Final Analysis.

The rest of the calculating is done by machines. The volume, the density of the material, and an allowance for the variations of slope of the stockpile are all taken into consideration. The result is an estimate of tonnage within one to two per cent error.

This accuracy and the time saved make the jobs of the men who make up the production schedule much easier than the old method.

The steel industry, using aviation, 3-D photography, map making, calculating machines, and engineers, "just for an inventory" keeps production at a constant rate.



A FABLE OF THE BARNYARD

(Continued from Page 17)

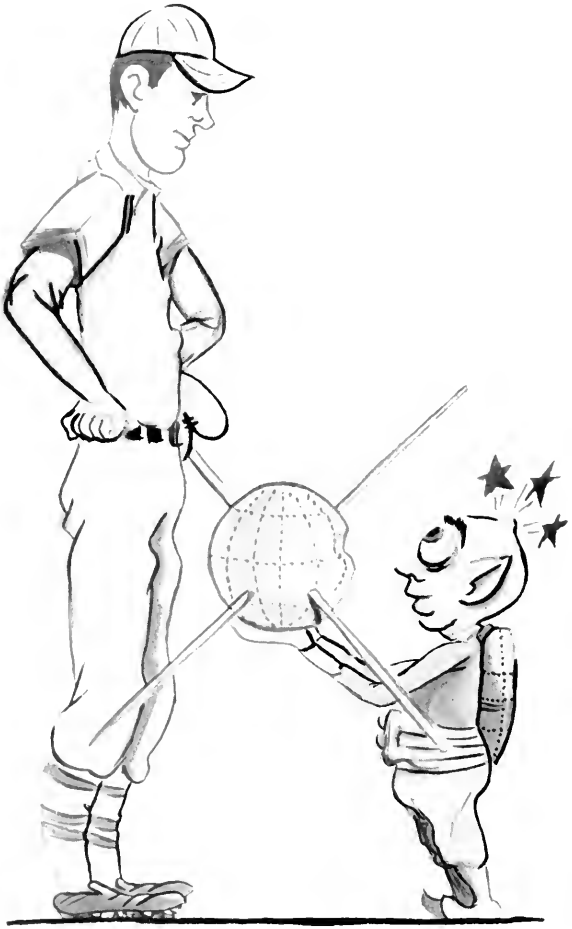
been out in the competitive field for a few days or weeks or months or years things will be different.

The man who can adapt to every situation, the one who knows more than how to solve the necessary equation, the one who has taken electives which reach far from his field will excel. I might even add that those who really become proficient in extra-curricular pastimes by joining teams and clubs have an even greater edge.

The really apparent parallel is identical to that of our friends: the mule and horse. The horse was efficient and yielding. He suppressed his own ideas to please the children. But he was not exciting to them. He didn't have the ingenuity to go beyond his training. The potential is equally bestowed on the horse and the mule to give children the pleasure of a ride in the afternoon. Yet one of them was the favorite—I'd even call him a "leader." This is comparable to our plight as engineers. We have equal resources in engineering. Our required courses must be mastered. However, in fields outside the technical area, there is a tendency to slough off. We must use these socio-humanistic fields to convey our engineering task to others.

We must realize our own make-up, physical, mental, and spiritual. These non-technical areas are also the key to getting along with your boss—knowing his limits and those of your co-workers and helpers.

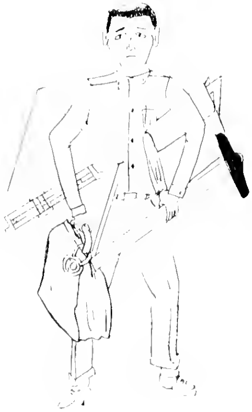
These and many other factors are needed in an engineer. We have a responsibility to the world we create with our automation that goes beyond the knowledge that an elevator cable will break with so much tensile stress. We must know if the people who will ride in that elevator are physically able to cope with the elevator's new facets. We must know if they can withstand its acceleration, or understand its self-operative features. This may open a whole new field of human engineering.



"Yours?"

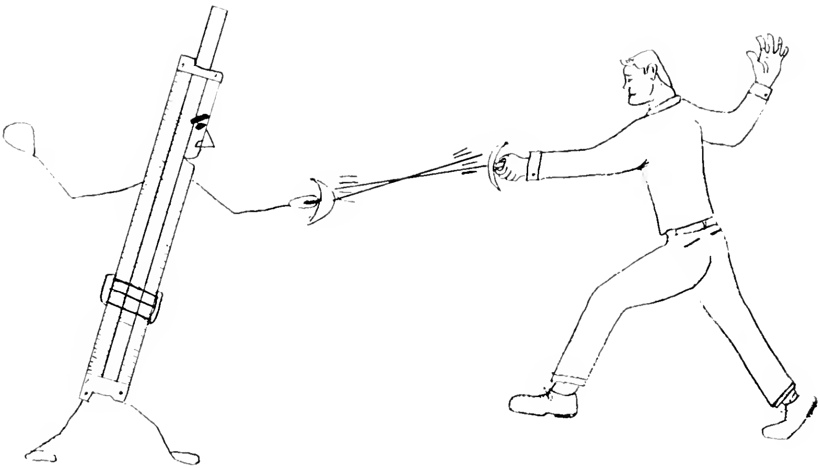
ENGINEERING FIRSTS

By I. E. Tuckman



FIRST DAY OF CLASS

BOY MEETS SLIDE RULE



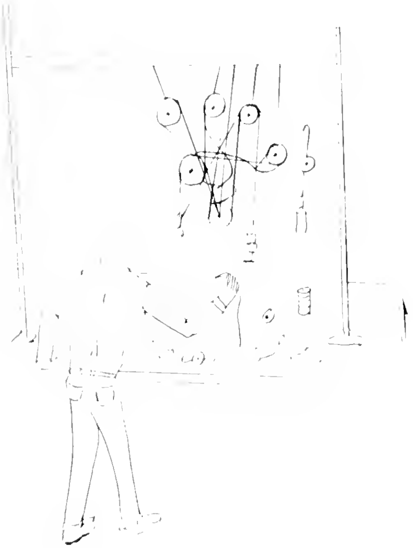
MASTERING THE SLIDERULE

FIRST EXAM

"Maybe I'll look it over tonight"

NEXT DAY

FIRST PHYSICS LAB

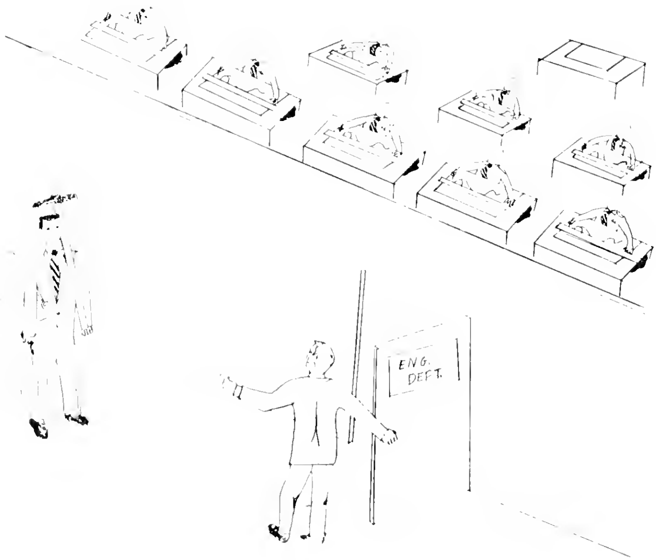


'I think I'll open a hot dog stand"

FIRST E.E. LAB

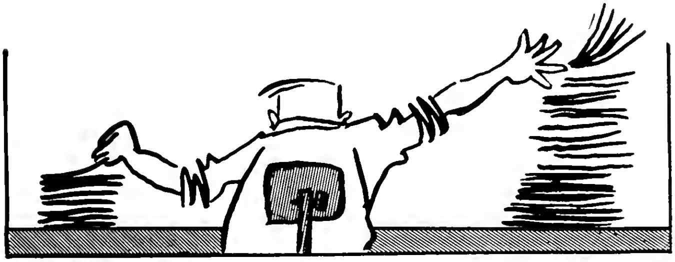
"WORKS, DOESN'T IT?"

FIRST JOB



"WE STRESS INDIVIDUALITY"

Skimming Industrial Headlines



Edited by The Staff

New Flagging Tape

A new, versatile plastic flagging tape was introduced by Keuffel & Esser Co. Made of tough, vinyl plastic in five vivid colors, it acts as a high-visibility marker for identification purposes.

Its far-reaching uses include locating boundary lines, stakes, stations, landmarks, center lines, property and utility lines and danger areas.

Ideally suited for engineers, surveyors, real estate firms, utility companies, builders, contractors and exploration companies, the weather and wind-resistant tape tears clean, takes pencil and ball point pen markings and remains supple at temperatures as low as minus 30 degrees F.

The tape comes in red, yellow, blue, white and orange. It is furnished in rolls 4 inches in diameter, 1¼-inch wide, 300 feet in length.

Hints on Interviewing

After accepting jobs, graduating students should not continue interviewing. College placement officers should not restrict the number of interviews a student has.

These are two suggestions among many in the first revisions of "The Principles and Practices of College Recruiting," a six-page leaflet published by the College Placement Council, Inc., Bethlehem, Pa., and the Chamber of Commerce of the United States, Washington. The leaflet lists mutual obligations of students, employers, and placement officers. The Council and the National Chamber are sending the leaflet to 1,500 college placement officers and 3,000 top business, college, and government executives.

With business booming again, the Council and Chamber expect a boom in the number of interviewers arriving on college campuses in the next few months to talk with the hundreds of thousands of senior and graduate students in the class of 1960. The Council and Chamber expect that, as during the hectic 1957 recruiting season, the shortage of top quality science graduates will continue.

The two organizations emphasize that departure from commonly accepted practices were few in 1957. They believe that a trend toward serious infractions was averted by the suggestions in the first joint statement. However, they point out that in 1958 and in 1959 the business recession caused a slackening in recruiting competition. The leaflet states that: "It is in the best interests of students, colleges, and employers alike that the selection of careers be made in an objective atmosphere with complete understanding of all facts."

Specific, mutual obligations of college students, placement officers, and interviewers are listed. For example:

"When a student is invited to visit an employer's premises at the employer's expense, he should include on his expense report only those costs which pertain to the trip. If he visits several employers on the same trip, costs should be prorated among them. . . .

"The (college) Placement Officer and faculty members should counsel students but should not unduly influence them in the selection of jobs. . . .

"Employers should not raise (salary) offers already made, except when such action can be clearly justified as sound industrial relations practices: such as, when an increase in hiring rate is required on an over-all basis to reflect salary adjustments in the employing organization."

The College Placement Council serves the eight Regional Placement Associations of the United States and Canada. Business, industry, and government personnel officers and college placement directors are members. The Chamber is composed of 3,450 business, trade, and professional organizations which have a membership of 2,750,000 business men.

Ductile Iron Pipe Production Seen Tripling This Year

Production of ductile iron pipe will triple this year and by 1961 it will climb to 100,000 tons annually. This prediction by The International Nickel Company, Inc., is based on the rapidly expanding use of this new engineering material for water mains; in underground gas distribution system; and for pipes aboard tankers and in chemical plants.

Two recent major installations in Chicago—one for gas distribution, the other for water—point up the trend in favor of ductile iron. Some 21,000 tons of this metal, which combines the strength and ductility of carbon steel with the corrosion resistance of gray cast iron, will be used for pipe this year.

Following successful underground insallations of ductile iron pipe on a pilot basis to test its resistance to ground settlement and traffic stresses, Peoples Gas Light and Coke Company of Chicago is now using many hundreds of thousands of feet of this pipe in sizes ranging from six to 30 inches throughout its gas distribution system.

"Ductile pipe possesses an impact strength from 12 to 15 times that of pipe produced from gray cast iron and, therefore, will withstand much greater shocks resulting from heavy traffic," James L. Adkins, chief technical engineer of Peoples Gas, reports. "The greater strength and bendability of ductile iron pipe permit it to withstand much heavier beam loading and greater deflections without failure."

Magnetic Roasting in Production Of Iron Ore

The gaseous selective reduction process employed by The International Nickel Company of Canada as a stage in the recovery of high-grade iron ore from nickeliferous pyrrhotite, was described. A closely allied procedure, magnetic roasting of iron oxides, is considered to be one of the most promising methods for beneficiating the low grade iron ores of the Lake Superior region.

Large-scale magnetizing roasting is being practiced, employing a novel process invented and developed by INCC. In this procedure, pre-heated hematite is subjected to a controlled reducing roast in kilns 13 feet in diameter, using gas generated by the partial combustion of heavy fuel oil or natural gas in a concurrent gas-solid operation. These are the largest known gaseous reduction kilns in the world.

The hot hematite feed is produced from nickeliferous pyrrhotite in fluid-bed roasters 26 feet in diameter. The roasters incorporate another concept invented and developed by Inco which results in uniquely high roaster capacity coincidental with a high degree of sulphur elimination and a high-quality sulphur dioxide off-gas.

After removal of nickel, copper and cobalt from the kiln product by leaching, the almost pure magnetic is agglomerated on balling discs and fired on an 8-foot-wide traveling grate pellet sintering machine. The final product consists of pellets one inch in diameter analyzing 68 per cent iron, considered to be the highest quality tonnage iron ore produced on the North American continent.

Advanced Infrared Sensistors

Lockheed Aircraft Corporation reports development of an infrared device so sensitive it can detect the presence of a glowing cigarette miles away.

Applications of infrared theory in a major new Lockheed research program have brought forth a similar device for West Germany's F-104G Starfighters.

Robert A. Bailey, California Division chief engineer, said the research product provides fire control systems with "multiple advantages" over equipment now installed in modern military aircraft.

"Meeting all requirements for supersonic fighter use, it is smaller and lighter, more reliable and more accurate than similar instruments in current use; in addition, it is operable both day and night," Bailey said.

Designed to supplement electronic tracking gear, it will provide measurement of angular target movement after initial radar contact.

Full Power Reached by Nation's First Dual Reactor

Two pressurized water reactors of the land-based prototype nuclear power plant for large surface ships have operated in parallel at full power at Idaho Falls, Ida. The plant, known as the A1W prototype, is the nation's first nuclear power plant to have two reactors powering one propeller shaft. Designed as the forerunner of the power plants for two Navy combatant ships now under construction, the guided missile cruiser, Long Beach, and the aircraft carrier, Enterprise, the A1W is the largest naval nuclear power plant in operation. Full power was achieved September 15, 1959.

The A1W prototype power plant was designed and developed by Westinghouse Electric Corporation at the Atomic Energy Commission's Bettis laboratory, Pittsburgh, under the direction of and in technical cooperation with the Naval Reactors Branch of the AEC.

Philip N. Ross, general manager of the Bettis atomic power laboratory, emphasized that the A1W prototype full scale test of the reactor, reactor system, steam plant systems apparatus, and controls will provide important technical information on over-all plant performance.

The two A1W reactors along with all the primary coolant systems are housed in an exact replica of a ship's hull section. Newport News Shipbuilding and Dry Dock Company, Newport News, W. Va., was responsible for the construction of the ship's hull and the installation of nuclear and propulsion plant components.

The cruiser, Long Beach, which was launched July 14, 1959, will use two A1W type atomic reactors in its propulsion plant, while the carrier, Enterprise, will utilize eight of these reactors.

Economy of Gravel Roads

Gravel or crushed stone roads are economical when traffic volume is low, but beyond a certain limit, potholing and washboarding raise maintenance costs to an extent that more expensive surfacing is cheaper, Prof. Eugene Y. Huang, University of Illinois civil engineering department, told the Highway Research Board.

He reported an investigation conducted under the U. of I. Engineering Experiment Station in cooperation with the Illinois State Division of Highways and U. S. Bureau of Public Roads.

Gravel roads studied by Prof. Huang were more resistant to potholing and crushed stone to washboarding. Both conditions are caused by traffic. Good drainage helped by maintenance of road crown and shoulders helps keep down these auto-shaking and teeth-jolting deformations of the surface, he said.

Potholes result when an auto tire passing over a soft spot in the roadway splashes out fine materials, then bounces out the loosened larger materials. Holes 5 or 6 inches deep result.

Washboarding results when a wheel passing over a soft roadway hits a small obstruction, bounces, pushes surface materials a bit, and bounces again until oscillations stop. Effect is compounded by one vehicle after another, and a corrugated surface results.

Number of vehicles causing such roadway deformation may be as low as 50 a day, Prof. Huang said. The deformities develop rapidly when traffic densities go beyond 400 vehicles a day.

New Metal Etching Control Material Described

A newly-introduced control material for metals-working industries which employ etching, photo milling, or plating techniques is now available.

Kodak Metal-Etch Resist was developed to assist in accurate and economical control of the removal of superfluous and hard-to-get-at metal from in-process pieces through etching or chemical milling. It is expected to have far-reaching applications in space-age industries which work largely with aluminum and titanium.

Kodak Metal-Etch Resist protects the surface of the in-process piece in those areas where the removal of metal is not required or is undesirable. The entire surface of the piece is first coated with Kodak Metal-Etch Resist. The piece is then exposed to high-intensity light, from a carbon-arc or mercury-vapor lamp, through a photographically prepared line negative which "masks" the piece, passing the high-intensity light to areas which require protection and excluding it from areas to be worked. This exposure forms an image of the desired pattern. After treatment with Kodak Metal-Etch Resist Developer, the protected areas will resist the action of the etching solutions.

Because it is a non-conducting material which adheres readily to a number of metals, Kodak Metal-Etch Resist is expected to be widely used also in plating to permit the plating of a piece in specific areas, while excluding the plating from other areas.

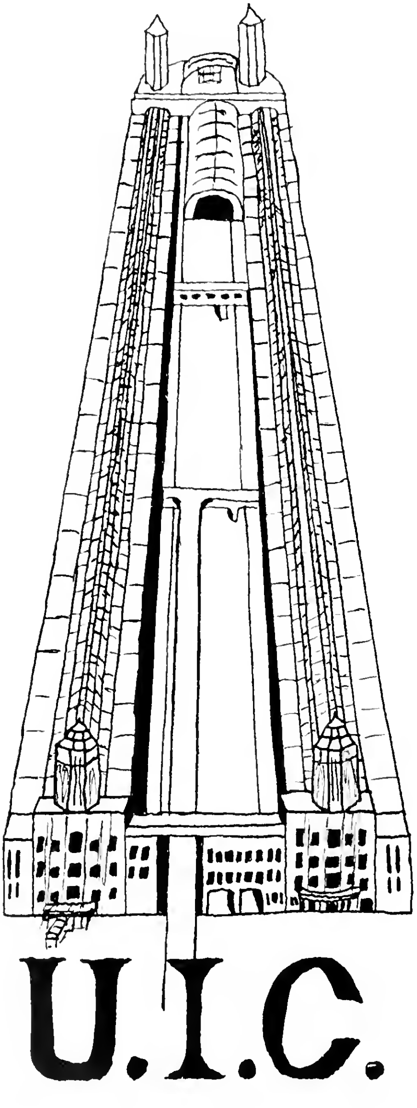
'Plastic' Transportation

A Canadian company is using plastic balls to float wood chips down the Frazer River. If the experiment proves to be successful, this method may eliminate the need to purchase 1,500 gondola-type railway cars to transport the huge volume of chips.

'Punctures' Help Tires

A tire company is puncturing its tires with thousands of tacks before offering them to consumers. The company has found an even spread of tiny holes on the tread gives a tire a crepe-like quality, lets the tread touch every dent and bump on a slippery road and develops maximum traction.

NEWS FROM NAVY PIER



Student Uprising

A pre-planned demonstration by student leaders, fulfilled a promise made last year in the Mayor's office on the occasion of the student march last spring.

It was promised last year that the students would again protest if no concrete action were made toward school relocation.

The demonstration began with a funeral procession and mock coffin being carried to the east end of the pier. A short eulogy was given and the coffin slid into the lake carrying with it Mayor Daley's promises for action. The coffin wouldn't break through the ice because as one student put it, "this showed the weakness and shallowness of the promises made by the Mayor."

After this loud but orderly procession about 30 cars proceeded in a solemn line to Garfield Park, one of the proposed locations, and a cornerstone was laid. It read: "Let it be known that we, the students of the University of Illinois at Chicago do hereby claim this land for a new UIC site on the 10th day of March, Anno Domini, 1960."

The press coverage included all the Chicago dailies "Newsweek Magazine" and NBC and CBS news commentators.

60-Story Cylinders

Two cylindrical 60-story apartment towers, the world's largest residential structures, will be built on the north bank of the Chicago River between State and Dearborn.

This unprecedented center will include a 10 story office structure, a wide plaza and sculpture garden facing the river, a theater, a marina for 700 small boats, a restaurant, an ice-skating rink, a swimming pool and an 18 story garage. The project is called Marina City.

Construction for the project will start this summer. Architect Bertand Goldberg, 46, a Harvard graduate, and one time student of Mies van der Rohe, devotes the first 18 stories to a spiral ramp for automobiles, and the top 40 stories to pie shaped apartments, each with its own balcony.

The cost for the project will be $36 million and will be financed by AFL-CIO Building Service Employees' International Union. The money will be taken from the Union's health and welfare funds to build up the central city where the members have their jobs. A 5 per cent return on the investment will be guaranteed the union under Title

...THE EXPLORATION OF SPACE

Since its inception nearly 23 years ago, the Jet Propulsion Laboratory has given the free world its first tactical guided missile system, its first earth satellite, and its first lunar probe.

In the future, under the direction of the National Aeronautics and Space Administration, pioneering on the space frontier will advance at an accelerated rate.

The preliminary instrument explorations that have already been made only seem to define how much there is yet to be learned. During the next few years, payloads will become larger, trajectories will become more precise, and distances covered will become greater. Inspections will be made of the moon and the planets and of the vast distances of interplanetary space; hard and soft landings will be made in preparation for the time when man at last sets foot on new worlds.

In this program, the task of JPL is to gather new information for a better understanding of the World and Universe.

"We do these things because of the unquenchable curiosity of Man. The scientist is continually asking himself questions and then setting out to find the answers. In the course of getting these answers, he has provided practical benefits to man that have sometimes surprised even the scientist.

"Who can tell what we will find when we get to the planets? Who, at this present time, can predict what potential benefits to man exist in this enterprise? No one can say with any accuracy what we will find as we fly farther away from the earth, first with instruments, then with man. It seems to me that we are obligated to do these things, as human beings."

DR. W. H. PICKERING, *Director, JPL*

CALIFORNIA INSTITUTE OF TECHNOLOGY

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A Research Facility operated for the National Aeronautics and Space Administration

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Send professional resumé for our immediate consideration. Interviews may be arranged on Campus or at the Laboratory.

Seven of the National Housing Act. Until now unions have been investing these funds largely in government securities.

Architect Goldberg has raised the 896 projected apartments well above city noise and dust, while providing garage space underneath for every family. The rooms open on a wide living room, opening on a wider balcony, to the wide arc of the horizon and strike an immense contrast with the boxlike rigidity of most city structures.

Goldberg has adopted a trunk and branch construction, "foliated form rather than the usual post-and-beam construction" (the building will be supported from its core, rather than by a box-like framework). This combats the high wind force at this height. Rents will start at $115 a month.

Use Radioactivity in Search for Water

Atomic tracers are being used in an effort to locate and measure new reliable sources of underground water.

This information was released in a report by the Atomic Energy Commission and the U. S. Geological Survey.

Research projects to develop the new atomic techniques for discovering water resources are underway in New Jersey, Wisconsin and New Mexico.

Tritium, an atomic substance injected into the atmosphere in nuclear bomb tests, is being used by the researchers. Raindrops are "tagged" so that they may be traced as they find their way into underground water reservoirs.

Raindrops have an affinity for absorbing minute and harmless quantities of tritium from nuclear fallout in the atmosphere.

Music Gap!

Saul Karsunsky, a communication engineer and musical scholar has designed an electronic musical instrument called a crystadia. This was reported by the Soviet news agency Tass. Tass reports that the instrument produces sounds like wind instruments "of very unusual and original timbres."

The Light Fantastic

Argonne national laboratory near Lemont is doing research with a giant "Atomic Spotlight" which penetrates living tissue with beams of colored light.

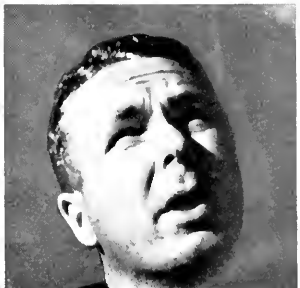
In years to come, a treatment of one colored light may soothingly put one to sleep or another atomic light may change ones mating habits.

The light was built by Dr. Charles F. Ehret of Argonne's division of biological and medical research, who calls it a biological spectrograph. He is using it to study the effects of various colored light—both visible and invisible—on cells.

THESE MEN HAVE ONE THING IN COMMON ...BESIDES SUCCESS

HARRY SUMNER, Sales Engineer, B.S. in Business Administration, University of South Carolina

KENT R. VAN HORN, Director of Research, Ph.D., Yale University



RICHARD C. WILSON, Assistant Manager of Distribution, B.S. in Aeronautical Engineering, University of Kansas

LAWRENCE M. DUNN, Manager of Architectural Department, Sales Development Division, B.S. in Mechanical Engineering, Iowa State University

THOMAS R. GAUTHIER, Cleveland Works, Chief Metallurgist, B.S. in Chemical Engineering, Iowa State University

GUSTAV O. HOGLUND, Division Chief of Alcoa Process Development Laboratories, B.S. in Aeronautical Engineering, University of Michigan

hese men have a faith. An abiding faith. It's in the future of a metal. Aluminum.

hey all are department heads at Aluminum Company of America. They all started with Alcoa as young men fresh ut of college. They all have prospered as Alcoa has prospered.

hey all have received their promotions on merit . . . the same merit which has contributed signally to Alcoa's status s the Twentieth Century's outstanding corporate success story.

oday, the prospects for a new employee at Alcoa are even brighter, even more challenging than they were when these ien first went to work. This is because the prospects for Alcoa and for aluminum are brighter.

a dynamic future in this kind of corporate environ-ient interests you, contact your placement officer to rrange an interview. For more details, write for our ree booklet, *A Career For You With Alcoa.* Write luminum Company of America, 810 Alcoa Building, ittsburgh 19, Pa.

Your Guide to the Best in Aluminum Value

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ALUMINUM COMPANY OF AMERICA

For exciting drama watch "Alcoa Presents" every Tuesday ABC-TV and the Emmy Award winning "Alcoa Theatre" alternate Mondays, NBC-TV

BRAIN TEASERS

Edited by Steve Dilts

The following teasers are quite popular and are typical of the variety involving logic.

* * *

A doctor met a good friend who was a lawyer and said, "I just saw three women walking along the street. The sum of their ages is twice mine, and the product of their ages is 2450. What are their ages?" The lawyer replied, "I can't tell." The doctor then added, "The oldest is younger than you are." (None are older than one hundred).

* * *

Probably after graduation from high school, plane geometry faded into the background for you. Here's a chance for you to see how much you can remember about it. See if you can find the fallacy in this proof that all triangles are isosceles.

1. Construct any triangle ABC.
2. Put in AG so as to bisect angle CAB. Angle CAG = Angle GAB.
3. Construct the perpendicular bisector of CB.
4. Name the point O at which the bisector of CB intersects AG, and D the mid-point of CB.
5. Construct OC and OB. OC = OB.
6. Construct OE perpendicular to AC and OF perpendicular to AB. $\angle$OEA = $\angle$OFA.
7. OA = OA.
8. Triangle AEO similar to triangle AFO. (s.a.a.—s.a.a.)
9. OE = OF.
10. Angle OEC = Angle OFB = Rt. Angle.
11. Triangle OEC similar to triangle OFB. (hyp. leg = hyp. leg).
12. AE = AF; EC = FB.
13. AC = AB.
14. Therefore every triangle is isosceles.

* * *

Stop, if you've heard of the three missionaries and the three cannibals. Again it's a question of crossing a river in a boat which holds only two men. The complication is that although each of the missionaries can row, only one of the cannibals, the cannibal king, can do so. Naturally, you must never let the cannibals outnumber the missionaries on either side of the river.

* * *

Suppose that we have a bucket containing a gallon of water and a keg containing a gallon of wine. We measure out a pint of the wine, pour it into the water, and mix thoroughly. Then we measure out a pint of the mixture from the bucket and pour it into the keg. Is there now more or less water in the keg than there is wine in the bucket?

* * *

Here are the answers to last month's teasers.

* * *

C asks himself: Can my hat be green? If so, then A will know immediately that he has a red hat, for only a red hat on his head would cause B to lift his hand. A would therefore leave the room. B would reason the same way and also leave. Since neither has left, C deduces that his own hat must be red.

A systematic approach would be to jot down the four possibilities — TT, TL, LT, LL—then eliminate the pairs that are inconsistent with the premises. A quicker solution is reached if one has the insight to see that the tall native must answer "Yes" regardless of whether he lies or tells the truth. Since the short native told the truth, he must be a truth-teller and his companion a liar.

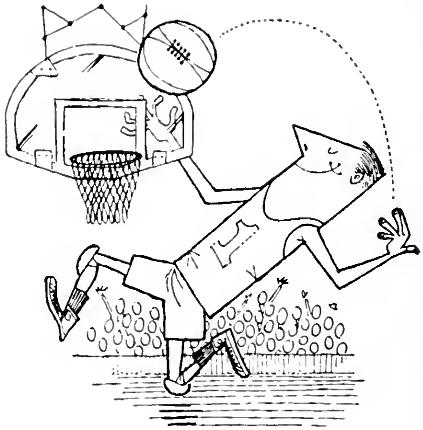
* * *

Let n be the number of steps visible when the escalator is not moving, and let a unit of time be the time it takes Professor Slapenarski to walk down one step. If he walks down the down-moving escalator in 50 steps, then $n - 50$ steps have gone out of sight in 50 units of time. It takes him 125 steps to run up the same escalator, taking five steps to every one step before. In this trip, $125 - n$ steps have gone out of sight in 125/5, or 25, units of time. Since the escalator can be presumed to run at constant speed, we have the following linear equation that readily yields a value for n of 100 steps:

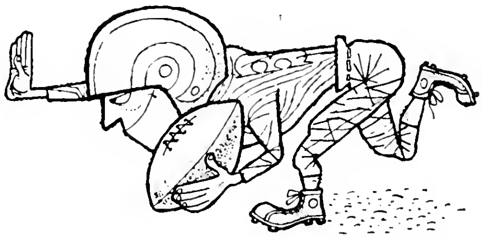
$$\frac{n - 50}{50} = \frac{125 - n}{25}$$

* * *

To determine the value of Brown's check, let x stand for the dollars and y for the cents. The problem can now be expressed by the following equation: $100y + x - 5 = 2\,(100x + y)$. This reduces to $98y - 199x = 5$, a Diophantine equation with an infinite number of integral solutions. Only one solution, however, meets the problem's condition that the value of y be less than 100. This solution is: $x = 31$ and $y = 63$, making Brown's check \$31.63.



In the field of Sports PPG is there, too...



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The Strange Science of Seeing

Through telescopes, it's now possible to see stars that are millions of billions of miles away. Through microscopes, we can take pictures of particles so tiny that a million billion of them, clustered together, would be invisible to the naked eye. We've devised electronic eyes, even supersonic eyes, but in spite of all the progress, one great question is still not fully answered:

"How much light is required for seeing?"

Architects and interior decorators have to guess at the answer all the time. How much light, for example, should come from the fixture on the kitchen ceiling? With too little light, things become somewhat harder to find. The likelihood of dropping a dish or knocking over a bowl increases. Without the full amount of light she needs, the housewife subconsciously becomes annoyed — and her annoyance rise to the level of consciousness if she stays in her kitchen long enough.

But too much light can be just as bad — and have the same effects. The room takes on the appearance of an excessively light photograph. There's too little distinction between light and dark. Glare rankles the nerves.

Those who plan lighting for store windows face the same problem. Use too little light, and people won't notice the wares; too much and the wares will be hard to see.

A major advance in the seeing science came with the development of the foot-candle, today the most widely accepted unit of light measurement. A foot-candle, logically enough, is the amount of light produced by a standard candle at a distance of one foot.

So—how many foot-candles do you need? "As many as you can get without burning your hair," was the answer in days when the fire was the sole source of indoor illumination. A variation of this answer applied to the gaslight and early electric days. But soon, when it became possible to get *more* than enough light, seeing scientists answered the question based on the size of the detail to be seen. Knitting, for example, is a small detail relative to washing clothes.

A major breakthrough in the science of seeing came in the late 1920's when the team of Cobb and Moss recognized that, in addition to size of detail, other factors had a bearing on the amount of light you need:

1. How much contrast is there between the detail and the background? You need somewhat more light to wash white clothes in a white tub than you need for blue jeans in the same tub. If you're knitting a black sweater, you need more light if you're using black needles than you need if you're using white ones.

2. What's the time interval of seeing? The red traffic light may be bright enough now, but if it were to flash on for just an instant—instead of remaining lit—it would have to be far stronger.

During the years since Cobb and Moss stated their findings, many other men contributed to determining optimum illumination levels. Names like Luckiesh, Weston, and Blackwell became well known as experts.

Recently, Dr. H. Richard Blackwell, Director of the Vision Research Laboratories, University of Michigan, developed a new method for determining the illumination required for various seeing tasks. At the core of his method is his "Concept of Visual Capacity"—a concept that takes into account, in figuring out how much light is needed for a given task, how long the eye must rest on the thing being seen. If an eye can see and recognize something in a second, it has the capacity of assimiliating four bits of information in one second. One ASP (assimilation per second) means that the eyes take one full second to see the task, and 10 APS means that it can see the task in one tenth of a second (or, to put it in another way, the eye can see a succession of ten of the things in one second).

Thanks to Blackwell's concept, it is now possible to be much more accurate in determining how much light is needed for a given seeing task. Blackwell found, for example, that reading the writing of a group of sixth graders who used a No. 2 pencil required 63 foot-candles for five APS. To read the writing of a stenographer who uses a No. 3 (lighter than No. 2) pencil, Blackwell found that 76 foot-candles are needed. And to read a fourth carbon copy of a letter requires 133 foot-candles.

But these seeing tasks are easy compared with some tasks. To notice a brown stain on a gray cloth, for example, took 1100 foot-candles. A brown spot on a red necktie required 2400 foot-candles; And in a textile mill, spotting a broken thread on a spinner-bobbin required light equivalent to that of 2900 candles one foot away!

Who cares about these findings? Almost nobody. Yet, almost everyone will benefit. Schools will be better lighted, thus promoting education and saving youthful eyes. Factories will also have more correct levels of illumination, boosting both safety and production. Stores will be more attractive and sell more goods. Offices will be disrupted with fewer errors, homes by fewer arguments due to eye-strain.

These predictions of better things to come are no pie-in-the-sky day-dreams; applications are already underway. The Illuminating Engineering Society, for example, has already published the new, more accurate figures indicating required levels of illumination. And now that it's known how much light should be cast, for example, on the desk of a school child, science has even devised a method for maintaining that level of light constantly—automatically boosting the output of electric light when natural light declines, decreasing electric light as natural light increases. Designed by Superior Electric Company, the device is called a Lumistat and actually does with light what a thermostat does with heat! The complete system is known as the Luxtrol Automatic Light Controller.

Of course, much research work in the lighting field remains to be done. Still unanswered are such questions as how much extra light is needed for older eyes . . . what's the best way to light our roads for peak seeing efficiency . . . how can we answer, with even greater accuracy, the question of how much light is required for a given task?

Of one thing, though, we can be sure! Thanks to Moss and Cobb's recognition of what determines how much light we need, thanks to Blackwell's concept and careful supporting experimentation, thanks to ingenious Lumistat and Luxtrol Automatic Light Controller—and thanks to scientists, who will provide us with the advances of the future—we will soon be seeing more attractive sights . . . through eyes that are less often sore.

One of a series

Interview with
General Electric's Earl G. Abbott,
Manager—Sales Training

Technical Training Programs at General Electric

Q. Why does your company have training programs, Mr. Abbott?

A. Tomorrow's many positions of major responsibility will necessarily be filled by young men who have developed their potentials early in their careers. General Electric training programs simply help speed up this development process.

In addition, training programs provide graduates with the blocks of broad experience on which later success in a specialization can be built.

Furthermore, career opportunities and interests are brought into sharp focus after intensive working exposures to several fields. General Electric then gains the valuable contributions of men who have made early, well-considered decisions on career goals and who are confidently working toward those objectives.

Q. What kinds of technical training programs does your company conduct?

A. General Electric conducts a number of training programs. The G-E programs which attract the great majority of engineering graduates are Engineering and Science, Manufacturing, and Technical Marketing.

Q. How long does the Engineering and Science Program last?

A. That depends on which of several avenues you decide to take. Many graduates complete the training program during their first year with General Electric. Each Program member has three or four responsible work assignments at one or more of 61 different plant locations.

Some graduates elect to take the Advanced Engineering Program, supplementing their work assignments with challenging Company-conducted study courses which cover the application of engineering, science, and mathematics to industrial problems. If the Program member has an analytical bent coupled with a deep interest in mathematics and physics, he may continue through a second and third year of the Advanced Engineering Program.

Then there is the two-year Creative Engineering Program for those graduates who have completed their first-year assignments and who are interested in learning creative techniques for solving engineering problems.

Another avenue of training for the qualified graduate is the Honors Program, which enables a man to earn his Master's degree within three or four semesters at selected colleges and universities. The Company pays for his tuition and books, and his work schedule allows him to earn 75 percent of full salary while he is going to school. This program is similar to a research assistantship at a college or university.

Q. Just how will the Manufacturing Training Program help prepare me for a career in manufacturing?

A. The three-year Manufacturing Program consists of three orientation assignments and three development assignments in the areas of manufacturing engineering, quality control, materials management, plant engineering, and manufacturing operations. These assignments provide you with broad, fundamental manufacturing knowledge and with specialized knowledge in your particular field of interest.

The practical, on-the-job experience offered by this rotational program is supplemented by participation in a manufacturing studies curriculum covering all phases of manufacturing.

Q. What kind of training would I get on your Technical Marketing Program?

A. The one-year Technical Marketing Program is conducted for those graduates who want to use their engineering knowledge in dealing with customers. After completing orientation assignments in engineering, manufacturing, and marketing, the Program member may specialize in one of the four marketing areas: application engineering, headquarters marketing, sales engineering, or installation and service engineering.

In addition to on-the-job assignments, related courses of study help the Program member prepare for early assumption of major responsibility.

Q. How can I decide which training program I would like best, Mr. Abbott?

A. Well, selecting a training program is a decision which you alone can make. You made a similar decision when you selected your college major, and now you are focusing your interests only a little more sharply. The beauty of training programs is that they enable you to keep your career selection relatively broad until you have examined at first hand a number of specializations.

Furthermore, transfers from one General Electric training program to another are possible for the Program member whose interests clearly develop in one of the other fields.

Personalized Career Planning is General Electric's term for the selection, placement, and professional development of engineers and scientists. If you would like a Personalized Career Planning folder which describes in more detail the Company's training programs for technical graduates, write to Mr. Abbott at Section 959-13, General Electric Company, Schenectady 5, N. Y.

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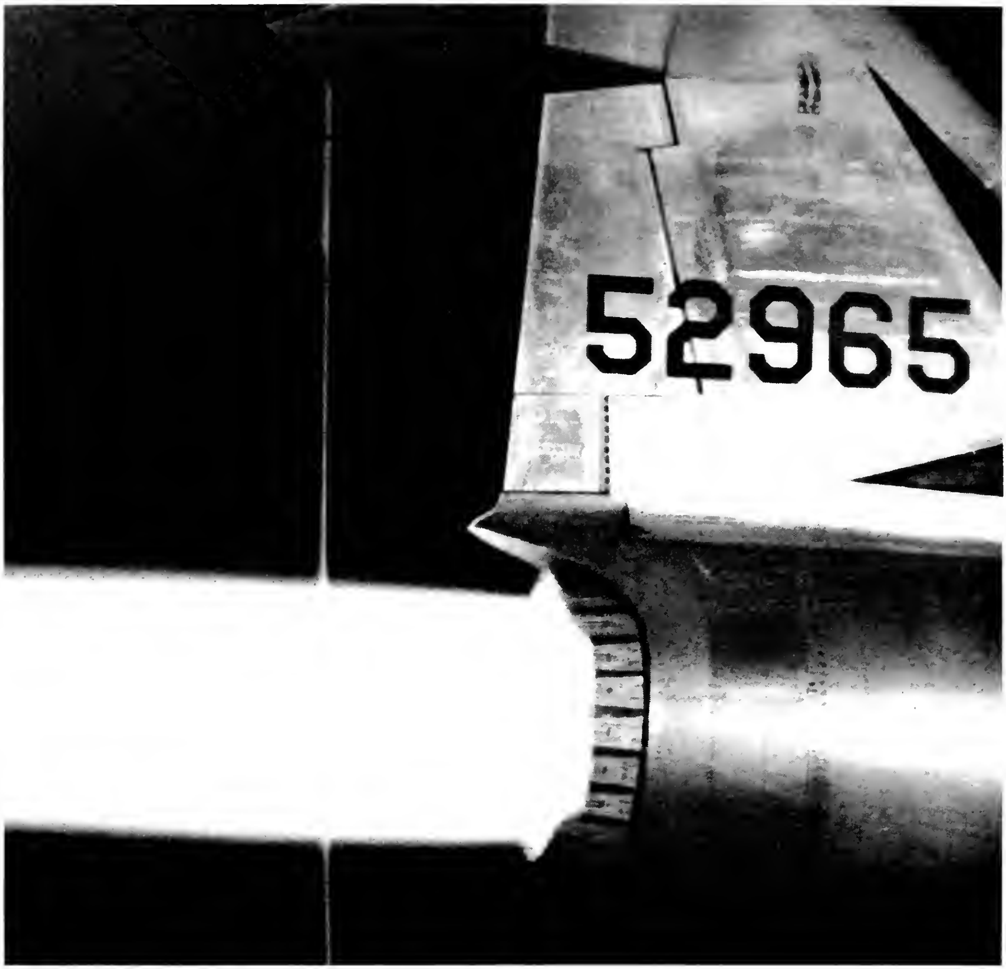
ILLINOIS TECHNOGRAPH

April · 25¢



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THE ILLINOIS TECHNOGRAPH

Volume 75, No. 7 April, 1960

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The theme of this issue is Electronics. Barb Polan has begun the theme with the cover and Dan Blattner picks it up on page 10 with his article on Proximity Fuses.

Engineer C. A. Booker and Technician L. G. Szarmach run an optimizing control test
to achieve the highest profit rate for a simulated chemical distillation process.

The New Products Laboratories help the Westinghouse engineer verify his theories

The engineer at Westinghouse can rely on the New Products Laboratories to help verify his theories. These laboratories at Cheswick, Pennsylvania, contain a group of advanced engineering development personnel who can converse in both the language of the fundamental scientist and of the designer.

These laboratories, through their diverse scientific activities, aid the work of engineers in all departments of the corporation and provide a means to convert theory into proven equipment. Among the many projects which have come into being through the New Products Laboratories are thermoelectric power generation, thermoelectric refrigation, ultrasonic cleaning, and OPCON, a new concept in process control systems. OPCON (optimizing control) has proven successful in the chemical processes industry. Other possible applications include the petroleum, steel and paper industries.

The young engineer at Westinghouse isn't expected to know all the answers . . . our work is often too advanced for that. Instead, his abilities and knowledge are backed up by specialists like those in the New Products Laboratories.

If you have ambition and ability, you can have a rewarding career with Westinghouse. Our broad product line, decentralized operations, and diversified technical assistance provide hundreds of challenging opportunities for talented engineers.

Want more information? Write today to Mr. L. H. Noggle, Westinghouse Educational Department, Ardmore and Brinton Roads, Pittsburgh 21, Pennsylvania.

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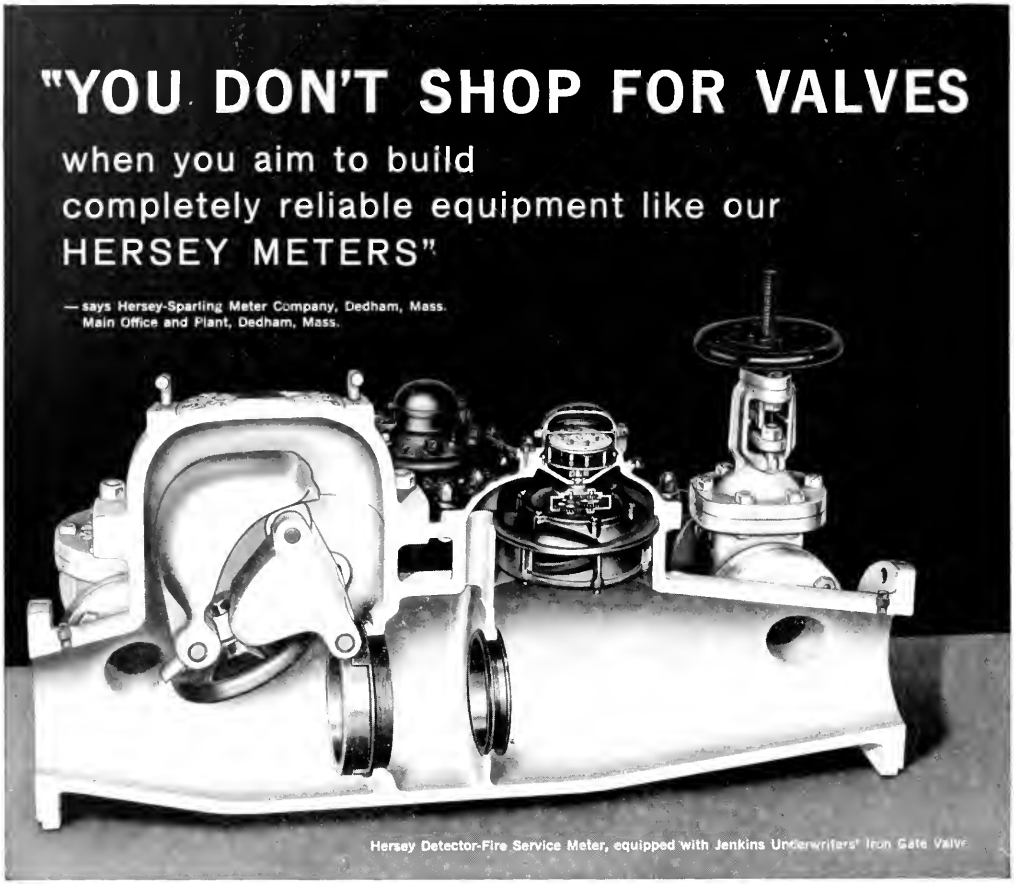

Hersey Detector-Fire Service Meter, equipped with Jenkins Underwriters' Iron Gate Valve

for 35 years, Hersey Meters have been equipped with JENKINS VALVES

Century-old Hersey-Sparling Meter Company does everything possible to make good its slogan — *You can't buy a better Water Meter than Hersey.* One example is seen in a rule that any part of the meter not made by Hersey must be obtained from sources which have Hersey's own policy of making the *Best.* For valves, Hersey's standard for quality has been JENKINS for 35 years.

Hersey-Sparling's customers, like the buyers of any equipment that incorporates valves, see the famous Jenkins DIAMOND trade-mark on the valves as a sure sign that nothing has been spared in assuring reliability and low maintenance costs. Architects, engineers, contractors and operating men are bound to respect equipment that carries the valves they so often specify to assure trouble-free piping systems.

Of course, valves of less quality can be had for a little less money. But it is worth remembering that Jenkins Valves, so widely known for reliability, cost no more than any *good* valves. Jenkins Bros., 100 Park Ave., New York 17.

JENKINS VALVES JENKINS SINCE 1864 **MOST TRUSTED TRADE-MARK IN THE VALVE WORLD**

United Air Lines pilots review flight plan calculated by Bendix G-15 Computer at UAL's Operating Base, Denver, Colorado.

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DIVERSE PRODUCTION AND RESEARCH — The graduate engineer has a chance to specialize with Bendix. He can probe electronics, nuclear physics, heat transfer, ultrasonics, aerodynamics, power metallurgy — and a long list of other challenging fields. Or, he can aim for broader areas of mathematics, research, administration, and management.

CHANCE TO LEAD — Bendix is a diversified engineering-research-manufacturing firm. Bendix products include: Talos and Eagle guided missiles; Doppler radar systems for aircraft navigation; numerical control systems for machine tools; power steering and power brakes for automotive vehicles; nuclear devices; flight control systems for aircraft; satellite controls. More important to you, as an engineering graduate, are the vast numbers of new projects now being planned — projects to which you can contribute your knowledge and ingenuity.

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Recent Developments . . .

This little poem is for the benefit of those soon to leave our institutional education with their green box in hand. We hope it will prepare them for what may come.

There once was a young engineer
In the fifth year of his great career
Still able and keen
With a drafting machine
Not his salary had grown
Just his rear.

The firm had another, I hear
Who varied his college career
He debated, he wrote
For this rag, please note
Now he is chief engineer.

—Dr. Paul D. Holtzman

Nuff said? (Dr. Holtzman by the way, is the head of the rhetoric department at Penn State University.)

* * *

I was surprised to hear several students complain because we have dropped the joke page. Actually, we found through a recent survey that it is was disliked more passionately than it was liked, so we thought best to discard it. We hope that those who so violently opposed the magazine for this reason will now sit down and read the technical articles with as critical an eye as they read the jokes. We could use some constructive criticism on the articles.

* * *

It was pleasing to find that the much talked about "Ugly American" was not only a "good guy," but also an engineer. Read this book if you have time. It's an interesting study in diplomatic blunderings by Americans.

* * *

If I seem to ramble, it's because I don't have my mind on my work. I got married April 10th, and who wants to write editorials to bearded slide-rule toters at a time like this.

—WDP

Why diversification makes a better all-around man

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KOPPERS

The Radio Proximity Fuse

Secret Weapon of World War II

By Donald J. Blattner

Japanese airplanes which attacked Pearl Harbor on December 7, 1941, scored 19 torpedo hits on American warships, undaunted by the ineffectual anti-aircraft fire thrown against them. Two days later, other Jap planes caught the British capital ships *Prince of Wales* and *Repulse* off the coast of Malaya and quickly sank them. During the year that followed, in a series of air-sea battles highlighted by the epic encounters in the Coral Sea and at Midway, U. S. and Japanese aircraft inflicted heavy losses on each other's surface vessels.

The balance of battle swung in favor of the U. S. with dramatic suddenness on January 5, 1943 when a Jap Aichi 99 dive bomber flew within range of the *USS Helena's* five-inch guns. On the second salvo the Japanese plane crashed in flames. The shells fired by the *Helena* were of a new type; mounted in the tip of each one was a tiny radio transmitter receiver which caused the shell to explode as it came close to its intended target. The tiny radio set was called a "proximity fuse." It defended the U. S. fleet against Japanese aircraft, enabling our planes to concentrate on offense; it helped save London from V-1 robot bombs; and it contributed to the defeat of the Nazi armies in the Battle of the Bulge. Its devastating arrival on the battle fields of World War II was the timely result of a fascinating scientific development program. The whole project was shrouded in secrecy for fear that the enemy might turn our weapon against us; exposure of our bomber formations to enemy proximity-fused fire could have imperiled allied mastery of the air.

In military terminology, the device that explodes a shell is called a fuse. Prior to the development of the proximity fuse, two types of fuses were in use: contact fuses, exploded by contact with their target; and time fuses, set to explode a fixed time after being fired. Contact fuses were satisfactory for use against ships, tanks, and strong buildings. For anti-aircraft and anti-personnel fire, time fuses were used, set to explode the projectile at a point where the maximum number of fragments would pass through the target. The difficulty was to set the fuses with sufficient accuracy to insure bursts at the height and range desired. Shells travel several hundred feet in one-tenth of a second, so in practice the explosion might occur anywhere along a 1000 ft. path. Thus handicapped, artillery fire was unable to follow the countours of terrain, and anti-aircraft was "good" when it brought down one plane for every 2,500 shots.

A fuse operated by proximity rather than by contact or by timing was a simple enough idea, but to develop an operable device for mass production was incredibly difficult. All combatants in World War II attempted it, but the only successful development of proximity fuses for shells was American. James Phinney Baxter 3rd, historian of the Office of Scientific Research and Development, has written that, except for the development of the atomic bomb, development of the proximity fuse constituted the most remarkable scientific achievement of the war.

The fuse had to be sensitive and rapid in operation, safe to handle, yet instantly detonated when triggered by the presence of a target. If the triggering pattern were not correctly related to the fragmentation pattern, the shell would be merely an expensive form of self-destroying ammunition. The shape of the triggering pattern was determined by the shape and location of an antenna ring molded into the plastic tip of the fuse. The ring and the body of the shell itself served as the radiating system, and were excited by a high frequency vacuum tube oscillator. The presence of a target body within the radiation pattern changed the energy absorption of the antenna, causing a change in oscillator plate current. This change of current was amplified in several tiny vacuum tubes and made to send a current through an electric blasting cap, thus detonating the shell.

This seemingly simple device, actually fantastically difficult to make operative in the tiny space and rugged environment of a shell, multiplied the effectiveness of the Navy's anti-aircraft fire. While the first trickle of proximity fuses were reaching the Pacific fleet, only one out of four AA shells fired had a proximity fuse, yet these few accounted for more than half of all enemy planes shot down by anti-aircraft fire. As the gunners became more accustomed to the new devices, the ratio of improvement grew even greater.

To the Army, the proximity fuse offered an ideal means of opening holes in enemy lines for advancing troops. All bursts inflict most damage to troops in trenches and foxholes when exploded at the proper height. Shells fitted with radio proximity fuses could deliver uniform bursts at the preferred height regardless of variations in terrain, bad weather, or darkness. There was danger, however, that the enemy might recover a dud and be able to duplicate the fuse in time to use it against us. Therefore, the Combined Chiefs of Staff maintained a rule that proximity fuses could be fired only over water, where there would be no risk of compromising the device.

Secret intelligence that the Germans were preparing to use robot bombs against London and the ports of southern England was received in the fall of 1943. This threat to the areas where the forces destined to invade Normandy were gathering, imperiled the success of the great cross channel operation. Detailed information concerning the buzz bomb was sped from allied intelligence services to the proximity fuse laboratories six months before the first V-1 was launched on England. A complete mockup of the robot bomb was constructed and hung between two towers near Alburqurque, New Mexico. Tests were made to find which model proximity fuse would function best against these targets. The Combined Chiefs of Staff relaxed their rules to permit the use of the fuses against the new Nazi menace. Three months before the first buzz bomb fell on British soil, a shipment of proximity fuses arrived in England. During the second week in July, anti-aircraft guns with SCR-584 radars and M-9 predictors were concentrated on the Channel coast (where duds and early bursts would not be dangerous to civilians). In the first week of proximity fuse operation, 24% of targets shot at were destroyed, 46% in the second, 67% in the third and 79% in the fourth. On the last day of the 80-day

The author is shown preparing a sketch of a proximity fuse for an artillery shell.

V-1 siege, 104 were detected by early warning radar, but only 4 reached London. Sixteen failed to reach the coast, 14 were shot down by the R.A.F., 2 were enmeshed by barrage balloons, and anti-aircraft fire destroyed 68.

After the invasion was launched, the Combined Chiefs released proximity fuses for the defense of the artificial "Mullberry" harbors constructed off the Normandy beaches, and later off Cherbourg, but no general release for use over land was permitted. The Army was eager for their use, however, so careful estimates were made of the shortest possible time in which Germany or Japan might duplicate the fuse. Finally, the Allied High Command determined to use it for howitzer fire in an offensive planned for December 26, 1944. Before this offensive could be launched, however, the Germans beat us to the punch, starting the great struggle known as the Battle of the Bulge. Fortunately, proximity fuses were on hand to stem the German advance toward Meuse and the threat to Liege. As familiarity with the fuse and appreciation of its capabilities grew, its use was extended from anti-aircraft and howitzer applications to include harrassing and interdiction fire by night and in fog as well as counter-battery operations on all parts of the front. The timely introduction of the proximity fuse had a devastating effect on the Nazis. Prisoners of war characterized our artillery as the most demoralizing and destructive ever encountered. The terrific execution inflicted and the consternation resulting from night and day bombardment contributed materially to victory in the Bulge. In the offensives that followed, notably the crossings of the Rhine, and in the defense of Antwerp against V-1's the proximity fuse continued to prove its worth. It was used to great effect in the Mediterranean theatre and in the heavy fighting on Okinawa and Luzon. Near the end of the war, a radio proximity fuse developed for the Army's 81 mm mortar increased effectiveness of mortar fire by 10 or twenty-fold.

For the Air Force, proximity fuse bombs and rockets were developed, although they could not be used until it was certain that Germany and Japan would not have time to duplicate them for use against us. They were first used with great effect by bombers of the 7th Air Force against Iwo Jima in February 1945. They paralyzed enemy AA and mortar fire on this and other occasions in the Pacific, European and Mediterranean theatres. Proximity-fused general-purpose, fragmentation, and gel-gas bombs were used with deadly effect by the 12th Air Force in Italy against personnel and materiel shielded from ordinary ground bursts. In the strikes by the Third Fleet against Japan near the end of the war, about one-third of all bombs dropped by the carrier planes had proximity fuses.

The complexity and magnitude of the proximity fuse program rank it among the scientific achievements of World War II. A radio transmitter receiver, complete with its power supplies, had to be fitted into a space about the size of a conventional radio receiving tube. At the same time, it had to be made rugged enough to withstand the shock of firing and the centrifugal force of rotation as the shell spun in flight. The tiny electron tubes used here were the components most vulnerable to these forces. Not only could the tiny tubes not break; their delicate cathodes, plates and grids had to maintain alignment, lest the performance of the tube be impaired or destroyed. The requirements of extreme ruggedness applied not only to tubes, but to batteries, condensers, resistors, switches and all the other variegated components. Plastic molding techniques, using casting resins to hold the many parts in place were developed for ruggedization of the entire fuse assembly. A miniature dry battery able to stand the shock of firing from the gun was developed but scaling to ever smaller sizes for smaller shells was difficult, and shelf life was a problem. Therefore, a battery was developed using a liquid electrolyte stored in a glass container. The glass was broken by the firing of the shell and the spin of rotation after firing spread the electrolyte into the battery plates. For unrotated projectiles such as bombs, rockets, and mortar shells, a propeller-driven generator was used in lieu of batteries.

Full production was begun in January, 1942. Standards of performance were the highest ever set for assembly line techniques. For example, every tube manufactured was spun in a centrifuge to an acceleration of 20,000 G and hundreds of thousands were shot from guns in quality control tests. By September 1942, production of proximity fuse shells had reached 400 per day. In the middle of November 4500 shells were sent out to the Pacific to the ships most likely to see early action. The Japanese plane which flamed into the ocean from *Helena's* first shots on January 5, 1943 was symbolic of the effect on land, sea and air of the proximity fuse in World War II. At the peak of production, utilizing one-fourth of the national electronic production facilities, and three-quarters of the plastic molding capacity, two million fuses were manufactured each month; over 15 million were produced in all.

Produtcion was carried out under extreme security conditions; each successive sub-assembly procedure was performed in a different, locked, room. Few individuals knew what the end product was; most knew only that they were working on "Madame X." Shipments of proximity fuses were accompanied by armed guards, and no personnel were permitted to leave ships transporting the fuses until each shell had been accounted for.

The tiny rugged tubes developed for proximity fuses still find some use today in rockets and missiles, although they have been largely superseded by the post-war transistor. Casting resin techniques are now standard in rugged equipments. Probably the outstanding contribution of the proximity fuse program to electronic technology is the now-ubiquitous printed circuit; first developed for proximity fuses, these widely used circuits remind electronics people of the days when radio fuses stood between the free and slave worlds.

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THE WULLENWEBER RADIO DIRECTION FINDER

At The University of Illinois

By John W. Kravcik

For quite a few years a research program in radio direction finders has been going on at the University of Illinois under the sponsorship of the Office of Naval Research. The program has been one of research and not one of designing specific equipment.

As early as 1946 research in the field of radio direction finding was going on here at the University of Illinois under the direction of Professor E. C. Jordan, now head of the Electrical Engineering Department of the University of Illinois. Various experiments and studies have led up to the existing status of radio direction finding research now in progress. This report will be mainly concerned with an explanation of the Wullenweber system, the research that has gone on concerning the Wullenweber-Type Antenna Array; and also to a lesser extent the Adcock Radio Direction Finder for comparison.

Although the evaluation of the Wullenweber radio direction finder has not yet been completed, indications are that it is very much superior to any other known type of direction finder. Many changes in design are now being considered which will improve the Wullenweber system. The Wullenweber system was designed and built by the Federal Telecommunications Lab, and constructed under the supervision of the University of Illinois.

Direction finders can be classified into two broad areas. One area is the fixing of a transimtter from a known receiving site and the other is fixing of a receiver location from a known transmitter. The type of direction finding that will be discussed in this paper will be the type that is concerned with getting the bearing of a signal by evaluating the direction of propagation at a receiving point rather than evaluating the time of arrival. The latter is usually used in navigation system such as loran or inverse loran.

One of the earliest methods used to measure the direction of arrival of a radio wave was a loop antenna. Balanced, shielded loop antennas were satisfactory for low frequency ground waves, but the rotating loop left very much to be desired at higher frequency ionospherically propagated signals.

The Adcock system is the successor to the loop antenna, and until the advent of the Wullenweber, was the best and most commonly used system for radio direction findings. Fig. 1 is a block diagram of the Adcock system. The system is defined as a 4-element Adcock antenna system, 16 feet in diameter, and is used in conjunction with a twin channel receiver and cathode ray tube goniometer. This type of system is known as a small aperture radio direction finder. The difference between a large and small aperture system lies in the fact that in a small aperture the largest dimension of the antenna system is one wave length ! The main downfall in the Adcock system is multipath propagation, or in other words, the same signal arriving from two different directions.

The Wullenweber radio direction finder has now been completed by the University of Illinois and is in the testing stage. The idea for the Wullenweber was first concived by the German Naval Ministry during World War II. Two systems were put into operation with a high degree of success. The evaluation by the Germans showed that the wide aperture Wullenweber had definite operational advantages over any other known direction finder.

The technique used in the Wullenweber is basically a method whereby the equivalent pattern of a mechanically rotating planar array of antennas is obtained by a number of fixed antenna elements symmetrically placed in a circle, behind which is a circular array of reflectors. In other words, two concentric circles are formed, the one with the larger diameter being the antenna array. The purpose of the reflectors, naturally, being to block any signal from being received from the back side of the antenna.

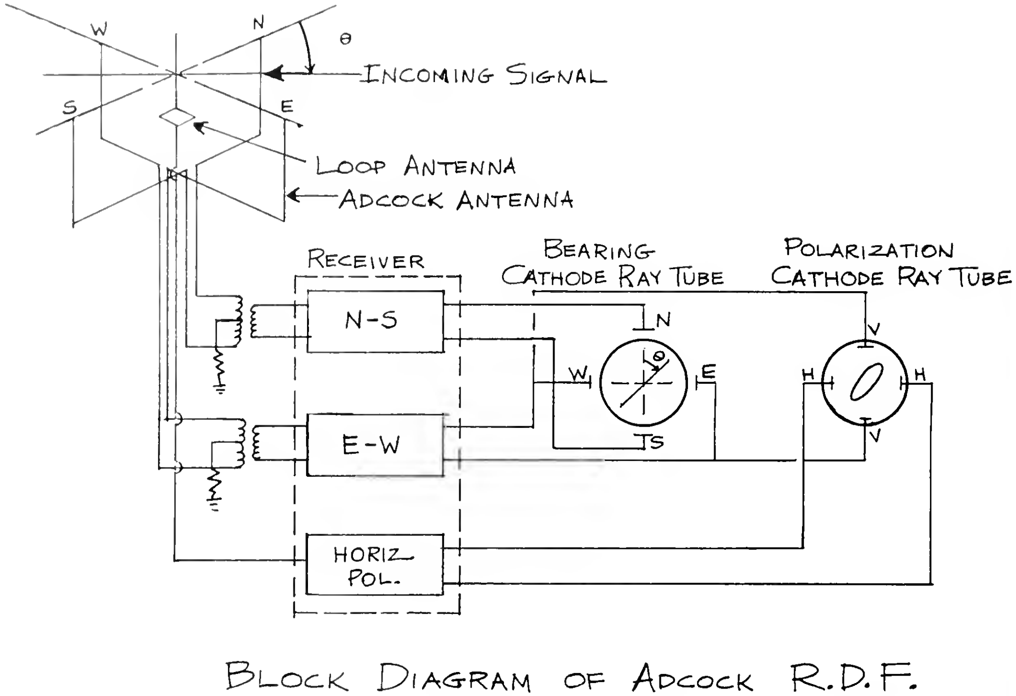
Fig. 2 shows an air view of the Wullenweber site which is located south of Bondville, Illinois. The project director for the Wullenweber is Dr. Hayden. A close look at Fig. 2 will reveal the two concentric arrays mentioned previously. The inner array which is much larger in height is the reflecting screen. The outer array which shows as white poles on the photo, is the antennas.

In order to convert the configuration into a rotating planar array, it is necessary to select a segment of adjacent antenna elements and, in effect, rotate electrically the sector around the array by some means of commutation. It is also necessary to insert delay lines so that the signals from the various antennas will arrive at a common mixing point in phase, and thus be additive. Fig. 3 illustrates the principle involved. It shows a group of five antennas placed on an arc of a circle, and a signal source placed a sufficient distance so that it can be considered planar. As can be seen, the signal arrives first at the element in plane 1 and then at certain time intervals, later at planes 2 and 3. Therefore, in order to achieve the planar effect the signals from antennas 1, 2 and 4 must be delayed by the time required for the wave to pass from place 1 to plane 3.

Now in order to get 360 coverage all the elements are connected to a switching device known as a goniometer which contains the delay lines and is located in the center of the array. It is a commutator type device. The rotor selects a predetermined number of adjacent antenna elements progressively picking up one and dropping one element as it rotates, thus giving 360 coverage. This signal is then fed to some type of indicator such as a rotating yoke cathode ray tube set up and the signal is displayed visually on a cathode ray tube. The type of display can usually be either a maximum or null type display on the cathode ray tube. The rotation of the yoke and the goniometer are synchronized, giving a true indication of the bearing on the scope.

The Wullenweber direction finder can be broken down into the following component parts:

1. Antenna Elements and Screen
2. Cables
3. Goniometer
4. Receiver
5. Indicator



BLOCK DIAGRAM OF ADCOCK R.D.F.

Fig. 1

6. Indicator Control Unit
7. Indicator Servo System

The system was designed to operate in the range of frequencies of 4 to 16 mc.

In designing the Wullenweber the first problem met was to decide upon the diameter of the array. Many factors entered into the determination of the diameter of the array, the three most important ones being sensitivity in angular activity, frequency range and economy. It was felt that in order to get any worthwhile improvement in a large aperture system over a small aperture system, it was necessary to make the diameter of the array at least one wave length at the low frequency range. After careful consideration the diameter of 1000 feet was choosen. One hundred twenty antennas would be required for this dimension.

The next important step was to select a site upon which to build the system. An area of 40 acres was sufficient for the array alone, but a total area of 360 acres was needed because the surrounding terrain must be completely free of obstructions. After months of searching for a suitable site, one was finally found about 10 miles southwest of Champaign. Preliminary surveying and excavating were contracted out to local firms by the University. The antenna array construction began in late 1956.

The supporting poles for the reflecting screen are 75 feet long. One hundred twenty poles were set into the ground about 9 feet deep. Boom boards were then hung between the poles to support the ground wires. The ground wires were then suspended from the boom boards every ½ degree and attached to a ground mat of 2 × 2 copper ground mesh. Normally better grounding would be required, but the conductivity of the soil at the site is extremely high. All the above mentioned work was done by local contractors.

The antennas (folded dipoles) were designed here at the University by the people connected with the project. Most of the design was done on a model basis.

The antennas were then constructed and set into place on 2 × 2 foot concrete foundations. The height of the antennas are approximately 16 feet. A coupling box mounted at the base of each antenna was provided to house the coupling transformer, element terminating resistors, and cable termination. Naturally, 120 coupling boxes were required. These boxes are air tight, waterproof, metal containers. In order to assure that the components contained in the boxes are kept dry, the boxes are pressurized (at 15 p.s.i.) with dehumidified air. In order to supply the coupling boxes with dry air under pressure, there must be a source of dry air to each box. This problem was solved by using a ½″ Phelps-Dodge Styroflex cable which has an inner conductor of solid copper and an outer conductor of a seamless aluminum tube. The inner conductor is supported by helical polystyrene tape. The outer conductor is covered by a polyethylene jacket. This type of cable also has to be pressurized. Therefore, since one end of the cable terminates in the coupling box, the cable could be used as a dry air supply for the boxes. This type of cable was available in continuous lengths long enough to meet the requirements without splicing. It is also rugged, of very low loss, and relatively easy to install. Since the manufacturing tolerance on the velocity of the cable is 2%, cutting the cable by physical length would not have been satisfactory. The cables were ready to be cut before the operations building was built, therefore, the initial cut of the cable was done by physical measurement. The cables were measured and then a few feet were added for tolerance.

For each cable a 3 foot deep trench

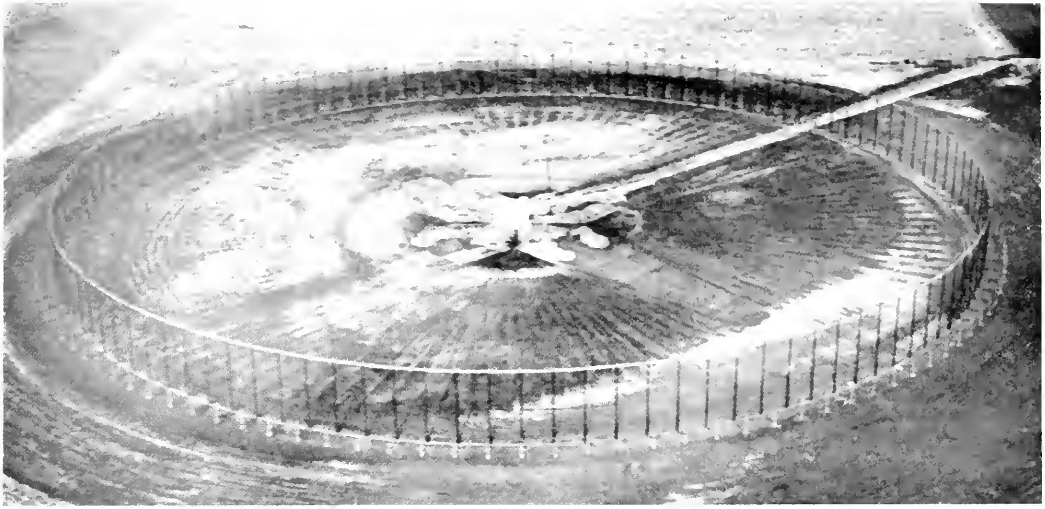


Fig. 2. The advantages of a wide-apertive direction-of-propagation measuring device are studied by radio direction finding researchers with this Wullenweber system, which has a diameter of 1000 feet.

was dug and the cables were buried. Each 90 degree sector of cable was focused to a point about 100 feet from the center of the array. At this point a large rectangular hole was dug to coil excess cable lengths. From here all the cables are enclosed in a 2 foot diameter drainage pipe which extends into the basement of the operations building. The final cut of the cables was made by using electrical measurements. This was done by short circuit impedance measurements at 10 mc. Since the cable impedance varies with temperature it was necessary to make the final cut after the cables had been buried and the temperature was a constant through out the cable. Two dehumidifiers are used to supply the dry air to the cables.

All of the terminal equipment such as delay lines, goniometer, receivers, and indicator system were designed and provided by the Federal Telecommunications Laboratories, a division of International Telephone and Telegraph.

The delay lines were provided in two sets, low and high band, which are mounted on the goniometer. The low band delay lines cover the frequency range of 4 to 8 mc and the high band covers the range of frequencies from 8 to 16 mc. A goniometer, which is a rotating, commutation type device is located in the basement of the operations building. It is basically a capacitive type of device. Each of the 120 antenna cables are connected to a stator. The stator is in the form of a cylinder, whose

(Continued on Page 17)

(Continued from Page 15)
diameter is about two feet, with 120 separate segments. The rotor, which is cylindrical in shape also fits inside of the stator and rotates at 600 RPM. Provisions were built into the goniometer so that it is able to feed more than one indicator at a time.

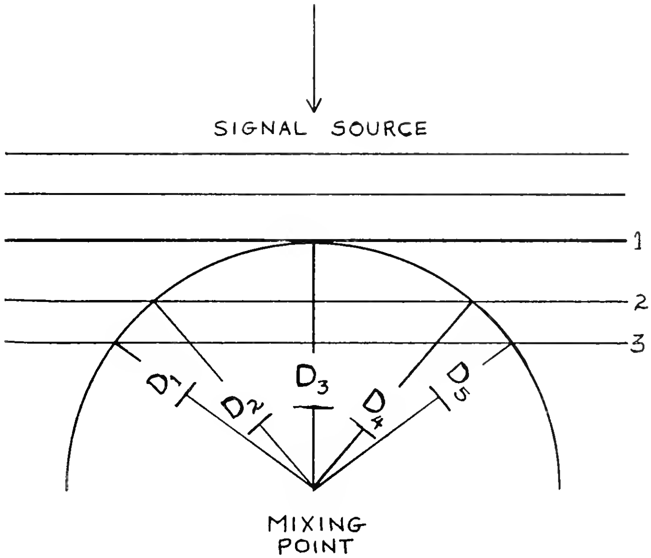
The receiver supplied with the terminal equipment was a Signal Corps type BC-1147-A. It's performance has been very unsatisfactory and has since been replaced. A discussion of this will be presented later in the paper when the overall system evaluation and recommendation will be discussed.

The indicator unit makes use of a 10-inch magnetically-deflected cathode ray tube, whose beam is radially deflected by a deflection coil which is rotated in synchronism with the goniometer. Synchronism between the deflection yoke and goniometer is maintained by a servo system which uses three wire synchro units as the error sensing device. The bearing of a signal may be read by lining up the cursor with the pattern on the face of the tube. Fig. 4 shows the type of displays that the system puts out. As mentioned previously, two types of displays can be obtained—the maximum and the null type. Fig. 4A shows the maximum and Fig. 4B shows the null type pattern.

On the indicators furnished for use with this system, automatic recording is accomplished by gearing to the cur or a digital shaft position encoder. This encoder is used to control the punching of paper tape by a Teletype tape punch.

On March 12, 1958, the first test was made on the completed system. The test run was very successful. Bearings taken on station WWV agreed to within 0.2 degrees of the calculated bearing. Further tests were made using the following procedure: A target transmitter was located in a jeep station wagon a distance of two miles or more from the site. A red kytoon was flown above the jeep. The bearing of the kytoon was then measured with a surveyor's transit from a point on the roof of the building exactly in the center of the array. At each location of the target, transmitter signals were transmitted on each integral megacycle frequency between 4 and 20 mc. The indicated bearing was read by the operator not aware of the true bearing to the nearest 1/4 degree.

Results of this test were again very gratifiyng. For the most part the errors were less than 1/2 degree, with only occasional points being in error by more than one degree. Admittedly, the method of getting the so-called true bearing of the transmitter by using a transit is open to criticism. Further tests will be made using some type of air craft as the target transmitter carrier. This will be of interest because most of the signals picked up by the system are not ground waves, but reflected waves. The problem of getting the true bearing of the target transmitter again arises. The only solution seems to be the use of a very large radar system. More thought is being given to this problem since a large radar setup would prove very costly.



D1, D2, D3, D4, D5 = DELAY LINES

D1=D5 D2=D4

FIGURE 3

WULLEN WEBER ARRAY

The sensitivity or efficiency of the system was the next area of investigation. The overall efficiency of the antenna system depends primarily on the efficiency of the antenna elements and on the efficiency of the goniometer. The efficiency of the feed cables is so high compared to the other devices that its effect on the overall efficiency is negligible. It was found that the in the antenna elements is about 6 or 7 db at midrange, while the loss in the goniometer is about 23db. Another interesting point found was that the high frequency range of the system was limited by the delay lines, and not the antennas as was previously thought. The antennas cut off at about 25 mc and the delay lines about 16 mc. Therefore, the weakest link in the system seems to be the goniometer.

It seems evident that the accuracy of the Wullenweber system will be considerably better than that of the small aperture Adcock system. The Wullenweber also has another distinct advantage over the Adcock in that it is much easier to read visually the bearing of a signal. In the Adcock system one cannot tell where a signal is coming from if the station is not identified. This is so because on the Adcock indicator a double looped pattern is displayed. (See Fig. 4c). The display of a multipath signal is very hard to read from the Adcock while from the Wullenweber it is quite simple.

A cure-all has not been found in the development of the Wullenweber, it has its pitfalls. The sensitivity of the Adcock is much better than that of the Wullenweber. Sensitivity of the Wullenweber could be improved by redesign of the goniometer. The other area of comparison that hasn't been mentioned yet is the comparative costs of the two systems. No actual cost figures are avail-

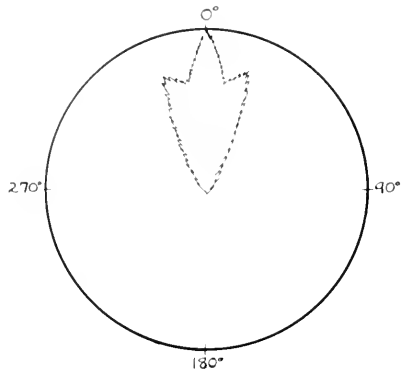


FIGURE 4A

WULLEN WEBER MAXIMUM TYPE INDICATOR

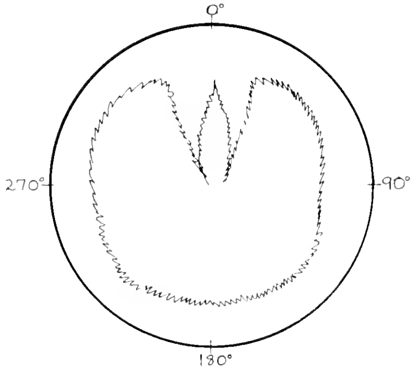


FIGURE 4B

WULLEN WEBER NULL TYPE INDICATOR

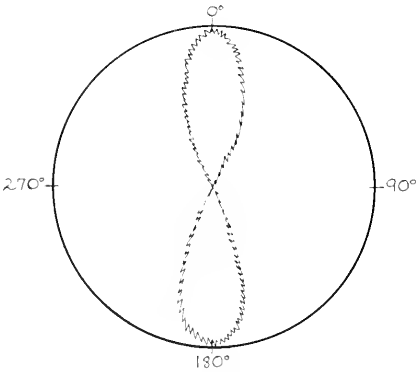


FIGURE 4C

ADCOCK INDICATION

able for the Adcock system nor are any available for the termination equipment in the Wullenweber setup. Figures are available for the Wullenweber, excluding all termination equipment.

The cost given below for the Wullenweber only includes the hardware for the antenna system, the cost of preparing the site for installation of the array, and the installing of the array. This total cost amounted to $198,000. A reasonable estimate for an Adcock system, again excluding termination equipment, would be about $30,000. Another point to consider is that the termination equipment of the Wullenweber is much more complex than that of the Adcock and therefore, would cost many times more than that of the Adcock. From the above then, one can see that the economics of the two systems is an important factor.

As for the future of the Wullenweber, there are many things that are under consideration. Below are listed some of the more important ones along with some of the changes that have already been made.

1. Consideration of using the new type of exponential type of antenna that has been developed here at the University of Illinois. This would change the range to 2 to 32 mc.

2. Redesign of the delay lines to meet the above frequency requirements.

3. Using an inductive type goniometer instead of the capacitive type so as to reduce losses.

4. Using a transistorized switching circuit to replace the goniometer.

5. Obtaining a digital computer to be installed as part of the system so as to increase the speed of data handling.

6. Redesign of the indicator to make it more stable.

Although the full capabilities of the Wullenweber have not yet been realized it is believed that the potentials of the system are tremendous as compared to any other type of direction finder. It will be interesting to note in the future whether or not the Wullenweber direction finder will be developed to its full extent.

Wanted: Stamplickers

Uncle Sam is probably amassing the world's largest collection of trading stamps after ordering its drivers to turn them in whenever they come with gasoline bought on government credit. The General Services Administration is negotiating for cash refunds from stamp companies, but one problem remains: Who's going to lick and enter the stamps into books.

Pushbutton Curls

Women soon will be sporting push-button curls, reveals Chemical Week, McGraw-Hill publication. Two companies will market aerosol permanent wave kits which are designed to give hair waves at the flick of a button.

Candles for Defense

The lowly candle is considered vital to U. S. national defense. A recent Federal Government study, made to determine their availability in case of attack, disclosed that the 1.1 billion candles made at 52 plants each year in the U.S. would supply light to one room in all dwellings for 137 hours.

Engineering Interns

A college professor predicts that internships and residencies now standard in the medical profession, may soon be adopted by the engineering profession. He states that the last 25 years have produced so much new and professionally valuable scientific knowledge that graduate-level instruction is increasingly important. He expects off-campus graduate-level teaching to become an integral part of the total education program.

Tomorrow's City

A British version of tomorrow's city will solve traffic problems by featuring roads at rooftop level.

Built-in Bomb

Tampering and pilferage of coin-operated machines had reached such heights that one company has begun building small tear-gas bombs into its machines.

Airport Problem

If the mai nrunway of the Akron Municipal Airport is extended as planned, it will intersect with a single-track spur of a railroad. Officials are expected to build a tunnel for the railroad, since an airport runway with railroad crossing gates seems highly impractical.

Artistic Pipe Fittings

An industrial supply firm, with an eye on the welded art constructions now found in modern museums, recently ran a contest for the most intriguing use of pipe fittings. Winning entry was a package of eight fittings and eight pieces of pipe assembled into a sukkah—a tent-like structure used in the Jewish religious ceremony of the Harvest Season.

Light, Tough Plastic

Japanese scientists at Kyoto University have developed a plastic that is lighter than aluminum an dharder than steel. The synthetic resin is made from formalin, a petroleum and coal derivative, and could be used for gearing, and other machine, aircraft and missile parts.

Blind Man Beats Machine

A blind inspector tests tiny ball bearings—nine would fit side by side on an aspirin—made by a New Hampshire bearing company for missile gyroscopes and electronic brains. The blind man's sensitive touch can detect vibrations that distinguish good bearings from rejects better than the complex electronic system which was designed to do the job.

Hats 'Cost' $13,660

It is costing North Carolina $13,660 to allow its troopers to wear hats while on patrol car duty. In a recent bidding, the dealer offering the lowest bid had models that were too small to accommodate troopers plus hats. The state had to pay the extra sum to buy cars that fit hat-wearing patrolmen.

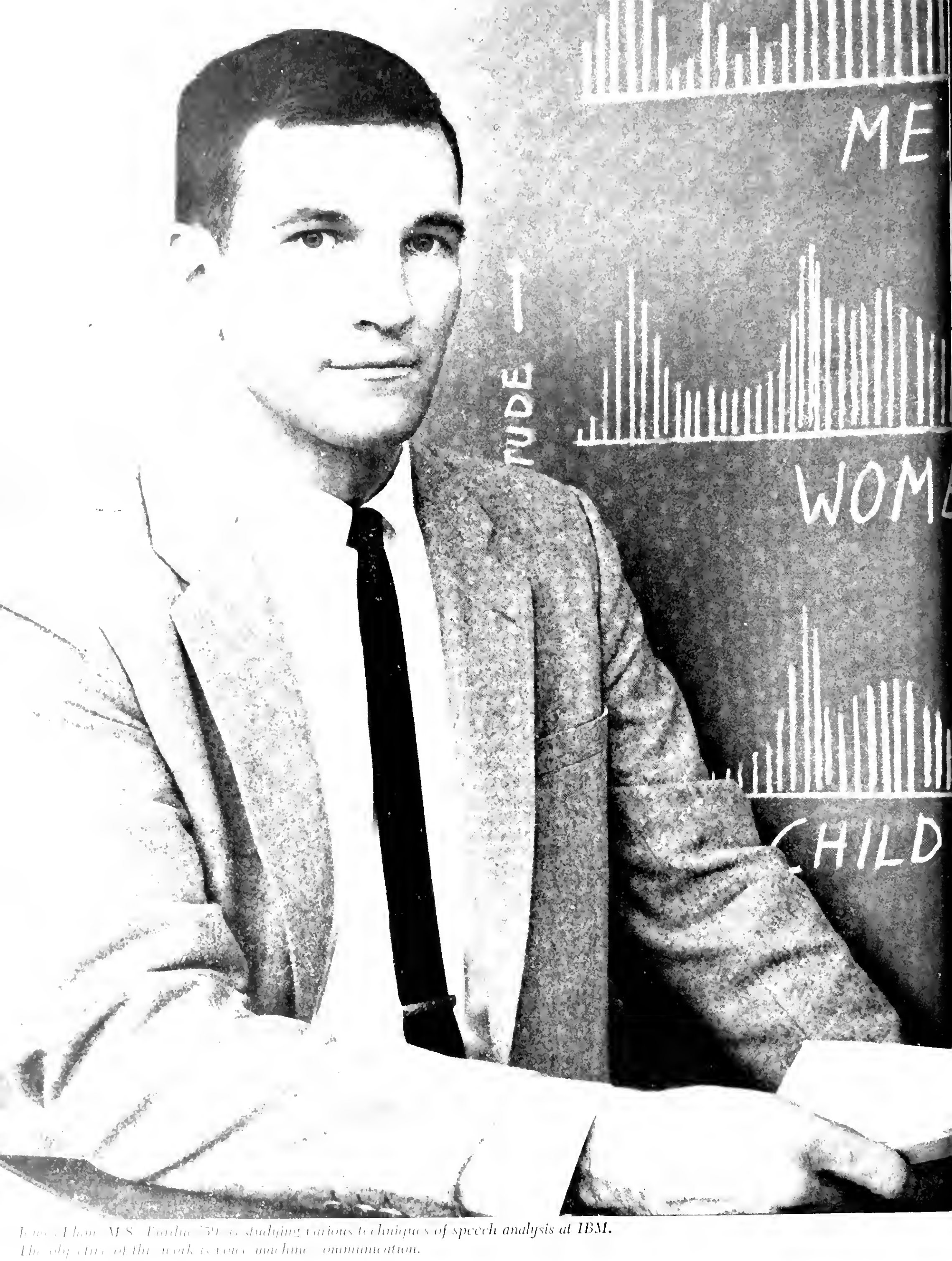
Stick-On Paint

Painting now can be as easy and neat as applying an adhesive bandage. The developer says his product is "pure paint" that comes sealed in a sandwich between two layers of paper. To use, a person strips off the bottom, sticks the paint down and then removes the protective cover.

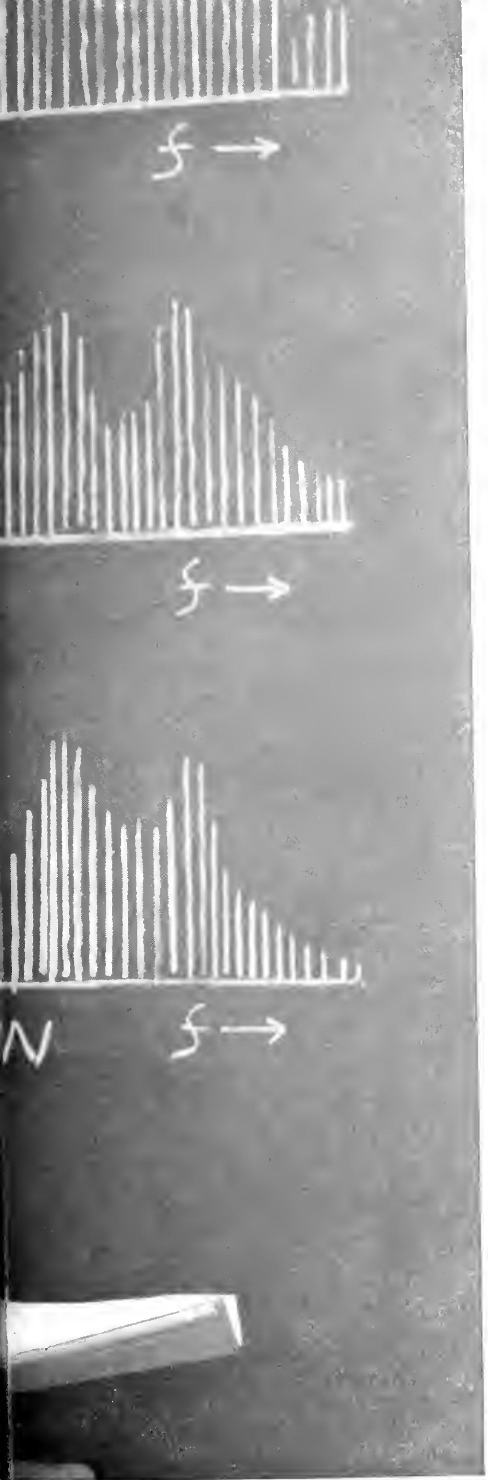
Popcorn Packing

Popped popcorn is used as packing to protect lamps from damage during shipment, according to Purchasing Week.

Don't ever trust a coed.
You'll be sorry if you do.
Don't listen to their double talk
That's my advice to you.
They come to this here college
Just to get themselves a man;
With one for every four of us
It's simple how they can.
As Sophs they've good intentions,
They're satisfied with one;
But time instills a greedy lust,
They add two more for fun.
It's one against two others,
Which starts a "battle-royal."
They rake in all the profits
As a pirate does his spoil.
Wake up you merry gentlemen,
And get this through your dome
If you must have a date at all
Take out that girl at home.



James Elam, M.S., Purdue '59, is studying various techniques of speech analysis at IBM. The objective of the work is voice-machine communication.



The Dean's Page...

The Objective of an Engineering Education

By W. L. Everitt

Dean of Engineering, University of Illinois

Your editor invited me to write an editorial for the Technograph. An editorial is intended primarily to pass out advice, which, in turn, has its dangers as indicated by an essay on Socrates, which a high school student wrote in three short sentences:

Socrates was a teacher.

He went about telling people what to do.

They poisoned him.

What is the value of your college education? There has been too much evaluation recently in terms of statistics such as—

The high school graduate who does not go to college earns, on the average, X dollars during his life. A college graduate earns, on the average, Y dollars. Hence, the value of a college education is:

$$(Y - X) \text{ dollars}$$

While this is no doubt an encouragement to families who have sacrificed and struggled, or are considering doing so, to help their children through college, it is, in fact, stuff and nonsense. The real values of a college education do not lie here. Even if there were no such place as college, those who now go to college would earn, on the average, more than those who do not, simply because college is a sorting mechanism of a kind, admittedly inadequate, such that the graduates of college are on the average more ambitious, more eager and able to learn, and have more family support and backing. But certainly, this sitting process would not in itself justify the cost of the plant, facilities, personnel, and student time now dedicated to higher education. Other, simpler means could be devised.

Is the value of your education then that you have learned how to be happy? Many believe that this is a worthy major objective in life. But I am afraid that the ignorant and the dumb are often found among the world's happiest creatures. Furthermore, happiness is an elusive quality. Those who spend their lives seeking it never find it, for dedication to this search implies excessive interest in self, and the selfish are never happy.

Is a college education justified then in terms of the knowledge of facts you may gain? I doubt if any of you will know, when you graduate, as many facts as are outlined in one volume of a 24-volume encyclopedia. Furthermore, some of the facts you learn will never be used, some will become obsolete, and unfortunately, some of them are just not so. Of course, an encyclopedic knowledge of facts and the ability to recall them instantly might help you on a quiz show?

One can also hope that, with the facts which you acquire, you will gain at least the basis for wisdom and judgment, more important because these terms imply knowledge plus understanding.

Is there even a danger in college? If we are given a false confidence in our selectivity, our intellectual acumen, or our knowledge, we can well end up "smart alecks with no sense" who do not take pains or time to use good judgment.

Dr. A. W. Hull of the General Electric Company once gave a definition of the purpose of a college education which I like. It was:

"The value of a college education is that it gives one confidence in his ability to learn."

But confidence in one's ability is not enough. One needs also the desire and energy not only to learn, but to relate and apply what one has learned to the needs of men. Ability to learn and relate should be one of the results of your college education, desire and energy you must still supply yourself.

In view of the explosive expansion of technology, engineering education especially has faced a most difficult task. We have had to recognize that the education of an engineer is a three-way responsibility. The engineering college or institute must teach what it best can, stressing particularly fundamentals or principles of widest possible applications:—the "why" and not the "how." The student's employer after graduation must make provision for instruction in the "how," the applications to a particular job or industry. But most of all, the individual must carry on a continual program of self-education to fill out those deficiencies which he, himself, must recognize. It is no excuse in professional life to be satisfied with ignorance of any needed knowledge, or permit a lack of understanding to continue long simply because you did not take a course in the subject.

An illiterate young man came to this country without funds and so found it necessary to go right to work. He started out driving a garbage wagon, but being of a frugal nature, he soon owned it. Next, he bought a garbage truck, then a fleet of trucks and ultimately obtained the contract for garbage disposal for a large seaboard city requiring a fleet of scows. One day he heard that there were complaints on where the scows were dumping. He went out to look the matter over and fell off one of his scows and drowned. At the funeral, his wife was asked by a friend, "Did Stanislaus leave you well fixed?" She replied, "Oh, yes, he left about ten milion." The friend remarked, "To think, Stanisaus left ten million dollars and he never even learned to read or write." And his wife said, "Nor swim."

You are going to have to learn to swim by yourself. In this complicated and rapidly-moving world, we not only need to swim in a familiar environment but also have the courage to plunge into strange ones. Your engineering education should then give you a desire to continue as a student throughout your life, confidence in your ability to grow intellectually, and the courage to attack the unknown.

'Weldable' Concrete

Russia claims the development of a "weldable" concrete with a grain structure similar to that of metal. The material is said to be flexible, almost as strong as cast iron, and can be "welded" by chemically softening adjoining concrete surfaces, then joining them under high pressure.

New Plastic Lifeboat

A new plastic lifeboat has been developed in Germany that will right itself automatically from any position. The lifeboat is completely enclosed and its four hatchways can be hermetically sealed so that the lifeboat is watertight. Plastic bubble sections on the top of the lifeboat offer complete visibility.

Suspend Roof Like Bridge

The roof over the arena being built for the 1960 Winter Olympics at Squaw Valley, Calif., is suspended from cables slung over steel towers in much the same way as suspension bridges are supported. The roof span is 300 feet—the length of a football field—and the stadium will seat 8,000.

Fuel Consumption Cut

Fuel consumption is said to be reduced 20 per cent by a dual-carburetor system developed in Russia. The system originally was designed for an engine for cold climates where diesels are hard to start. Russia claims this system exceeds even the diesel in economy.

NEW PREFIXES FOR UNITS

The National Bureau of Standards has decided to follow the recommendations of the International Committee on Weights and Measures to use new prefixes for denoting multiples and sub-multiples of units. The Committee adopted the prefixes at its meeting in Paris in the fall of 1958. In addition to the 8 numerical prefixes in common use, which are given in the table below, the Committee expanded the list by adding the 4 prefixes marked with an asterisk. Thus, for example, 10^{-12} farad is called 1 picofarad, and is abbreviated 1 pf.

MULTIPLES AND SUB-MULTIPLES	PREFIXES	SYMBOLS
10^{12}	tera	T*
10^{9}	giga	G*
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10	deka	dk
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	u
10^{-9}	nano	n*
10^{-12}	pico	p*

Scooting to Work

Workers in the next few years may be using a motorized scooter for traveling in large plants. A scooter, designed by a college student, now beats the smallest foreign car for fuel economy, using only three ounces of gasoline on a ten-minute run. To start the engine, rider places one foot on platform, pushes off with the other. He holds a handle and leans in the desired direction to steer.

Jets Clear Snow

Air Force jets are using sonic booms to set off safe snowslides along a highway in Glacier National Park. The planes crash the sound barrier over accumulations of snow overhanging the highway. The blast triggers the slides, making it safe to remove snow from the road.

Smallest Radio-Phonograph

A Japanese company has designed the smallest radio-phonograph — small enough to be held in one hand. The radio-phonograph weighs 45 ounces and has demensions of 7½ by 5⅛ by two inches. It uses a micro-motor, seven transistors, two diodes and a thermistor.

Blisterproof Paint

A Canadian paint company has introduced a plastic-based outside paint which cuts application time in half and is more blisterproof than any other type. The acrylic-latex paint has "pores" and "breathes" like the human skin, preventing the build-up of moisture vapor beneath it that usually causes blisters.

Worker Wives Work

A Chicago consultant in human motivation advises businessmen to solve employee production problems by talking to workers' wives. If management can convince a wife that the quality of her husband's work contributes to her security, the husband is sure to get the message, he says.

TV Help for Dentists

Dentists soon may be using a television camera for inspecting their patients' mouths. The camera in a prototype closed-circuit TV system, has a lens located at the end of a probing cable and permits a distortion-free, magnified image of any part of a patient's mouth.

Worst Diets

Teen-age girls have the worst diets —low in calcium, iron, thiamine and vitamins—reports Food Engineering, McGraw-Hill publication.

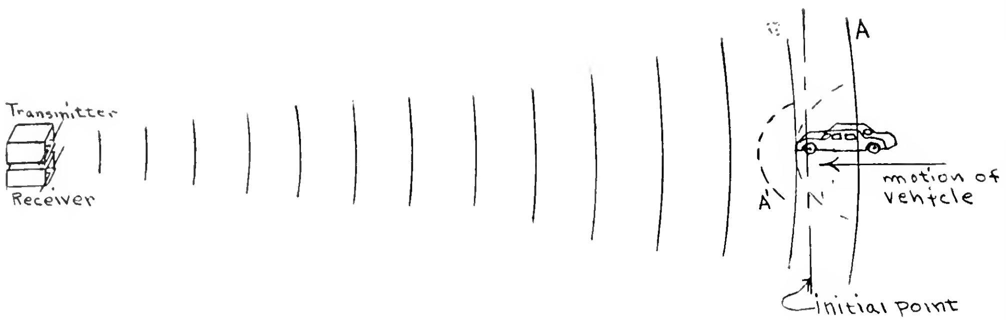


Fig. 1

RADAR SPEED METERS

By Verner K. Rice

Prior to a few years after the second World War the only method that man had to determine the speed of a moving vehicle, when he was not in the vehicle, was to time its travel between two fixed points over a known distance. With the invention of Radar and its ultimate utilization for commercial purposes we have come up with a nifty little device called a Radar Speed Meter. The purpose of this article is to discuss the method of operation of speed radar, to talk briefly of two different kinds of speed radar, and to see what factors affect its accuracy and how they can be eliminated.

RADAR, which is short for Radio Detection and Ranging, in its general aspects consists of a transmitted pulse of radio frequency energy directed toward a target, a portion of which is reflected from the target and returns to the received which shares a common antenna with the transmitter. The echo is picked up on the receiver and converted into a form that is suitable for making time measurements to determine the range to the target. At the extremely high frequencies used in radar, in the microwave region, radio waves behave like light; they are transmitted to and reflected from the target in a straight line. Thus the direction of the radar antennae indicates the direction of the target.

A Radar Speed Meter, while it uses a reflected radio wave to determine the speed of a vehicle, uses a little different phenomena for it's operation than the ordinary search type of radar. A Radar Speed Meter's transmitter transmits a continuous wave in contrast to the pulsed type of transmission that is used in the ordinary search radar. A vehicle moving in a beam of reflected signal either up or down depending on whether the vehicle is approaching or going away from the transmitter. This shift in frequency of the reflected wave is called Doppler Effect and is proportional to the speed of the vehicle. Actually, the name Radar Speed Meter is a misnomer. A speed meter that uses radio waves in the above manner to determine a vehice's speed should be called a Doppler-Radar Speed Meter.

Figure 1 shows how Doppler Effect works.

The radar transmitter located on the left in the figure sends out a train of continuous radio waves, that propagate to the left at a constant velocity. The wave A hits the moving vehicle at the indicated initial point and sends back toward the receiver the reflected wave A'.

After the first wave hits the vehicle at the initial point the vehicle continues to move toward the transmitter thus causing the wave B to hit the car a little sooner than it would have if the car had remained stationary at the initial point. This action will cause the reflected waves A' and B' to be a little closer together than the original waves A and B. Since the transmitted and reflected waves are traveling at the same velocity there will be more waves per second cutting the receiving antenna than were transmitted. The increase in the number of waves per second constitutes an increase in frequency over the transmitted frequency. Thus the frequency of the reflected wave will vary in proportion to the speed of the reflecting object.

The frequency varies according to the following equation.

$$R = \frac{C + V}{C - V} T$$

R is the received signal frequency in cycles per second.

T is the transmitted frequency in cycles per second.

C is the velocity of light 186,000 miles per second.

V is the velocity of the vehicle in miles per second.

A sample calculation will illustrate the use of the above formua.

Given: $T = 10{,}525{,}000{,}000.00$ CPS
$C = 186{,}000$ MPS
$V = 65$ MPH 0.01805 MPS

$$R = \frac{186000 + 0.01805}{186000 - 0.01805} (10525000000.00) = 10{,}525{,}002{,}041.00 \text{ CPS}$$

$$\frac{2041 \text{ CPS}}{65 \text{ MPH}} = 31 \frac{\text{CPS}}{\text{MPH}}$$

(Continued on Page 32)

NEW ELECTRONIC "BRAIN" CELLS FIT IN THE EYE OF A NEEDLE

Basic building block for compact, electronic "thought savers" will serve you in your office, in defense – someday, in your home

● Today, science not only is working on labor-saving devices—but on *thought-saving* devices as well.

These "thought savers" are electronic computers —wonder-workers that free us from tedious mental work and are capable of astoundingly rapid computations. Naturally, the more *compact* these computers can be made, the more applications they can have. Not only in industry, defense and research—but in the office and ultimately in the home.

"Squeezing" exacting components

A big advance has recently been made by RCA research towards making these "thought savers" smaller than ever before, for broader than ever use.

Take, for example, the new "logic" circuit which actually fits in the eye of a needle. It is a new computer component developed by RCA.

Today, the electronic functions of this micro-miniature device require a whole fistful of wires, resistors, transistors and condensers.

These tiny units will calculate, sort, "remember," and will control the flow of information in tomorrow's computers. Yet they are so small that 100,000,000 of them will fit into one cubic foot!

Cutting computers down to home size

This extreme reduction in size may mean that someday cigar-box-size electronic brains may help you in your home—programming your automatic appliances, and keeping track of household accounts.

Remarkable progress in micro-miniaturization is another step forward by RCA—leader in radio, television, in communications and in all electronics—for home, office, and nation.

Needle's eye holds electronic "brain" cells — Photograph shows how new RCA "logic" element can be contained in the eye of a sewing needle.

RADIO CORPORATION OF AMERICA
THE MOST TRUSTED NAME IN ELECTRONICS

. . . THE EXPLORATION OF SPACE

Since its inception nearly 23 years ago, the Jet Propulsion Laboratory has given the free world its first tactical guided missile system, its first earth satellite, and its first lunar probe.

In the future, under the direction of the National Aeronautics and Space Administration, pioneering on the space frontier will advance at an accelerated rate.

The preliminary instrument explorations that have already been made only seem to define how much there is yet to be learned. During the next few years, payloads will become larger, trajectories will become more precise, and distances covered will become greater. Inspections will be made of the moon and the planets and of the vast distances of interplanetary space; hard and soft landings will be made in preparation for the time when man at last sets foot on new worlds.

In this program, the task of JPL is to gather new information for a better understanding of the World and Universe.

"We do these things because of the unquenchable curiosity of Man. The scientist is continually asking himself questions and then setting out to find the answers. In the course of getting these answers, he has provided practical benefits to man that have sometimes surprised even the scientist.

"Who can tell what we will find when we get to the planets? Who, at this present time, can predict what potential benefits to man exist in this enterprise? No one can say with any accuracy what we will find as we fly farther away from the earth, first with instruments, then with man. It seems to me that we are obligated to do these things, as human beings."

DR. W. H. PICKERING, *Director, JPL*

jpl

CALIFORNIA INSTITUTE OF TECHNOLOGY

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A Research Facility operated for the National Aeronautics and Space Administration

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Send professional resumé for our immediate consideration. Interviews may be arranged on Campus or at the Laboratory.

SPEED METERS

(Continued from Page 26)

This shows that there is a change of approximately 31 cycles per second per mile per hour of speed, for this particular transmitter frequency.

The returning echo frequency together with a small amount of the transmitted frequency are fed into the mixer stage of the receiver, where they are hetrodyned or beat together to produce a sum, difference, and the two original frequencies. These frequencies are fed into a low-pass filter to eliminate all but the difference frequency. The difference frequency is selected because it makes possible the use of audio frequency amplifier and detector circuits. Audio frequency circuits are much easier to design and construct than the ultra ultra high frequency circuits that would be necessary if the sum frequency were used. The output of the filter is amplified and then sent through a circuit that gives an output proportional to the applied frequency. The output of the frequency measuring circuit operates a meter or strip chart recorder that is calibrated in miles per hour.

Most of us, if we drive a car, have at one time or another passed an unmarked car sitting along side of the highway with a small, olive-drab colored box sitting on a tripod next to it, or maybe sitting on the ledge over the back seat pointing at the traffic, or perhaps peeking out of a partially opened trunk. Whether we knew it or not at the time we were being checked by a radar speed meter.

This particular model radar speed meter, made by the Automatic Signal Division of Eastern Industries Inc., was one of the first speed radar used by our state police. The radar operates at a frequency of 2,455 megacycles and is accurate to within plus or minus 2%, from 0 to 100 miles per hour. The receiver-transmitter are packed in a single case together with the amplifiers and detector and indicating circuits, the unit is portable and can be operated off of 120 volt AC or a 12 volt battery. A block diagram of this speed radar is shown in figure 2.

The oscillator employes a 2C40 in a ultra ultra high frequency circuit to feed a coaxial hybrid mixer assembly. Part of the output of the oscillator is picked off in the mixer assembly and used as the local oscillator signal, the rest is fed out to the antenna system where it is radiated into the traffic pattern. The antenna system is made up of eight dipoles arranged to give a directive radiation pattern. The returning echo signal is hetrodyned with the local oscillator signal in the mixer assembly, and then the difference frequency is fed into a series of broad-band cascaded audio amplifiers to the grid of the frequency measuring circuit. The frequency measuring circuit is one-half of a 12AU7 connected as a grid limited audio amplifier. See figure 3 for a schematic diagram of the frequency measuring circuit.

The incoming signal Es drives the tube from a full conduction condition into cutoff, as the tube is cutoff by the incoming signal the voltage across the tube rises to the value of B plus. This voltage rise which occurs at the frequency of the incoming signal is placed across the RC circuit of R1 and C1. The input impedance of the RC circuit as seen by the output of the tube is a function of the frequency. As the frequency of the incoming signal rises the impedance of the RC circuit decreases and the current through the resistor R1 increases giving a voltage drop across R1 that rises in proportion to the applied signals frequency. The voltage across R1 is read on a conventional VTVM circuit whose meter is calibrated directly in miles per hour. The function of the two diode limiters is to insure that no reverse voltage is read across the resistor R1 which would cause the meter to read backwards and might damage it.

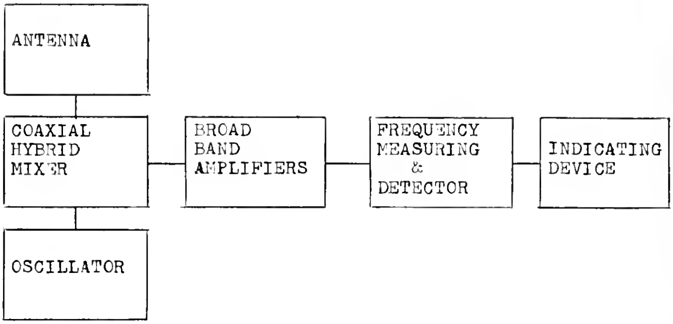


Fig. 2

Another more recent Radar Speed Meter that the author has had the opportunity to work with is the radar speed timer built by the Muni Quip Corporation.

The equipment is a good deal smaller than the first unit and is built in two separate sections. The receiver-transmitter is housed in an aluminum housing that is circular in shape and about the size of an automobile spotlight. The receiver-transmitter is connected to the amplifier and frequency measuring chassis by two short lengths of cable. The transmitter uses a klystron tube for the oscillator, which makes possible a much higher operating frequency, and allows the transmitter to be placed in a much smaller space.

Another advantage of using a klystron for the oscillator is that the frequency is more stable. The antenna structure of this radar is a good deal different from that of the first piece of equipment. The antenna is a tapered piece of plastic that is attached to the end of the wave guide that comes out of the klystron. The antenna shapes radiated energy into a cone that is seven and one-half degrees wide on either side of center. The receiving antenna is similar in shape to the transmitting one and lies directly below it. The incoming signal is hetrodyned with the local oscillator in a crystal mixer assmbly in the receiver-transmitter chassis and then fed into the amplifying and frequency measuring chassis. This equipment operates at a frequency of 10,525 megacycles with a maximum radiated power of 50 milliwatts and is accurate to within 2% from 0 to 100 miles per hour.

Now that we have discussed the theory of operation of a Radar Speed Meter and two different types of Radar Speed Meters, what are the principle sources of error? The principle sources of error in Radar Speed Meters result from shifts in carrier frequency, frequency measurements and meter inaccuracies, and errors in reading either due to parallax or human error. Another error results from the fact that the speed read by the meter is not the linear speed of the vehicle relative to the ground. Reference to Fig. 4 shows that the speed of the vehicle relative to the point P, where the receiver-transmitter is located, is equal to Vo CosΘ, and is negligible for small value of theta. This factor however limits the distance that the received-transmitter can be placed from the road and still give accurate readings. This factor of error is always in favor of the driver and al-

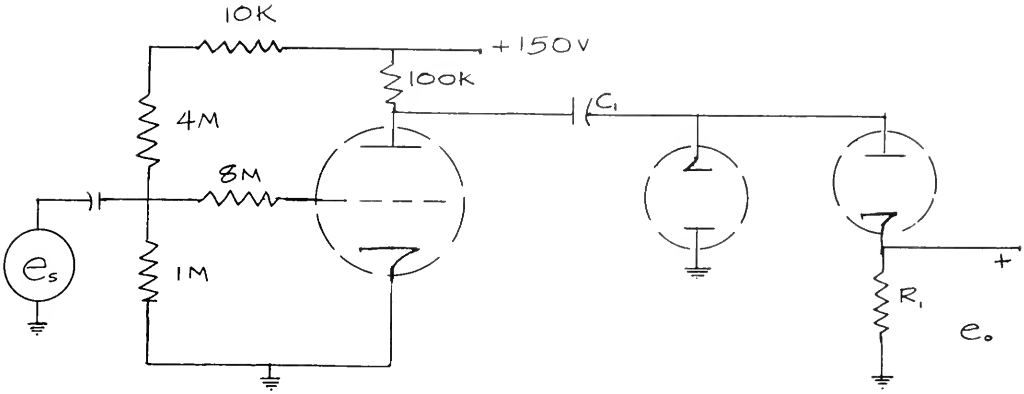


Fig. 3

ways understates the true speed.

Carrier frequency drift results in a very small error in readings assuming that drift is limited to 1 MC, which is a reasonable assumption with a well regulated power supply and a klystron that has a cavity that is fixed in dimensions and subjected to small temperature variations.

Parallax errors which result when the operator does not look directly down on the meter needle, can be largely eliminated by making the meter needle small and placing it as close as possible to the calibrations on the meter face. Parallax can give errors of plus or minus .5 to 1.5 miles per hour.

Operator errors, like the poor, are always with us, and there is not too much that can be done about them, except to make the meter calibration as clear as possible and very easy to read.

In summary the advances in radar technology have given us a very portable, accurate, and jam proof piece of equipment that can be used to measure speed.

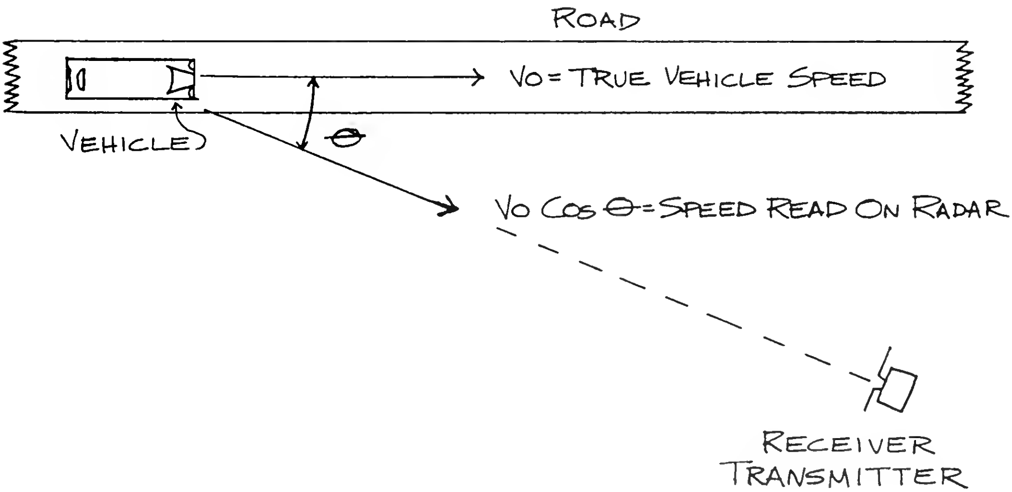
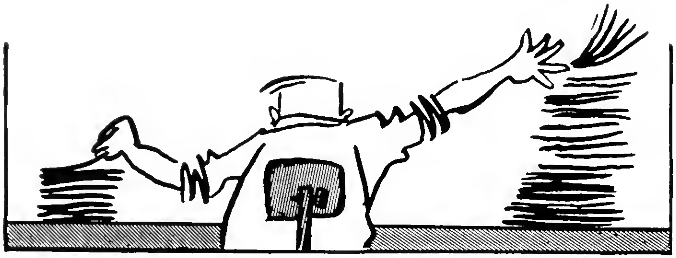


Fig. 4

Skimming Industrial Headlines



Edited by The Staff

Lockheed X-7 Retires to UCLA

The Lockheed-built Air Force X-7, which holds the free world's speed and altitude records for air-breathing missiles, is joining the "teaching staff" at UCLA.

Converted into a space age teaching tool, the X-7 was contributed by the Air Force to UCLA where the missile is being installed at the university's engineering building on the Westwood campus.

This X-7, an early special edition now several years old, was built at the Van Nuys plant of the Lockheed Missiles and Space Division at an original cost of $1.5 million. However, fast-changing developments in the field have made this older version obsolete and, rather than scrapping this early X-7, the Air Force decided to turn it over to UCLA where its value as teaching equipment is estimated at more than $100,000.

Prior to being sent to UCLA the missile was repainted and refurbished by Lockheed, which also contributed the display stand.

Accepting the 38-foot missile on behalf of the university, Prof. Wendell A. Mason, vice chairman of the department of engineering, said:

"The X-7 will be of great value for instruction and research in the fields of electronics and instrumentation and will be especially useful to engineering students planning to specialize in aircraft and missile research."

Primary purpose of the X-7, whose speed record is in the neighborhood of 3000 miles per hour, is to test new developments in ramjet engines and other components for advanced Air Force interceptor missiles such as the Bomarc.

The X-7 now at UCLA is equipped with instrumentation that includes an automatic pilot, guidance, telemetary, and recovery systems. It has a 10-foot wing span and a 20-inch diameter.

This particular missile was part of a special X-7 program that led to the development of underwing rocket boosters, a new recovery system, drag parachute clam-shell doors, and introduction of a hydraulic system for the autopilot. Much of this was applied to the later Q-5 Kingfisher target missile and to a more advanced version of the X-7, both of which are now in flight programs at the Air Force and Army bases in New Mexico.

Air-Cooling for Hydrogen Lamps

A new air-cooled hydrogen lamp has been developed by Sylvania Lighting Products for incorporating into the Hydrogen Arc Illuminator produced by Bausch & Lomb Optical Co.

The chief advantage of this revised system using the Sylvania lamp over water-cooled systems is the elimination of a water supply and the tube breakage that could result from a necessarily complex arrangement of supply and drainage tubes.

The illuminator is designed for use with several models of the B & L Grating Monochromator, whenever a relatively high, intense source of continuous illumination is required in the ultraviolet region of the spectrum. Equipped with the Sylvania lamp, the B & L Illuminator combines the advantages of a long-life, air-cooled hydrogen lamp with a power supply which converts the alternating current line voltage into direct current. This conversion results in a valuable increase in light output and a steady direct current source for use with rotating sectors without introduction of harmful stroboscopic effects that can occur when tuned AC amplifiers are used.

The design of the Sylvania lamp and the B & L power source will prolong lamp life, reduce unwanted atomic spectra from the metallic parts in the interior of the lamp and permit higher radiation intensity.

The new lamp is designed for widespread use in the field of spectrophotometry as a source for measurement of UV absorption of organic and inorganic materials.

In addition, the Sylvania-equipped B & L Illuminator can play an integral part in such specialized studies as: (1) fluorescence, a source for exciting radiation in order to study emission characteristics of materials; (2) phosphorescence, a special type of fluorescence which characterizes decay-time in excited materials and (3) ultraviolet reflectance, which is used as a source to measure the diffused and specular reflectance of materials such as optical coatings.

In educational and research fields, the illuminator is used an an ultraviolet source for studying the general optical properties of materials.

Railroad Comeback

Railroads in Germany and Italy still think they have a future. In Germany, 94 per cent of the 3,320 railroad bridges destroyed and damaged in the war have been rebuilt. In Italy, a five-year plan of railway electrification will end next year with 4,800 miles of the country's 10,000-mile rail net using kilowatts instead of coal.

Stretching A Point

The 250 million pounds of gum chewed a year by Americans would encircle the earth 60 times if formed into one stick. And, it could be stretched to Mars.

Slanted Parliament

The British Minister of Works admits that two of Parliament's towers aren't in top form. The 329-foot-high Big Ben tower and the 336-foot-high Victoria are each 15 inches out of plumb. Engineers believe it may be due to wartime bombing.

Power for Arkansas

More than 14 feet in diameter and 30 feet long, this steel frame will house the world's largest 3600-rpm turbine-generator. The unit is now under construction at the Westinghouse Electric Corporation's East Pittsburgh, Pa., plant.

Rated at 384,000 kilovolt amperes, the completed unit is scheduled to be delivered to the Arkansas Power and Light Company's new station near Helena during the summer of 1960.

The 325,000-kilowatt steam turbine to drive the generator is being built at the Westinghouse plant in Lester, Pa.

Revolutionary Aircraft Landing System

A new and revolutionary instrument landing system for aircraft is under development by Boeing Airplane Company. It weighs less than 10 pounds and costs only a fraction of present systems in operation.

The Boeing technique requires only the addition of two small units to automatic direction finding equipment (ADF receivers) currently used on most aircraft plus two radio "homer beacons" on the ground.

Present all-weather navigation, approach and landing systems require ground-based radar or very high frequency (VHF) radio navigational aids costing millions of dollars each and normally found only at major improved fields.

The Boeing system had its beginning in 1958 when research engineers were tossed this problem: Develop a method of low altitude navigation and landing aircraft on unimproved fields in zero-zero conditions without the aid of lights, complex ground equipment and ground station personnel. In addition, the equipment on the ground had to be lightweight, inexpensive, extremely portable and operable by untrained personnel.

Because of its line of sight limitations, VHF radio transmission is extremely restricted at low altitudes. Due to this, Boeing researchers turned to low frequency channels. By solving two problems the low frequency signal's tendency to follow the earth's curvature would make it ideal for low altitude communications.

The problem areas were: Static encountered on low frequency channels can induce bearing, or heading inaccuracies. Also, during "blind" landings the pilot doesn't have time to continually compute his position—information normally provided by the more complex ground stations.

The basic Boeing idea calls for installation of two "homer beacons" on the ground. Transmitting a steady, low frequency signal, one beacon would be placed on the centerline of the runway's departure end and the other at a known distance to the left or right at the approach end.

To operate with the beacons, the airplane's standard ADF receivers would need a special filter and coupler—both weighing less than six pounds. The filter, after screening information coming out of the ADF, provides the system with a true heading.

The coupler, a tiny but critically accurate "brain," then examines all available data and supplies the same intelligence to the pilot, except for altitude, that normally is given by ground-based navigational and landing aids.

Signals from the beacons are channeled through the new system to an instrument continuously showing the pilot his exact location in reference to the runway regardless of wind. The "third dimension," continual and exact altitude information, is supplied by the plane's radar altimeter while the ADF coupler reports constantly the number of feet remaining before touchdown.

Correlating his altitude and distance-to-touchdown information with what he sees on a visual display instrument, the pilot can bring his aircraft down safely without ever looking outside.

The new system already has completed more than 40 hours of flight testing, including 60 successful approaches. Five of the approaches terminated in blind touchdowns on the runway. Developed basically for military operations, Boeing considers potential widespread application exists for both commercial and private flying.

Constant Heat for Lab Ovens

Keeping an oven hot isn't much of a job. But keeping it at the exact same heat for long periods is a task that calls for unsual equipment. Many laboratories, specialized businesses, and industrial plants need such ovens. The American Instrument Company has just introduced a piece of equipment to answer this special need.

The new oven has approximately four cubic feet of work space, with an all-stainless steel interior, including the inside panel of the door. The stainless is a contributing factor to two of the oven's outstanding features—constant and uniform heat.

In a laboratory test, a temperature recording of a thermocouple suspended in the center of the oven for approximately four hours, showed a constancy of plus or minus 0.5 degrees F at 150 degrees F, 500 degrees F, and 100 degrees F. Electric resistance heaters are located in all six walls, weighted thermally to produce maximum temperature uniformity. The maximum deviation from test temperature as measured simultaneously by nine thermocouples (one in the center and one in each corner) was plus or minus 0.5 degrees F at 150 degrees F, and plus or minus 4.0 degrees F at 500 degrees F and 1000 degrees F.

The temperature range of the oven is 125 degrees F to 1000 degrees F, with a heat-up time of room temperature to 725 degrees F in one hour; to 1000 degrees F in 3½ hours, with only 2500 watts maximum electrical input.

Durability (under conditions of use) and ease of cleaning were other factors weighed in choosing stainless steel for the oven's interior, according to the manufacturer.

Overall exterior dimensions are 34½ inches wide by 42 inches high by 33 inches deep. The interior work area measures 20 inches wide by 19 inches high by 18 inches deep. Weight is approximately 200 pounds.

The oven's operation is simple. Controls are located on the front panel above the door. The controls include: (1) an electronic, thermistor type, temperature controller which is connected to a 10-turn helical potentiometer with panel-mounted dial (graduated from 0 to 1000) for fine temperature setting; (2) a controller which cycles the heaters to produce a pre-determined average wattage (adjustable from approximately 6 per cent to 100 per cent of total heater wattage); (3) a master switch and pilot light; (4) an adjustable safety thermostat to prevent accidental overheating.

The exterior design permits stacking of ovens, if desired.

King Solomon's Furnaces

A real claim to fame of King Solomon is the copper blast furnace complex he built in the Arabah desert in Palestine. The furnaces were similar in construction to modern Bessemer-system smelters invented a century ago and each could smelt 14 cubic feet of material at one time.

Where There's Smoke . . .

There's no fire in a new waste receptacle that uses smoke to put out flames. When a fire starts in the receptacle, its smoke is diverted back towards the flames, cutting off oxygen and putting out the fire.

Gracious Living

Mass production has come to the outhouse. An aluminum outhouse, originally conceived for public parks and forests, has drawn "amazing response" from farmers. A 6½-by-5½-foot model costs $300.

BRAIN TEASERS

Edited by Steve Dilts

Given nine coins, one of which is counterfeit and too light, find a method of finding the counterfeit by balancing the coins against each other on a pan balance; there is a limit of two trials.

* * *

The next three teasers are courtesy of *Scientific American.*

* * *

Professor Merle White of the mathematics department, Professor Leslie Black of philosophy, and Jean Brown, a young stenographer who worked in the university's office of admissions, were lunching together.

"Isn't it remarkable," observed the lady, "that our last names are Black, Brown and White and that one of us has black hair, one brown hair and one white."

"It is indeed," replied the person with black hair, "and have you noticed that not one of has hair that matches his or her name?"

"By golly, you're right!" exclaimed Professor White.

If the lady's hair isn't brown, what color is it?

* * *

A square formation of Army cadets, 50 feet on the side, is marching forward at a constant pace. The company mascot, a small terrier, starts at the center of the rear rank, trots forward in a straight line to the center of the front rank, and then trots back again in a straight line to the center of the rear. At the instant he returns to his position at the rear, the cadets have advanced exactly 50 feet. Assuming that the dog trots at constant speed and loses no time in turning, how many feet does he travel?

If you solve this problem, which calls for no more than a knowledge of elementary algebra, you may wish to tackle a much more difficult version proposed by the famous puzzlist, Sam Boyd. Instead of moving forward and back through the marching cadets, the mascot trots with constant speed around the outside of the square, keeping as close as possible to the square at all times.

(For the problem we assume that he trots along the perimeter of the square.) As before, the formation has marched 50 feet by the time the dog returns to the rear. How long is the dog's path? If the reader does not want to get involved with fifth-degree equations, he had better not attempt this second version.

* * *

In H. G. Wells' novel *The First Men in the Moon* our natural satellite is found to be inhabited by intelligent insect creatures who live in caverns below the surface. These creatures, let us assume, have a unit of distance that we shall call a "lunar." It was adopted because the moon's surface area, if expressed in square lunars, exactly equals the moon's volume in cubic lunars. The moon's diameter is 2,160 miles. How many miles long is a lunar?

* * *

Here are the answers to last month's teasers.

The number 2450 may be divided into the following prime factors: 1, 2, 5, 5, 7, 7. Of all the possible permutations and combinations of these six numbers to yield three numbers which sum to less than one hundred, there are only two sets which have the same sum: (5, 10, 49) and (7, 7, 50). The identical sum would be the reason why the lawyer would not know at first. The doctor must be 32. Since the oldest woman is younger than the lawyer and the lawyer was able to tell their ages, the lawyer must be 50, and the women must be 49, 10, and 5.

* * *

The fallacy of the proof that all triangles are isosceles is that the construction is only possible for an isosceles triangle or an equilateral triangle.

* * *

The king takes over a cannibal and returns to take over the other one. He returns and two missionaries go over. One missionary comes back with a cannibal to take over the king and to bring back the other cannibal. Then two missionaries go over, and the king makes two trips to bring over his tribesmen.

* * *

There is exactly the same amount of water in keg as there is wine in the bucket. Regardless of the proportions of wine and water transferred—and regardless of the number of exchanges—if the two containers first held equal volumes of pure liquid and eventually are left with equal volumes of mixtures, equal amounts of wine and water have changed places.

New . . .
Super Conductors

Uranium—the nuclear fuel that made possible large-scale useful atomic power—has yielded a new "family" of chemical compounds among the most unique in science. The new uranium compounds belong to a group of substances called superconductors—materials characterized by the remarkable ability of permitting an electric current, once started in them, to flow in undiminished strength forever.

The new superconductors were discovered by Dr. B. S. Chandrasekhar, physicist in the metallurgy department of the Westinghouse Research Laboratories, and Dr. J. K. Hulm, manager of the Laboratories' solid state physics department.

The superconductors were found during research on the electrical resistance of uranium alloys at temperatures less than one degree above absolute zero—459 degrees below zero Fahrenheit.

The new superconductors, four in all, include the first ever known to contain manganese and iron, two elements that always have been considered alien to the existence of superconductivity. All are known as "intermetallic compounds" and are alloys of uranium and one other metal.

"Superconductivity is among the most startling phenomena in all physical science," Dr. Hulm said. "It occurs in various metals and alloys at very low temperatures. For reasons that are not now well understood, the electrical resistance of these materials suddenly drops to about one-millionth or one-billionth of its normal value. Electric currents flow in them undiminished and apparently forever.

"One can readily visualize the immense practical importance of this behavior if it could be made to occur at reasonably high temperatures," he said. "Such superconductors would make possible electrical and electronic devices not now even visualized, and would revolutionize the practices and products of these industries as we know them today. They are beginning to find application in midget computers useful for airborne control of rockets and missiles.

"Because of the widespread application as a nuclear fuel, the metallurgy of uranium and its alloys has been extensively explored. But no comparable research has been carried out on the electrical properties of these materials. Our purpose was to study the unique electrical resistance of uranium alloys down to very low temperatures and to continue a basic investigation of superconductivity that has been pursued in these laboratories for many years.

"The measurements of electrical resistance," Dr. Hulm said, "were made on uranium-molybdenum and uranium-niobium alloys that have been stabilized in crystal structure by heating to 1650 degrees Fahrenheit for 24 hours and rapidly quenching in water.

"The alloys showed surprising temperature-resistance behavior. Contrary to all known alloys, their electrical resistance became progressively larger as the temperature was decreased all the way down to one or two degrees above absolute zero, at which temperatures they became superconductors. The superconductivity," Dr. Hulm said, "also was surprising in view of the rise in electrical resistance preceding it. Correlation of the superconductivity and resistivity data has thrown new light on the electronic structure of the atoms making up the alloys," he declared.

To probe more deeply into the superconducting behavior of uranium alloys, the Westinghouse scientists then studied a group of "intermetallic compounds." Such compounds form when uranium is chemically combined with such metals as aluminum, manganese, iron, cobalt, and nickel. It was from these studies that the completely new superconductors emerged.

"Four undiscovered superconductors were found among the intermetallic compounds containing cobalt, manganese and iron," Dr. Hulm reported. "Of special interest is the fact that two of them are the first superconducting compounds ever known to contain manganese and iron.

"Heretofore, the presence of these two elements has been regarded as 'death' to the superconducting state. That theory is no longer acceptable. Indeed, these new superconductors not only are a reality, but may be among the most useful in superconductor research."

BOOK REVIEW SECTION

MALLEABLE IRON CASTINGS

by the Malleable Founders Society. The Ann Arbor Press, Inc., Ann Arbor, Michigan. 1960. 526 p. ($10.00).

Malleable Iron Castings, a comprehensive and up-to-date handbook on one of America's most versatile engineering materials, is now available to the metalworking public.

Published by Malleable Founders Society, the work reflects the authoritative knowledge of the malleable industry's foremost foundry technicians and casting designers.

The editors have taken into account the industry's great progress in recent years, expanding the content of new publication by more than 40% over the previous edition, published in 1944.

New emphasis has been given to the description of pearlitic malleable iron. This steel-like material offers greater hardness and wear-resistance than ferritic malleable, but has sufficient ductility and machinability to make it ideal for many moving-part applications—gears, crankshafts, sprockets and hubs.

Since machinability is one of malleable iron's outstanding characteristics, this subject is also covered in detail. Included in the machining chapter are discussions of all the basic operations—turning, drilling, boring, milling and tapping.

The chapter includes ten representative case histories in which each operation in the processing sequence is illustrated. Data such as tool feeds and speeds, rake angles, etc. accompany each of these drawings.

While it covers the basics of foundry operation the handbook is also designed to help the engineer in design of metal components; the purchasing agent in materials selection and the production planner in processing malleable castings.

One metalworking authority, W. S. Pellini, Superintendent of the Metallurgy Division of the United States Naval Research Laboratory, says of the handbook . . . "it is quite evident that no pains have been spared in developing concrete factual information while retaining a high degree of readability."

In addition to the material on Pearlitic Malleable and Machining, chapters are devoted to Uses and Products, Mechanical and Physical Properties of Standard Malleable, Design, Metallurgy, Manufacture, and Alloyed Malleables. Price of the new handbook is $10.00. It is available from Malleable Founders Society, 781 Union Commerce Building, Cleveland 14, Ohio.

One of a series

Interview with
General Electric's Earl G. Abbott,
Manager—Sales Training

Technical Training Programs at General Electric

Q. Why does your company have training programs, Mr. Abbott?

A. Tomorrow's many positions of major responsibility will necessarily be filled by young men who have developed their potentials early in their careers. General Electric training programs simply help speed up this development process.

In addition, training programs provide graduates with the blocks of broad experience on which later success in a specialization can be built.

Furthermore, career opportunities and interests are brought into sharp focus after intensive working exposures to several fields. General Electric then gains the valuable contributions of men who have made early, well-considered decisions on career goals and who are confidently working toward those objectives.

Q. What kinds of technical training programs does your company conduct?

A. General Electric conducts a number of training programs. The G-E programs which attract the great majority of engineering graduates are Engineering and Science, Manufacturing, and Technical Marketing.

Q. How long does the Engineering and Science Program last?

A. That depends on which of several avenues you decide to take. Many graduates complete the training program during their first year with General Electric. Each Program member has three or four responsible work assignments at one or more of 61 different plant locations.

Some graduates elect to take the Advanced Engineering Program, supplementing their work assignments with challenging Company-conducted study courses which cover the application of engineering, science, and mathematics to industrial problems. If the Program member has an analytical bent coupled with a deep interest in mathematics and physics, he may continue through a second and third year of the Advanced Engineering Program.

Then there is the two-year Creative Engineering Program for those graduates who have completed their first-year assignments and who are interested in learning creative techniques for solving engineering problems.

Another avenue of training for the qualified graduate is the Honors Program, which enables a man to earn his Master's degree within three or four semesters at selected colleges and universities. The Company pays for his tuition and books, and his work schedule allows him to earn 75 percent of full salary while he is going to school. This program is similar to a research assistantship at a college or university.

Q. Just how will the Manufacturing Training Program help prepare me for a career in manufacturing?

A. The three-year Manufacturing Program consists of three orientation assignments and three development assignments in the areas of manufacturing engineering, quality control, materials management, plant engineering, and manufacturing operations. These assignments provide you with broad, fundamental manufacturing knowledge and with specialized knowledge in your particular field of interest.

The practical, on-the-job experience offered by this rotational program is supplemented by participation in a manufacturing studies curriculum covering all phases of manufacturing.

Q. What kind of training would I get on your Technical Marketing Program?

A. The one-year Technical Marketing Program is conducted for those graduates who want to use their engineering knowledge in dealing with customers. After completing orientation assignments in engineering, manufacturing, and marketing, the Program member may specialize in one of the four marketing areas: application engineering, headquarters marketing, sales engineering, or installation and service engineering.

In addition to on-the-job assignments, related courses of study help the Program member prepare for early assumption of major responsibility.

Q. How can I decide which training program I would like best, Mr. Abbott?

A. Well, selecting a training program is a decision which you alone can make. You made a similar decision when you selected your college major, and now you are focusing your interests only a little more sharply. The beauty of training programs is that they enable you to keep your career selection relatively broad until you have examined at first hand a number of specializations.

Furthermore, transfers from one General Electric training program to another are possible for the Program member whose interests clearly develop in one of the other fields.

Personalized Career Planning is General Electric's term for the selection, placement, and professional development of engineers and scientists. If you would like a Personalized Career Planning folder which describes in more detail the Company's training programs for technical graduates, write to Mr. Abbott at Section 959-13, General Electric Company, Schenectady 5, N. Y.

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TECHNOGRA

THE ILLINOIS TECHNOGRAPH

Volume 75, No. 8 May, 1960

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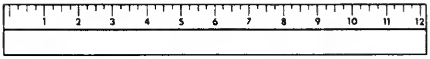
Cover . . .

Old man Sol is the source of useful power we are beginning to learn. Barb Polan also has found in him a source for our last cover of the year. For more details on the sun see page 13.



ONLY 12 INCHES WIDE...

Tom Speer, Senior Engineering Research Supervisor at Standard Oil, inspects one of the 12 sections in a new miniature road tester. Under simulated weather conditions, four wheels whirl around to reveal wear patterns and other vital information. (INSET) Ruler shows wear pattern after strip has taken pounding from tires during rain, freeze, thaw and heat.

...THIS 'ROAD' CARRIES

WORLD'S HEAVIEST TRAFFIC!

Say good-bye to washboard pavements and chuck holes—their doom may be sealed!

Key weapon in the war on costly road damage is a new miniature highway developed in the Standard Oil research laboratories in Whiting, Indiana. It is only 12 inches wide and 44 feet in circumference, but it carries heavier loads than any highway in the world. This Tom Thumb turnpike will eventually lead to methods of building longer-lasting, smoother, safer highways...at far less cost to taxpayers.

Four wheels whirling around hour after hour can give it any degree of traffic intensity desired. Pressure that corresponds to the weight of the heaviest trucks can be applied to the wheels. To simulate actual traffic, the wheels are placed on braking and acceleration 90 per cent of the time. Automated electronic equipment can quickly change "road conditions" from desert dry to cloudburst drenched. "Road conditions", too, can be changed from freezing to thawing.

Within weeks, the new test-tube roadway can determine what happens to roads during years of use in all kinds of weather. It can pretest paving formulas and techniques, and may show how to eliminate washboard pavement and chuck holes. Savings in highway research alone may run into millions of dollars. Even larger savings in auto and road repairs and possibly in gasoline taxes are in sight.

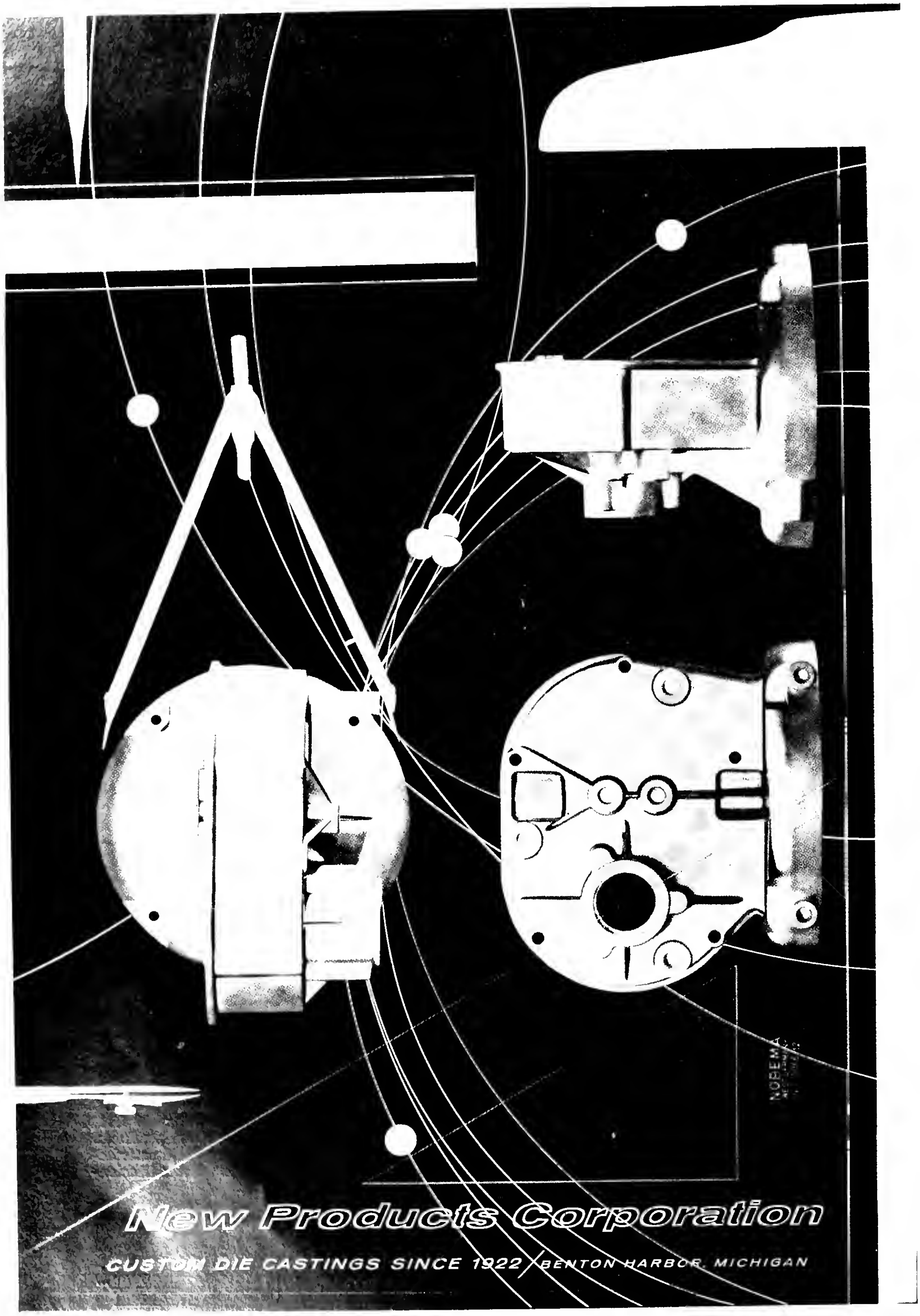
This test-tube roadway is just one of the many exciting developments at Standard. Every day, scientific research, pure and applied, points the way to new or improved products. This work holds great challenge and satisfaction for young men who are interested in scientific and technical careers.

STANDARD OIL COMPANY

910 SOUTH MICHIGAN AVENUE, CHICAGO 80, ILLINOIS

STANDARD

THE SIGN OF PROGRESS...
THROUGH RESEARCH


New Products Corporation
CUSTOM DIE CASTINGS SINCE 1922 / BENTON HARBOR, MICHIGAN

The Merry-Go-Round . . .

"Professor Flugg, what should we do about students who use files in our course?" Professor Flugg leans back in his plush conference chair to the right of the chairman. It is time for the committee on student activities and coffee testing to convene for the final time before resting up for next semester.

"Hak-kaff! Well, Professor Course (known affectionately by the students as Ole Abee) I think we should go to all the fraternities and collect their files. Those are the offenders."

Professor Snap awakes from a drouse long enough to mumble something about MRH having a more complete set on his course, but he is ignored because he talks in his sleep anyway.

Course raps his spoon on his coffee cup and wakes Snap along with three other professors who wandered in for the coffee. "Gentlemen, I heard an amusing suggestion the other day. One of our grad students wanted to know why we didn't change our exams each semester!"

The crowd breaks up at this point chuckling over the joke they just heard. Re-write indeed!

* * *

"Say, Joe, what are you going to take next semester?"

"Well, I've got a file in 199 that's pretty good, but I hear that steam engines aren't the coming thing any more so I guess I'll have to take something else. You know any good courses? ("Good" loses something in translation, but it is close to easy).

"Yeah, I took one last semester, 219, but somebody stole my file and I had to do most of the work in it. I ended up knowing enough that I didn't even have to use a pony for the final. Talk about wasted time.

"Gee, that must have been bad. You made up a file after the semester was over though, didn't you?"

"Yeah, I did, but I can't loan it to you. The instructor wanted it to give to a grad student who was going to help him teach next semester."

"That's Okay, I hear the boys are going to get together on Tuesday nights for 219. They've got the old lab reports and they're going to carbon them up for everybody. Professor Course won't have to spend as much time grading them that way. Standardization is the key to fast checking, you know.

"That's right but you'd better be careful, I hear this grad student wants to change some of the problems. Chances are he won't though. I think they still have a few hundred copies of the old exams to use up first. Besides, nobody would take the course if he did.

This story lasts for four years but you know the way it goes.

A. Hypocrite

WANKEL'S WONDER

Amazing Conception in I. C. Engine Design

By Pete Thelander

The last few weeks of the 1950's saw the announcement of a significant new engine. It combines the smoothness of the turbine engine with the efficiency of the piston engine. But its greatest attribute is its utter simplicity: it has only two rotating parts!

This dramatically clever device is the brainchild of Dr. Felix Wankel and is the result of thirty year's work in the field of sliding seals. Perhaps Dr. Wankel's greatest contribution prior to his rotaty combustion engine was his cylindrical rotary valve used in some of Germany's World War II aircraft engines.

The West German motorcycle manufacturing firm of Neckarsulm Werke undertook the original development of the rotary combustion idea and ran the first experimental engine in February, 1957. The following year Curtiss-Wright Corporation was licenced to develop the engine in this country.

Description

A goodly portion of the energy released by the fuel in a piston engine never reaches the crankshaft as usetul power. It goes, instead, into accelerating and decelerating the rather extensive reciprocating masses; pistons, valves, springs, pushrods, etc. This, in turn, requires a heavy structure to absorb the resultant pounding.

Dr. Wankel's engine, having only a powershatt and rotor, does away with all this stop-and-start motion completely. The powershaft is basically a round bar with a circular eccentric tangent to it. The rotor is shaped like an equilateral triangle with its sides bowed out. It has a hole in the center so that it can rotate on the eccentric of the powershaft. At one edge of this hole is an internal gear. The center of the bowed-out sides is recessed to increase the combustion volume, and each corner of the triangle is slotted to accept a spring-backed wiper which effects a seal between the rotor and the casing.

The casing is composed of two side plates which bolt to a center section. At the center of each side plate, a hole is bored that acts as a bearing in which the power-shaft may turn. Around one of these bearings, a gear is afixed to the inside of the plate. This external gear meshes with the internal gear in the rotor and has exactly two-thirds as many teeth as the rotor gear.

The inside contour of the center section is defined by the vertices of the rotor as it "walks" around the gear on the side plate. The resultant shape, called an epitrochoid, is a short, squat oval with a slightly "pinched" waist.

Such an arrangement, of course, is not balanced, so two counterweights are splined to the shaft outside of the casing. Fuel is metered to the air by a conventional carburetor and inhaled through a port in either the center section or one of the side plates. The burned gases are exhausted through a second port in the center section. Also located in the center section, is the single spark plug. The engine may be either water-cooled or air-cooled.

In operation, the vertices of the rotor remain in contact with the casing, forming three chambers which increase and decrease in volme as the rotor "walks" around the fixed gear. When the rotor is in the position shown in Fig. 2, chamber A will be at a minimum volume. In this sketch the shaft is cross-hatched and the eccentric is defined by the tips of the gear teeth on the rotor.

As the shaft rotates, the rotor "walks"

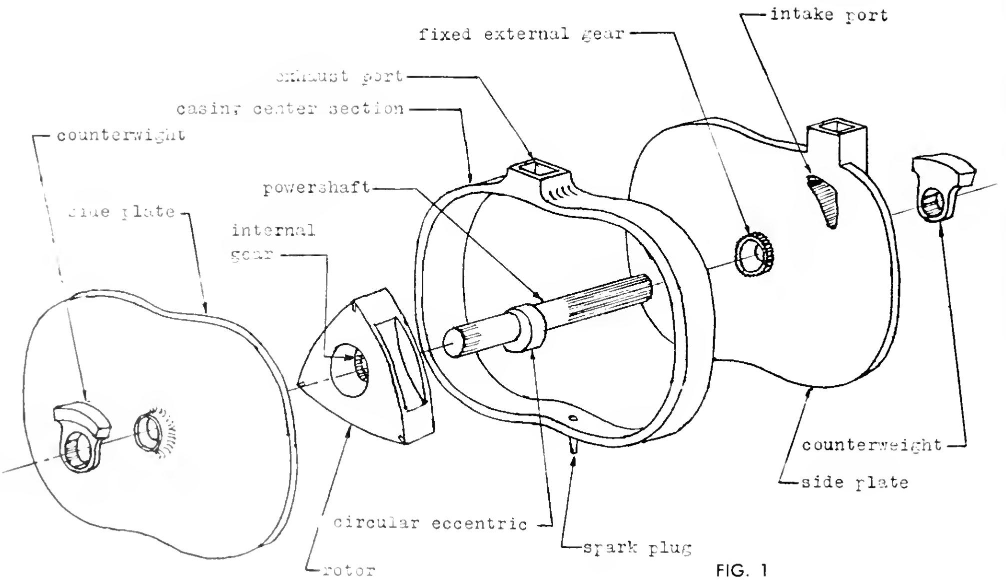


FIG. 1

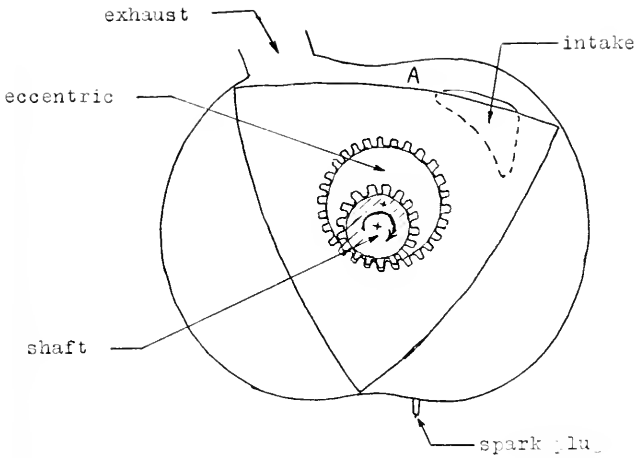


FIG. 2

around the fixed gear, and the chamber increases in volume. The intake port is uncovered so that fuel-air mixture is drawn into the chamber (Fig. 3). The port is covered again as the chamber nears maximum volume (Fig. 4). This much of the cycle has taken one complete revolution of the powershaft.

During the next 180° of shaft rotation, the mixture is compressed as the chamber goes through another minimum volume (Fig. 5). The fuel-air mixture is now ignited, and the expanding gases drive the rotor and shaft until the chamber has reached maximum volume again.

The tip of the rotor then passes over the exhaust port, allowing the burned gases to escape (Fig. 6). The chamber continues to decrease in volme exhausting the combustion products. The port is closed as the chamber reaches its minimum volume, completing the cycle, and the intake begins to open again.

This complete cycle has taken three revolutions of the powershaft. The other two sides of the rotor have been going through the same cycle in sequence. Thus a power impulse is provided during each powershaft revolution.

Performance

It is interesting to note that during the 360° of shaft rotation during which any chamber is being charged, the intake port is open about 315°, or 87% of the time. Such long duration of inhaling (and exhaling) periods permits very high rotational speeds. NSU's small experimental engine has been run up to 17,000 rpm which is comparable to the speed of gas turbine units. Successful reduction gearboxes have been developed for gas turbines, so these high speeds should pose no new problems.

NSU's basic engine has a swept volume[1] of fifteen cubic inches and delivers 43 hp at 8,000 rpm. The engine is said to have a very smooth flat power curve, so it is reasonable to assume approximately this power can be maintained up to twice this speed. It is reported to be so smooth in operation that a glass of water placed on the running engine does not have any ripples in its surface.

This fifteen cubic inch engine is about a foot in diameter and weighs 35 pounds. It is made of cast iron, but there is no reason why it could not be made of aluminum, reducing the weight to the neighborhood of 20 pounds. So even in cast iron form this engine has a very good power-to-weight ratio, 1.23 hp for each pound of engine weight.

In comparison, the Volkswagen engine displaces 66 cubic inches, develops 36 hp, and weighs 198 pounds. This represents a power-to-weight ratio of only .18 hp lb. A typical aircraft piston engine delivers about .5 hp lb., while the gas turbine will produce around 2 hp lb.

Curtiss - Wright Corporation, the American licensee, has exclusive worldwide rights to aircraft use of this amazing new engine. Work at Curtiss-Wright is centered around a unit with a swept volume of sixty cubic inches. The following performance figures have been published[2] concerning this unit:

Compression ratio: 7.5 to 1.
Power: 100 hp at 5500 rpm.
Torque: 100 ft-lb at 2000-6000rpm.
Max. rpm: 8000.
Weight: 100 lb.
Material: cast iron.
Specific fuel consumption: .47 lb hp-hr.

This is seen to correspond to a power-to-weight ratio of exactly 1.00 hp lb. The same engine with a peripheral intake port rather than a side port developed 124 hp at 6500 rpm, or 1.24 hp lb.

Another common basis for comparing engines is the power produced by each cubic inch of displacement. Automotive engineers have been striving for years to reach the magical figure of 1 hp cu in. A few modern, high-performance engines approach this figure.[3] For the NSU engine, this ratio is 2.87 hp cu. in. Curtiss-Wright's engine produces 1.67 and 2.05 hp cu in. for the side port and peripheral port models, respectively.

Design Features

The principal design problem to date has been that of sealing the combustion chamber. Spring-backed wipers at the vertices of the rotor have been reasonably satisfactory in sealing the joint between the rotor and the center section. Like the rings and valves in a piston engine, these seals will probably be the parts most prone to wear. The engine's designers are understandably reluctant to divulge details, consequently, even less is known about the method used to seal the sliding point between the rotor and the side plates.

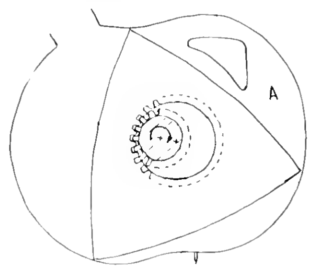


FIG. 3

While no specific claims are being made, durability is said to be above average. This seems reasonable in view of the extreme simplicity of the design. Curtiss-Wright has run its engine for 300 hours under load, then disassembled it for inspection and run it another 100 hours.

Means of extracting more power from a given size unit appear to be somewhat limited. The sides of the rotor can be bowed out farther to increase the compression ratio with a slight sacrifice in swept volume. Increasing the diameter of the eccentric for a given size rotor would increase the swept volme and require a more oval, narrower-waisted casing. This method also increases the distance between the axis of the shaft and that of the eccentric. The resultant of the combustion pressure forces on the rotor, would, therefore, act at a greater distance from the axis of the shaft. This should result in improved torque output. A limit is rapidly reached here, however, as the material left in the rotor soon becomes insufficient to hold itself together under the stress of centrifugal force.

A very obvious method of raising the power produced is simply to put another eccentric on the powershaft and provide a second rotor and casing. Again, practical complications will probably limit this "stacking" to four units.

This engine is also readily adaptable to supercharging and fuel injection. By combining all these techniques, a whole

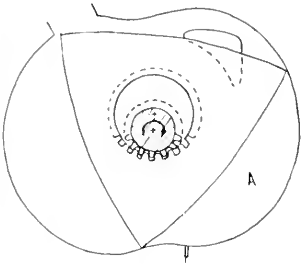


FIG. 4

family of engines covering a wide range of powers can be built around a single basic rotor-and-casing unit.

On the basis of power-to-weight ratio and space required, the Wankel engine is far out in front of the piston engine. A gas turbine may have a comparable, or slightly better, power-to-weight ratio, but its high operating temperatures and numerous blades lead to several very

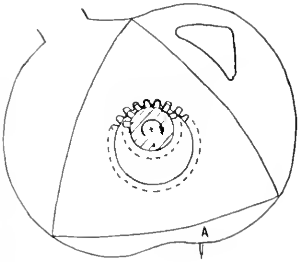


FIG. 5

difficult problems. Turbine blades have to retain their shape and strength at temperatures up to 1800 to 2000°F. Costly new metals had to be developed before turbines became practical.

On the other hand, the hottest parts of this new engine reach only 200 to 300°F, according to the Curtiss-Wright. This is well within the structural limit of aluminum which loses its strength at relatively low temperatures. A further problem might be that of chamber distortion due to combustion temperature and pressure. NSU's metalurgical research and Curtiss-Wright's endurance tests tend to disprove that this will be a serious problem, however.

Piston engines have a large number of parts that have to be machined to close tolerances; turbines have many blades that require even greater precision; but only the rotor and the inside of the casing need to be precision machined in the Wankel engine. Ordinary manufacturing tolerances are adequate for other components.

Neither NSU or Curtiss-Wright is quoting prices, but production versions of the engine are expected to be competitive with the engines they are designed to replace.

Low octane gasoline and even diesel oil are satisfactory fuels. With no hot spots, this engine is virtually immune to detonation. As mentioned before, conventional automotive or aircraft carburetors work very well. Throttle response is good due to the small rotating mass.

Conclusion

Much work still needs to be done, but this engine does hold much promise. Right now efforts are being concentrated on improving low-speed performance. Early use of the engine is expected to

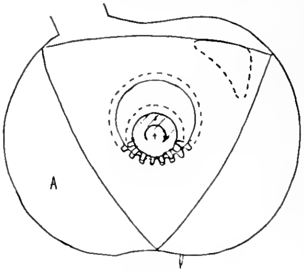


FIG. 6

be in applications that do not require great speed variation, such as industrial generators and pumps.

Curtiss-Wright is expected to have its industrial version in production by the end of the year, and NSU plans to start producing rotary combustion engines within two years.

Volkswagen is reportedly very interested in the project, so perhaps the first major change in the venerable old beetle car will be a switch to this revolutionary new power plant.

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The Dean's Page...


Russ Martin, C.E.

ENGINEERING

and

ATHLETICS

☆ ☆


Stan Yukevich, I.E.

By H. L. Wakeland

Associate Dean of Engineering

"He's An Engineer?" Occasionally you will hear this question asked during a college ball game when a player makes an exceptional play. The general public today has a great tendency to associate all college athletes with mental mediocrity, overgrown brawn and professionalism. Publicly aired cases of undesirable recruiting tactics and illegal support of college students has unfortunately slandered many high level, sincere and deserving college students that have had the gumption to participate in an athletic activity as well as their school work.

Engineering students at the University of Illinois have shown that it is possible to be a good engineering student and also participate in varsity sports. They have illustrated that engineering education and college athletics can be compatible and they certainly have not stood for mental or scholastic mediocrity.

Of the 260 students listed in varsity eligibility lists this year, 40 or 15.4% of them were enrolled in the College of Engineering. These 40 students had an average grade point of 3.67 which by College of Engineering standards ranks them above the all engineering student average of 3.54 and would place them in the upper 40% of the engineering classes. This grade point also places them considerably above the all University average of 3.49. Scholastically, the highest ranking athletes on these lists in cross country, golf, swimming, wrestling, and football were engineers. On the varsity football eligibility list five of the six top students scholastically were engineers. Following is a breakdown of the engineers participating in each major sport and their scholastic averages.

The high mental calibre of these students is also indicated by their average high school percentile rank which places them in the upper 20% of their high school classes.

It is estimated that approximately 75 engineers participated on freshmen teams this year. Of these 75 students—26 reported for football and 7 for basketball. Their composite record, shown below, is not as high as upperclassmen engineers on the varsity squads.

Of the 26 reporting for freshman football, 15 received freshman numerals and four of the seven reporting for basketball received numerals. Through competition, both scholastic and athletic, the number of engineers participating in sports is reduced from the freshman year to the senior year. Students unable to carry a sport along with their engineering studies are bluntly advised to drop sports participation. Though the freshman scholastic average of athletes is not high, it will improve as many drop athletic competition of their own volition or are advised to do so.

Each year there are engineering freshmen who distinguish themselves athletically. During the past four years engi-

(Continued on Page 12)

ENGINEERING STUDENTS LISTED ON VARSITY ELIGIBILITY LISTS

Varsity Sport	*Number of Engineers Participating*	*Scholastic Average*	*Average High School Percentile*
Football	11	3.63	84
Baseball	7	3.23	82
Tennis	4	4.08	94
Basketball	3	3.59	86
Cross Country	3	3.77	78
Fencing	3	3.91	94
Golf	2	4.01	81
Swimming	2	3.85	81
Track	2	3.50	97
Wrestling	2	3.72	93
Gymnastics	1	4.00	79
Total	40	3.67	81.5

ENGINEERS AND ATHLETICS . . .

(Continued from Page 10)

neers have received either three or four of the 11 Freshmen Scholastic Athletic Awards presented each year. These awards are given to the highest ranking freshman in each sport.

Any student considering an engineering education and also wanting to participate in a varsity sport should not be deceived by these statistics. This combination is not for the student who is lackadaisical or complacent or willing to do only enough to "get by." This combination of education and athletics, like any other combination of education and student activities is for the alert—the aggressive—the ambitious student who realizes that with achievement comes sacrifice. The College of Engineering is justly proud of the students who distinguish themselves scholastically and athletically as it is proud of engineers making similar achievements in other student activities. The college has always emphasized scholarship first and activities second and will continue to do so. It should be known though, that this group of athletes is not a stumbling, mediocre, overgrown group of athletes being subsidized to "stay" in school but rather are a high level group of students willing to work and having the ability and desire to prepare themselves for their future opportunities in engineering and society.

ENGINEERS REPORTING FOR FRESHMEN FOOTBALL AND BASKETBALL SQUADS

Freshman Sport	*Number Reporting*	*Scholastic Average*	*Average High School Percentile*
Football	26	3.34	79.6
Basketball	7	3.17	78.6
Combined averages		3.21	79.3

ENGINEERS RECEIVING FRESHMEN SCHOLASTIC ATHLETIC AWARDS

School Year 1955-56
Robert G. Breckenridge—Tennis
Ronald S. Nietupski—Football
Thomas H. Gabbard—Wrestling

School Year 1956-57
Alan E. Gosnell—Basketball
John A. Bronson—Football
Robert M. Lansford—Tennis
Stephen B. Lucas—Wrestling

School Year 1957-58
Lars E. Henriksen—Football
Howard W. Hill—Golf
Roger A. Sedjo—Wrestling

School Year 1958-59
Stanley F. Yukevich—Football
George M. Fisher—Baseball
Michael K. Yates—Swimming
John C. Zander—Wrestling

THE PROSPECTS OF POWER FROM SOLAR ENERGY

By Jack L. Diederick

The idea of harnessing the power of the sun has interested both fantasy writers and serious scientists for a long time. Their interest is easy to understand. In two days the earth receives in sunlight more energy than is stored in all the known reserves of fossil fuels. Time and again men have devised schemes for tapping sun-energy directly, usually by focusing to heat something, such as the boiler of a steam engine. None of these attempts to convert sunlight into power has ever achieved commercial success.

Yet all over the world there is a clamor for more energy. Scientists in many lands are making a concentrated effort toward finding ways of putting the sun's energy to work more directly, more efficiently, and on a much broader scale.

Our Sun As A Source

The sun is a huge incandescent ball kept at temperatures of a million degrees or more by atomic and nuclear reactions. Radiation spreads from the sun in all directions; the earth, 93,000,000 miles away, is in line to receive only a small fraction of this energy. Of the radiation directed to our planet, only a small proportion gets through our atmosphere and clouds and reaches the earth's surface. Half of the radiation received is in the form of visible light which can bring about chemical reactions; the other half of the energy, which cannot be seen and is chemically inactive, provides radiant heat. Both forms of the sun's energy, however, can be used for heating and for the operation of an engine.

Actually the sun is the source of all our conventional forms of energy: coal, oil, natural gas, wind, water—not to mention food. The sun showers on earth 30,000 times as much energy as we are now using for all purposes. Why then, one asks, is it so difficult to utilize this boundless source of energy more directly? The answer is that in most cases it is not difficult but is simply uneconomical. The patent offices of all nations are full of devices to harness sunshine. Many of these could produce useful power, but their output would be so small that it would not justify the cost of the equipment.

Although the amount of sunshine that falls on the earth is very large, it is also spread very thin. Thus any attempt to produce solar power means collecting the energy falling on a large area. This is the main reason for the high cost.

In areas of the world where fuel is expensive because it must be brought great distances, solar power units may be economical. An enterprising Italian company is actually marketing a small solar engine for such locations. In Central Australia where sunshine is plentiful and fuel must be brought by truck some 1,000 miles from the coast, the use of solar engines for pumping water and similar purposes is close to being economically sound.

In other parts of the world, there are two ways in which the present far from adequate methods can be improved: first, by raising the efficiency of the actual conversion of the solar energy, and secondly, by developing "collectors" which are not prohibitively expensive to manufacture on a large scale.

At present there are several devices which have been developed for the transformation of solar energies into useful forms. Most are in the embryonic stages, however, and are far from perfected. With certain refinements these devices might well become extremely useful and valuable to mankind.

Photo-cell Possibilities

In recent years there has been hopeful progress in exploiting the possibilities of the photo-electric cell. This device is fairly familiar to us today in the form of the photographic light meter, the automatic door opener, and many other similar uses. The photo-electric cell transforms light energy directly into electrical energy; however, it can deliver only about one half of one per cent of the energy it absorbs.

Engineers and scientists have thought that this conversion efficiency is much too low to be of any practical value in making the photoelectric cell of any commercial worth for the production of power. But now the Bell Telephone Laboratories have developed a new photoelectric cell—or solar battery, as it is called—which is twenty times more efficient than the usual cell. This new cell is capable of deriving electric power from the sunlight at a rate of ninety watts per square yard of collector surface.

A photoelectric cell is an extension of some of the principles involved in transistors. Basically it works like this: The element silicon, which has four valence electrons and is very stable, is combined with small amounts of the elements arsenic and boron, having five and three valence electrons respectively. These two added elements, when absorbed into the crystalline structure of the silicon, create an electrically unstable situation. The arsenic attaches its four valence electrons to the neighboring silicon crystal but has one unattached electron left over. The boron does just the opposite: being short one valence electron, it attaches itself squarely to the silicon atoms.

An analogy can be drawn between this situation and a bridge party where there is not the correct number of players to fill all the tables. For example, if all the tables were filled except one which had three players instead of four, there would be one vacancy. If one "dummy" player were to move from one of the other tables to fill the vacancy, he would leave a vacancy at his table.

This has a dual effect—not only has the player moved positions but so has the vacancy: i.e., the player who moved is at a different table now and so is the unoccupied chair. Therefore, in this "unstable" bridge situation there is a constant movement of both players and of vacancies.

The same situation exists in the silicon-arsenic-boron crystalline structure. The extra "player" is the extra valence electron from the arsenic atom and the "vacancy" is that left by the lack of a fourth boron valence electron. As the "players" or electrons are negatively charged, the "vacancies" must then have the effect of a positive charge. There

there exists a state of unstable equilibrium.

When light falls upon this alloy and the photons of light energy are absorbed, the equilibrium is disturbed. Electrons and vacancies begin to flow and to set up an electrical potential within the substance which, if properly tapped, will produce an electric current. Each photon of light absorbed creates an electron-vacancy pair. Not all wavelengths of light have the energy to dislodge electrons, of course, and some wavelengths have too much energy for efficient use. About 45% of the energy in the total spectrum of the sunlight can be trapped by such a photoelectric solar battery. Because of various other losses in the construction of such a battery, however, it can't convert more than 29% of the net sunlight energy reaching it.

The question that now comes to mind is: will its efficiency of conversion be great enough to make this solar battery commercially applicable? For example, can a rural housekeeper now install one of these systems and then ignore or quit his commercial electricity supply completely? To do this he would have to provide for some means to store the energy converted during the day so that it would be available for use at night. This would necessitate storage batteries of high enough capacity to store about two weeks supply of power in preparation for a stretch of cloudy weather.

All in all, this would require about one ton of storage batteries costing approximately $500 and yearly maintenance charges of nearly $1,000. This example shows that solar energy is definitely not "free" power and that large scale commercial applications of photoelectric power are not everywhere feasible right now. However, it is not safe to assume that the solar battery will be of no use with further development.

Communications

In fact, it appears that there are going to be many applications in the field of communications for the photoelectric source of power. Communications, as a matter of fact, are ideally suited for the solar battery: small power demand, often in remote inaccessible spots where there is no available power from other lines. In these uses the solar battery has one great advantage over the dry cell: the solar units will never run down because it is recharged and fueled by the sun.

The actual power consumed by each telephone is only about 1/20 of a watt. If a solar battery is used in conjunction with long-lived storage batteries, it can actuate a telephone installation for years without attention. The Southern Bell Telephone Company in Americus, Georgia, put into operation in 1955 the first successful commercial solar battery. This converts the sun's energy directly and efficiently into substantial amounts of electricity. The Bell System contends that this device is fifteen times as efficient as the best previous solar energy converters.

The unit is now being used on several lines where amplifiers are needed to maintain the strength of the signal, but where there are no power sources within a reasonable distance. On clear and even somewhat overcast days the collector draws enough power for its operation from the sunlight and diverts the rest of the energy to a storage battery which supplies the power during the hours of darkness. The whole unit generates enough power for the effective continuous operation of the system at 10 watts, supplying eight phones on a rural line.

Solar Furnaces

Another interesting adaptation of solar power is the solar furnace. In Mont-Louis, France, in the Pyrenees Mountains, is located a factory which manufactures refractory furnace linings. Very high temperatures are necessary for this process, as the refractory materials have a very high melting point. Heat is usually obtained from electric arc furnaces, but this particular factory has been using solar furnaces at a 25% lower cost than for the electric arc method.

The apparatus consists of two large mirrors to gather and concentrate the rays of the sun. A flat mirror is mounted on a motor-powered swivel so as always to direct the rays into the parabolic reflector. This steps up the effective energy falling on the surface of the earth by a factor of 20,000, producing temperatures in excess of 5400°F (iron melts at 2800°F). Its equivalent power is 75 kilowatts; comparable electric arc furnaces would require a generator driven by a 1000 HP motor.

Domestic Use

Another very important potential use of solar power is in the field of domestic heating and air-conditioning units. As a matter of fact the Federal Government expects a market for 13 million solar heating plants by 1975. In New York there are already two houses which have had operative solar heating systems since 1949, both working quite satisfactorily.

One method is to heat air by the rays in glass collectors outside the house. The air is then circulated to the heat storage area where it is absorbed in bins of special salts. Then when heat is needed in the home, a combined radiant and hot air heating system transfers the energy from the salt bins to the living areas. Usually a standard commercial heating unit is also provided as an auxiliary supply in case of many cloudy days or excessive heat demands during the early morning hours. Another method of heat storage sometimes used instead of salts is a very large water tank in the basement which will absorb and retain heat. There is still some doubt, however, as to whether a pure solar heating system will be completely self-sufficient in northern latitudes.

Sometimes, to reduce over-all costs, solar heating and an air-conditioning system are combined. The air-conditioning function is just the opposite of the heating function. Hot air is pumped out of the living area during the day, stored in the heat storage area, and the stored heat expelled to the outside at night. A system like this is actually in operation today.

Evaluation

To summarize, it may be said that using solar energy to supply low-temperature heat is already economical in many circumstances, and a large increase in the number of houses heated and cooled by solar energy can be expected in the next few years. The production of power from the sun by means of a heat engine is still uneconomical in most areas. Advances in methods of collector design show promise of improving the economics to a point at which solar energy will be worth while in many areas where cheap conventional fuels are not available. Even today it is economical in a few extreme cases. Among the non-thermal processes, photosynthesis may one day offer another reasonable method of harnessing sunshine. Large-scale power operations by the photoelectric process will be significant only if improved methods are developed which will reduce the cost of the apparatus significantly.

Efforts in solar research have thus far been limited, and problems are many. No new era of solar energy properties is just around the corner. Years of research and development are necessary. But the basic concepts are within our grasp and without much doubt can be brought to realization in the forseeable future.

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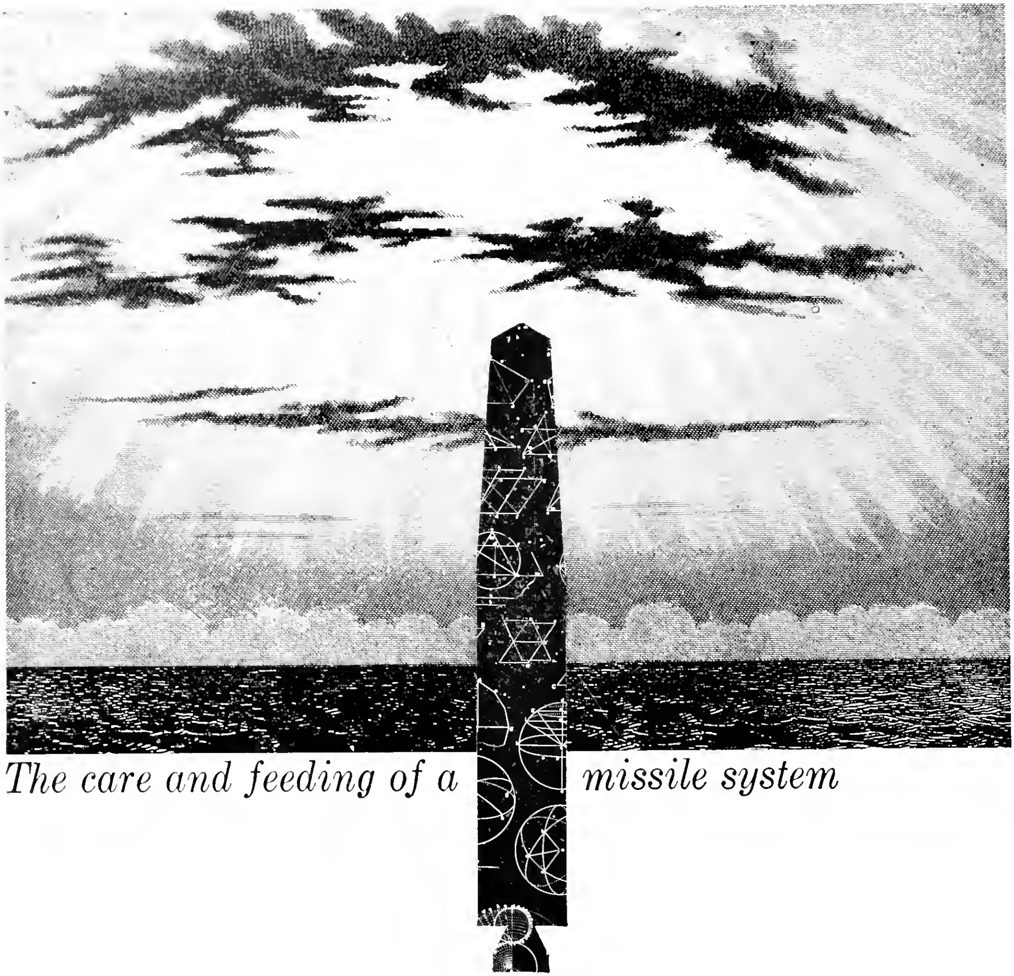

The care and feeding of a missile system

It takes more than pressing a button to send a giant rocket on its way. Actually, almost as many man-hours go into the design and construction of the support equipment as into the missile itself. A leading factor in the reliability of Douglas missile systems is the company's practice of including all the necessary ground handling units, plus detailed procedures for system utilization and crew training. This complete job allows Douglas missiles like THOR, Nike HERCULES, Nike AJAX and others to move quickly from test to operational status and perform with outstanding dependability. Douglas is seeking qualified engineers and scientists for the design of missiles, space systems and their supporting equipment. Write to C. C. LaVene, Box 600-M, Douglas Aircraft Company, Santa Monica, California.

Alfred J. Carah, Chief Design Engineer, discusses the ground installation requirements for a series of THOR-boosted space probes with Donald W. Douglas, Jr., President of **DOUGLAS**

MISSILE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB® ■ GROUND SUPPORT EQUIPMENT

Automation and Applications of Transfer Machines

By Max E. Zuigley

Automation is an integration of mechanical, hydraulic, pneumatic, electrical, and electronic devices to perform and control operations of production without constant human intervention. Although the word itself is relatively new, automation is the gradual evolution and application of tremendous advances that have been made in the technology of production. These advances, in turn, have been dependent to a great degree on the developments within the last few years in the field of electronics.

Automation is, therefore, an extension of the concepts of the Industrial Revolution. These were basically the substitution of machine power for manpower, from which came Eli Whitney's idea of interchangeable parts, and the concepts of mass production lines developed by Henry Ford. To these notions have been added that of incorporating into machines the thinking processes of man. Then, just as mechanization has largely eliminated the need for man's physical power, automation will eliminate the need for the mental control tasks that were previously associated with this power.

This is not to imply that all of man's work is finished. It is rather the beginning of an era in which the duties of workers will be on a much higher plane than before. It marks the beginning of an era in which the formulation of ideas and design and maintenance of machines will be the major responsibilities, tasks of the people in our industrial force.

Mechanization and automatic machinery have been available for years. Where, then, is the dividing line between the employment of manually controlled automatic machinery and automation? This dividing line lies in the methods employed to control the machines and in the materials handling aspect of mechanized operations.

In mechanized production operations, the machines that are used must be individually set up for the operations to be performed, and must be controlled by an operator. The inspection of the finished product as it comes from these machines must be carried out manually, even though the person engaged in this inspection may have the use of very advanced techniques. In this process, when the finished material is not within the

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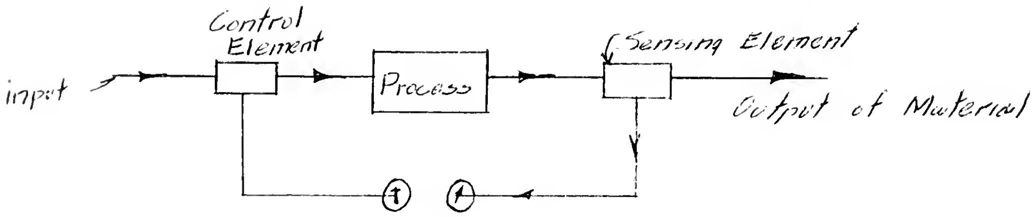
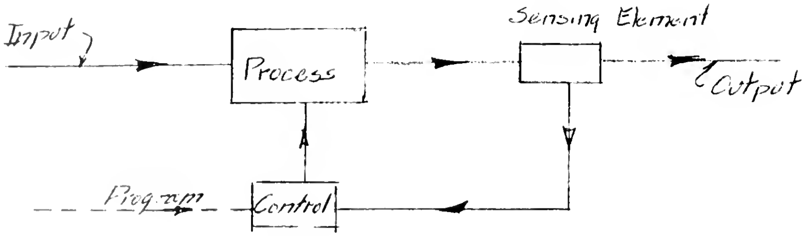
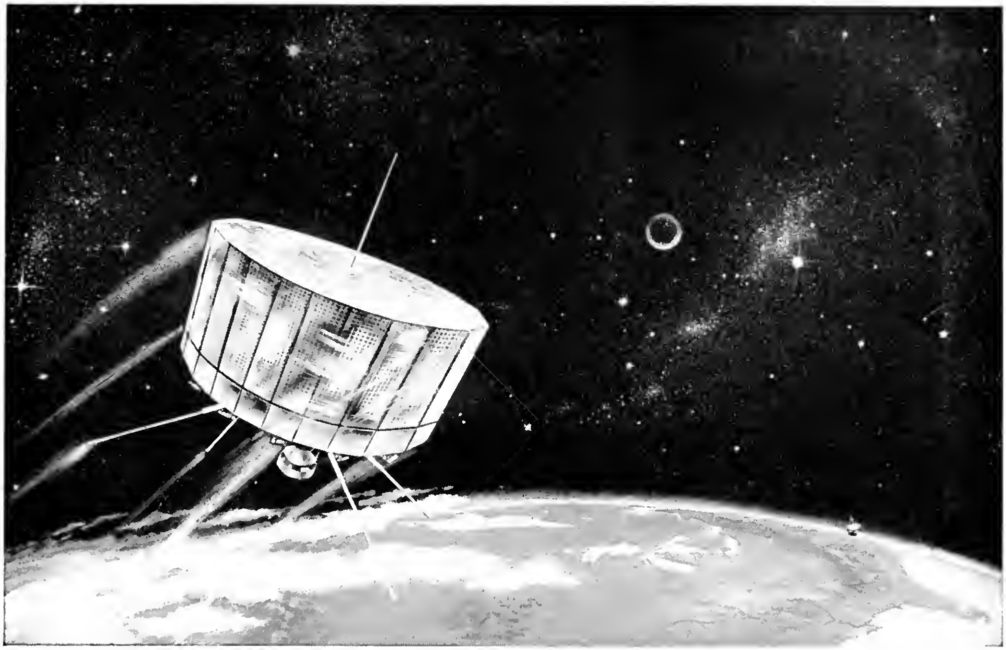


Open - Loop Control



Closed - Loop Control



TIROS satellite orbiting towards ground station in Eastern United States.

RCA-BUILT "TIROS" SATELLITE REPORTS WORLD'S WEATHER FROM OUTER SPACE

As you read these lines, the most remarkable "weather reporter" the world has ever known hurtles around our globe many times a day, hundreds of miles up in outer space.

The TIROS satellite is an orbiting television system. Its mission is to televise cloud formations within a belt several thousand miles wide around the earth and transmit a series of pictures back to special ground stations. Weather forecasters can then locate storms in the making . . . to help make tomorrow's weather forecast more accurate than ever.

The success of experimental Project TIROS opens the door to a new era in weather forecasting—with benefits to people of all lands. This experiment may lead to advanced weather satellites which can provide weathermen with hour-by-hour reports of cloud cover prevailing over the entire world. Weather forecasts, based on these observations, may then give ample time to prepare for floods, hurricanes, tornadoes, typhoons and blizzards—time which can be used to minimize damage and save lives.

Many extremely "sophisticated" techniques and devices were required to make *Project TIROS* a success—two lightweight satellite television cameras, an infra-red horizon-locating system, complex receiving and transmitting equipment, and a solar power supply that collects its energy from the sun itself. In addition to the design and development of the actual satellite, scientists and engineers at RCA's "Space Center" were responsible for the development and construction of a vast array of equipment for the earth-based data processing and command stations.

Project TIROS was sponsored by the National Aeronautics and Space Administration. The satellite payload and ground station equipment were developed and built by the Astro-Electronic Products Division of RCA, under the technical direction of the U. S. Army Signal Research and Development Laboratory.

The same electronic skills which made possible the success of man's most advanced weather satellite are embodied in all RCA products—RCA Victor black & white and color television sets, radio and high-fidelity systems enjoyed in millions of American homes.

RCA

THE MOST TRUSTED NAME IN ELECTRONICS

RADIO CORPORATION OF AMERICA

(Continued from Page 18)

limits of the designated tolerances, the operation of the machine must be adjusted to correct the deviation.

In the use of automatic machinery which has automatic testing devices as an integral part of the processing, faulty parts may also be rejected by the testing device and the operation halted, or some sort of warning device may be used to make the operator aware that adjustment is necessary.

Open vs. Closed Loops

The two systems above, which comprise the major portion of present production facilities, are known as open-loop systems. Automation employs what is known as a closed-loop system, in which the input to the process and the process itself are controlled by the results of testing the output. The figure on page 18 shows the basic principles of the open and closed-loop systems.

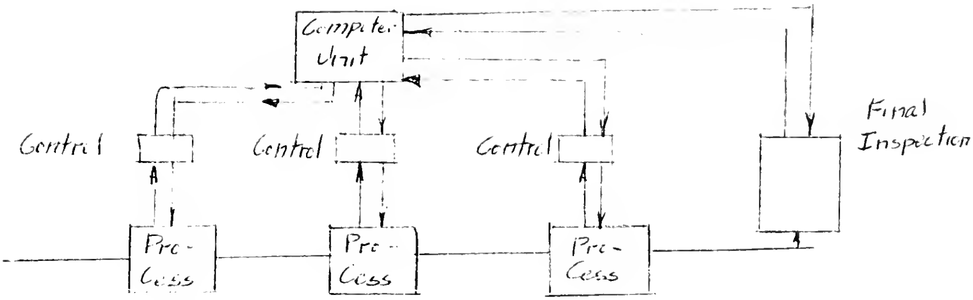
The simplest examples of the closed-loop system are the flyball governor and the thermostat. As the speed of the shaft on which the governor is mounted is increased, the weights are lifted by centrifugal force, and through the proper linkage these weights activate a valve which increases or decreases the amount of steam entering the steam engine. In the case of the thermostat, a thermocouple is used to activate the switch of the heating unit. In each of these cases, however, it can be seen that the output of the system directly controls the input, and these are therefore closed-loop systems.

In the application of automation to production processes, several combinations of the factors of production are possible, but all employ the same basic principles. Machines which perform multiple operations may be of several basic types, the choice of which depends upon considerations of space, relative position in the entire production operation, and economy. These machines which load, move the material through different phases of the operation, perform the different operations, carry on inspection, and unload the finished product are known as transfer machines.

Transfer Machines

Most transfer machines are controlled by computer, either analog or digital. Analog computers are so named because they set up physical models in order to solve problems. In the electronic analog computers these models are in the form of voltages. The chief advantage of the analog computer is the fact that the device need be no more complicated than the problem or model that it deals with. Another advantage is the fact that the analog computer gives continuous and instantaneous solutions to the problems presented.

The digital computer is a much more



complicated machine than the analog, but is capable of solving much more complex problems. The name is derived from the fact that these machines are designed to solve problems by performing mathematical operations on the data supplied. Because of this, there is a time lapse between the feeding of the information to the machine and the solution of the problem. With increasing refinements in the design of this type of machine, howver, the time for the operations is being measured in milliseconds, and in very advanced machines in microseconds, so that their use is becoming more and more widespread.

Machine-Tool Uses

In the use of computers to control machines, the sequence of operations to be performed is recorded on punched or magnetic tape. These instructions are read into the computer, and are stored in its memory circuits. The computer then controls the operations of the machine by referring to these instructions in the proper sequence.

In most transfer machines electronic inspection devices relay any deviations from prescribed conditions to the controlling computer, which in turn makes adjustments to the operation, correcting for the deviations. The above sketch shows a schematic diagram of a sequence of operations controlled in this manner.

Transfer machines with this type of control may be of two types, unitized or sectionized. The unitized machine operates as a complete unit, and in order to shut down one phase of the operation the entire machine must be stopped. In the sectionized machine, groups of related operations are built in different sections, so that one section can be inoperative without affecting the others. In these machines, reserve banks of the material in process are kept on hand for each section, so that if a section is shut down the sections performing the subsequent operations can draw material from the reserves and total production will not be affected.

In connection with the sectionized machine a device called a toolorometer is used. This is an automatic tool programming method whereby a memory device keeps track of the number of operations that each tool has performed. At a predetermined number of operations the toolorometer then automatically stops the section in which the tool is located, to allow for tool replacement. At the same time other tools in the section which are close to their change times can be replaced, thus eliminating the need for further stoppages. Down time due to tool changing and breakage is a big factor in limiting the number of operations that a transfer machine may be designed for, and therefore such controls are very important.

In the materials-handling phase of the transfer-machines operation the material to be processed moves through the machine on pallets or on some sort of conveyor. If the pallet system is used, the material is clamped into blocks when it enters the machine. The motion of these types of machine is intermittent, as the movement must stop while the operations are being performed. In some machines movement is constant the material moves through the machine on conveyors, and is pushed into the heads of the various tools by loading and unloading devices.

The use of transfer machines is seemingly unlimited. Our industry has just scratched the surface in adapting these machines to our production. As an example of some of the uses of transfer machines: in 1956 the Plymouth V-8 engine line consisted of one transfer machine 560 feet long, and two cylinder head assembly lines 126 feet long. The three lines were coordinated and timed to produce 150 finished engines per hour.

Ford V-8 engine blocks were produced by a transfer machine 350 feet long which performed 555 separate operations and turned out 100 parts an hour. The Russians have a plant where aluminum ingots are taken in one end and at the other end aluminum pistons are sorted into four sizes, inspected, greased, wrapped in paper, and packed in boxes of six. All operations are carried out automatically, and this plant produces 3500 pistons in a twenty-four hour day with a work force of only nine men per shift.

Other Applications

Automation is not limited to the use of transfer machines in the industries mentioned, but rather to every phase of business. In the fields of data processing and the flow processes in the chemical industry, completely automatic operations are being utilized. In transportation railroads are practicing automatic handling of cars in yards from central control computers.

With its implications of less work to be done, automation has, for some time, been a controversial subject for discussion between labor and management. It is being used more and more, however, and just as mechanization and mass production methods enabled us to raise our standard of living constantly and at the same time have more leisure, so automation will further this trend.

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"Doc, you've got to help me. Last night I drank two quarts of stolen gold paint."

"Good Heavens! How do you feel now?"

"Guilty."

INERTIAL GUIDANCE

By M. Staloff

In this the so called age of missiles, guidance systems of various types are of the utmost importance. It goes without saying that a missle doesn't consist solely of a power plant and a warhead or whatever else its payload may be. There must be some way of guiding the machine to its destination. This is the sole function and reason for being of the guidance system. The work being done in this field is an important part of military ordnance and civilian space projects.

There are various basic types of guidance systems in use and in development. Some of these are: the beam rider system, the homing system, the command system, the baseline system and the inertial guidance system. The first three mentioned are used primarily for moving target applications and depend on some sort of response to stimuli either originating from or reflected from the moving target by a ground radar station. The last two systems baseline and inertial, are used for fixed targets. Radar again plays the major role in the baseline system. The three moving target systems and the baseline then all depend on radar. The big disadvantage with this is that these systems are susceptible to enemy jamming. The remaining system, the inertial space guidance system, is a completely self contained, automatic and jamproof means of guiding a missile to its target or an airplane to its destination.

The inertial guidance system shall be discussed here under three main topics: the basic idea, refinement to the basic system, and a brief description of some of the less familiar components.

The inertial guidance system carries within itself all the information necessary to guide the machine to its target or destination, that is, the location of the target and an internal means for sensing deviations from an arbitrary path to the target. The inertial navigation system is essentially a form of dead reckoning device. This means that the geographic position of the starting point and destination must be known and set into the equipment. The system is then capable of determining and supplying the following information: a) geographic position of the vehicle at any time, b) ground velocity and track, c) the distance traveled and distance remaining to the destination, d) the direction to destination, e) attitude of the machine. This information is utilized by computers to furnish an output, finally, to serve motors which control the vehicle. The major components needed to accomplish this job are as follows:

1) Accelerometers. These are the basic sensing elements.

2) Integrators. Mechanical or electronic devices which are capable of performing integrations.

3) Gyro stabilized platform. This maintains the accelerometers horizontal and isolates them from aircraft attitude changes.

4) Spherical trigonometric computer. Converts distance traveled to corresponding changes in latitude and longitude for the particular latitude. This is necessary due to the fact that the distance between meridians of longitude decreases with increasing latitude.

The basic theory underlying inertial space navigation is straightforward and appealing in its simplicity. A first and second integration of acceleration yields respectively velocity and distance. If suitable means are employed for sensing the acceleration, performing the required integrations, and processing this data into useful information, then the job of navigation can be accomplished.

Shown in Fig. 1 is a block diagram of the basic system. Accelerometers are mounted on a gyro stabilized platform which isolates the accelerometers from aircraft motions such as pitch, roll and yaw. The accelerometers produce an output, usually electrical, which is proportional to the acceleration. This output is fed into an integrator which yields distance traveled. This output is then fed into the spherical trigonometric computer which corrects the distance and its output is then used to drive servo motors.

The basic system, as has been mentioned, is simplicity itself. The real work in making a practical, workable system comes in in problems of corrections and accuracy. An example of the kind of accuracy needed is indicated by the fact that Minneapolis-Honeywell chose the site of their new plant, which is engaged exclusively in this work, on the Florida west coast because the ground foundation is sand. A sand foundation offers a very stable platform in that it absorbs and does not transmit earth disturbances such as earth quake waves, which may be not at all discernable except to a very sensitive seismograph. However even disturbances as minute as these cannot be tolerated in the manufacture of some of the delicate components.

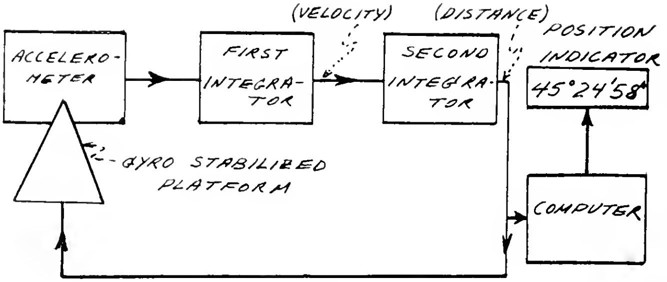


FIG. 1

One major fault with the basic system lies in the fact that the gyros stabilize the platform housing the accelerometers in space and cannot stabilize with respect to an earth reference such as horizontal. It is necessary to maintain the accelerometers absolutely horizontal because if they were allowed to experience and respond to a component of acceleration due to gravity, they would have no way of distinguishing gravity from an acceleration of the craft, and would produce erroneous outputs.

This problem is solved in every inertial guidance system by the utilization of a physical principle investigated in 1923 by a German professor of applied mechanics, Dr. Maxmilian Schuler. Dr. Schuler put forth the concept of the '84 Minute Pendulum'. Briefly the idea involved here is as follows: An ordinary pendulum is, of course, not subject to vertical accelerations when in the equilibrium position. When subjected to horizontal accelerations of its point of suspension, however, it is displaced from equilibrium. A change in direction of motion even without a change in speed can cause the pendulum to deflect as this also constitutes an acceleration. This is more or less intuitively obvious as one can imagine the effects on a pendulum suspended in a moving train which is either undergoing a change in speed or a change in direction. In either case it would deflect. It can be shown that the pendulum would be unaffected by spurious accelerations under one condition; namely that the length of the pendulum be equal to the radius of the earth! Underthis condition the point of suspension of the bob could be moved about without any deflection of the bob from the equilibrium position. The reason for this is that the pendulum's center of gravity is at the center of the earth and hence remains at rest. This is a very interesting result but certainly, it seems of only academic value as it would be a bit inconvenient to carry around such a pendulum. The value of all this lies in the fact that any pendulum system which has a natural period of oscillation equal to this so called earth pendulum, would exhibit this same independence of linear accelerations. From the equation for the period of a penulum, $T = 2\pi\sqrt{L/G}$, the period is found to be approximately 84 minutes—thus the name 84 minute pendulum.

These results are all very interesting but how do they help us in our inertial guidance problem? Previously it was mentioned that the trouble with our basic system was that it could not reference the accelerometers with respect to the earth's surface, and that this was necessary in order to isolate them from the effects of gravity. The significance of Schuler's 84 minute pendulum is that it is, essentially, a vertical determining device. The refined inertial system operates in the following manner:

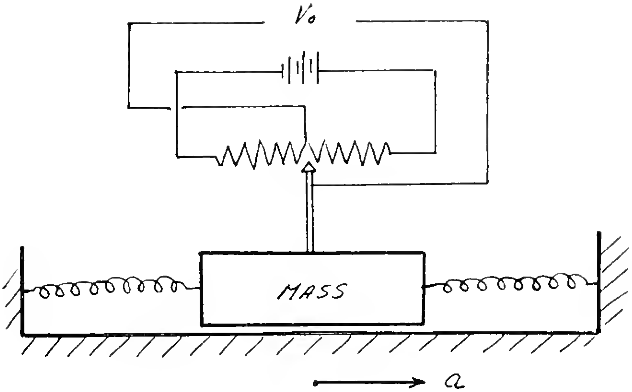


FIG. 3

The accelerometer platform is mounted on the gyro stabilized platform on an axis about which it can be rotated. As the vehicle moves around the earth, a signal from the second integrator output (distance) is fed back to servo motors which rotate the accelerometer platform with respect to the gyro stabilized platform, a number of degrees identical with the angular displacement of the vehicle. When this signal is fed back to the accelerometer platform, the whole combination of gyro stabilized platform, accelerometers, integrators, and servos acts as an undamped pendulum. If this system is constructed to have the 84 minute period, then it will be vertical seeking and continue to maintain its position horizontal to the local vertical.

The building blocks of which the complete inertial guidance system is composed are, for the most part, standard aircraft components which have found previous applications in instrumentation and autopilots. In cluded in this category are such items as gyros and servo mechanisms. Two devices which may not be as familiar and therefore deserve some mention are the accelerometer and the integrator.

The accelerometer whose function, as has been previously explained, is to sense acceleration and deliver an output proportional to this acceleration—is essentially a simple device.

One form of accelerometer, as illustrated in the sketch, might be a mass supported on a horizontal platform. Two end springs are attached which lie along an axis in the direction of the component of acceleration it is desired to measure. Attached to the mass is a potentiometer slide which governs an output voltage. As the unit is subjected to a linear acceleration, the mass will be displaced to a new equilibrium position until the acceleration stops at which time the mass will be returned to the null position by the action of the springs. If the potentiometer is linearly wound, the output voltage will be proportional to the displacement of the mass which is in turn proportional to the displacement of the mass which is in turn proportional to the acceleration. This form of accelerometer is limited in the range of accelerations to which it can accurately respond by such factors as friction and spring constant. In mis-

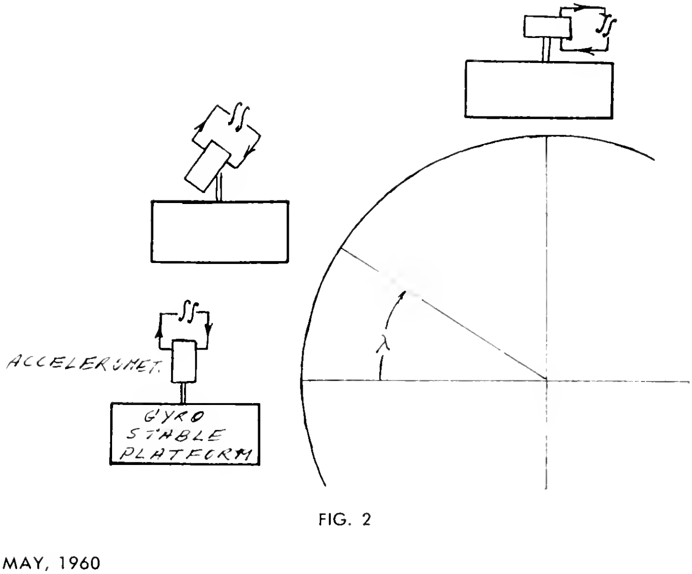


FIG. 2

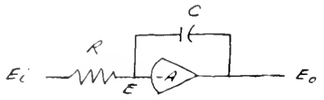
sile applications the required range of accelerations may be as high as 100,000:1.

A much better accelerometer can be made employing an 'electrical spring.' This form is shown in the following sketch.

Under the influence of a linear acceleration, the pendulum, which is attached to the motor case is deflected. If a voltage is then applied to the motor armature causing it to rotate in the proper direction, a torque opposing the pendulum motion is developed. A voltage just large enough to produce a torque which exactly cancels the torque due to the pendulum is applied and the pendulum maintains its equilibrium position. The torque produced by the armature rotation is proportional to the applied voltage and hence the applied voltage will be proportional to the acceleration which caused the pendulum to deflect. This type of accelerometer has no springs to be concerned with and the bearings can be made relatively frictionless.

There are various devices which are capable of performing the mathematical operation of integration. They can be either mechanical or electrical in nature. The most commonly used are electrical or electronic devices. The one in particular I shall describe is the type used in electronic analog computers.

This integrator is simply a high gain, direct - coupled, operational amplifier with a capacitor in a feedback loop. To see how this amplifier can integrate it is necessary to look at the equations that can be written. In the following circuit it is assumed that the amplifier draws on current at its input grid.



It is seen, then that the output of the integrator is approximately equal to the negative integral, with respect to time, of the input. The approximation which depends on the gain of the amplifier, is a good one as typical gains for this type of amplifier are 10[illegible] to 10[illegible].

Another possible integrating device is the ordinary a.c. tachometer generator. The tach generator is caused to rotate at such a speed that it produces a voltage which cancels out the signal voltage which it is required to integrate. The speed of armature rotation is then proportional to the signal voltage and the total number of armature revolutions over a period of time is proportional to the integral of the signal voltage.

In conclusion, then, it has been attempted to present a clear workable picture of the inertial guidance system by means of three main topics. First a presentation of the basic theory, second discussion of refinement of the basic unit to convert it into a workable one, and third a brief description of two of the major components. It is hoped that the subject has been presented to the reader in a clear and understandable manner.

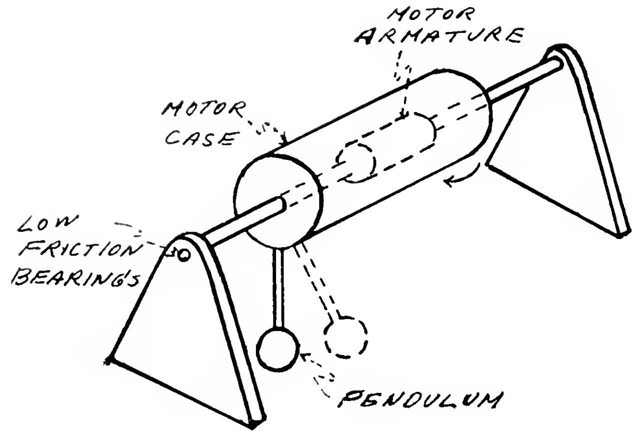


FIG. 4

Using operator notation: $S = j\omega = d/dt$

$$E\left(\frac{1}{R} + SC\right) - E_i\left(\frac{1}{R}\right) - E_o\,(SC) = 0$$

$$E_o = -AE \quad , \quad E = -\frac{E_o}{A}$$

$$-\frac{E_o}{A}\left(\frac{1}{R} + SC\right) - E_i\left(\frac{1}{R}\right) - E_o\,(SC) = 0$$

$$E_o = -\left[\frac{1/R}{\frac{1}{AR} + \frac{SC}{A} + SC}\right] E_i \qquad A \ggg 1$$

$$E_o \cong -\frac{1}{SCR}\,E_i \quad \text{Take : } R = 1\times10^{6}\,\Omega$$

$$C = 1\times10^{-6}\,f$$

$$E_o \cong -\frac{1}{S}\,E_i = -\int E_i\,dt$$

Equations for circuit shown in first column

VALVE MECHANISM

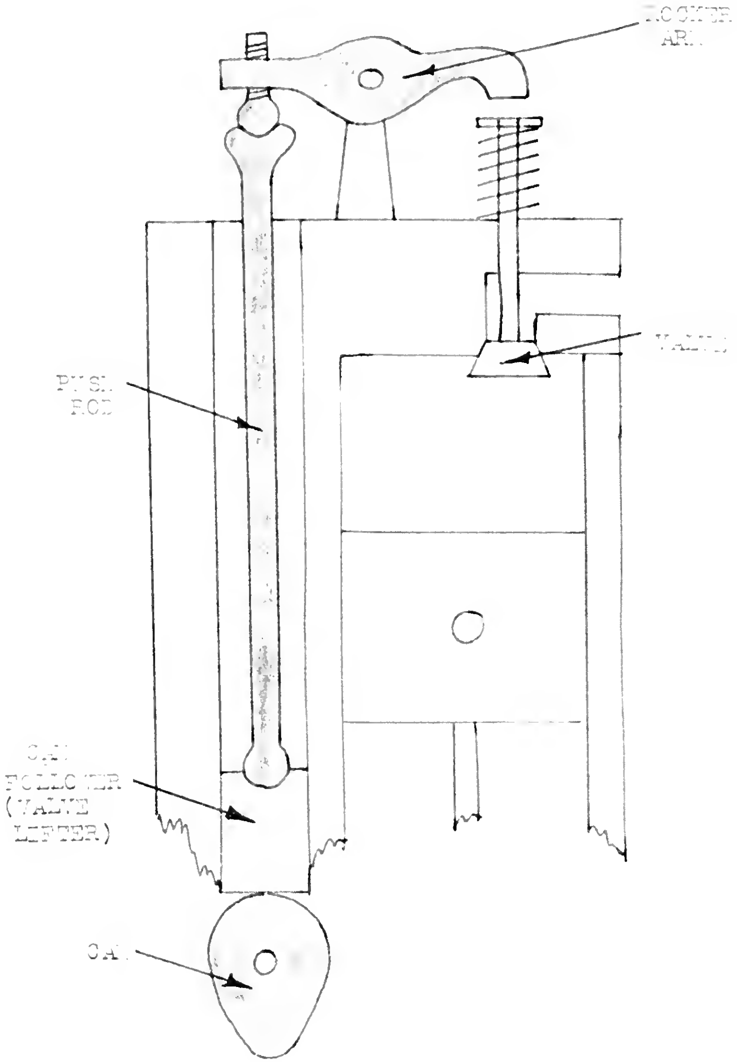


FIG. 1

The Why and the How of . . .

HYDRAULIC VALVE LIFTERS

By J. R. Marchetti

In order to realize the need for such a device as the hydraulic valve lifter, the operation of the overhead valve automobile engine before this innovation was introduced must be considered. The following diagram (figure 1) illustrates a commonly employed automotive valving mechanism in which each valve is operated by a rotating cam which imparts linear motion to a follower. The follower or "valve lifter" then actuates a push rod and rocker arm which in turn operates the valve.

The effectiveness of this type system has been well proven. It is used in boats, planes, trains, and nearly every other machine that employs an overhead valve internal combustion engine.

However, this valving mechanism is no longer popular in American automobiles because of its inherent ability to produce noise. And why is this so? Simply because of the fact that an unrestrained metal part tends to expand as it is heated. This means that in order for the mechanism to function properly at engine operating temperatures a little "slack" must be allowed to exist in the system when it is cold. It is this "slack" or "lash," as it is termed, that results in the undesirable noise.

If, however, the exact amount of required slack could be determined and employed, the engine would produce this noise only when cold and it would be more severe under this condition. But due to mass production requirements, this is not practicable as the proper amount of lash may differ with each engine.

As a result of this, the manufacturer must include a small additional value of lash in order to be certain that each valve train contains the necessary amount. For if sufficient lash were not present in the system when cold, the valves would be prevented from closing completely at operating temperature, and the undesirable result of this condition is an extremely short valve life.

But how does all this affect the automobile owner? Most probably it annoys him extremely upon starting his engine and may continue to do so considerably as he drives down the highway, for each time a cam pushes open a valve this lash is taken up with a resounding "click." The combined effect of a dozen or more valve trains all clicking continuously may well be considered as a nuisance.

This "tappet noise," as it is commonly referred to, was for many years either ignored or accepted as a necessary evil by the majority of automobile owners. But the consumer who purchased the more expensive and luxurious automobile demanded that it operate more quietly. And so it was in this type of automobile there first appeared an ingenious gadget which at last did away with "tappet noise."

This clever little device replaced the solid cam follower and completely eliminated valve lash and noise at all engine temperatures. As its operation was based upon the incompressibility of a liquid, it was labeled the "hydraulic valve lifter" although it did not actuate the valves hydraulically in the usual sense of the word.

It did, however, open the valves quiet-

(Continued on Page 29)

HYDRAULIC VALVE LIFTER

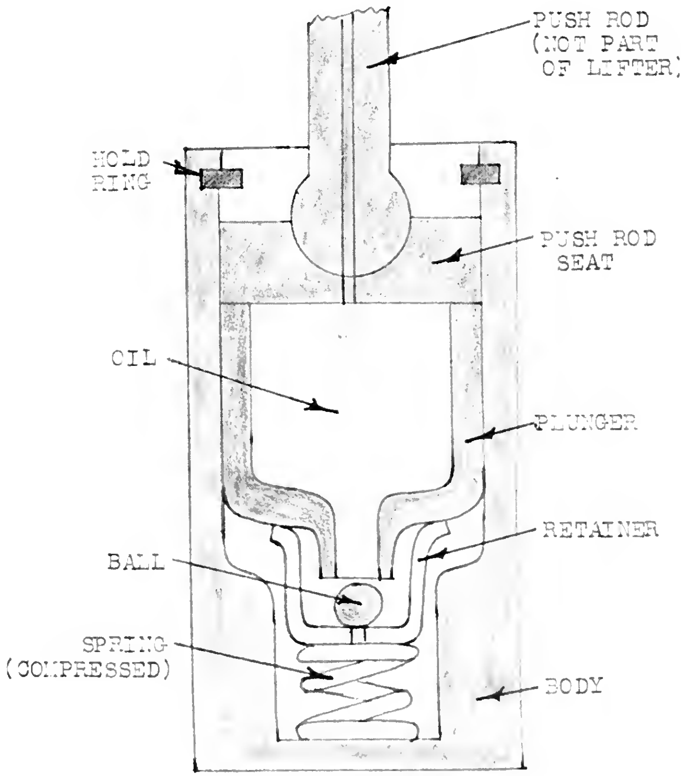


FIG. 2

Hydraulic Valve Lifters . . .

(Continued from Page 27)

ly and, for this reason, was gradually adopted by the auto manufacturers as the overhead valve engine became almost universally employed. At present all of the major American automobile producers use the hydraulic valve lifter and, although the device has been somewhat altered and refined since its introduction, the basic principle of operation remains unchanged.

Let it be understood at this point that the following discussion refers specifically to neither the earliest nor the most modern hydraulic lifter, but has been chosen rather as perhaps the most representative.

As the diagram (figure 2) illustrates, the lifter consists of seven principle parts as labeled.

The plunger and the body are ground to very close limits and are selectively fitted to obtain free movement with the least possible clearance, in order to control the leakage of oil from the lower chamber within very close limits. The spring exerts enough force to take up all lash between parts in the valve train without affecting positive seating of the valve. The check valve ball seats in the plunger hole and the retainer limits its travel to a few thousandths of an inch.

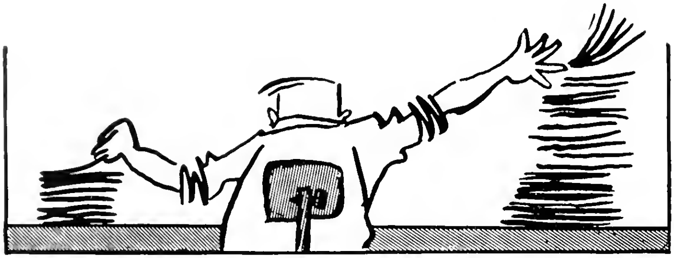
In operation, the plunger and lower chamber are kept filled with oil being supplied through a passage in the push rod. When the valve lifter is on the cam base circle the spring raises the plunger to eliminate the lash in the valve train. If the lower chamber is not completely filled with oil at this time, oil will run down through the feed hole past the check valve to fill the chamber.

As the rotating cam raises the lifter body, the pressure created in the lower chamber closes the check valve so that the plunger and push rod seat move with the body. Force is then transmitted to the push rod, rocker arm, and valve without lost motion. As the parts of the valve train expand due to heat, the volume of oil in the lower chamber of the lifter is automatically adjusted through the check valve to compensate for these changes and to maintain zero valve lash at all times.

Return to figure 1 and mentally remove the solid metal cam follower. Now fit snugly into its place, in order to remove all lash, a cam follower which realizes that the parts of the valve train will expand as the temperature rises. As this expansion occurs, this new follower will shorten itself by the same amount and maintain the snugly fitting condition that existed in the valve train when the engine was cold. The new follower will then facilitate smooth and quiet valve train operation at all engine temperatures. This device is referred to as a Hydraulic Valve Lifter.

"Say Emmy! You best give them fellers at Cape Canaveral another call!"

Skimming Industrial Headlines



Edited by The Staff

Infrared Seeing

A new infrared system sensitive enough to see moving objects near room temperature solely by means of the invisible heat rays they emit has been developed by scientists of the Westinghouse research laboratories in Pittsburgh, Pa. Known as the phothermionic image converter, the all-electronic device changes the infrared radiation emitted by an object into a visible picture on a television screen. The speed with which it responds to infrared is roughly equal to that of the human eye to visible light.

Disclosure of the infrared imaging device was made at the winter meeting of the American Institute of Electrical Engineers, by Dr. Max Garbuny, head of the team of Westinghouse research scientists that developed the system. The development, first in a series of such devices, was sponsored mainly by the Wright Air Development Center of the U. S. Air Force.

Dr. Garbuny described the Westinghouse phothermionic image converter as operating on infrared radiation of relatively long wavelengths. Such radiation is emitted by comparatively cool objects such as the human body. Hotter objects, for example those that actually glow red hot, emit more energetic radiations of shorter wavelength in the "near" infrared, and are easier to detect.

"Infrared is becoming increasingly important, particularly in its military applications," Dr. Garbuny pointed out. "Infrared systems are used for missile guidance, fire control, reconnaissance and warning systems. Their outstanding advantage is that they are undetectable by the enemy. No telltale signals are broadcast. All objects above the temperature of absolute zero constantly emit infrared radiation, and infrared systems simply pick up these naturally occurring signals through space.

"These systems operate upon the broad principle of sensing the heat energy radiated by a body and converting it, by means of some form of heat-sensitive detector, into equivalent electrical signals that can be amplified and made visible to the human eye. The traditional method has been to use a sensitive crystal, or infrared cell, to detect the radiation, and a mechanical scanning system to make the image visible.

"The newer approach is an all-electronic imaging system, because such a device has the potential advantages of faster response, higher sensitivity and better picture detail. The photothermionic converter is an important step in bringing this type of system to reality.

"It is sensitive enough to detect moving objects near room temperature when they exhibit temperature differences of approximately 20 degrees Fahrenheit. This is just about the spread between the temperature of the human body and that of the average living room. In addition, the system is fast enough to follow the movement of such objects with the same speed as a normally visible object is followed by the unaided human eye."

The key component in the newly announced system, Dr. Garbuny said, is a unique infrared-sensitive detector, or retina. The retina is a three-layer sandwich only a few millionths of an inch thick. The center layer of the sandwich is an ultra-thin support film of aluminum oxide about one millionth of an inch thick. This film is made by chemically dissolving away all of the aluminum metal in a piece of suitably treated household aluminum foil, leaving only the thin layer of aluminum "rust" which coats the foil's surface.

The front surface of the oxide film is coated with an even thinner layer of nickel, deposited in such thickness that it strongly absorbs infrared radiation. The back surface of the film is coated with a thin layer of a photoemitting material called cesium bismuth—a chemical compound capable of releasing electrons when light shines upon it. Of key importance is the fact that the photoemitter's ability to release electrons under the stimulus of light varies with its temperature, changing two or three per cent for every degree its temperature changes.

To increase the over-all sensitivity and performance of the detector, it is cooled to a temperature of about 180 degrees below zero Fahrenheit.

"In use, the infrared radiation from an object is focused on the heat-absorbing layer of the retina, forming a temperature pattern of the scene," Dr. Garbuny explained. "This temperature pattern transfers through the thin support layer to the photoemitting surface, where it can be perceived simply by scanning a spot of light across the surface. As the light spot scans the photoemitting surface, many or few electrons flow from the surface in exact conformity to the heat pattern on it. These electrical signals are then amplified and fed to a standard television picture tube, where a visible picture appears. Thus, a point by point description of the temperature scene is created on the television screen."

Two Westinghouse research physicists, T. P. Vogl and J. R. Hansen, joined in leading the technical development of the photothermionic image converter, Dr. Garbuny reported.

Moon Reflector

University of Illinois scientists, having used the moon as a radio wave reflector for more than a year, now are going to study how large an area of the sphere actually is doing the reflecting.

They're going to feel out the width of the area by using radio fingers stretched out into space in the antenna pattern of a sensitive radio receiver known as an interferometer.

The study will be undertaken next month under sponsorship of the Army Signal Corps by Prof. Harold D. Webb of the electrical engineering department, with Prof. George W. Swen-

(Continued on Page 32)

BRAIN TEASERS

Edited by Steve Dilts

This month the brainteasers are in the form of an "Aptitude Test"; but, be careful, for the questions are trickier than they appear. The answers can be found with the answers to last month's teasers. Score yourself as follows:

16 correct—genius.
10 correct—normal.
8 correct—sub-normal.
5 correct—idiot.

1. If you went to bed at 8:00 o'clock at night and set the alarm to get up at 9:00 o'clock in the morning, how many hours would this permit you to sleep?

2. Do they have a 4th of July in England?

3. How many birthdays does the average man have?

4. Why can't a man living in Winston-Salem, N. C., be buried west of Mississippi river?

5. If you had only one match, and entered a room in which there was a kerosene lamp, an oil heater, and a wood burning store, which would you light first?

6. Some months have 30 days, some have 31, how many have 28 days?

7. If a doctor gave you 3 pills and told you to take 1 every half hour, how long would they last you?

8. A man builds a house with four sides, and it is rectangular in shape. Each side has a Southern exposure. A big bear comes wondering by. What color is the bear?

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

10. What 4 words appear on every denomination of U. S. coins?

11. What is the minimum number of active baseball players "on the field" during any part of an inning? How many outs in each inning?

12. I have in my hand 2 U. S. coins which total 55c in value. One is not a nickel. Please bear that in mind. What are the two coins?

13. A farmer had 17 sheep. All but nine died. How many did he have left?

14. Divide 30 by ½ and add 10. What is the answer?

15. Two men play checkers. They played five games and each man wins the same number of games. How could this happen?

16. Take two apples from three apples and what do you have?

17. An archaeologist claimed he found some gold coins dated 46 B. C. Do you think that he did?

18. A woman gives a beggar 50c. The woman is the beggar's sister, but the beggar is not the woman's brother. Why is this?

19. How many animals of each species did Moses take aboard the ark with him?

20. Is it legal in N.C. for a man to marry his widow's sister?

21. What word is misspelled in this test?

* * *

Here are the answers to last month's teasers and for the "Aptitude Test."

Take three random groups of three each and balance two of the groups against each other. If one of the groups contains the counterfeit coin, the group is spotted; if they balance, the third group contains the counterfeit. From the spotted group take any two coins and balance them; the lighter coin is the counterfeit if they don't balance; otherwise, the third coin is the one.

* * *

The assumption that the "lady" is Jean Brown, the stenographer, quickly leads to a contradiction. Her opening remark brings forth a reply from the person with black hair, therefore Brown's hair cannot be black. It also cannot be brown, for then it would match her name. Therefore it must be white. This leaves brown for the color of Professor Black's hair and black for Professor White. But a statement by the person with black hair prompts an exclamation from White, so they cannot be the same person.

It is necessary, therefore, to assume that Jean Brown is a man and that either Merle White or Leslie Black is the lady. (All three given names are used for both sexes.) Either assumption leads to the conclusion that Black's hair is white, White's hair is brown and Brown's hair is black. The lady's hair is thus either white or brown. If it isn't brown, the problem asks, what color is it? Answer: Professor Black is a platinum blonde.

A general formula for this type of problem can be derived as follows. Let s be the length of the formation of cadets, and assume that they march this distance in one unit of time. The dog's trotting speed (in the same distance and time units) is d. Let t be the time it takes the dog to trot from the rear to the front of the moving formation, and f the distance of this forward trot. As the illustration below indicates, the distance of the return trip is $f - s$. This same distance can be expressed in a different way. The dog's entire trip takes one unit of time, so the time it takes the dog to trot back is clearly $(1 - t)$. We can therefore write the following equation:

$$d(1 - t) = f - s$$

Expanding the left side and substituting dt for f on the right gives:

$$d - dt = dt - s$$

By the time the dog reaches the front, the cadets will have gone a distance of st. Therefore the dog's total distance forward must equal s plus the st feet that the cadets have moved by the time the dog reaches the front rank. This enables us to substitute $s + st$ for dt in the last equation. The resulting equation simplifies to:

$$d = s + 2st$$

The right side of this equation is now substituted for d in the equation $dt = s + st$ to yield:

$$t(s + 2st = s + st$$

In solving the above equation the st terms cancel out and t is found to have a value of $1 \sqrt{2}$. The dog's total distance is now easily shown to be $s + s\sqrt{2}$ that is, the length of the marching formation plus the same length times the square root of two. In this particular case $s = 50$ feet, so the dog travels a little more than 120.7 feet.

The answer to Sam Loyd's version in which the dog trots *around* the moving square, is 209.07 + feet.

* * *

The volume of a sphere is 4π 3 times the cube of the radius. Its surface is 4π times the square of the radius. If we express the moon's radius in "lunars" and assume that its surface in square lunars equals its volume in cubic lunars, we can determine the length of the radius simply by equating the two formulas and solving for the value of the radius. Pi

BRAIN TEASERS . . . *(Continued from Page 31)*

cancels out on both sides, and we find that the radius is three lunars. The moon's radius is 1,080 miles, so a lunar must be 360 miles.

* *

1. One hour.
2. Yes.
3. One per year.
4. He is alive.
5. The match.
6. All of them.
7. One hour: one now, the second after a half hour, and the last at the end of an hour.
8. White polar bear.
9. Until he is completely in the woods; then he is running *through* the woods.
10. United States of America; In God We Trust.
11. Zero; six outs; zero *active* between the top and bottom of the inning.
12. Nickel and fifty cent piece—one of these isn't a nickel.
13. Nine.
14. Seventy.
15. They were playing other men.
16. Two apples.
17. No; since Christ had not yet lived, the symbol, B.C., was not yet used.
18. The beggar is the woman's sister.
19. Moses didn't take any; Noah did.
20. He can't since he is dead.
21. *Wondering* should be *wandering* in No. 8.

MORE INDUSTRIAL SKIMMING

(Continued from Page 30)

son Jr. of electrical engineering and astronomy as consultant.

If the moon were a polished ball, signals would be reflected from a tiny point. Since it is not, they bounce back toward earth from a fair sized part of the rough surface. The radius of the area has been estimated as much as one-third the radius of the moon.

To find out, the Evans Signal Laboratory, Fort Monmouth, N. J., will beam a radio signal at the moon. As it bounces back to earth, this signal will be received at the University.

The radio interferometer has a receiving pattern like the spread fingers of a hand. Every time the moon passes over one of the fingers the signals will come in strong; between fingers it will drop off.

By adjusting these radio fingers into space, the engineers will feel out the width of the reflective area and measure it.

Camera-Binocular

One of the latest gadgets developed in Japan is a binocular that takes pictures. The camera has an f:3.7 lens and a 30-exposure magazine. The binocular has 400 millimeter 1.8 teleconversion lenses and magnifies 15 times.

Credit Card Complaint

A San Francisco appliance dealer complained over lunch in a restaurant recently that nobody, except banks and women, likes bank credit cards, because they cost retailers a percentage of their profits. "We could fight the banks, but women would rather argue with the old man after charging a purchase than try to get money from him in advance," he said. The dealer then paid the check with his credit card.

Chemistry Goes To Hollywood

A new era in high school chemistry will be unveiled when the image of Prof. John C. Bailar Jr., University of Illinois chemist and president, American Chemical Society, appears on a motion picture screen to introduce a project sponsored by that society and made possible by the Fund for Advancement of Education and Encyclopaedia Britannica Films Inc.

He will be introducing a series of 160 half-hour long sound-color motion picture films which present an entire one-year high school chemistry course. The films are intended for classroom use. They include closeups of experiments and scenes of chemical plants.

Prof. Bailar will attend the premier showing along with government, educational, and scientific leaders, science writers, and other representatives of science and the public.

In his introductory remarks, Prof. Bailar points out that "The American Chemical Society is directly concerned not only with training of professional chemists and chemical engineers, but also with the problem of acquainting every high school student with the meaning and importance of chemistry."

Teacher in the filmed series is Prof. John F. Baxter, University of Florida, whom Prof. Bailar presents as "the classroom colleague for every teacher who uses the films."

"As president of the American Chemical Society," says Prof. Bailar, "I believe this project will make a significant contribution to improvement of high school chemistry, and thus to strengthening the American educational system."

Costly Mistake

It has cost the Alaska District of the Corps of Engineers $210,000 to find out that cold weather and steel-framed windows do not mix, according to Engineering News-Record. Wood frame windows are replacing the old ones at two subarctic Air Force bases. It was found that frost builds up so heavily on the steel in subzero weather that the windows are rendered useless for illuminating purposes.

Smoke Much?

Puffing a cigarette while working or driving is a hindrance, not a help, reports Factory Management and Maintenance. Carbon monoxide gets the blame. The bloodstream absorbs the gas 210 times faster than oxygen. It takes only 3 per cent of carbon monoxide to cause measurable impairment of vision and depth perception. Heavy smoking causes a carbon monoxide concentration as high as 10 per cent. One cigarette adds one-to-one-half per cent of the gas to your system.

It was the sleepy time of the afternoon. The prof. droned on and on formulae, constants and figures. A Ch. E. Student sitting in the second row, was unable to restrain himself and gave a tremendous yawn. Unfortunately, as he stretched out his arm he caught his neighbor squarely under the chin, knocking him to the floor. Horrified, he bent over the prostrate form just in time to hear him murmur, "Hit me again, Sam, I can still hear him."

One of a series

Interview with General Electric's Byron A. Case Manager—Employee Compensation Service

Your Salary at General Electric

Several surveys indicate that salary is not the primary contributor to job satisfaction. Nevertheless, salary considerations will certainly play a big part in your evaluation of career opportunities. Perhaps an insight into the salary policies of a large employer of engineers like General Electric will help you focus your personal salary objectives.

Salary—a most individual and personal aspect of your job—is difficult to discuss in general terms. While recognizing this, Mr. Case has tried answering as directly as possible some of your questions concerning salary:

Q Mr. Case, what starting salary does your company pay graduate engineers?

A Well, you know as well as I that graduates' starting salaries are greatly influenced by the current demand for engineering talent. This demand establishes a range of "going rates" for engineering graduates which is no doubt widely known on your campus. Because General Electric seeks outstanding men, G-E starting salaries for these candidates lie in the upper part of the range of "going rates." And within General Electric's range of starting salaries, each candidate's ability and potential are carefully evaluated to determine his individual starting salary.

Q How do you go about evaluating my ability and potential value to your company?

A We evaluate each individual in the light of information available to us: type of degree; demonstrated scholarship; extra-curricular contributions, work experience; and personal qualities as appraised by interviewers and faculty members. These considerations determine where within G.E.'s current salary range the engineer's starting salary will be established.

Q When could I expect my first salary increase from General Electric and how much would it be?

A Whether a man is recruited for a specific job or for one of the principal training programs for engineers—the Engineering and Science Program, the Manufacturing Training Program, or the Technical Marketing Program—his individual performance and salary are reviewed at least once a year.

For engineers one year out of college, our recent experience indicates a first-year salary increase between 6 and 15 percent. This percentage spread reflects the individual's job performance and his demonstrated capacity to do more difficult work. So you see, salary adjustments reflect individual performance even at the earliest stages of professional development. And this emphasis on performance increases as experience and general competence increase.

Q How much can I expect to be making after five years with General Electric?

A As I just mentioned, ability has a sharply increasing influence on your salary, so you have a great deal of personal control over the answer to your question.

It may be helpful to look at the current salaries of all General Electric technical-college graduates who received their bachelor's degrees in 1954 (and now have five years' experience). Their current median salary, reflecting both merit and economic changes, is about 70 percent above the 1954 median starting rate. Current salaries for outstanding engineers from this class are more than double the 1954 median starting rates and, in some cases, are three or four times as great.

Q What kinds of benefit programs does your company offer, Mr. Case?

A Since I must be brief, I shall merely outline the many General Electric employee benefit programs. These include a liberal pension plan, insurance plans, an emergency aid plan, employee discounts, and educational assistance programs.

The General Electric Insurance Plan has been widely hailed as a "pace setter" in American industry. In addition to helping employees and their families meet ordinary medical expenses, the Plan also affords protection against the expenses of "catastrophic" accidents and illnesses which can wipe out personal savings and put a family deeply in debt. Additional coverages include life insurance, accidental death insurance, and maternity benefits.

Our newest plan is the Savings and Security Program which permits employees to invest up to six percent of their earnings in U.S. Savings Bonds or in combinations of Bonds and General Electric stock. These savings are supplemented by a Company Proportionate Payment equal to *50 percent* of the employee's investment, subject to a prescribed holding period.

If you would like a reprint of an informative article entitled, "How to Evaluate Job Offers" by Dr. L. E. Saline, write to Section 959-11, General Electric Co., Schenectady 5, New York.

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