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MARCH
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The Wisconsin
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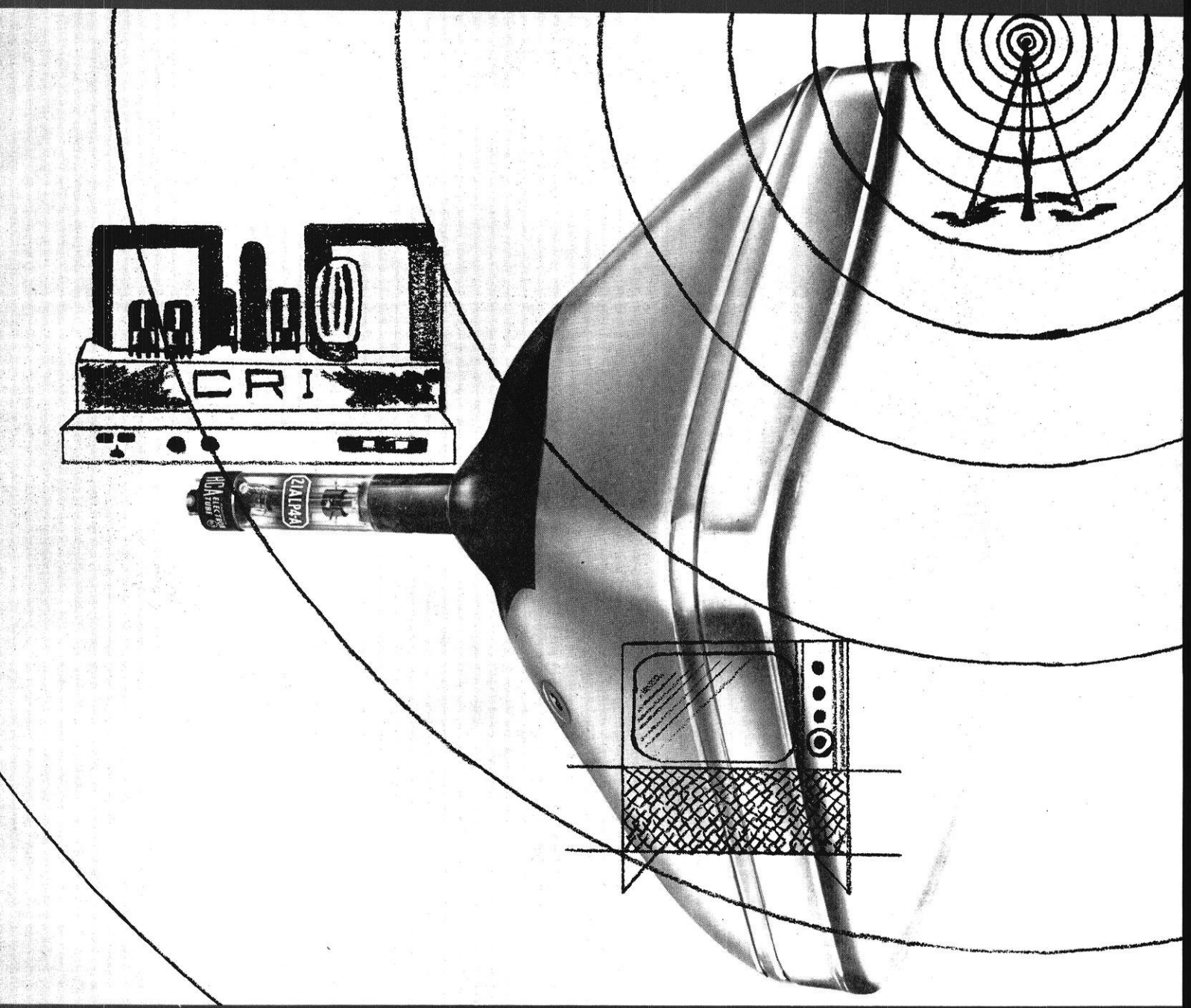

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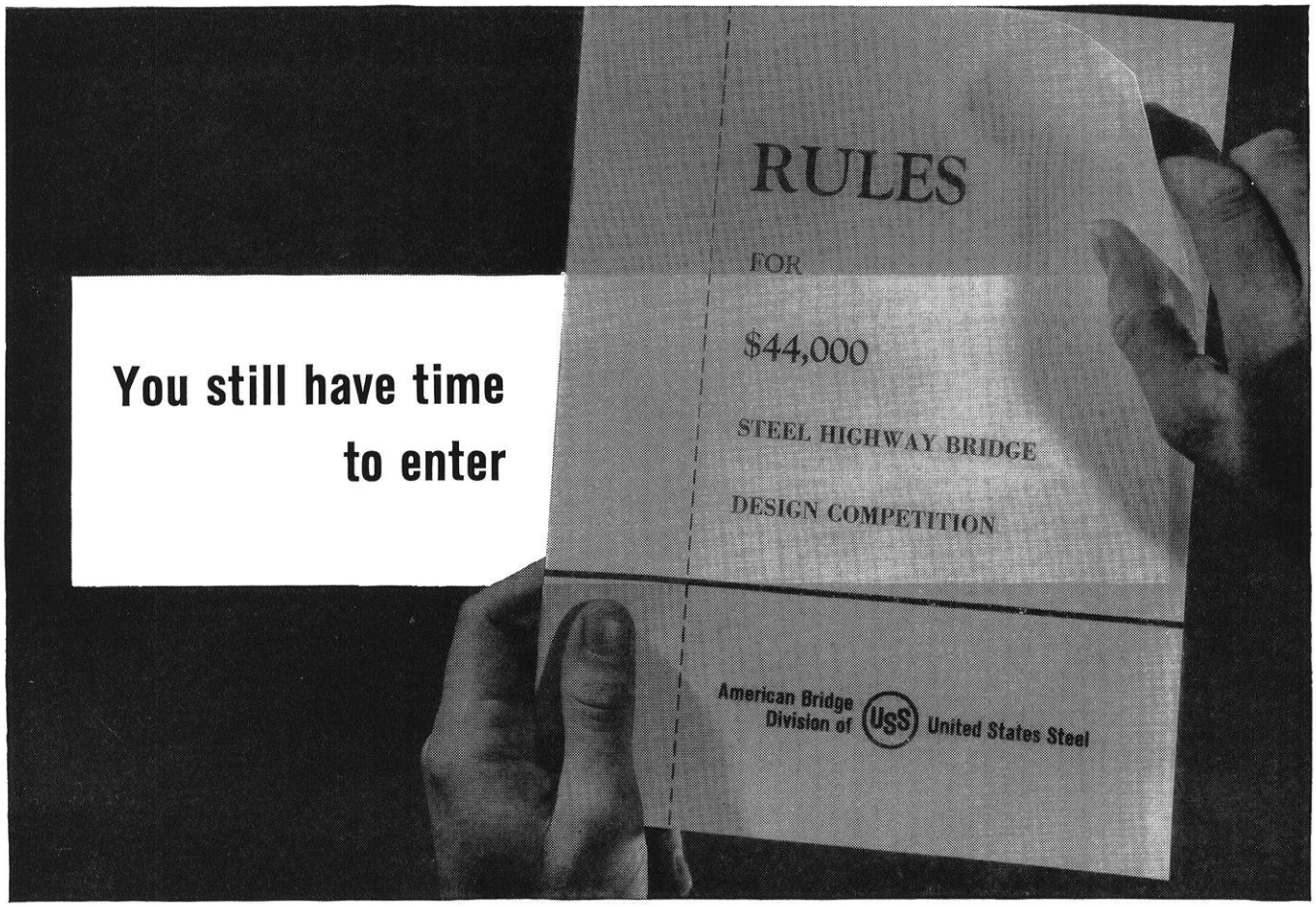

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THE WISCONSIN ENGINEER??

"It says, "St. Pat was an Engineer"

Volume 63 MARCH 1959 Number 6

WISCONSIN ENGINEER

The Student Engineer's Magazine
FOUNDED 1896

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Cover

The television picture tube brings to mind many things that were unknown before the present electronic age. Here Cal Kreunen illustrates for story on page 10.

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STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Company

In this fast-moving age we find that we can no longer insure leadership... or even survival... by doing things the traditional way. If there's a better way, we must find it.

Our DC-8, C-133, Thor, Nike-Hercules, Genie, Sparrow and other aircraft and missiles are all the finest of their type and time. But their success, and that of our many new projects, depends on superior engineering.

That's why I'm looking for engineers dedicated to quality work. Only through such dedication can the extra performance and reliability of our products be attained. If you feel as we do about this principle, we'd certainly like to hear from you in regard to a future at Douglas.

Write to Mr. C. C. LaVene,
Douglas Aircraft Company, Box P-600
Santa Monica, California

MANY SCIENTIFIC SKILLS are needed to meet the research challenges of the petroleum industry. Shown above are (l. to r.): Kemp Bunting, mechanical engineer; Arthur Sisko, physical chemist; Thornton Traise, organic chemist; Wilbur Hayne, chemical engineer. They are members of the research team that developed Standard Oil's revolutionary new Supermil ASU greases. These amazing lubricants are the first to deliver normal performance at *both* extremely high and low temperatures.

Four heads are better than one

Seldom is a major petroleum advance the work of one man—or one kind of knowledge. It is the result of a group of scientists whose skills encompass many fields.

Take Standard Oil's amazing new Supermil ASU greases, for example. These revolutionary lubricants assure normal performance at fantastic temperature extremes—from 70° F. below zero to 480° above. Their development has made possible major advances in America's Space Age defense program and its industrial efficiency.

The story behind the development of Supermil ASU greases is as fascinating as the products themselves. For it is a story of Standard Oil research teamwork. Physical chemists, organic chemists, chemical engineers, mechanical engineers and technicians worked together for *five years* to break down a major barrier in the lubricant field.

At Standard Oil, scientists and engineers of many types have the opportunity to work on a wide variety of challenging projects. That is one reason why so many young men have chosen to build satisfying careers with Standard Oil.

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ENGINEERING STUDENTS
UNIVERSITY OF WISCONSIN

HI FELLOWS:

The college of Engineering of the University of Wisconsin is inviting you to participate in the 1959 Engineering Exposition. It will be held on the weekend of April 10, 11, & 12—one week after the Spring recess. Hence, it is less than three weeks in the future; BUT, there is still ample time to setup an exhibit.

Since January, engineering students have been working on the planning and building of exhibits. They will display the spectacular and unusual aspects of engineering. I was recently informed that two Electricals have a flying saucer nearly perfected. Some of the Civil Engineers have a tricky method of determining your height and weight by beam deflection. The Metallurgists are working out a plan for casting aluminum souvenirs. And so it goes—the Chemical, and Mechanical, and Agricultural Engineers—everybody has something. It is expected that over 80 student exhibits representing all branches of engineering will be displayed.

A lot of you expressed interest in the progress of the Exposition and would likely have already begun construction on the Exhibit of your choice if it were not for your busy schedule. Actually, the time involved is less than one expects and it is worth every minute in regard to experience, leadership training, future reference, and, of course, an opportunity to receive honors as a prize winner in one of the five exhibit classifications. Most of the work on your exhibit could be accomplished during the Spring vacation, and its actual setup along with your final adjustments would be performed on Thursday April 9 or Friday April 10.

Registration blanks are available in the pockets of Exposition posters located in the engineering buildings. At least several days before the Exposition, space will be allocated for your exhibit by the Exposition Committee. Remember, you may obtain permission from the faculty to use available equipment in the engineering buildings for use as part of your exhibit or for demonstrational purposes.

We appreciate your participation.

Sincerely,

Kendrick J. Lewandowski

Student Exhibits Chairman

EXPOSITION

April 10, 11, & 12

PURPOSE: The Exposition is opened to the public to reveal how science, engineering, and industry serve the people and influence the daily lives of everyone. To express this purpose, the theme "WORKING FOR YOU" has been adopted for the exposition.

HOW THE EXPOSITION STARTED: For the past 48 years, engineering schools throughout the country have set aside the 17th of March to honor St. Pat, the Patron Saint of Engineers. The College of Engineering of the University of Wisconsin first celebrated this day in 1912 when they held a St. Pat's parade. Year after year the St. Pat's procession ended in a riot as the engineering and law students aided and abetted by other students and town's youngsters exchanged rotten fruit, eggs, mud, and stones. In 1940, the parade was discontinued and the first Wisconsin Engineering Exposition replaced the parade as the keynote of the St. Pat's celebration.

The Exposition was such a large hit in its first year (7500 people came to view the exhibits) that another Exposition was held in 1941 and again was a success. The war caused cancellation of the Exposition until it was revived in 1953. It is now set up on a triennial basis.

STUDENT EXHIBITS: The breakdown on exhibit classifications and prizes is listed in the Table below. Plaques will also be awarded to winners in the organization classification and ribbons will be given to all prize winners. The Deans of the University of Wisconsin and Michigan State Colleges of Engineering, Deans Kurt Wendt and Jack Ryder respectively, and Mr. Henry Hunt of the Meade and Hunt Consulting Engineering Firm will serve as judges for the student exhibit award competition.

Unusual and eye catching exhibits will receive special publicity consisting of news releases to state and local newspapers plus announcements on television. A description of each exhibit will also be printed in the Exposition Program.

Deadline for exhibit registration: April 6th, the first day after spring vacation.

INDUSTRIAL EXHIBITS: More than 30 Industrial Exhibits are planned. Included in these exhibits are a working model of an oil cracking plant by Universal Oil Products, an electrical static clutch by International Business Machines Corporation, and an automatic, technical quiz game by DuPont Corporation.

OPENING PROGRAM: The Opening Program for the Exposition will include speeches by Dean Kurt Wendt on "School and Engineering" and by Mr. Henry Hunt on "Industry and Engineering". A mechanical device will cut a ribbon to officially open the Exposition to the public.

The Exposition will be open to the public April 10, 11, and 12, from 1:30 to 10:00 P.M. Friday, 10:00 A.M. to 10:00 P.M. Saturday, and 1:00 to 9:00 P.M. Sunday.

TABLE 1.—EXHIBIT CLASSIFICATIONS AND AWARDS

CLASSIFICATIONS	AWARDS		
	1st	2nd	3rd
Organizations (Honorary and Professional)	$50.00	$30.00	$20.00
Individual Students (1 student)	25.00	15.00	10.00
Student Groups (2 or more students)	50.00	30.00	20.00
Craftsmanship (1 or more)	15.00	10.00	—
Graduate Students (1 or more)	15.00	10.00	—

Plaques will be awarded to winners in the organization class and ribbons to all prize winners.

The Manufacture of Television Picture Tubes

by Duane A. Schneider Me '59

The modern television picture tube is another item that is most often taken for granted. Here the author details production procedures of tube manufacturing in an attempt to point out the vast complexity of this common necessity.

MILLIONS of Americans use products daily that are very complex without once giving any thought to their complexity. The television receiver is one of the most complicated pieces of equipment found in the modern American home; yet, along with the many other home appliances, it is ordinarily taken for granted. This article deals with one part of the television receiver, the picture tube, and covers the manufacturing processes involved in constructing a working television picture tube as well as the material and equipment used.

CATHODE-RAY TUBES

The television tube or cathode-ray tube was not new with the advent of television. Cathode-ray tubes were in existence as far back as 1897. These tubes, although crude, worked under the same principles as do modern television picture tubes. Early in the twentieth century, Campbell–Swinton, a leader in the electronic research of his day, proposed that the cathode-ray tube be used for television. Early researchers used mechanical means for obtaining the required pattern on the screen. Then, in the late 1920's, German scientists found that the proper image could be obtained on a screen by the use of an oscillating magnetic field. This opened a whole new thought process in the development of television. One must bear in mind that the cathode-ray tube was initially developed to study wave characterists in mechanical and electrical vibrations. They are the tubes that are used in oscilloscopes which have such important use in modern science and industry.

Great strides in the development of the cathode-ray tube occurred during World War II. These included: a more rugged tube, finer and better images, and a more unique method of electron deflection.

After the war, it was anticipated that the demand for tubes in television application would surpass the demand for tubes for military purposes. This led to research in manufacture, with methods of mass production being developed.

Further developments were made in the few years following the war. Researchers have been able to improve on the size of the tube, whereas in the early sets the picture was almost always 10 inches or smaller. Even better pictures were obtainable through aluminized backing of the phosphor screen. In addition, higher angle of deflection of the electron was made possible. Also, in the last few years, all-glass rather than part-glass part-steel tubes have become popular. With this change came a modification of the tube shape from circular to rectangular.

PHYSICAL PHENOMENA IN THE TUBE

A very basic explanation of how a picture tube works is necessary to provide a better understanding of the processes involved in its manufacture. An explanation of several physical phenomena will help to explain what happens within the electron (picture) tube, but no proofs of the phenomena are given in the article. These facts must be accepted as true:

1. An element upon being heated emits electrons (a charged particle of minute mass).
2. An electron can be accelerated to a tremendous speed by being attracted to a plate of opposite charge in the vicinity of the electron emitter.
3. An electron, upon passing through a magnetic field, can be deflected a certain degree, depending upon the strength of a field.
4. An electron hitting a particle of phosphor will cause the phosphor to illuminate.

With these facts in mind, it can be seen that in a television picture tube the filament heats a surrounding metal which emits electrons. The electrons are accelerated toward the front of the tube and are deflected according to a magnetic field. Upon hitting the front of the tube, the electrons illuminate the phosphor coating. In this way, by varying the magnetic field through which the electrons pass, the entire screen can be scanned. At the same time, the acceleration of the electrons can be controlled; black and white spots appear on the screen. The combination of these two impulses forms the image on the front of the screen.

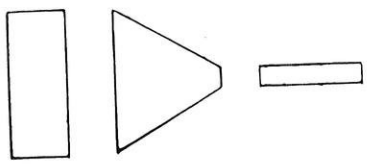
MANUFACTURING THE BULB

The first step in the manufacture of the tube is the production of the glass portion of it. The glass must be able to withstand high pressure due to the vacuum within the tube. Consequently, expensive materials are used to impart strength to the bulb. Early tubes were blown or hand molded, but modern electron tubes are made in three sections.

Large high-temperature furnaces are required for melting the materials to make the glass. The molten glass is poured into huge glass-pressing machines where it is formed into one of the three shapes. Dimensional accuracy is very important; therefore, the molds into which the glass is poured are expensive.

The three portions of glass are fused together by acetylene torches. Considerable research and expense were incurred in developing this particular process. While the tubes are being fused together, a small metal anode button is inserted along the sloping side of the bulb. This anode connects with a coating of graphite that is painted on the inside of the tube. High electric potential is placed in the anode which in turn gives potential to the inner coating. In this way, electrons hitting the screen can be collected and drawn out of the tube. The anode is held in place while an operator uses high-frequency-induction heating to weld it to the glass at 700° C. This intense heat develops localized strains in the glass. These must be removed by curing at elevated temperatures for more than an hour.

For the cure, the bulb is automatically routed on a conveyor belt through an electrically heated annealer. The oven consists of four zones: preheat, entrance, high temperature, and cooling. Temperatures in the high temperature zone are 480° C.



The three sections of a modern electric tube.

After annealing, the tubes are washed. This process takes 20 minutes and is usually handled on semi-automatic or automatic machinery. The slightest trace of dirt or grease would prevent phosphor particles from adhering properly to the face of the tube. Handling marks, such as finger prints and etched areas in the face plate, would have an affect on the appearance of the screen and an even greater affect on the television picture.

APPLYING THE PHOSPHOR FILM

After the tubes have been completely washed, they are dried by heat and passed along the production line to the next process. The next step is to apply the phosphor screen. A solution containing phosphor particles is poured into the tube at the start of the process and the tube continues along the production line a few inches a minute. The particles suspended in the solution slowly precipitate and form a thin layer on the inside of the tube screen. Affinity of the phosphor for glass makes it possible for the solution to be carefully decanted, as the conveyor moves over a large sprocket, leaving the deposit on the glass. On the underside of the belt, the sides and neck of the bulb are washed to remove any screen particles and the screen is then dried.

ALUMINIZING

Before the early 1950's this ended the processing of the screen, but more recently another process, aluminizing, has improved the picture tube. In essence, this screen differs from the older type in that it has a thin film of aluminum deposited over the phosphor screen, so that the phosphor is between the aluminum and the glass face-plate of the tube. In older tubes, somewhat less than half the light emited by the phosphor reached the front of the picture tube, but in newer aluminized tubes, the backward-directed light is reflected by the aluminum film toward the face plate, thereby enhancing the brightness and contrast range.

The process of aluminizing starts by pouring a metered amount of water into the tube. A carefully controlled amount of lacquer is added. The lacquer spreads out over the surface of the water and the solvent evaporates and the lacquer forms a dry film. The bulb is then tilted allowing the water to run out from under the film, while the latter adheres to the phosphor, forming a smooth surface onto which the aluminum can be deposited.

A short slug of aluminum wire is inserted into a tungsten filament. The tungsten filament with the aluminum is inserted into the neck of the tube and the tube is evacuated to less than 0.1 mm Hg. At this point, power is supplied to the tungsten filament causing the aluminum to vaporize and form a thin coating over the inner surface of the bulb. Thus, the tube is aluminized and is ready for the next operation.

APPLYING THE GRAPHITE COAT

The next operation is to apply the graphite coating to the inside

(Continued on next page)

of the glass cone and neck of the tube. The graphite must be brushed on mechanically to avoid marring the screen surface. This coating, as previously mentioned, connects with the metal button and serves to collect the electrons from the face-plate of the picture tube.

Following this operation, the bulb assembly is then baked at 150° C. to insure adherence of both screen and graphite coating.

At this point, the bulbs are ready to receive the other components of the picture tube; namely, the electron gun and the base.

THE ELECTRON GUN AND BUTTON STEM ASSEMBLY

In another department of the factory, while the bulbs are being processed, another component of the picture tube is being manufactured, the electron gun. This portion of the tube produces the electrons, gives them speed, and, at the same time, regulates the flow of electrons to the screen.

The electron gun consists of a cathode (filament and coated cathode sleeve) and five grids. Grids 1 and 2 form the electrons into a beam. Grid 3 accelerates the beam and controls the flow of electrons to the screen. Grids 4 and 5 focus the beam.

Processing the Gun Parts

The metal used for the grids and cathode sleeve is stainless steel. The insulator is made of mica. The metal and insulating parts are punched or rolled into the required shape and, with the exception of the cathode sleeve, move on to the final assembly area. The cathode goes through an additional operation before it is ready for assembly. A thin layer of electron emitting material, such as alkaline earth oxides, is sprayed onto the cathode sleeve. The sleeve is then baked. Care must be taken that the baking is thorough, as in operation the sleeve attains high temperatures.

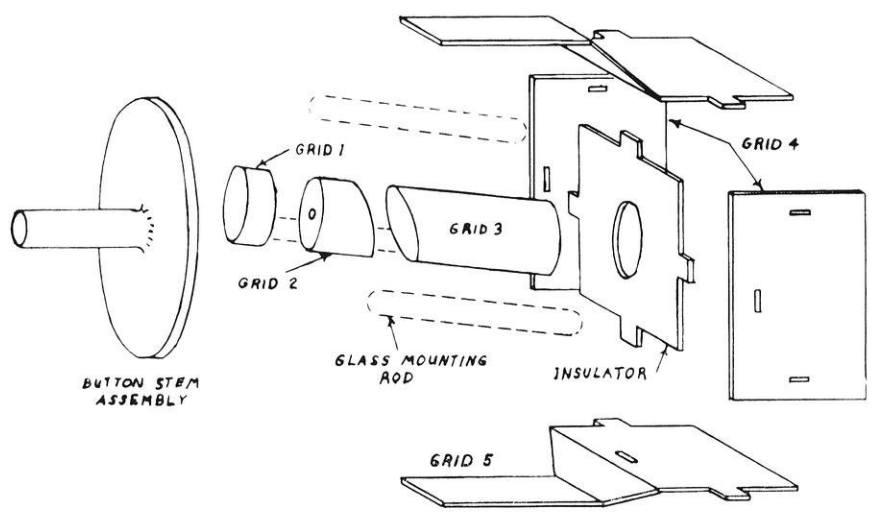
The filament for the gun is made of drawn tungsten or tungsten-alloy wire and is used only to heat the cathode sleeve.

Button Stem Assembly

Another portion of the tube, not directly a part of the electron gun but considered in the production of the gun, is the button stem assembly. It serves two purposes: first, as the "cap" that is placed on the end of the bulb to seal the bulb; and second, as a rear mount for the electron gun. Copper and steel wires are drawn on a large machine and placed in a jig which holds the wires in the proper position. Glass is poured into a mold around the wires. When the glass solidifies, the wires are cut to proper length. Thus, the button stem assembly with wires running through it is ready for attachment to the electron gun.

Assembly of the Gun

One machine serves to assemble the electron gun. An operator places the components of the gun into a jig and the machine pinches Grids 4 and 5 and the insulator together. Then, all of the wires are spot-welded in place. In this operation, nearly one hundred spot-welds are performed. Three wires that are spot-welded to Grids 1, 2, and 3 have no electrical connections. These wires are embedded in three glass rods that hold the finished gun assembly together. The finished gun is inspected under magnification and infra-red light before it is ready to be placed into the bulb.



An exploded view of an electron gun. It consists of a cathode and five grids.

THE BASE AND PINS

Other parts of the finished tube, the base and pins, go through simple operations before they are ready for assembly. The plastic base of the tube is compression-molded to the proper shape. The pins are initially in the shape of small metal tubing. The metal tubes are placed in the base. In one operation, they are attached to the base, cut to size, and their ends rounded. There is a hole left in the tips of the pins to facilitate soldering in a final operation.

FINAL OPERATIONS

All of the component parts are processed and assembled. The parts are then ready to be united into the finished picture tube. The electron gun is placed in the neck of the bulb. Grid 5 makes contact with the graphite coating on the inside of the bulb. In this way, Grid 5 acts as a forward mount for the electron gun and also obtains electric potential from the graphite coating. The electron gun is placed in the neck of the tube so that the rear of the gun slants slightly. It is positioned this way so that ions (heavy charged particles) also emitted from the cathode are not accelerated directly towards the screen. These particles will darken the tube completely unless they can be taken from the electron beam. Being heavier, ions do not react to magnetic fields nearly as fast as electrons. Thus, they strike an anode before they can be deflected enough. Electrons are also directed towards an anode, but they can be deflected sufficiently to pass on to the screen.

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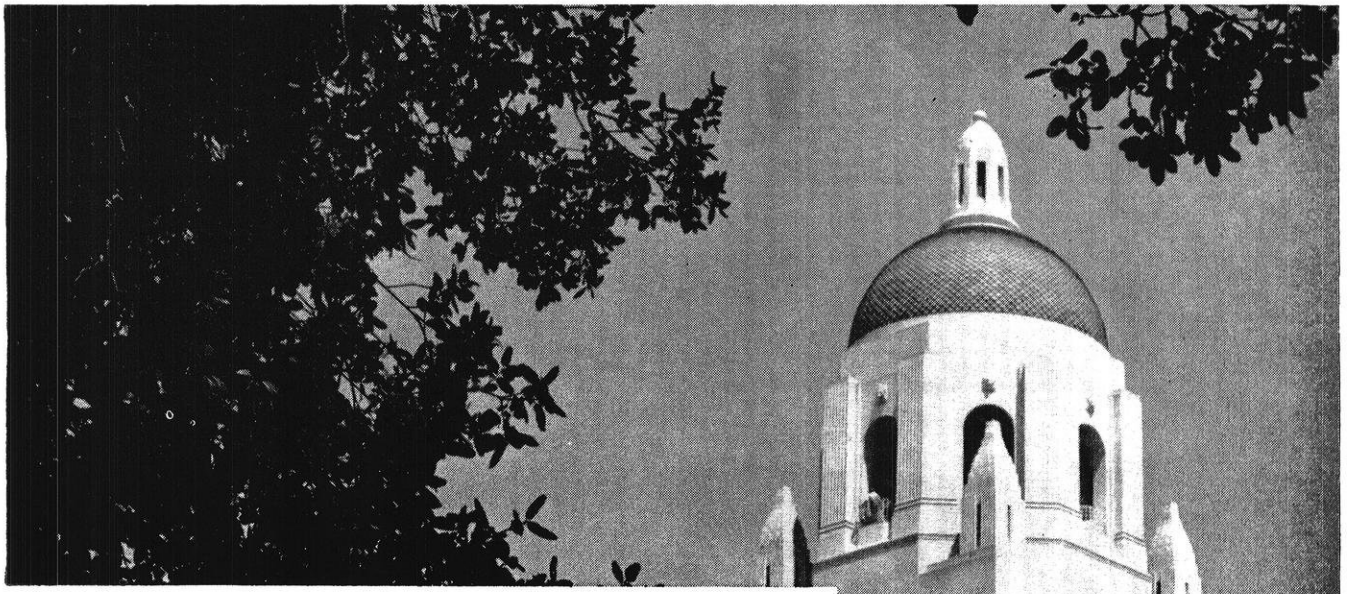

Why Lockheed –

Lockheed's leadership in aircraft is continuing in missiles. The Missile Systems Division is one of the largest in the industry and its reputation is attested by the number of high-priority, long-term projects it holds: the Polaris IRBM, Earth Satellite, Kingfisher (Q-5) and the X-7. To carry out such complex projects, the frontiers of technology in all areas must be expanded. Lockheed's laboratories at Sunnyvale and Palo Alto, California, provide the most advanced equipment for research and development, including complete test facilities and one of the most up-to-date computing centers in the nation. Employee benefits are among the best in the industry.

For those who qualify and desire to continue their education, the Graduate Study Program enables them to obtain M.S. or Ph.D degrees at Stanford or the University of California, while employed in their chosen fields at Lockheed.

Lockheed Missile Systems Division was recently honored at the first National Missile Industry Conference as "the organization that contributed most in the past year to the development of the art of missiles and astronautics."

For additional information, write Mr. R. C. Beverstock, College Relations Administrator , Lockheed Missile Systems Division, Sunnyvale , California.

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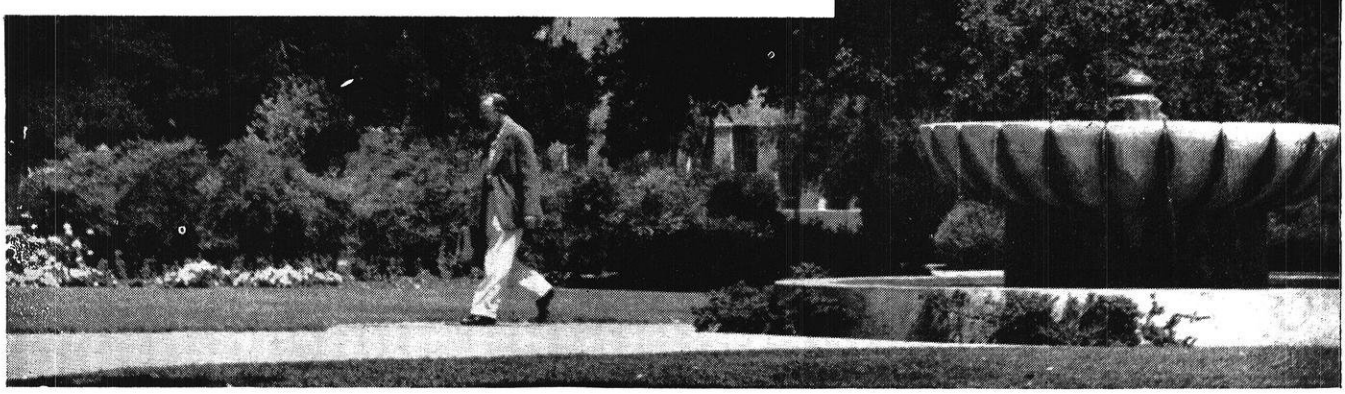


The Engineer's Transit

by Leon Cochenet, CE '61

Every engineer should know something about the transit. He may sometime be faced with the purchase of a transit and should know what is available and should know how to choose one.

—Photo by Steve Zimmerman

Here is the article's author surveying on the UW Campus.

THE transit is one of the Civil Engineer's most essential pieces of equipment. The basic function of this instrument is to measure vertical and horizontal angles, which are used to determine distances, elevations, bearing, and azimuths of lines. The transit is essentially a telescope mounted on a tripod in such a way that its movement within a vertical or horizontal circle can be measured by the angles read from graduated circles. Most instruments also include a compass which is mounted in such a manner that angles measured off with the telescope can be recorded as bearings or azimuths of a line. The transit is often referred to as the universal survey instrument, because it can be used in place of most other surveying instruments. It can be a very accurate instrument. The accuracy depends largely on the characteristics of the particular instrument.

PURCHASING OF A TRANSIT

When considering the purchase of a transit, there are a number of desirable features for which the engineer should look. He not only wants the greatest accuracy possible, but also speed and ease of operation. The most desirable characteristics of a good transit are:

1. **Permanence of adjustments.** Any instrument out of adjustment introduces errors. Therefore, it is necessary that the instrument be of sturdy construction and be designed to stay in adjustment during handling. Time is wasted if the en-

gineer must re-adjust the transit every time he uses it.

2. **Good Construction.** The instrument must be able to withstand a normal amount of abuse. Proper lubrication and protection against dust and moisture are also important features.

3. **Size and weight.** Generally, accuracy increases with an increase of size and weight. Adequate size without excessive weight plus a short telescope are characteristics of the better modern transits.

4. **Desirable optics of the telescope.** The power of the telescope depends on the purpose for which it is intended. This article does not delve into the finer details of optics; however, one should keep in mind that the type of telescope on the transit should correspond to the work which it will be doing.

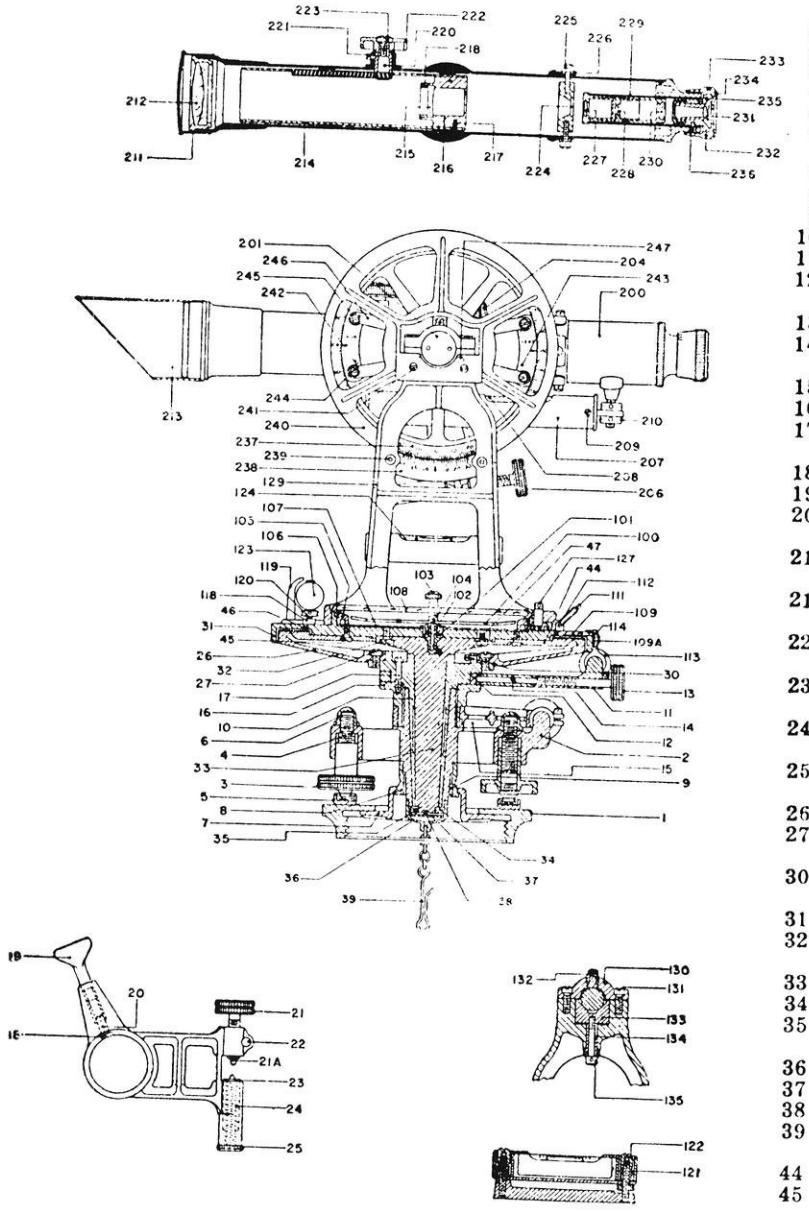
5. **Accuracy of graduation.** This refers to the graduation of the verniers. The transits on the market today are graduated by an automatic dividing machine and are usually quite accurate. One should not negelect to check this.

ESSENTIAL PARTS OF THE TRANSIT

The transit consists of about four hundred distinct parts, all of which are essential to its operation. This article is concerned only with four main sections; namely, the telescope, the upper plate (motion), the lower plate (motion), and the leveling head.

The telescope is mounted on the upper motion and rotates in a vertical plane about a horizontal axis. Attached to one side around the axis is a graduated circle, which moves with the telescope, allowing the user to read vertical angles with the aid of the stationary vernier. On the bottom of the telescope is a level tube. This is a long tube filled with an oil and an air bubble which lies in the center of this tube when the telescope is truly horizontal. The level is used when an angle is measured from the horizontal to an elevated point. It may also be used to locate points of equal elevation.

(Continued on page 40)



1 Tripod Plate
2 Leveling Head
3 " Screw Head
4 " " Stem
5 " " Shoe
6 " " Cap (Left Hand Thread)
7 Shifting Plate
8 Half Ball
9 " " Lock Screw
10 Outer Center
11 Vernier Plate Clamp
12 " " " Gib
13 Vern. Pl. Cl. Screw
14 Vernier Plate Clamp Screw Pin
15 Lower Clamp
16 " " Collar
17 " " " Mounting Screw
18 Lower Clamp Gib
19 " " Screw
20 " " Screw Pin
21 Lower Clamp Tangent Screw
21A Clamp Tangent Screw Pivot Pin
22 Clamp Tangent Screw Tension Screw
23 Lower Clamp Tangent Screw Plunger
24 Lower Clamp Tangent Screw Spring
25 Lower Clamp Tangent Screw Cap
26 Horizontal Circle
27 " " Mounting Screw
30 Horizontal Circle Adjusting Screw
31 Vernier Plate
32 " " Mounting Screw
33 Inner Center
34 Center Nut
35 " " Lock Screw
36 Center Cap
37 " Spring
38 " Ball
39 Plumb Bob Chain and Hook
44 Vernier Disc
45 " " Mounting Screw
46 Vernier Disc Height Adjusting Screw
47 Vernier Disc Centering Screw
100 Compass Needle
101 " " Lifter
102 Compass Needle Lifter Bushing
103 Compass Needle Lifter Screw Assembly
104 Compass Needle Pivot
105 " Ring
106 " " Spring
107 " Dial
108 " Cover Glass & Mount
109 Vernier Cover Glass
109A Vernier Cover Glass Strap
109B Vernier Cover Glass Strap Screw (not shown)
111 Vernier Reflector
112 " " Frame & Hinge
113 Vernier Plate Clamp Tangent Screw
114 Vernier Plate Clamp Tangent Screw Spring Box
115 Tang. Sc. Plunger
116 " " Spring
117 " " Cap
†(Not shown but similar to Nos. 22, 23, 24 & 25.)
†(For Vernier Plate & Telescope Cl. Tang. Screws)
118 Plate Level Bracket & Posts complete
119 Plate Level Vial Guard
120 Plate & Standard Level Adj. Nut
121 Plate & Standard Level Spring
122 Plate & Standard Level Post Cap
123 Plate & Standard Level Vial, Tube & Ends complete
124 Plate & Standard Level Vial

The essential parts of the transit.

Patents Are Important

by Allan O. Maki, Ch. E. 4

Patent information is a subject of great importance to engineers yet many of us know very little about how, where, why and when, to obtain a patent.

THE idea of granting an inventor the right to exclude others from making, using, or selling his invention for a period of years in return for the full disclosure of the invention to the public is not new. Records exist of patents being granted by the Signoria of Florence, Italy, as early as 1421.

The Constitution of the United States grants to Congress broad authority for the granting of patents to encourage inventiveness by recognizing the right of the inventor to profit from his invention. These patent rights, defined by acts of Congress and subsequent court decisions, have played an immeasureable part in the attainment of our advanced technological development and present high standard of living. Because they as a group are continually encountering new problems which often lead to skillful and inventive solutions, engineers have a vital interest in the field of patent law which necessitates at least a rudimentary understanding of the system defined by the statutes.

The general field of subject matter that is capable of being patented includes new and useful processes, machines, manufactures, compositions of matter (including mixtures of ingredients as well as chemical compounds). It does not include the revelation of something which exists but was unknown such as forces or laws of nature, properties of materials, mathematical formulae, and scientific principles. In general, mere improvements of old items are not patentable, but if the degree of difference means the difference between failure and success, it may be patentable. For instance, Edison made a successful light-bulb filament by shortening the length from 1/32 inch to 1/64 inch, a simple change which brought success where many previous attempts had failed.

The patent laws also provide for the granting of design patents for new, original, and ornamental designs for articles of manufacture. Also covered are distinct and new varieties of plant life, an item of only passing interest to engineers.

It is important for anyone working continually with new ideas to be aware of existing patents in his field so that he does not illegally use someone else's patented ideas. The fact that you do not intend to infringe will not save you, if you do infringe. It is much like selling beer to a minor, the fact that you did not know will not relieve you of violation.

The patent application is one of the most difficult of all legal documents to draft. Because the preparation of a patent application and the conducting of the resulting proceedings require a thorough knowledge of the scientific and technical details involved, most inventors hire patent attorneys or agents to do this work for them. A patent attorney is an attorney-at-law who has been registered to practice before the Patent Office; whereas, a patent agent is any other person who is not an attorney, but who has been thus registered. If an invention is commercially good and the patent is well drawn, the result is a salable or otherwise valuable possession. However, if the patent is inadequately worded or the claims insufficient, loopholes may be left which would allow other persons with a small amount of ingenuity to successfully copy the invention without actually infringing in the eyes of the law. In the words of a Federal Court of Appeals decision, "An omission from the claims in any patent application would leave the features so omitted unprotected by the patent statute and the prey to whomever might seize upon them."

When an inventor believes he has made a patentable invention, he files, or has a registered patent agent or attorney file, an application in the Patent Office, where it is read and examined. The inven-

tion, in order to be granted protection, must pass three tests of patentability: novelty, utility, and invention. The examiner studies the claims of the application and then searches the prior art which encompasses the prior knowledge in the field, including United States and foreign patents, periodicals, trade journals, etc., to see whether the claimed invention is novel or whether it has been anticipated by a prior invention. It is not ordinarily fatal if someone in the United States once had the same idea if there was no reduction to practice or if the idea was reduced to practice but unappreciated and subsequently abandoned. This attitude is justified on the ground that the patent system is designed to protect the inventor who has benefited the public by disclosing his invention. If the examiner can find no equivalent invention in the prior scientific art, he decides by the application of legal principals and court decisions whether the claimed invention is useful and whether it involves patentable invention over the most pertinent prior art as distinguished from mere mechanical skill. If the application is formally correct, falls within one of the statutory classes of invention, and passes the three criterion of patentability, the examiner recommends that a patent be allowed. Upon approval by the head of the examining division of the Patent Office, the patent is granted. If the claimed invention fails to meet the test as to novelty, utility, or invention the examiner recommends its rejection.

Rejected applications are subject to appeal to the Board of Appeals in the Patent Office and to the Courts. Also, the validity of patents issued by the Office may be challenged in the Courts during infringement suits.

To the individual inventor, patent protection for an invention makes possible the sale or licensing of his idea to another person or group. Without this protection there would be no restrictions against theft of his invention. Furthermore, many companies will not consider purchasing an outsider's invention unless he has filed a patent application. This is because it has occurred that the same or a similar idea has been simultaneously conceived somewhere within the organization. In spite of honest intentions, a company in this embarrassing position is hard pressed to prove that it did not steal the idea from the inventor who took them into his confidence. As a result, the outsider is usually required to sign a form relieving the company of any liability or responsibility arising from the presentation of the invention to the company's patent attorney. Some companies take the easy way out by refusing to look at an invention unless the inventor has already filed an application for a patent.

The patent system also offers many advantages to corporations. In general, companies require employees to assign all patents granted to them on work done while employed by the company to the company and the employees are legally bound to do so. Properly drafted patents can prevent competitors from taking a free ride on the corporate research and development money. If a company delayed applying for a patent until a competitor discovered the invention and had it patented, it would be forced to redesign its process or make royalty payments to the rival. Therefore, holding patent rights promotes a more competitive selling price because it is not loaded with unnecessary redesign costs or royalty payments. It also might prevent unnecessary delays in launching a new or improved product, delays brought on by patent conflicts.

In spite of the fact that holding a patent on an invention includes these numerous advantages both for individuals and corporations, there has been a growing trend toward secrecy as opposed to public disclosure and protection. It is not possible to legally have both secrecy and protection. In the words of a court decision, "It is a condition upon an inventor's right to a patent that he shall not exploit his discovery competitively after it is ready for patenting; he must content himself with either secrecy or legal monopoly." Nor is it legal to delay an application to stall for time.

Applications are not rapidly rising despite a record rate of invention and an all-time high in corporate research expenditures. This is due in part to court decisions showing an increasing unwillingness to sustain the validity of contested patents or to approve judgments against alleged infringers. In the words of one unfriendly judge, ". . . the only patent that is valid is one which this court has not been able to get his hands on . . ."

Patents still protect the individual, often financed by a small manufacturing concern. But among the big corporations, it is becoming increasingly rare that a new product or process, once on the market, cannot be somewhat successfully copied by competitors. Thus, a seventeen-year patent protection seldom offers the opportunity to recover the heavy research costs and is relatively meaningless commercially. In a highly competitive market, moreover, the advantages of secrecy often outweigh the protection offered by recording a patent.

The course of these trends will be decided by future legislation and court decisions. A graduating engineer can expect the possibility of encountering these issues in the form of personal patents held or secrecy and strict security regulations depending on the policies set forth by the management of the firm that hires him.

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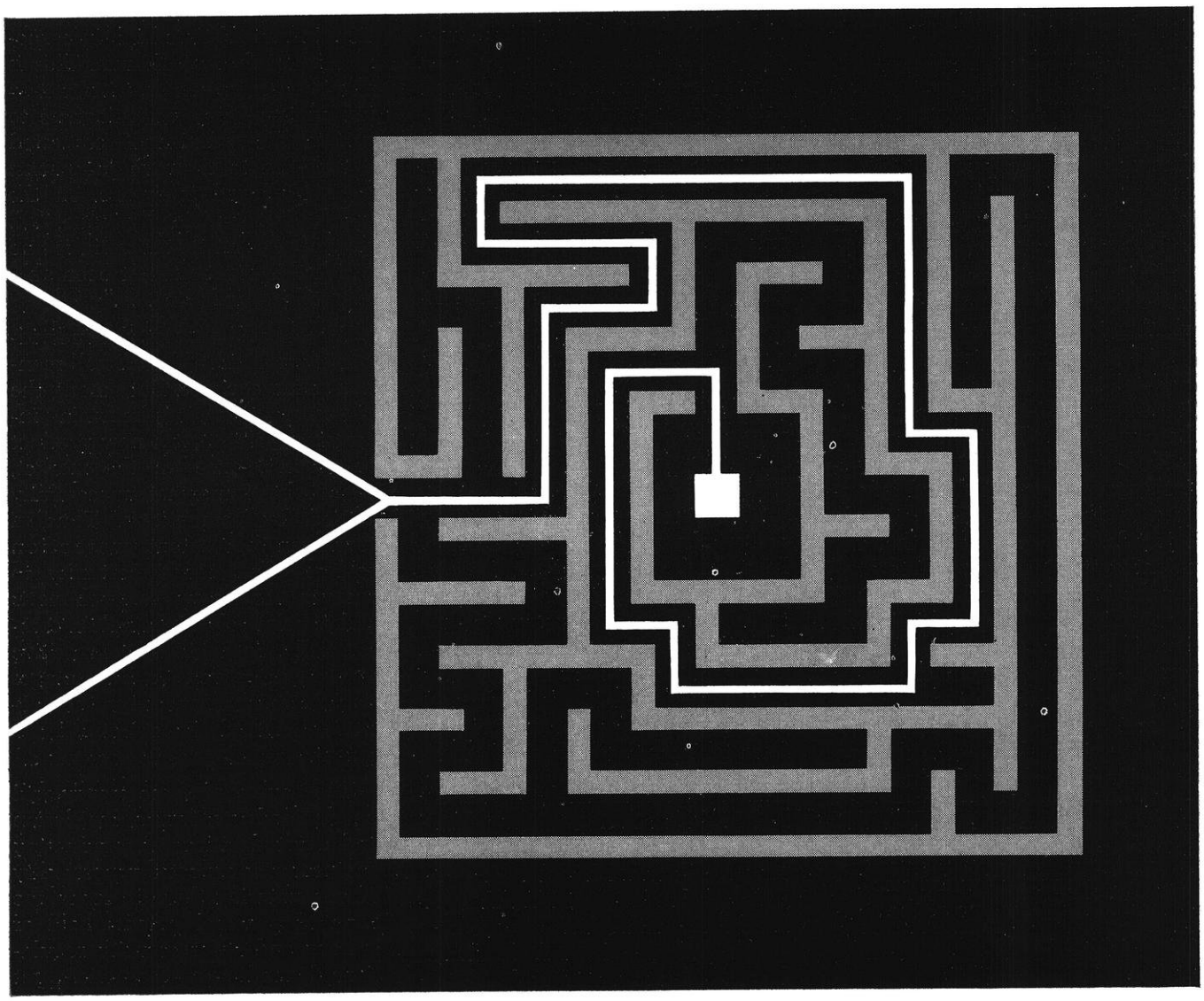
THE END



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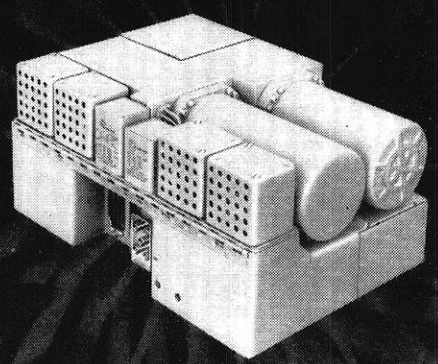

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Industrial Balancing

by Ray L. Young

A discussion of the balancing problems in the design and manufacture of rotating machines

IN THE past few years the subject of "balancing" has greatly increased in importance, primarily due to the increase in rotational speeds and the increase in the number of machines requiring low vibration.

The phases of balancing in an industrial plant and the considerations in each phase are herein considered.

GENERAL

There are two types of unbalance which result when the two conditions of equilibrium are not met. When the sum of the forces not equal to zero, the center of gravity will not lie on the rotational axis. The resulting unbalance is referred to as "force" unbalance. When the sum of the moments about the center of gravity not equal to zero, the principal inertia axis will be inclined with respect to the rotational axis and the resulting unbalance is referred to as "moment" unbalance.

Unbalance exists in a part when the principal inertia axis does not coincide with the rotational axis. Vibration results because the part wants to rotate about the principal inertia axis instead of the rotational axis. "Force" unbalance is present when the principal inertia axis is displaced parallel to the rotational axis and "moment" unbalance exists when the principal inertia axis is inclined angularly with respect to the rotational axis.

PROBLEMS IN DESIGN

Unbalance Correction Considerations

The designer's first consideration in balancing is to estimate the amount of unbalance expected. For a balanced condition, the centrifugal forces of all particles of mass in the part must be in equilibrium about the rotational axis. The conditions are that the sum of the centrifugal forces in any direction must equal zero and the sum of the moments of these forces about the center of gravity must also equal zero. (Moments about any point on the rotational axis will equal zero if they are zero about the center of gravity.)

First, the rotational axis of the part should be identified. This will be the axis dictated by the two journals if the part has its own shaft. If the part does not have its own shaft, the rotational axis will be defined by a face and O.D. or I.D. location. Then, the distribution of mass about this axis should be analyzed. The effect of any unequal distributions (which are not counterbalanced to satisfy the conditions of equilibrium) should be calculated in terms of the resultant effect in the planes of correction. All the causes of unbalance should be considered in their worst possible condition and added together to give the maximum expected unbalance in the chosen correction planes.

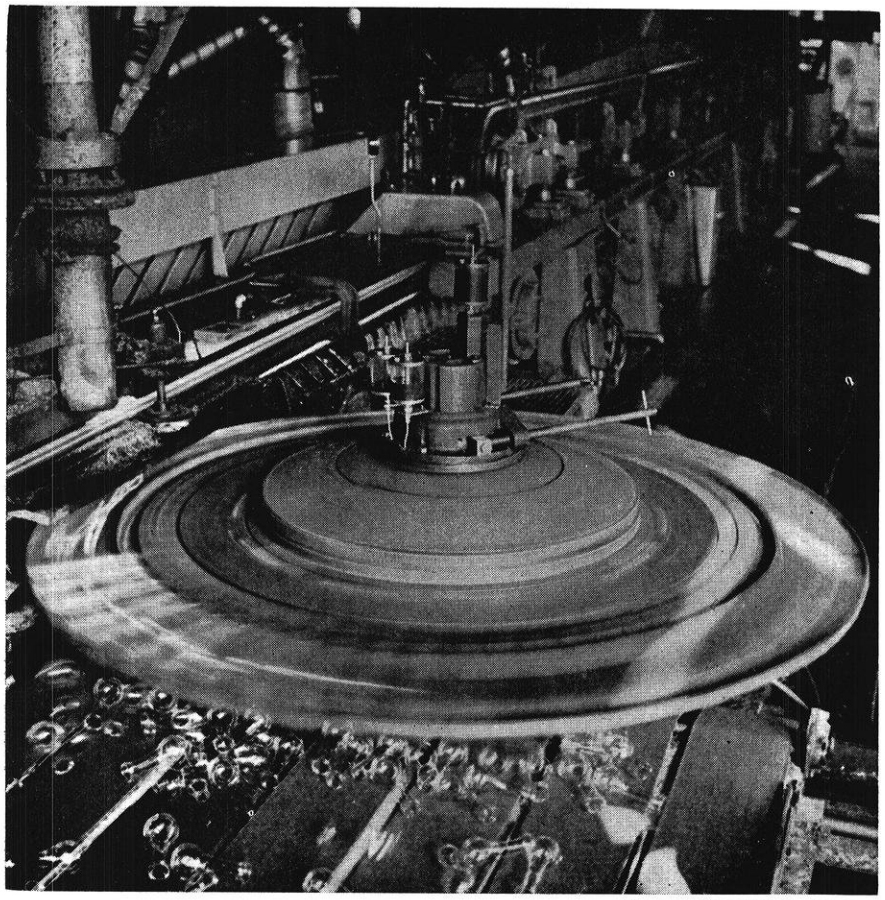
Most causes of unbalance fall under three general classifications. The first is mass distribution due to the function of the part. Examples are a keyway, a hole in one side but not in the other, a cam, or a boss. If these effects are excessive, it will be necessary to counterbalance them with equal and opposite effects.

The second classification is dimensional control. For instance, if the main body of a cylindrical rotor has a runout tolerance of 0.002 inches T.I.R. with respect to the journals, it would be possible for the center of gravity to be displaced 0.001 inches. If the body weighs twenty pounds, the effect in the plane of the center of gravity of the body would be:

20 pounds $\times$ 16 ounces/pound $\times$ 0.001 inches $=$ 0.32 ounce inches.

This effect must then be converted into the resultant effect in the correction planes. A hollow part where the inside surface runs out with respect to the journals would cause a similar situation.

As another example, if the part to be balanced is an assembly of two parts, there will be a consideration of the location of one part with respect to the part containing the shaft. There will be three dimensional tolerances to investigate, one face and two runout locations. Another example is angular tolerance. If a part has several masses which are located radially from the shaft the angular tolerance of these masses would have to be investigated.



—Corning Glass Works Photo

Fig. 1.—The rotor supporting this whirling circle of pans which scoop newly blown bulbs from the Corning ribbon requires accurate balancing for satisfactory operation.

The third classification includes the unpredictable causes of unbalance such as variation in density of the material and internal voids in castings. These causes cannot be estimated and added to the totals. However, since all of the predictable causes were taken at the worst condition and added, the result will probably be high enough to be a good estimate of the maximum expected unbalance.

With a knowledge of the maximum expected amount of unbalance, the designer can determine the method of correction. This will normally be either an addition or a removal of mass. There must be enough capacity in the correction method to take care of the expected amount of unbalance.

Determining the Tolerance

The designer's next consideration is the balancing tolerance. For economy, he must determine the maximum unbalance that can be left in the part and still have it give satisfactory operation. Satisfactory operation is usually judged on one of two bases. One basis is the disturbance caused by the amplitude and frequency of the vibration. The second basis is the wear or stress caused by centrifugal forces at the bearings. The forces and frequency caused by a tolerance can be predicted quite closely but the amplitude of vibration is very difficult to predict. It depends upon the shape and weight of the part, the location of the bearings with respect to the correction planes, the mass distribution of the housing with respect to the correction planes, the rigidity of the housing, and the rigidity of the mounting.

Sometimes it is more economical and satisfactory to determine the tolerance empirically. This can be done by building several prototypes and leaving a successively larger amount of unbalance in each one. The one with the largest amount that gives satisfactory results will determine the tolerance.

Drawing Specifications

The third consideration for the designer is the drawing specifications. These specifications must show the method of correction with any limitations, the tolerance, and the surfaces to be used for locating the part during the balancing operation.

It is the designer's responsibility to designate the method of correction. He is in the best position to know how the corrections will affect the strength of the part and how much clearance there is for corrections. With these things in mind, he should show any limitation such as the maximum depth to drill or the maximum height of a solder correction.

The tolerance is best described by stating the amount of unbalance that can be left in each of the designated correction planes. To give the tolerance without specifying the plane is not a complete specification. An alternate method is to specify the amount of "force" unbalance allowable in ounce inches and the amount of "moment" unbalance allowable in ounce inch inches. Because of their shape, some parts may not have a significant amount of moment unbalance. In this case, only the force tolerance is necessary and a "single plane" correction specified.

A complete specification for a design drawing shows the method of correction with limitations, the tolerance, and the surfaces to be used for support during the unbalancing operation. With this information furnished by the designer, the manufacturing phases of balancing can be dealt with.

DESIGN OF TOOLING

Purpose and Description

The purpose of balancing tooling is to adapt the part to the balancing machine. The tooling must support the part on the surfaces specified by the designer. This is necessary so that the part is balanced about the correct rotational axis. To balance it about one axis and rotate it about another axis in the final assembly would defeat the purpose of balancing. Tooling may also be required to adapt the part to the driving device of the machine.

Dimensional Tolerances

The dimensional tolerances of balancing tooling are very critical.

(Continued on page 42)

Previewing Your Career in Industry

by Don Roeber Me '60

This summer two University of Wisconsin students attended a two week summer workshop program at Procter & Gamble Company. Their experiences, as told to a member of the Engineer staff, are a preview of the work of the engineer in industry.

"WHERE can I get a summer job?"

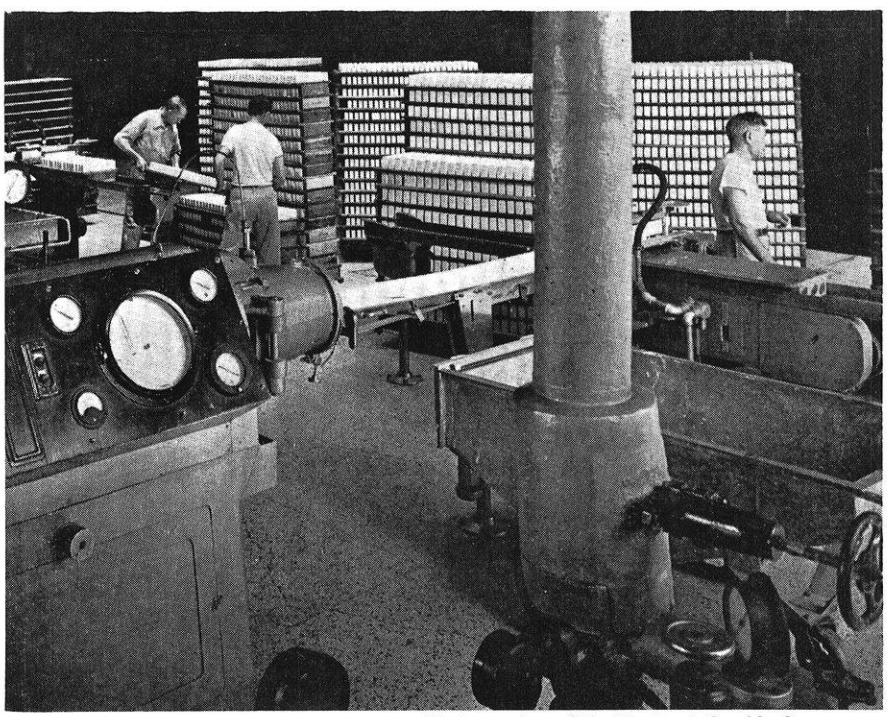
"How do I know which field in industry offers me the career I want; can I preview a field?"

In the next few months, like thousands of university students all over the nation with technical training and interests, you'll be asking yourself those questions.

They're the same questions that last summer led Wisconsin undergraduates Gene Venzke and Ken Lewandowski and 125 men from 45 other colleges and universities to the two summer training programs of The Procter & Gamble Company. These programs combine summer employment with the opportunity to see, at first hand, the roles of university-trained men in industry.

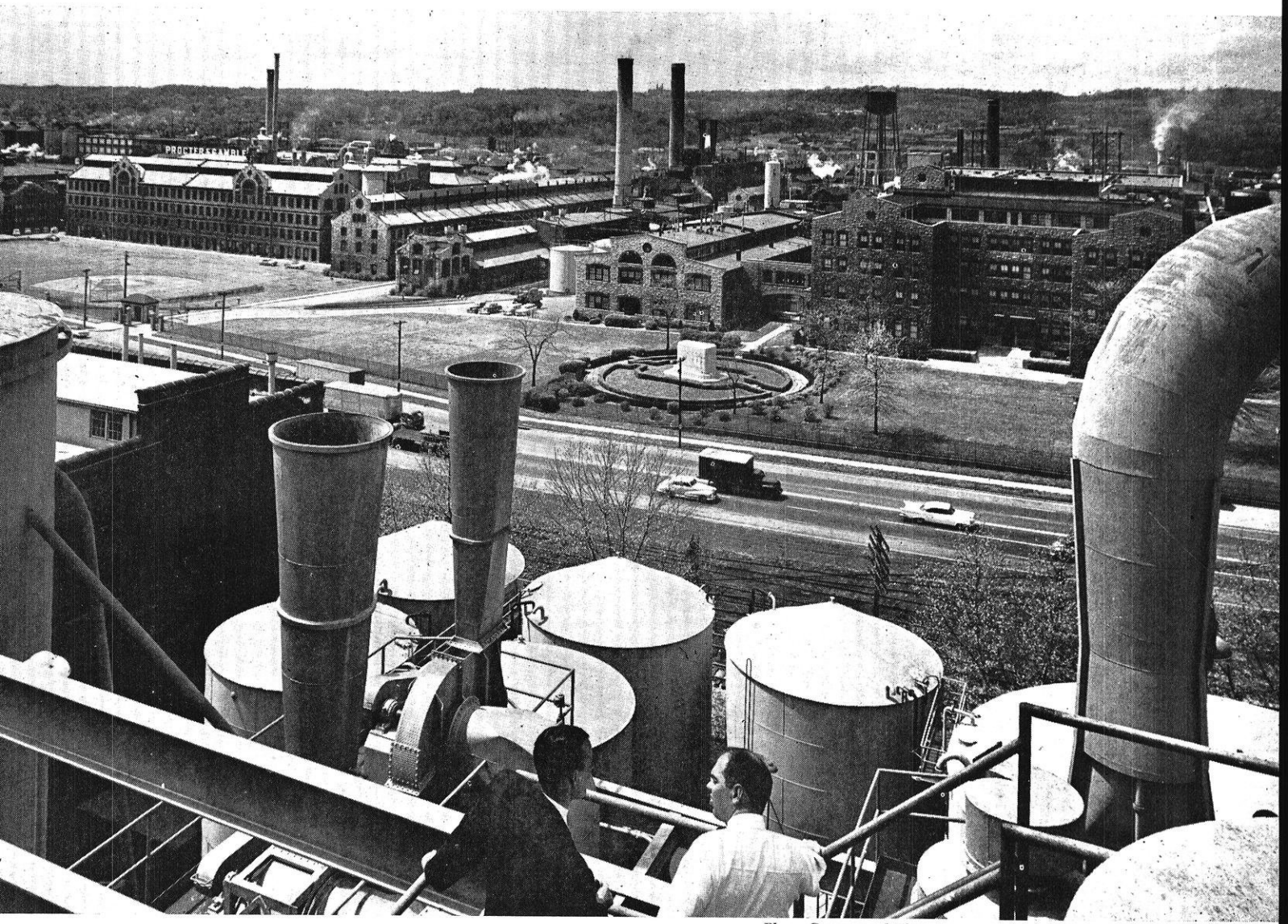
One of the nations leading chemical processors, P & G offers a Full Summer Program and a Summer Workshop Program to engineering and science students who are within a year of receiving an undergraduate or graduate degree.

The Full Summer Program lasts from five weeks to all summer. The Summer Workshop Program, designed especially for college students who can spend only a part of their summer in industrial training because of military, academic, or other commitments, is "capsuled" into two weeks in August and September. As a "getting to know you" device, young men gain their initial industrial experience; and more important, they have the opportunity to preview the field of their choice in an industrial setting.



—Photo courtesy of the Procter & Gamble Company

Both Full Summer and Workshop people work on current technical problems actually being faced by the company. In the area of operations shown above, for example, a Summer Training man might be asked to study ways of reducing dust and of eliminating the possibility of any foreign material getting into the product.



—Photo Courtesy of The Procter & Gamble Company

Staff division Workshops in engineering and industrial engineering and research and development are based in P & G's manufacturing and technical headquarters in Cincinnati, on the right above. A plant management Workshop is held each year at Ivorydale, center and left, P & G's largest manufacturing installation.

They gain a better understanding of industry and of their own career aims. Workshop and Full Summer participants are paid regular salaries, plus transportation expenses from their home or campuses to P & G locations.

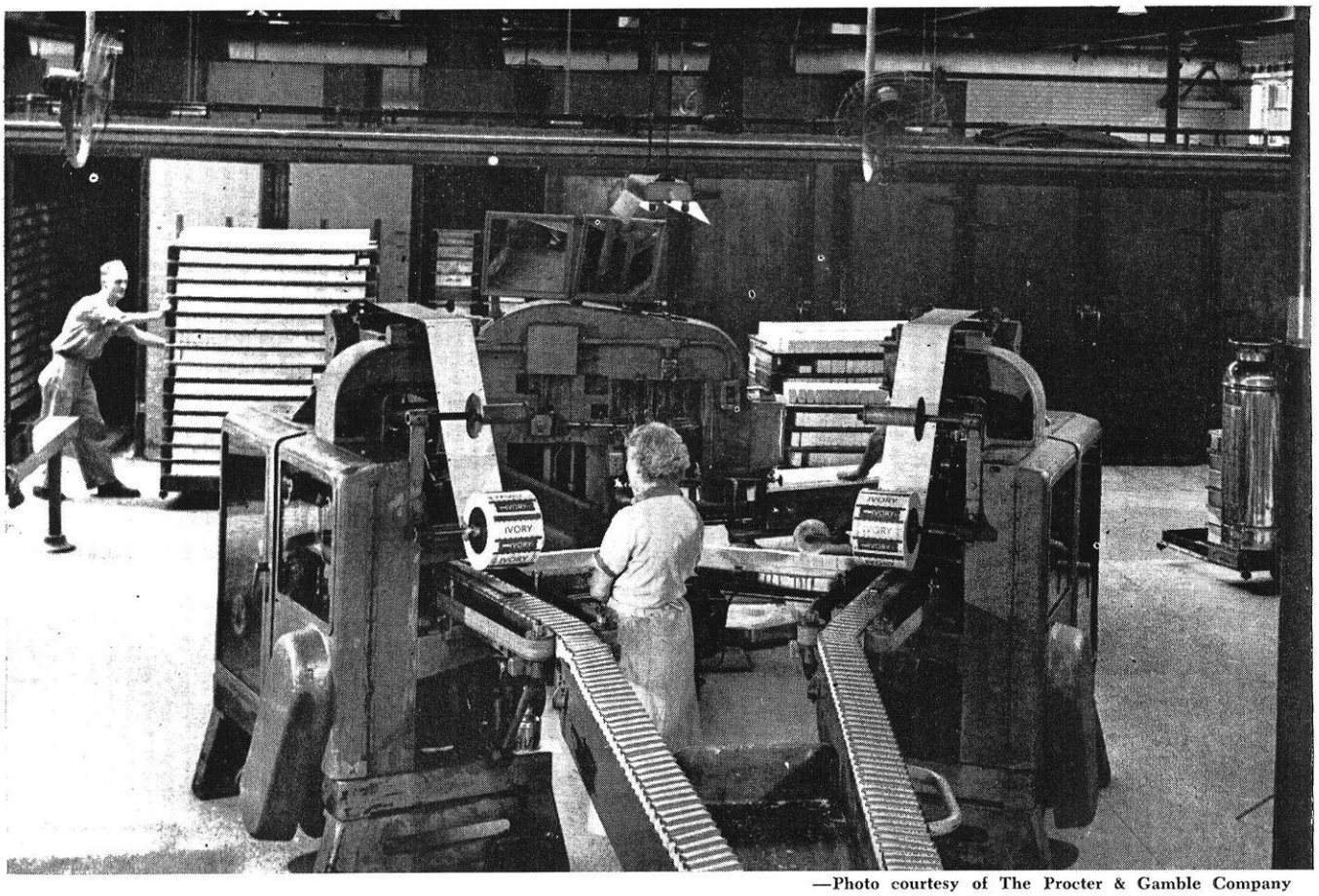
Provides Insight

Both programs are designed to furnish the student with a new insight into industrial activities in one of four distinct career fields: plant management, engineering, industrial engineering, and research and development. In the program in which they participated each of the Wisconsin students had a chance to examine several possible careers through personal experience in actual work and through close teamwork and discussions with members of company management and fellow student trainees.

Lewandowski, who expects to be graduated with a Bachelor of Science degree in Electrical Engineering in February, 1960, first made a close and detailed study of a problem in time-bonus administration. As part of his work in this important area of "extra pay for extra production," he outlined recommendations for clean up methods and prepared a clean up schedule for a department packing the company's new deodorant soap bar. On a later assignment, he observed at first hand the daily role of an electrical foreman in the plant's operations. Ken comes from West Allis, Wis. He is a member of Phi Eta Sigma, Eta Kappa Nu, A.I.E.E., I.R.E.–Polygan Board Representative, Joint Military Board, and the Sailing Club. He is associate editor-in-chief of the "Wisconsin Engineer."

Venzke participated in one of P & G's two Engineering Workshops, held August 18–29 at the company's technical and manufacturing headquarters in Cincinnati. Lewandowski was a member of the Plant Management Workshop held August 18–29 at the Ivorydale plant, P & G's largest manufacturing installation, in Cincinnati, Ohio.

Venzke, who expects to receive his Bachelor of Science degree in Electrical Engineering (with a major in Communications and Electronics, plus a Physics option) in June was first assigned the problem of determining what equipment and procedural changes were



—Photo courtesy of The Procter & Gamble Company

Bars of high-quality Ivory Soap stream off the wrapping machines at Ivorydale plant—oldest and largest of P & G's manufacturing locations. In the operation above, for example, a high percentage of wrappers on the finished bars may not be "in register." The Summer Training man might be asked to find the cause for the faulty registration and devise a way to eliminate it.

needed for a twenty per cent increase in the sulfation capacity for making a liquid detergent. Later, he worked on the development of a reject mechanism that, coupled with a premium detector, would remove cartons of detergent granules that had not had a planned premium inserted in them. Gene, whose hometown is Waukesha, Wis., is a member of Eta Kappa Nu, Phi Eta Sigma, and Tau Beta Pi.

Typical Assignments

Some other typical problems which P & G Workshop students were assigned:

1. Determine optimum warehouse inventory levels for certain company products at a plant.

2. Measure forced air flow through a synthetic detergents spray drying tower, then make comparisons of air flow to objective data already known such as power usage of the tower exhaust fan, in order to determine effective operating controls on the air flow.

3. Evaluate a modification which has been made on a pilot plant in synthetic granules production and determine the best operating conditions for producing detergents using the modification.

4. Find the source and determine how to correct product loss through the vacuum system on a high-speed synthetic detergents packing line.

5. Develop a method and design equipment to accomplish economically a special short production run.

6. Investigate the effects of formulation and process variables on physical properties of liquid shortening under various storage conditions.

7. Prepare a multi-factor incentive plan for a production operator.

Procter & Gamble Workshops in Plant Management were held at plants in several parts of the country. All staff division Workshops in Engineering and Industrial Engineering were held at the company's technical and manufacturing headquarters in Cincinnati.

Individual Workshops in career fields were kept small, eight to ten men, to insure participation. Each Workshop man presented a report on his problem to the others in his group and to members of company management; these group reports giving each student an over-all picture of the company's technical and engineering operations in his Workshop area.

In Cincinnati, Workshop men were furnished housing at a University of Cincinnati dormitory. Similar arrangements were made for the men participating in Workshops at each of the P & G plant locations.

And the two weeks were not all work. Friendships formed quickly in the exchange of information between men coming from different colleges. Evenings, and during the single week end, the men were free to enjoy the sports, cultural, and social facilities and historical points of interest in and around the city.

(Continued on page 46)

Wisconsin Society of Professional Engineers

by Darell Meyer ee'61

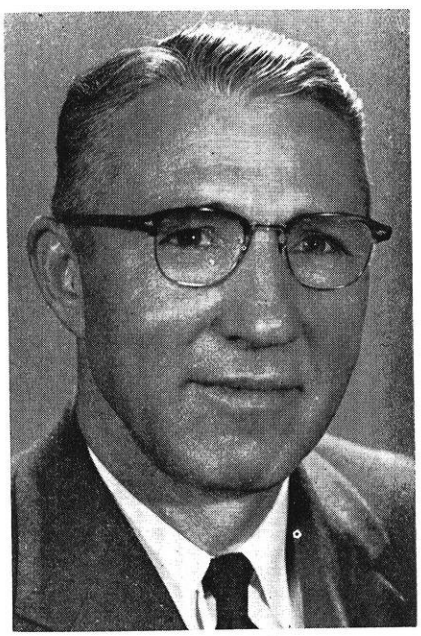
NEW DISTRICT I HEAD

The State Highway Commission has called back to Madison from La Crosse Vere L. Fiedler, P.E., to fill the vacancy of District I Engineer left by J. C. Jones, P.E., who retires June 1, 1959. A 32-year veteran with the Commission, Fiedler will take on the responsibilities of heading the Madison District which is entering the largest program of highway construction in its history, with 17 miles of Interstate Highway already under contract, part of which is already under construction.

Vere Fiedler was born in 1903, in Oakdale, Wisconsin, and graduated from Tomah High School. He attended Tri-State College at Angola, Indiana, where he received his B.S. degree in Civil Engineering.

After a year of experience in subdivision and street layout work, he came to the La Crosse District of the Highway Commission in 1926, where he worked as an inspector, chief of party, and resident engineer until 1929. In 1930, he rejoined the Highway Commission at the Green Bay District where he resumed highway work in various capacities, but mostly in construction, until 1942. During World War II, he was with the Bureau of Public Roads on the Alcan Highway and in the Philippine Islands on rehabilitation work.

In early 1947, he rejoined the Green Bay District and was assistant District Construction Engineer when he was transferred to the Main Construction Office, in Madison, late in 1948. In 1953, he became Assistant State Maintenance Engineer until December, 1954, when he was appointed District Engineer to La Crosse.



Vere L. Fiedler.

Mr. Fiedler is a registered Professional Engineer, a member of N.S.P.E., and the Western Chapter of W.S.P.E., serving currently as Board Director of the last mentioned organization.

Civic minded, he is a member of the La Crosse Lutheran Hospital Association, Director of the La Crosse County Easter Seal Board, and has served as chairman of the Lay Committee on the study of school construction costs in La Crosse.

His social affiliations include membership in the La Crosse Elks Club, the Rotary, and the Shrine.

In December, 1924, Mr. Fiedler married Grace E. Haase. They have three sons; Harold L., an engineer with the Milwaukee District of the Highway Commission; Ronald L., with the Waukesha District II, and Dean E., at home.

Mr. Fiedler's hobby is traveling. At college, he engaged in boxing.

Mr. Fiedler's coming to Madison will be a gain to the Southwest Chapter at the expense of the Western Chapter of W.S.P.E.

STATE BOARD ACTION

The State Board at the January 10 meeting considered for action the restatement of the Articles of Incorporation of W.S.P.E. so as to conform to recent amendments to the By-Laws.

Amendments to By-laws

The amendments to the By-Laws are considered to facilitate the use of the so called "Texas-Plan" whereby it invites new P.E. and E.I.T. registrants to join W.S.P.E., granting them free introductory membership for the balance of the year in which they join.

Meet the President

G. D. Simonds, President Fox River Valley Chapter.

G. Douglas Simonds, President of the Fox River Valley Chapter of W.S.P.E., came to Clintonville, Wisconsin, in 1935, at the age of 41 to assume the duties of Assistant Chief Engineer for the Four Wheel Drive Auto Company. He became Chief Engineer in 1952, and in 1954, he became Vice President of Engineering.

Born in Newark, New Jersey, in 1896, he resided, worked, and acquired engineering experience in New York and New Jersey until his coming to Wisconsin. He acquired his Mechanical Engineering education at Cooper Union and began his first engineering work as a draftsman for the Splitdorf Electric Company at Newark, New Jersey, in 1916. Until 1921, he worked for several companies in the New York Metropolitan area as draftsman, chief draftsman, layout and designer for equipment ranging from adding machines and typewriters to auto parts and various electrical equipment.

From 1921 to 1935, his work ranged from Engineer to Sales Engineer for A. T. & T. Bell System, the Graybar Electric Company, and the Four Wheel Drive Auto Company.

Professionally, Mr. Simonds is affiliated with S.A.E., N.S.P.E., and W.S.P.E. Fox River Valley Chapter, serving currently as president of the last organization.

His civic activities, beside Rotary, are definitely of musical leaning as he belongs to the Clintonville String Quartette and is president of the civic orchestra.

Socially, he is active in the Clintonville Ski Club and the M. & M. Yacht Club.

In the engineering field, he is credited with important patents, inventions, and developments in A–11 Wheel Drive Trucks. He is also responsible for the expansion of the Engineering Division at the Four Wheel Drive Corporation.

Mr. and Mrs. Simonds (the former Mildred Brook) have two children, Alice May, born May 23, 1921, and George Jr., born October 30, 1929.

From his civic and social activities, it can readily be seen that his hobbies are sailing and skiing.

(Continued on page 46)

ENGINE EARS

by Tom Corth, ee'60

NEWS FROM KAPPA ETA KAPPA

The spring semester's first meeting of the Delta chapter of Kappa Eta Kappa, professional electrical engineering fraternity, was held at the chapter house located at 204 North Murray Street, Madison. The new officers for the spring semester are: President, Al Goshaw; Vice President, Al Spangler; Treasurer, Fred Hermann; Recording Secretary, Don Eliason; Corresponding Secretary, Myron Stanke; Alumni Secretary, Bob Baltes; and Social Chairman, Jim Teppo.

ATTENTION! PROFESSIONAL FRATERNITIES AND SOCIETIES

Publicize your group through news items in the *Wisconsin Engineer*. Every professional fraternity and society knows the value of publicity for reaching new members. Here is a perfect opportunity to make known your group's activities and plans. All we ask that you do is to hand in your news items with fairly detailed information, especially names, in a reasonably well written or typed form. Have the information in to the Wisconsin Engineer office, room 333 M.E. Building, by the fifth day of the month preceding the date of publication. This is our service to you. It costs you nothing, so take advantage of it!

KHK is looking forward to an active semester socially, academically, and professionally. Two smokers were held for prospective pledges on February 9 and 16. The smokers were held to familiarize the new students with the men and activities of the fraternity. Of course, there were plenty of refreshments served along with a good deal of socializing between the actives and new students. The new pledges will have a chance to display their wit and talent at the pledge party on April 18. From past records it can be noted that the pledge planned party usually is the most interesting party of the year.

Last semester's pledges were formally initiated into the fraternity at the chapter house on March 7. The new initiates are: Donald Bendis, Rodney Littlefield, Carlos Matos, Myron Noth, and David Schroeder. Also at this time, Mr. Donald Gritzmacher, faculty member of the Electrical Engineering Department, was initiated into the fraternity as an honorary member. After the formal initiation, the members were assembled at Hans Thaller's Steak House for the initiation banquet. Mr. Scott Cutlip, of the Department of Journalism, was the guest speaker.

Socially, KHK has a well planned program for second semester. The parties that are planned will take place at the fraternity house on the evenings of February 14 and 28 and April 18. The semester's social festivities will be terminated with a picnic to be held on May 9. All of the members are looking forward to another fun filled Campus Carnival exposition. KHK and Victoria House are presently planning a booth that will undoubtedly be just as novel and exciting as last year's.

The members of Kappa Eta Kappa have submitted a proposal for a student workshop to the faculty of the electrical engineering department. The workshop will be open two nights a week if the plan is accepted, and will be made available to all electrical engineering students. All in all, it looks like another well rounded program for the members of KHK to enjoy during this spring semester.

TRIANGLE FRATERNITY

The second semester rolled into full swing at Triangle with an informal party on February 7, and a Valentine Party on February 14. Final plans are now being made for St. Patrick's Day, with a buffet lunch for Triangles and their dates scheduled at the fraternity house preceding St. Pat's Dance. Oscar, the Ironman, mascot of the engineers, is being polished for his appearance as guest of honor at the dance.

Rushing smokers were held on February 2, 6, and 16, in an effort to acquaint the engineering student with Triangle. Dean Bruce Davidson spoke on "A Broader Education for Engineers" at the February 6 smoker. Faculty guests included Al Szews and Professor George Sell.

Triangle Publicity Chairman, Steve Resan, has begun making contacts for the annual Parent's Weekend tours through the Engineering Buildings. These tours have been sponsored by Triangle

(Continued on page 47)

MEET ARLIS

SUBJECT:

Arlis Edgington

ORIGIN:

Los Angeles

DESCRIPTION:

Class—Senior

College—L & S (English)

Age—22

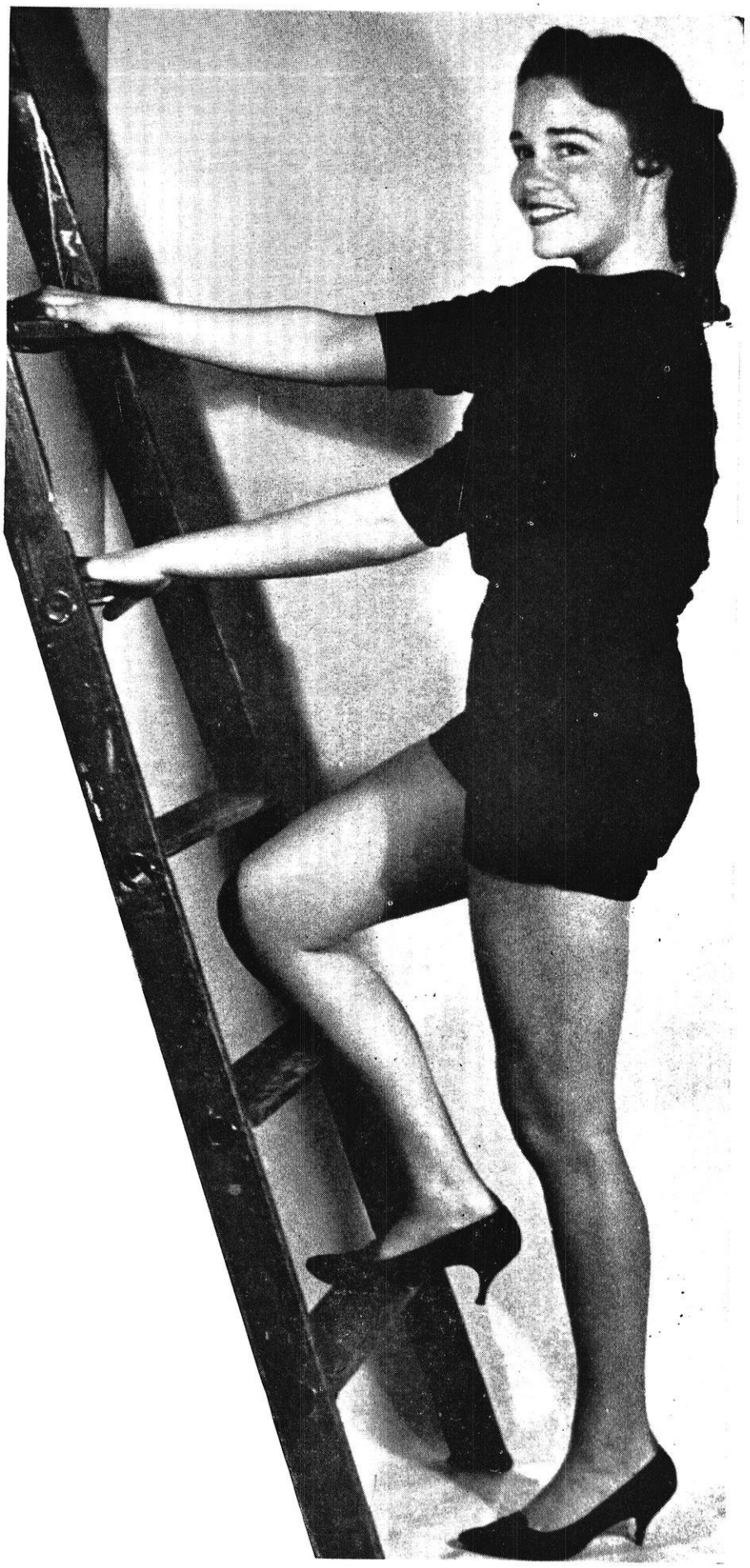
Dimensions—Yes

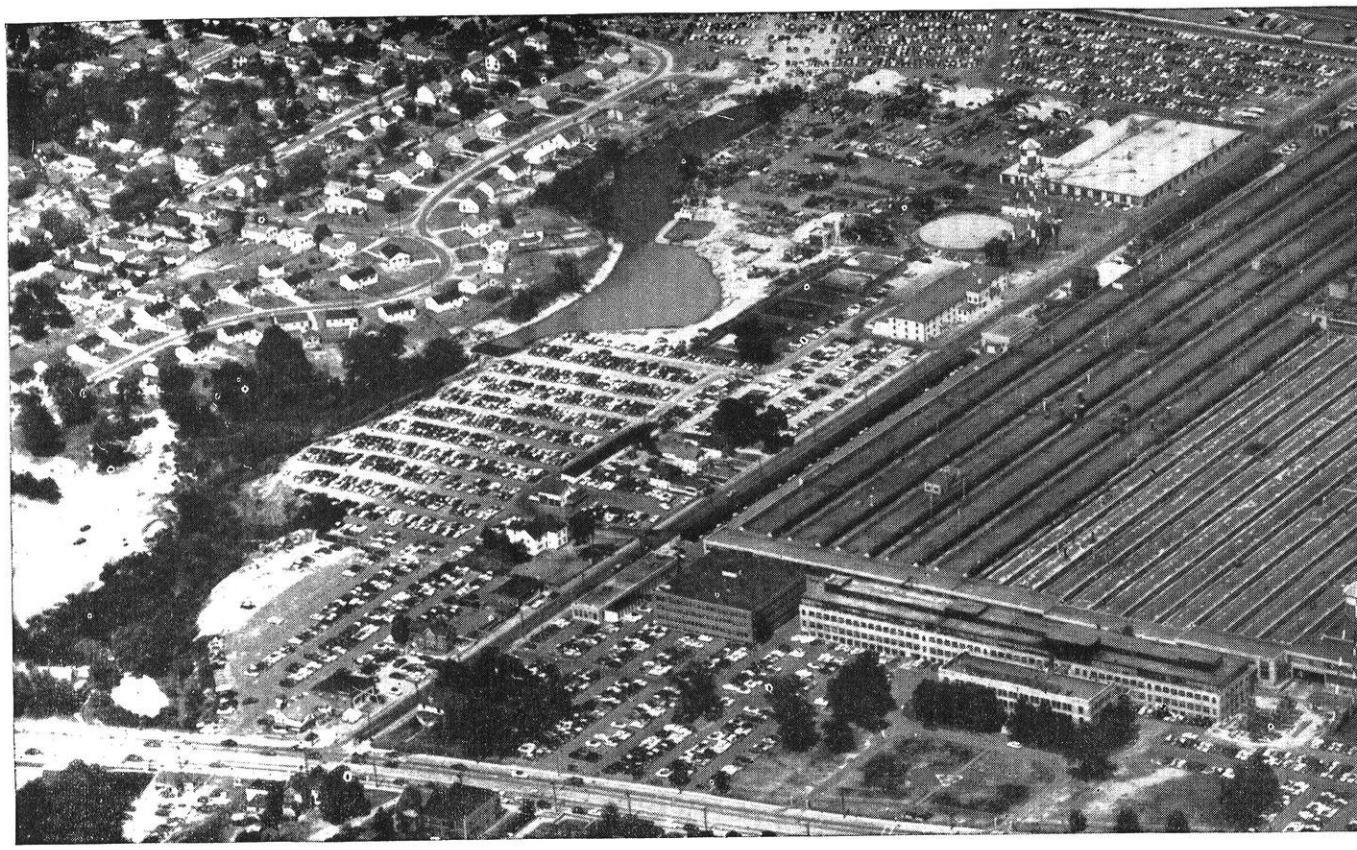
PROCEDURE:

AL 5–6763
(Kappa Kappa Gamma)

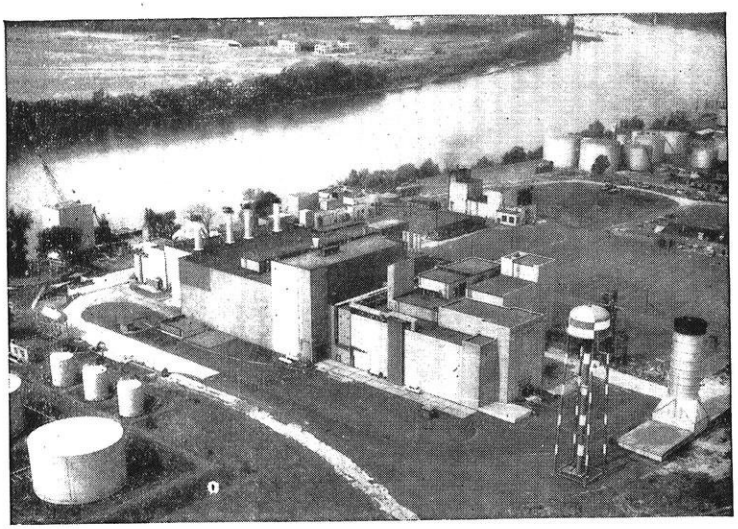
OBJECTIVES:
(In order of preference)

1. Men
2. Dancing
3. Sports

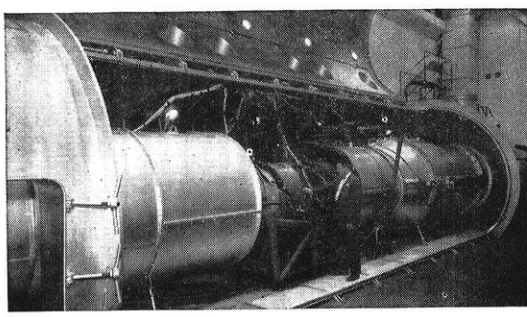




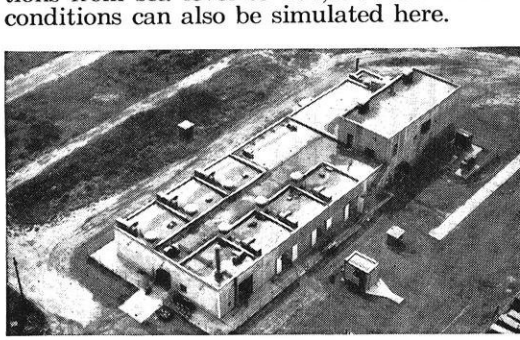
CONNECTICUT



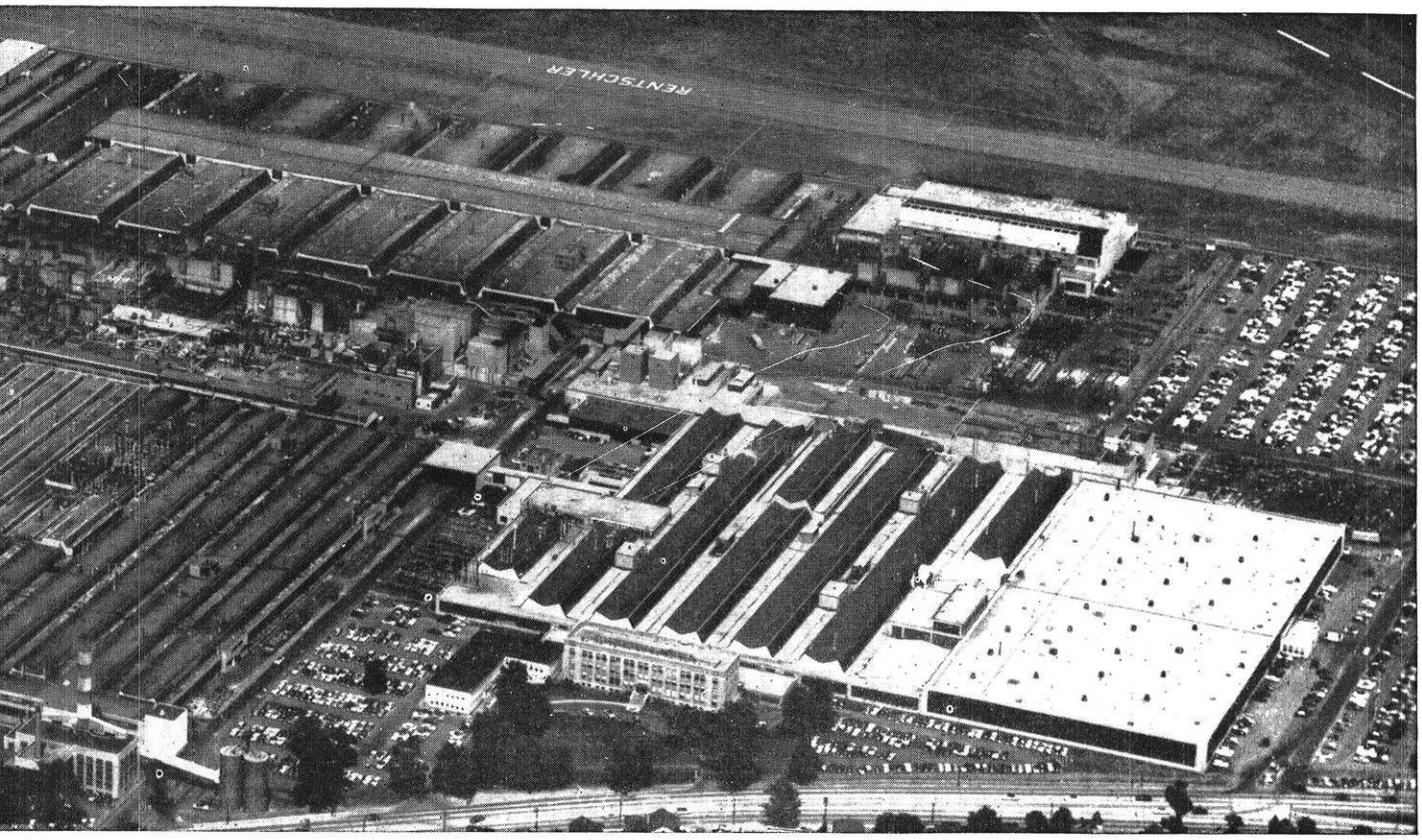
The Willgoos Turbine Engine Test Facility is the world's most extensive privately owned turbine development laboratory. Designed and built specifically to test full-scale experimental engines and components in environments simulating conditions at extreme altitudes and speeds, it is currently undergoing expansions that will greatly increase its capacity for development testing of the most advanced forms of air breathing systems.



In chambers like this at the Willgoos Turbin Engine Test Facility full-scale engines may b tested in environments which simulate condi tions from sea level to 100,000 feet. Mach conditions can also be simulated here.



In the new Fuel Systems Laboratory enginee can minutely analyze the effects of extreme e vironmental conditions on components of fu systems — conditions such as those encou tered in advanced types of flight vehicl operating at high Mach numbers and high alt tudes. Fuel for these tests can be supplied any temperature from −65°F to +500°F.



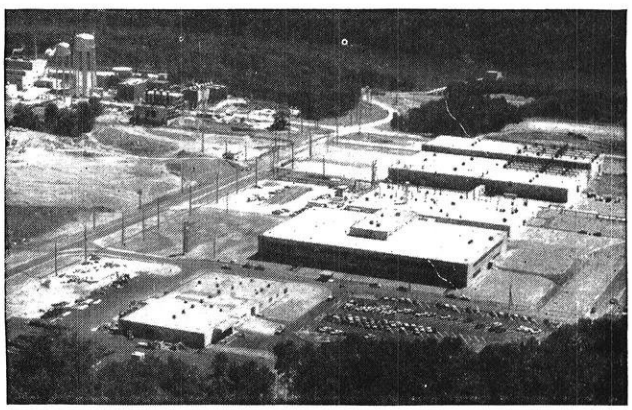
OPERATIONS

Unmatched Engineering Facilities for Developing Advanced Flight Propulsion Systems

Operations at Pratt & Whitney Aircraft are essentially those of an engineering and development organization. As such, an engineering atmosphere dominates the work being done, much of which directly involves laboratory experimentation.

In the past three decades, expansion at Pratt & Whitney Aircraft has been almost tenfold. In recent years, greatest emphasis has been on extending engineering facilities to meet the needs of advanced research and development programs in flight propulsion.

Among the Connecticut P & W A facilities are many that are unequaled in the industry. Thus today, Pratt & Whitney Aircraft is better prepared than ever to continue development of the world's best aircraft powerplants . . . to probe the propulsion future . . . to build and test greatly advanced propulsion systems for coming generations of flight vehicles — in whatever form they take.



The Connecticut Aircraft Nuclear Engine Laboratory, operated by Pratt & Whitney Aircraft, is situated on a 1,200-acre tract near Middletown. The Laboratory was specially built for the development of nuclear flight propulsion systems.

For further information regarding an engineering career at Pratt & Whitney Aircraft, consult your college placement officer or write to Mr. R. P. Azinger, Engineering Department, Pratt & Whitney Aircraft, East Hartford 8, Connecticut.

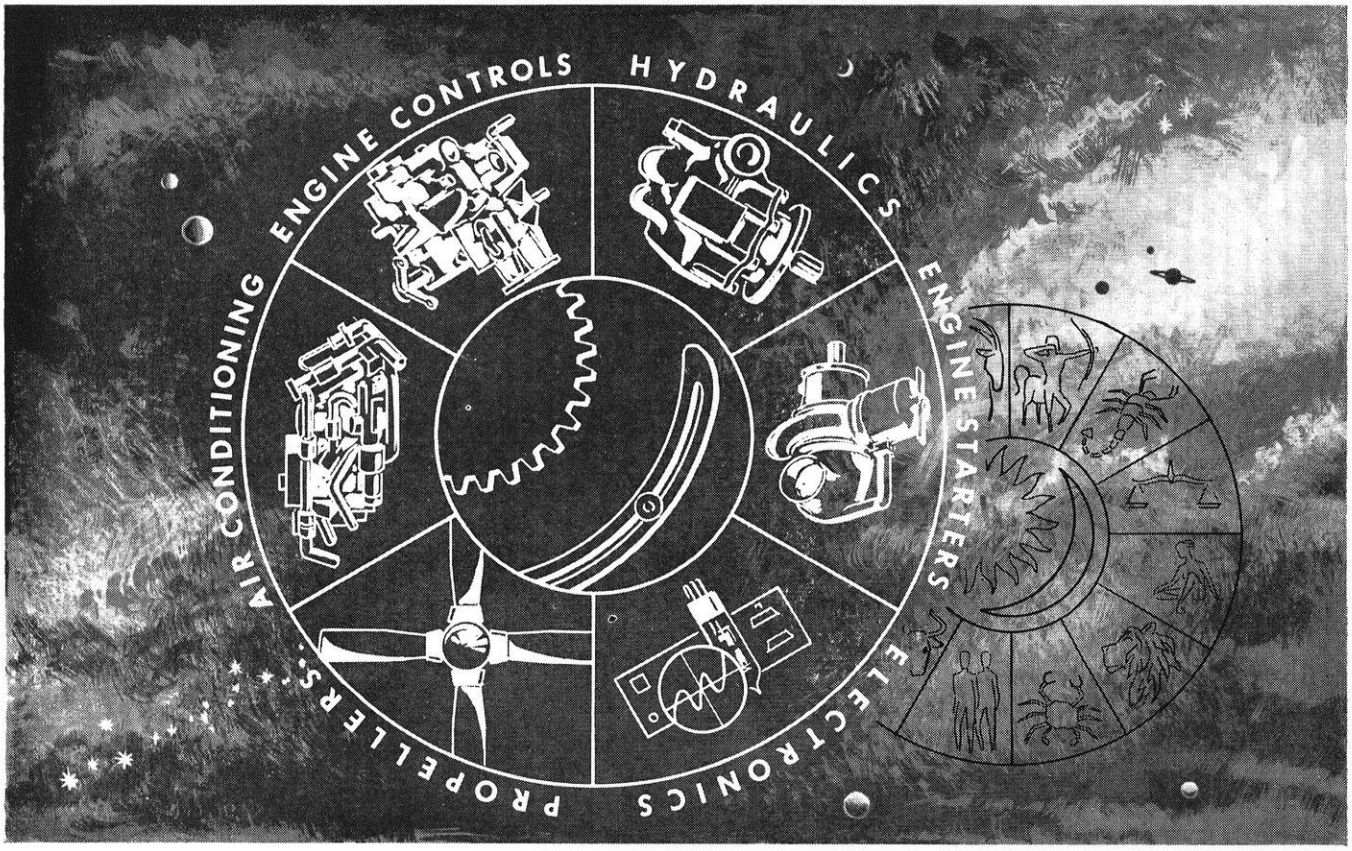
PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

CONNECTICUT OPERATIONS — East Hartford

FLORIDA RESEARCH AND DEVELOPMENT CENTER — United, Florida

SIGN OF THE FUTURE



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*aerodynamics	therodynamics	control dynamics
heat transfer	stress analysis	mechanical analysis
mechanical metallurgy	vibration	systems analysis
fluid dynamics	measurement techniques	instrumentation development

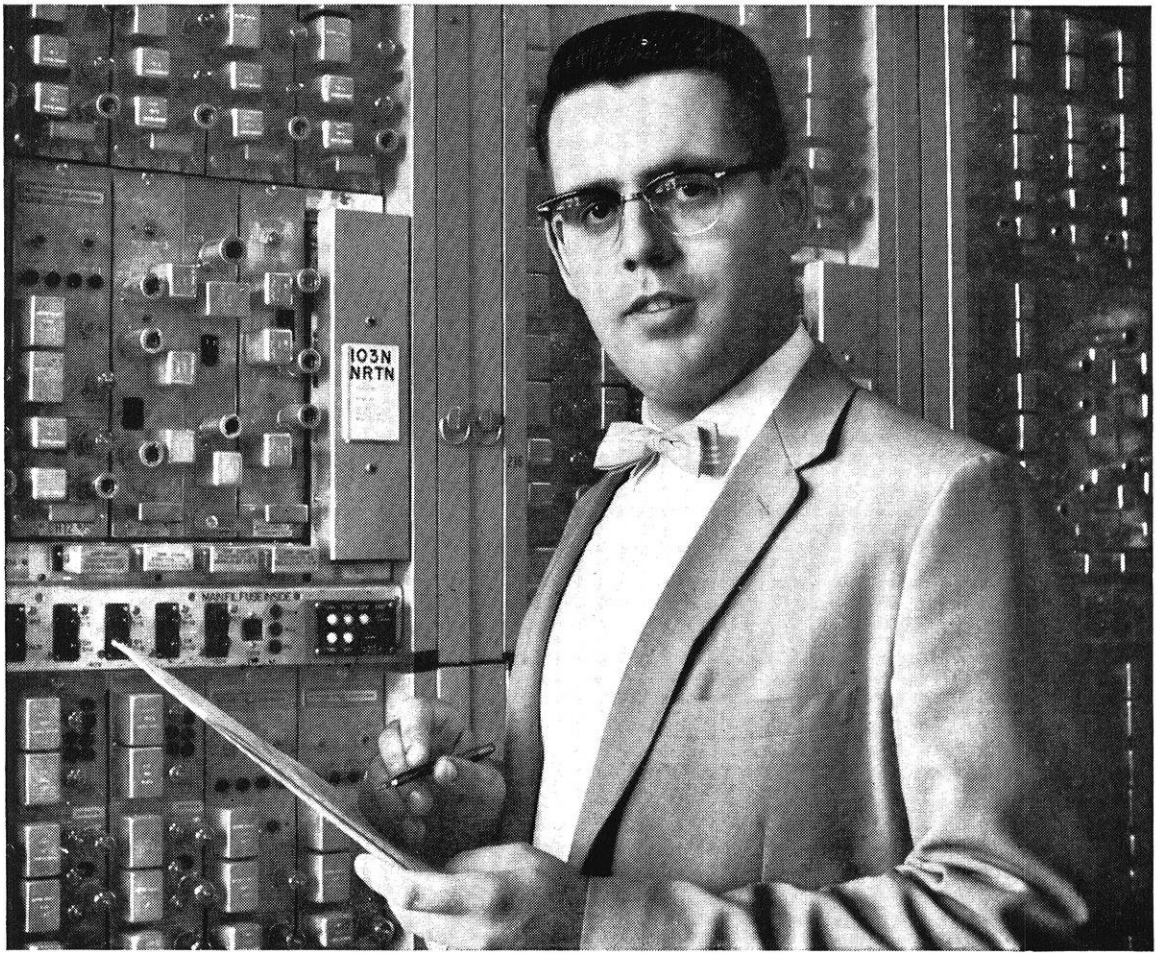
reliability and statistical methods
IBM and analog computing; data deduction

If you are interested in designing and developing such products as these, contact Timothy K. Bye, Engineering Personnel Coordinator, or arrange for an interview with your college placement officer.

HAMILTON STANDARD

DIVISION OF UNITED AIRCRAFT CORP.
47 BRADLEY FIELD ROAD • WINDSOR LOCKS, CONNECTICUT

A Campus-to-Career Case History



"I wanted a job I could grow with—and I've got it"

H. James Cornelius graduated from Swarthmore College in 1954 with a B.S. in Electrical Engineering. He's been "growing" ever since with the Bell Telephone Company of Pennsylvania.

After an initial 44-week inter-departmental training course, Jim was made Facility Engineer in charge of the fast-growing Norristown-Pottstown area. In that capacity, he engineered over half a million dollars' worth of carrier systems and cable facilities between major switching centers in Pennsylvania.

Today, he is one of 50 young engineers from the Bell Telephone Companies chosen to attend a special Operating Engineers Training Program at Bell Laboratories. This 19-month course of study—with full pay—deals with advanced techniques and new concepts in electronics which signal a new era in telephony. It involves both classroom theory and practical laboratory applications.

When Jim and his colleagues return to their companies, they'll review major engineering projects. This will assure the best use of equipment for current engineering, as well as for expected new developments in communications.

"I wanted a job I could *grow* with," says Jim, "and I've got it. I can't think of a better place than the telephone company for an engineering graduate to find a promising future."

Many young men like Jim Cornelius are finding rewarding careers with the Bell Telephone Companies. Look into opportunities for *you*. Talk with the Bell interviewer when he visits your campus. And read the Bell Telephone booklet on file in your Placement Office.

BELL TELEPHONE COMPANIES

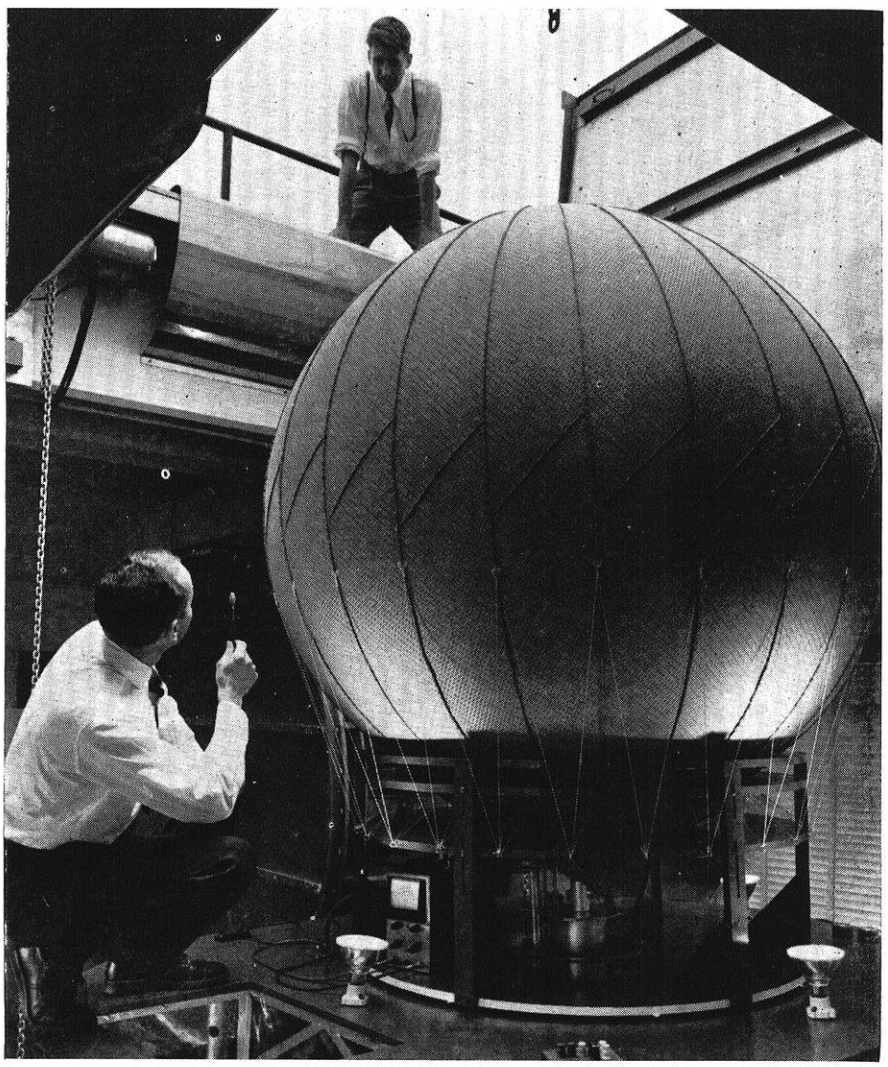
SCIENCE HIGHLIGHTS

Jim Mueller me'59

New Type Radar Antenna

A new radar antenna that may be the forerunner of antennas for powerful, long-range antimissile radars of the future has been announced by the Westinghouse Electric Corporation. An important characteristic of the antenna, known as a Helisphere, is that it scans the sky throughout a complete circle without any motion of the antenna structure itself. In contrast, a conventional radar antenna must rotate continually as it sweeps the sky in search of flying aircraft. In addition, the Helisphere antenna is extremely effective in concentrating high-frequency radar waves into an intense, narrow, moving beam.

The Helisphere radar antenna has several advantages over conventional types. A nonrotating design permits faster scan and track rates and eliminates the driving power normally required to turn it. Antenna construction is simplified and the problem of rotating bearings, especially acute in large ground-based radar systems, is done away with. The Helisphere secures these advantages by substituting motion of radar energy inside the antenna for the customary rotation of the antenna structure itself.



Ready to emerge through the roof of the Westinghouse Research Laboratories for tests of its radiation pattern is this six-foot model of the Helisphere, a new kind of radar antenna considered the forerunner of the future.

Experimental versions of the Helisphere have included both rigid and inflated balloon-shaped models. The inflated version offers the additional advantage of a large structure that is light in weight, portable, and quickly and easily erected.

It is believed that the Helisphere is an important advance in radar antenna design, particularly for those applications requiring large antenna installations.

Essentially, the Helisphere antenna is a sphere, either inflated like a balloon or of rigid construction like a plastic globe. On the surface of the sphere, or imbedded in it, are narrow metal conducting strips. These strips wind around the sphere in an endless spiral shape, or helix, as do the threads on a wood screw. It is from this peculiar helical layout on the sphere that the Helisphere gets its name.

Radar Waves are Polarized

Operation of the Helisphere depends upon the fact that radar waves can be polarized; i.e., made to vibrate back and forth in a single plane. These polarized radar waves are sprayed against the inside surface of the sphere in such a manner that they vibrate parallel to the thin conducting strips on the sphere. When so oriented, the surface acts as a reflector for the radar waves and reverses their direction back to the other side of the sphere.

Because of the nature of a helix, the strips on the opposite surface of the sphere lie at right angles, not parallel, to the reflected radar waves. Therefore, the waves pass through these strips without reflection and continue on into space as a narrow radar beam.

The phenomenon is quite similar to the behavior of light rays from an automobile headlight as they bounce off the surface of a wet pavement. Such light is polarized. This polarized light is blocked, and its glare eliminated, by a pair of Polaroid-type sun glasses. But, if the glasses are rotated and held vertically in front of the eye, the light and the glare come through.

Fifty yards of drapery material, purchased in a Pittsburgh department store have been converted into a working model by scientists. The "department store" version of the Helisphere antenna consists of a balloon-like cloth structure six feet in diameter. The all-important conducting metal strips winding spirally around the surface of the antenna are simply the decorative metallic threads that were woven into the fabric when it was loomed as a drapery material.

The cloth is placed around a rubber bladder and the Helisphere is inflated to shape by pumping it full of air. Only low pressures are required; about one-three-hundredth of the pressure inside the average automobile tire.

Another inflated cloth structure, called a radome, completely covers the balloon-shaped Helisphere. A large plastic bag acts as a low-pressure air lock through which the scientists enter and leave the space between the Helisphere and its radome. The radome protects the antenna from the weather and keeps it stationary in the wind. Because a sphere is inherently the most stable of inflated shapes, the Helisphere is especially rigid and sturdy.

Large Diameter

A full-scale Helisphere would be about 100 feet in diameter and would employ radar waves about one foot in wave length. The present inflated model works on wave lengths about 10 times shorter than this.

The radar waves are fed into the antenna through a vertical, hollow tube, or wave guide. The top end of the wave guide is bent at right angles and is aimed horizontally at the inside surface of the antenna just about at its center. Simply rotating this short piece of wave guide inside the antenna rotates the resulting radar beam along the horizon in a full circle.

Experiments have shown that the Helisphere antenna operates effectively over a considerable range of beam elevation angles. The transmitted beam shows a width of only one degree. Spurious radiation from the sides and back of the antenna is no higher than that produced by conventional types.

All in all, there is no technical reason why the Helisphere will not scale up to very large sizes and eventually emerge as a highly useful and desirable type of radar antenna structure.

FULL-SCALE TEST OF WELDED CONSTRUCTION

On September 6, the eleven-story welded-steel framework of a new building being erected in Toronto, Canada, for Union Carbide Canada Limited collapsed in a high wind and was completely demolished. Two consulting firms have now reported their findings as to the cause of the collapse.

Findings of the two firms state that because of insufficient temporary bracing during erection, the steel framework, which had been welded up to the seventh floor, was unable to withstand the extremely high local winds.

The January 3 edition of the Toronto newspaper, *The Financial Post*, made the following statement: "The collapse proved an invaluable test of full-scale welded construction. Welding of the steel framework on the 11-story building had been completed up to and including the seventh floor level. When the building collapsed, welded sections were subjected to tremendous stresses—far greater than any they would be forced to bear under normal conditions. Experts were amazed at the way the welds took the strain. Inspection by the Canadian Welding Bureau showed that only one of several hundred had failed."

The consultants, architects, and other structural engineer authorities gave unqualified approval to both the unusual design of the building, which was free of interior columns, and the welded connections.

3-D TECHNIQUE PROBES AIR TURBULENCE

A new three-dimensional technique for studying air turbulence has been developed.

Part of studies designed to improve cameras and film for taking pictures at long-range, the new 3-D technique, can pinpoint moving pockets of air that deviate light rays and interfere with aerial and similar long-distance photography.

Photo experiments were performed at lonely Canadice Lake, in upper New York State.

The pockets of air under study were from four inches to six feet

(Continued on next page)

in diameter. The air pockets had a temperature a fraction of a degree higher or lower than the surrounding air. As a result, they had a refractive index different from the rest of the air. This deviates some of the light rays and causes fuzziness of the image in long-distance photographs.

Because wind causes movement of the air pockets, watching their images on a screen is like "looking at a waterfall sideways."

At Canadice Lake, scientists set up two high-intensity light sources focused on a screen 1.3 miles across the north end of the lake. Each of the light sources was polarized with a filter.

Behind the screen, which was designed for rear projection, stood an observer wearing a pair of spectacles like those once used to view 3-D movies.

A pattern of "shadows" in constant motion appeared on the screen, with each of the light sources producing a shadow of the pocket in a different place on the screen. The observer with the 3-D glasses could thus "look into" the space between the screen and the light source, get an effect of depth, and judge the distance of each pocket from the screen.

Knowing the distance between the light sources and the distance between the shadows appearing on the screen, the scientists were able to calculate, through triangulation, the distance of the disturbances from the screen.

The scientists also took pictures of the screen images by holding a large piece of film directly in front of the screen and using a shutter on one distant light source.

THE ACOUSTOELECTRIC EFFECT IN GERMANIUM

A direct current can be induced in a semiconductor under certain conditions by passing acoustic waves through it. This effect is known as the "acoustoelectric effect."

An acoustic wave traveling through a semiconductor tends to produce a net force acting on the charge carriers in the direction of propagation of the wave. To offset this force, an electric field is induced in the semiconductor material. This field can be measured by attaching contacts along the length of the sample.

Since this effect depends on some bunching of the carriers, it is normally reduced greatly by their mutual electrostatic repulsion. There are some situations, however, in which more than one type of carrier is present, and it is possible to bunch each type separately without developing a net space charge. Such is the case with n-type germanium, in which the electrons belong to a band which has a number of distinct energy minima or "valleys." The electrons in the vicinity of these various valleys react differently to the acoustic wave, giving rise to the acoustoelectric effect. The magnitude of this effect gives a measure of the intervalley scattering time; i.e., the mean transition time between the separate groups of states in the conduction bands which lie near the minima of energy (valleys).

Experimental verification of the acoustoelectric effect has been obtained by passing acoustic waves at frequencies of 20 mc and 60 mc through a bar of n-type germanium and measuring the voltage induced along the bar. To minimize stray effects, the acoustic waves are modulated with an audio frequency, thus producing an audio frequency induced voltage rather than a d.c. voltage.

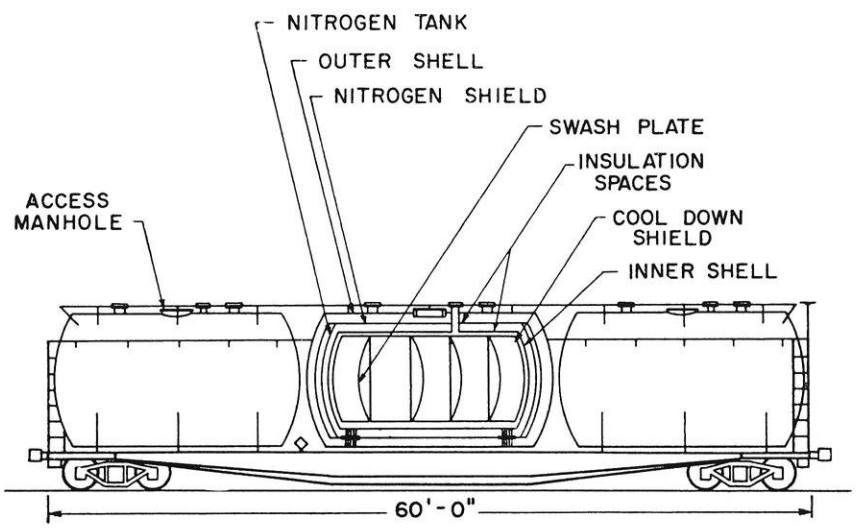
A study of intervalley scattering time has led to a better understanding of semiconductor materials. It has been found that this scattering is due in part to phonon scattering and in part to impurity scattering. These two effects may be separated, as the photon effect becomes greater at higher temperatures (above 100°K) while the impurity effect is predominant at temperatures below about 60°K. Between 60°K and 100°K, the two effects are mixed.

HELIUM LIQUEFACTION AND TRANSPORTATION

The Boulder, Colorado, laboratories of the National Bureau of Standards has made a study for the Navy Bureau of Aeronautics on the feasibility of transporting helium over long distances in liquid form. The study reveals that large-scale liquefaction plants and liquid distribution systems compare favorably with compressed gas systems as a means of transportation when quantities and distances are sufficiently great.

The current importance of helium to national defense and to both basic and applied research has focused attention on the cost of its transportation. For large users, such as the Navy, liquefaction and transportation of helium at or near its liquid density will lower

(Continued on page 54)



Insulated rail tank car, 13,000-gallon capacity, designed for large-scale transportation of helium at or near its liquid density.

Engineer Larry Klivans reviews the results of a computer-simulated ground checkout of Radioplane Division's near-sonic RP-76 rocket-powered target drone. Formerly at Norair Division, Larry came to Radioplane in 1955. At 31, he is Manager of the Division's 140-man Electronic Support Group, is working toward his doctorate at UCLA.

YOUNG ENGINEERS ARE NORTHROP'S NEWSMAKERS!

Northrop Corporation's dynamic and diversified corporate structure creates an ideal work climate for forward-thinking scientists and engineers. Our three autonomous divisions are all in Southern California – are all headed by progressive management eager to examine and try new ideas.

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YOU'LL WORK with men who are acknowledged leaders in their fields – men chosen for their own capabilities *and* for skills in guiding and developing the creative talents of younger men. And, these are men who delegate authority, assuring your fair share of credit for engineering triumphs.

YOU'LL BE FLEXIBLE–able to apply your talents to the work you enjoy, in the field best suited to your own inclination and ability. Northrop Corporation and its divisions offer wide diversity, with over 30 operational fields to choose from. All offer challenge aplenty – opportunity unlimited!

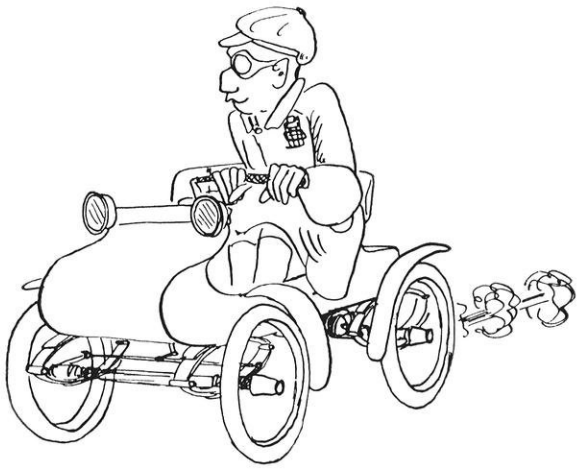
RADIOPLANE DIVISION. Creator of the world's first drone family; has produced and delivered tens of thousands of drones for all the U.S. Armed Forces. Now developing ultra-advanced target drone systems for weapon evaluation, surveillance drone systems, and missile systems.

NORTRONICS DIVISION. Pioneer in celestial and inertial guidance. Currently exploring infrared applications, airborne digital computers and interplanetary navigation; developing ground support, optical and electro-mechanical, and data-processing equipment.

NORAIR DIVISION. Creator of SAC's intercontinental USAF Snark SM-62. Currently active in programs for the ballistic recovery of orbiting man; flight-testing the USAF T-38 supersonic trainer; readying the N-156F NATO-SEATO fighter for flight tests.

NOW WRITE! Get full information on Northrop Corporation and all of its Divisions. Then choose the division that offers *you* the most challenge. To reserve your spot where news is *happening,* write: Engineering & Scientific Personnel Placement Office, Northrop Corporation, P.O. Box 1525, Beverly Hills, California.

Divisions of NORTHROP CORPORATION



THE ENGINEER OF YESTERYEAR

by John Nichols ee'60

THE DEVELOPMENT OF THE MODERN ELECTRIC LIGHT

November, 1929

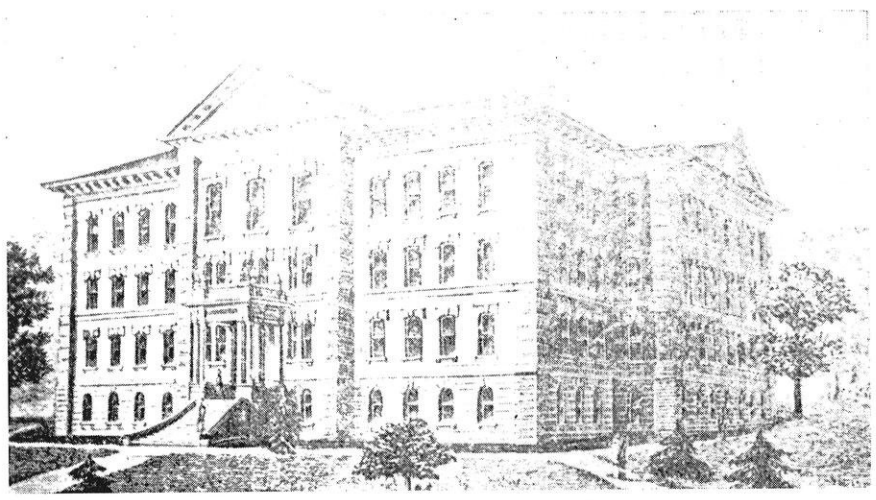
THE first incandescent light for which there is any record was made in 1840, by Sir William Robert Grove, an English judge and scientist. It consisted of a coil of platinum wire covered by an inverted glass tumbler set in a dish of water. This arrangement kept the wire from being cooled by air currents and reduced oxidation of the wire. The lamp gave only a feeble light because, if attempts were made to obtain a stronger light, the temperature of the platinum filament would have been raised above its melting point.

De Moleyns, another Englishman, obtained the first patent on an incandescent lamp in 1841. His lamp consisted of a glass globe, the upper part of which held a glass tube containing powdered charcoal. The tube was open at the bottom and through it ran a platinum wire which terminated just below the tube in a small coil. Another platinum wire came up through the globe at the bottom and ended in another coil just below the first one, almost touching it. The space inside the coils and between them was filled with powdered charcoal which was heated to incandescence by a current passed through the wires. Most of the air within the globe was removed so the charcoal would not burn up immediately. The small amount of charcoal that did evaporate was automatically replaced by that in the tube above. This lamp proved to be impractical, because the globe blackened very rapidly from the evaporation of the charcoal.

One of the most important early contributions to the study of incandescent lights was made by an American, J. W. Starr. His lamp consisted of a rod of carbon operating in the vacuum above a column of mercury. One terminal was a platinum wire running through the upper end of the glass tube containing the mercury, the other was the mercury itself. Blackening of the glass by carbon kept this lamp from becoming a commercial success, as it had the others.

In the spring of 1878, Edison began the study of the problem at his laboratory at Menlo Park, New Jersey. His first experiments were made along the lines of previous ones, simply for the purpose of confirming their failure. He quickly gave up carbon as a light-giving element and turned his attention to platinum. Edison discovered that after the platinum filaments had been heated to incandescence several times, gases were apparently driven off and the wire became harder and could be operated at a much higher temperature. Since he was operating his filaments in a high vacuum to facilitate the escape of the gases, Edison decided to once more try a carbon filament which he thought might last in the vacuum. He finally succeeded in carbonizing a piece of ordinary sewing thread. This he mounted in a glass bulb using platinum wire to make the connections to the outside. The filament was gently heated while the lamp was still on the exhaust pump, eight hours being required before the gases stopped coming off the carbonized thread. When the current was applied to the lamp on October 21, 1929, it burned for 45 hours before giving out. Edison soon found that carbonized paper filaments lasted for several hundred hours.

Subsequent development of the incandescent light was devoted



First home of the Electrical Engineering Department.

largely to a search for more suitable filament materials and for gases which could be used in the bulbs to give better operation.

Osmium, tantalum, and metalized carbon filaments were found to give a high degree of efficiency but were fragile and expensive. As soon as a method for drawing tungsten into a wire was found, tungsten became the "standard" filament.

PAVING BRICK LAID ON IRON BASE

December, 1930

Three different designs of brick paving with a sheet-iron base received their first test in 150 feet of pavement on the Grand Avenue connection with the Rochester Road near Springfield, Illinois. The iron base was laid on a very carefully rolled and leveled subfrage. The following layer was a layer of two and one half or three inch brick with asphalt filler. Three 50 foot sections were laid, one using blue, annealed flat sheets, and the two other galvanized, corrugated iron of 10 gage.

ENERGY FROM THE SUN

It has long been known that a very high temperature could be obtained at the focus of sun's rays reflected from a mirror. It is said that Archimedes set fire to the Roman fleet at Syracuse, in 212 B. C., by focusing the sunlight on the ships with large mirrors.

Probably the most successful of the earlier sun-power engines was Ericson's. He used a series of mirrors that reflected the sunlight to a central focus where he had a steam boiler. He had a small steam engine connected to the boiler with which he succeeded in developing a few horsepower under favorable conditions. However, his engine was not approved, because it was too expensive and impractical.

Due to the high cost and non-durability of the mirrors, various other schemes of concentrating the sunshine were tried, among these was the "hot-bed" plan. It was well known that an ordinary hot-bed would become very hot on a bright, sunny day. Schumam built a number of hot-beds and tested them for their ability to develop sun-power. He succeeded in getting temperatures high enough to boil water and to run a small steam engine.

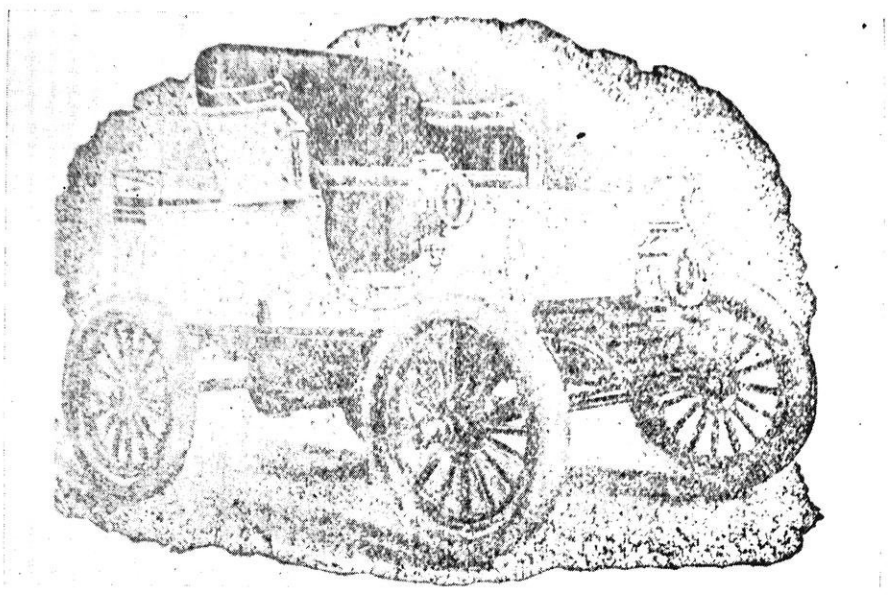
The temperature developed in the hot-beds was not high enough to produce the necessary pressure to run an engine efficiently by using steam, but ether will produce a high pressure under a comparatively low temperature. A sun-power plant using ether as the working substance was built in Arizona to be used for irrigation. The ether was heated by running it through pipes covered by hot water from the hot-beds. After going through the engine, it was condensed by the water which had been pumped by the engine. After having served as cooling water, the water was used for irrigation. The plant could develop about one horsepower for every two-hundred square-feet of heating surface on a good clear day, but it could only be operated while the sun was shining, only about six or seven hours a day.

Ether is inefficient as a means of converting heat into power, and it is also impractical. Therefore, an attempt was made to use sulphur dioxide instead of ether. Sulphur dioxide motors had been used in Germany for years to utilize the heat from the exhaust steam from non-condensing engines. The operation of the sulphur dioxide motor was much like that of the ether, except that a large storage tank was used. The storage tank was filled with hot water that had been heated during the day, to be used to run the engines at night and on cloudy days when the sun was not shining. The plant was operated one whole summer pumping thousands of barrels of water. It turned out to be impractical; it was too expensive and not dependable. At nine, in the morning, and at four, in the afternoon, the heat absorbed was only one-fifth as much as that absorbed at noon. The plant withstood weathering very well and showed but little depreciation after several years.

Perhaps the most practical and successful sun-power plant developed so far is the Meadi plant in Egypt.

It showed favorable results in tests made during the summer of 1912; and in the summer of 1913, it ran all summer, irrigating several-thousand acres of land. The heat absorber consisted of five parabolic mirrors, 204 feet long. A trough was placed in the focus of each mirror, and water was sent through the trough. The mirrors were controlled automatically so that they followed the sun and were turned toward it all the time. The mirrors were made by setting a number of small mirrors in a steel framework. They were made strong enough to withstand any ordinary tropical storm, and were protected from the weather. Low pressure steam, 14.7 pounds per square inch, was used because it was found to give the best power output per unit cost. It was possible to generate high pressure steam of up to 500 pounds per square inch; but the heat losses were too great. The variation in the amount of heat absorbed from morning to night was only about 85 percent, because the mirrors faced the sun all through the day.

THE END



Engineer's Transit

(Continued from page 15)

Inside of the telescope are the normal horizontal and vertical cross-hairs and two stadia hairs. They are located above and below the horizontal cross-hair and are used to determine distance. The space between these two hairs will appear to be one foot or approximately so at a distance of 100 feet.

The lens system has a magnifying power of from 18 to 30. In American instruments, an extra lens is added to give an erect image. Most foreign instruments leave the image inverted thus, using one less lens and receiving more light.

The upper motion contains, along with the telescope, the compass and two level tubes which are at right angle to each other. A long spindle fits inside the cylinder of the lower motion. The spindle is extended from the center of the horizontal circle of the upper motion, which allows it to ride on a smaller circle of the lower motion. Therefore, the telescope can be rotated horizontially 360 degrees in either direction. Rotation of the upper motion is controlled by the upper or vernier plate clamp screw, and fine adjustment is made with the upper tangent screw.

The lower motion rests in the leveling head just as the upper motion rested in the lower motion. It has a circle graduated from 0 to 360 degrees. Readings are taken from this circle with the aid of verniers through two openings in the upper motion. The verniers are labeled the A and B verniers and are situated 180 degrees apart. Horizontal angles are thus measured by first sighting the telescope on a particular point by moving the lower motion when the upper motion and lower motion are clamped together with the upper clamp screw. Then the lower motion clamp screw is tightened, the upper clamp screw is loosened, and the telescope is rotated to the second point. The vernier has moved with the upper motion to a different point of graduated circle indicating the angle turned.

The leveling head consists of two plates held together by four evenly spaced leveling screws. By turning two adjacent screws at one time the motions are leveled with the corresponding plate level. The leveling head is attached to a tripod by means of a large screw. A small hole can be found centered and below the leveling head. This is used to connect a plumb-bob.

ADJUSTMENTS OF THE TRANSIT

There are certain relationships which must exist in the adjustment of the transit in order for the engineer to do satisfactory work. Readings taken while an instrument is out of adjustment will obviously produce erroneous work. Most of the errors tend to accumlate and increase in magnitude as the length of the survey increases. Following are some of the most important adjustments in the operation of the transit:

1. **Vertical cross hair adjustment**—to make the vertical cross-hair should lie in a plane perpendicular to the horizontal axis. This is accomplished by making the vertical hair line remain over a distant point as the telescope is moved up and down.

2. **Plate level adjustment**—to make the axis of each plate level lie in a plane perpendicular to the vertical axis. This means that the plate level tubes should stay centered regardless if the telescope is rotated in the horizontal circle. Corrections are made by adjusting the screws on the plate levels.

3. **Line of sight adjustment**—to make the line of sight perpendicular to the horizontal axis. Correction for any error in this case is taken care of by adjusting the intersection of the cross hairs by the screw adjustment on the eye piece.

4. **Horizontal axis adjustment**—to make the horizontal axis perpendicular to the vertical axis. The objective here is to adjust the horizontal axis either by raising or lowering one end of it until the axis is perpendicular to the vertical axis.

5. **Axis of the telescope adjustment**—to make the line sight parallel to the axis of the telescope level. The correction is made by raising or lowering one end of the level tube on the scope until its axis is parallel to the line of sight.

6. **Vertical circle adjustment**—to make the vertical circle or vernier read zero when the line of sight is horizontal. Any error here can be easily corrected. With the line of sight horizontal the vernier can be shifted in either direction until it reads zero.

7. **Optical axis adjustment**—to make the line of sight intersect the optical center in a true horizontal plane. To do this, the intersection of the cross hairs is moved until the mentioned condition is achieved.

The various methods used to obtain the proper adjustments will not be discussed in detail. It is more important that the individual understand the relationships necessary in the transit to provide accuracy in survey work. The adjustments must be done in the order given above. The reason for this is so that when a particular part is put into adjustment it will not be taken out by a following one.

TYPES OF TRANSITS

As mentioned previously, transits are basically all alike. However, there are modifications in their construction, depending on the purpose for which they are intended. Following are the four types of American transits available:

Plain transit. This instrument is limited to measuring horizontal angles and taking bearings of a line. It comes without the vertical circle and telescope level.

City transit. This one is used for city surveying and is therefore designed for measuring vertical and horizontal angles and distances rather than line bearings. It is like the standard instrument without a compass.

Repeating theodolite. This is basically the same as a fully equipped transit, but is larger and heavier in construction. It has verniers more finely graduated and levels more sensitive. It usually has permanently attached magnifying glasses for reading the verniers more accurately and an optical centering device for more accurate centering. The repeating theodolite is used for work on very high precision.

Mining. This is similar to the engineer's transit except that an auxiliary telescope is attached

(Continued on page 49)

TV Picture Tubes

(Continued from page 12)

The glass base assembly is welded, as was done in earlier operations, to the base of the picture tube. With the completion of this operation the tube is air-tight, except for the evacuation rod protruding from the glass base of the tube.

The picture tube must be evacuated so that the flow of electrons will not be hampered by molecules of air. The tube is evacuated to 1×10^{-6} mm of Hg. Until recently, cathode-ray tubes were exhausted one at a time on what was essentially laboratory equipment. However, new automatic equipment now performs this operation.

The tube is attached to the equipment and the evacuation process begins. A mechanical pump starts the vacuum operation. The mechanical pump reduces the pressure to a point where a vapor pump may be turned on to lower the pressure to its final point. The tubes are heated in ovens during part of the time the pumps are working. This heating causes the air in the tube to be less dense, and consequently, the process of evacuation becomes easier. Finally, the getters are flashed. Getters are electrodes that are heated so that they react with the oxygen remaining in the tube during the final stage of exhaust. This protects the gun elements from deterioration while the tube is in normal operation.

At the end of the exhaust cycle, the stem in the glass base of the tube is automatically pinched off, a vacuum-tight seal being produced.

The tube is then transferred by means of a conveyor belt to the next area where the plastic base is applied and baked with infra-red heading to cure the basing cement. After this operation, the leads from the electron gun are soldered to the base pins by sweating solder into the small holes that were left in the pins.

TESTING THE TUBE

Before the tube can be tested, the cathodes must be aged to obtain stable emission. This operation is performed while the tube is on the conveyor belt that carries the tube from the basing area to the testing area.

Each tube is individually operated and inspected. The test operator not only checks the physical and electrical characteristics of the tube, but also inspects its over-all quality and appearance. Each tube is painted while on the conveyor line that carries it to the packing department for packing and shipment.

To insure standard quality, a sample lot of each day's production is set aside for additional test prior to tube shipment. Some tubes are pressure-tested at 50 pound per square inch to evaluate their strength; some are subjected to a life test to determine how they will operate throughout life, and others are stored for a period of time and then retested. If the tubes fail to pass any of these tests, a larger number of that same day's production is tested and if they, in turn, also fail to pass the tests, that day's production is either rejected or tested 100 per cent.

1000 TUBES A DAY

Several of the large companies produce as many as 1000 picture tubes a day in one plant. The average time is takes to produce one tube in a highly mechanized plant is just over four and one-quarter hours. At a rate of 1000 tubes a day, at least two tubes must come off the production line every minute. This is a good average in relation to the number of workers engaged in producing the tubes.

Thus, the manufacture of the television picture tube is completed. It can be seen by the recent strides in theory (thinner tubes) and manufacturing (mass production methods) that much thought, research, and capital are being utilized to obtain a cheaper and better product.

THE END

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Balancing

(Continued from page 21)

It is possible for the tooling to introduce serious errors. These errors are not normally detected during the balancing operation and, consequently, the part will not be within tolerance when released. As an example, suppose a part does not have its own shaft. It is then necessary to provide an arbor for the balancing operation. The desired rotational axis of the part is the centerline of the bore. However, if the arbor surface that locates the bore of the part is not concentric with the arbor journals, the part would not be balanced about the proper axis. The balancing machine would indicate that the part is within tolerance if the part is balanced about the arbor rotational axis. Therefore, the error would go undetected until the part is placed in the final assembly and rotated about the bore centerline.

Errors can also be introduced if the tooling (which is directly fastened to the part) contains an unbalance. If the arbor contains an unbalance, a correction will be made in the part for the unbalance contained in the arbor. In effect, it would be an unbalancing operation. It is therefore necessary that the tooling design provides a convenient means of balancing the tooling.

The tooling should also be of minimum weight to reduce the loss of sensitivity during the balancing operation. However, it must remain rigid. A flexure under the forces of unbalance will cause errors in machine calibration. All errors introduced by tooling should be held to a minimum and should never exceed one fourth of the balancing tolerance.

The material and method of manufacture are also critical. The tooling must be very stable and wear well after completion. If any warpage occurs, the critical dimensions and balance will both be affected.

PRODUCTION PROBLEMS

Selection of Balancing Machines

Balancing machines are usually selected on the basis of capacity, accuracy, and durability under shop conditions. Under capacity, there are two considerations. The first is the size and weight of the part that can be handled. The second is the speed with which it can produce balanced parts. There are also two considerations under accuracy. The machine should indicate accurately the amount of unbalance in a specified plane, regardless of where the plane is and regardless of how much unbalance is in the other correction plane. In other words, readings in the left correction plane should not change if a correction is made in the right plane and vice versa. This is called "plane separation" and is essential if the machine is to be calibrated. The second is the sensitivity to extremely small unbalances. Sensitive machines should be purchased even though all the sensitivity is not needed for the part under consideration. It may be needed later. At any rate, it is not a good policy to be operating at the limit of a measuring instrument if it can be avoided.

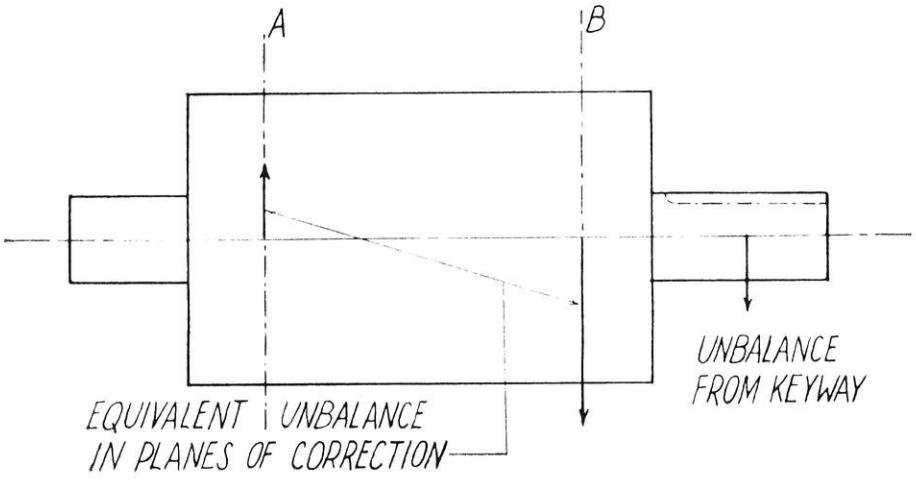


Fig. 2—The resultant effect of an unbalance force due to a keyway is replaced by equivalent forces in the arbitrary planes of correction, A and B.

A balancing machine must be durable enough to operate under shop conditions if it is to be used as a production tool. This means that it must maintain its accuracy under changing temperature and humidity conditions, it must eliminate extraneous floor vibrations from the unbalance readings, and it must be rugged enough to withstand reasonable material handling procedures.

As is normal in all machine selection, it will be necessary to decide upon the most economical selection from a long range production standpoint. This will include a choice between special equipment and standard or universal equipment. Balancing equipment is available in both forms including integral correction equipment.

Correction Equipment

Correction equipment must be selected which will do the operations called for by the designer in the part drawing. The equipment can be completely separate from the balancing operation or it can be integral and controlled by the balancing machine. Regardless of where it is, the amount control should be correlated with the unbalance readings so that the correct amount of material can be added or removed as called for by the balancing machine.

Operation Sheets

Operation sheets should be furnished to the production floor to supplement the design drawing. These sheets should describe in detail the setup procedure of the balancing equipment and correction equipment for a particular part (including the tooling to be used). The sheets should also state the tolerance in terms of correction units instead of ounce inches. For example, if the design print calls for a tolerance of 0.25 ounce inches in plane "A" and specifies a drill correction, the operation sheets should state the tolerance in terms

of drill depth. Since the balancing machine is calling for drill correction, the operator will know he is within tolerance when the machine calls for a correction which is less than the tolerance in terms of drill depth.

QUALITY CONTROL

Ordinarily, the quality control department has its own equipment for checking finished parts. However, this is usually not possible in checking balanced parts since a balancing machine is normally the best device available for inspecting them. If one hundred percent inspection is required, it may be possible that a balancing machine and a complete set of tooling would be placed in the production line behind the balancing operation and controlled by inspection. But, normally, it is a case of spot checking the production machines.

If this is the case, the following procedure should be followed. First, inspect the balancing machine to be sure it is calibrated accurately. Second, inspect the tooling to be sure it is not introducing errors of the type outlined under "Design of Tooling." Third, inspect the part to be sure it is within the tolerance specified in the operation sheets.

MAINTENANCE

The normal procedures for maintenance of machine tools apply to balancing machines as well. However, the periodic check and preventive maintenance techniques are especially valuable. The procedures for periodic checks and stock of parts can be specified by the manufacturer.

Tooling also presents a maintenance problem. Adequate protective storage should be provided for all tooling when it is not in use. This helps to prevent nicks, bumps, and warpage which could disturb the critical dimensions and cause mis-location of the part. A great deal of care must be exercised in the handling and use of tooling. Periodic checks should also be set up for the tooling. They should include an inspection of all critical dimensions and the balance if appropriate.

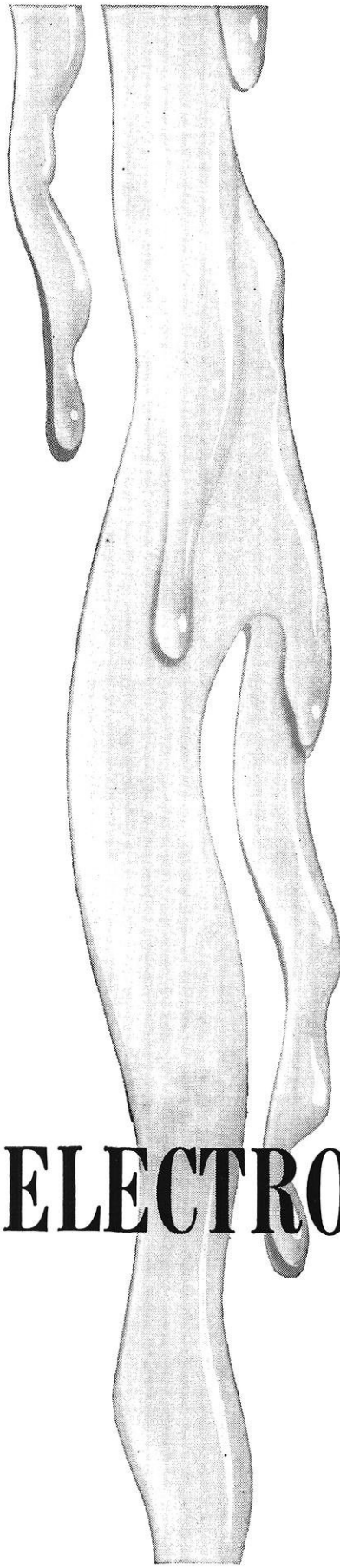
THE FINAL ASSEMBLY

If excessive vibration is found in the final assembly, the fault is often placed immediately upon the balancing program. There are other possible reasons for excessive vibration which makes it advisable to analyze the characteristics of the vibration before revamping the balancing procedure. One possibility is that some member of the machine has a natural frequency at or near the rotating speed of some part, or that the rotating part is operating at or near its critical speed. It takes very little to excite the member so lowering the balancing tolerance of the rotating part would be a very ineffective and costly solution to the problem. Changing the natural frequency of the member would be a much better approach.

If the analysis indicates a flaw in the balancing procedure, the trouble can be caused by a number of things other than too high a tolerance. If the vibration analysis shows an amplitude higher than is possible with a tolerance unbalance there must be another source of unbalance. The following is a list of some of the places to look:

1. An erroneous setup on the balancing machine.
2. Mal-function of the balancing machine.
3. Errors introduced by tooling design or use.
4. Accumulative unbalance caused by assembly fits and eccentricities. (Included in this should be the possibility of oversights in the assembly. Example: If a pulley is balanced without a key and the shaft is balanced without a key the assembly will be out of balance by the weight of the key times the radius of the key's center of gravity.)
5. Deflection of some portion of the part due to centrifugal force at the operating speed.

This list of course only covers the more frequent and general problems. Specific problems can vary widely depending on the type of part. THE END



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Meet the President

(Continued from page 27)

J. C. Jones.

RETIRING WITH DIGNITY

Joseph Clarence Jones, P.E., will retire June 1, 1959, after 36 years of service with the Wisconsin State Highway Commission. He is retiring as District I Engineer after serving in that position since September, 1946.

Born May 26, 1894, in Chicago, Mr. Jones attended Kansas State College from which he graduated, in 1913, with a B.S. degree in Civil Engineering. Until World War I, he was engaged in Municipal Engineering and Railroad Engineering with the Santa Fe Railroad and the Chicago and Northwestern Railway Company.

In World War I, he served as a First Lieutenant in the Corps of Engineers. Upon discharge from the service in 1919, he engaged in highway engineering until coming to Wisconsin and the Highway Commission in 1923.

The next 36 years were devoted in faithful and meritorious service to the State Highway Commission where, starting as an instrument man, he deservedly advanced to head the District I office. During this period of service with the Commission, he has experienced and aided in the growth of this District from a construction budget of less than one million to a construction program, for 1959, of 40 million dollars.

Mr. Jones is a member of the Madison Rotary and, as a registered engineer, has been a member of the National Society of Professional Engineers and the Southwest Chapter of the Wisconsin Society of Professional Engineers for a number of years.

Married to Florence Flagg of Edgerton in 1920, the Joneses have two children; a daughter, Mrs. Edith Kelley, Seattle, Washington; and a son, Lt. Donald S. Jones, U.S.N., stationed at Kingsworth, Texas; and six grandchildren.

W.S.P.E. ANNUAL MEETING

President Clifford B. Nelson announced the Program Committee for the Wisconsin Society of Professional Engineers Annual Meeting to be held this year on April 9, 10, and 11, at the Hotel Schroeder, in Milwaukee.

The committee is as follows:

John Gammel, *Co-Chairman*
Louis C. Geier, *Co-Chairman*
Louis J. Larson
Fred Agthe
Carl Werwath
Charles Nagel

Previewing Career

(Continued from page 24)

Why should a large chemical processing company spend money and time on a plan essentially designed to aid men still in college? Part of the justification lies in the fact that the summer men in their investigations of current technical problems being faced by P & G quite often have come up with solutions helpful to the company.

But the principal "why" behind the summer programs stems from a much more basic fact: trained men are needed in industry today more than ever before. Some technically trained people don't find industrial careers simply because they are not sure that careers satisfying to them exist in industry. The Workshop problem-solving situation helps to structure the thinking of men soon to make a career decision as well as show the technical and management opportunities within an industrial company.

And training is not the only thing. The individual himself should be happy in his work, and he should be suited for the job. Industry is looking for men who know what they want, what they like, and what they will be doing when they are hired.

Career surveys, like Procter & Gamble's Summer employment programs, help students make these decisions. They help men pick the right job. They help industry get the right men. **THE END**

APPLICATIONS FOR MEMBER AND AFFILIATE MEMBER—JANUARY 10, 1959

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Karl Schneider, PE Chief Engr.—Large Exc. Div. Harnischfeger Corp.	5400 S. 51st St. Milwaukee 19, Wis.	E-4793	W. E. Bunch, PE
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James E. Maloney, PE Engineer Plant Div. Wis. State Bureau of Engr.	Syene Rd., Rt. 3 Madison 5, Wis.	E-2877	A. C. Besserdich, PE
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Frederick W. Fuchs, ET Special Projects Engr. Fox Body Co.	1109 Galena St. Janesville, Wis.	ET-2004	R. E. Krempel, PE
Delbert D. Glass, ET Engineer General Engineering Co.	912 W. Wisconsin St. Portage, Wis.	ET-1650	H. V. Tennant, PE

Campus News

(Continued from page 28)

in the past and have met with the approval of both the faculty and the parents.

ASTE EDUCATION AWARDS PROGRAM OFFERS TWENTY SCHOLARSHIPS TO ENGINEERING STUDENTS

For the ninth consecutive year, the American Society of Tool Engineers will again sponsor an International Education Awards program for engineering students interested in pursuing tool and production engineering as a profession. This year twenty scholarships totaling $11,000 will be awarded, ten at the college and university level, and ten to students attending junior colleges and technical institutes.

In making the announcement, ASTE Executive Secretary Harry E. Conrad said, "No force in industry today offers greater challenge to the young engineer . . . or greater opportunities for advancement, than manufacturing. The growing complexity of space age manufacturing due to the introduction of countless new products, new materials, new methods and radically new approaches to our production problems, has presented industry with a pressing demand for the Tool Engineer expertly trained in the "know-how" of modern manufacturing." Tool Engineering is not confined to any single branch of industry but enters all phases and segments of the manufacturing processes.

College or university engineering students who are interested in tool engineering or related fields as a profession and who have completed their freshman and sophomore years, may apply for one of ten $700 scholarships. Juniors may apply for their senior year, and seniors for a year of graduate study. Technical institute and junior college students are offered ten Awards of $400 each to further their second year studies of such subjects as metal processing, plant layout, tool design and development, inspection and quality control, and manufacturing processes. Competition is open to engineering students in both the United States and Canada. A high level of scholastic achievement, a demonstrated interest in tool engineering as a career, and financial need are the basic requirements to qualify.

Application forms have been sent to the Deans of 400 engineering schools. Selection of winners will be made by the ASTE National Education Committee early in March. Grants will be made effective beginning in the autumn of the 1959–60 school year, and will be paid directly to the institution, on a quarterly or semester basis. The student must maintain satisfactory grades to receive the balance of the allotted Award.

STUDENT–TRAINEE JOBS BEING OFFERED BY FEDERAL AGENCIES

Several thousand student-trainee employment opportunities will be offered to college students and high-school graduates by Federal agencies during the next twelve months, the Civil Service Commission has announced. Most of the training opportunities will be in engineering and science fields.

The Commission has stepped up efforts to interest students in work-study training programs conducted by Federal agencies and installations, with the expectation that trainees may be attracted to careers in civil service after completing their studies.

The programs provide on-job training for students in Federal research laboratories and offices throughout the country. Although plans vary from agency to agency, there are three basic ways to participate. Students may work during summer vacation and attend school during the regular academic year, may alternate periods of employment and school attendance, or may be employed part-time while attending school.

As a result of the recent ten per cent general pay increase, trainees are paid salaries at the rate of from $3,25 to $3,755 a year, according to the level of scholastic training. They are paid only during periods of employment. For example, a student employed in grade 3 ($3,495 per year) for twelve weeks during the summer would earn about $811.

After completion of work required for a bachelor's degree, trainees may be promoted to full-time professional and technical positions at grade 5; however, those with outstanding collegiate records as well as those with at least six months' student-trainee experience may be appointed at grade 7. Normal entrance salaries for these grades are $4,040 and $4,980 a year, respectively, but for most engineering and science positions entrance salaries at the professional level are higher. In these fields, the starting salary for grade 5 is now $4,490, and for grade 7, $5,430.

SUCCESSFUL ENGINEERING PLACEMENT EXAMS

The Civil Service Commission reports much enthusiasm has been shown in its new examination aimed at recruiting and identifying young engineers and physical scientists with outstanding ability for research work. Government Scientists and personnel officials, college placement officers, and department heads, as well as officials of national science associations, have indicated considerable interest in the examination and its possibilities for attracting candidates with the desired potential. College seniors and graduates are now submitting applications for the first examination to be held in February, 1959.

Further details are given in Civil Service Announcement No. 175, which may be obtained from the college placement office.

UW RECEIVES GRANTS FROM DU PONT

The University of Wisconsin recently received $23,500 from the Du Pont Company as a part of an annual aid to education program in which $1,200,000 was awarded to 139 colleges and universities. The entire program is for fundamental research by universities and for strengthening the teaching of science and related liberal arts in the 1959–60 academic year.

A $15,000 grant was received for fundamental research in the field of chemistry, with an additional $5,000 devoted to chemical engineering. A postgraduate teaching assistantship was also provided in which the graduate student receives $3,000; and the University, $500. THE END

SNEED'S REVIEW

by Earl Kelling me'59

MECHANICAL IMPEDANCE METHODS FOR VIBRATION PROBLEMS

ASME Publication. $5.50

Over the past few years, there has been a growing interest in approaching mechanical vibration analysis from a standpoint new to mechanical engineers, but old to electrical engineers and physicists. This approach, the mechanical impedance concept, is particularly applicable to the description of linear dynamic systems of rather high complexity when only limited information is desired. Feeling that the time was ripe to review and discuss the state of the art in this area, the Shock and Vibration Committee of the ASME Applied Mechanics Division sponsored a Colloquim which was held during the Societys 1958 Annual Meeting.

The Proceedings of the Meeting is now available. It gives precise definitions and shows how impedance methods apply to lumped and continuous systems of simple and moderate complexity, reviews measurement techniques, demonstrates the power of digital computers by comparing the calculated and measured characteristics of a highly symmetrical system of moderate complexity, gives measured values of typical structures of large size and high complexity, discusses the importance of the impedance in influencing shock and vibration spectra measured in field service, shows how to apply impedance methods to the calculation of vibration insolator effectiveness, treats impedance of some disordered systems, and illustrates how impedance methods may be used to find the response to random excitation.

COMPANY CLIMATE AND CREATIVITY

Industrial Relations News Publication. $10.00

"Company Climate and Creativity" is a study by Deutsch and Shea, Inc., technical manpower consultants. More than a hundred leading authorities on the subject of creativity have contributed their ideas and opinions to this publication which represents the first comprehensive study of the effect of the internal "climate" of a company on its creative technical people.

Among the subjects covered by this book are current attitudes toward creativeness in industry and in the American culture, the role top management plays in stimulating or inhibiting creative work, the other barriers to creativity in business and industry, how much structure and control should be exercised in creative technical research, motivating creative people, and a profile of the ideal supervisor for creative personnel. The book also contains a complete list of contributing panelists and a bibliography.

LATEST TECHNOLOGY IN OIL AND GAS POWER

ASME Publication. $3.00

This Volume contains all of the papers presented at the 1958 Conference of the ASME Oil and Gas Power Division, discusses Division sponsored papers given at the 1957 ASME Annual Meeting, and a review of eight papers on internal combustion lubricants originally presented at the 1957 London Conference on Lubrication and Wear.

CONTENTS: Artic Lubrication of Diesel Engines. Development of a Lightweight, High-Output Four-Cycle Diesel Engine for Naval Service. Lubrication of Large Diesel Engine Oils. A Method of Charge Stratification for Four-Stroke-Cycle Spark-Ignition Engines. The Contractors Part in the Development of a Diesel Engine for the U.S. Navy. The Free-Piston-Engine Possibilities. The U.S. Naval Engineering Experiment Station's Part in the Development of a Diesel Engine for the United States Navy. The Bureau of Ship's Part in the Development of a Diesel Engine for the United States Navy. The Buchi-Telescope-Valve System on Four-Cycle Diesel Engines. Scientific Design of a Diesel Governor. Development of a Turbocharged Uniform Two-Cycle, Spark-Ignition Gas Engine. A New Look at Diesel Lubrication. Performance of Economy Diesel Fuels in a Railroad-Locomotive-Type Diesel Engine. What Happens to Turbochargers. Maintenance of

Fuel Injection Systems. Pressure Fluctuations in Multi-Cylinder Exhaust Manifolds. A Low Temperature Supercharging System for Compression, Pilot Oil and Spark Ignition Engines. Review of Papers on Internal-Combustion Lubricants.

ADVANCES IN MATERIALS HANDLING

ASME Publication. $4.50

The thirteen papers in this book were presented at the 1958 Materials Handling Conference, which was sponsored by the ASME Materials Handling Division. One group of papers is concerned with scientific management in materials handling; another with new developments in pneumatic materials handling, and in industrial bulk handling, as well as the application of advanced materials handling techniques to non-mass production plants. A third group deals with the design and development of special equipment such as used for high capacity bulk handling, and for handling nuclear materials. The fourth group deals with handling problems, with radioactive materials, material handling equipment in missile launching, and materials handling in logistics for missiles.

1958 PROCEEDINGS OF THE 3RD U.S. NATIONAL CONGRESS OF APPLIED MECHANICS

ASME Publication. $20.00

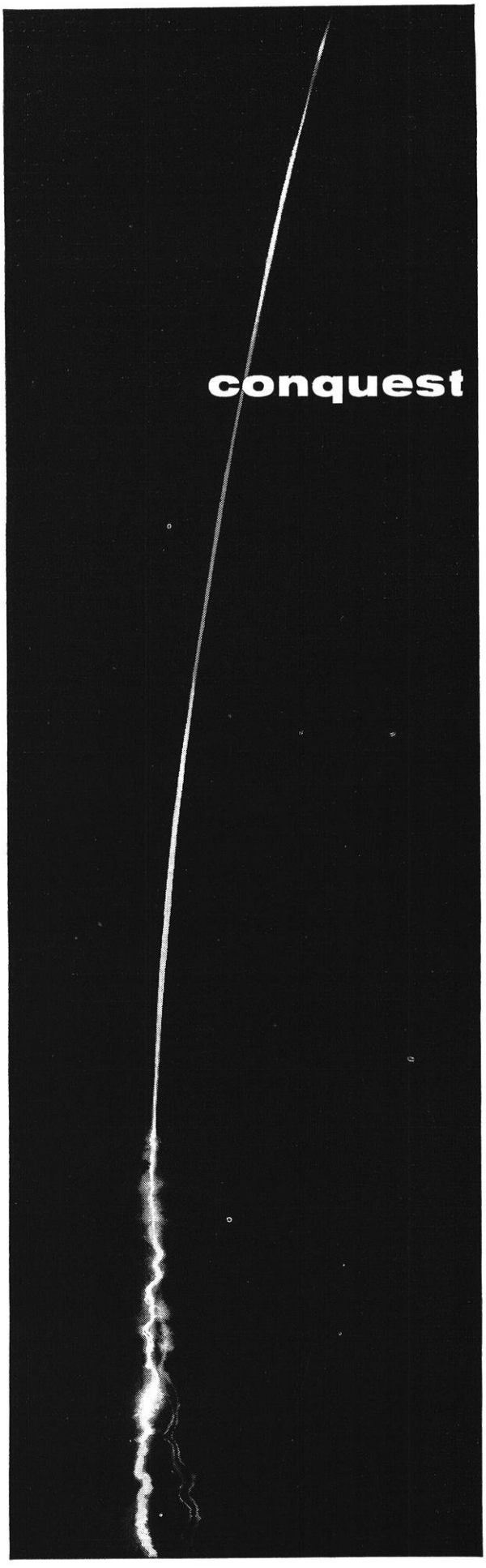
It offers, in 904-pages, research results, new theoretical and statistical methods, new correlations, unique approach to difficult problems, new analytical tools, original viewpoints, background information, and numerous bibliographies, enhanced by a thousand illustrations in the form of charts, graphs, and photographs. Problems covered are those associated with dynamics, vibrations, elastic waves, elasticity, elastic structures, plasticity, viscoelastic flow, fracture, fluid flow, aerodynamics, and heat transfer. The subjects are dealt with in 102 papers which were prepared by 155 recognized authorities in the areas involved. In brief, this is a compendium of the most recent advances made in connection with major problems encountered throughout modern applied mechanics. THE END

Engineer's Transit

(Continued from page 40)

either to one end of the horizontal axis or to the top of the main telescope. The vertical vernier is not a full circle but rather an arc of 180 degrees. This instrument is used only in mining work.

The use of European transit in this country is becoming increasingly popular. The European-made transit is a combination of high degree of precision with ease of operation and lightness of weight. The system of reading the verniers greatly decreases error in vertical and horizontal angles. Other features of the European type include observation of the horizontal and vertical circles and control levels from the eye-end of the instrument, a stadia interval of 100, internal focusing, dustproof and moisture proof, few field adjustment, three leveling screws, and optical centering. THE END



conquest of the thought barrier

Over the years, we have been hearing of many "barriers" in science . . . the sound barrier, the water barrier, the thermal barrier.

Of all the barriers, the hardest one to break through has always been the thought barrier. Every one of these "barriers" has been conquered by men to whom the word, impossible, means: "hasn't been done, *yet.*"

The sound barrier is a shattered concept, as discredited as the phlogistic theory.

Don Campbell's *Bluebird* stopped all talk of the water barrier.

The heat of air friction against the metal "skin" of an airplane was supposed to create a heat barrier at Mach 3. Materials now in production can safely withstand the much higher temperatures involved in flight at Mach 5.

Today the thermal barrier is being called the "thermal thicket"—evidence in itself that no barrier exists.

An interesting point that all of these "barriers" have in common: each was conquered with the help of nickel-containing alloys.

This is not surprising when you stop to consider how many useful properties and combinations of properties are offered by the various nickel alloys:

Corrosion resistance to a wide variety of solids, liquids and gases . . . strength at high temperatures . . . toughness at sub-zero temperatures . . . unusual electrical properties . . . ability to protect product purity . . . spring properties.

When you are faced with a metal problem, investigate Nickel and its alloys. Inco's List "A" and List "B" contain descriptions of 377 Inco publications which are available to you, covering applications and properties. For Lists "A" and "B", write Educational Service.

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A symphonic note?

Is it harmful?

How can it be put to use?

Waste energy?

What are its psychological and physiological results?

What is a phonon?

A precise definition of sound is important to Allison because energy conversion is our business and sound is a form of energy. We convert the energy of sound to destroy materials, to nondestructively peer into material, to join materials without applying heat from an arc or a torch, and for myriad other applications.

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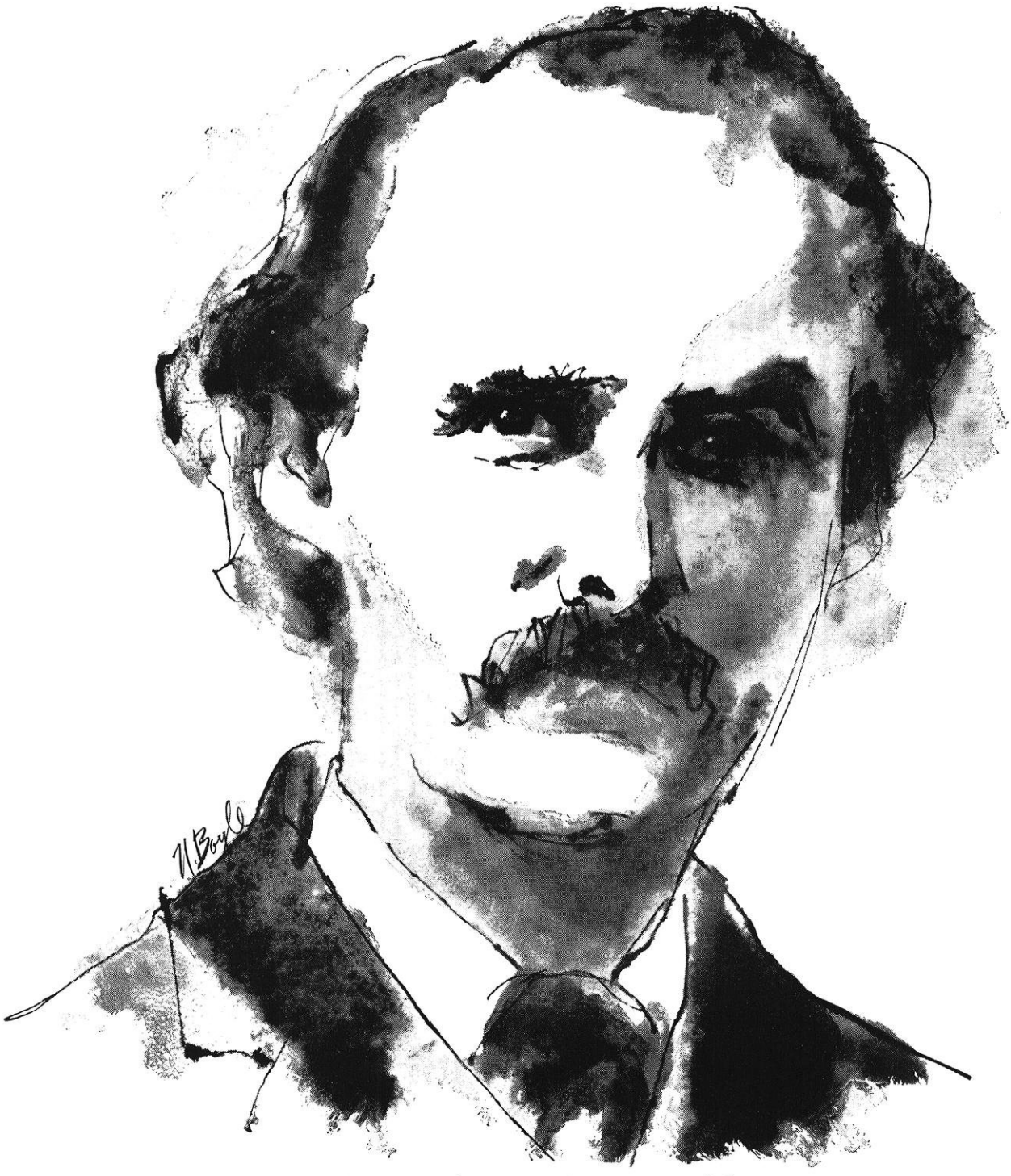

Alfred Marshall...on the tendencies of human action

"The laws of economics are to be compared with the laws of the tides, rather than with the simple and exact law of gravitation. For the actions of men are so various and uncertain, that the best statement of tendencies, which we can make in a science of human conduct, must needs be inexact and faulty. This might be urged as a reason against making any statements at all on the subject; but that would be almost to abandon life. Life is human conduct, and the thoughts and emotions that grow up around it. By the fundamental impulses of our nature we all—high and low, learned and unlearned—are in our several degrees constantly striving to understand the courses of human action, and to shape them for our purposes, whether selfish or unselfish, whether noble or ignoble. And since we *must* form to ourselves some notions of the tendencies of human action, our choice is between forming those notions carelessly and forming them carefully. The harder the task, the greater the need for steady patient inquiry; for turning to account the experience, that has been reaped by the more advanced physical sciences; and for framing as best we can well thought-out estimates, or provisional laws, of the tendencies of human action."

—*Principles of Economics*, 1892

THE RAND CORPORATION, SANTA MONICA, CALIFORNIA

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

NUMBER TWO IN A SERIES
ON MARQUARDT MANAGEMENT

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Science Highlights

(Continued from page 36)

gas costs by reducing shipping charges. This procedure will also facilitate distribution.

Helium gas is obtained from natural gas mixtures in the West Texas area, where it occurs in concentrations of up to eight percent. At present, distribution of the extracted and purified gas from production plants to consumers requires the use of extremely heavy, high-pressure, cylinder tank cars having a limited gas capacity. Transportation costs are therefore an appreciable percentage of the total cost of the gas delivered to the consumer.

Uses of Helium

Both private and government research since World War II has extended the number of uses for helium as well as increased the over-all demand. Today, consumption is 600 percent greater than it was a decade ago. Until the war years, the primary application of helium was the lighter-than-air craft operations of the Navy. Although this use still represents a considerable percentage of the total helium consumption, other military and civilian users have been making larger and larger inroads into the supply of helium. Department of Defense requirements alone have outstripped liberal estimates. At present, rocketry, shielded arc welding, weather balloons for routine and research aerological activities, nuclear reactors, aeronautical research, and low temperature (cryogenic) investigations are the chief applications of this inert gas.

Liquefaction of helium, first accomplished by Onnes at the University of Leiden in 1908, is rapidly becoming a common cryogenic technique. Basically, the process of reaching low temperatures (close to absolute zero) is similar to that used in producing ordinary refrigerator temperatures. Compression of purified helium gas to a pressure of 220 pounds per square inch yields about ten percent liquid when suitably pre-cooled and expanded.

The solution which helium liquefaction offers for transportation difficulties led CEL to undertake the design of suitable liquefaction facilities and transportable containers. This program calls for location of the facilities close to a helium production plant for the greatest economy.

Process simplicity and ease of operation are of primary importance in planning the initial facility. The process recommended employs work-producing expansion engines, and requires the use of liquid nitrogen or liquid air as pre-coolants to produce the necessary refrigeration. In this way, pre-cooling by liquid hydrogen with its accompanying hazards is eliminated and operational complexity is reduced. Another desirable result is greater cycle efficiency.

The operation suggested is a simple Claude-type cycle which consists of one expansion engine operating at a temperature below that of a liquid nitrogen pre-coolant bath. A modification, made possible by a 155-atmosphere pressure differential, employs a second expansion engine in the helium-feed gas stream for the conservation of the liquid nitrogen refrigerant. The pressure of the helium feed from the production plant is 170 atmospheres while the operating pressure of the liquefier is only 15 atmospheres.

Pipe lines, insulated and shielded with liquid nitrogen or liquid air, make possible the efficient transfer of helium from the liquefier to transportable containers. The containers designed by CEL are of a conventional liquid-nitrogen shielded, three-shell construction with evacuated powder as insulation. A new insulation, recently reported by private industry, has a thermal conductivity low enough to eliminate the need for liquid nitrogen shielding.

Transportation Problems

During transportation, isolation of the container allows the pressure to rise to some fixed design value based on travel time and rate of heat transfer, accomplishing "no-loss" storage. For example, newly designed tank cars call for an inner helium vessel capable of withstanding a 10-atmosphere pressure rise within a 10- to 15-day period. This is adequate for transportation within the continental United States. Stainless steel meets the requirements for the pressure vessel. Carbon steel or aluminum are the preferred metals for the outer ambient temperature vessel.

Upon arrival at a specific destination, helium must be transferred into compressed storage facilities; it cannot be kept indefinitely at low temperature without refrigeration. Two methods are proposed for this transfer: (1) if an adequate pressure is maintained in the container, helium can be forced through a heat exchanger, warmed to ambient temperature, and then piped to gas storage cylinders through conventional compression equipment; or (2) a low-temperature pump can be used to force the helium through a heat exchanger to compressed-gas storage.

Thermodynamic Problems

The thermodynamic problems encountered in this proposed program of helium liquefaction and transportation have received considerable attention. Two of these problems are: (1) reducing the amount of liquid helium required to cool the storage vessel; and (2) eliminating temperature stratification of helium in the container.

The "cool-down" of equipment in which liquid helium is the only refrigerant is wasteful because of helium's low heat of vaporization. To reduce this waste, a well-known cryogenic technique was adopted so that a portion of the sensible heat of the cold helium gas that has been vaporized during the initial stages of the "cool-down" could be utilized. This was accomplished by incorporating a concentric shell inside the helium pressure vessel to channel the evaporated helium between the vessl and pressure shell. This design decreases the amount of liquid helium required for cooling by a factor of ten. An operational solution for the second problem is not, as yet, available. However, early results of an investigation currently underway provide a method of minimizing temperature stratification. It is thus possible to keep temperatures in-

side the vessel quite uniform so that pressure will not rise more rapidly than predicted. Being carried out concurrently with studies of liquefaction and storage is the design of transport containers of an optimum size with respect to minimum gross weight and maximum performance.

The specific design resulting from this study will fulfill Navy requirements for a liquefaction facility capable of condensing helium and delivering it to storage at a rate of 50 gallons per hour. The liquefied gas will be transported by insulated rail tank car having a capacity of approximately 13,000 gallons. The interest of other large consumers, stimulated by the economic and technical feasibility of the accepted design, has extended the studies to the design of liquefaction facilities with an hourly rate of 260 gallons. Truck-trailers with capacities to 6,000 gallons have been proposed for the transportation of less-than-carload quantities.

Air Shipment Possible

Small quantities of liquid helium are now also air shipped in the United States. During the last six months, CEL has shipped 12.5- and 19-gallons helium containers to a destination about 2,000 miles from the liquefaction source. Four to five shipments per month have been made by commercial air lines. The only special precaution necessary is a check valve on the normal vent line. This prevents air from being drawn into the liquid helium space by changes in atmospheric pressure. Losses during a typical shipment of this kind are less than one-quarter of a gallon.

If large-scale helium liquefaction becomes a reality, many research programs will benefit from a much lower cost of the liquid. This would reduce the cost of such studies as the development of liquid-helium —cooled, solid-state MASERS (Microwave Amplification by Stimulated Emission of Radiation) and cryotron computers. The MASERS are vital to scientific progress in radio astronomy, and the cryotrons may make possible much more compact computers than are currently available.

THREE-PURPOSE 'HOT-COLD-LIGHT' PANEL

Wall or ceiling panels, perhaps no thicker than a picture frame, may some day cool a home in summer, heat it in winter, and light it the year round. The first experimental model of such a three-purpose panel was revealed by Dr. J. A. Hutcheson, Westinghouse Electric Corporation Vice President in charge of engineering and research.

The experimental panel combines into a single operating unit two of man's newest technological advances, thermoelectric refrigeration and electroluminescent lighting. Thermoelectric refrigeration produces cooling in certain solid materials directly from the flow of an elecric current. Electroluminescent lighting is produced by glowing treated panels no thicker than a sheet of ordinary window glass.

The new foot-square "hot-cold-light" panel, composed entirely of solid state materials, has no moving parts. It produces as much light as a 2-watt light bulb, can maintain a surface temperature approaching that inside a household refrigerator, and, by the flick of a switch, can raise that surface temperature to about 130 degrees Fahrenheit, a temperature suitable for radiant heating.

NEW TYPE OF UTILITY PUMP

The amazing Continental Utility pumps which all incorporate the famed helical screw principle have no vanes, turbines, or impellers. There is only one moving part, turning in a tough rubber stator, providing positive displacement. These pumps are self-priming to as much as 25 feet of suction lift, have high reserve pressure, low internal turbulence giving continuous uniform flow, and freedom from air locking. Properly applied, these pumps will yield performance never before accomplished with other types.

Small in size, light in weight, easy to maintain, requiring no lubrication, this new pump is ideal for many kinds of transferring, circulating, metering, filling, sprinkling, irrigating, draining, and spraying jobs. THE END

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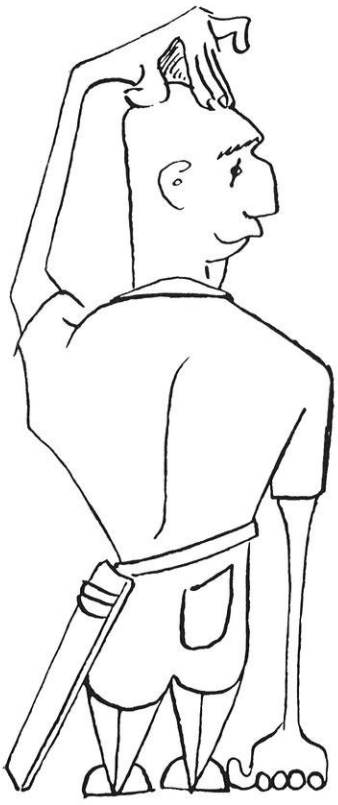
It is partly through this method of training that Du Pont develops its management men of tomorrow. And the need is increasing every day for qualified people to supervise the development, production and distribution of new products as well as Du Pont's 1200 existing products and product lines. So if you join Du Pont you can be sure that you will retain your identity as an individual and be prepared for advancement as quickly as your abilities —and job openings—permit.

WATCH THE
DU PONT "SHOW OF THE MONTH"
ON TELEVISION

DU PONT
REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY



So You Think You're SMART!

by Sneedly bs'60

Thin, fat, short, or tall;
Poems can be wrote by all.
Some are funny;
Some are sad.
Are they good;
Or, are they bad?

WITH this poem as an introduction, Sneedly asks you to let him know what you think of the whole idea of printing poetry. Since he received poems from the weaker sex as well as from males, a comparison can be established.

The topics and forms are many, but they all express a feeling, or an idea, in verse form. As the artist creates, the poet writes.

While Sneedly is speaking of artists, he would like to thank Keith Halverson for his excellent caricatures.

Even though a lot of poetry has been interfering with his clear thinking, Sneedly has not forgotten about this month's problems. He has picked some out which will not be too easy. So for those of you whose middle name is not coward, he would just like to give the reminder that the earliest correct solution is worth $10.

First, here are the solutions to February's teasers:

The lingerie problem was really quite easy. Two equations with two unknowns should have given the ridiculously low prices of $2.75 and $3.25 per item. (Buying some for my girl-friend recently, I found some of the unmentionables quite a bit steeper.)

* * *

The second problem was somewhat harder. Manipulating the numbers and ruling out certain combinations should have resulted in the following array of numbers:

```
  281
  332
  ---
  562
 843
843
-----
93292
```

The answer being the final result of 93,292.

* * *

The third problem required some thinking. Here is one of the ways it could have been done:

Add the ten weights together and divide by 4 to get 289 lbs. as the weight of the five trusses together. Let A be the lightest truss, B the next, etc., and set up the equations using the weights given. It will then be found that ABDE added together gives 231 lbs. This makes truss C 58 lb. Using this same process several times, the weights of 54, 56, 58, 59, and 62 lbs. are found to be the weights of the trusses.

1. It was St. Pat's time again and one of the law students who insisted that St. Patrick was a lawyer wanted to attend but had no date. A good natured Engineer fixed him up with a blind date and told him, "If you reverse her age, you will get half of what she will be in a years time." Being a law student, he of course did not know what to do with this bit of information. Do you? The problem is to find the age of the law student's date. Clue: The Engineer and the Lawyer were anything but friends ever since the night of the dance.

* * *

2. A typical UW Engineer had once again run low on cash. In that all important letter to his parents, he wrote the following:

```
  SEND
  MORE
--------
MONEY
```

Because he did not want his mother to know how much money he needed, he set the total amount as the sum of two numbers shown above. How much money did he ask for?

* * *

3. At seventeen minutes past one on a Sunday afternoon, a camper set out in his canoe and paddled upstream at the rate of four mph against a current of 1½ mph. At five minutes past two, he drew abreast a corked bottle floating in the stream. Deciding against stopping it he continued on his way, only to be overcome presently by his curiosity. He turned around, paddled back, and caught up with the bottle just as both he and the bottle reached his camp. How far did he get from camp before he gave in to his curiosity?

No, but poetic!

THE WORD

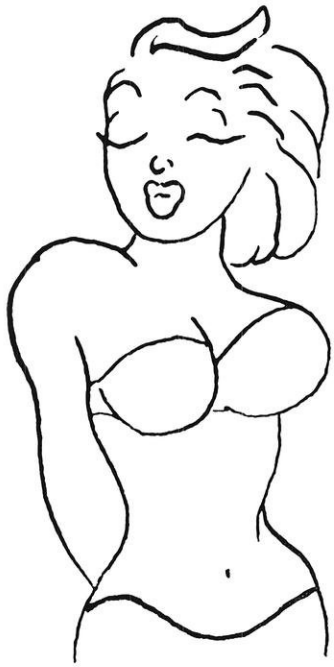
I sometimes wonder who and what
gives us the words to say.
As they are said a brighter day
is sometimes here to stay.
As they are said we crucify
someone, sometimes, somewhere.
And sometimes, when we have to say
the word—it isn't there.

M. Utti

THE THERMO TEST

Oh! somewhere Carnot lies in state
And Gibbs is in the ground,
But adiabats and isotherms
Keep going round and round.
But today we have a test to take,
Tonight we students squirm.
The test is graded with no curve,
The professor is quite firm.
The instructor reads the papers
With a corrugated brow,
He has to grade this lousy test
And he has to do it now.
With F and H and E and S
Things really are in quite a mess.
Entropy and enthalpy
Whirl through his muddled head,
Instead of seeing Q and P
He wishes he were dead.
His slipstick is superfluous,
C scales are useless here.
So he flunked the whole damn lot of them;
I'll see you all next year!

Jerry Last



DEDICATED

Openly I will not cry
As those lonely days drag by;
For I must prove to be steadfast
And strong and straight, alike a mast.
So that when then I draw you near
I'll shed that hidden, held back tear.
A tear of joy, then running free
For united once again we'll be.

L. Phi

° ° °

CAME THE WRECKERS

His love reached out for me
As rust reaches out for new steel,
His passion weakened the structure
Of my resistance, and . . .
I rusted.

Gail Gaiser

° ° °

Now this fellow got an education
In a mode of relaxation.
Providing, of course, you get
co-operation
(And give her a bill of large
denomination.)
So he swallowed his pride in
contemplation
Of this sad situation.
But the net result of calculation
Was a night with a relation.

A. Tion

THE FERROUS WHEEL

by Bill Timmler

Two junior sized "cats" were loitering on the street corner when one said to the other.

"How old is you?"

"Ah's five. How old is you?"

"Ah don't know."

"You don't know how old you is?"

"Nope."

"Does women botha you?"

"Nope."

"Youse fo'."

I wish I wuz a kangaroo
I wish I wuz a clock
I wish I wuz the orchid stripe
In sumwun's sky blue sock.
I wish I wuz a purple pigg.
With polkadotted trimming.
I wish I wuz a zooloo gal
I wish I wuz in swimming.
I wish I wuz a mutton legg
Or just a legg of lamm—
Ide gladdly be most ennything
But this dumm thing I amm!

A landlord asked his guest: "How did you find the room?"

"Terrible," replied the frank guest. "I didn't close my eyes all night."

"That's your own fault, sir. If you want to sleep you must close your eyes."

* * *

"I was once in love with a twin."

"Wasn't that awkward? I mean—didn't you ever kiss the wrong one by mistake?"

"Oh, no—her twin brother wore a moustache."

* * *

Fashion is a tyrant from which nothing frees us.—Pascal.

* * *

"You would hardly know Freddie since he got back from Las Vegas. He lost all his money there and . . ."

"Hardly know him? Why, I shan't know him at all."

* * *

"Where's Dad?"

"Somebody made him a present of a small bottle of brandy so he's gone into the bedroom to feel faint."

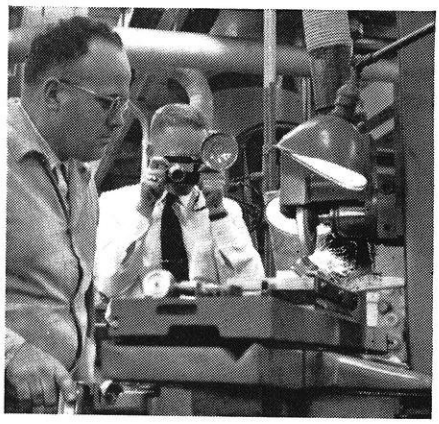
* * *

Friend: "Has your son's college education proved helpful since you took him into the firm?"

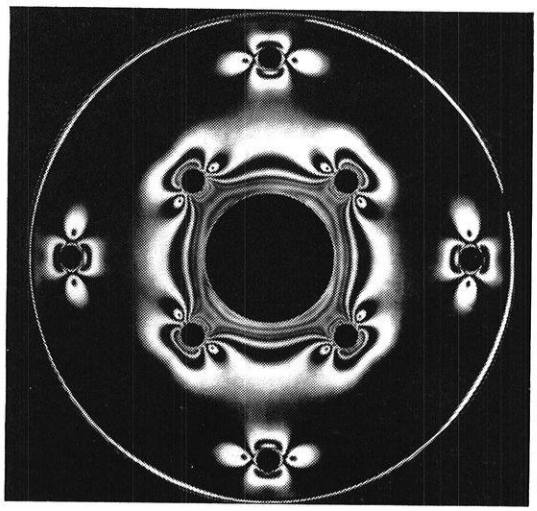
Father: "Oh, yes, whenever we have a conference, we let him mix the cocktails."

"Peter has grown another foot since he went to college."

From research to finished product–
Photography works with the engineer



Sparks fly as the plant photographer records a grinding technique for study.



Photoelastic stress analysis helps the design engineer pinpoint areas requiring extra strength.

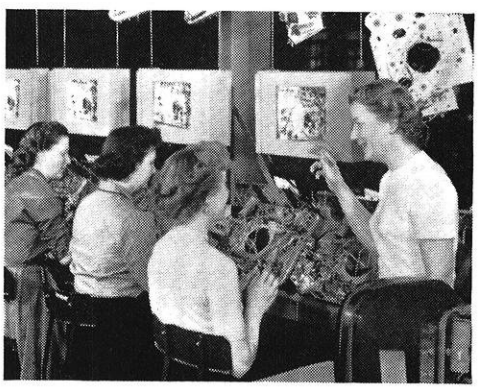
Giant machines produce a flow of photo-exact engineering drawings—save countless hours of drafting time.

Today photography plays many important roles in industry. It speeds engineering and production procedures. It trains and teaches. It sells. In whatever work you do, you will find photography will play a part in improving products, aiding quality controls and increasing business.

Careers with Kodak

With photography and photographic processes becoming increasingly important in the business and industry of tomorrow, there are new and challenging opportunities at Kodak in research, engineering, electronics, design and production.

If you are looking for such an interesting opportunity, write for information about careers with Kodak. Address: Business and Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N.Y.



Color transparencies on the production line aid operators in assembly operations—save time and reduce errors.

EASTMAN KODAK COMPANY
Rochester 4, N.Y.

Kodak
TRADEMARK

One of a series*

Interview with General Electric's Earl G. Abbott Manager—Sales Training

Advancement in a Large Company: How it Works

Where do you find better advancement opportunities—in a large company or a small one? To help you, the college student, resolve that problem, Mr. Abbott answers the following questions concerning advancement opportunities in engineering, manufacturing and technical marketing at General Electric.

Q. In a large Company such as General Electric, how can you assure that every man deserving of recognition will get it? Don't some capable people become lost?

A. No, they don't. And it's because of the way G.E. has been organized. By decentralizing into more than a hundred smaller operating departments, we've been able to pinpoint both authority and responsibility. Our products are engineered, manufactured and marketed by many departments comparable to small companies. Since each is completely responsible for its success and profitability, each individual within the department has a defined share of that responsibility. Therefore, outstanding performance is readily recognized.

Q. If that's the case, are opportunities for advancement limited to openings within the department?

A. Not at all. That's one of the advantages of our decentralized organization. It creates small operations that individuals can "get their arms around", and still reserves and enhances the inherent advantages of a large company. Widely diverse opportunities and promotions are available on a Company-wide basis.

Q. But how does a department find the best man, Company-wide?

A. We've developed personnel registers to assure that the best qualified men for the job are not overlooked. The registers contain complete appraisals of professional employees. They enable a manager to make a thorough and objective search of the entire General Electric Company and come up with the man best qualified for the job.

Q. How do advancement opportunities for technical graduates stack-up with those of other graduates?

A. Very well. General Electric is recognized as a Company with outstanding technical skills and facilities. One out of every thirteen employees is a scientist or engineer. And approximately 50 per cent of our Department General Managers have technical backgrounds.

Q. How about speed of advancement? Is G.E. a "young man's Company"?

A. Definitely. A majority of all supervisors, managers and outstanding individual contributors working in the engineering function are below the age of forty. We believe that a job should be one for which you are qualified, but above all it should be one that challenges your ability. As you master one job we feel that consideration should be given to moving you to a position of greater responsibility. This is working, for in the professional field, one out of four of our people are in positions of greater responsibility today than they were a year ago.

Q. Some men want to remain in a specialized technical job rather than go into managerial work. How does this affect their advancement?

A. At G.E. there are many paths which lead to higher positions of recognition and prestige. Every man is essentially free to select the course which best fits both his abilities and interests. Furthermore, he may modify that course if his interests change as his career progresses. Along any of these paths he may advance within the Company to very high levels of recognition and salary.

Q. What aids to advancement does General Electric provide?

A. We believe that it's just sound business policy to provide a stimulating climate for personal development. As the individual develops, through his own efforts, the Company benefits from his contributions. General Electric has done much to provide the right kind of opportunity for its employees. Outstanding college graduates are given graduate study aid through the G-E Honors Program and Tuition Refund Program. Technical graduates entering the Engineering, Manufacturing, or Technical Marketing Programs start with on-the-job training and related study as preparation for more responsible positions. Throughout their G-E careers they receive frequent appraisals as a guide for self development. Company-conducted courses are offered again at all levels of the organization. These help professionals gain the increasingly higher levels of education demanded by the complexities of modern business. Our goal is to see every man advance to the full limits of his capabilities.

If you have other questions or want information on our programs for technical graduates, write to E. G. Abbott, Section 959-9, General Electric Co., Schenectady 5, N. Y.

***LOOK FOR other interviews discussing: • Qualities We Look For in Young Engineers • Personal Development • Salary.**

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