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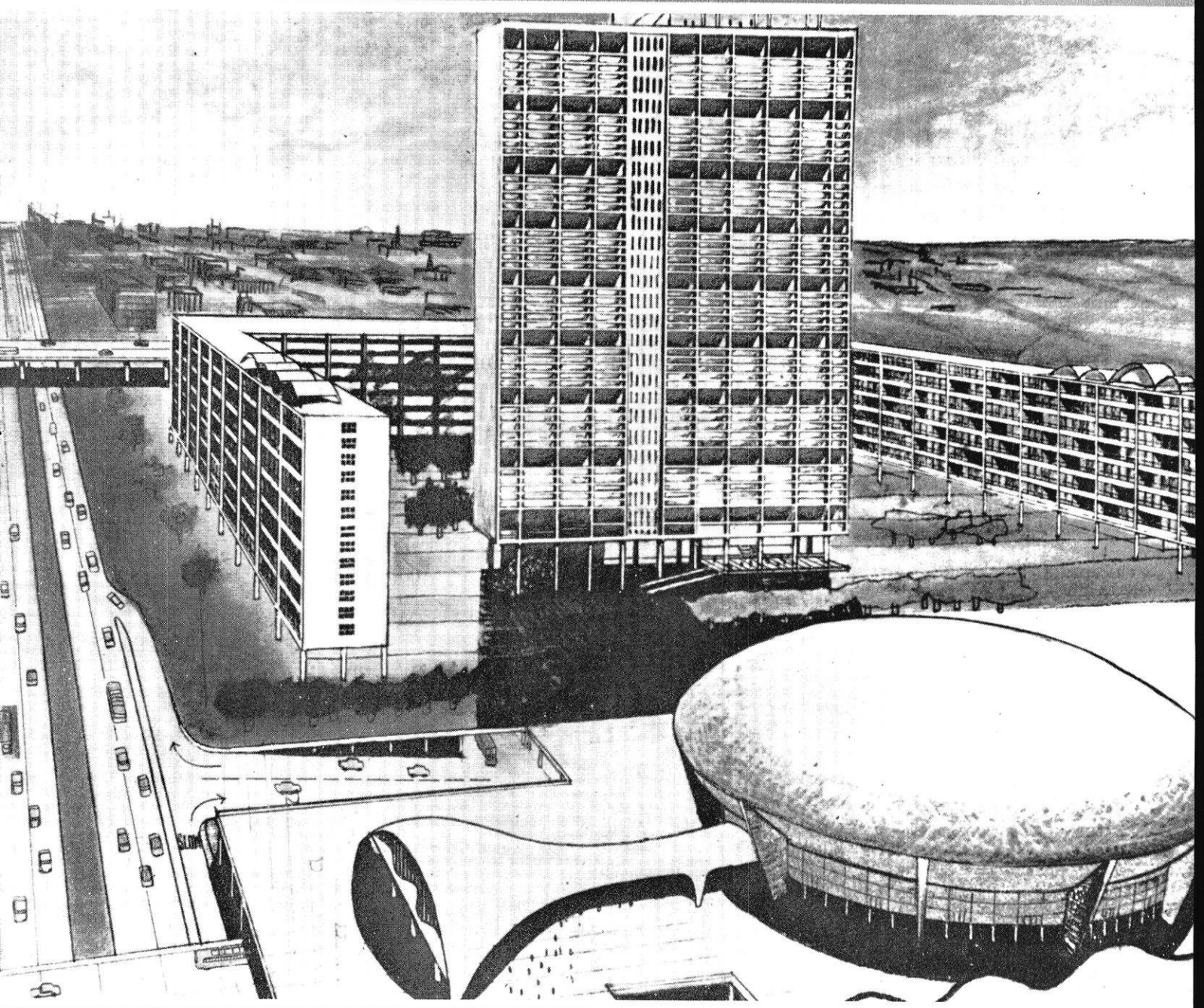
NOVEMBER
1958
The Wisconsin
25¢

engineer



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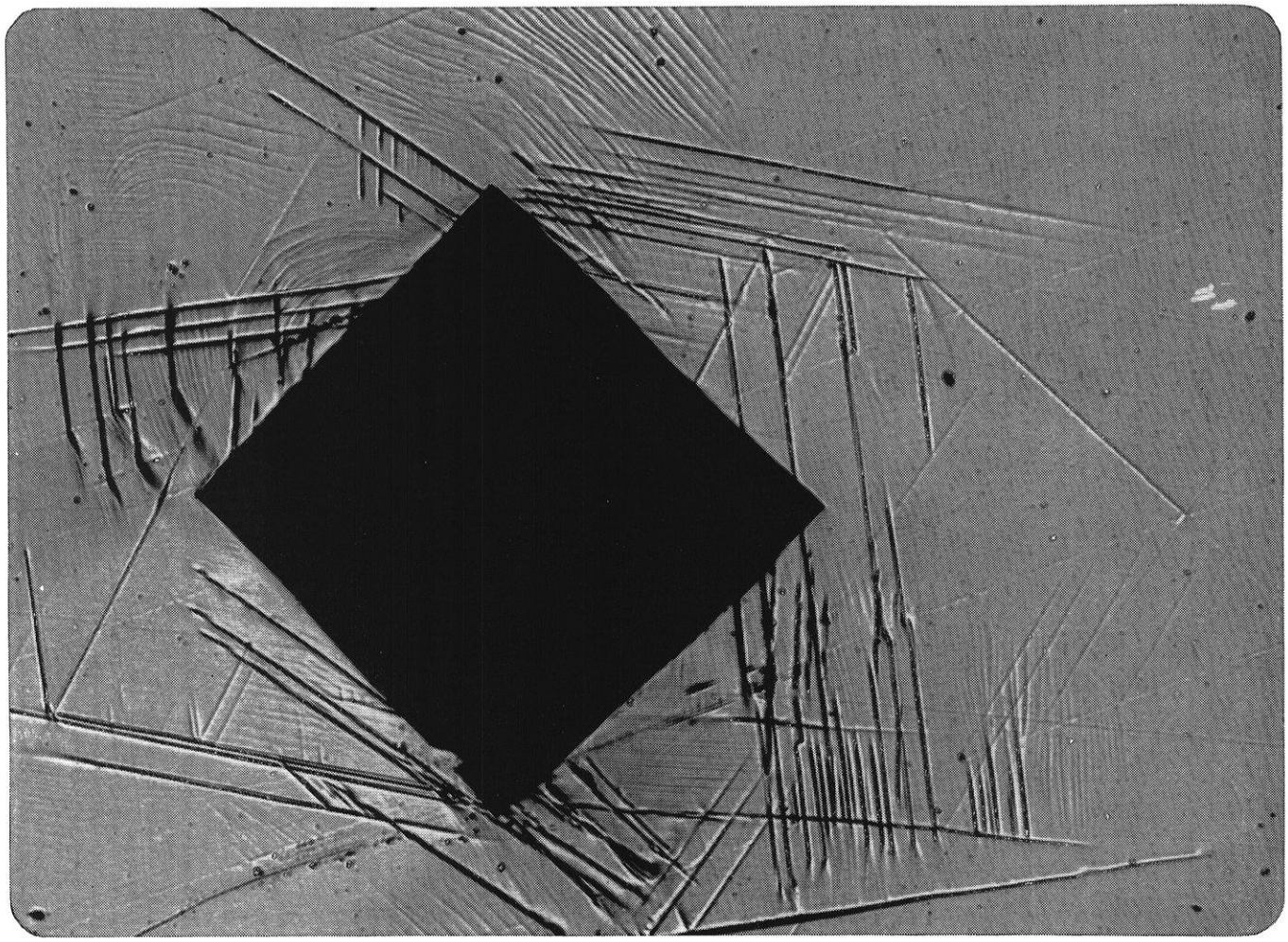

Did you ever hear atoms move?

The physicist positions a single crystal of age-hardened steel under the sharp diamond penetrator. He touches a pedal, and the pyramidal tip of the diamond squeezes into the polished surface of the steel.

The instant that it touches, things begin to happen inside the crystal. Atoms begin to slip and slide, in layers. Some layers abruptly wrinkle and corrugate. If you listen hard when this happens, you hear a faint, sharp "click." This is the sound of atoms suddenly shifting within the crystal.

You can see the action, too — or, rather, the results of it. The photomicrograph above shows the characteristic ridges and ripples. The black diamond in the center is the depression made by the penetrator.

By studying these patterns, and correlating the information with other data, scientists at U. S. Steel are trying to learn what happens atomically when a steel is bent, flexed or broken. Secrets thus learned are helping us to develop new and better steels not only for everyday products, but also for missiles, rockets, submarines, and other intricate machines to explore the universe above and the world below us.

"Tomorrow" is an exciting word today — and never more so than at United States Steel where we are accepting the challenge of the future with energy, resourcefulness and confidence.

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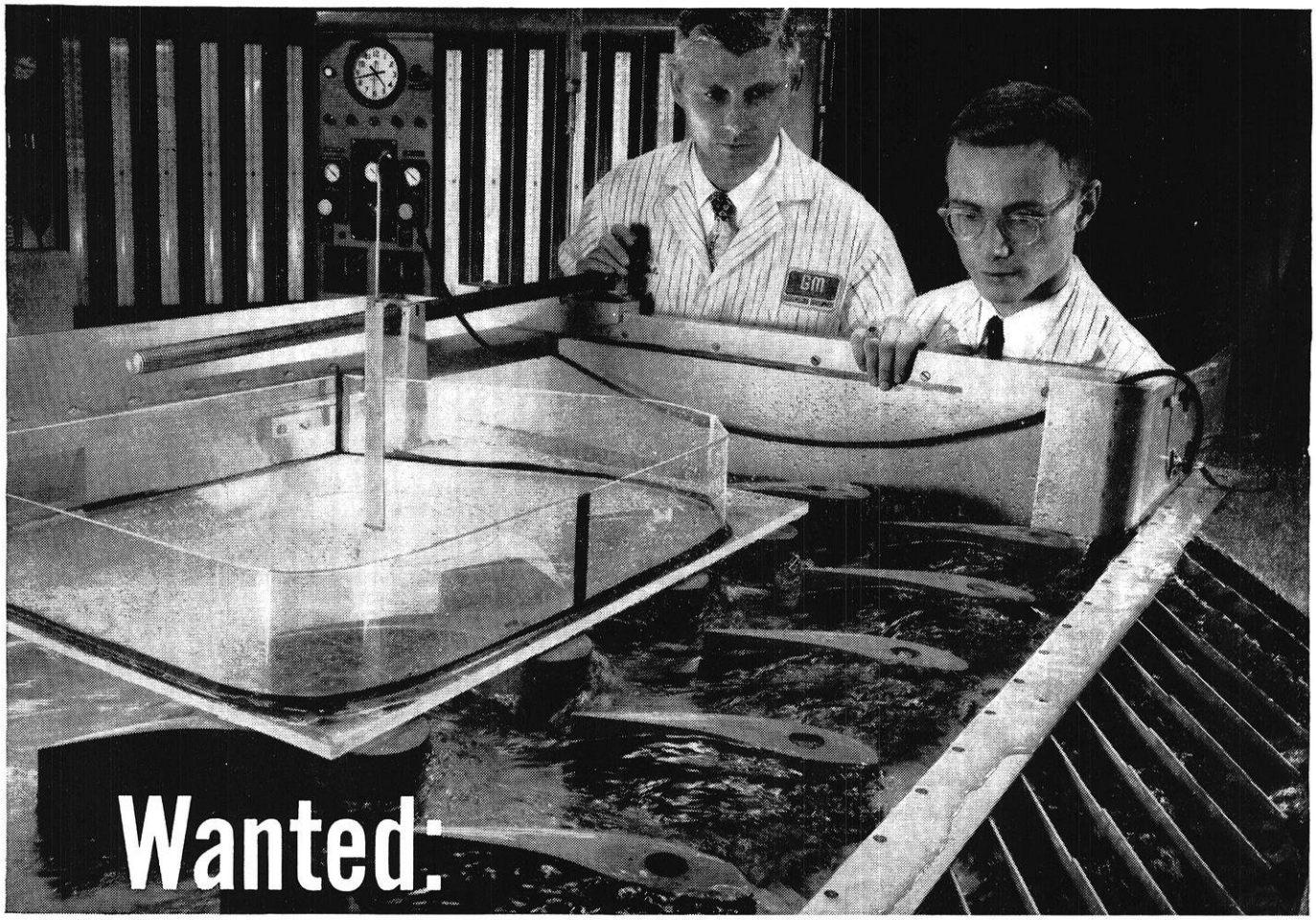

Wanted: Inquiring Minds

TEAMMATES—Young engineer Warren Conner—B.S.M.E. 1956—teams up with Armand J. Bilitzke of GM Engineering Staff's Transmission Development Group to test blade-shape models for torque converters. Mr. Bilitzke helped design flow table which is unique to the automotive industry.

No matter where your interests lie in the vast field of engineering, there's a better-than-good chance you'll find your place in the sun with one of the 35 Divisions of General Motors.

For these GM Divisions run the gamut of virtually every field of engineering and science—from engineering, designing and producing automobiles, trucks and hundreds of important industrial products to helping to solve the unknown challenges of the Space Age.

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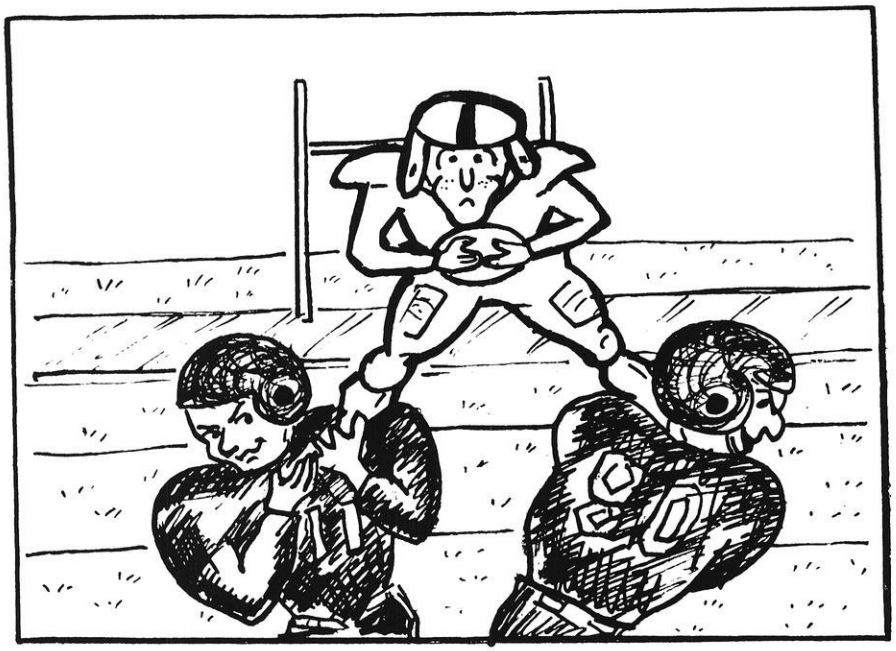
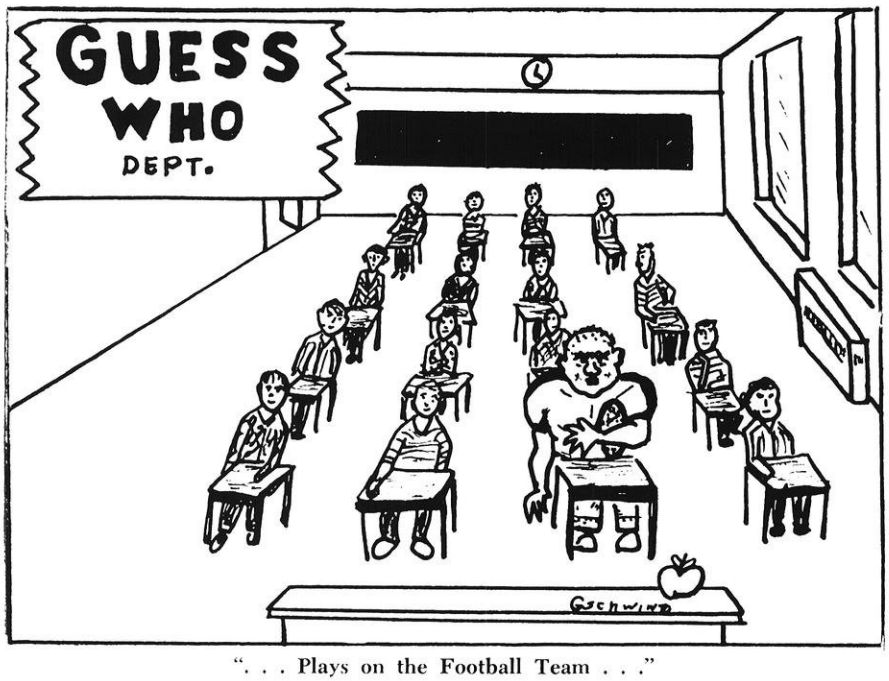


"Make A Wish."

THE WISCONSIN ENGINEER??



". . . Plays on the Football Team . . ."

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Volume 63 NOVEMBER 1958 Number 2

WISCONSIN ENGINEER

The Student Engineer's Magazine

FOUNDED 1896

Features

Departments

Cover

Artist's conception of an American city of the future, with its large underground parking garage, thin-shell concrete roof auditorium and broad freeways, may not be so fanciful as it may seem.

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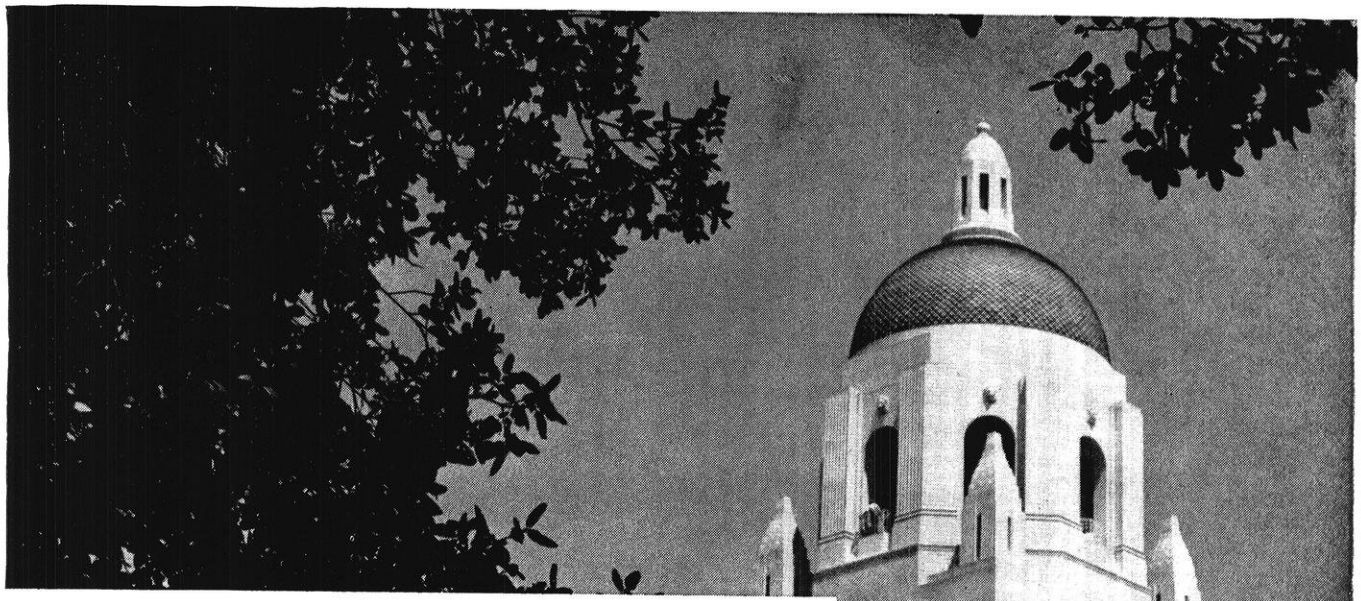
Alfred North Whitehead...on the passion for discovery

"Disinterested scientific curiosity is a passion for an ordered intellectual vision of the connection of events. But the goal of such curiosity is the marriage of action to thought. This essential intervention of action even in abstract science is often overlooked. No man of science wants merely to know. He acquires knowledge to appease his passion for discovery. He does not discover in order to know, he knows in order to discover. The pleasure which art and science can give to toil is the enjoyment which arises from successfully directed intention. Also it is the same pleasure which is yielded to the scientist and to the artist."

—*The Aims of Education, 1917*

THE RAND CORPORATION, SANTA MONICA, CALIFORNIA

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



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 Director, Lockheed Missile Systems Division, Sunnyvale , California.

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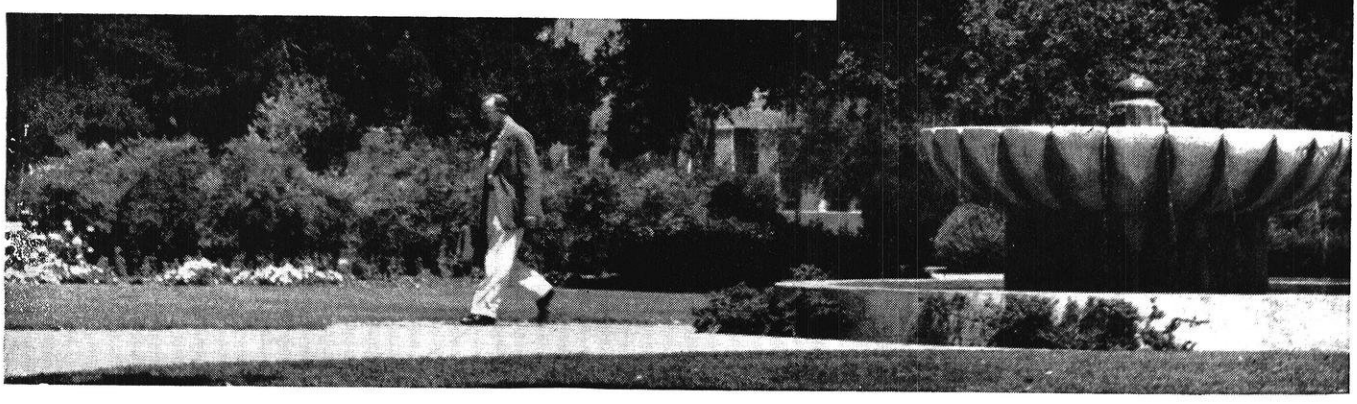
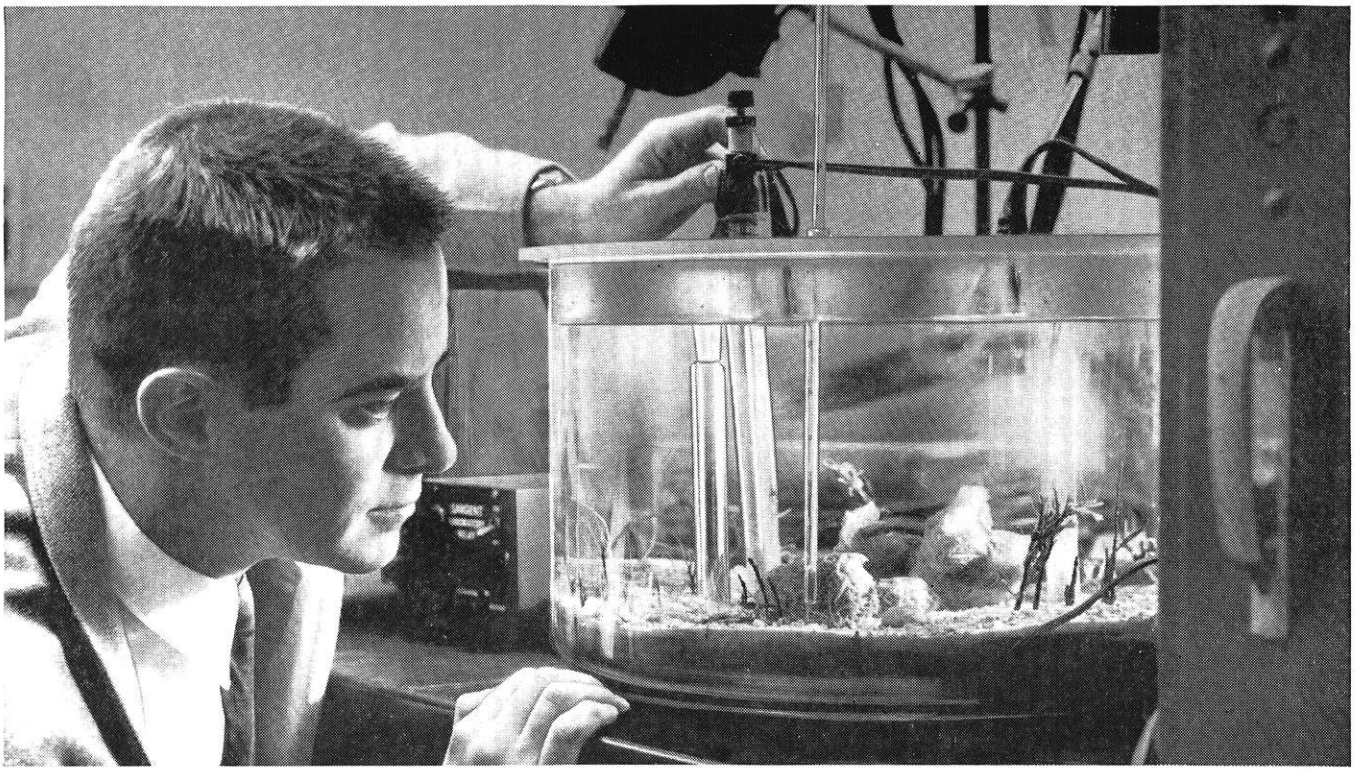
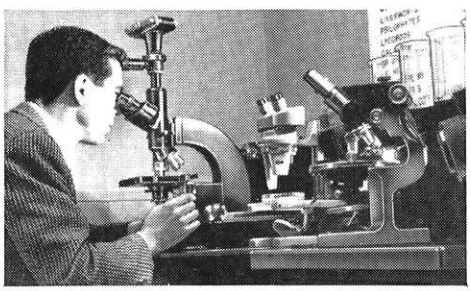




WHAT CAN A FISH BOWL TELL? The tiny plants and animals that grow in this "fish bowl" will be similar to those that grew in oceans fifty million years ago and more. The aim of this experiment is to add to man's knowledge of where to look for oil deposits. Pictured is Dr. F. G. Stehli.



HAY FEVER SUFFERERS may be interested to know that pollen is helpful—in the search for oil, that is. Here Dr. A. T. Cross studies traces of pollen in rock millions of years old to interpret underground formations. A comparatively new science, this study of ancient pollen opens previously explored areas to new examination.

THE SEARCH FOR OIL goes on in some of the most inaccessible regions in the world. And expensive, specially-built equipment like this "swamp buggy" is needed to overcome the obstacles of nature and to find more new oil every year than is taken out of the ground.

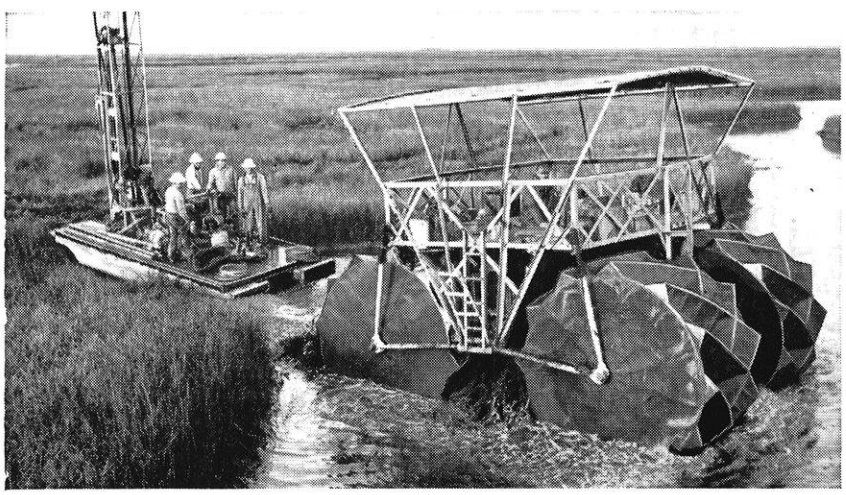
Time turned back 50 million years; Scientists seek new clues to oil!

Tiny marine plants and animals, very like those living when dinosaurs roamed the earth, are being grown today in a research laboratory.

In glass containers similar to fish bowls, scientists of Pan American Petroleum Corporation, a Standard Oil affiliate, have transplanted sand and sea water from an ocean shore line. Then, by controlling temperature, pressure and salt content, they have simulated the environment of plants and animals that grew 50 to 300 million years ago.

The chemical composition of the microscopic life that grows in the laboratory will offer more positive clues to the type of environment of ancient fossils; that is, whether the tiny animals lived and died in deep, shallow, or protected water.

This knowledge will help scientists to map ancient seas with greater accuracy, to pinpoint the location of prehistoric shore lines and barrier reefs where conditions were ideal for oil to form. Such knowledge will improve our ability to find oil in sufficient quantities to meet today's steadily increasing needs.



This is another example of the way research works at Standard and its affiliates to discover quicker, surer methods of finding oil, to keep the supply up and the price down.

As the result of such trail-blazing research work as the fish bowl project, America's proved underground reserves have grown larger, prices have remained reasonable, and America has been assured of an adequate supply to keep its defenses strong.

What makes a company a good citizen? One measure is a company's concern for the welfare of future generations. In our business, a "let-tomorrow-take-care-of-itself" attitude would be disastrous. Through research, we at Standard are working to make life more comfortable and secure for all—today and for the future.

STANDARD

STANDARD OIL COMPANY

THE SIGN OF PROGRESS...
THROUGH RESEARCH

THE MAN* WITH KOPPERS

"... versatility recognized"

***Arthur Herman** graduated from Johns Hopkins in 1955 and went to work immediately in the Metal Products Division of Koppers as a Design Engineer.

In December of the same year, he was promoted to Supervising Engineer of the Design Section, where he found that Koppers offers truly challenging problems in design engineering.

Then, in September 1957, Art was transferred to the Coupling Sales Department as a Coupling Application Engineer. He is serving in that capacity now.

An employment record alone is seldom descriptive of the opportunities and responsibilities many positions represent. For instance, Art was recently designated as Division Representative to investigate the potentialities of a new product developed by a European manufacturer. This assignment took him abroad.

Art is particularly articulate about his job and the constant challenge it presents for him as an individual.

"When I first started as a design engineer," he said, "I didn't realize the scope of activities in which I'd be called on to participate. Sure, I had good theory and background for design engineering, but I had little concept of the problems of production, and even less familiarity with the techniques of sales or marketing. My work as an application engineer gets me into almost every phase of the business — development, production, marketing, finance, and so forth.

"At Koppers I feel that I receive the necessary guidance to enable me to contribute fully to the Company's activities. I am encouraged to make decisions. If these decisions involve factors with which I am not entirely familiar, I can rely on the judgment and experience of others working with me. At all times, I feel that I have real access to upper levels of management where my ideas have always been received thoughtfully and given full consideration. Now, I feel confident that I am doing a job for Koppers, and, what is equally important, that my associates and supervisors understand and appreciate it, too! I have found that through such methods as the Management Appraisal Program, Koppers makes every effort to recognize and reward good performance."

A lot of things could be said about Art Herman, and the career he found at Koppers. But as the manager to whom Art reports commented recently: "Art's an able man . . . we're glad to have him. He is making a real contribution to the Company. All we in management can do is try our best to develop a man's best qualities and, when he proves to have the versatility that Art has, to see that this versatility is recognized."

If you feel that this is the atmosphere in which you would most like to build your profession and mark your progress, write to the Manager of Manpower Planning, Koppers Company, Inc., Pittsburgh 19, Pennsylvania or contact your College Placement Director.

KOPPERS

KOPPERS

"If creative engineering is your career be sure you choose an engineer-minded company"

says R. T. Cox, Vice-President of Research & Development, Collins Radio Company

"Collins Radio Company is a dynamic, fast-growing company with an excellent reputation built on a solid foundation of engineering talent. Sales have increased 10-fold in the last 10 years. Employment of research and development personnel has more than kept pace. Collins will continue to grow; you can grow with Collins.

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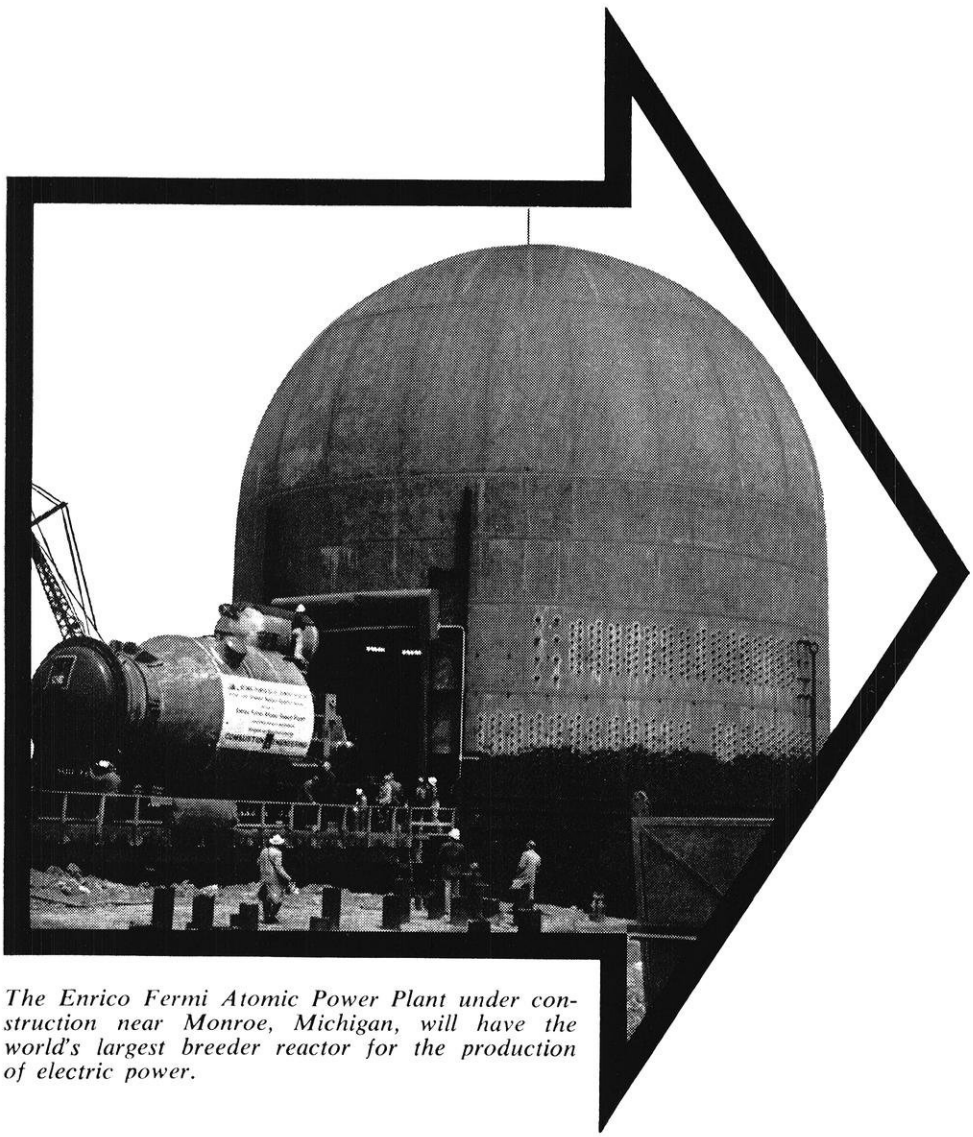
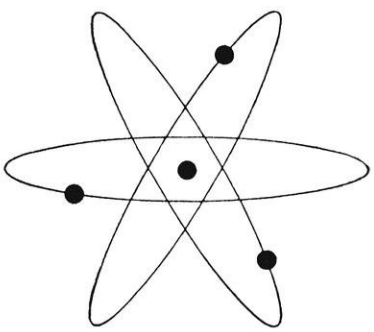
Into the atomic era of new engineering opportunities



The Enrico Fermi Atomic Power Plant under construction near Monroe, Michigan, will have the world's largest breeder reactor for the production of electric power.



To the young engineers of America's electric power systems, the hope and promise of the peaceful atom grows clearer day by day. In laboratories and on construction projects these young men are serving our nation's new atomic-electric power industry.

Research and design, development and testing of new equipment, building of special structures and operation of reactor plants—for the more efficient production of electric power – offer opportunities for doing things that have never been done before.

A Detroit Edison representative will visit your campus in the near future to tell you of the job opportunities in the electric power industry. Check your placement office for appointments.

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Rambling WITH THE EDITOR

"Hurray for Swarthmore College!" This is what we wanted to say a few months ago when we read a news release about Swarthmore's proposed "Honors Program in Engineering Sciences" which was to have gone into effect this fall. This new, unprecedented curriculum stresses "basic disciplines and fundamentals needed by all engineers with emphasis on the physical sciences and mathematics."

Engineers are learning more and more that "technicians" are not what Industry wants today. A man with only know-how is not advanced, is not given responsible jobs. Engineers must "think" and think well. They must be able to organize, to improvise, to administrate. They must be able to "get along with people." They must be able to "be diplomatic" in this growing surge of "politics" in Industry. They must not only know "how" to operate a steam engine or a computer, but they must know "why" it operates the way it does.

ON THE BASIS of this type of analysis, the Honors program, which has worked well for other schools of the College, was initiated into the Engineering school. The following is a reprinted portion of that news release describing the program.

The sciences fundamental to civil, electrical, and mechanical engineering—physical sciences, engineering sciences, and mathematics—will be studied intensively in the framework of the Honors plan of study which was first established at Swarthmore in 1922. This plan enables gifted students who have the maturity and capacity to do independent work to meet in seminar groups of from five to seven students for six to nine hours each week under the direction of an instructor. Each student will take two such seminars each semester in his junior and senior years. He may choose his seminars from the following group: Advanced Calculus and Differential Equations, Mechanics of Solids, Electrodynamics, Thermodynamics, Fluid Mechanics, Modern Physics, Linear Systems, Electronics, Structural Mechanics, Mechanical Design, and Earth Science. The first six seminars are specified, while the remainder are elective. Honors students in the junior and senior years are thus freed from standard academic procedures such as courses, credit, and grades, but at the end of their senior year they must take written and oral examinations, covering their two years' work, given by visiting examiners from other educational institutions.

The Honors Program in Engineering Sciences, which has been under consideration for a year, has the backing of industry and of the first rate engineering graduate schools in the country which were consulted during preliminary discussions. One prominent engineering graduate of Swarthmore, George Schairer, Director of Research at the Boeing Airplane Company commented: 'When we talk about engineering today, we are talking more about science than practical know-how, quite a different story than fifty years ago when it was essentially all art or practice.' Dr. Smith further said: When' we took this forward step in engineering education, we took a backward look at the history of engineering education at Swarthmore, which is as old as the College itself.' In 1877 minutes of the Board of Managers talked about the 'why' of engineering education: 'While a liberal amount of practical work is given, care is taken that the student understands the reasons for the work done.' "

This could become, for those who qualify for such a program, a great aid that could never be obtained in what we consider the "usual" engineering curriculum. Here they could have a chance to "act" (for want of a better word) like engineers. The seminar setting can provide a place where they may consult with one another in solving their own particular problem or in coming to a mutual solution of a problem as a group. Their own initiative can be tried and tested as they work at their "own pace" on problems or projects.

THIS COULD provide valuable training for the type of work they will have to do after graduation. But, on the other hand, as was pointed out in this column last month, we certainly can not neglect the training of an engineer's hands to work with the tools he uses. An engineer with a degree should know how to handle the basic "hardware" of his profession and the principles of engineering science which tell him the "why".

So, what is the answer? It seems almost inevitable that, if both these ideas are to be incorporated into any curriculum, an extension to a 4½ to 5 year course is necessary. Medicine and law schools require more than this before a candidate is considered competent. The handling of many of the problems in Engineering Science are becoming just as crucial, and all of these problems can not be handled by engineers with doctor degrees—indeed, they may be problems that might not warrant all the competence of a PhD but would warrant more preparation than present curriculum provides.

Road building has developed to this for the modern engineer. Here, the John F. Fitzgerald Expressway carries streams of traffic over the Boston elevated Thruways.

The Soil-Cement Methods of Road Construction

by Jerry D. Seinwill

an analysis of soil-cement road construction and its advantages

SOIL–CEMENT is an intimate mixture of soil, portland cement, and water that is now widely used as a low-cost base for light-traffic roads. Since the first soil–cement road was built in 1935, 180 million square yards have been used in this country.

This article presents general but complete information on soil–cement in hopes that it will lead highway engineers to study this method further and realize that including soil–cement construction in their highway work will economically benefit their counties. A general explanation of soil–cement is presented to acquaint the reader with this construction method. A complete section on construction is included, and the article is concluded by presenting the advantages of soil–cement.

Types of Soil–Cement

Soil–cement is a thorough mixture of pulverized soil and measured amounts of portland cement and water, compacted to a high density. As the cement hydrates the mixture becomes a hard, durable paving material. There are three general types of soil and cement mixtures:

Plastic soil–cement is a hardened mixture of soil and cement that contains, at time of placing, a consistency similar to that of plastering mortar. It is used to pave steep, irregular or confined areas such as highway ditch linings and other erosion control structures.

Cement-modified soil is a semi-hardened mixture of soil and cement. The addition of portland cement reduces the soil's plasticity and its water-holding capacity, and increases its bearing value. It may be used for highway fills, base courses, subbases, treated subgrades, and as trench backfill material.

Compacted soil–cement contains sufficient cement to harden the soil and enough moisture both for adequate compaction and hydration of the cement. Since it is by far the most commonly used type of soil and cement mixture, compacted soil–cement hereafter will be referred to simply as soil–cement.

When relatively small quantities of portland cement and moisture are added to a granular soil or a silt-clay soil, the chemical and physical properties of that soil are changed. The color of soil–cement is much the same as that of the soil which it contains when that soil is tightly compacted in a moist condition and then dried. While the hardened mixture does make a very serviceable paving material, it should not be confused with portland cement concrete. Its strength and modulus of elasticity are appreciably lower than those of concrete.

The cementing, hydration, and hardening of portland cement in soil–cement is similar to the same action in concrete. Water is needed for this action. The damp soil–cement mixture must be compacted to final density before final set of the cement takes place. The more compaction and the more tightly the mass is packed together, the more efficiently will the cement hold the mass together. Most specifications permit a period of six hours for adding water and final compaction of the mixture. Generally, engineers and contractors keep this period as short as possible.

Composition of Soil Cement

Three basic materials are needed in soil–cement:

1) Portland cement.
2) Water.
3) Soil.

Portland cement of any type that complies with requirements of the latest ASTM, AASHO, or federal specifications may be used. Types 1 and 1A, normal and air-entraining portland cements are most commonly used. Characteristics of the soil determine the percentage of cement required to produce a satisfactory mixture. Proper cement content is the first requisite

—Photo Courtesy Portland Cement Association

This road in Wisconsin was paved with soil cement in 1936 and is still in good condition.

for soil–cement construction. Table 1 gives the normal range of cement requirements for soils of the various space AASHO soil groups. Table 2 gives average cement requirements for miscellaneous materials and special types of soil.

Table 1.—NORMAL RANGE OF CEMENT REQUIREMENTS FOR B AND C HORIZON SOILS

AASHO Soil Group	Per Cent By Volume	Per Cent By Weight
A–1–a	5–7	3–5
A–1–b	7–9	5–8
A–2–4	7–10	5–9
A–2–5	7–10	5–9
A–2–6	7–10	5–9
A–2–7	7–10	5–9
A–3	8–12	7–11
A–4	8–12	7–12
A–5	8–12	8–13
A–6	10–14	9–15
A–7	10–14	10–16

Table 2.—AVERAGE CEMENT REQUIREMENTS OF MISCELLANEOUS MATERIALS

Material	Per Cent By Volume	Per Cent By Weight
Caliche	8	7
Chat	8	7
Chert	9	8
Cinders	8	8
Limestone screenings	7	5
Marl	11	11
Red dog	9	8
Shale	11	10
Shell soils	8	7
Slag	9	7

Water used in soil–cement should be relatively clean and free from harmful amounts of alkalies, acids, or organic matter. Water fit to drink is satisfactory. Two functions are performed by water in the soil–cement mixture. One is to lubricate the mass to facilitate compaction. This requires that each cement particle and each soil particle be covered with moisture. The second function of the moisture is to hydrate the cement.

Soil–cement that has been mixed and is ready for compaction must be near its optimum moisture content. This optimum moisture is determined by AASHO Test 134. Usually, water must be added to bring the moisture to the optimum point. For a 6-inch compacted thickness, sandy soil–cement mixtures require about 5 gallons per square yard. Silty and clayey mixtures require 7 gallons per square yard.

A slight excess of moisture is better than not enough. In general, the highest moisture content should be maintained that permits packing and finishing without surface checking, rutting, or displacement during final compaction and finishing.

Soil used in soil–cement includes practically all soils and soil combinations. Usable soils are divided into three main groups:

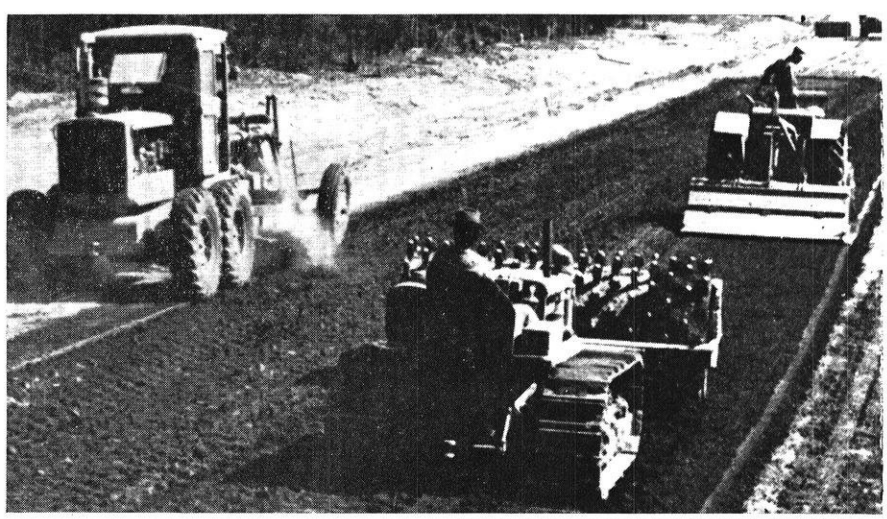
1) Sandy and gravel soils with 10 to 35 per cent silt and clay.
2) Sandy soils deficient in fines.
3) Silty and clayey soils.

The soils of Group 1 are readily pulverized, easily mixed, and can be used under a wide range of weather conditions. Group 2 soils make good soil–cement, although the amount of cement needed is greater than with the Group I soils. They require greater care during final packing and finishing. Group 3 soils also make good soil–cement but are harder to pulverize and require more cement. Construction with these soils is also more dependent on weather conditions. From a construction or cost standpoint, it is sometimes better to use a selected borrow soil instead of the soil in place. Predetermining the type of soil in place will indicate the most economical construction schedule.

Construction

In soil–cement construction, the objective is to mix pulverized soil and portland cement thoroughly in correct proportions with suffi-

(Continued on next page)



—Photo Courtesy Portland Cement Association

Three steps of soil cement construction are shown here. A mixing machine blends cement, soil and water; a sheepsfoot roller gives initial compaction and a motor grader smooths the mixture prior to further compaction.

—Photo Courtesy Barber–Greene Company

The travel plant picks up the windrowed material and deposits it into the twin shaft mixer where it is proportioned with the correct amount of binder and put back into the road surface for spreading.

cient moisture to permit maximum compaction. The construction methods are simple and follow a definite procedure:

Preparation

1) Shape the road to crown and grade.
2) If necessary, pulverize, scarify, and prewet the soil.
3) Reshape to crown and even grade.

Processing

1) Spread portland cement
2) Mix and apply water
3) Compact
4) Finish
5) Cure

Surfacing

The equipment used in soil–cement construction is the same as that of any road construction with the addition of some type of mixing machine.

Mixing equipment:

Heavy-duty road mixing equipment, or
Travelling mixing machines, or
Stationary, central-mix plants.

Compaction equipment:

Sheepsfoot rollers.
Pneumatic-tire rollers.
Steel-wheel rollers.

Additional equipment:

Motor graders with scarifying attachments
Pressure water distributors
Auxiliary-feed water tanks
Spike-tooth harrows
Broom drags
Cement hauling trucks.
Cement spreaders.
Bulk cement loading and batching equipment.

Before construction starts, the crown and grade of the roadway should be checked and any fine grading should be completed. Since there is little longitudinal displacement of soil during processing, the grade at start of construction will determine the final grade to a major extent. If borrow soil is to be used, the subgrade should be compacted and shaped to proper crown and grade before the borrow is placed. Guide stakes should be set to control the width of roadway and to guide operators during construction. Arrangements must be made to receive, handle, and spread cement and water efficiently.

When silty or clayey soils are used, scarification and pulverization are usually necessary. The key to rapid pulverization is the moisture content before and during pulverization. Most soil types may be pulverized by using common agricultural methods. When an old roadway is to be rebuilt using soil–cement, the oil mat is scarified and then either bladed to the side of the road and saved for the new surface, or pulverized and mixed with the old base-course material for processing with cement.

Spreading portland cement is accomplished in three ways:

Hand spreading—In this method, bags of cement are spotted on the roadway at regular, predetermined intervals. When opened, the cement is dumped so that it forms a uniform transverse windrow. The cement is then spread evenly by making three or four passes over the area with a drag.

Mechanical spreading on top of windrows of soil—A mechanical spreader straddles the windrow and deposits a uniform amount of cement along the top as it travels forward.

Mechanical spreading, flat-type —This method uses a spreader box mounted on the job truck. In this and the preceding method the spreader should be operated at a slow and constant rate of speed to obtain a uniform cement spread.

—Photo Courtesy Barber–Greene Company

Soil–Cement stabilized base for this highway is prepared by this travel plant. Travel speed of this unit is about 18 feet per minute.

Mixing and water application is handled by four methods, depending on the equipment used:

Construction with windrow-type travelling mixing machine—The prepared soil is bladed into a windrow by a motor grader. An evener is pulled along the top of the windrow to make it of uniform cross-section. Usually two or three windrows are spaced longitudinally on the roadway, and cement is spread on top of each. As the mixing machine moves along, the mixture is picked up, dry-mixed, water added, wet-mixed, and deposited in a windrow. The wet mixture is then spread with a motor grader.

Construction with flat-type travelling machine—Most of these machines have a highspeed pulverizing motor; therefore, preliminary pulverization is unnecessary. The machine picks up the flat spread mixture, pulverizes and dry-mixes it, moistens, remixes, and deposits it flat on the roadway.

Construction with multiple-pass rotary mixer—Before mixing with a rotary mixer, the cement and soil is prewetted by a water truck equipped with a pressure spray bar. Multiple passes with the rotary mixer prepare the soil for compaction.

Construction with stationary mixing plant—When borrow soil is used this method is usually used. The soil, cement, and water are mixed at the stationary plant and then hauled to the construction site in covered trucks. Plant-mixed soil–cement should be spread through spreader boxes and compacted immediately. If the haul time from plant to roadway is greater than 30 minutes, it is usually better to haul the borrow to the site, spread it, and then mix with one of the previous methods.

—Photo Courtesy Barber–Greene Company

Stabilization Pugmill set-up in California. The large bin and elevator are used to feed the cement to the aggregate in the twin shaft pugmill.

Compaction should start immediately after the soil, cement, and water have been mixed and spread. Moisture lost by evaporation, as indicated by the greying of the surface, should be replaced with light applications of water. While many new types of compaction equipment have been developed, compaction is usually accomplished with sheepsfoot, pneumatic-tire, and steel-wheel rollers.

For the common 6-inch lift, the sheepsfoot is used for initial compaction. Pneumatic-tire or steel-wheel rollers are used for final rolling. Most specifications require the soil–cement to be compacted within 5 pounds or 95 per cent of the maximum density. This maximum density is determined by AASHO Test 134. Excess densities are beneficial.

Finishing produces a smooth, dense, moist surface that is free of cracks, ridges and compaction planes. Steel-wheel rollers smooth out ridges left by initial pneumatic-tire rolling. Any irregularities in the surface are leveled out with a broom drag and then rolled. Finally, the surface is sealed with a light application of water, and rolling by a pneumatic-tire roller.

Curing of soil–cement occurs in a period of about seven days. After the mixture is compacted and finished; a moisture-retaining cover is placed over the soil–cement to retain the moisture and permit the cement to hydrate. Most soil–cement is cured with bi-

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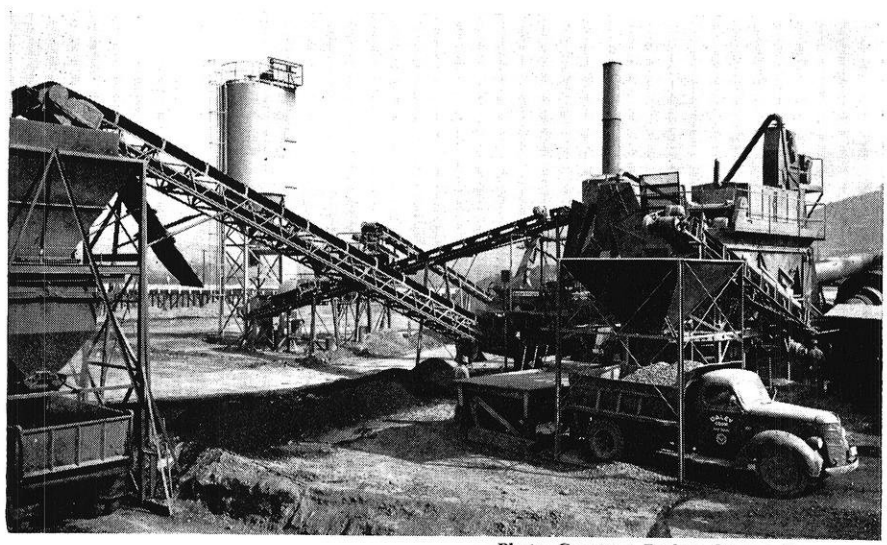

—Photo Courtesy Barber–Greene Company

A stationary central-mix plant in California that can produce 80 to 120 tons of soil–cement an hour.

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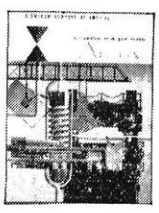


The Ideal Foundry Cupola

by Thomas Lohr

The basic foundry cupola has been improved by either the hot blast or the water cooling system. A combination of the hot blast and water cooling system though, incorporated into the common cupola provides the ideal type.

THERE is one basic type of cupola which is in use today. This has been supplemented in some cases by accessories which improve operation. The two most common accessories are hot blast and water cooling systems. The hot blast system aids combustion by heating air which is blown into the cupola to support combustion. The water cooling system cools the cupola shell so no refractories are necessary in areas of extreme heat.

Cupolas range from one to several stories in height and from 24 to 96 inches inside diameter. The entire shell and bottom doors are made of steel. The shell is lined with a refractory material, usually a special type of brick, for protection against molten metal and heat. The bottom doors are covered with rammed sand during operation and swing open to drop any material that remains at the end of the heat.

Coke is dropped into the cupola through the charging door and ignited to start operation. Charges consisting primarily of coke, limestone, pig iron, scrap iron, and small amounts of scrap steel are dropped on top of the coke bed. Air is forced by a large blower or several blowers through the wind box and tuyeres which distribute it into the area just above the well. The blast air and burning coke provide the heat which melts the charge to produce iron. The molten iron collects in the well and the slag, which floats on top, runs off through the slag hole. When the well becomes full the iron is removed through the tap hole.

The initial cost of an ordinary cupola such as the one discussed previously is low in comparison to other types. This type is used very successfully in small foundries where large amounts of iron are not required and where it would not be economical to supplement the cupola with expensive systems to help production and economy.

Disadvantages of Common Cupola When Large Amounts of Iron Are Required

1. The melting rate is comparatively low with respect to other systems.
2. A high percentage of coke must be used for the amount of iron produced.
3. The weather affects melting conditions.
4. The cost of refractories is very high.
5. The labor expense for daily repairs is excessive.
6. Iron temperatures vary considerably during intermittent melting.

There are several types of hot blast systems used with cupolas. One method used for preheating blast air is the two stage recuperative heater which uses heat from the effluent cupola gases. The most widely used and generally most successful system in use today is the Griffin System. Using this system, hot gases and air are drawn off either below or above the charging door and travel into the combustion chamber where they are mixed with air supplied by a bypass from the main blast pipe. The air unites with the carbon monoxide of the effluent gases and burns to carbon dioxide with a liberation of heat. ($CO + \frac{1}{2}O_2 +$ 4370 Btu per lb (CO.) The hot gases then pass through cast iron heat exchanger tubes which are filled with clay to protect them from attack by the hot gases, prevent air leakage, and allow for expansion and contraction. When the gases leave these tubes they pass through the primary and secondary transfer chambers and then go back into another set of heat exchanger tubes. As the gases leave the second set of tubes they pass through the exhaust chamber and an exit tube into a blower which blows them into the atmosphere.

The air to be used for the blast is driven into the system by a blower and takes a path through the heating chambers. The air is deflected by baffle plates and flows around the heat exchanger tubes in a direction opposite to the flow of the hot combustion gases. After

the air has passed through the heating chambers it leaves the system and enters the cupola at temperatures of about 600 degrees F.

The principles of the three stage Griffin Recuperator are exactly the same as the two stage type. The only difference in construction is 3 heating chambers and 3 sets of heat exchanger tubes. This type is usually used where there is sufficient space available because it is more efficient and the recuperator lasts longer.

Disadvantages of Recuperative Systems

1. The initial cost is high, although no fuel has to be purchased for blast heating.
2. There is some fluctuation in the blast temperature because it is dependent on the cupola melting condition.
3. There is a lag between the time the blast is turned on and the blast air is heated.

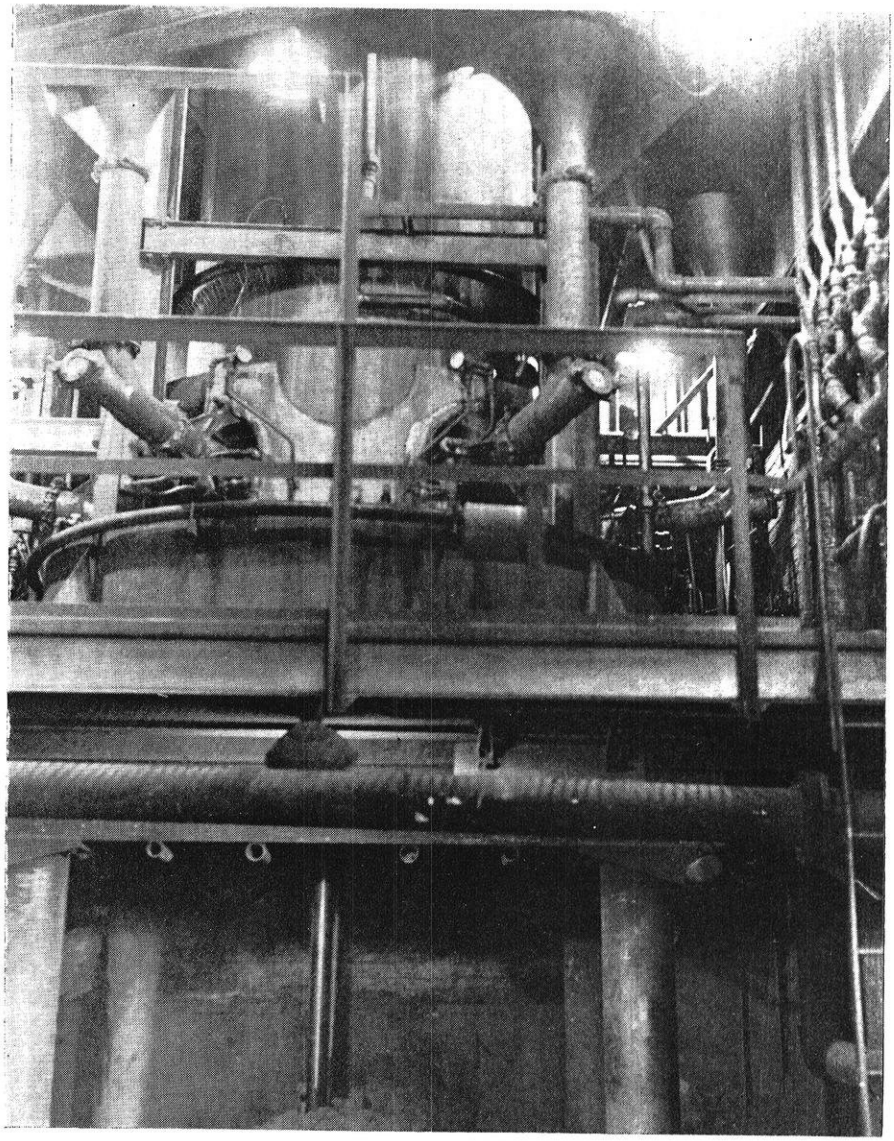
Many different externally fired hot blast systems are in use today. The only major difference between these systems and the recuperative types is that some kind of a furnace replaces the combustion chamber. Oil, gas, and coal have been used successfully as fuel for these furnaces.

Advantages of Externally Fired Hot Blast System Over The Recuperative Type

1. There is no delay in starting because blast temperatures may be attained before cupola operation is started.
2. The system is very flexible in operation during intermittent melting.
3. The initial cost is considerably less than the recuperative type, although fuel must continually be purchased.

Overall Advantages of Hot Blast Systems

1. The metal temperature does not vary appreciably during intermittent melting.
2. More uniform composition of the metal results because of better control of the cupola.
3. Less coke is required to produce a given quantity of metal at a given temperature.
4. There is somewhat lower sulfur pickup and decreased oxidation losses of manganese, silicon, and iron.
5. Cupola operation is better with much less tendency bridge.
6. The need for using fluxes is less and refractors costs are lower.



Cupolas are one to several stories in height and have an inside diameter of 24 to 96 inches.

There are two main types of water cooling systems used with cupolas. The external system uses water to cool the cupola shell directly. The shell is usually made of 1.25 in. rolled steel plate and is of an all welded construction mounted on a concrete foundation. Water flows around the shell in distributor rings and as the water over-flows it travels down the shell covering it completely. Water consumption depends on the initial water temperature and the melting rate, but is usually about 270 gpm with a maximum water temperature of 120° F. The discharging water is used to cool and granulate slag which makes very fine road ballast.

Internal water cooling is accomplished by built in water jackets or by use of a series of closely spaced water tubes. These jackets or tubes make up the inside of the cupola in the melting zone. This eliminates the use of any refractory in the reduction, melting, and combustion zone. The water temperatures are about the same as for the externally cooled system and the discharging water is also used to cool and granulate slag.

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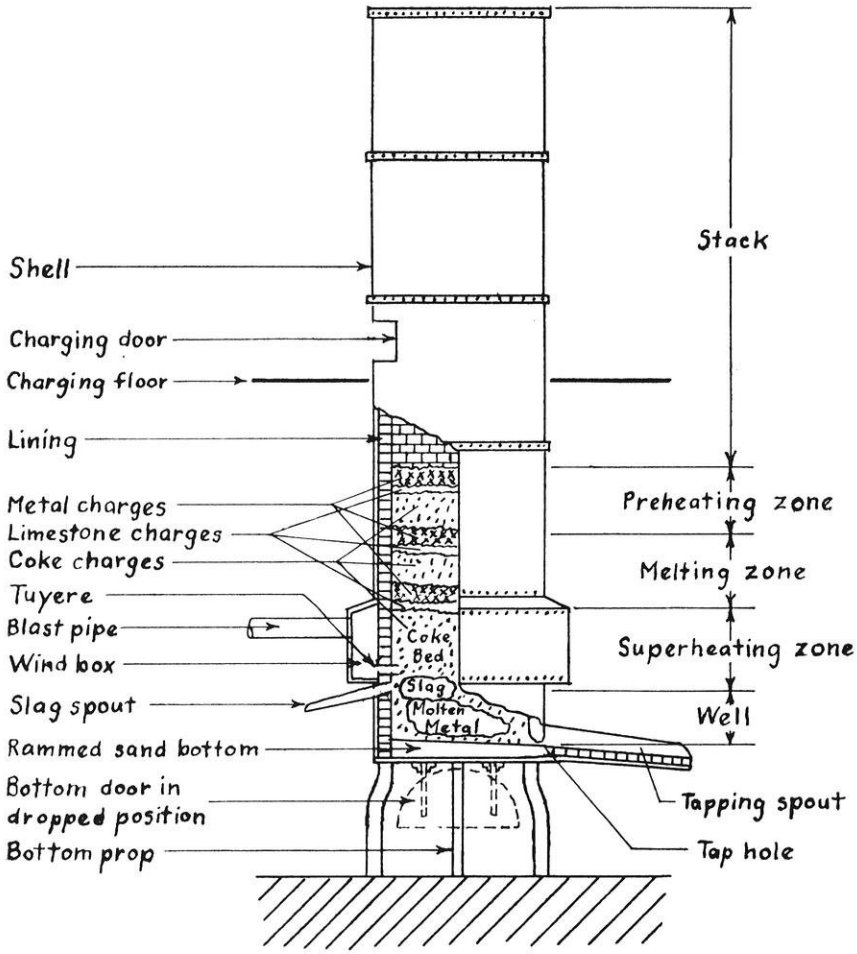

The basic foundry cupola.

Advantages of Water Cooling System

1. Expensive cupola and refractory maintenance are decreased appreciably.
2. Continuous melting can be done for long periods of time.
3. The melting process is made very flexible and can be controlled very easily.

Most foundries prefer the external system to the internal system because it is equally as effective as the internal and the conventional cupola is more easily converted to an external cooling system.

A combination of hot blast and water cooling systems incorporated in the common cupola provided what is believed to be the ideal cupola for most foundries. The only disadvantages are that it is impractical when less than 40 tons of iron are melted during an 8 hour shift or a company does not have the capital for the high initial investment.

The ideal cupola can have any combination of the hot blast and water cooling systems that were mentioned previously. The most common type has an externally fired hot blast system and an external water cooling system. The external water cooling system is used because the initial cost is less and it is easier and less expensive to convert an ordinary cupola to this system. The externally fired hot blast system is used because the initial cost is less.

The Advantages of The Combined Units

1. Flexibility of operation.
2. Slag analysis can be regulated very closely.
3. Prolonged melting operation.
4. High melting rate.
5. Much less tendency to bridge over.
6. Cost of operation decreased.

The operation of this type cupola is very flexible because melting rates can be varied from high to low extremes with very little variation in the temperature of the iron. With an ordinary cupola the iron temperature drops until it is too cold to use successfully with very low melting rates.

The variation of the slag analysis gives us very good control of the properties of the iron. When small amounts of limestone are used the slag has more silica than lime in it so this produces an acid slag. With an acid slag there is moderate carbon pickup, no desulphurization, and relatively low loss of silicon. When large amounts of limestone are used there is more lime than silica in the slag and it has a basic analysis. This would dissolve most refractories but carbon block is used and has worked out very well. The melting rate is lower with a basic slag analysis but higher temperatures are attained and desulphurization is rapid and effective. The main advantage is that all scrap steel may be used in the charges when the cost of scrap steel falls below the cost of scrap and pig iron.

The melting operation can be continued for longer lengths of time than with an ordinary cupola. This would make the use of it for two 8 hour shifts every day practical because it takes only a short time to make minor repairs. The cupola can also be run for several weeks without dropping the bottom for major repairs.

The high melting rate assures an adequate supply of iron at times when large amounts are needed. With an ordinary cupola molds would have to remain in the working area until there was enough iron to pour them. This would slow down production or could possibly stop it.

Bridging Over (The hardening of molten metal in the melting area to completely span the inside of the cupola) is reduced greatly. This is important because, when the bridge cannot be broken by dropping something down the stack, extensive damage is done to the cupola.

Cost of operation is reduced in many ways. The decreased cost of labor for maintenance is great because it is not necessary to drop the bottom every day to repair the

(Continued on page 55)

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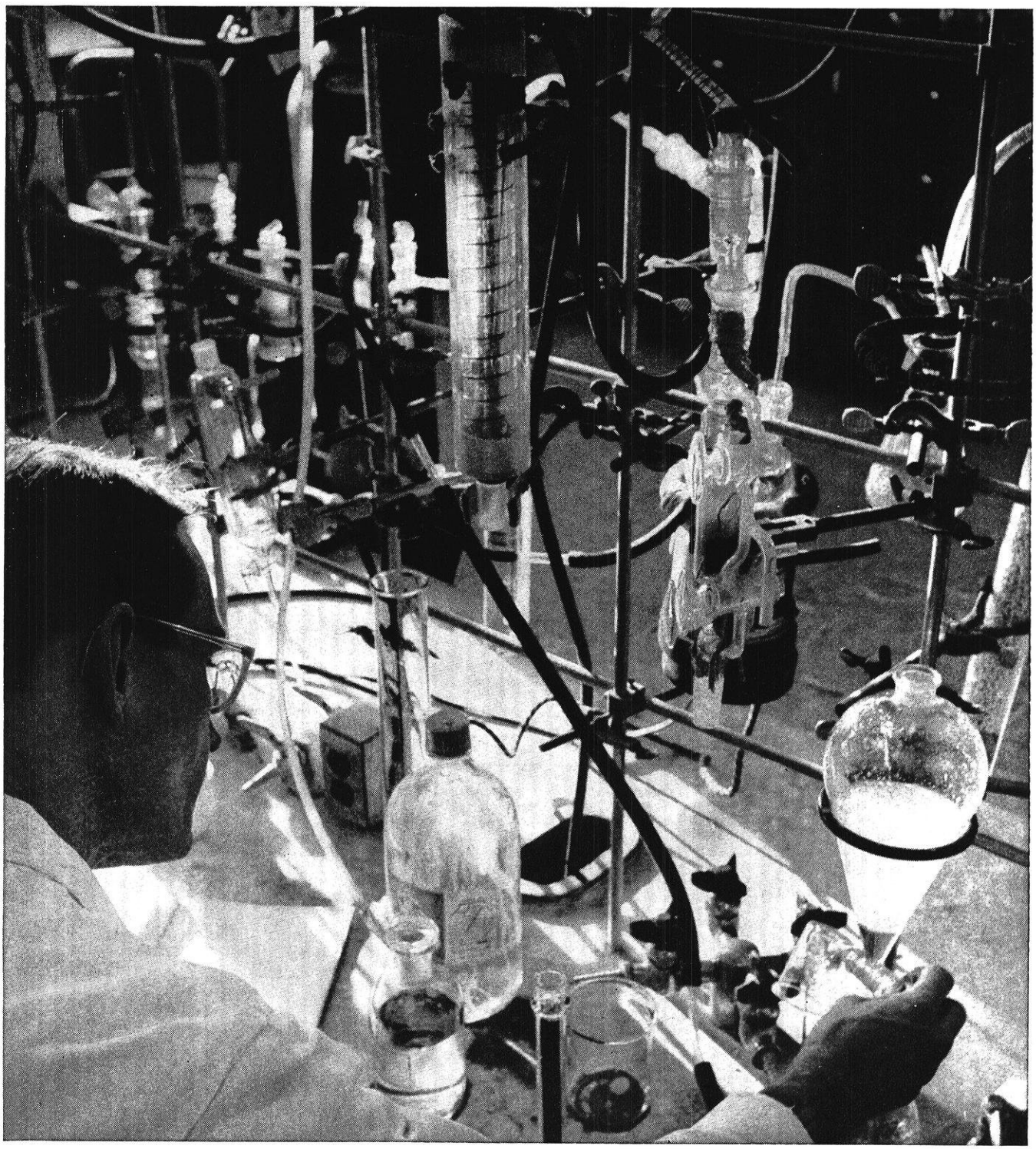


Photographing High Speed Motion

by George Lassanske

A brief survey of the difficulties in taking photographs of subjects in rapid motion and several cameras designed to solve these problems is expanded here in semi-technical fashion.

THE development of high speed motion picture photography is closely related to the history of photography itself. Man has realized for a long time that the eye is limited in observing rapid movement. Therefore, he has tried to find some method of recording accurately these otherwise unrecordable phenomena.

The main problem in recording all fast movement is the achievement of a sufficiently short exposure time. It is generally understood that the only way to avoid movement in a photograph is to reduce the exposure time. This is done so that the amount of movement by the subject is insufficient to produce a blurring of the photograph. In ordinary work fast exposure times are not usually necessary, but in the scientific field much higher velocities are often encountered and the exposure times must be shortened accordingly.

Mechanical Difficulties

Early pioneers in the field found it very difficult to produce mechanisms which would give them sufficiently short shutter exposure. At the same time the photographic materials which they had available were very slow compared to the materials used today. Various methods have been used to provide the necessity shutter exposure and they will be discussed later.

However, the analysis of movement cannot be carried out merely by the use of satisfactory still pictures. It is usually necessary to produce a series of pictures as a function of time so that velocities and accelerations may be calculated. The problems of producing a series of high speed pictures in rapid succession are much greater than those involved in taking a single picture.

Motion picture photography did not appear until still photography was already well established, mainly due to purely mechanical difficulties. It is interesting to note that intermittent and non-intermittent mechanisms were developed almost side by side. This made it unnecessary to produce new equipment for ultra-high-speed motion picture photography. It was soon realized that when using non-intermittent drive of the film with comparatively long exposure time, each picture could be made reasonably sharp by means of optical compensation during exposure. This could be accomplished by moving the lens parallel to the film in such a way that the lens, image, and the film all move together during exposure. Another method was the use of a system of mirrors or prisms which bend the rays coming from the lens so the image was moved with the film during exposure and the lens remained stationary.

When motion pictures are taken at high speed with any type of camera one of the primary problems is film transport or how to move the film. This has to be done at the correct speed without vibrating, breaking, or abrading the film. The rapidly moving film must be properly guided, with little friction so that the temperature of the film is not raised to the ignition point. In addition, there should be no build up of large quantities of static electricity. Since uniform maximum speed of the film is important, a means of obtaining uniform rapid acceleration must be provided.

Problem of Film Transport

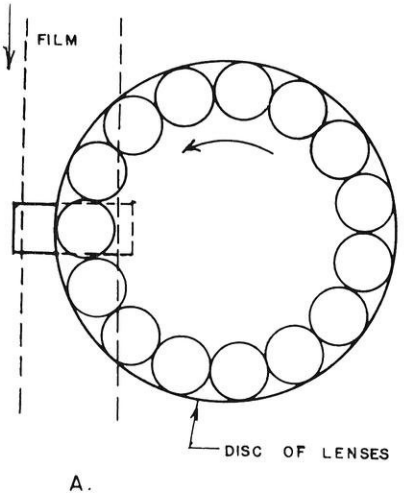
In certain elementary types of cameras used in scientific work, a plate of film under gravitational acceleration may be sufficient. Then again, it could be as simple as a length of film wrapped on the inside or outside of a rotating drum. Drum cameras, either with or without optical compensation have been used widely. At their best they can produce short strips of film which can be projected in a normal projector. However, they present no great problems of film

transport since the complete strip of film is fastened to the drum. The normal clock work mechanism used in ordinary motion picture cameras can be used for film speeds up to about 300 frames per second. Higher speeds than this have been attained, but only at the expense of picture quality and possible damage to the film.

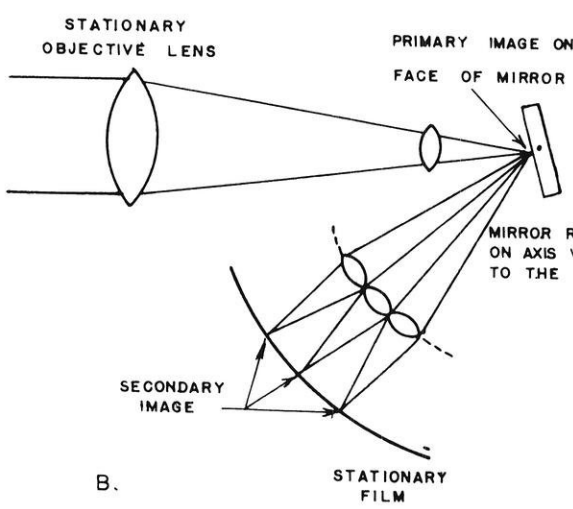
When using continuous film drive with normal lighting, the problem of optical compensation arises immediately. This is because it is difficult to achieve adequate exposure with the short exposure time required to obtain a sharp picture. Optical compensation can be accomplished by moving lens, reflector or refractor systems. These systems are illustrated.

The most obvious method of compensation is to move the lens during the period of exposure. In this way the lens, the image cast by it, and the film can move together at the same speed, so that there is no relative displacement. Perfect lenses can be moved, theoretically, in such a manner that there is no defect in the displaced image. In practice this is not so simple. The first difficulty is that the physical diameter of the lens is limited to less than the height of the frame. The lens must have a sufficiently long focal length to cover the frame area satisfactorily and this in turn limits the maximum possible aperture.

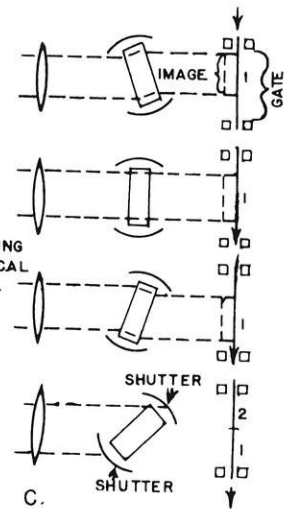
The only other alternative would be to have the pictures placed further apart on the film than is possible for normal projection. An improvement can be obtained if a stationary lens is used in conjunction with the moving lens. This enables a much wider aperature to be employed. It is necessary to design the two components in such a way that they give satisfactory optical performance when used together. This system leads to the possibility of using comparatively simple moving lenses instead of having to use a large number of highly corrected lenses. Other arrangements of multiple-component lenses are possible. In all such cases, the mechanical problem of how to move the lenses is extremely important.



A. Moving-lens optical compensation with the disc of lenses rotating counterclockwise while the film moves downward behind an aperature.



B. The rotating mirror allows a moving subject to appear stationary on the non-moving film.



C. A rotating prism causes the refracted image to move in the same direction as the moving film to reduce the relative velocity.

The easiest and most efficient method, however, is to arrange the lenses around the periphery of a wheel. Even this does not give the correct movement, since the lenses move along an arc instead of a straight line. The alternative to moving the lens is to provide some optical means of moving the image so that it travels with the film. This can be done in a number of ways and cameras have been made which utilize mirrors, refracting prisms, and parallel sided refracting plates.

The mirror is probably the first method which comes to mind in this connection. Many methods have been devised using mirrors, but all introduce some distortion of the image. If the movement of the image is small this error is negligible and the method can be used with accuracy. Refracting prisms provide a satisfactory method of moving the image but tend to give unwanted aberrations. As a prism of narrow angle is moved into the beam it will tend to bend the rays and distortion will be apparent. In addition there will tend to be some dispersion. This can be overcome to some extent by using two prisms at a slight angle to each other, but even so the mechanical problems involved are great.

The other refraction method which has been used is that employing a rotating plane-parallel plate between the lens and film. As the parallel faces of any such plate rotate, they refract the image in the direction of rotation. This introduces both spherical aberration and astigmatism, but these do not become important if a small angle of tilt is used.

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There are a very large number of cameras designed for taking a series of pictures at a high frequency. Many of these do not produce films which may be projected by a normal motion picture projector. Only those cameras which use film that can be projected will be considered. High speed motion picture photography involves the use of film at speeds above 300 frames per second. This necessitates some form of compensating device to prevent the image from moving across the film during the instant of exposure. Of the compensating devices theoretically available, there are three actually employed in practice on cameras of several different makes. The rotating-glass block has been used most widely. Next to this are the lens-ring and rotating mirror types.

Optical Compensation

There are two cameras commercially available which make use of the rotating glass block as an optical compensator. These are the Fastax camera, developed by Bell Telephone Laboratories and the Kodak high speed camera, made by the Eastman Kodak Company. The two cameras are somewhat different in design, as they have dissimilar drive mechanisms. The Fastax uses a multi-sided glass block whereas the Kodak uses a parallel-sided plate. The Fastax is made in three gauges—an 8mm camera to take up to 8,000 frames per second and 16mm and 35mm to operate between about 150 and 4,000 frames per second. The Kodak camera is made to take 16mm only and operate at speeds between about 300 and 3,000 frames per second.

All the Fastax cameras are similar in general design; they consist of a circular housing containing a feed reel, a sprocket on which the film is exposed, and a take-up reel. The film travels from the feed reel to the sprocket, with a hold-down roller to keep it in position. It then wraps 180 degrees around the sprocket and then travels to the take-up reel. A stripper plate is present about 45 degrees further around the sprocket in case the film tends to bind.

The sprocket and the take-up spindle are driven by separate motors. The compensating prism, rotating between the lens and the sprocket, is synchronized with the film movement by means of gears. It is held inside a prism housing, which consists of a cylinder containing pairs of slots corresponding to the pairs of faces on the prism. The 8mm camera has an octagonal block and the 16mm camera a square block. The Fastax cameras are designed for use on a sturdy tripod and for smooth operation the film must be fresh and with positive tolerances on the perforations, or there will be danger of binding on the sprocket.

A control has been built for this camera which applies the normal 130 volts for 70 milliseconds, then automatically increasing the voltage suddenly to 280 volts. It thus provides for maximum possible acceleration without risk of rupturing the film, and ensures that maximum speed is also reached; 14,000 frames per second with the 8mm camera, 7,500 with the 16mm, and 5,500 with the 35mm.

The Kodak high-speed camera consists of a housing containing a feed reel, a gate with a sprocket on either side of it, and a take-up reel. The film leaves the feed reel, runs over a plastic idling roller and over the top sprocket, where it is held by means of a clamp. It then passes through the gate and over another sprocket, and is held with a second clamp. Then it goes through a specially designed stabilizing system of idler rollers to the take-up reel, which has a film guard on it to prevent flapping of the tail end of the film.

The top sprocket is spring-loaded to insure that the film is always held in tension across the gate. This prevents flap, which would cause the picture to run in and out of focus. The film wraps around the sprockets for about 80 degrees and therefore there is no difficulty with regard to binding of the film. The parallel-sided glass block, in its cylindrical mounting, rotates between the gate and the lens.

The camera has a single motor which drives all the components: the glass block directly, the two sprockets through a suitable gear system, and the take-up reel through a belt drive and a slipping clutch. This motor is dynamically balanced to eliminate vibration and needs no lubricaiton. The Kodak camera, like the Fastax, is designed to be used on a tripod. The voltage applied is used in conjunction with a rheostat to vary the film speed from 300 to 3,000 frames per second.

Rotating Lens Designs

The theory of the rotating lens, lens-ring camera has already been described. In practice, good results depend upon the use of a relatively large number of lenses. This in turn, attributes a fair amount of bulk and weight in the camera, together with the need of a powerful motor drive. Most of the earlier cameras used up to twenty-four lenses but the more modern ones usually employ forty-eight. There are several different brands of this type of camera but the one generally used is the Vinten H3000. The Vinten H3000 employs a duralumin disc, very carefully balanced with forty-eight matched lenses peripherally mounted. The film is fed continuously, from a magazine, around a revolving gate, over two controlled sprockets and on to the take-up reel.

The driving mechanism is a 4 horsepower motor, with a heavy flywheel mounted at the back of the camera. The power is transmitted through a friction clutch and a three-speed gear box, similar to the type used in a small car. The complete camera is set up on a cast iron bed plate mounted on an adjustable stand. At the maximum speed of 1,800 frames per second, the film runs at a speed of 45 feet per second.

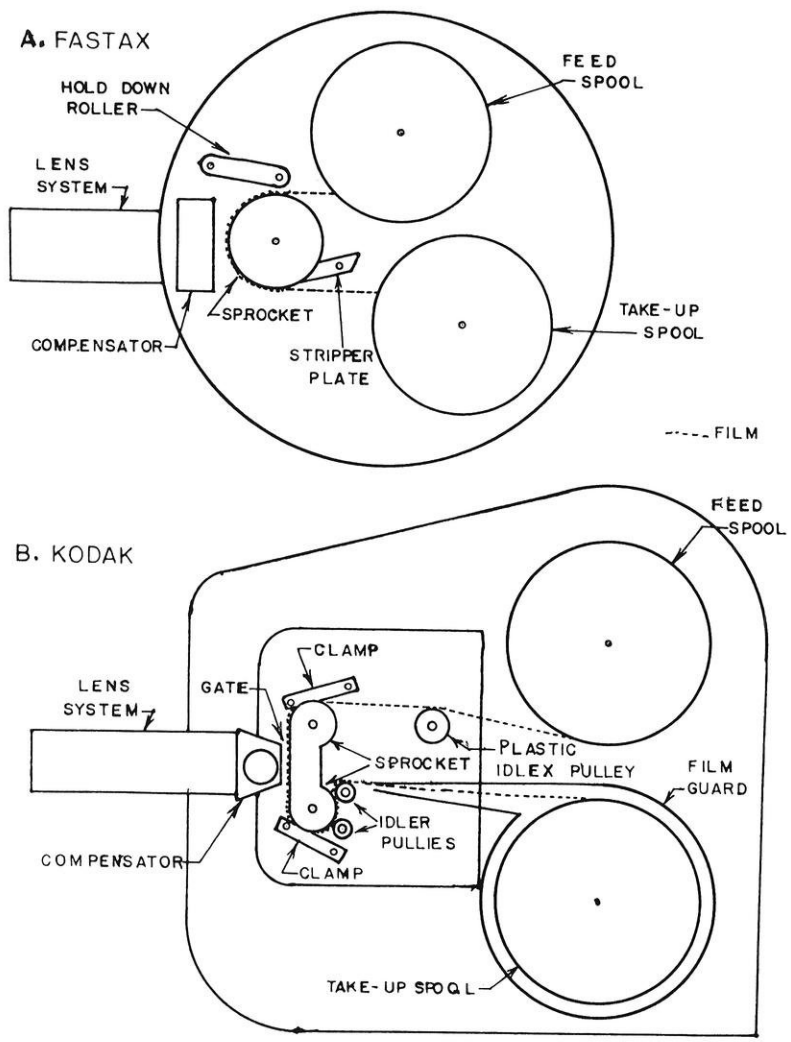
There are also several other designs based on the lens ring principle. One employs a drum of lenses in place of the disc, while another uses a modified ring of lenses in conjunction with a stationary lens. The maximum speed of both these cameras is approximately 150 feet per second.

The rotating mirror type of camera is exemplified by the Zeitlupe camera marketed by the Zeiss Ikon Company. Originally it consisted of a drum with external mirrors, placed between the lens and the subject. This proved quite satisfactory for many years. Later it was found more satisfactory to use a drum with internal mirrors be-

cause it made the camera much more compact. This second camera has a system of stationary reflecting prisms to project the light from the subject on to the mirrors inside the drum and then through the lens to the moving film. It should be noted that unlike the glass block compensators which work between the lens and the film, the mirror compensator is outside the lens. The normal speed of this camera gives a frame frequency of about 1,500 frames per second. The maximum frame frequency attainable is approximately 6,000 frames per second.

Camera technique in high speed motion picture photography is very similar to that used in ordinary motion picture photography. The things which have to be remembered are the shortness of exposure and the provision of adequate intensity of lighting. If the very best results are to be obtained the technique used in high speed photography becomes much more complex. If direct photography is decided upon as a preliminary, which is the usual case, then the direction of view of the camera must be decided upon. Next, a focal length of lens must be chosen to give an image of adequate size. The camera must have a clear field of view in a direction from which the subject can be clearly studied and which allows adequate lighting. This must be done remembering that the camera can see no more than the human eye.

The second point of importance is to ensure that as much of the subject matter as possible is in the picture area. The resolving power of any high speed motion picture camera is not so high that space can be wasted. As accurate measurements will probably have to be made from the film later and as the individual frame size is very small, it is important to fill the available picture area with as much of the subject as possible.



A simplified view of the mechanical construction of two representative high-speed cameras: (A) the Fastax camera developed by Bell Telephone Laboratories, and (B) the Kodak 16mm unit of Eastman Kodak Company.

Picture Frequency

Having settled on the view to be photographed, the next requirement is to decide the picture frequency necessary to record the subject properly. This necessitates some knowledge of the velocities involved in the subject. Usually those investigating the problem will have a general idea of the magnitudes of the velocities and accelerations involved. If not, a rough idea can be obtained by making some preliminary shots using widely differing frequencies, or the subject can be observed through a stroboscope if it is cyclic in nature. There are two points of view with regard to the choice of picture frequency. One, if the final film is to be viewed purely as a slow motion record, then the picture frequency is the most important consideration. Two, if the film is to be analyzed frame by frame it is essential that each frame be as sharp as possible and this necessitates the minimum exposure time for each frame.

In some cameras the exposure time can be varied independently of the picture frequency but with most they are interdependent. The degree of slow motion achieved can be calculated from the ratio of projecting speed to taking speed. Thus taking a picture at 3,200 frames per second will be projected 200 times as slow when projected at 16 frames per second. Also, an action taking one tenth of a second can be viewed for 20 seconds. If the film is required for analysis frame by frame, it may be necessary to use a higher picture frequency than is desirable for slow motion examination to achieve adequate sharpness on each individual frame.

In all calculations it should be remembered that there is a minimum displacement that can be seen by the camera. In the case of vibration, for example, the velocity may be such that a sharp image is

(Continued on page 49)

STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Company

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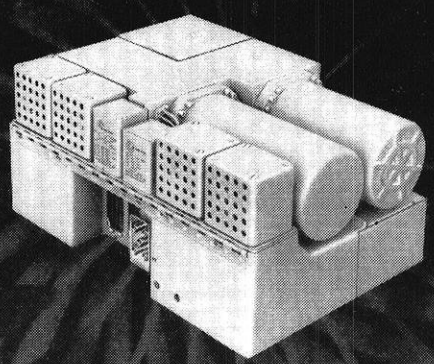

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Time Study

by Lalit K. Sarin

An analysis of time study in industry today—its methods, purpose and its results

INDUSTRY, business and government agencies recognize the necessity for continually improving methods which will assure profitable operation. Time study is one of the means through which this objective can be accomplished. In the operation of any manufacturing enterprise or business, it is fundamental that time standards be set. Time is the one common denominator from which all elements of cost may be evolved. In fact, everyone uses time for practically everything he does or wants anyone else to do.

The Role of Time Study

Frequently, time study is defined by the layman as a method of determining a "fair day's work." However, this definition is not complete and leaves doubt as to what is involved in a fair day's work. It is essential to understand the meaning of time study before studying the subject any further. A well recognized definition of time study follows:

> Time study is that technique which management uses in an attempt to determine the time which should be allowed a worker, who has normal skill and ability and is working at a normal pace, to perform a defined job according to a certain method under certain conditions.

Objective of Time Study. The objective of time study is the determination of a "Standard" or an "Allowed Job Time." If a proper "Standard Time" is determined, it will remain proper only so long as the job, the method of work, and the conditions under which it was performed at the time of the study continue to exist. Should they change, the "Standard Job Time" can no longer be said to be proper. As the time study procedure is explained, it is important to keep constantly in mind this exacting definition of the objective of time study—"Standard" or "Allowed Job Time."

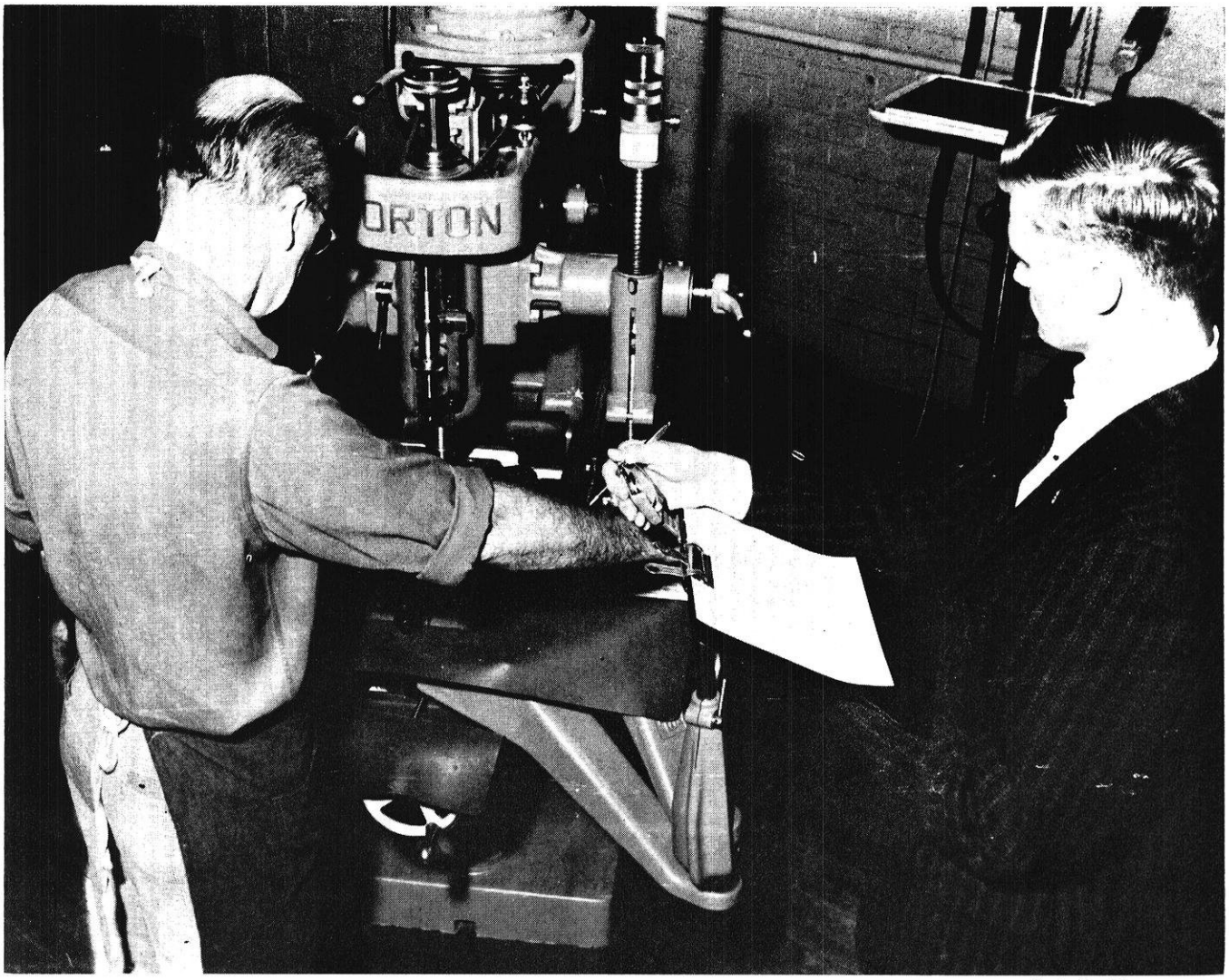
Time Study Techniques. Time standards may be determined in a number of ways:

1. By estimate.
2. By performance records.
3. By stop-watch time study.
4. By standard data.
5. By time study formulas.
6. By work sampling methods.

All of these methods have application under certain conditions and all have limitations as to accuracy and cost of installation. It should be noted that methods 3, 4, 5 and 6 will give considerably more reliable results than either method 1 or 2. This article will concentrate on an analysis of a stop-watch study.

Use of the Time Study Result. Time study results may be used for a variety of purposes, but of particular interest is the use of time standards as applied to the effective operation of a manufacturing enterprise. Several of the results of the application of time study in this way are listed as follows:

1. Basis for Wage Incentive Plans.
2. Common denominator in comparing various methods.
3. To secure an efficient layout of available space.
4. Means of determining plant capacity.
5. Basis for purchasing new equipment.
6. Basis for work scheduling.
7. For the improvement of production control.
8. For the determination of operational costs.
9. For managerial and quality control.
10. For the improvement of service to the customers.



—Photo by Zimmerman

Senior ee Ken Lewandowski times operations as machinist Joe Dunnigan completes a duplicating operation in the Mechanical Engineering shop.

While it is difficult to elaborate on the uses of time study in this article, it must still be pointed out that the most significant result of time standards is maintenance of over-all plant efficiency. If efficiency cannot be measured, it cannot be controlled, and without control it will markedly diminish. Once efficiency goes down, labor costs rapidly rise and the result is eventual loss of competitive position in the market. By establishing and maintaining effective standards, a business can standardize labor costs and control over-all costs.

Outline of The Time Study Requirement

Time study is an important and exacting form of work. Its procedures are the only known way to supply certain information that is needed for many vital determinations. There are three basic steps in time study's determination of an "Allowed Job Time" and job standard.

1. The determination and recording of the relevant "job" data; that which is essential to defining the job performed, the conditions under which it is performed, and the method by which it is performed.
2. The determination and recording of the basic "time" data; that which indicates the actual time spent by a worker in performing the defined job, the relationship of the observed work effort to normal work effort, and the necessary job allowances.
3. The computation of the "Allowed Job Time" and job standard from the recorded "time" data.

Each of these steps are important to every time study, and they should be carried out with great care and thoroughness. The above three requirements are discussed in more detail later.

Determination of Job Data

The first approach to the time study problem is to thoroughly analyze the job to be studied. It is of fundamental importance that all details of the method and working conditions be first standardized. Unless this is true, the time standards have little value and are a continual source of mistrust, grievances, and internal friction.

Notifying Appropriate Personnel. It is of utmost importance that the time study man notify and consult with appropriate personnel in the department where the job

(Continued on next page)

is being performed. The departmental foreman, the union steward and the operator must be informed well ahead of time, so that each of these parties will be able to make any specific plans in advance and thereby take the necessary steps to allow a smooth, coordinated study. Before taking a time study, it is essential that the following three conditions be fulfilled:

1. The job should be performed under normal conditions.
2. Standard work method should be used.
3. The worker to be studied should have approximately normal skill and ability and should be one who works regularly on the job.

In order to satisfy these conditions it is essential that the time study man has the full cooperation of the department personnel as well as the union representative. The complete success of the operation depends on this understanding. There is no justification for secret studies. Should they be permitted, they can only result in increased worker and union distrust of management's motives and actions.

Recording Job Conditions. After the job is ready to be studied, the time study analyst should observe the job as it is being performed for the purpose of determining and recording on a time study observation sheet the circumstances and conditions under which the job is being performed at the time of the study.

The necessity of recording information is not to be overlooked. The exacting definition of "Allowed Job Time" requires such a procedure. A standard time remains applicable only so long as the job circumstances and conditions which existed at the time it was established continue to exist. This relationship between the job conditions at the time of the study and the "Allowed Job Time" should not be forgotten.

Recording Work Elements Performed. The third task of the time study man in determining "job" data is that he should observe the job as it is being performed for the purpose of determining and recording on the observation sheet the defined job's work elements, including their break off points. This record accurately indicates the job's work method at the time of the study; what the worker does and how he does it.

The following five suggestions have considerable merit in determining work elements:

1. Each work element should consist of a group of related work movements.
2. The elemental break off points (beginning and ending points) should be easily recognized.
3. Work elements should be as short as possible, but it is recommended by many authorities that no work element on the average be less than 0.05 minutes in length.
4. Machine elements (elements which are machine controlled) should be defined separately from manual or handling work elements.
5. Foreign elements (unavoidable delays) performed during the study should be clearly defined and recorded on the sheet.

Determination of "Time" Data

The time study man, after he has accurately and completely determined and recorded the relevant "job" data, next proceeds to the actual determination of the "time" data.

Determining Observed Elemental Performance Times. After completely understanding the job and having definitely fixed the end points, the time study man then proceeds to actually time the job.

The time study man determines the observed elemental performance times through the use of a decimal-minute stop watch and clipboard, the time being recorded on the observation sheet. A decimal-hour stop watch can also be used. The observation sheet is so designed that the analyst can conveniently record watch readings, foreign elements, rating factors, and still use the sheet to calculate the allowed time. In this form, the various elements are recorded vertically row by row and the various cycles are recorded horizontally across the top of the page. In the "R" column are recorded the watch readings, while in the "T" column are recorded the elemental elapsed values.

It is necessary that an experienced time study man should time the job. The work requires skill for the analyst must be able to

(1) Recognize each elemental break off point.
(2) Determine the stop watch reading at the time an elemental break off point occurs.
(3) Record the stop watch reading on the sheet.

These three actions are performed within a fraction of a minute, hence only an experienced person can be trusted with this work.

Length of Time Study. It is difficult to determine how long a time study should actually be run. The activity of a job, as well as its cycle time, directly influence the number of cycles that can be studied from an economic standpoint. The theory of statistics can be used to determine a certain size sample but this also has its limitations. It should be remembered that for an "Allowed Job Time" to be acceptable, it must represent as true a value as possible and hence it must be calculated from a reliable size sample.

While different companies and agencies have different methods of determining length of time study, a somewhat standard statistical relationship can be expressed as follows:

$$N = \frac{(40\sqrt{n\Sigma x^2-(\Sigma x)^2})^2}{\Sigma x}.$$

where N: Number of observations
n: Actual number of observations made.
x: Individual elemental values.

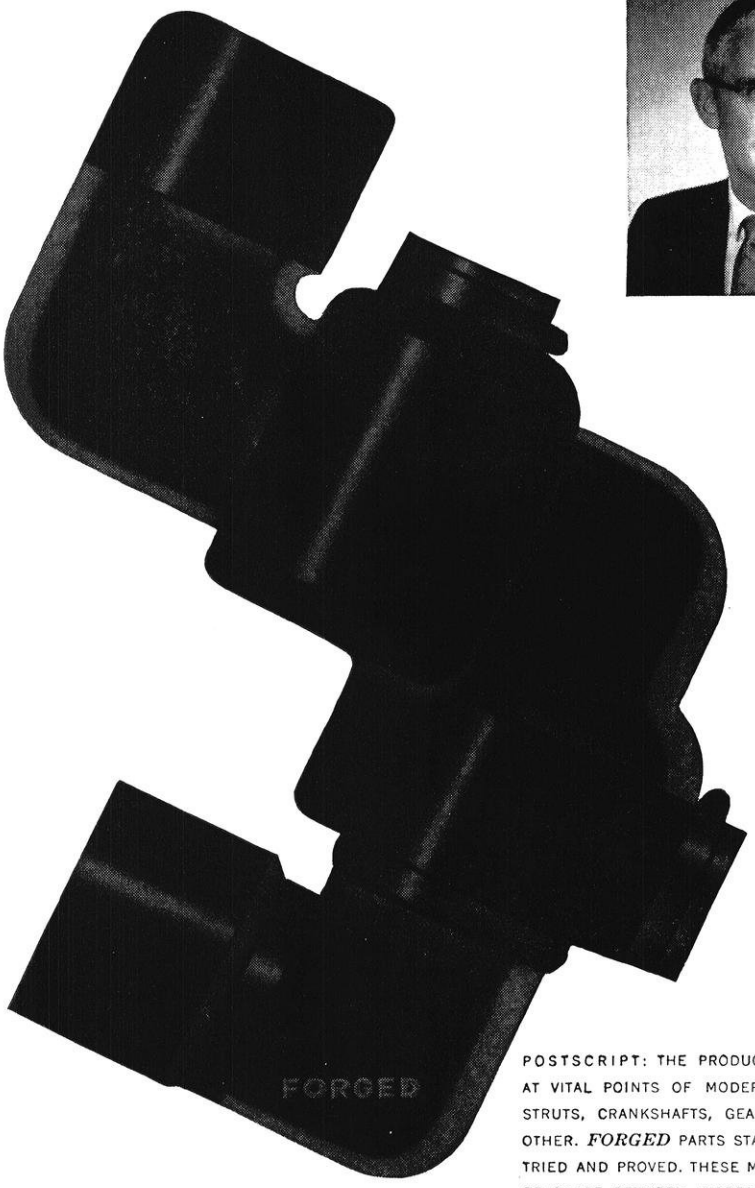
The Performance Rating Factor. The performance rating factor is the time study man's statement of the relationship between the observed work performance and a normal work performance for the defined job. Since it is essential that the "Allowed Job Time" be for a normal performance, the performance rating factor becomes necessary. Only then can the re-

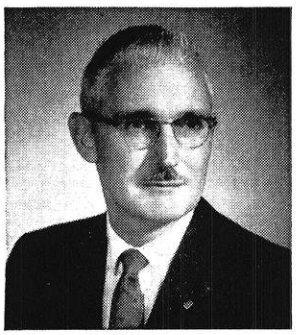
(Continued on page 54)

FORGED Parts

are Free from Inside Faults

—sound from center to surface





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G. M. BAGNARD
Chief Engineer,
Chiksan Company, makers of swivel joints, rotary hose, mud mixing guns.
(Subsidiary of Food Machinery and Chemical Corporation)

POSTSCRIPT: THE PRODUCTS OF THE FORGING INDUSTRY ARE FOUND AT VITAL POINTS OF MODERN CONVEYANCES AND MACHINES...LEVERS, STRUTS, CRANKSHAFTS, GEARS. THE FORGING PROCESS IS UNLIKE ANY OTHER. *FORGED* PARTS START WITH REFINED METALS—METALS ALREADY TRIED AND PROVED. THESE METALS ARE GIVEN ALMOST ANY DESIRED FORM OR SHAPE BETWEEN IMPRESSION DIES, UNDER ENORMOUS PRESSURE OR BY CONSECUTIVE BLOWS FROM POWERFUL HAMMERS. THE RESULT IS ADDED STRENGTH AND TOUGHNESS...WHICH PERMITS WEIGHT-SAVING DESIGNS, CUTS SERVICE COSTS, HELPS PROVIDE SAFETY IN A HIGH-SPEED WORLD.

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SCIENCE HIGHLIGHTS

by Pete Kienast ee'60

A BIG BAG OF AIR

A GIANT air-supported building fabricated from a new polyester film has been erected in Northfield Minnesota, by the G. T. Schjeldahl Company; makers of stratospheric balloons, air-supported buildings, and plastic bag-making machinery.

The building, which is 340 feet long and 30 feet wide, is being used to house production lines for the firm's Balloon and Special Fabrics Division. Thirty people will work inside the building. Employees enter and leave the building through air lock doors.

The new factory—dubbed a "Schjel-Mile"—is semi-cylindrical with ends of solid construction. An inside structure, located at the north end of the building, houses restrooms and heating and air-blower equipment which holds the building to contour.

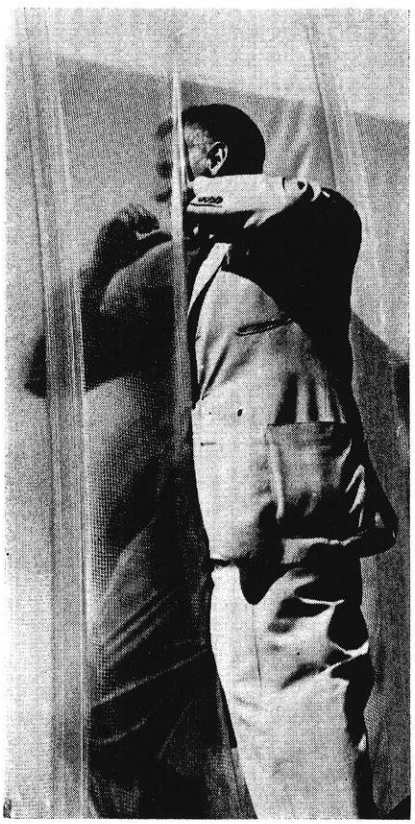
This is the first time a plastic fabricating firm has made its own factory from its own product.

Buildings of this type will be marketed for use as factory structures, farm buildings, construction site covers, swimming pool covers, and a variety of other uses.

The skin of the building is fabricated from a new reinforced heat-sealable polyester plastic called "Scotchpak" by its maker, Minnesota Mining and Manufacturing Company.

The skin has contained in it a grid of nylon fibers which tend to form a rope by combining their individual strands whenever the plastic is subjected to a tearing force. This eliminates the possibility of a "run" in the material.

While no aging tests have yet been completed on the film, Schjeldahl is confident the skin will wear well. "When it needs replacing, we can shed our cocoon and replace it in less than two hours," Schjeldahl says, "and at a cost comparable to that of a paint job for a conventional structure."



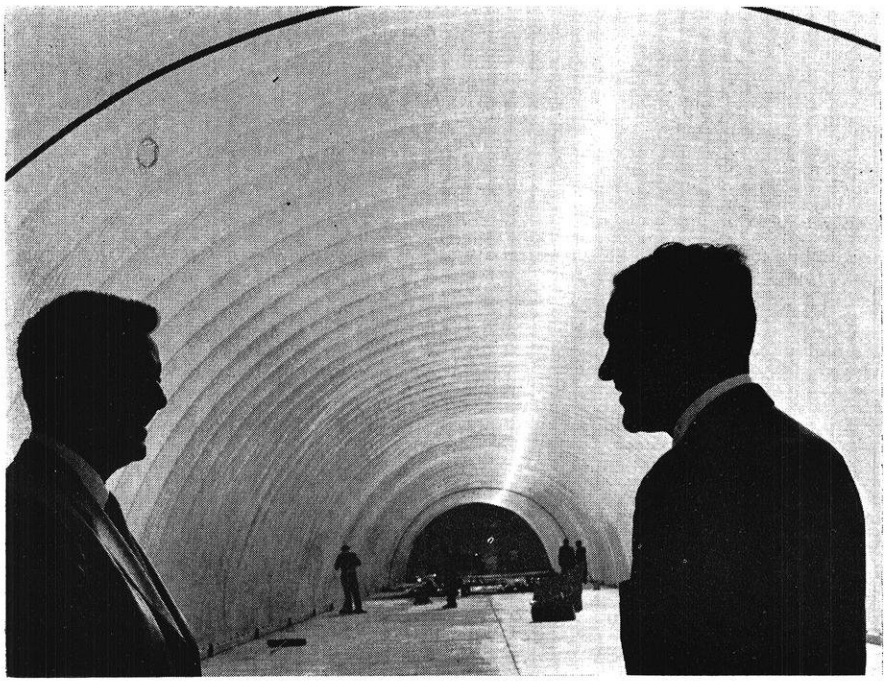
G. T. Schjeldahl, fabricator of the "Schjel-Mile", cut a seven-foot-long gash in the "Scotchpak" skin to prove that small holes won't deflate the building.

The semi-transparent skin will permit solar heating of the factory in winter. The plastic admits as much as two million BTUs heat per hour on bright sunlit days. An ordinary home furnace has an output of about 90,000 to 120,000 BTUs per hour. Conventional heating equipment will be used on cloudy days. A system of sun shades and air conditioners will keep the building cool in the summer.

Schjeldahl expects that the plastic skin of the building will pay for itself in heat savings over a period of the next five years.

The skin is impervious to moisture, heat, cold, grease, or solvents. The basic "Scotchpak" film from which the building was fabricated has been used to package oil, acid, boil-in-a-bag foods, and both wet and dry chemicals. It has a workable temperature range of from minus 70° F. to 230° F. It will not dry out or become brittle with age.

In a press demonstration held inside the building Schjeldahl graphically demonstrated some of the the building's properties. He suspended a swing from the roof of the structure and got onto it to show that the air supported skin is very rigid. So rigid, in fact, Schjeldahl claims the building can withstand near hurricane force winds. Yet, the amount of air pressure necessary to hold the contour is about as much as is required by



Workmen put the finishing touches to the inside of the "Schjel-Mile" as G. T. Schjeldahl, left, fabricator of the building and Lee Berlin, manager of Minnesota Mining and Manufacturing Company's Film Products Group, which made the "Scotchpak" skin, look on. Inside ribs (one is seen overhead) are for suspending light fixtures, not for structural support.

a person to puff out his cheek. An air-pressure device on display inside the building showed one pound per square inch pressure difference between outside and inside.

In another test Schjeldahl held a blow torch to the side of the building and melted a hole in it to prove the building is fireproof and the small holes will not cause a failure in the structure. To show this more vividly, an archer shot arrows from the outside of the building into a target which was placed inside the building.

In further tests Schjeldahl cut his way out of the building with a butcher knife making a seven-foot-long gash in the side. The building did not deflate, and it was quickly repaired with tape. He also got on top of the building and walked the length of it.

AN ALIBI FOR CRASHES

Design of special cameras for photography of shipboard radar screens was outlined recently by Devern A. Chubb, chief engineer at Abrams Instrument Corp., before the annual convention of the Society of Photographic Scientists and Engineers in Rochester, N. Y.

Radar picture records containing time of sighting and radar range would be valuable for legal reference. They could provide incontrovertible evidence about the cause of an aircraft accident or of a maritime collision such as that involving the Andrea Doria, he pointed out.

Chubb's talk covered the design of radar recording systems from "haywire systems" using standard cameras and manual control to the complex equipment in use today.

Modern systems incorporate safety features to signal proper automatic film advance, low film supply, jammed film, or film breakage, he said. The control systems are completely self-contained and follow and record radarscope transitions automatically in any sequence.

Chubb also described the latest Abrams 35mm camera system. It simultaneously photographs a counter, data card, clock and range indicator, he said. The camera is built to withstand many adverse environmental conditions such as shock, vibration, and high and low temperatures, he reported.

ULTRA STRONG STEEL "WHISKERS"

An ultra-high strength steel that well may be one of the structural materials used in tomorrow's space vehicles has been perfected by the metallurgy department of Ford Motor Company's Scientific Laboratory.

Tensile strengths of more than 400,000 pounds per square inch have been attained experimentally, Dr. Michael Ference, Jr., director of the Scientific Laboratory, told a Ford Consumer Panel recently.

"These new strengths give design engineers an entirely new range in which to work," Dr. Ference said. "By way of illustration, a wire of this new steel only one-eighth inch in diameter could support 4,920 pounds, more than the weight of a 1959 Ford Skyliner and four passengers."

The strongest metals known appear in the form of "whiskers", incredibly fine filamentary single crystal wires with diameters a small fraction of a human hair. These iron "whiskers" have the maximum theoretical tensile strength predicted by metal physicists—approximately 1,000,000 pounds per square inch. He added that attainment of these properties in engineering materials may be close at hand.

He explained that the Ford-developed process hinges mainly on the two factors of temperature and mechanical working prior to tempering. Time is not too great a problem if the proper temperatures approximately 700° to 1,000° F. are maintained during working.

"In addition to a marked increase in yield strengths, our new ultra-high strength steels also have very good ductility," Dr. Ference said. "We have overcome the brittleness normally associated with tensile strengths in excess of 300,000 psi."

In essence, the method calls for mechanically working the steel while it is in one crystal form (austenite), changing it to a second form (martensite) by quenching and then tempering at about 500° Fahrenheit to obtain the higher tensile strengths and ductility.

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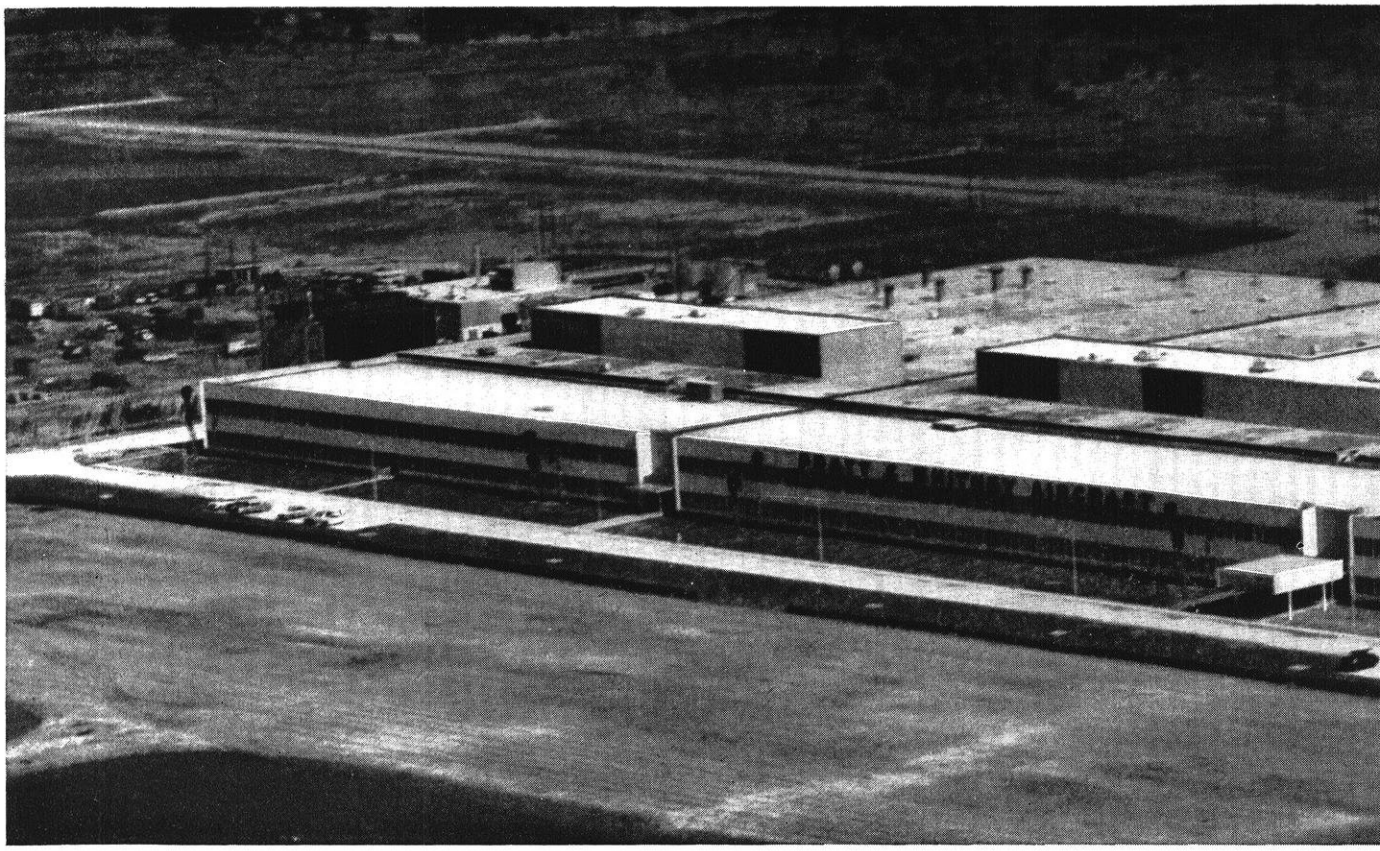
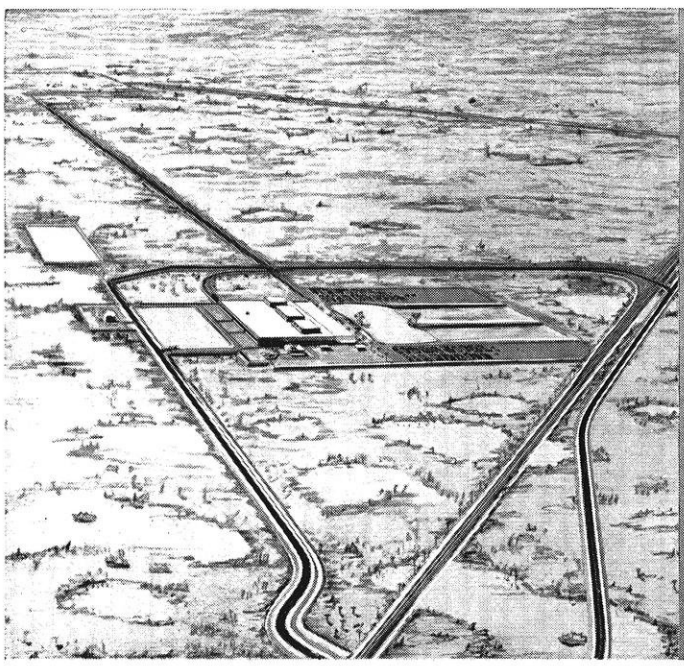
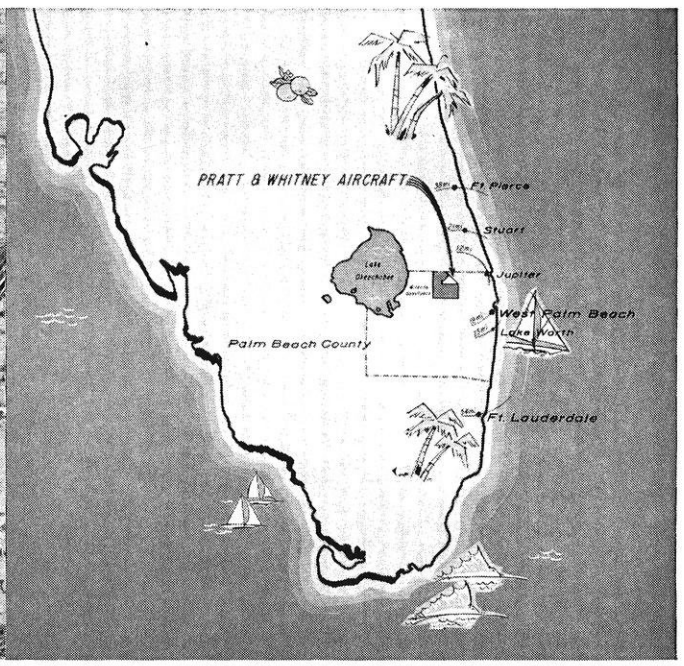


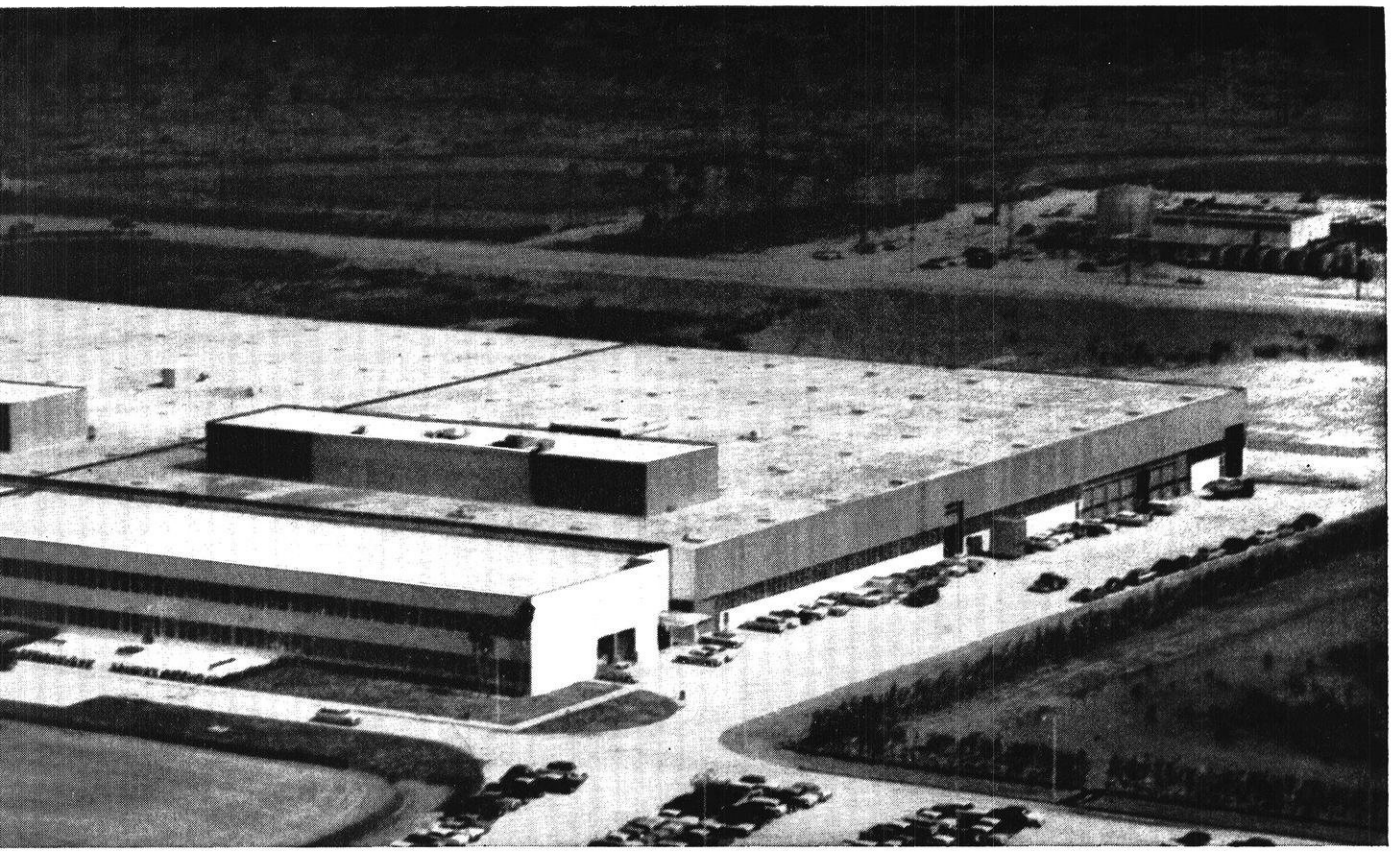
FLORIDA RESEARCH AND





ISOLATION—Ten square miles comprise the site of Pratt & Whitney Aircraft's new Florida Research and Development Center. Experimental shops and offices covering some 17 acres are in the foreground, while the tests areas, barely visible in upper left, lie four miles in the background.

LOCATION—The new Center is located at United, Florida, midway between West Palm Beach and Lake Okeechobee, in the upper Everglades area. It is almost surrounded by a wildlife sanctuary. Most employees live in the cities and towns along the east coast of Florida, driving to the Center on excellent new highways.



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To probe the propulsion future . . . and to build and test greatly advanced propulsion systems for coming generations of flight vehicles, Pratt & Whitney Aircraft is now operating its new Florida Research and Development Center. This facility supplements Pratt & Whitney's main research and development installations in Connecticut.

The new Florida Center, financed and built by Pratt & Whitney Aircraft, is unique in America's air industry. Here a completely air-conditioned plant with 17 acres under roof is specially designed and equipped for the development of new power plants of virtually any type. Testing is handled in special isolated areas; the nearest is four miles from the plant and many miles from any inhabited area. The new Center can be greatly expanded on its 10-square-mile site. Continued isolation is insured by a vast wildlife sanctuary in which the Center is located.

Of the many people employed at the Center today, about half are scientists, engineers and highly trained technicians. By late next year, the total number is expected to be almost doubled.

The new Florida Research and Development Center is one more reason why Pratt & Whitney Aircraft is able to continue producing the world's best aircraft propulsion systems . . . in whatever form they take.

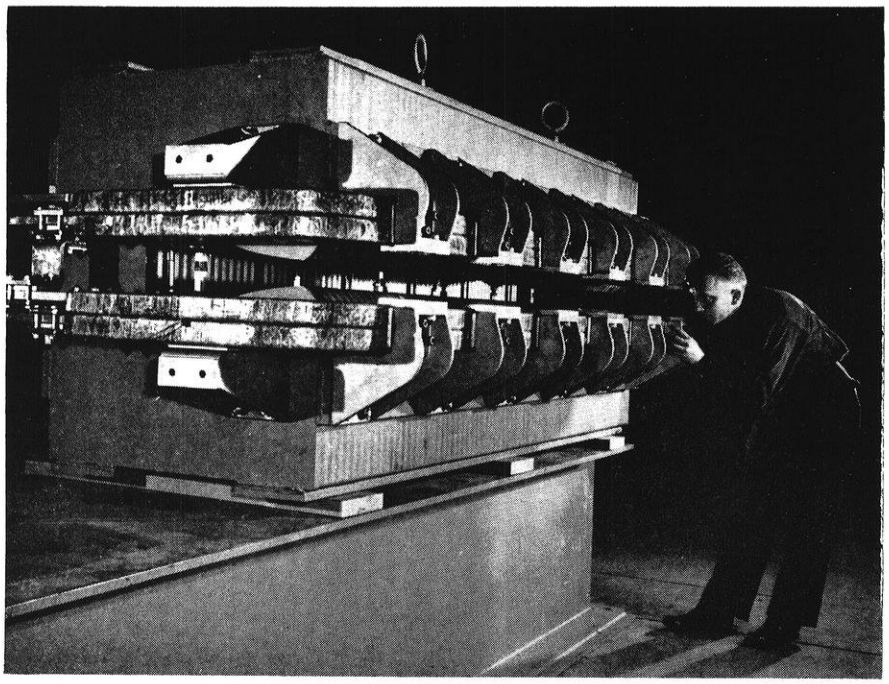
For further information regarding an engineering career at Pratt & Whitney Aircraft, contact your college placement officer.

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

CONNECTICUT OPERATIONS — East Hartford

FLORIDA RESEARCH AND DEVELOPMENT CENTER — United, Florida



Matter to energy and back again. Photo shows one of the 240 giant magnets used at the Brookhaven National Laboratory on Long Island (N. Y.), which will be used in the new mammoth synchrotron.

TWENTY FIVE MILLION GOES FOR ATOM SMASHER

They want to change matter into energy and then change energy into matter, and see what results they get.

What Brookhaven plans to do is pure research, and what may eventually develop from the facts gained is not at this time the concern of the scientists. However, dozens of industries might change their present day thinking, new industries might arise, medicine might come up with new and startling changes, old power sources might become obsolete. Chemistry, biology, space travel could all be shoved further and faster along by knowing some of the answers that Brookhaven hopes to learn.

To work with such minute bits of matter and energy, man has to build a huge machine. The synchrotron now being built, which will be ready for use in 1960, costs in the neighborhood of $25,000,000. Other machines have been built to smash the atom, but all except this proton synchrotron and a similar one being built at Geneva in Switzerland are using a different principle. The Russians have built a 10 billion-volt synchrotron of a somewhat different type, and began operating it about one year ago.

The Brookhaven synchrotron will accelerate protons until they have up to 25 or 30 billion volts of energy. The higher the energy of the particles, the faster they travel and the greater the possibility of "breaking" the nucleus and uncovering new facts about atomic structures.

The process of strong focusing is made possible with specially designed magnets that are alternately bowed out-and-in like large letter "C's." The magnetic force created by the magnets keeps the accelerating protons on course during the energy build-up period. The material for these large magnets was made by Allegheny Ludlum Steel Corporation, and was the largest single order ever produced by the company for this type of electrical steel. More than 3800 tons of electrical grade steel was used for the Brookhaven job, and delivered over a nine-month period.

How Does The Synchrotron Work?

The heart of the synchrotron is the combination of 240 magnets arranged in a circle more than a half mile in circumference, inside which is placed a vacuum chamber seven inches in diameter and 3⅜ inches high. The giant magnets will develop enormous magnetic force of 10,000 to 13,000 gauss, and will be buried in a giant subterranean cement tunnel, 17-feet 9-inches high and 18-feet wide. The tunnel will be covered with twelve feet of earth.

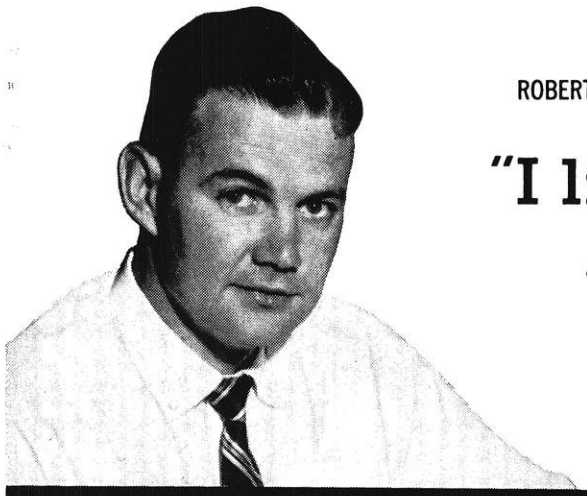
The vacuum chamber, which is located in the jaws of the "C" of the magnets, will contain a clear aperture 2⅜ inches high and six inches wide. It is through this narrow aperture that a beam of protons will be made to travel as they are accelerated to tremendous energies.

Before the protons go into the synchrotron, their energy is first raised in a high-voltage generator to 750,000 electron volts. From here, they go into a linear accelerator and by stages are raised to an energy of 50,000,000 electron volts, and at this stage they are injected into the half-mile track to whirl round-and-round. Each time they go around the track, twelve radio-frequency accelerating stations give them additional boosts in energy so that at the end of their travels —one second in which they have gone around the half-mile track some 350,000 times—they are traveling with an energy of 25-to-30 billion electron volts, and at a velocity approaching the speed of light.

At precisely this moment the proton hits the nuclear of an atom and "breaks" it so that protons and neutrons are released. In addition, a variety of mesons will also be created. The meson is a mysterious particle, and is believed to be a special cosmic cement that holds the parts of the atom together.

Once this is done, Brookhaven scientists hope to be able to observe through various ways what happens and what are the forces which really hold the nucleus together.

(Continued on page 43)

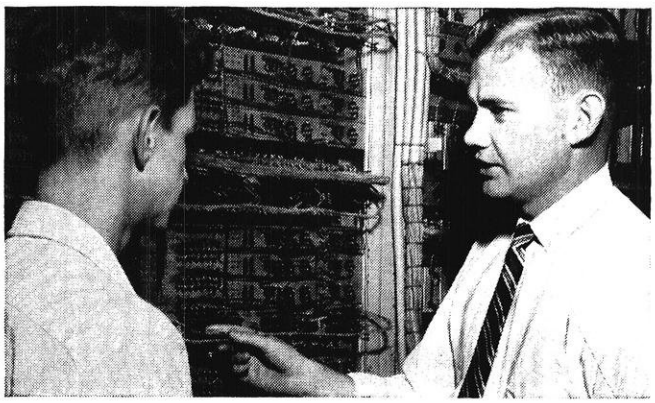


ROBERT H. SWISHER, B.S.E.E., GROVE CITY COLLEGE, '54, SAYS:

"I like my job. Here's why."

"I'm a radio transmission engineer for Bell Telephone Company of Pennsylvania. My work is interesting and full of variety, and I get all the responsibility I can handle. Have a look at today's assignment, for example —and see for yourself."

"8:30 a.m. I'm at my desk applying a new method for overcoming interference on Pittsburgh's mobile radio channels. It involves operating inactive channels on reduced power."



"10:45 a.m. Before any modifications can be made, it's important that I check apparatus and wiring options. That's what I'm doing here at the Remote Control Terminal equipment."

"1:30 p.m. After lunch, I take a company car out to the transmitter tower site. Here I check wiring and explain our plan to one of our mobile radio maintenance men."

"3:15 p.m. I review my proposed modifications of auxiliary control circuits with Supervisor Sid Graul. Now I'll prepare work orders, and next week we'll make operational tests."

"Final phase. The operational test is made from an actual mobile radio unit. I'll make test calls and monitor the channels from various points within the Pittsburgh area."

"See what I mean? I really get to 'carry the ball.' Soon I'll be taking a special course in advanced electronics at Bell Labs—a great opportunity. As I said —I like my job."

Like Bob Swisher, *you* may find a bright engineering future with the Bell Telephone Companies. 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

There's a Metal Problem in your future that Inco can help you solve

In the meantime, see if you can tell which nickel-containing alloy proved to be the answer to these problems.

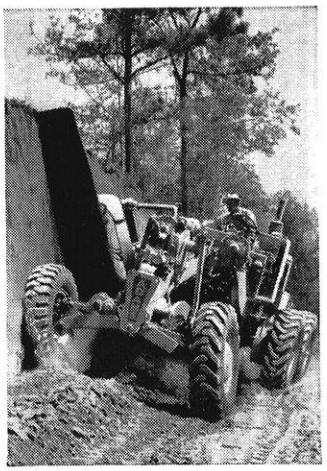
Number the picture captions!

1. Nickel cast iron
2. Chromium-nickel stainless steel
3. 4340 constructional alloy steel
4. Ductile Ni-Resist*
5. Cupro-nickel
6. Nickel-aluminum bronze
7. Ni-Resist nickel cast iron

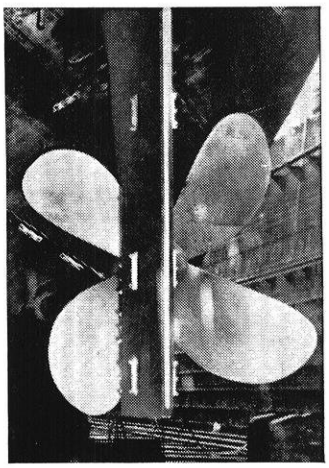
*Registered trademark

See answers below

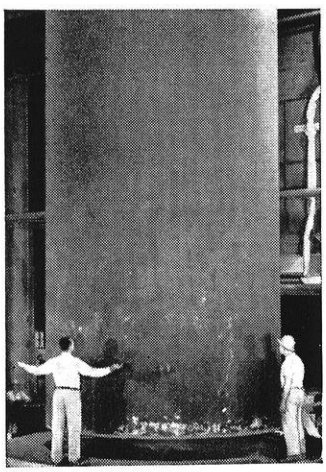
☐ **Piston ring carrier insert**—Needed: wear resistance, thermal expansion to match aluminum. Which alloy?



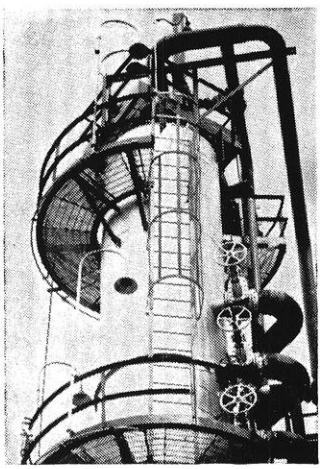
☐ **Grader drive axle**—Needed: toughness, impact resistance, greatest strength, with least weight. Which alloy?



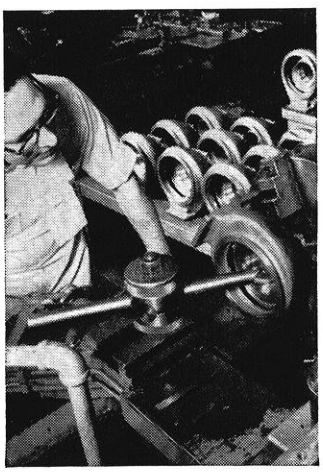
☐ **Ship's propeller** — Needed: light weight, high resistance to erosion, sea water corrosion. Which alloy?



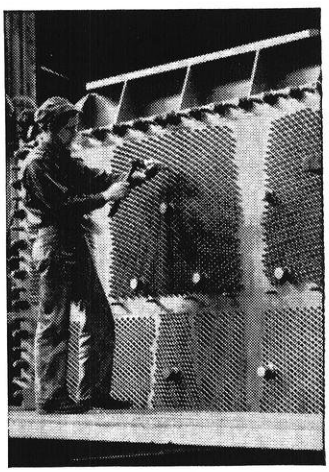
☐ **Yankee dryer roll** — Needed: high strength, uniform structure in cross sections of heavy castings. Which alloy?



☐ **Catalytic polymerization tower** — Needed: resistance to phosphoric acid at 375°F, 500 psi. Which alloy?



☐ **Turbocharger housing** — Needed: resistance to thermal shock, heat, corrosion at 1500°F. Which alloy?



☐ **High pressure marine condenser**— Needed: heat transfer, stress, corrosion resistance. Which alloy?

You may have to take this kind of quiz *again*. You may be designing a machine which requires a metal that resists corrosion . . . or wear . . . or high temperatures. Or one that meets some destructive *combination* of conditions.

When you start to design equipment, you will have to select the proper material to meet given service conditions. Over the years, Inco Development and Research has successfully solved many metal problems, and has compiled a wealth of information to help you.

For more on special problems solved with nickel-containing alloys, send for "Standard Alloys for Special Problems." Write The International Nickel Company, Inc., Dept. 189G, New York 5, N. Y.

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

answers

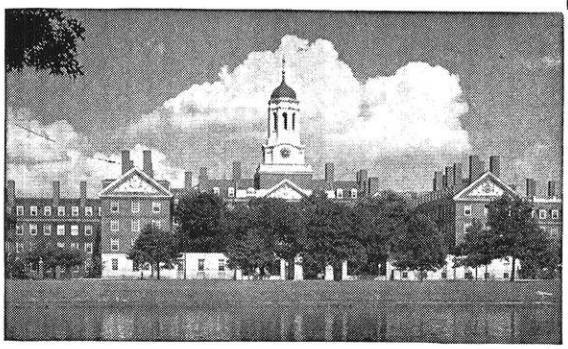
- Piston ring carrier insert.....7 Ni-Resist
- Grader drive axle.....3 4340 constructional alloy steel
- Ship's propeller..6 Nickel-aluminum bronze
- Yankee dryer roll.....1 Nickel cast iron
- Catalytic polymerization tower.....2 Cr-Ni Stainless
- Turbocharger housing..4 Ductile Ni-Resist
- High pressure marine condenser.....5 Cupro-nickel

Inco Nickel

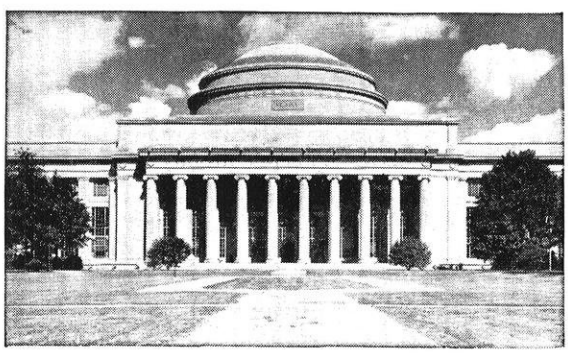
makes metals perform better, longer

Raytheon Graduate Program

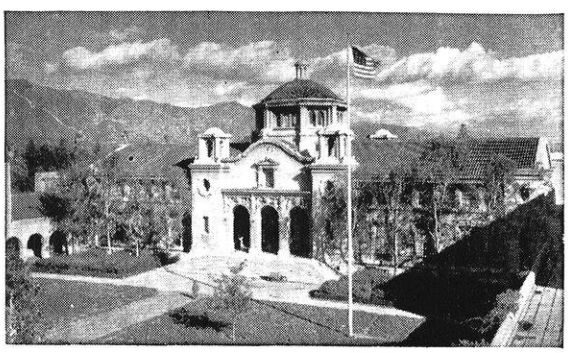
FOR STUDY AT HARVARD, M.I.T. AND CALTECH IN 1959-60



HARVARD



M. I. T.



CALTECH

The Raytheon Graduate Program has been established to contribute to the technical development of scientists and engineers at Raytheon. It provides the opportunity to selected persons employed by Raytheon, who are accepted as graduate students by Harvard University, Massachusetts Institute of Technology and California Institute of Technology, to pursue at Raytheon's expense, regular courses of study leading to a master's or doctor's degree in science or engineering in the institution of their choice.

The Program requires, in general, two or three semesters of study, depending on circumstances, with the summer months spent in the Company's research, engineering, or manufacturing divisions. It includes full tuition, fees, book allowances and a salary while at school. Students are eligible for health, accident, retirement and life insurance benefits, annual vacation and other privileges of full-time Raytheon employees.

To be considered for the Program, applicants must have a bachelor's degree in science or engineering, and should have outstanding student records, show technical promise, and possess mature personal characteristics. They may apply for admission to the Program in anticipation of becoming employees of Raytheon.

YOU ARE INVITED TO ADDRESS YOUR INQUIRY to Dr. Ivan A. Getting, Vice President, Engineering and Research, outlining your technical background, academic record, school preference, and field of interest, prior to December 1, 1958.

RAYTHEON MANUFACTURING COMPANY, Waltham 54, Mass.

Excellence in Electronics RAYTHEON

ENGINE EARS

by Tom Corth, ee'60

FORMER UNIVERSITY STUDENT

Major James E. Devine of Edgerton, Wis., has been assigned to duty with the Army Corps of Engineers' Eastern Ocean District. He will serve as Assistant for Operations at the District's area office in Sondrestom, Greenland, supervising construction at Sondrestrom Air Force Base and at DEW (Distant Early Warning) Lines sites in Greenland. Announcement of his assignment was made today by Colonel Carlin H. Whitesell, District Engineer, at his headquarters in New York City.

Born in Edgerton, Wis., Major Devine is the son of Mr. and Mrs. Henry T. Devine of that city. On graduation from Edgerton High School, he entered the University of Wisconsin where he studied for three years. He later attended Texas A & M College, where he received a B.S. degree in civil engineering in 1955.

During World War II, Major Devine served in the European Theatre of Operations in France and Germany. From 1948 to 1950 he served in Alaska with an Aviation Engineer Battalion on air base construction, and from 1951 to 1954 he served in Germany with a Combat Engineer Battalion.

Major Devine comes to the Eastern Ocean District from Fort Leavenworth, Kans., where he recently graduated from the Command and General Staff College. He is also a graduate of the Officers Topographic School and the Engineer Officers Advanced Course at Fort Belvoir, Va.

TRIANGLE

Triangle Fraternity launched into its social program with a beer supper on Friday, October 3 and a party on Saturday, October 4. A group of over 30 Triangle men from the Marquette Chapter were entertained at the party after the Marquette game.

On October 11, Triangle delegates attended their Regional Chapter Administration Forum at the Marquette Chapter in Milwaukee. Triangle Chapters from Marquette, Minnesota, South Dakota Mines, Illinois Institute of Technology, Northwestern, and Wisconsin were present for discussions of:

1. Alumni Relations.
2. Rushing.
3. House Management.
4. Pledge Training.
5. New House and Major Improvement Financing.
6. Scholastics.

Officers for the 1958 school year recently took over their respective offices.

President ..... Don Roeber
Vice President ..... Fred Klaus
Recording Secretary ..... Darell Meyer
Corresponding Secretary George Kenkkila
Treasurer ..... Forrest Dowling
Social Chairman ..... Dick Drake

STRONG FOCUSING

Unusually uniform electrical grade steel has helped make possible a new concept in smashing the atom, and will make possible the gathering of much more information on these basic building blocks of the universe. The new concept, called strong focusing, depends on huge magnets holding electrically charged atomic protons "bullets" on course, and using these particles to hit and break the nuclei of other atoms. The nuclear properties can then be observed and studied.

Now being built at Brookhaven National Laboratory on Long Island, New York is the world's largest and most powerful atomic machine—a mammoth new proton synchrotron. In somewhat less technical language, the Brookhaven people not only want to smash the nuclear of the atom, but they want to study the broken pieces and then see if they can put them back.

UW'S EXTENSION DIVISION

The University of Wisconsin Extension Division today announced a series of refresher institutes designed to help Wisconsin engineers prepare for registration examinations conducted by the State Board of Engineers.

The institutes are designed to help engineers gain professional status and have been endorsed by the Wisconsin Society of Professional Engineers as part of its "pet drive" to obtain 100 per cent registration in the state. State law requires engineers to pass the regis-

tration examinations before they practice independently.

Cass F. Hurc of the UW Extension Division's Engineering Institutes said there are 4,808 registered professional engineers in Wisconsin, along with an estimated 5,000 college engineering graduates who have not completed state requirements. He said each engineer must pass the basic examination plus one in his specialty to qualify for registration.

The basic engineering institute was held on the University campus Oct. 16–17. Other scheduled refresher programs include civil engineering, Nov. 20–21; chemical, mining and metallurgical engineering, Jan. 29–30; mechanical engineering, Feb. 27–27; and electrical engineering, April 23–24.

Among lecturers at the institutes will be State Chief Engineer Ralph D. Culbertson; W. A. Piper, secretary of the Wisconsin Registration Board of Architects and Professional Engineers; and Dean Kurt F. Wendt of the UW College of Engineering. Other faculty members will represent the various University engineering departments.

Clifford Nelson, Black River Falls, president of the Wisconsin Society of Professional Engineers, said every engineer in the state should prepare for and pass the state examinations to remove "an important gap in their professional stature."

He said that registration of engineers is required by the state in order to protect the public. The examinations are designed to stop the practice of engineering by non-engineers and to oust from the profession those who are incompetent.

M&M Professor Appointed

Dr. Franz H. Vitovec, international authority on mechanical and high temperature metallurgy, was appointed associate professor of mining and metallurgy in the University of Wisconsin College of Engineering.

Dr. Vitovec, 37, comes to Wisconsin from the University of Minnesota where he was associate professor in the department of mechanics and materials. He begins his work on the Wisconsin faculty immediately, teaching courses in nuclear metallurgy and in metal physics during the current semester.

He received both the Dipl. Ing. degree in mechanical engineering and a Doctor of Technical Science degree in physical metallurgy from the Vienna Technische Hochschule. Winner of the Vienna Prize as outstanding young scientist in 1952, he was lecturer and research associate at the Institute for Research in Materials in Vienna before coming to the United States.

He has taken part in international technical meetings in Switzerland, Spain, Belgium, and the United States and is author of some 40 technical papers in his field.

Society News

AIEE-IRE

The first meeting of the student branch of the AIEE–IRE was held on Wednesday, October 1, with about sixty members attending. The speaker for the evening was Mr. Keating of McDonnell Aircraft Corporation, who gave a very interesting talk on the effect of nuclear radiation on electronic components.

The membership drive, which was organized by Carl Kaack and held at the start of this semester, was very successful. The result of Carl's fine work was a total of 100 new members.

For the first time since 1950 the AIEE–IRE technical paper competition will be held here at the University of Wisconsin. The contest will be run in April with students from twenty two schools participating. This contest is open to anyone, and those interested can obtain more information by contacting Ken Lewandowski.

The officers for the 1958–1959 school year are: President, Jim Skofronick; Vice President, Al Goshaw; Secretary-Treasurer, Joan Donahoe. The various committee chairmen are: Membership, Carl Kaack; Engineering Exposition, Don Hardin; Program, Al Goshaw; Paper Competition, Ken Lewandowski; Putting Hubby Through, Kurt Reisen; Refreshments, Ken Lewandowski; Display, Don Hardin; and Publicity, Paul LeMere.

NEWS FROM ALPHA CHI SIGMA

University president Conrad A. Elvehjem, a member of Alpha Chi Sigma, addressed the chapter and guests at the first professional meeting of the semester for the professional chemical and chemical engineering fraternity. Mr. Elvehjem's talk was on the policies of the University of Wisconsin in the future.

The Alpha Chi Sigma safety committee has again distributed laboratory safety booklets to all freshman chemistry students. On October 16, AXΣ put on a chemical magic show at Burlington High School, Burlington, Wisconsin. The show was designed to stimulate interest in science.

NEWS FROM KAPPA ETA KAPPA

At the fall semester's first meeting, officers of Kappa Eta Kappa, professional electrical engineering fraternity, were elected. The new officers are: President, Don Olsen; Vice President, Dick Frosh; Treasurer, Bill Hanke; Recording Secretary, Al Goshaw; Corresponding Secretary, Lee Eichenseer; and Social Chairman, Don Kleindl. The thirty one members met at the Delta chapter house at 204 North Murray. Rushing functions were held on September 22 and 29, at which entertainment and refreshments were provided.

A banquet was held for the initiation of the preceding semester's pledges on September 27 at Hans Thallers. The formal initiation took place in the early evening at the chapter house. Members, guests and alumni enjoyed the guest speaker, Mr. Richard Sherman of the Wisconsin Bell Telephone Company. Mr. Sherman spoke on the advent, use and future of semi conducting devices within the Bell system. Solar batteries were demonstrated and used to operate small motors and telephones. The phone of the future, transmitting a picture of the speaker, was also discussed. His address was entitled "Dial F for

(Continued on next page)

Future", and was very well received.

The following ten men were formally acknowledged and introduced as new members of Kappa Eta Kappa: Robert T. Baltes, Neil F. Beneditz, James D. Elbert, Donald E. Eliason, Robert A. Felde, Donald G. Hintz, Charles J. Holderness, Donald L. Martell, Carl H. Much, and Paul A. Spangler.

KHK is looking forward to an active semester both socially and academically. Parties and outings have been planned, also guest speakers in various technical and professional fields have been contacted for our future meetings.

Recent Highlights

DESIGN COMPETITION

A steel highway bridge design competition offering 15 awards totaling $44,000 to engineers and college engineering students is being sponsored by American Bridge Division of United States Steel Corporation, it was announced today by Austin J. Paddock, division president, and L. Abbett Post, executive vice president of the American Institute of Steel Construction, who will administer the program.

The competition is dedicated to the stimulation of the best use of steel in the design of bridges for the 41,000-mile system of interstate and defense highways to be built during the next 15 years.

It has been estimated that more than one bridge per mile of road will be required to complete the vast network of highways that will link all parts of the nation.

"Being the strongest and most versatile construction material, readily available and familiar to all engineers, steel will save the program many a day and dollar in the next 15 years," Mr. Paddock said. "But we in American Bridge are convinced that steel can contribute even more if the engineering mind is stimulated to a more imaginative and effective use of its abundant properties."

Open to professional and design engineers and to college engineering students, the competition poses the problem of designing an overpass structure in steel to carry a two-lane highway at right angles over a four-lane interstate highway on level ground. The overpass must be designed in accordance with standards developed by the American Association of State Highway Officials and approved by the U. S. Bureau of Public Roads. These standards are entitled "Geometric Design Standards for National System of Interstate and Defense Highways."

Eight awards will be made for winning entries submitted by professional and design engineers, including a top award of $15,000. Other grants in this category will include $10,000 for first honorable mention, $5,000 for second honorable mention, and $1,000 each for five third honorable mentions.

College engineering students will compete for $9,000 in awards, with the first award being $4,000. Also to be given are $2,000 for first honorable mention, $1,000 for second honorable mention, and $500 each for four third honorable mentions.

All entries will be judged on the basis of originality of design, utilization of the properties of steel, economy, and appearance of the structure. The type of overpass structure, length of spans, and other factors will be left to the discretion of the entrant.

Any professional and design engineer and college engineering student may enter the competition, except employees or members (and their immediate families) of the following organizations: United States Steel, its divisions, subsidiaries, agents and dealers; structural steel fabricating firms; the American Institute of Steel Construction; and the competition's rules committee and judges.

Contestants are limited to a single entry, although two or more individuals may submit a joint entry.

All entries in the competition will be judged by a special jury of award under the chairmanship of L. Abbett Post. The jury will consist of at least five members of the competition's rules committee, which is composed of 17 distinguished engineers and architects.

Complete information on the competition may be secured from American Bridge Division, United States Steel Corporation, 520 William Penn Place, Pittsburgh 30, and from the American Institute of Steel Construction, 101 Park Avenue, New York 17.

Deadline for entering the competition is midnight, May 31, 1959. Entries should be mailed to the Institute of Steel Construction at the above address.

FILMS ON SPACE TECHNOLOGY

Under the sponsorship of the College of Engineering, the Extension Division, the College of Letters and Science, and the Engineering Society of Milwaukee, a series of seventeen filmed lectures on Space Technology will be presented throughout the first semester of 1958–59. All interested persons are invited to attend. The times of showings of the lecture-films are Mondays, 7:00–9:00 P.M. and Tuesdays, 3:30–5:30 P.M. (repeat showing). These films will be shown in room B–10 of the Commerce Building.

The topics include all phases of space technology, such as rocketry, space satellites, lunar flight, propulsion systems, guidance and space communication, magetoaerodynamics, space medicine, etc. The lecturers will be well-known scientists and engineers in the field of space science, such as Joseph Kaplan, Joseph Siry and many others. Lecture notes will be available and University faculty will be on hand to answer questions at the conclusion of each lecture. Further information may be obtained through the Engineering Experiment Station, Extension 2216.

ENGINEERING INSTITUTES TO MEET

Each year engineering institutes are held to enable those interested to find out the latest developments and ideas in the various fields for which these institutes are held. All institutes are planned to meet the needs and interests of persons in industry. Speakers are chosen on the basis of their ability to communicate effectively as well as their technical competence. They are from industry, the faculty of the University of Wisconsin, other educational institutions, consulting firms, federal and state agencies, and private research organizations. Talks are presented very informally with ample opportunity for

(Continued on page 45)

Science Highlights

(Continued from page 36)

WHERE DO FATIGUE-CRACKS START?

It has been commonly observed in bending tests that fatigue cracks start at the edge of a plate or sheet specimen. This naturally led to the conclusion that resistance to fatigue-crack initiation is lower at the edges than on a flat surface. However, in recent National Bureau of Standards experiments a type of specimen was used that permitted a direct comparison of the fatigue strengths both at the edges and on a nearly flat surface. The results indicate that the preponderance of edge cracks previously observed in conventional specimens is caused by the stress pattern rather than by lower fatigue strength at the edges.

The initiation of fatigue cracking is usually the first sign of metal failure, and is thus of considerable interest of metallurgists and design engineers. Several investigators have attempted to evaluate the tendency of cracks to start at the edges by comparing data obtained from testing specimens of various shapes. Their results, however, were not always consistent. Among factors thought to influence the results were the lack of restraint against slipping in the material at the edge, and the stress present in the specimen's surfaces. In order to obtain quantitative information on these factors, the present investigation was undertaken.

The specimens used in the bending tests were especially designed by J. A. Bennett and J. G. Weinberg of the Bureau of Standards' mechanical metallurgy laboratory. Made of ¼-in.-thick plate, they were 7 in. long, and from 2 to 3 in. wide. A reduced section toward the middle of the specimen was formed by 4 cuts. The two broad surfaces were each milled into the shape of a saddle and rounded notches were cut into the adjacent edges, varying in depth according to the desired width. The saddle-shaped surfaces were designed to provide maximum thickness at the center of the reduced section.

Tests were conducted on a plate bending machine. One end of the

(Continued on next page)

specimen was clamped in a vise and the other end was oscillated by a motor-driven eccentric and connecting rod. Because of the shape of the reduced section, the axial stress in the center was greater than at the edge. By varying the contour of the saddle shape and the width of the specimen at the reduced section, it was possible to obtain any desired value for edge-to-center stress ratio. Then by observing crack origin location, the relative probability of edge and non-edge cracks could be determined as a function of edge-to-center stress ratio.

Results obtained with 5052-H34 aluminum alloy specimens show that the reduction of fatigue strength at the edge decreases as the specimen width decreases, and that no reduction might be expected for a specimen of zero width. From this it appears that the probability of fatigue cracking at the edge is not caused by lack of restraint but by the strengthening effect of biaxial stress on the surface away from the edge.

By changing the radius and included angle at the edges of the specimen's reduced section, the techniques used in these tests can be adapted to investigate the influence of other geometrical factors on metal fatigue. As the results depend on the comparative fatigue strength of different portions of individual specimens, many possible sources of error are eliminated.

NEW PLASTICS FOR MISSILES

A new plastic especially designed for use in missiles and rockets was announced here today by Reichhold Chemicals, Inc. Laminated parts made from it will withstand up to 4500° F for brief periods, and up to 500° F for 100 hours and longer.

The new phenolic resin, designated Plyophen 5900 by RCI, is said to produce laminates having not only exceptionally high strengths at elevated temperatures, but also low moisture absorption, good insulation properties, and good resistance to organic solvents, weak inorganic acids, hydraulic

(Continued on next page)

aircraft oil, de-icing fluids, and hot gas erosion.

Earlier plastics of this type had been proven better than most metals at withstanding high temperatures for short periods of time, but they had not been recommended for continuous service at temperatures above 300° F, according to RCI.

Reinforced with glass cloth or asbestos, the resin will be used for nose-cone sections, skin strengtheners, internal hoops, electronic equipment mountings, and other missile and rocket parts.

The new plastic is suitable for either low-pressure or high-pressure lamination. According to Reichhold, laminates produced by either method more than meet the usual requirements and specifications for such materials. In fact, the firm claims, low-pressure laminates made with Plyophen 5900 exhibit better properties than those obtained at high pressures with some earlier resins of this type.

Typical test results are: Ultimate strength flexural, flatwise, 85,900 psi, compared with the usual specification of 50,000 psi. Ultimate compressive strength edgewise, 60,240 psi, compared with the specification of 35,000. Ultimate strength flexural, flatwise, at 500° F, after 100 hours' exposure to 500° F—67,320 psi, compared with the specification of 12,500 psi.

(Continued on page 56)

Campus News

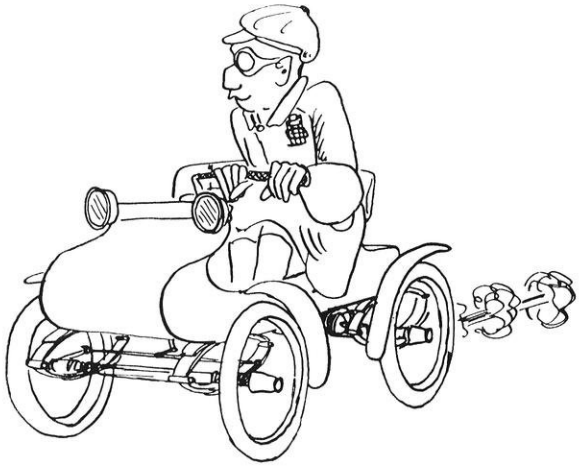
(Continued from page 42)

questions and discussion from the floor.

The schedule of engineering institutes to be held through January 1959 is as follows:

- Civil Engineering Refresher—November 20–21
- Surveyors—December 3–5
- Industrial Plant Maintenance—December 10–12
- Industrial Computer Applications—January 7–9
- Structural Engineering—January 14–16
- Time Study Appreciation—January 19–23
- Technical Expression—January 21–23
- Chemical, Mining, and Metallurgical Engineering Refresher—January 29–30
- Power System Protection—January 29–30

THE END



THE ENGINEER OF YESTERYEAR

by John Nichols

FLAME IGNITION OF INTERNAL COMBUSTION ENGINES

June 1896

FROM the time of the earliest gas engine the subject of ignition has been one of considerable controversy, and the igniter is still the part that gives the most trouble in the modern gas and gasoline engines.

Electric ignition was applied in the Senior engine but later the flame method was the more popular one. The flame method could be readily applied to those engines in which the charge was not compressed, for the piston could be made to uncover a port at the proper time and suck in the flame from a burner just outside the port. But when the charge in the cylinder was compressed to a pressure of several atmospheres this problem of communicating the flame to the charge became a very difficult matter. Upon opening a port from such a charge beside an external flame, the latter would be immediately extinguished by the sudden rush of gases, and it was evident that some means must be employed to maintain this constantly burning flame.

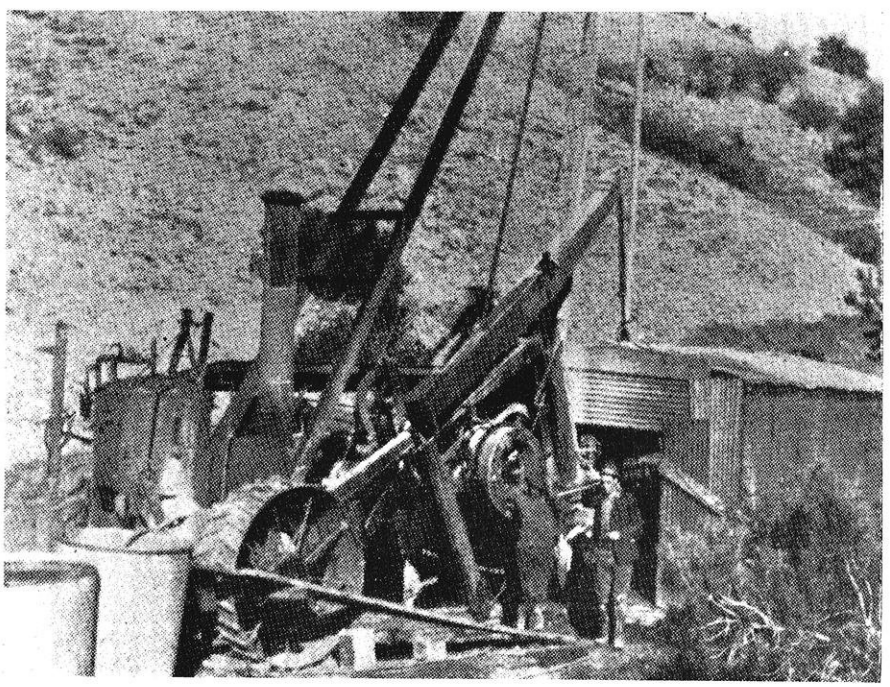
This object was first attained by Burnett in his igniting cock. This was a hollow cock with a port on one side which could be turned so that this port opened to the air, or in another position was opposite a port connecting with the explosion chamber of the engine. Inside this cock was a small gas jet and just outside the cock and pointing into the opening when the cock was opened to the air was another gas jet. In action, the cock was first turned to the open air when the jet inside would be lighted from the jet outside. Then the cock was revolved and its port closed first, enclosing the burning jet and a small quantity of air, and then opening to the cylinder, thus firing the charge. The inner jet was extinguished by the force of the explosion but was immediately relighted upon turning the cock so as to communicate with the air and the external flame. This made a very sure method of ignition but could only be worked at rather slow speeds.

SIX MONTHS OF ELECTRICAL JOURNALISM

October 1896

The *Electrical Review* has just completed its twenty-eighth volume, which contains some of the best reporting ever done by a technical journal. In addition to giving thoroughly reliable news of the progress of electrical work in all its branches, the *Electrical Review* has secured in the past six months a large number of unusually valuable and exclusive articles on important subjects. It printed the first official interview with Professor Roentgen and the only interview with Professor Salvione, of the University of Perugia, Italy, who made some very interesting and remarkable discoveries on the Roentgen ray.

The *Review* was also the first to give an illustrated description of the new Westinghouse–Baldwin electric locomotive, and obtained the first official interview with Thomas A. Edison on his new fluorescent lamp. The greatest



A scar drilling machine used for copper prospecting in Arizona in 1910.

honor that this journal has attained is that it was selected exclusively by Nikola Tesla for giving to the world the remarkable series of articles written by him, describing his wonderful progress in X-ray photography and in vacuum-tube lighting.

GOVERNMENT LAND SURVEYS

June 1896

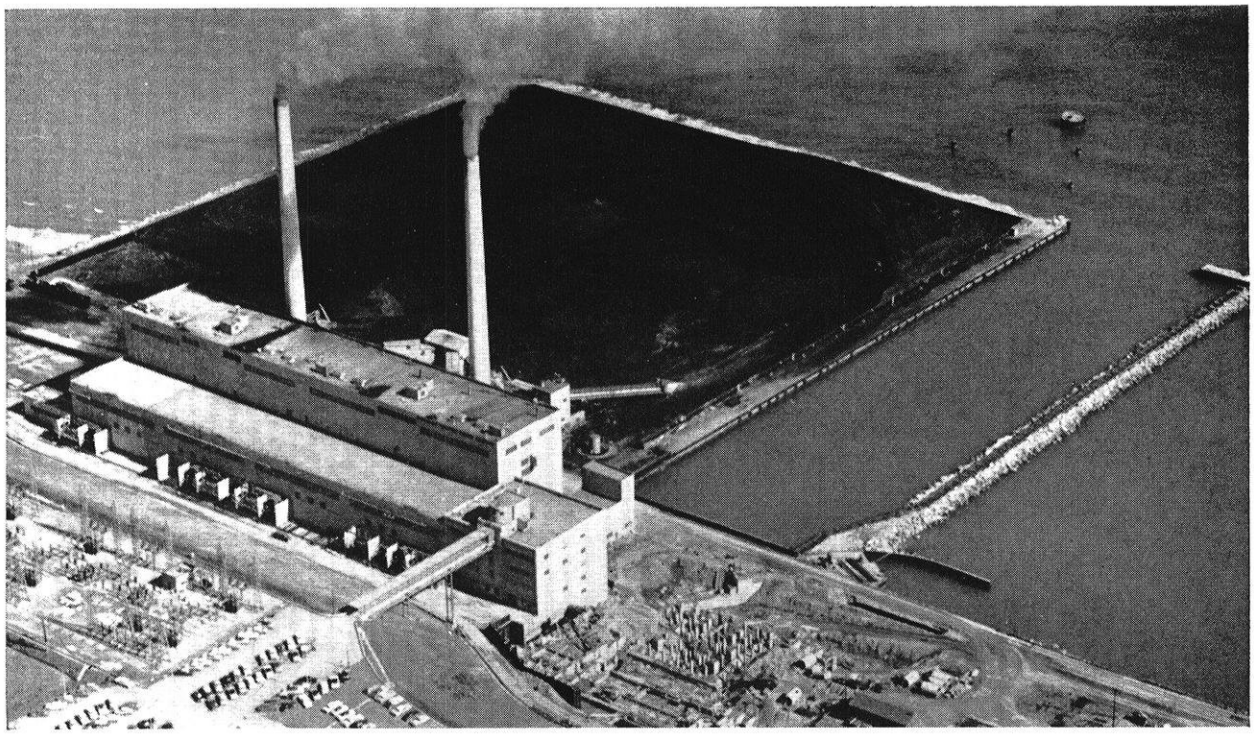
Whenever any subdividing of government lands is to be done, the Surveyor General receives bids for the work and awards contracts to "Deputies." The rate payed per mile depends upon the character of the country in which the work is to be done, that for mountainous country being higher than for level country. For work in ordinary timber the rate is about twenty dollars per mile, and for meandering about twenty-three dollars. Meandering is the most profitable, as it is generally much easier to work along the banks of a river than in timber.

The Deputy receives instructions from the Surveyor General as to how much of a township is to be surveyed, but he must use his own judgment in doing the work. That is, no work must be done where the country is so mountainous that it would be impracticable to survey it.

It is the duty of the Deputy to run and measure all lines as accurately as circumstances will permit. Section corners, quarter section corners, meander stakes, witness corners, etc., must be set and carefully marked. Bearing trees must be established and plainly marked also. This is a very important part of the work, and much stress is laid upon the kind of tree to be selected, and the manner in which it shall be marked. In connection with the work, a fairly accurate topographical map of the country must also be made, which renders it necessary to take plusses of elevations and depressions and of streams. All streams over two chains in width should be measured. If anything of interest is found on or near the line, such as indication of ore, or a rancher's cabin, it should be noted. The lines must be well blazed in order that the settlers may follow them readily in staking out their claims.

(Continued on page 65)

It takes skill...



It takes *engineering skill* to design, build and operate the generating facilities of a growing electric power system. The first four units of the Oak Creek power plant (above) have increased system capacity by 500,000 kilowatts since 1953. A fifth unit, now under construction, will be rated at 250,000 kilowatts. It will operate with steam pressure at 2400 psig and with throttle temperature of 1050° F. The Company's policy of doing its own design and development work is responsible for the many innovations incorporated in the Oak Creek plant.

We're looking for men with qualities like these!

Excellent job opportunities at Wisconsin Electric Power Company are waiting for young engineers of outstanding skill, foresight, imagination and judgment.

At Wisconsin Electric Power Company you will have a chance to use your engineering skills in a wide variety of fields — electrical, mechanical, civil, chemical, statistical, research, sales, administrative, etc.

Demands for our services are so great that our current expansion program anticipates the doubling of our facilities within a 10 year period. We invite you to grow with us. Whatever your work may be, it will be worthy of achievement and will bring with it the material rewards which accompany success.

WISCONSIN ELECTRIC POWER COMPANY SYSTEM

Wisconsin Electric Power Co.
Milwaukee, Wis.

Wisconsin Michigan Power Co.
Appleton, Wis.

Wisconsin Natural Gas Co.
Racine, Wis.

Photography

(Continued from page 25)

obtained, but the movement is so small that the camera does not adequately record it. If similar methods of calculating are used for determining the velocity of a part from the film record, the picture frequency must be determined accurately by means of a time base on film. It should not be taken from information supplied by the manufacturer which is only intended as a guide.

When the running speed of the camera has been decided, the next important thing to do is to synchronize the camera with the movements of the subject. In the case of cyclic or repetitive movements this introduces no difficulties, provided the cycle is of reasonably short duration. Few cameras run at high speeds for more than about two seconds. Although a lower running speed will give a longer running time, this may not be acceptable for the minimum picture frequency calculated. It is not usually possible to trigger the running of a camera from the subject, as the starting characteristics of most cameras are unsteady. Successful electrical triggering devices have been built, but long delay times are not possible.

Where it is impracticable to actuate the subject by electrical means it is often possible to use a manual method. In general, any method of sychronization should aim to record the subject movement as near to the end of the film as possible. This is recommended because most films are not running at maximum speed until after the first 50 feet, although they may be running at a useful speed well below this value.

One important aspect of high speed motion picture photography is the provision of adequate illumination. As the exposure times involved cover the range from about 1/1000th of a second down to about 1/50,000th of a second, it is therefore quite difficult to achieve a high enough subject brightness. For small subject areas this may not present a very difficult problem. However, for areas larger than about ten square feet

(Continued on page 53)

Soil Cement

(Continued from page 15)

tuminous material, but waterproof paper, moist straw or dirt are also satisfactory. However, the bituminous cover may also serve as a tack coat for a subsequent surface coat. After the soil–cement is freed of all dry, loose and extraneous material, the bituminous coating is applied. Rate of application varies from 0.15 to 0.30 gallons per square yard. When traffic is to be maintained, the cover coat is sanded to prevent its pickup by traffic. Approximately 10 pounds of sand per square yard should be applied.

A bituminous surface should be placed on the completed soil–cement as soon as practical. The type and thickness of surfacing depends on the traffic volume, availability of materials, cost, and local practices. In general, the thickness of the wearing course necessary will be less than that required on a granular-type base. Surfaces from ¾-inch to 2-inch thickness are generally used.

The bituminous surface, consisting of a prime coat and surface course, may be placed immediately after the seven-day period of protective cover. If poor results are obtained from poor finishing, surfacing will be saved by exposing the soil–cement to traffic for a few weeks to show up the poor areas. These poor surface areas can then be cleaned off to hard soil–cement before the bituminous materials are placed. The bituminous surface can then be bonded firmly to hard soil–cement.

When the soil–cement is ready for surfacing, the surface should be thoroughly cleaned of all loose material with power brooms and blowers. A heavy bituminous prime is then applied to supply the bond between the soil–cement and surface course. Penetration will not be needed since all the dust and loose material is removed. The surface course of high-grade bituminous plant mix is then applied in one or two lifts, depending on the desired thickness.

The service life of bituminous surfaces on soil–cement bases is longer than on granular-type bases. Periodic, thin surface treatments are required every five years or longer to replace material worn away by traffic. Shrinkage cracks occurring in the soil–cement after the bituminous surface is placed usually come through the bituminous surface.

Advantages Of Soil–Cement

When built for equal load-carrying ability, soil–cement is less expensive than other low-cost pavements. The main factors leading to this low cost are:

1) Efficient machinery. The rapid increase in the use of soil–cement since its start in 1935 has prompted equipment manufacturers to produce efficient central plants, travel plants, and finishers. More complete information on the equipment used may be found in the construction section.

2) Use of in-place soil. Almost all soils can be hardened with portland cement. About 90 per cent of the soil–cement mixture is soil present at the construction site

–Photo Courtesy Portland Cement Association
Rubber-tire rollers put the final smooth finish of the soil–cement base.

or obtainable from a local borrow pit. This saves the cost of excavating and hauling in gravel or other road base aggregate.

3) Small amount of portland cement needed. Although the percentage of cement needed varies with the characteristics of the soil, it ranges from 5 to 15 per cent. In general, the finer the soil texture the more cement is needed to harden the mixture to a satisfactory degree.

Strength of soil–cement increases with age, assuring a long life for

soil–cement roads. The first of these roads, built in 1935, still are giving good service at low maintenance cost. Since soil–cement roads use in-place soils they are easily patched and widened. Application of a bituminous surface increases the life of these roads.

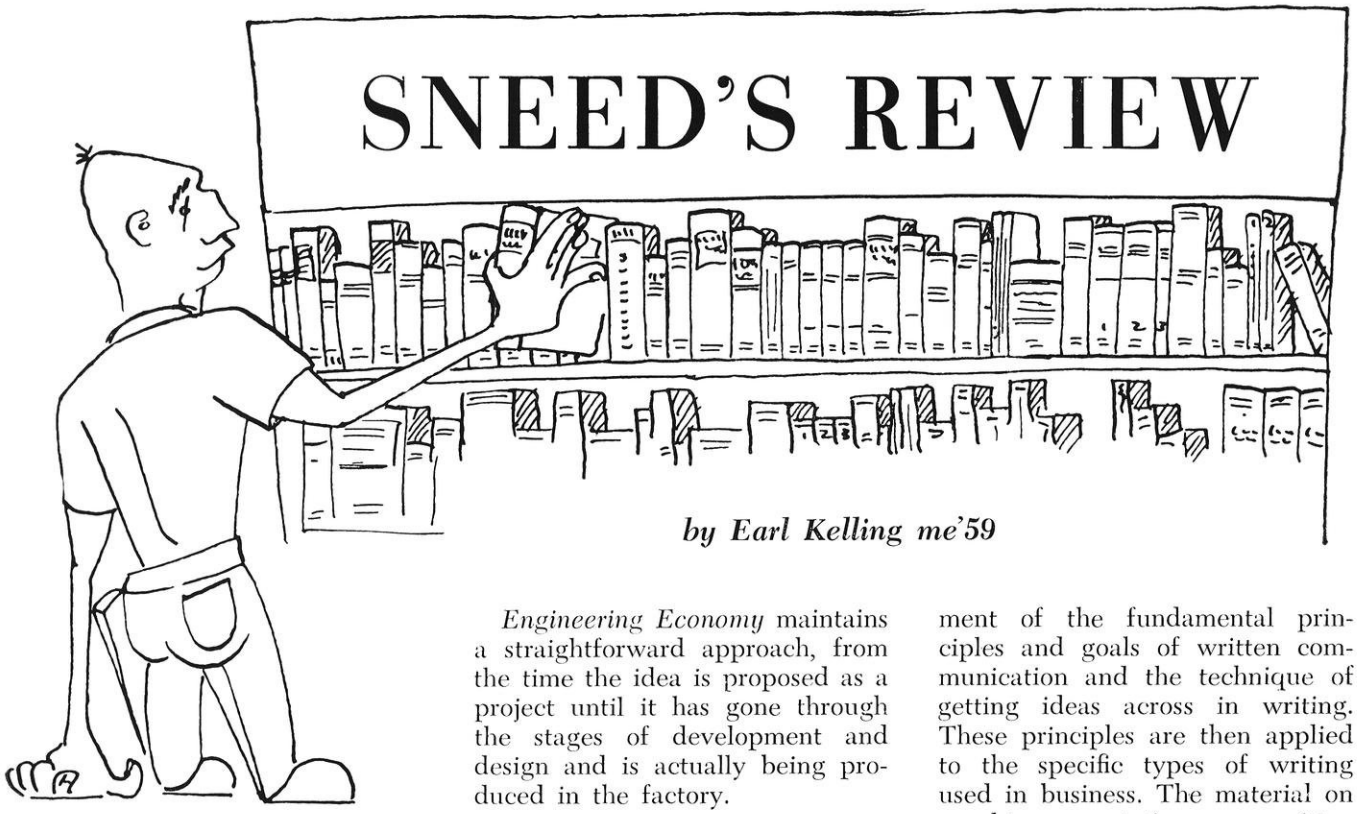
Soil–cement is 50 to 100 per cent stronger inch for inch than other low-cost pavements. Modern design methods require soil–cement thicknesses that are ⅓ to ½ less than granular bases carrying the same traffic load over the same subgrades. Since soil particles in soil–cement are tightly bound together by cement, the entire mass is hardened into a slab with enough rigidity and strength to spread loads over a large area of the subsoil.

During construction the mixture is compacted to a high density. As the cement hydrates, the mixture hardens in that state. Soil–cement does not soften when exposed to extreme wetting and drying or freezing and thawing. This hard, unchanging pavement maintains its strength through heavy rainstorms and spring breakups.

Soil–cement roads are quickly and easily built, often more than a mile per day. Usually no excavation is necessary and the inconvenience of detours is kept to a minimum. Construction of millions of square yards of soil–cement in all climates proves that rain is not a serious construction hazard. During construction, water equivalent to 1 to 1½ inches of rain is added; therefore weather delays are rare. Local residents greatly appreciate the speed of soil–cement construction.

In its relatively short life of 23 years, soil–cement is proving itself to be a wise choice for light traffic road construction. Its main disadvantage is merely that it is a relatively new method and unknown to many highway engineers. Construction procedures, specifications, and field tests are now becoming well established. As more engineers include soil–cement in their highway work, contractors and equipment manufacturers will be encouraged to equip and organize for this type work. The result—more miles of roads at a lower cost to all. THE END

SNEED'S REVIEW



by Earl Kelling me'59

ENGINEERING ECONOMY

Third Edition

By Clarence E. Bullinger
McGraw–Hill $7.00

This book acquaints the engineer with the economic factors of engineering projects, shows him how to evaluate such factors and to estimate costs, how to separate and define the intangibles, etc. It deals with the methods and problems inherent in the financing of a project and provides an understanding of the type of economic study which engineers in industry are called upon to make when considering the functional solution of engineering problems.

The book covers three separate but definitely related analyses which comprise such an economic study:

1. The Economy Analysis, which attempts to evaluate the worthwhileness of the project in terms of profit and yield on the investment.
2. The Intangible Analysis, which determines the worth-whileness in terms of those factors which are difficult to evaluate because of the factors of human judgement involved.
3. The Financial Analysis, which explores the problem of providing the funds with which to make the project possible.

Engineering Economy maintains a straightforward approach, from the time the idea is proposed as a project until it has gone through the stages of development and design and is actually being produced in the factory.

UNIT OPERATIONS OF CHEMICAL ENGINEERING

By Warren L. McCabe and Julian C. Smith
McGraw–Hill $10.50

Written at an undergraduate level, this volume covers the unit operations of chemical engineering from both a practical and a theoretical standpoint. Each unit operation is treated separately. General discussions are also included covering fluid mechanics, flow of heat, and mass transfer, each giving scientific and theoretical foundations for several operations. In place of a multiplicity of mass transfer coefficients, only one —the Drew–Colburn Coefficient—is used throughout. The book includes 113 worked-out examples, nearly 150 unsolved problems, 500 figures, and 275 references to the chemical engineering literature.

WRITTEN COMMUNICATION IN BUSINESS

By Robert L. Shurter
McGraw–Hill $6.00

Here is a comparative treatment of the major principles of business communication, and analysis of the most widely used forms of business writing—the letter, the report, and the memorandum—and a discussion of the associated skills of dictation and reading.

The book begins with a statement of the fundamental principles and goals of written communication and the technique of getting ideas across in writing. These principles are then applied to the specific types of writing used in business. The material on graphic presentation was written by Mr. Kenneth W. Haemer, a topranking authority in the field, and this material shows the importance of the use of charts and graphs in the writing of business reports.

OPERATIONAL MATHEMATICS

By Ruel V. Churchill
McGraw–Hill $7.00

Operational Mathematics is a textbook on the theory and applications of Laplace transforms, Fourier transforms, and other integral transforms, and on the theory and applications of orthogonal functions. Applications to problems in partial differential equations arising in engineering physics, and other mathematical sciences are emphasized. At the same time, considerable attention is also given to problems in electrical circuits and vibrating mechanical systems, involving systems of ordinary differential equations.

Here is a sound mathematical treatment designed to give advanced students of science and mathematics not only a working knowledge of operational mathematics, but also a clear understanding of how, when and why integral transformations can be used. The mathematical background required is approximately the level of advanced calculus.

Photography

(Continued from page 49)

the problem could be great. Also, with very small areas, below one square inch, it may be difficult to direct enough light to the right place.

There are so many applications of high speed photography, both in science and in industry, that it would be impractical to discuss all of them. Therefore, only a few of these methods will be mentioned.

Gas flow has been studied by various means through the use of smoke, dust, etc., carried in the gas. Many records have been made of air flow around aerofoils and other bodies in wind tunnels. This is done for the purpose of seeing what the flow patterns are around them to determine streamlines. Similar thought has been given to the flow of liquid in various containers and through various types of aperatures.

The application of high speed photography to problems connected with the railways, aircraft, cars, and other vehicles has been extensive. In railroads, such things as the passing of the train wheels over rail joints has been thoroughly studied. This was done mainly to determine how much vibration it causes in the train. In aircraft work many problems have been investigated including performance of landing gear and wheels during landing.

One application of high speed photography which must not be neglected is the use of films for training purposes. Training methods with the use of visual aids, of one sort or another, is now wide spread. There are many machine operations and fundamental points of engineering practice which can only be adequately demonstrated by means of high speed photography. There is no doubt that the average operator could learn much more from seeing a slow motion film of a machine or operation than from considerable verbal explanation. Also, there are many well known phenomena which cannot be illustrated any other way. For example the movement of the tongue in speech or the opening and closing of the eye pupil when room lights are switched on and off.

THE END

Time Study

(Continued from page 30)

corded elemental performance time be adjusted upward or downward to determine normal performance time.

In order to determine the performance rating factor, the time study analyst must first have a very clear concept of a worker who has normal skill and ability and who is working at a normal pace. Such a worker is assigned a factor of 100 percent. A below normal performance may be rated as 85, 90, 95 percent. An above normal performance may be rated as 105, 110, 115 percent.

This numerical comparison of the observed work performance (worker's skill, ability, and speed) to a normal work performance (time study man's concept of a normal worker's skill, ability, and speed) is a highly controversial subject. Here, too much depends on a person's judgment, which can vary greatly from individual to individual. However, with adequate training and experience, this personal judgment can be limited to a very short range.

The Job Allowance Factor. To take care of the many interruptions, delays, and slowdowns which are encountered in every work assignment, a job allowance factor is applied. In general, allowances cover three broad areas:

1. Personal delays.
2. Fatigue.
3. Unavoidable delays.

As stated earlier, an "Allowed Job Time" should not only represent a normal performance but it should represent a normal performance under normal conditions. Hence, the application of job allowances is necessary. By means of this adjustment factor, the normal performance time may be properly adjusted in recognition of the existence of non-productive time. This factor is also based on the analyst's judgment, but it does not come under the same severe criticism as the performance rating factor.

The application of these two important factors can be summarized as follows:

Observed or Average Time $\times$ Performance Rating Factor $=$ Normal or Levelled Time

Normal or Levelled Time $\times$ Allowance Factor $=$ Standard or Allowed Job Time

Computation of Job Standard

Once the analyst has properly recorded all necessary information on the time study form, has observed an adequate number of cycles, and has properly performance rated the operator, he should then proceed to compute the study. The following procedure in chronological sequence is observed in the computation of a typical study with continuous watch readings:

1. Make subtractions of consecutive readings to obtain elapsed times.
2. Circle and discard all abnormal or wild values.
3. Summarize remaining elemental values.
4. Determine mean of the observed values of each element.
5. Determine elemental normal time by multiplying the mean elapsed time by the performance rating factor.
6. Add the appropriate allowance to the elemental normal values to obtain the elemental allowed times.
7. Summarize the elemental allowed times on the reverse side of the time study form to obtain the standard time.

The above seven steps are self-explanatory, however, it should be mentioned that the time study should be computed with great care and preferably by the time study man himself. An error in computation can ruin the whole study.

The main difficulties in time study computations are:

1. Elements missed by the observer. A missed element as well as the succeeding one are both disregarded.
2. Elements missed by the operator. These elements are also disregarded, since they

have no effect on the preceeding or succeeding values.

3. Out-of-order elements. These elements are included in the study.
4. Foreign elements. It is necessary to deduct the time required for the foreign element from the cycle time.

During the process of taking a time study, any of these irregularities can be encountered. Only an experienced time study man can cope with these difficulties and still record reliable data.

THE END

Cupola

(Continued from page 20)

inside. The refractory that would be used for this maintenance is replaced by carbon block which lasts for at least the length of time required to melt 100 thousand tons of iron. The ratio of iron to coke is raised from 8 to 1 to at least 10 to 1 for most purposes and higher for others. This provides a saving of 20 per cent or more on the cost of coke. This system has replaced the need for two cupolas in almost all of the foundries where it is now used. The cost of having one cupola lying idle for repairs at all times is eliminated. Water is necessary to granulate slag for any cupola, providing the slag is used for road ballast. The water from the cooling system discharge can be used for this, so very little expense is incurred for cooling system water. Very few expensive fluxes are needed because the metal properties can be controlled very close.

At the present time there are only ten cupolas in use in North America that combine hot blast and water cooling system. These are all being used very successfully.

The successful use of the combination of the common cupola with hot blast and water cooling systems helps prove that it is the ideal cupola.

THE END

Science Highlights

(Continued from page 45)

LIGHT OPTIC GLASSES

Special light-weight optical glasses with high refractive indices and high dispersions have been developed by the National Bureau of Standards for the Navy Bureau of Ordnance. Because of their optical properties, these glasses may be used as elements of compound lenses, particularly in applications such as aerial photography and periscopes where a wide field of view with minimum distortion is essential. In such systems, elements of these glasses would be advantageous for eliminating astigmatism, coma, and chromatic and spherical aberrations. The low densities of the glasses make them especially suitable for use in aircraft where weight is of prime importance.

Usually, optical glasses with high refractive indices and high dispersions contain lead oxide as the principal constituent. However, since increasing the lead content of such glasses increases the refractive index, it also places a limiting value on the corresponding dispersion. As glasses are needed in which both the refractive indices and dispersions can be increased beyond the present limits, work aimed in this direction was undertaken in connection with basic research in the properties of glass-forming systems.

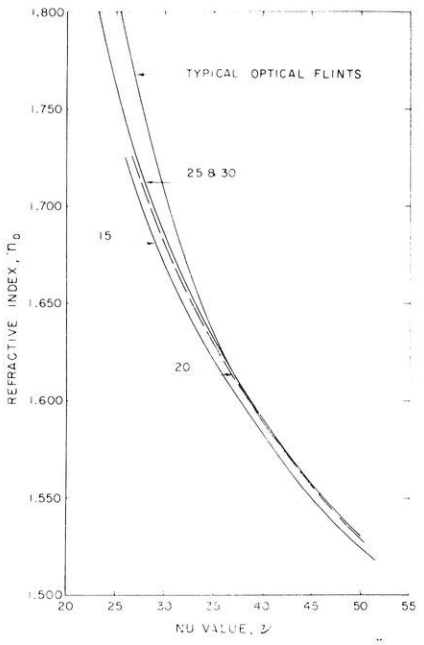


Fig. 1.—A comparison of the 2-value and refractive indices of sodium titanium silicate and flint glasses. Curves of 2-value vs refractive index are given for titanium glasses containing 15, 20, 25 and 30 mole percent of Na_2O, and for a typical lead-containing glass. Above an index of 1.600, the 2-values for all titanium glasses are lower, (dispersions higher) than for the typical flint glass. The higher-dispersion glasses were developed by the National Bureau of Standards for special optical uses.

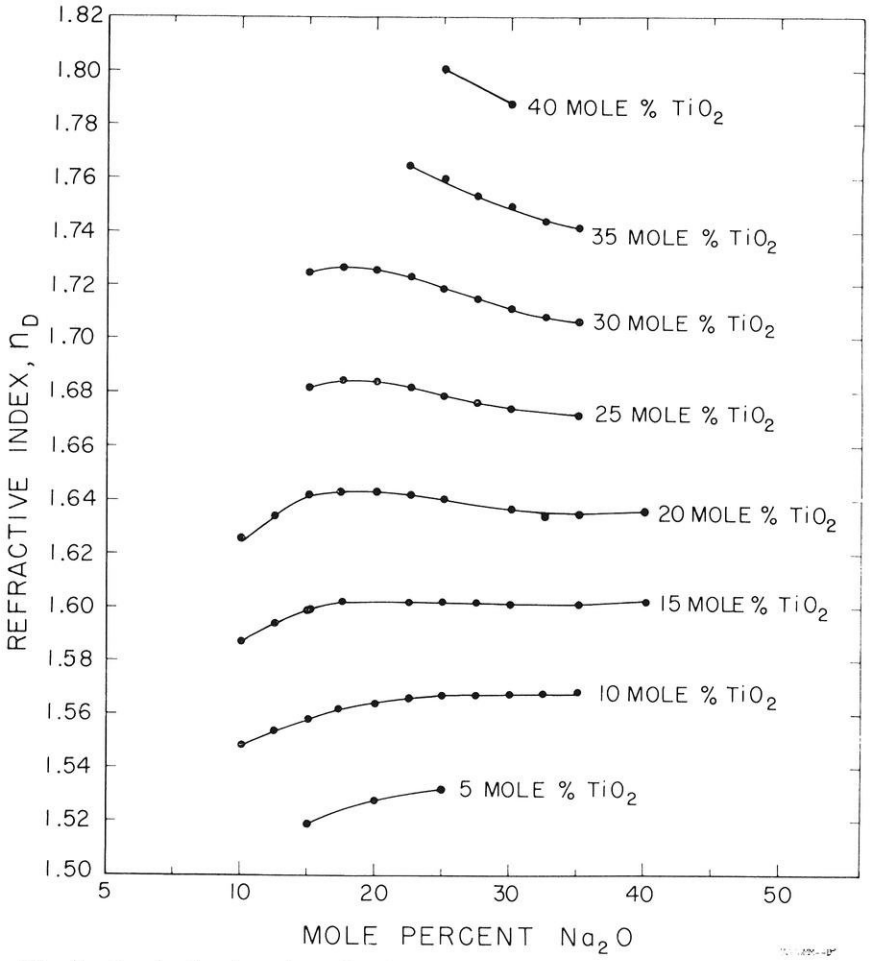


Fig. 2.—Graph showing the refractive indices of various sodium titanium silicate compositions developed by the National Bureau of Standards for use in optical instruments.

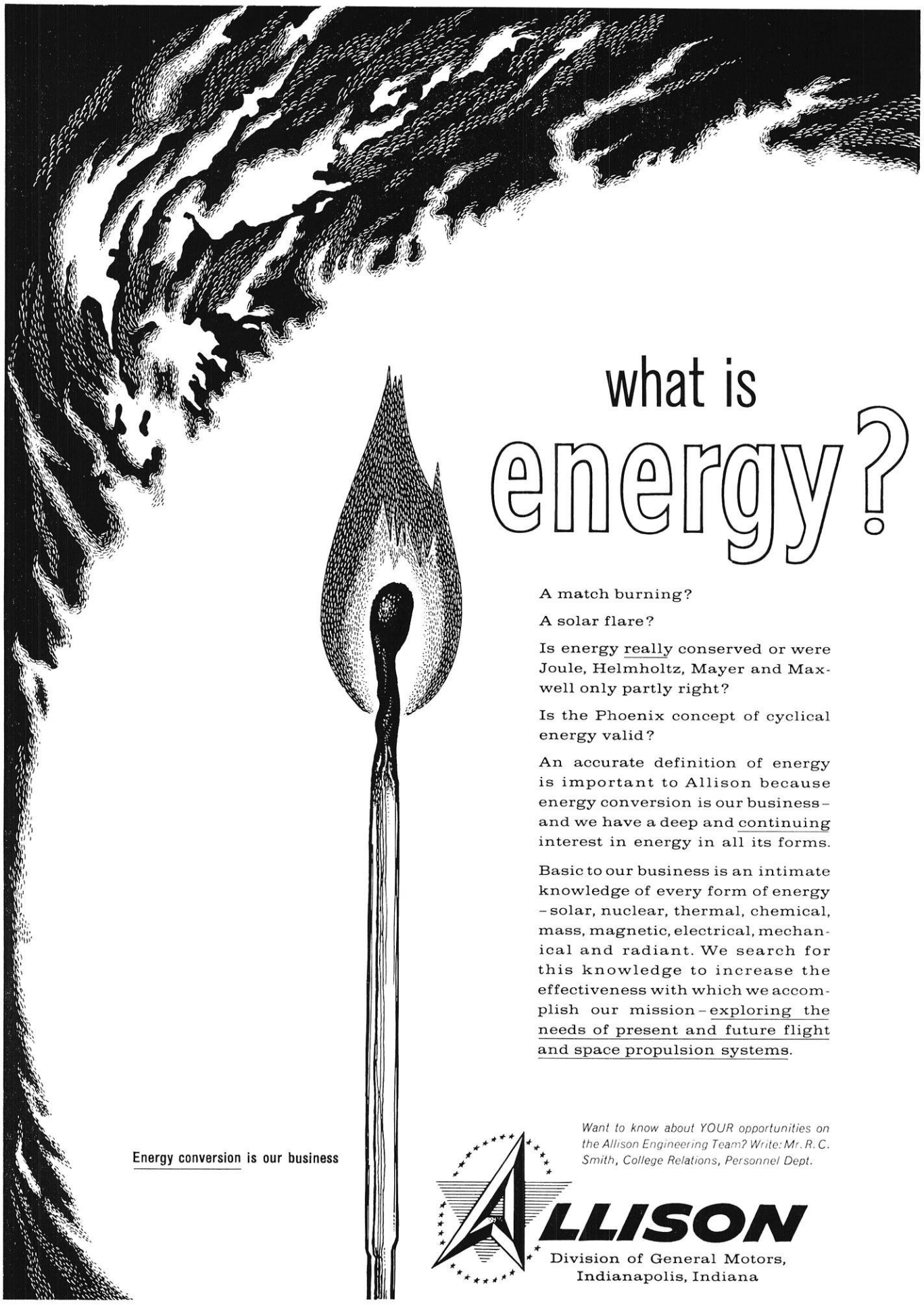
For example, the titanium glass with a refractive index of 1.7184 had a ν-value of 27.6, while extra-dense flint glass with an index of 1.7200 had a ν-value of 29.3. The lower ν-value of the glass under investigation is indicative of its greater dispersion. This dispersion would be even higher if the refractive index of the investigated composition were increased to equal that of the flint glass. The increase in refractive index is effected by raising the ratio of TiO_2 to SiO_2, or TiO_2 to Na_2O.

As a starting point for the study, use was made of the fact that glasses containing appreciable quantities of titanium oxide have high-refractive indices and dispersions. The sodium titanium silicate system was investigated in detail by E. H. Hamilton and G. W. Cleek of the Bureau's glass laboratories, and found to produce glasses with the desired optical characteristics.

Glasses were made which contained from 10 to 45 mole percent Na_2O, 0 to 40 percent TiO_2, and 30 to 85 percent SiO_2. For such compositions, refractive indices range 1.5184 to 1.8005, and ν-values—inverse functions of dispersion—from 51.5 to 23.2. The refractive indices are comparable to those exhibited by lead-containing, or flint glasses; and, as desired, the dispersions are higher than for flint glasses at corresponding high indices.

Composition has an effect on physical as well as optical properties. All glasses containing 5 mole percent of TiO_2 and some containing 10 and 15 percent of this substance were practically colorless, while all other compositions were either amber or yellow. The darker

(Continued on page 65)



what is energy?

A match burning?

A solar flare?

Is energy really conserved or were Joule, Helmholtz, Mayer and Maxwell only partly right?

Is the Phoenix concept of cyclical energy valid?

An accurate definition of energy is important to Allison because energy conversion is our business – and we have a deep and continuing interest in energy in all its forms.

Basic to our business is an intimate knowledge of every form of energy – solar, nuclear, thermal, chemical, mass, magnetic, electrical, mechanical and radiant. We search for this knowledge to increase the effectiveness with which we accomplish our mission – exploring the needs of present and future flight and space propulsion systems.

Energy conversion is our business

Want to know about YOUR opportunities on the Allison Engineering Team? Write: Mr. R. C. Smith, College Relations, Personnel Dept.

ALLISON
Division of General Motors,
Indianapolis, Indiana

Wisconsin Society of Professional Engineers

by Darell Meyer ee'61

STUDENT CHAPTERS GO NATIONAL

A program of active aid in the formation of NSPE Student Chapters is gaining impetus throughout the nation. The October 1958 issue of the American Engineer carries an article on the activities of the present NSPE Committee on Student Chapters, written by the Committee chairman, Professor J. Neils Thompson. That article indicates that the State of Ohio leads in number of NSPE affiliated student chapters. With this fact in mind we are reprinting here a portion of a recent article in the October 1958 issue of the Ohio Engineer by Kenneth W. Cosens, P.E., Chairman of the Ohio Society of Professional Engineers Student Chapters Committee entitled "Student Chapters Go NATIONAL".

During the last year great strides have been made by NSPE to provide more support for student chapters and their members. It has been recognized that great benefits come to a profession when its members have been introduced to its many professional problems at the time of formal education. In engineering there have been student chapters of many of the technical societies for a long time, but this has not been true, generally, of the professional society.

Ohio has been the leader in the organization of student chapters. The first student chapter charter in the country was issued to the Ohio University Student Chapter in 1947. Since then seven other student chapters have been organized and chartered in Ohio. A recent survey shows that there are only 19 student chapters in the United States, representing a combined membership of approximately 1550, in eleven different states.

We can be proud of the untiring efforts of our executive secretary, Lloyd A. Chacey, and the other OSPE members and committees who have contributed so much to the formation of the student chapters here in Ohio. Now NSPE recognizes the soundness of this program and has come forth with an aggressive program designed to strengthen the student chapter and its membership.

ENGINEERS' CREED

As a professional engineer, I dedicate my professional knowledge and skill to the advancement and betterment of human welfare.

I PLEDGE

To give the utmost of performance, to participate in none but honest enterprise, to live and work according to the laws of and the highest standards of professional conduct. To place service before profit, the honor and standing of the profession before personal advantage, and the public welfare above all other considerations. In humility and with need for Divine Guidance, I make this pledge.

The program of the present NSPE Committee on Student Chapters, headed by Professor J. Neils Thompson, of the University of Texas, was approved in principle at the NSPE national meeting this summer in St. Louis. Certain parts were to be put into effect as soon as possible while others had to wait for the development of manuals, etc.

The present program from NSPE provides assistance for the existing student chapters that are affiliated with OSPE. There are five phases to the entire program as the national committee visualizes it. These phases are as follows: (1) the need for professional development of the student engineer; (2) promotion of professional development of the student engineer through NSPE student chapters; (3) the operation of student chapters; (4) services to student chapter members; and (5) future program.

When university classes convened this fall there was available a kit of promotional material for engineering students prepared by NSPE. In addition, there are publications from OSPE and NSPE which will be helpful to each student chapter as it prepares to affiliate with NSPE.

The literature includes the following:

1. Ethics for Engineers (NSPE)
2. The Key to a Greater Profession (OSPE)
3. What Does It Mean to You? (OSPE)
4. Full Membership — Engineering Student (OSPE)
5. The Ohio Look at Professionalism for Engineers (OSPE)
6. From Engineering Student to Professional Engineer (OSPE)
7. Next Step Registration (NSPE)
8. Petition to Participate in the NSPE Student Chapter Program (NSPE)
9. The Promotion of Professional Development of the Student Engineer (NSPE)
10. Student Chapter Manual (OSPE)

The NSPE kit contained (1) September issue of the *American Engineer*, (2) student chapter membership pin, (3) "The Engineers' Creed," and (4) a student membership card.

ARMCO-NSPE—CIVIL ENGINEERING SCHOLARSHIPS

The National Society of Professional Engineers has a special opportunity for assisting a number of worthy high school seniors interested in civil engineering to attend four years of college.

A number of scholarships have been provided for students in civil engineering by the Armco Foundation, Inc., at the request of Armco Drainage and Metal Products, Inc. They have asked NSPE to administer the scholarship plan. Representatives from NSPE and Armco worked out the procedures and the National Society is requesting the assistance and cooperation of the

(Continued on page 62)

Meet the President

Alva F. Ahearn

Alva F. Ahearn, President of the Southwest Chapter was born on August 2, 1900 at Menominee, Michigan.

Attended the University of Michigan and received the degree of Bachelor of Science in Civil Engineering in 1925. Employed by State Highway Commission of Wisconsin from 1926 to 1947, excepting World War II service from 1942 to 1946.

Became Superintendent of Building and Grounds of the University of Wisconsin in 1947 and is presently in that capacity.

Served two years as a Navy enlisted man in World War I and four years as an officer in the Navy Civil Engineer Corps during World War II. Now a member of Naval Reserve with rank of Commander.

Member of University Club, Technical Club, Military Order of World War II, Nakoma Golf Club and Madison Curling Club.

HUGHES MASTER FELLOWSHIPS

THE MASTER'S FELLOWSHIP PROGRAM offers direct exposure to a potential professional field combined with academic training leading to a Master's degree.

One hundred and thirty-five awards are open to applicants receiving their Bachelor's degree during the coming year in Aeronautical Engineering, Electrical Engineering, Industrial Engineering, Mechanical Engineering or Physics.

You will pursue a two-year schedule of laboratory work and graduate study. During the summer, you will have the opportunity to work under the guidance of experienced scientists and engineers. You may elect assignments based on your interest and technical experience in Radar Systems, Servomechanisms, Computers, Systems Analysis, Information Theory, Automatic Controls, Physical Analysis, Microwave Tubes, Pulse Circuitry, Semiconductor Physics, Photo Devices, Test Equipment Design, Miniaturization, Electro-mechanical Design, Gyros, Hydraulics, Subminiaturization, Mechanical Design, Instrumentation, Telemetering, Antennas and Wave Guides.

You may request your graduate school from the following seven institutions: University of Southern California, Stanford University, UCLA, University of Arizona, Purdue University, California Institute of Technology, and University of West Virginia.

Fifteen awards are open to applicants receiving their Bachelor's degree in Business Administration during the coming year. The work program will involve interesting assignments in the administrative areas of the company and graduate study will be at UCLA or University of Southern California.

Salary is commensurate with your ability and experience and all company benefits are extended to those participating in the program. Tuition, fees, books and thesis preparation and reproduction expenses are provided and travel expenses outside of the Southern California area are paid.

Upon attainment of Master's degree, Fellows may apply for the Hughes Staff Doctoral Fellowship Program.

Consult your College Placement Officer for interview information. Or, write to the Office of Advanced Studies at the address at right.

HOWARD HUGHES DOCTORAL FELLOWSHIPS

If you are interested in studies leading to a Doctor's degree or in post-doctoral research, you are invited to apply for one of the ten awards in the Howard Hughes Fellowship Program.

This unique program offers the doctoral candidate the optimum combination of high-level academic study at California Institute of Technology, and practical industrial experience in Hughes laboratories.

The Howard Hughes Doctoral Fellowship provides an annual award of approximately $7200, of which $1800 is for tuition, books, fees, thesis and research expenses. The remainder is the award of a cash stipend and salary earned by the Fellow.

You should plan to pursue research in the fields of Electronics Engineering, Microwave Physics, Mechanical Engineering, Electron Dynamics, Electronic Computing, Physical Electronics, Propulsion Engineering, Solid State Physics, Aerodynamics, Analytical Mechanics or Information Theory.

The Fellowships are open to students qualified for admission to graduate standing. A Master's Degree or equivalent graduate work must have been completed before beginning the Fellowship Program.

Application closing date: January 15, 1959

HOW TO APPLY: *For information concerning either of the Hughes programs described, write, specifying program of your interest, to: Office of Advanced Studies—P.G.O., Building 6, Hughes Aircraft Company, Culver City, California.*

The classified nature of Hughes work makes ability to obtain security clearance a requirement.

the West's leader in advanced electronics

HUGHES

Hughes Aircraft Company, Culver City, California

W.S.P.E.

(Continued from page 58)

state officers and the local chapters of NSPE to participate in the administration of this scholarship plan.

Scholarship Provisions

The Armco Foundation is providing five, $3,000, civil engineering scholarships during the school term beginning in the fall of 1959. The recipients may attend the accredited college or university of their choice. Each scholarship will provide $750.00 per year for four years, if preferred, $600.00 per year for five years. The Armco Foundation will make an additional grant of $100.00 per year to the institution chosen by the recipient for the period of the scholarship, in the case of a tax sponsored institution, or $500.00 per year for a privately endowed institution.

Applicant Qualifications

1. Actual need for substantial financial aid to attend college.
2. A high school record which, at the time of application, indicates that the student applying is qualified to handle college work.
3. Graduation from high school during the year of application for a scholarship.
4. A firm decision to enroll in, and continue the study of, civil engineering at an accredited college or university.

Continuation of the annual stipend will depend on the successful completion of the requirements for the preceding school year and the favorable recommendation of the college or university.

Scholarship Procedures

1. Each local chapter of NSPE is urged to publicize the availability of these scholarships to high schools in their area, and to solicit applications from candidates. The necessary publicity material will be sent from NSPE at the appropriate time. Each local chapter will select from these applications the one candidate whom they wish to recommend as best qualified. They will send the application of their selected candidate to the state society scholarship committee chairman. All required forms will be sent from NSPE.

2. Each state society scholarship committee will select from the applications received from the local chapters one candidate who appears best qualified for the scholarship.

3. The state winner will then be asked to take a series of phychological and aptitude tests. The test blanks will be sent to the state society scholarship committee chairman by the Armco Company. These tests will be supervised by local school authorities and will be returned to the Armco Company for scoring.

4. A National Selection Committee appointed by NSPE and Armco will make the final selection of the scholarship winners based on:

1. Financial need.
2. High school record.
3. NSPE chapter recommendations.
4. Rating in aptitude and psychological tests.

5. These winners will be selected on a regional basis as follows:

2 scholarships — New England, Eastern Seaboard, South and Southeast.

1 scholarship — Ohio, Kentucky, West Virginia, Illinois, Indiana, Michigan and Wisconsin.

1 scholarship — Montana, North and South Dakota, Minnesota, Iowa, Nebraska, Missouri, Kansas, Arkansas, Mississippi, Louisiana, Oklahoma and Texas.

1 scholarship — Rocky Mountain states, Pacific Northwest and West Coast.

In addition to selecting the five winners, the National Selection Committee will also choose five first alternates and five second alternates.

6. NSPE will make the official announcement to the winners and will handle appropriate publicity. Armco will handle all financial arrangements with the college selected by the winners.

NSPE Engineering Scholarship Committee
Dan H. Pletta, P.E.
R. A. Freese, P.E.
Leland S. Hobson, P.E.
Chairman

(Continued on page 64)

W.S.P.E.

(Continued from page 62)

NEW NSPE FILM

"Building for Professional Growth," a 16mm film covering the activities of the National Society of Professional Engineers, has been released by the 46,000-member engineering group. The 20-minute film will be "previewed" by the Board of Directors of the National Society at the organization's fall meeting in San Francisco, October 23–25.

Narrated by radio-TV network announcers, the film is centered around an explanation of the values and benefits of National Society membership to the individual, and to the engineering profession as a whole. Included in the film are such National Society projects as encouraging registration for professional engineers, legislative cooperation, income and salary surveys of engineers, public relations programs, and other professional activities.

To illustrate the three-level structure of the National Society, the film includes scenes from actual meetings at the chapter, state, and national levels.

The film was produced by Sid Alpert Productions in Washington, D. C. Inquiries concerning reservations for prints should be made to the National Society headquarters, 2029 K Street, N. W., Washington, D. C.

LACK OF UNITY FEELING AMONG ENGINEERS BEGIN IN COLLEGE

At the national convention of the American Society of Civil Engineers held at Portland, Oregon, last June, several sessions were held during which the subject for achieving professional unity was widely discussed. Of particular interest to engineering students and Society members is the following excerpt from a report of the convention as it appeared in the Engineering News Record of July 3, 1958:

Disunity Being Taught?

Another angle of the unity problem was introduced by F. G. Lindall, chairman of the division of engineering of California Institute of Technology and president, American Society for Engineering Education. He said, "The lack of a feeling of unity among engineers begins in college with the influence of professors who deliberately make certain branches of engineering seem different from others."

Professor Lindall urged that engineers and their societies not make the professor's job more difficult by accentuating imagined differences, and particularly by insisting that the many new subjects being stimulated by technological advances be assigned to some specific branch of engineering.

The business of a university is to teach principles. And these are largely common to all branches, he said.

Engineering education and the professor's problems in making it more effective also were discussed by two other speakers. Prof. Elbert Rice, University of Alaska, argued against the necessity of adding general cultural courses to the engineering curriculum. He cited surveys that show engineering students rate higher in cultural knowledge and appreciation than those who take liberal arts courses. Engineers, he said, should not have inferiority complexes about their cultural knowledge.

Prof. Jack McKee, California Institute of Technology, argued against self-pity by engineering professors, particularly about their pay. He contended that earnings of engineering professors, which usually include outside consulting fees, are reasonably high. He urged more opportunities for supplemental earnings, not competitive with private industry, so professors will have enough enthusiasm to attract capable students to careers as engineering teachers.

SOUTHWEST CHAPTER

The 1958–59 Kick-Off Meeting of the Southwest Chapter was held October 2, at the Cuba Club in Madison. William R. Raiford, Military Relations Representative of I. B. M. in the Madison area discussed the installation of a SAGE (Semi-Automatic Ground Environment) facility at Truax Field.

At the conclusion of his talk and the viewing of a film on SAGE, the various chapter committees met to start planning toward a successful year of activities.

Announced were the forthcoming meetings of November 6, featuring Professor Jim Villemonte on the subject of "Technical Aid to India" and December 3, featuring Captain Harry Alvis, Chief of Submarine Medicine, Pentagon, on the subject of "The first 50 years of Navy Space Ships".

APPLICATIONS FOR MEMBER AND AFFILIATE MEMBER—SEPTEMBER 27, 1958

Name and Position	Address	Reg. No.	Sponsor
MILWAUKEE			
John H. Schmidt, P.E. Senior Project Engineer A. C. Spark Plug	1901 E. Beverly Rd. Shorewood 11, Wis.	E-6579	Norbert Sem, P.E.
Herbert J. Zwarra, P.E. Transmission Engr. Wis. Telephone Co.	4791 N. Elkhart Ave. Milwaukee 11, Wis.	E-6596	W. C. Lallier, P.E.
Francis R. Manci Mechanical Engr. Lofte & Fredericksen	11833 W. Gilbert Ave. Milwaukee 13, Wis.	ET-1855	W. C. Dries, E.T.
Richard A. Pieri Service Engr. General Electric Co.	4855 W. Electric Ave. Milwaukee 1, Wis.	ET-1381	C. E. Matheis, P.E.
SOUTHWEST			
W. Perry Bentheimer, P.E. Design Engr.—Elec. Dept. Carl C. Crane, Inc.	2702 Monroe St. Madison 5, Wis.	E-6678	Carl C. Crane, P.E.
Joseph W. Spradling, P.E. Product Engineer Carnes Corporation	4316 Hillcrest Dr. Madison 5, Wis.	E-4797	Stanley Nestingen, P.E.
REINSTATEMENTS **FOX RIVER VALLEY**			
Emil A. Weber, P.E. President McMullen & Pitz Construction Co.	923 Commercial St. Manitowoc, Wis.	E-486	Charter Member
Total—Members 5 Affiliates 2			

THE END

Eng. of Yesteryear

(Continued from page 47)

All of the work must be within the limits of 50 links per mile in alignment and the same amount in measurement. A Deputy receives no remuneration for his work until it has been examined and accepted. This renders it necessary for the Commissioner of the General Land Office to send out men whose duty it is to inspect the work done by the Deputies.

It is the duty of an Inspector to examine at least fifteen percent of the Deputy's work, but the time spent on a particular contract depends largely upon the accuracy of the work. Where it is evident that the lines have been carefully run, part of them are simply measured; but at every post the bearing trees with their markings are noted.

NOTES ON ELECTRIC STREET RAILWAY TRACK

January 1897

In streets where no paving has been used or contemplated the common practice has been to spike the rails directly to the ties and fill the track with dirt or ballast even with the rail top; for this a rail of ordinary height has answered. But where paving has been used it has, until late years, been customary, in order that a rail of ordinary height—say four or five inches—might be used with paving blocks of 6 or 8 inches or of ordinary thickness to support the rail a sufficient height above the ties to bring its top even with the top surface of the paving blocks. One manner of supporting the rail very widely practiced was with cast or wrought iron chairs spiked to the ties. However this method was never satisfactory, as it placed the rail too far from its real support—the ties—the consequence being that most generally the rails, sooner or later, spread or tilted badly.

In certain instances care was taken to electrically weld the rails and chairs together. Another method was to lay the rails on 6″ x8″ or 5″x7″ stringers which were placed upon the ties and held against being spread by spiking cast angle braces against both sides on each tie. This added some stiffness to the track vertically and the spacing between the ties was on this amount increased to 3 feet in many instances. As it was difficult to properly tamp the ties directly under the stringers and also because fewer ties were used, track in most cases did not hold up as well as where stringers were not used. In spite of the stringers being braced, the rails were spread upon them, inasmuch as the stringers were frequently split by the driving of the spikes. Then as soon as the stringers began to decay the rails would be disturbed. The result of this experience has been that both chair supports and stringer supports for the rail have been abandoned in recent work and the older, simpler, and surer method of spiking the rails directly to the ties has been taken up again as the only substantial and satisfactory one.

In order to simplify the construction of track in paving, rails are now made deep enough to reach the ties without supports. The sections are made comparatively narrow at the base (usually about 5 inches) and with a web, in proportion to the height. The gauge is maintained by means of tie rods placed between the rails at intervals. **THE END**

Science Highlights

(Continued from page 56)

glasses are of course not suitable for use in optical instruments, except possibly as filters. However, increasing the ratio of Na_2O to SiO_2 reduces the amount of color, making the sodium titanium silicate glasses compare favorably with lead-containing glasses in this respect also.

The density of the titanium glasses is significantly lower than that of lead glasses with comparable properties. Specific gravities of the recently-developed glasses range from 2.12 to 3.00, compared with 3.0 to 5.0 for the lead oxide glasses.

Before these glasses are actually employed as lenses, filters, or windows, certain modifications in composition will be necessary. For example, constituents must be introduced to compensate for devitrification in some glasses or for hygroscopicity in others. With these relatively simple additions, the sodium titanium silicate system can be employed to manufacture glasses with refractive indices and dispersions previously unattainable. **THE END**

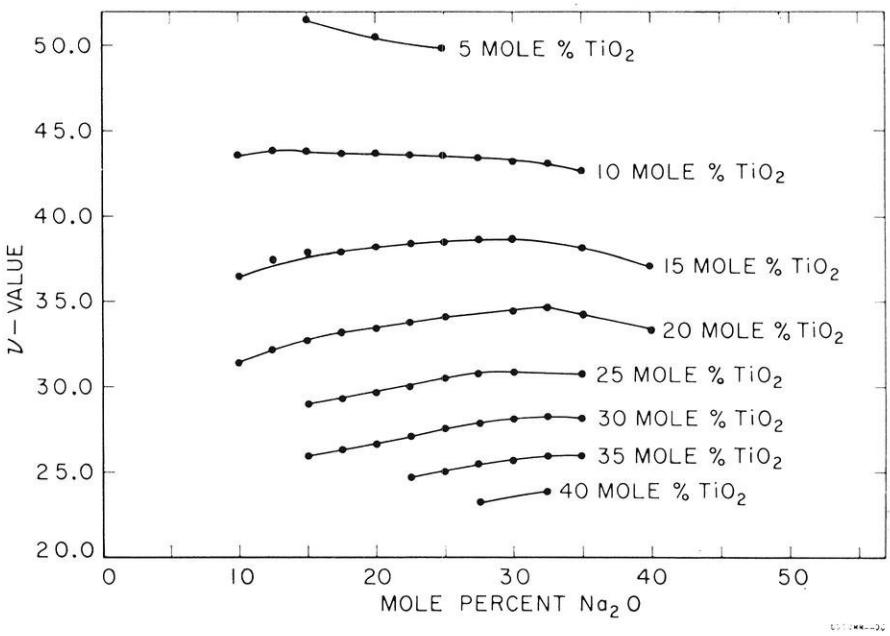
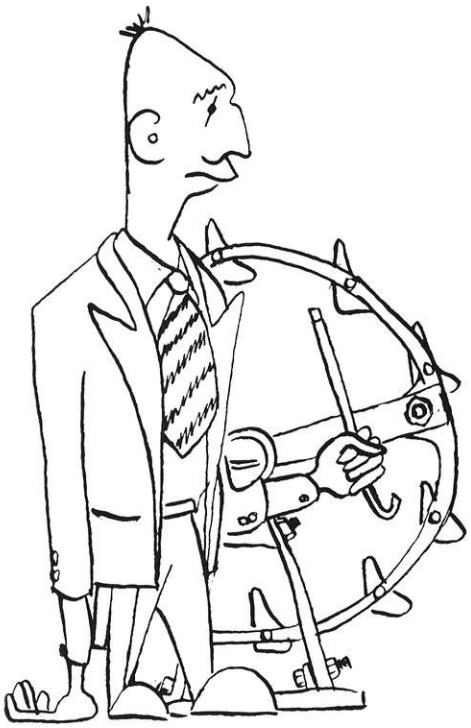


Fig. 4.—Graph showing 2-values of various sodium titanium silicate compositions developed by the National Bureau of Standards for use in optical instruments.



THE FERROUS WHEEL

by Joe Coel

"I'm going to have a little one,
Said the girl friend, gay and frisky;
But the boy friend up and fainted
Not knowing she meant whiskey!

* * *

"Shay, lady, you're the homeliest woman I ever saw."

"Well, you're the drunkest man I ever saw."

"I know, lady, but I'll get over it in the morning."

* * *

Ch. E. "What is the most beautiful thing in the world?"

C. E. "I say a beautiful woman is the most beautiful thing in the world."

E. E. "I claim that sleep is the most beautiful thing in the world."

M. E. "Yes, next to a beautiful woman, sleep is."

* * *

A young lady with a touch of hay fever took with her two handkerchiefs to a dinner party. She stuck one of them in her bosom. At dinner she began rummaging to the right and the left in her bosom, searching for the fresh handkerchief. Engrossed in her search, she suddenly realized that the conversation had ceased and people were watching her, fascinated.

In confusion, she murmured, "I know I had two when I came in!"

* * *

I serve one purpose in this school
On which no man can frown
I quietly sit in every class
And keep the average down.

The M. E.'s wife found her husband in a bar, sampled the highball he was drinking, and demanded, "How can you drink such horrible stuff?"

"See," said the husband, "and all the while you thought I was out having a good time!"

* * *

A South American man was describing his country to an American woman:

"Our most popular sport is bullfighting," he told her.

"Isn't it revolting?" she asked.

"No," he replied, "That's the second most popular sport."

* * *

Kid Brother: "Give me a nickel or I'll tell Dad that you held hands with my sister."

E. E. "Here you are."

K. B.: "Give me a quarter or I'll tell him that you kissed her."

E. E.: "Here, pest."

K. B.: "Now give me five dollars!"

* * *

The height of bad luck—seasickness and lockjaw.

* * *

First Englishman: "Sorry to hear you buried your wife, old man."

Second Englishman: "Had to, dead you know."

* * *

Susie married an official of the Three-In-One Oil Company. In about two years she gave birth to a pair of triplets. Upon hearing this, her sister immediately cancelled her engagement. Her fiance was an official of the Phillips 66 Company.

A Long Island Potato married an Idaho Potato and eventually the two became the proud parents of a little Sweet Potato. Sweet Potato grew up and one day announced her engagement to Gabriel Heater.

"But you can't marry him," her shocked parents wailed, "He's only a commentator!"

* * *

Mike: "Well, Doctor, how is my lawyer friend today?"

Doctor: "He's lying at death's door."

Mike: "Is he now? Well, that's just like a lawyer. At death's door and still lying."

* * *

Willie fell down the elevator—
Wasn't found till six days later.
Then his mother sniffed, "Gee whiz!
What a spoiled child Willie is!"

* * *

Old-timer: "Tell me, my little man, do you have a fairy godfather?"

Junior: "No sir, but I have an uncle we're a little suspicious of."

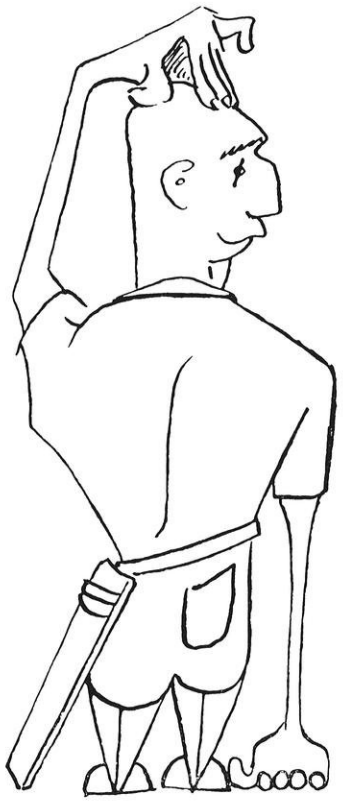
* * *

A tramp knocked on the door of an inn known as "George and the Dragon." When the landlady opened the door, the tramp asked, "Could you spare a poor hungry man a bite to eat?"

"No!" said the woman as she slammed the door.

The tramp knocked again. As the woman opened the door, he asked:

"Could I have a few words with George?"



So You Think You're SMART!

by Sneedly bs'60

SNEEDLY is back again to offer a hearty welcome to all you newcomers. To the loyal followers who are still reading his column he extends his condolences.

Due to the recession during the past summer Sneedly decided to go treasure hunting in our great Midwest. And by jove if he didn't strike it rich!

In order to escape the scheming tax collectors Sneedly has decided to share his treasure with those worthy of it. He will award $10.00 every month to the earliest postmarked correct solution to his thought twisters. So why don't you help him beat the tax! The problems aren't really hard at all. A "hill" student told me that he could solve them between halves of the Minnesota–Wisconsin football game. So come on you engineers. Show them that you can do it better and faster.

Even though the solutions sent in will not be entered in any art competitions Sneedly would appreciate legible and orderly entries.

As you solve these problems remember the advice the professors always like to give: "If you get stuck on one problem go on to the next and come back to that one afterwards."

1. An Engineer walked into a store and made this proposition: "If you will give as much money as I have in my pocket, I will spend $10 in your store." His terms were immediately accepted and he received the equal of the money in his pocket, spent $10 and departed.

He entered two more stores stated his proposition was accepted each time spent $10 each time and departed. He left the last store broke, without a cent of cash in his pocket. Now, how much money did he have in his pocket when he entered the first store?

* * *

2. If I am twice the age that you were when I was your age, and when you get to be my age our ages total 63 years. How old are we?

* * *

3. I counted the lines of a page of my EE report. Counting by threes, I found a remainder of two, by fives a remainder of two and by sevens a remainder of five.

How many lines are there on the page?

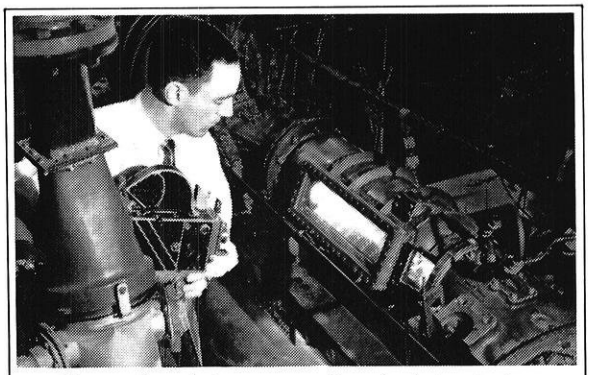
Sneedly would also appreciate it very much if he would receive some thought twisters from his readers.

Send your solutions, comments and criticisms to:

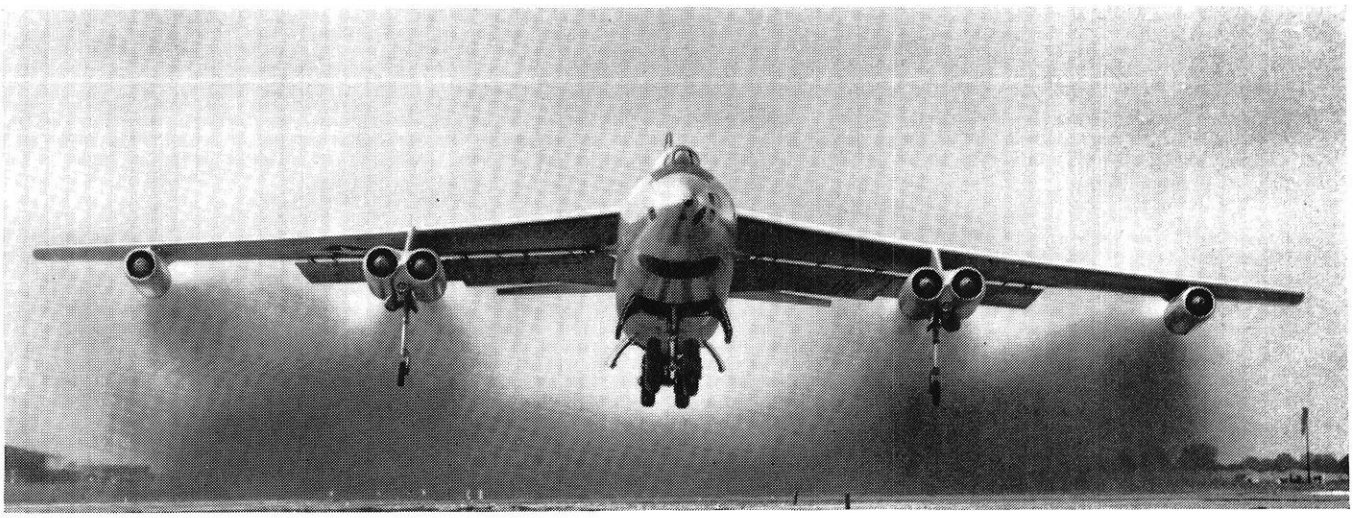
SNEEDLY
c/o The Wisconsin Engineer
Mechanical Engineering Bldg.
Madison, Wisconsin.

PHOTOGRAPHY AT WORK—No. 35 in a Kodak Series

For Jets
more thrust, more range, more payload



The motion picture camera is seeing into a turbo-jet combustion chamber operating on a new fuel.



With photography as a tool, the N.A.C.A. Lewis Flight Propulsion Laboratory studies jet engine combustion chambers, and compounds that can result in new high-energy jet fuels

How much faster and farther our aircraft and missiles can go seems now to depend on developing new high-energy fuels. This is a job of the Lewis Laboratory of the National Advisory Committee for Aeronautics.

And as in all kinds of industry, photography is playing an important role in this work. Motion pictures are taken of the interior of jet engine chambers through transparent walls. From the pictures the scientist learns the behavior of the fuel, the flame and exhaust through the engine turbine and tail pipe.

The use of photography in research and the development of new or better products is but one of the ways it is helping all kinds of businesses, large and small alike.

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.

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TRADE MARK

EASTMAN KODAK COMPANY, Rochester 4, N.Y.

One of a series

Interview with General Electric's Frank T. Lewis Mgr., Manufacturing Personnel Development

The Next Four Years: Your Most Important

The United States is now doubling its use of electrical energy every eight years. In order to maintain its position as the leading manufacturer in this fast-growing electrical industry, General Electric is vitally interested in the development of young engineers. Here, Mr. Lewis answers some questions concerning your personal development.

Q. Mr. Lewis, do you think, on entering industry, it's best to specialize immediately, or get broad experience first?

A. Let me give you somewhat of a double-barreled answer. We at General Electric think it's best to get broad experience in a specialized field. By that, I mean our training programs allow you to select the special kind of work which meets your interests—manufacturing, engineering, or technical marketing—and then rotate assignments to give you broad experience within that area.

Q. Are training assignments of a predetermined length and type or does the individual have some influence in determining them?

A. Training programs, by virtue of being programs, have outlined assignments but still provide real opportunities for self-development. We try our best to tailor assignments to the individual's desires and demonstrated abilities.

Q. Do you mean, then, that I could just stay on a job if I like it?

A. That's right. Our programs are both to train you and help you find your place. If you find it somewhere along the way, to your satisfaction and ours, fine.

Q. What types of study courses are included in the training programs and when are the courses taken?

A. Each of our programs has graduate-level courses conducted by experienced G-E engineers. These courses supplement your college training and tie it in with required industrial techniques. Some are taken on Company time, some on your own.

Q. What kind of help do you offer employees in getting graduate schooling?

A. G.E.'s two principal programs of graduate study aid are the Honors Program and the Tuition Refund Program. If accepted on the Honors Program you can obtain a master's degree, tuition free, in 18 months while earning up to 75% of full-time salary. The Tuition Refund Program offers you up to 100% refund of tuition and related fees when you complete graduate courses approved by your department manager. These courses are taken outside normal working hours and must be related to your field of work.

Q. What are the benefits of joining a company first, then going into military service if necessary.

A. We work it this way. If you are hired and are only with the Company a week before reporting to military service, you are considered to be performing continuous service while you are away and you will have your job when you return. In determining your starting salary again, due consideration is given experience you've gained and changes in salary structure made in your absence. In addition, you accrue pension and paid-vacation rights.

Q. Do you advise getting a professional engineer's license? What's it worth to me?

A. There are only a few cases where a license is required at G.E., but we certainly encourage all engineers to strive for one. At present, nearly a quarter of our engineers are licensed and the percentage is constantly increasing. What's it worth? A license gives you professional status and the recognition and prestige that go with it. You may find, in years to come, that a license will be required in more and more instances. Now, while your studies are fresh in your mind, is the best time to undertake the requirements.

Your next four years *are* most important. During that period you'll undoubtedly make your important career decisions, select and complete training programs to supplement your academic training, and pursue graduate schooling, if you choose. These are the years for personal development — for shaping yourself to the needs of the future. If you have questions still unanswered, write to me at Section 959-6, General Electric Co., Schenectady 5, N. Y.

LOOK FOR other interviews discussing: • Salary • Advancement in Large Companies • Qualities We Look for in Young Engineers.

GENERAL ELECTRIC