The Wisconsin engineer. Volume 64, Number 7 April 1960

Madison, Wisconsin: Wisconsin Engineering Journal Association, [s.d.]

https://digital.library.wisc.edu/1711.dl/7P3DBZ6M5SIJV8I

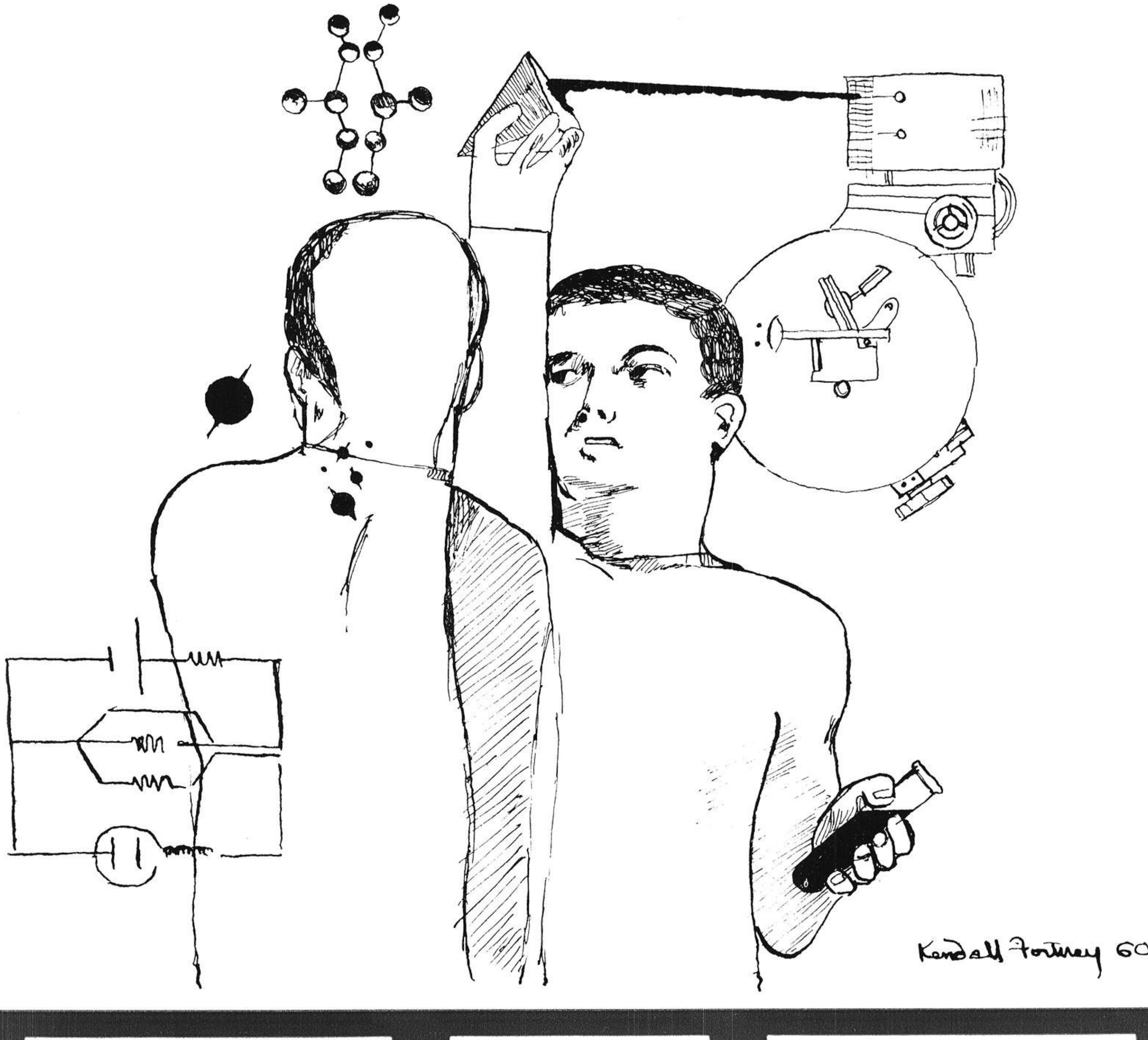
APRIL

1960

The Wisconsin

engineer

25¢

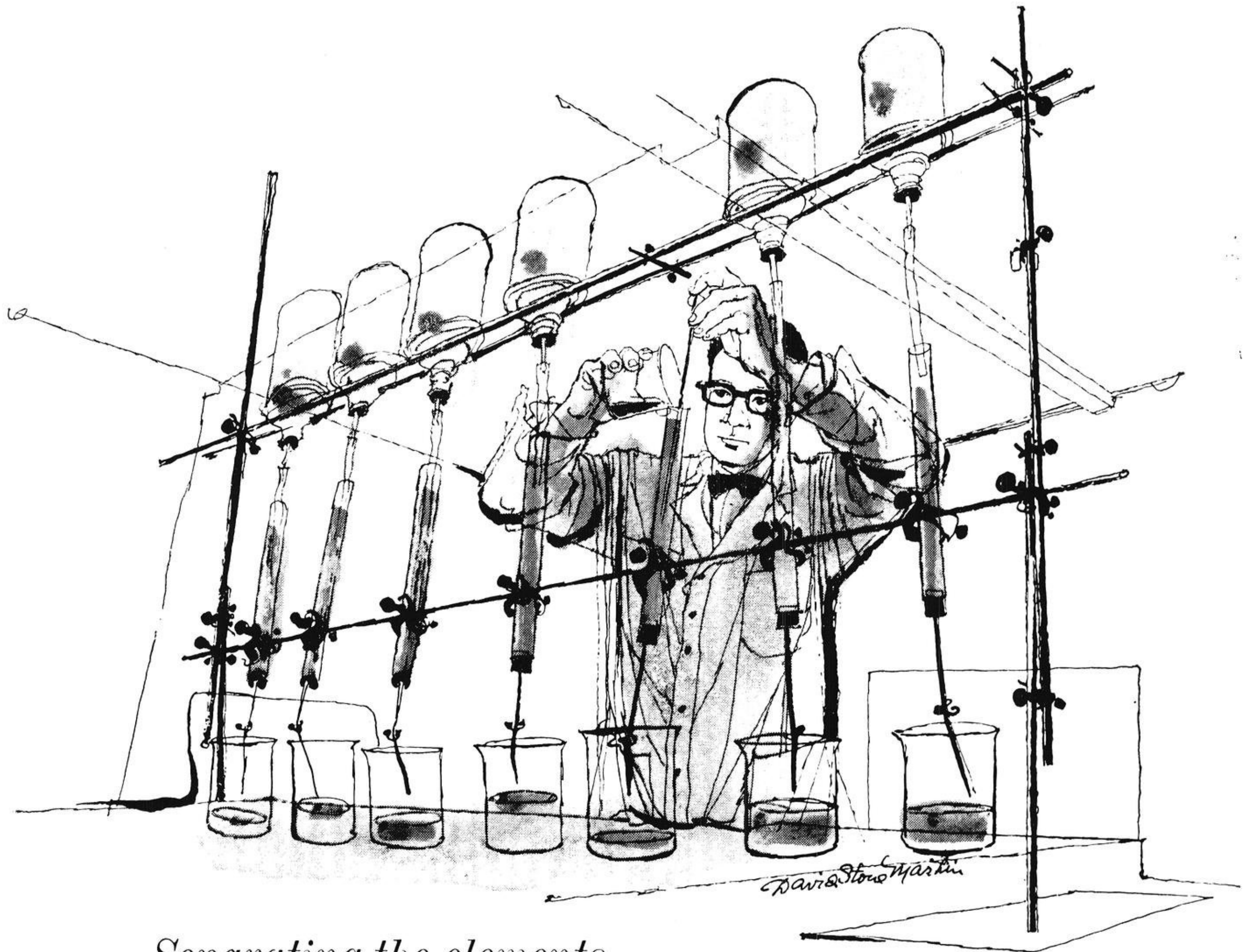


IN THIS ISSUE

Highway System

Nuclear Engineering

Special High School Section



EDITORIAL STAFF

Editor-in-Chief
Donald D. Roeber me'60

Associate Editor
Karl Lonngren ee'60

Art Editors
Richard Jones ee'61
David W. Sharp met'61

Layout Editor
Darell Meyer ee'61

Copy Editor
Thomas A. Roth met'60

Article Editor
LeRoy Lutz ce'60

Photo Editor
Walter Ronn

Secretary
Lynne Anselman ee'62

Staff
Larry Cepek ce'61
Floyd Gelhaus ee'60
Bob Helm ce'61
Tom Sobota ee'60
Allan Dahl me'60
Wm. Huebner che'61
Don Norris ee'60
Todd Deutsch me'61
John Schubert che'61
Leo Schley met'61
Dick Hussa me'62
Judy Kinder che'63

BUSINESS STAFF

Business Manager
Sally Trieloff me'60

Advertising Manager
John P. Tralmer met'61

Circulation Manager
Robert Daugherty ee'61

Staff
Fritz Hasler me'63
Jeff Hoehne me'61
Bob Baltes ee'61
James Vierbicher ce'62
Barbara Friede che'63
Janice Jenks che'63

Board of Directors
George Sell, Chairman
J. L. Asmuth, Faculty Advisor
Howard B. Doke
Mechanical Drawing
David J. Mack
Mining & Metallurgy
R. N. White
Civil Engineering
W. K. Neill
Member at Large

Volume 64 APRIL, 1960 Number 7

WISCONSIN ENGINEER

The Student Engineer's Magazine

FOUNDED 1896

Features

Departments

Cover

The High School Senior, the College Senior, decisio ns face them both. For one it is the question of whether to enter engineering, and if so, what particular branch. For the other it is the question of whether to enter graduate school, the service, or whether to go into industry.

In this High School issue's cover by artist Kendall Fortney, many forms of engineering are presented, but the decision still must face the young person as he enters into his chosen profession.

MEMBER OF

ENGINEERING COLLEGE MAGAZINES ASSOCIATED

Chairman:
Stanley K. Stynes
Wayne State University
Detroit, Michigan

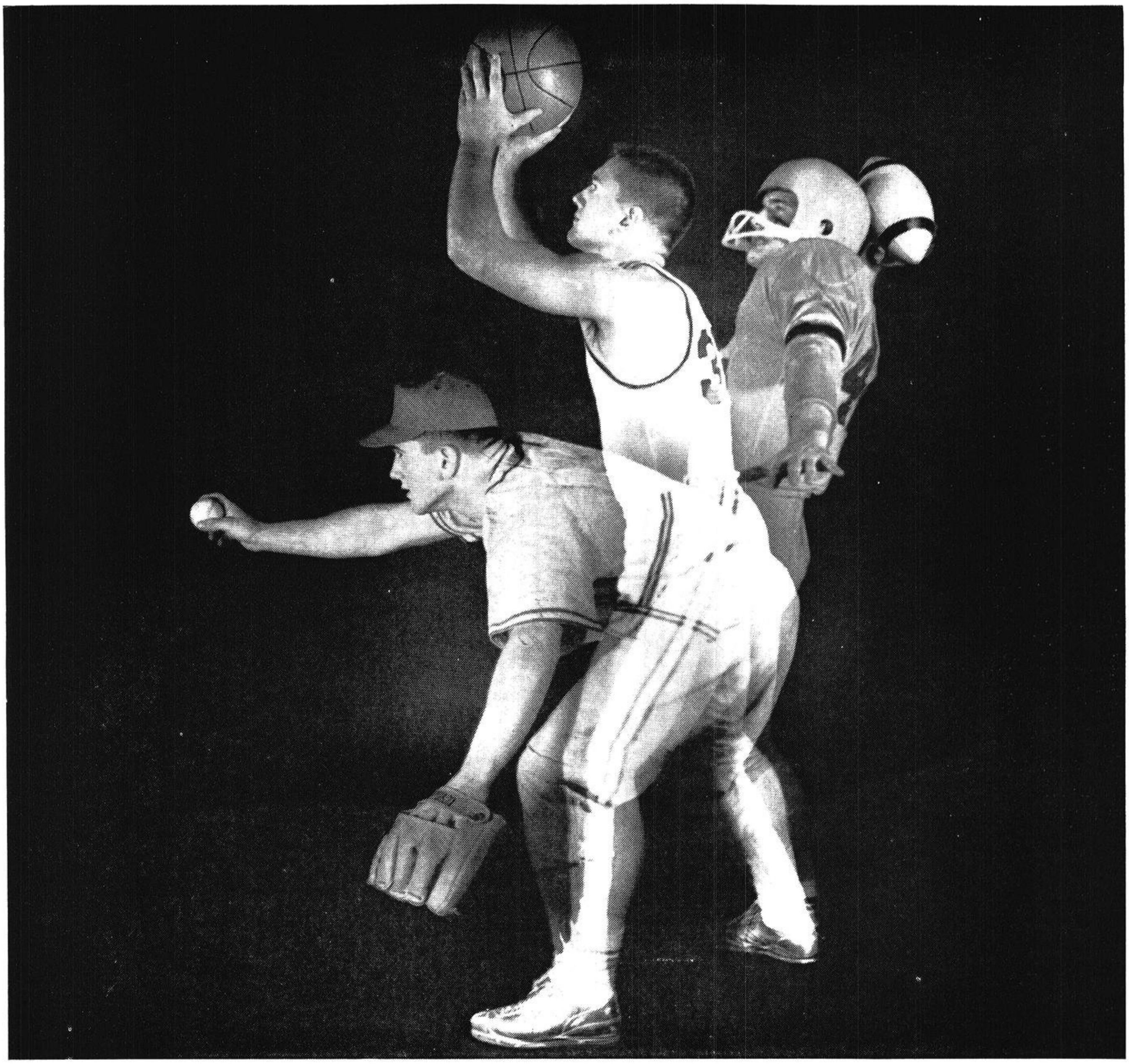
Publishers' Representative:
Littell–Murray–Barnhill, Inc.
369 Lexington Avenue
New York 17, New York

Second Class Postage Paid at Madison, Wisconsin, under the Act of March 3, 1879. Acceptance for mailing at a special rate of postage provided for in Section 1103, Act of Oct. 3, 1917, authorized Oct. 21, 1918.

Published monthly from October to May inclusive by the Wisconsin Engineering Journal Association, 333 Mechanical Engineering Building, Madison 6, Wisconsin

Subscription Price

$4.00 FOR FOUR YEARS • $1.25 PER YEAR • SINGLE COPY 25¢



Why diversification makes a better all-around man

DIVERSIFICATION of effort makes for versatility—and versatility pays off in business as well as on the athletic field. We've found that to be especially true here at Koppers.

Koppers is a widely diversified company—actively engaged in the research and production of a wide range of related and seemingly unrelated products, such as remarkable new plastics, jet-engine sound control, wood preservatives, steel mill processes, dyestuffs, electrostatic precipitators, coal tar chemicals, anti-oxidants and innumerable others.

Because we are diversified, our work is interesting. Through job rotation, our engineers and management personnel are given the opportunity to learn many of the diverse activities at Koppers. The result? Versatility.

While you are moving laterally at Koppers, you are also moving *up*. Your responsibilities are increased. Your ability is evaluated and re-evaluated. And you are compensated accordingly.

You don't have to be with Koppers for 20 years before you get somewhere. If you have ability, ideas, spark—you'll move ahead, regardless of seniority or tenure.

At Koppers, you'll stand on your own two feet. You'll get responsibility, but you'll also have free rein to do the job the way *you* think it should be done. No one will get in your way.

Koppers is a well-established company—a leader in many fields. Yet, it's a forward-looking company, a young man's company. Perhaps, *your* company.

Why not find out? Write to the Personnel Manager, Koppers Company, Inc., Room 230, Koppers Bldg., Pittsburgh 19, Pennsylvania. Or, see your College Placement Director and arrange an appointment with a Koppers representative for the next recruiting visit.

KOPPERS

KOPPERS

men on the move

take the right steps to launch their engineering career

CONVAIR-POMONA... in Southern California

offers NEW PROGRAMS with excellent opportunities today for Engineers. Convair-Pomona, created the Army's newest weapon, REDEYE, Shoulder Fired MISSILE and developed the Navy's ADVANCED TERRIER and TARTAR MISSILES and many other, still highly classified programs.

Positions are open for experienced and inexperienced Bachelors, Masters and Doctorates in the fields of Electronics, Aeronautics, Mechanics and Physics.

ADVANCEMENT opportunities are provided for the competent engineer as rapidly as his capabilities will permit in currently expanding programs.

PROFESSIONAL ENVIRONMENT—CONVAIR-POMONA'S facility is of modern design and completely air-conditioned. You will work with men who have pioneered the missile industry and are now engaged in some of the most advanced programs in existence.

ADVANCED EDUCATION—Tuition refund is provided for graduate work in the field of your specialty. Company sponsored in-plant training courses offer the Engineer the finest of educational opportunities.

CALIFORNIA LIVING—Suburban Pomona offers lower living costs and moderate priced property, unexcelled recreational facilities, freedom from rush hour traffic and the ultimate in comfort and gracious living.

Contact your placement office immediately to assure yourself of a campus interview with Convair-Pomona.

If personal interview is not possible send resume and grade transcript to B. L. Dixon, Engineering Personnel Administrator, Dept. CM-500, Pomona, California.

CONVAIR/POMONA
Convair Division of
GENERAL DYNAMICS CORPORATION
Pomona, California


BUCYRUS ERIE
Peabody Coal Co
Swan

Rambling WITH THE EDITOR

Attention High School Students

In this issue which is dedicated to high school students, I feel it appropriate to give a few comments as to the rewards and responsibilities of the engineering student. As high school students contemplating the engineering field you have undoubtedly heard of the unlimited opportunities offered to the engineering graduate. Yes, the rewards are high; the average starting salary for 1959 was approximately $525 per month. Although the engineering curriculum is not easy, this monetary reward, challenge offered by engineering, plus a respected position in our country's labor force lends us the incentive to become an engineer.

In choosing engineering you have a responsibility as in most professions, to your school, your parents, your country and yourself. Now is the time to start living up to this responsibility by doing a good job of preparation in your high school work. This means taking the courses needed for an engineering background in addition to prevailing upon yourself to do a good job in gaining the basic understanding needed for success in an engineering school. Four years of mathematics, some chemistry, physics, English, and other courses pertaining to science are prerequisites at Wisconsin and most engineering schools.

I want to emphasize, especially to the freshmen, sophomores and juniors in high school that their engineering education must start now. By planning ahead to take the mathematics and science courses needed you will be in an enviable position in that you can then gain admittance to engineering colleges or you can, of course, enter any other field and not have spent wasted effort since math and science backgrounds are recommended for nearly every field of study.

If you are contemplating engineering as a profession, I heartily recommend this choice. However you must remember that now is the time to start planning for a successful career in engineering.

DONALD D. ROEBER
Editor

The largest self-power mobile land vehicle in the world represents the work of all types of Engineering. The stresses are to be determined, the power to be supplied, and the material to be used; these are the problems that face the Engineer, not one but all Engineers. What does the Engineer know about the machine? Weight—14,000,000 pounds, Lifting capacity—115 cubic yards, Power requirements—equal to a city of 12,000. With these facts, the Engineer must design a power shovel, always keeping costs in mind. Thus the Engineer must be a master of many arts.

—Photo Courtesy Bucyrus-Erie Company

The National System of Interstate and Defense Highways

Their maintenance, construction and finance

by Gerald E. Paul ce'61

THE planned highways are being constructed to bring raw materials closer to manufacturers and manufactured products closer to markets.

Within the state the system will open new locations for business, residential, and manufacturing development in remote rural areas. In Boston, off Massachusetts Route 128, more than 40 new plants and buildings worth $100 million have gone up. A number of new industrial centers are now being laid out. Developments along the New York State Throughway tell an inspiring story of economic growth, improved opportunities and the meeting of traffic needs.

It is possible to show the success of interstate and defense highways on the basis of safety factors alone. The completion of Michigan's controlled highways will save a base minimum of one life annually for each ten miles of the system. In a very real sense, all other factors can be considered as an extra bonus.

Studies by the Bureau of Public Roads of 108,000 accidents on 2100 miles of highway reveal that traffic accidents were cut four-fold on these routes, as compared to conventional highways. On these interstate and defense highways, accidents averaged 171 per 100 million vehicle miles of travel. On the conventional highways, the rate was 408 per 100 million vehicle miles. The death rate on fully controlled interstate highways was 2.8 per 100 million vehicle miles and on conventional highways the rate was 9.6.

The traffic carried by the old routes for the period before the opening of the new interstate and defense highways was 14 percent less than the combined traffic carried by the same routes after the opening of the new interstate system, plus the traffic carried by the new interstate highways. In other words, 69,320,223 more vehicles were handled after the opening of the interstate and defense highway system in the same traffic corridors.

The summary of accident records before and after the opening of this improved highway system is very significant. The 150 miles of this new system studied enabled 14 percent more traffic to be served, and these interstate and defense highways reduced the number of fatal accidents by more than one-half. They reduced the fatality rate per 100 million vehicle miles by two-thirds, while the total number of accidents was reduced by more than one-fourth.

In 1946, automotive economists forecasted 36 million cars on the road by 1955. The fact is that 52 million cars were registered by 1952. This forecasting error of 16 million represents more cars than in all of Western Europe today.

The continued rapid-growth predictions are based on Michigan's prosperity because it is the main part of the largest consumer market on the North American continent. The 35 million people in Michigan, Wisconsin, Illinois, Indiana, and Ohio are among the world's most highly industrialized and possess the highest standard of living and income. Consequently, this section of the country is very dependent on automobile transportation.

The interstate and defense highways are being constructed to meet the needs of today and the challenge of tomorrow.

The system will shrink distances tremendously for local and out of state motorists, and will greatly increase economic growth for the state involved.

MAINTENANCE

All maintenance of the completed base or wearing course is aimed at accomplishing these basic objectives:

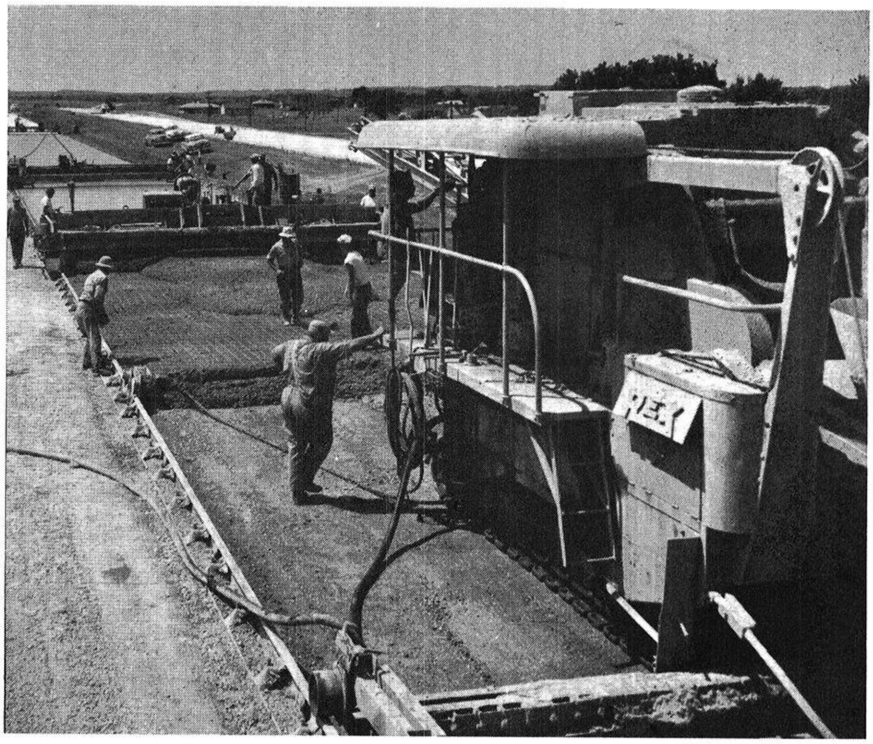
1. A firm and consolidated surface free of loose material.
2. Adequate crown to permit rapid run-off of surface water.
3. Application of a component, usually calcium chloride, to keep the road surface dust-free.

When the base is to remain an open surface under traffic for a period of time, calcium chloride is applied at a rate of one-half to one pound per square yard. This application is uniform over the entire surface and made immediately after completion of the base. The completed base is dampened just before applying the surface treatment. The proper use of calcium chloride on a road saves about 75 percent of the aggregate replacement and blading costs. In addition to this, it gives a dustfree, smooth riding surface.

Some roads need treatment oftener than others. Observation of the surface conditions determines the necessity for oiling a bituminous surface.

In treating a highway of this nature, one-half gallon of bituminous material and twenty-five pounds of coverstone per square yard are used. This generally suffices for at least a four year period.

The cost of material for a highway 20 feet wide amounts to $1010 per mile. To this must be added labor costs and the cost of hauling coverstone. Thus, the complete cost for a 20 foot wide highway averages $1500 per mile.



Above: Construction on the Wisconsin Interstate near Milwaukee.

Below: Completed portion of the same highway.

Maintenance of Concrete Surface

The main problem in concrete highways is that concrete cracks, and with time may cause pot holes. Cracks in reinforced concrete are controlled in the sense that they remain permanently closed. Cracks in plain concrete are entirely uncontrolled, being free to open as adjacent slabs contract.

This is one of the problems that is faced by the highway engineers of today. At the present time, it is costly to maintain these highways because they have to be given constant attention in the application of crack sealer. Cracks in reinforced concrete are less expensive to maintain because they do not separate as do the cracks in plain concrete.

Maintenance of Shoulders

One objective of shoulder maintenance is to keep it smooth and flush with the pavement edge. A second is to keep it free from rutting. This may require adding some sort of aggregate in soft spots to keep it level. A third requisite of maintenance is to keep the shoulder firm and dustfree.

Maintenance procedures include use of a maintainer which has been adapted for routine shoulder maintenance in a one pass operation. An underbody blade pulls material back up to the shoulder, a strikeoff blade moves it off the pavement, and a rubber-tired roller provides compaction. This procedure combined with the application of one to two pounds of calcium chloride per square yard in spring and fall results in economical shoulder maintenance.

Maintenance of the Roadside

The expansion of the interstate highway system has brought the need for re-examination of the problem of roadside planting. Because these highways will have as much as 30 acres of right-of-way per linear mile to maintain, built-in maintenance has a high priority.

Uses of new fertilizing techniques has eliminated the need for nursery grasses such as rye grass and red top. Kentucky blue grass and fine leaf combinations do not grow too tall, are attractive in appearance, and require a minimum of maintenance.

Grading and Drainage

Studies to determine the equipment most suited for a given grading job begin with the examination of the plans. The plans show quantities to be moved, length of haul, and a typical cross section.

Engineers are consulted about character of the soil and rock formations. These steps are taken into consideration by the contractor before bidding on a job. Under any system the speed and cost of work done will be affected by the judgment used in selecting equipment.

Line Grading

Management plans grading operations to resemble a production line as closely as possible. At the head of the line is the clearing crew. Their function is to clear all growth from the projected highway.

Following behind the clearing crew comes the pilot grading crew. Their work consists of opening a tractor road within the cleared area so that equipment may be placed at various working points. Often, a culvert crew follows close behind, installing those culverts that can be placed ahead of grading work. If rock is to be excavated by blasting, a drilling and blasting crew comes next. This crew will do all such work ahead of earth grading, except where rock excavation is of such magnitude that the drilling and blasting must be carried on simultaneously with excavation.

Rock Work

Drilling and blasting tools, with accessory tools for sharpening drill steel and maintaining portable air compressors, are capable of producing 100 cubic feet of air per minute for each drill. About one pound of blasting powder is used for each cubic yard of rock excavation. Power shovels are usually used for loading blasted rocks. Those having a dipper capacity of 1½ to 2½ cubic yards are usually used for this work. Hauling units are selected according to length of haul. If the distance is long, large dump trucks are convenient. A shovel will excavate between 50 and 100 cubic yards per hour per cubic yard capacity. Therefore, sufficient hauling equipment has to be available to keep it in continuous operation.

Soil-Cement Surface

Soil-cement surfaces are constructed where the surface soil is of a suitable character, as shown by laboratory tests, or may be made suitable by the addition of some granular material.

If the soil is suitable, it is cut to a depth of six inches and is sufficiently smoothed. If sand is to be added, the thickness of the sand and the depth of the cut is indicated by tests.

Following this the cement is distributed over the surface, a small section at a time. Machines are used to spread the concrete and to rough smooth it. The crew members have to keep the forms straight on grade, and they also smooth the concrete.

Bituminous Surface

The bituminous mixture is transported from the plant to the paving machine in trucks. The boxes are lubricated with light oils. Tarpaulins are generally used in cold or damp weather to cover the truck boxes. At the paving machine a maximum temperature drop of 20°–30° F from the plant temperature is sometimes specified.

In order to attain minimum plant operational costs the minimum plant temperature is employed consistent with adequate aggregate drying, proper mixing, spreading and compacting. During cold weather the plant temperature is raised to make up the loss of heat when transported.

Grade stakes are commonly used to ensure that the base course has been fine graded to the designed cross section. The surface is primed except where a bituminous stabilized base has been laid and string lines are then placed with which to guide the paving machine. The speed of the paving machine is restricted from ten to twenty feet per minute. Higher speeds are permitted, provided that a smooth uniform texture is produced without tearing or shaving.

All agencies but one use a vertical butt joint to form the transverse joint. Generally the joint is painted with asphalt the day before paving. A few organizations also require longitudinal joints to be painted with hot asphalt before the adjacent strip is placed.

These strips are rolled down by steel rollers. The specifications for steel wheel rollers are quite varied and extensive, both as to weight and operating speed. The pavement is compacted to a certain density and it is up to the contractor to accomplish this.

Concrete Surface

There are certain advantages of reinforced pavement design over a plain concrete pavement having the same dimensions. Both pavements are 24 feet wide and 9 inches thick. Contraction joints are 18 feet apart in the plain pavement and 60 feet apart in the reinforced.

For one mile of pavement the plain concrete contains 293 transverse joints as compared to 88 in the reinforced pavement. At a length of 24 feet per joint this amounts to 7032 and 2112 linear feet respectively.

More important, structurally, is the fact that load transfer is provided at all joints and at any cracks that might occur in the reinforced concrete.

In the design of concrete pavements full consideration must be given to:

1. The volume and weight of traffic expected.
2. The character of the soils on which the pavement will rest.
3. The weather conditions.
4. The materials available for use in the concrete mix.

The following factors will determine the detailed design requirements of the pavement:

1. The proportions used in the mix to obtain the highest strength.
2. The need for a sub-base to overcome the effects of volume change in underlying soils.
3. The width of pavement to accommodate traffic.
4. The thickness of the concrete to resist stresses.
5. The distance between expansion and contraction points.
6. The type and amount of steel required.

Methods of Financing

The first state to require that motor vehicles be registered was New York, which imposed this requirement in 1901. By 1915 all states and Washington, D. C., had motor vehicle registration laws. The possibility of financing highway work from this source was recognized. Some 2,300,000 vehicles were registered in 1915 and contributed more than $18 million. Registration taxes produced the greater portion of the income from motor vehicle owners until 1929. Actually, registration taxes were greater than highway expenditures up until 1945. Since then highway expense has greatly increased, and new fund raising methods have had to be used, the most important being Federal Aid.

Construction of the interstate system is financed 90 percent from Federal funds and 10 percent by the states. The states are responsible for 100 percent of the maintenance costs.

The following methods are used to acquire funds for the interstate system:

1. 4¢ per gallon on motor fuels until June 30, 1961; thereafter, 3¢ per gallon.
2. 5 percent manufacturers excise tax on buses, trucks, and trailers.
3. 8¢ per pound on automotive tires, and 9¢ per pound on tubes.
4. 3¢ per pound on retread rubber.
5. $1.50 per 1000 pounds gross weight per year on motor vehicles over 26,000 pounds gross weight.
6. Beginning July 1, 1961, amounts equivalent to a 5 percent manufacturers' excise tax on automobiles and a 5 percent manufacturers' excise tax on spare parts and accessories.

Federal Aid Systems

The Federal Aid systems were established to insure the development of an efficient network of highways within a reasonable period. It also establishes the area of Federal participation. The administration of state or county road remains with the state or one of its political subdivisions even though the Federal government had a large part in building them.

The national system of Interstate and Defense Highways is probably the most important single system of roads and streets. Created by the 1944 Federal Aid Highway Act, it was originally named the National System of Interstate Highways and limited to a maximum of 40,000 miles. Under the Federal Aid Highway Act of 1956, the system was increased to 41,000 miles and the title changed to the National System of Interstate and Defense Highways. Although the authorized mileage amounts to only slightly over one percent of the total roads and streets, it is expected to carry approximately 20 percent of all traffic when completed.

The Federal Aid Primary System was authorized by the Highway Act of 1921 and was formerly known as the Seven Percent System. This title was derived from the fact that the system mileage was originally limited to seven percent of the road mileage in a state.

Depending upon the provisions for completion and maintenance, this mileage may be increased above the seven percent limitation. The Primary System consists of 194,393 miles of highways and streets. Over these roads travel a third of all traffic.

The Federal Aid Secondary System has the largest mileage of all Federal Aided Systems. The provisions for expenditure of funds for secondary roads was made by Congress as far back as the National Industrial Recovery Act of June 16, 1933. The Secondary System was finally authorized in 1944. Routes are designated by the State highway departments in cooperation with county officials and the commissioner of Public Roads. It includes routes not on the primary system which are selected to serve best the transportation needs of the rural population. There is no limitation on mileage. It consists of 523,237 miles of rural roads, and carries a quarter of all rural traffic.

How Federal Aid Money Gets to the States

The first step in Federal participation in the financing of Federal Aid highway improvements is the enactment of legislation by the United States Congress. The act of Congress authorizes money to be appropriated from the United States Treasury in amounts determined by Congress. Authorizations are made on a fiscal year basis (July 1–June 30), generally for two years at a time.

A precedent was set by the 1956 act which authorized funds to be appropriated for the Interstate System for a 13 year period (1957–1969). The Federal Aid primary and secondary systems remained on a two year basis.

Federal aid funds authorized are distributed among the 50 states, the District of Columbia, and Puerto Rico, in accordance with formulas prescribed by law. The funds are apportioned on or before January 1, by the Bureau of Public Roads. The actual dates of apportionment are usually six months in advance so the states may plan for highway improvements.

The Federal Aid Highway Act of 1958 was approved by the President on April 16, 1958 and authorized ABC funds (Federal Aid program) for the fiscal years ending June 30, 1960, and 1961. The apportionment of the funds for the fiscal year 1960 was effective on August 1, 1958.

When an apportionment is made, an amount not to exceed 3.75 percent of the sums authorized is deductible for carrying on research of highway construction and development.

The formulas for apportionment of ABC funds involve three factors. These factors are:

1. Populations in each state.
2. Area of each state.
3. Mileage of rural mail routes in each state.

Primary system funds are apportioned one-third the ratio which the area of each state bears to the total area of all the States. One-third the ratio of a state's population to the population of all the states and one-third the ratio of the mileage rural mail routes in each state to the total mileage of mail routes in the United States are the last two parts of the ABC program.

The secondary system funds are apportioned by the ratio of the population in cities and urban places in each state to the total population in cities in all of the states. For the purpose of apportionment of urban funds, Connecticut and Vermont towns are considered cities.

Interstate system funds beginning with the year 1960 are apportioned to the states in accordance with the estimating cost of completing the Interstate System in each state. These are determined by Federal studies on re-evaluation of needs subject to approval of the Congress. THE END

NUCLEAR ENGINEERING
AT WISCONSIN

A view of the nuclear engineering department which is being established at the University of Wisconsin

by Lynne Anselman

WITH all the publicity given the Nautilus, Hiroshima, and the danger of radioactive fallout, it is no wonder that this period we live in is often referred to as "the Atomic Age." Today's teen-agers never knew a time when the atomic bomb was not omnipresent. Yet the small atom (a hydrogen atom has a diameter of about 0.00000001 centimeters) has many peace-time uses, even if they are less publicized. Most of the applications of nuclear energy seem very remote from our everyday life. Why should we be concerned with nuclear powered submarines and aircraft? How will the use of radio-isotopes as traces in medicine, agriculture, and industry affect us individually? Is the generation of power from atomic fission and fusion and the production of rare metals and rare earths as important as modern scientists would lead us to believe?

The answer is *yes*. Nuclear energy concerns every one of us. It is a well-known fact that our petroleum and coal supplies will not last forever. But we will still need a source of heat, electricity, and energy. Nuclear energy can provide this source. As a matter of fact, one pound of uranium can provide us with as much heat as 1,800 tons of coal without the usual smoke problem. We will probably live to see the day when uranium becomes competitive to coal and oil. If for no other reason than its use as a source of energy, nuclear energy concerns us all.

"Well," you say, "what is being done about it?" Many colleges and universities are initiating nuclear science and engineering programs. They are being established to give you, if you are interested in becoming a nuclear scientist or engineer, the necessary formal education.

What Has the University of Wisconsin Done to Provide You With an Education in Nuclear Engineering

The Nuclear Engineering program was inaugurated in 1957.

As an undergraduate you would probably have taken courses in differential equations, nuclear physics, reactor physics, applied transport phenomena, thermodynamics, and physical metallurgy. This would fulfill the requirements for the Nuclear Engineering Option. You would have received a Bachelor of Science degree in the department of engineering in which you were enrolled (civil, chemical, electrical, mining, metallurgical, or mechanical).

You, with your degree in engineering, and other students with degrees in chemistry and physics could then enter the Master of Science program where it would be possible for you to receive your Master of Science in Nuclear Engineering. Courses you might take are reactor theory, automatic control and instrumentation of nuclear reactors, materials of nuclear technology, nuclear reactor design, nuclear engineering laboratory, nuclear engineering seminar, radiochemistry, and either an elective or a thesis.

The first student is expected to enroll in the program for a doctorate in Nuclear Engineering in September, 1960. He will be under the direct supervision of the Nuclear Engineering Committee, which is composed of representatives from each of the departments of engineering and from the departments of chemistry and physics.

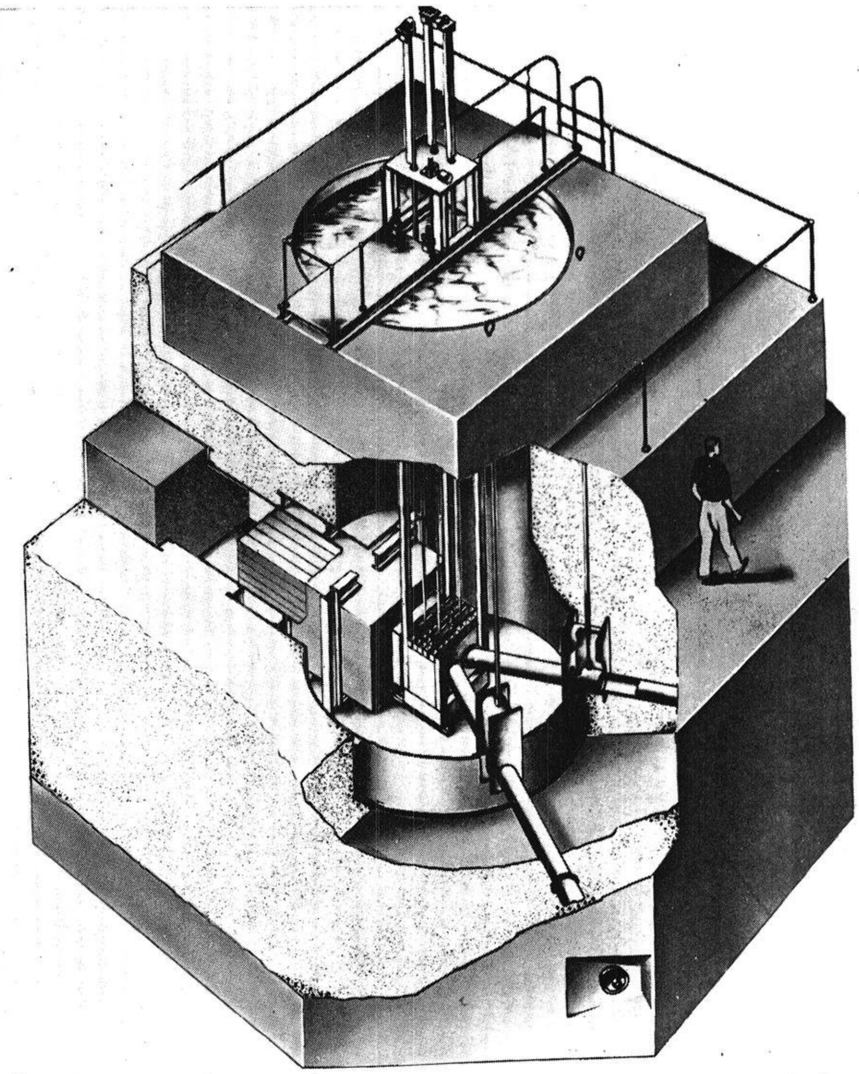
What Laboratory Facilities Are Available at the University of Wisconsin?

While at the University of Wisconsin you may use a natural uranium sub-critical assembly for thesis or research work, as a supplement to your classroom lectures or in a laboratory course. This assembly consists of an aluminum tank four feet in diameter and five feet high. It has a volume of 62.8 cubic feet and can hold 3,900 pounds of water. The tank contains 271 aluminum tubes held in a hexagonal lattice by templates. The fuel, 1,289 slugs of natural uranium encased in aluminum, is on loan from the Atomic Energy Commission (AEC). Its total weight is 5,510 pounds, and its total value is $89,000. The U^{235} isotope which has the energy of 65,000 tons of coal when completely fissioned comprises 0.714 per cent of the fuel. The neutron sources, also on loan from the AEC, are two plutonium-beryllium alloys, each emitting 1.7 million neutrons per second. This subcritical assembly can measure flux distribution and give the necessary data to calculate neutron diffusion length and neutron multiplication. Radiation from the total mass of fuel is less than that from one gram of radium. The water around the core in the tank acts as a shield to reduce the external radiation to a negligible value.

When you take the course in materials of nuclear technology, you will use the nuclear metallurgical laboratory. It enables you to study some of the metallurgical properties of uranium and other materials used in reactors first-hand. You can become familiar with the metallurgical equipment commonly used with reactor materials. The metallurgical principles and processes will be demonstrated to you and your fellow students. This new laboratory is in the Mining and Metallurgy building here at the University of Wisconsin. Some of the facilities available are metallographic equipment, metallographs, microscopes, a vacuum melting furnace, heat treating furnaces, a rolling mill, and an Isolator-Laboratory glove box. This room has been reconstructed to handle the various radioactive and pyrophoric materials safely.

Other equipment now available includes a reactor simulator used to illustrate the fundamental principles of nuclear reactor control.

On January 11, 1960, the University of Wisconsin awarded a contract to General Electric for the construction of a full-fledged nuclear reactor to be in operation on the campus by the end of 1960. It will be used to demonstrate theories talked about in lectures, to train you in nuclear research procedures, and for thesis and advanced research in engineering, chemistry, and other fields. This reactor will be housed in the Mechanical building, permitting you to become familiar with a wide variety of problems such as core loading, reactor control, and fuel handling and storage. A $15,000 grant from the Atomic Energy Commission will help pay for the reactor.



—Photo by University News Service

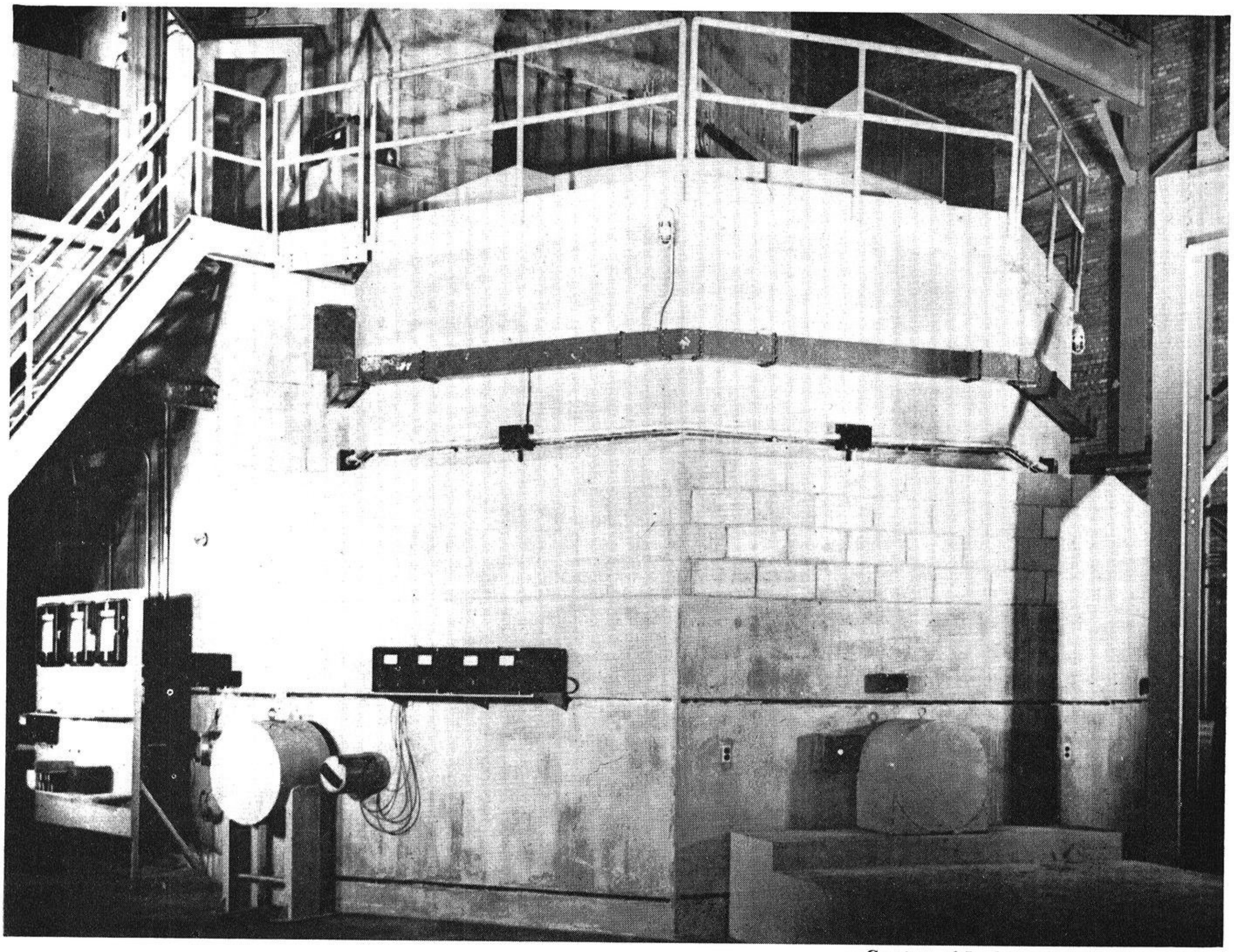
A reactor of the type being put in at University of Wisconsin.

Laboratory and thesis work may also be done at Argonne National Laboratory in Lemont, Illinois, a suburb southwest of Chicago. Argonne is co-operating with the Associated Mid-West Universities which has enabled the member universities to use the facilities at Argonne in their nuclear science and engineering programs.

With all these radioactive materials lying around, it is only natural for you to worry a little about radiation hazards. Your fears should be partially alleviated when you realize that the Atomic Energy Commission takes elaborate precautions to make sure there will be no radiation hazard before it gives its consent for nuclear energy equipment to be built. A nuclear reactor *must* be operated by a licensed person. The disposal of wastes, which might pose hazards also, is very carefully controlled. Protection from exposure to radiation is of constant concern to people working with nuclear energy, but it is not something to live in deadly fear of.

What Are Some of the Job Opportunities Available to Students Trained in Nuclear Engineering?

After receiving your education in nuclear engineering, you may find yourself making reactor physics calculations concerning critical masses and the insertion of poison (cadmium or boron control rods)



—Courtesy of Lookout Mountain Laboratory

A reactor at the National Reactor Testing Station, Idaho. Much like that at the University of Wisconsin.

into reactors. You may be carrying out scoping studies in preliminary reactor design where you would be concerned with neutron balance and economy or the cost of electricity by determining the amount of uranium to be used, the best method of cladding the fuel elements, the type of coolant to be used and the temperature at which it is to be maintained, and the efficiency of the system. Most nuclear engineers will be found in the broad areas of research and development, process control, and design. As an example of one process which requires a nuclear engineer, there is much research being done on obtaining materials such as ammonia (NH_3) and ethylene glycol ($C_2H_4(OH)_2$) by interspersing uranium dust in the air. The exact chemical equations of the resulting reactions are not known, but fission occurs, and the desired products can be formed in this manner. It is known that about 85 per cent of the reaction energy will be dissipated as kinetic energy of the fission products. Radiation also finds use in density and thickness gages, as indicators of wear, and as leak detectors in oil pipe lines.

Some of the companies and government agencies which interview for nuclear engineers at the University of Wisconsin are the Atomic Energy Commission, Los Alamos Scientific Laboratory, Oak Ridge National Laboratory, Argonne National Laboratory, the United States Department of Defense, Allis Chalmers, Westinghouse, General Electric, Babcock and Wilcox, American Machine and Foundry, DuPont, Douglas Aircraft, Boeing, Pratt and Whitney, Union Carbide, and Bethlehem Steel.

Where Can You Obtain More Information About This Program?

You can write to Dean Kurt Wendt, 203 Mechanical Engineering Building, the University of Wisconsin, Madison 10, Wisconsin, and ask for the College of Engineering Bulletin which devotes a page to an explanation of the Undergraduate Option and the M.S. program in Nuclear Engineering. You may also ask for the pamphlet, "Nuclear Engineering Program," which explains the program in more detail. Any other questions you may have can be sent to Professor Max Carbon, Chairman of the Nuclear Engineering Program, 324 Mechanical Engineering Building, the University of Wisconsin, Madison, Wisconsin.

What happened at Hiroshima brought nuclear energy out into the open. As a weapon of defense, the atomic bomb has frightening implications. But nuclear energy has vast peace-time uses also. It is the job of the nuclear engineers to put this tremendous source of energy to its best use. Nuclear energy can either destroy or be a boon to mankind. Which path is taken is up to you.

THE END

RCA REPORTS TO YOU:

NEW ELECTRONIC "BRAIN" CELLS FIT IN THE EYE OF A NEEDLE

Basic building block for compact, electronic "thought savers" will serve you in your office, in defense – someday, in your home

● Today, science not only is working on labor-saving devices—but on *thought-saving* devices as well.

These "thought savers" are electronic computers —wonder-workers that free us from tedious mental work and are capable of astoundingly rapid computations. Naturally, the more *compact* these computers can be made, the more applications they can have. Not only in industry, defense and research—but in the office and ultimately in the home.

"Squeezing" exacting components

A big advance has recently been made by RCA research towards making these "thought savers" smaller than ever before, for broader than ever use.

Take, for example, the new "logic" circuit which actually fits in the eye of a needle. It is a new computer component developed by RCA.

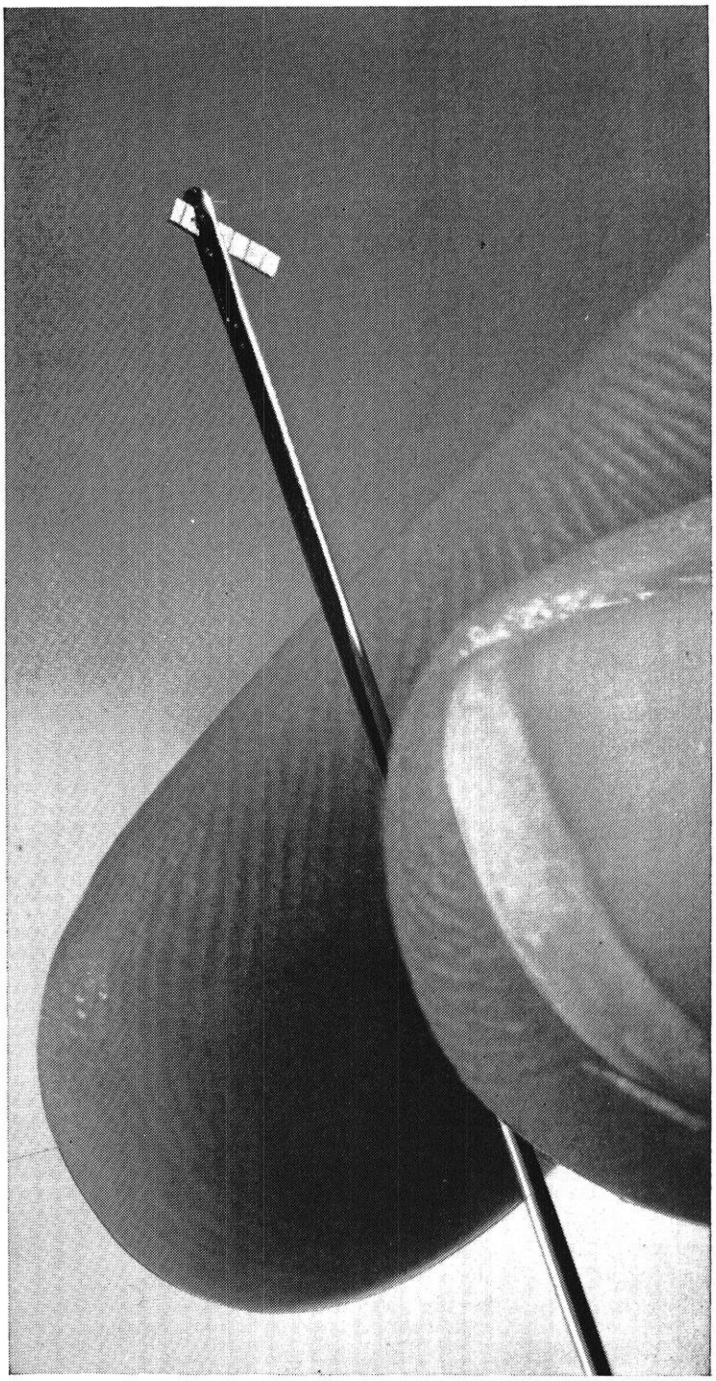
Today, the electronic functions of this micro-miniature device require a whole fistful of wires, resistors, transistors and condensers.

These tiny units will calculate, sort, "remember," and will control the flow of information in tomorrow's computers. Yet they are so small that 100,000,000 of them will fit into one cubic foot!

Cutting computers down to home size

This extreme reduction in size may mean that someday cigar-box-size electronic brains may help you in your home—programming your automatic appliances, and keeping track of household accounts.

Remarkable progress in micro-miniaturization is another step forward by RCA—leader in radio, television, in communications and in all electronics—for home, office, and nation.



Needle's eye holds electronic "brain" cells— Photograph shows how new RCA "logic" element can be contained in the eye of a sewing needle.

RADIO CORPORATION OF AMERICA
THE MOST TRUSTED NAME IN ELECTRONICS

SCIENCE HIGHLIGHTS

by Donald Norris, ee'60

THIS month's Science Highlights column features an article on the plating of tungsten on metal surfaces. This method may be applied to coating rocket and jet engine parts. Another article describes the development of thermoelectric modules used for cooling purposes. Other articles describe the expansion of high pressure standards at the National Bureau of Standards and the use of an electronic machine to solve compressor plant problems.

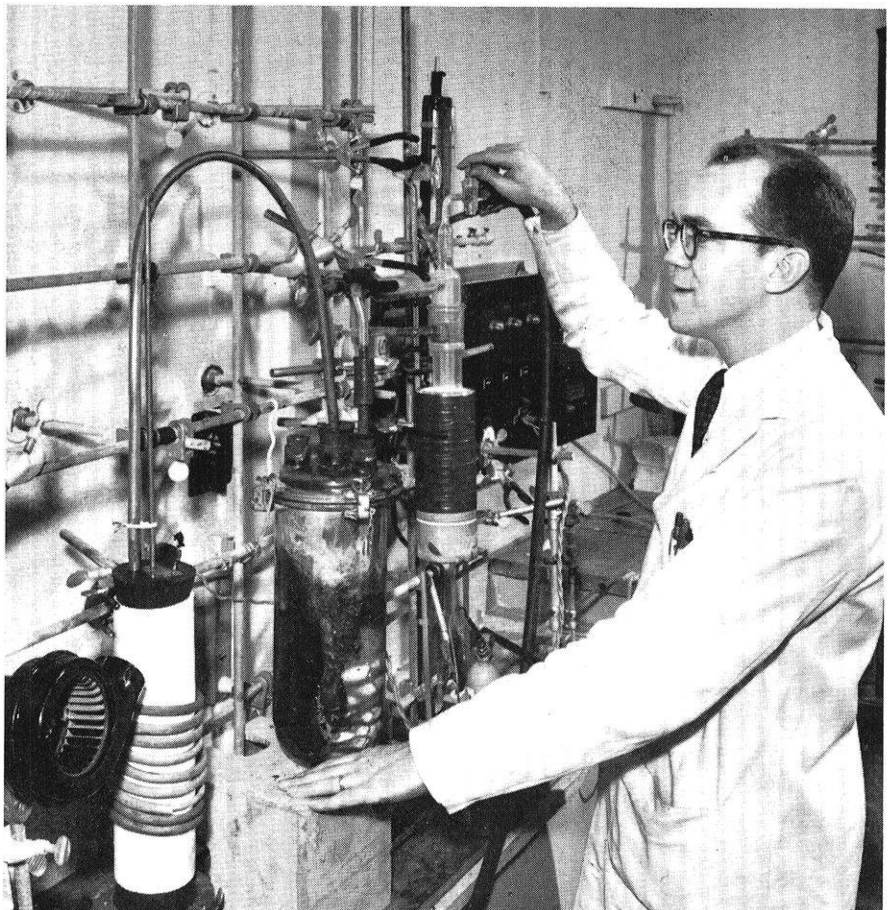
TUNGSTEN FOR HIGH-TEMPERATURE COATINGS

High-purity tungsten can now be easily plated on metal surfaces by using a vapor deposition process which the National Bureau of Standards has developed for the Navy. The method, devised by W. E. Reid and Dr. A. Brenner of the Bureau's electrodeposition group, involves reducing gaseous tungsten hexafluoride with hydrogen by passing it over the heated object to be plated. At temperatures above 300°C, tungsten is deposited on the hot surface, and the only other reaction product, hydrogen fluoride, passes out with the excess of hydrogen.

By this method, it is possible to coat numerous simple and complex surfaces such as rocket and missile nozzles and jet engine parts. The technique also lends itself to the fabrication of tungsten articles, and may be the only way that complicated shapes of tungsten can be formed. Simple tungsten shapes for use in vacuum tubes have already been fabricated.

Tungsten is one of the few metals that possess structural strength at temperatures above 2000°C. Its extremely high melting point (3140°C), hardness, and corrosion resistance make it a desirable material for high-temperature equipment. However, until lately, the high-temperature properties of tungsten could not be effectively utilized. Its brittleness and hardness prevented it from being machined by conventional methods while its weight restricted its uses in aeronautical equipment. For these reasons, efforts were made to develop a practical method for depositing tungsten coatings.

Because tungsten deposition has not been accomplished from either aqueous or organic solutions, it was necessary to evaluate deposition from both fused electrolytes and the gaseous phase. However, in the fused electrolyte processes, the rate of plating was too slow, the



To produce tungsten coatings, hydrogen and tungsten hexafluoride are passed over the object to be plated (in ceramic cylinder at left). Hydrogen fluoride, the only impurity formed, is absorbed in the trap (vessel in center).

deposit was too rough, and coatings could not be built up to the desired thickness.

Method

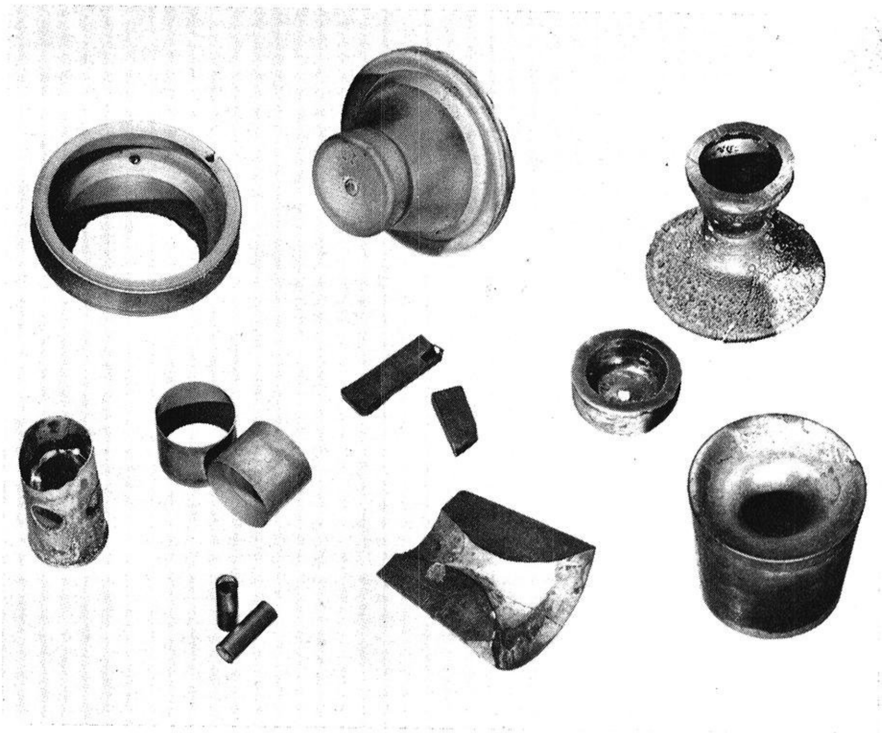
Tungsten hexafluoride was selected for use in the vapor deposition process for two reasons. First, the compound is a gas at room temperatures and therefore convenient to use. Secondly, tungsten apparently forms only one compound with fluorine, WF_6. Thus the reactions are straightforward, uncomplicated by many products or side reactions.

The equipment required is simple. The object to be plated is placed inside a cylinder of ceramic material and the air pumped out and replaced by hydrogen. A controlled temperature induction furnace heats this object to about 650°C. Then the two gases, tungsten hexafluoride and hydrogen, are passed through ordinary glass flowmeters into the reaction chamber. When the gaseous mixture comes in contact with the heated object, tungsten is deposited on the hot surface. The by-product of this reaction, hydrogen fluoride, is absorbed in a suitable trap.

Although the theoretical ratio of three moles of hydrogen to one mole of hexafluoride is needed for complete reduction, satisfactory coatings are obtained when the ratio is lower. However, in practice, smooth deposits are insured by using a hydrogen-to-hexafluoride ratio greater than six. Wide variations in the flow rate of the gases and in the pressure in the system have no major effects on either the efficiency of the process or on the quality of the coating. Although the optimum temperature range for rapid formation of smooth deposits is 650 to 700°C, temperatures in the range from 300 to nearly 900°C are fairly effective. Definite crystal growth is observed at 900°C when the ratio of hydrogen to hexafluoride is three to four.

Nature of the Deposit

Spectrochemical examination shows that the tungsten obtained by vapor deposition is purer than ordinary commercial tungsten. Silicon is the only impurity present in a concentration of 0.1 percent or more. Then too, the deposited metal has the theoretical density of pure tungsten, 19.3 g/cm which is higher than that of tungsten compacts produced by powder metallurgy, or by flame spraying. That is, plating eliminates the very tiny holes between tungsten particles resulting from the other two processes. The hardness of the deposits obtained at 650°C is about 475 Vickers hardness number (VHN) or about the hardness of ordinary commercial tungsten. The crystals deposited at 900°C are not as hard (410 VHN), indicating a slightly higher degree of purity.



Specimens of simple and complex tungsten forms and coated objects produced by vapor deposition method developed by the National Bureau of Standards.

The adhesive bond between the tungsten coating and various basic materials was investigated. Adhesion to molybdenum and to nickel was good; to copper, somewhat weaker; and to iron, rather poor. The tungsten-graphite bond was about as strong as the graphite itself. Tungsten deposited on ceramics also showed good bonding.

Deposits 1/16 inch thick were obtained by vapor deposition in an hour. In this same time only 0.001 inch thickness of tungsten could be plated from fused salt melts in electrodeposition. The maximum thickness of deposit that can be obtained by the vapor method has not been determined but would depend on the permissible roughness of the surface. Because of the rapidity of deposition, this process lends itself to the continuous production of tungsten-coated strips or wires.

THERMOELECTRIC MODULES FOR COOLING INDUSTRIAL AND MILITARY ELECTRONIC EQUIPMENT

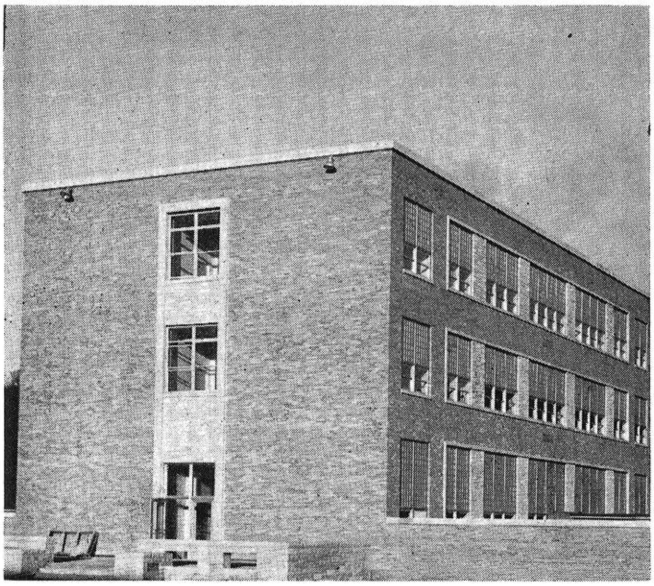
The first line of commercially available thermoelectric cooling devices for industrial and military applications has recently been developed.

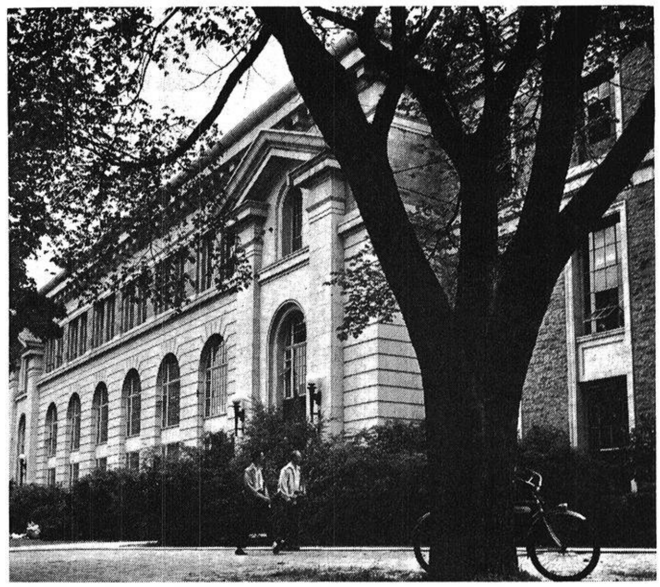
The "thermoelectric modules" are used in electronic component coolers, and other applications where compactness, silent operation with no moving parts, and a controlled cooling rate is desired.

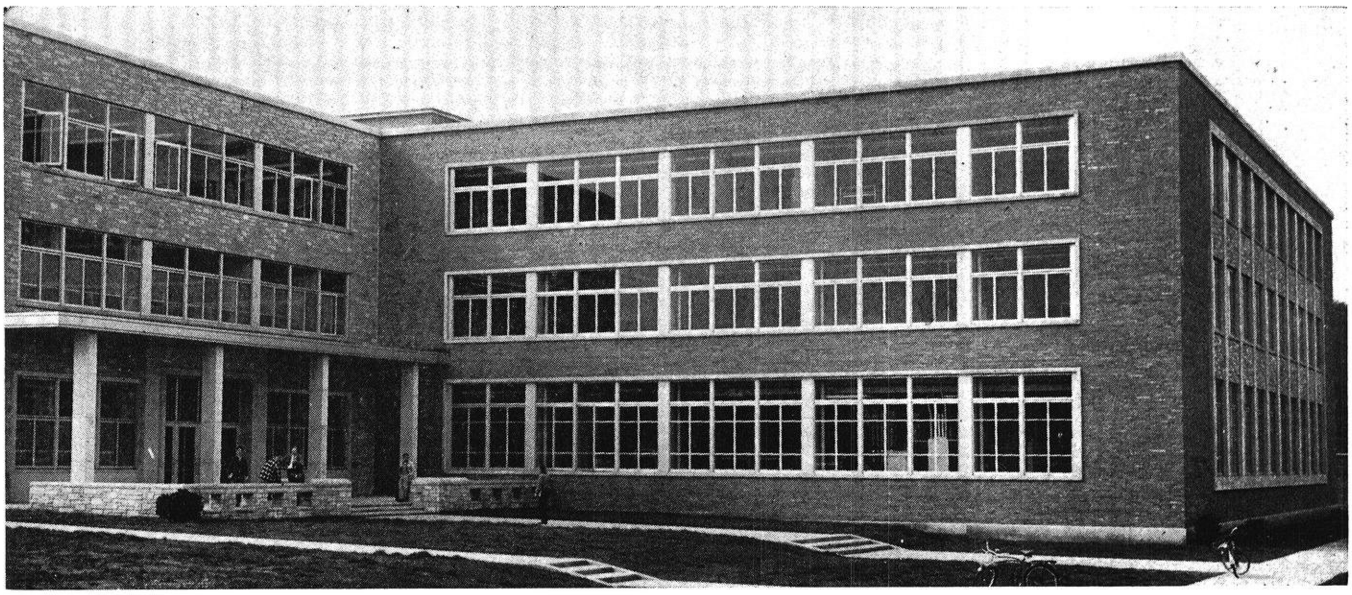
These modules are designed in a variety of shapes and sizes for simple mounting in any position when used with transistors, diodes, and other electronic components. The basic units can be physically paralleled to cool a large flat area, or stacked in series like building blocks for increased cooling.

The need for an efficient electronic component cooler stems from the rapidly changing electronic field itself. Space, weight, and operating temperatures are

(Continued on page 62)







Top left: Chemical Engineering Building. Top right: Mechanical Engineering Building.
Bottom: Electrical Engineering Building.

High School Section

compiled by LeRoy Lutz, ce'60

We of the Wisconsin Engineer staff want to extend our greetings to all high school students. Our intention in the following pages is to inform prospective college students about the engineering profession and engineering instruction in the University of Wisconsin College of Engineering.

To accomplish this we have asked a group of the top educators in the various fields of engineering education to comment on the facts and the opportunities in each field. Also included is an engineering freshman's schedule, and answers to typical questions as well as comments from a top engineering student.

We hope that this information will help you in choosing a career in engineering and the University of Wisconsin as your Alma Mater.

Engineering—Opportunity For You

by *Kurt F. Wendt*
Dean, College of Engineering

Dean Wendt received his B.S. degree in Civil Engineering from the University of Wisconsin in 1927 and has taught in the College of Engineering since 1927. For twelve years he was in charge of the Materials Testing Laboratory, then served as Associate Director of the Engineering Experiment Station, and now is Dean of the College of Engineering and Director of the Experiment Station.

IT IS a pleasure, through this High School issue of the *Wisconsin Engineer*, to extend greetings to all students in our Wisconsin high schools. Those of you who are interested in the field of engineering are invited to visit us, to see our laboratories, and to discuss your plans for the future. Dean Shiels, who is in charge of our program for freshmen, and members of his staff will make you most welcome.

During the past century engineering has made great strides and its many contributions to our high level of economic well-being are universally recognized. You need only look around to see the products of engineering on every hand. The automobile, the airplane, trains, ships, bridges, buildings, roads, electric light and power, radio, television, water and sewer systems, machine tools, refrigerators, and heating systems, to mention only a few, are all the result of engineering design and production. Today engineers are making major contributions in the fields of nuclear power, rockets, missiles, satellites, and space technology.

You may well wonder whether there is anything left to develop for the future. Actually, the discoveries and applications in engineering are increasing at an unprecedented rate and it is the considered opinion of scientists, engineers, and industrialists that we will see many more developments in the future than we have in the past. We have just begun to realize the potential in the fields of nuclear and solar energy, in solid state physics, in communications, in plastics, and in automation. The problems of space are only beginning to emerge. A great challenge and a most interesting future lie ahead for young men and women in all engineering fields.

Every week we receive many questions and among the most frequent are: What engineering courses are available at Wisconsin? Which courses are most popular? What does the engineer do? Should I be an engineer?

The profession is divided into five major fields: chemical, civil, electrical, mechanical, and mining and metallurgical engineering, each with many subdivisions. Wisconsin has curricula in all of these fields. Last fall a new curriculum in engineering mechanics was introduced to meet the demand for a broad, basic course in engineering with strong emphasis on science. Both undergraduate and graduate work are available in each of the areas mentioned. In addition, graduate training is also offered in nuclear engineering.

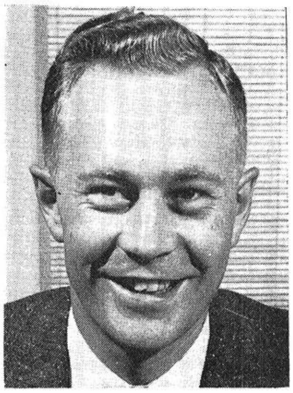
At the present time electrical and mechanical engineering are about equally popular and together account for about two-thirds of our total enrollment. The demands of industry are high, however, in all areas of engineering and it behooves you to investigate the entire field to determine your special interests before choosing a particular branch.

Manufacturing and processing of substances from raw materials through carefully controlled chem-

(Continued on page 44)

Career Opportunities in Engineering

by James A. Marks
College of Engineering, Placement Director



Professor Marks received his B.S. degree in Mechanical Engineering from Purdue in 1948 followed by an M.S. degree in Industrial Engineering in 1951. After working in industry for several years he came to the University of Wisconsin in 1954 as an instructor in Engineering Drawing and Descriptive Geometry. In 1956 he was appointed to his present position of Engineering Placement Director.

WITHIN the past year the job market for engineering graduates has improved rapidly. This does not imply that there was a surplus of engineers one or two years ago; on the contrary, even during the recession in 1958 the job situation for engineering grads was substantially better than for almost any other field. Fewer jobs were available, but they were still relatively plentiful. Regardless of the supply and demand situation, scholastic achievement, extra-curricular activities, personality, character are still the important factors that employers look for in college graduates. As for the immediate future numerous exhaustive studies by professional, governmental, and business groups all conclude that at least for the next several years, probably for the next decade, the demand for engineers along with other technical and scientific personnel will continue and will very likely increase.

The expected increase in the demand for engineers along with the intense competition for better students has meant that starting salaries are not only staying as high as they have been in the past but in many cases are increasing. It is not unusual for the graduate engineer to receive a salary of $6,000 during his first year after graduation. There is every reason to expect that starting salaries will continue to rise at least as much, if not more, than general income levels rise. Certainly engineers can expect handsome financial rewards in the years to come.

Of course, salary should not be the prime reason for anyone choosing a career in engineering, or in any other field, for that matter. Instead, the individual should consider the kind of work he (or she) will be doing and whether or not he will be happy doing it. While this might imply that only those who have a deep interest in things mechanical, for example, would consider engineering, it should be pointed out that for many jobs normally considered to be non-engineering in actual practice virtually demand an engineering background.

Sales, production supervision, management, and many other jobs have become exceedingly technical in nature and an engineering education is a real asset in almost any field. Under these circumstances the high school student who has the ability will find an engineering education to be better basic training than perhaps any other college program and a real asset in any field of endeavor.

Engineering education, a most vital part of the entire engineering profession, provides excellent opportunities that are often overlooked. The demand for engineers will obviously provide more and more opportunities in the teaching of engineering. The individual who would enjoy a career in education and who has the ability to pursue engineering will find an extremely bright future in engineering education.

The Placement Office of the College of Engineering has expanded

(Continued on page 44)

The Freshman's Weekly Schedule

by **K. G. Shiels**
Assistant Dean and Freshman Advisor

Professor Shiels was born in Baraboo, Wisconsin, and received his B.S. and M.S. in Mechanical Engineering from the University of Wisconsin. In addition to his duties as adviser for engineering freshmen, he is chairman of the Department of Drawing and Descriptive Geometry.

FREQUENTLY, freshmen in the College of Engineering come to the Freshman Adviser lamenting that they "had no idea that engineering would be like this." To forestall this, and to help prospective engineers understand what some of the situations they meet will be like when they register for and enter college, an outline of registration procedures is given and a preview of a typical weekly class program for a freshman mechanical engineer is presented on the next page.

When prospective freshmen apply for admission to the University of Wisconsin, they fill out several forms, submit a transcript of their high school record, and receive a permit to register. They then usually come to the University during the preceding summer to register for the Fall semester. During this pre-registration period, students are given a variety of tests, including a mathematics placement test to evaluate their facility in this all important subject, and are given the opportunity to discuss with a representative of the Adviser's office the field of engineering in which they wish to enroll, and the course choices open to them.

Looking at the schedule of a typical work week for a freshman mechanical engineer, we see that he is carrying seventeen credits, a normal load in the College of Engineering. Of the 168 hours in the week, approximately thirty hours are spent in class, approximately thirty-five hours should be allotted to out-of-class study. A realistic schedule allows fifty-six hours per week for sleep, twenty-one hours per week for meals, dressing, etc., and twenty-six hours for personal activities such as dates, sports, church, relaxation, etc. Students who plan to work for support, participate in a major sport, or who are slow learners must recognize that time for these activities must come from the fixed total of 168 hours per week, either through a curtailment of personal activities, or through reduction of the academic credits carried. It is important to recognize before coming to college that a student needs to budget his time carefully, and to organize his day fully, in order to insure success.

Now to examine the specifics of the weekly program . . . three mornings a week at 7:45 our freshman reports for his Air Science instruction, which he elected as his branch of Reserve Officers training. (Other students elect Military Science or band to satisfy this requirement.) He attends Speech at 8:50 MW where he finds an opportunity to develop skills in public speaking, important to engineers in presenting their ideas to other people. Following speech, our freshman spends two hours, three times a week in drawing class, where he learns to read and write the language used in all engineering work.

Our typical freshman has lunch, and then has approximately an hour and a half of free time, which he might wisely devote to study and/or review. At 2:25, he attends chemistry lecture twice weekly. As a supplement to these lectures, he spends four hours per week in chemistry laboratory, and an additional hour in a chemistry discussion class. At 3:30 on Tuesday and Thursday, he attends the mathematics 60 lecture where he learns the concepts of calculus and analytic geometry. At 3:30 on Monday, Wednesday, and Friday, he attends a discussion session where he receives help in applying the mathematical theory to the solution of problems. This very important subject requires ten hours per week of study time outside of class. Our freshman reports to English class three hours per week, where he learns the principles of composition and gains facility in the use of language, important skills for our fledgling engineer. Two hours per week are spent in physical education class. On Tuesday mornings at 9:55, all freshman engineering students attend freshman lectures, an orientation program designed to introduce freshmen to key members of the college faculty, and to discuss various aspects of the jobs engineers perform.

The Office of the Freshman Adviser is open at all times for freshman engineers to come for consultation about any special problems which might arise. Students may need and receive help with financial problems, with scholastic difficulties, and with re-defining their vocational objectives. If the freshman needs more specialized help than his adviser can give, he will be referred to the proper person or agency.

The Freshman Adviser is sincerely interested in the welfare of each student, and welcomes inquiries from high school students. If you should visit the campus and wish to talk over your plans before enrolling in the college, you will be welcome to come to Room 22 of T24 building for a visit.

THE END

A SUCCESSFUL ENGINEERING STUDENT MUST EXPECT TO BE BUSY AND ORGANIZED!

Hour	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
7;00	Could Sleep	Get up,	dress, eat,	off to	classes		Could
7;45	Late	Air Sci.1a	Air Sci. 1a	Study Chemistry	Air Sci. 1a	Chem.2a Q	Sleep
8;50	Free time	Speech 8a	English 1a	Speech 8a	English 1a	Study Chemistry	Late
9;55	Free time	Drawing	Freshman Lectures	Drawing	Study Chemistry	Drawing	Study
11;00	Free time	12	Phy. Ed.	12	Phy. Ed.	12	English
			NOON MEAL				
12;05		Study		Study		Study	
1;20	Free time	Drawing	Chem.2a	Drawing	Chem.2a	Drawing	Free
2;25	Free time	Chem 2a L	Lab	Chem. 2a L	Lab	English 1a	Time
3;30	Free time		Mathematics 60				Free
4;35	Free time		Study Chemistry				Time
6;00			Relax after evening meal				
7;00			Study Mathematics			D	Study
8;00			Study Mathematics			A	Air Sci.
9;00	Study	Study	Study	Study	Study	T	Free
10;00	Speech	English	Speech	English	English	E	
11;00	Hit the sack!					?	Time

University Extension

by Professor Paul J. Grogan
Chairman, Extension Engineering Department

Professor Grogan has served in the above capacity since 1951. Earlier, he taught mechanical engineering subjects at both The University of Wisconsin and The University of Notre Dame. His educational background includes a M.S. from UW and a B.S. from Purdue. The professional field in which Professor Grogan has gained the greater amount of his practical experience is power generation. This has been reflected in his extensive writings on the subject in professional and trade journals.

THE University Extension Division is the off-campus arm of The University of Wisconsin. One of the units of the Extension Division is the Department of Engineering. Included among its responsibilities are the programs of undergraduate instruction in engineering at the several Extension Centers in the state. Centers are located at Kenosha, Racine, Sheboygan, Manitowoc, Marinette, Green Bay, Menasha, and Wausau.

Substantial blocks of credit toward a degree in any of the several fields of engineering offered by The University of Wisconsin may be obtained through the Extension Center System. It is only fair to mention at this time that The University of Wisconsin–Milwaukee (UW–M) offers considerable opportunity for the study of engineering at both the undergraduate and graduate levels. There are further opportunities for beginning an engineering career at the State Colleges distributed throughout Wisconsin. These latter operations are not a part of the University Extension Center system, but a great deal of harmony and accord exists within the entire state-supported system of higher education in Wisconsin.

Questions are often asked whether or not an individual is able to obtain "full credit" for work taken in an outlying institution, and whether or not an engineering program can be completed in a normal four years if one starts off campus.

Transfer of Credit

Credits earned at the eight University Extension Centers may be "transferred" to the University at full grade-point value. The quotes on the word "transferred" are purposeful. Actually, Extension Center credits *are* UW credits and no "transfer" ever takes place. The original and permanent record card of the Extension Center student is maintained among residence student records in Bascom Hall, the main administration building of the University. Transfers from UW–M are at full grade-point value, although the record card in this instance actually transfers from Milwaukee to Madison.

Transfers from the State College System may be made on a "credit-for-credit" basis where the course work is applicable to any part of the requirements for the degree program of particular interest. Grade points, however, are entered on the same basis as transfers between any pair of neighboring institutions; this being a nominal "C" or 2.0 grade points per credit for all work of "C" quality or better. Grades originally below a nominal "C" are entered on the transfer record at the lower value.

Full applicability of credits available for transfer towards the requirements of the particular degree in mind requires wise selection of program within the offering of the outlying institution of choice. Student counsellors are generally very well informed on matters of local course selections applicable to the degree program of choice. Any doubtful matters may be cleared up quickly by a telephone call, a letter, or a personal visit to the appropriate departmental chairman in Madison.

(Continued on page 44)

If You Like a Challenge—

by Robert C. Onan, Jr., Met 4
President, Polygon Board

MANY high school seniors are contemplating studying engineering in college. There is a challenge waiting for those who decide upon this course, but it is not only the challenge of engineering physics, math, and mechanics problems. The engineer of today is confronted with a greater challenge . . . to develop a flexible mind.

"The engineer of today and tomorrow must have a flexible mind whether he is a research, design, production, sales, or managing engineer," said Mr. Cary H. Stevenson in speaking to freshman engineers at the University of Wisconsin in a program sponsored by the Polygon Board—the student governing body of the College of Engineering. Mr. Stevenson, vice president of Lindberg Engineering Company which manufactures heat treating furnaces and equipment, has helped many young engineers on their way to successful careers.

What is a flexible mind? It is one which can remember the past, realize the present, and work with the future in mind. It takes a man with a flexible mind to realize that the successful American industrialist no longer goes to the European or Japanese manufacturers to say, "What can I tell you about how we do things back in America?" Instead he goes with open eyes and ears to see how the European or Japanese carries on his manufacturing. It will take a flexible mind to use well established engineering principles to precipitate new innovations to compete with not only other American firms but also with the increasingly competitive European, Russian, and Asiatic industries.

There is a terrific demand for men who can flex their minds to work with all types of people in order to devise new products and operations that are economically feasible. With the vast amount of knowledge coming from foreign countries, a speaking knowledge of a foreign language is a prerequisite to having a flexible mind. You must make the initial step to communicate with the foreign industrialist who knows something which can help you.

There is a gross misconception that a college education is a ticket to quick success and that people without the benefit of a college education are not important to a company. Many companies do hundreds of thousands of dollars worth of business annually without a college degree in the company. It will take young engineers with flexible minds to realize that they will be learning from the men in the shop and, in fact, from everyone. Imagine trying to design, produce, and sell a new casting without working with a draftsman for shape and dimensioning, a foundryman for advice on what alloy to use and how to cast it, a metallurgical engineer for property specifications, a foreman for setup, the workmen to explain the operation and their part in it, the sales engineer for putting the casting on the market, and still be able to convince the management that they should invest the money to manufacture the product.

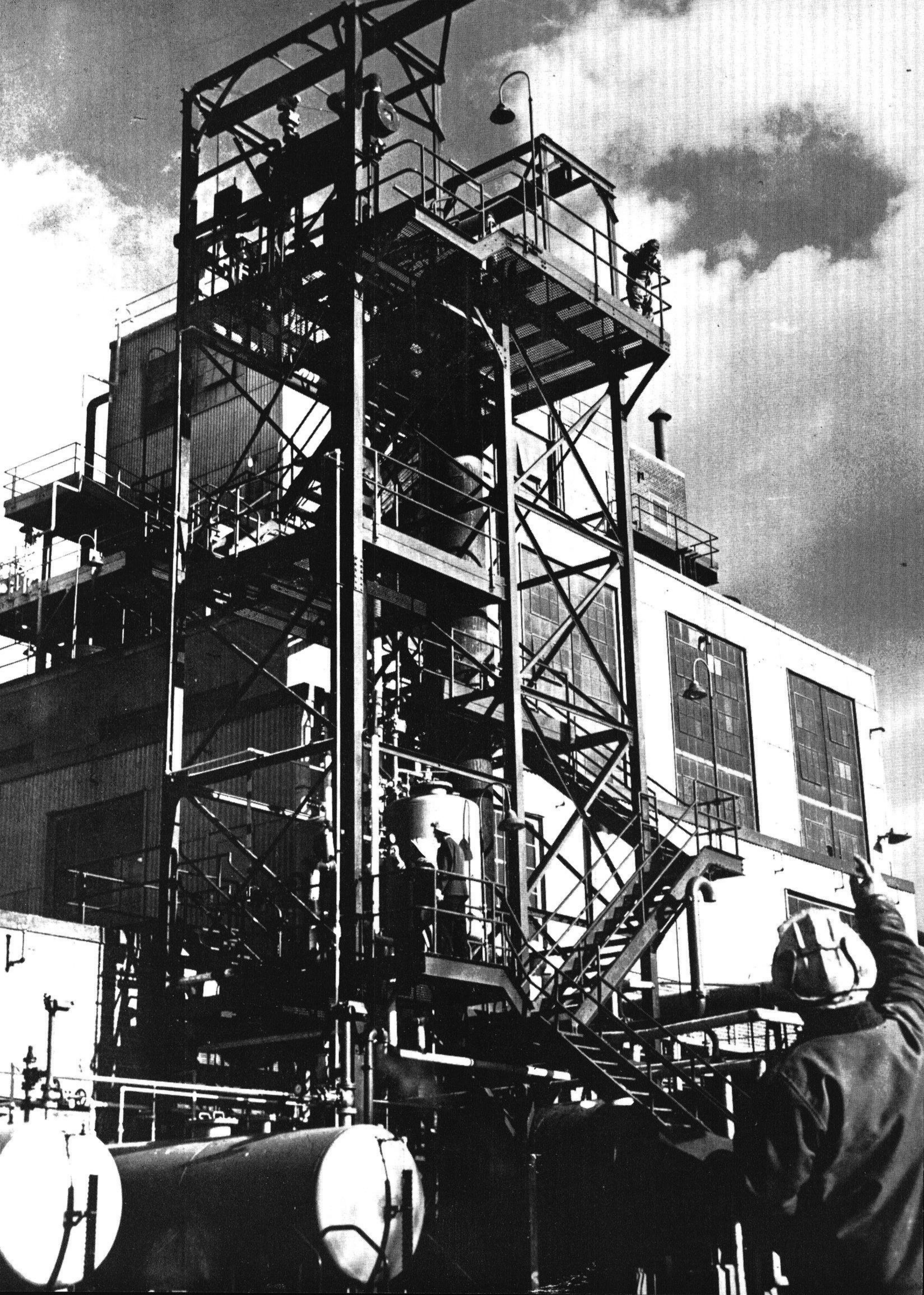
Many engineers have the potential to move into managerial or administrative positions. Men in these positions must have the technical background and understanding that most engineers acquire, but they must also be skilled at handling the human relations problems of a business and communicating with people, be they engineers, sales personnel, accountants, or customers. It is the possession of these skills as well as the technical background that marks a man with a flexible mind.

I think the most important part of the development of a flexible mind is a desire: desire to get along with all kinds of people; desire to come upon new and difficult problems and decide upon the best possible solutions; desire to understand yourself; desire to appreciate subjects like music, art, and nature; and desire to learn about new or unexplored realms.

It is September, 1960, you are one of the 1,000 freshman engineers at one of the greatest universities of the world. The diversity of the University of Wisconsin could well be the key to the development of your flexible mind—if you are willing to make an effort. Study your lessons, get into your work, do not take the "It's only wasteful studying" attitude, chat with the foreign student down the hall, attend a Sunday concert, visit the art shows at the Union, or stop at the top of Observatory Hill on a fresh, autumn day and look at one of the most beautiful campus scenes in the world.

You can coast through college without opening yourself to a new and interesting way of life, and you will coast just as easily into a routine, monotonous occupation when you leave school. There is a challenge waiting—I sincerely hope you will accept it.

THE END



Chemical Engineering

by Professor R. A. Ragatz
Chairman, Chemical Engineering Department

Professor Ragatz is a native of Wisconsin. Born in Prairie du Sac, he received his B.S., M.S., and Ph.D. degrees at the University, the latter in 1931. He has worked in the field of chemical engineering materials, and is co-author of two widely-used texts in chemical engineering.

THE work of the chemical engineer differs in character from the work of the chemist. It is the function of the chemical engineer to translate the laboratory discoveries of the research chemist into commercial production. The research chemist generally works with small-scale laboratory equipment, which usually is made of glass. He works with small quantities of material, and his product yields are small, a few grams generally. The chemical engineer, on the other hand, designs and operates the large-scale apparatus required to produce the desired material in commercial amounts, frequently running to many tons per day.

The chemical engineer finds employment with companies engaged in the manufacture of gasoline, Diesel fuels, heating oil, lubricating oil, greases, asphalt, paraffin wax, rocket fuels, synthetic rubber, rubber products, plastics, synthetic textile fibers, synthetic detergents, soaps, pulp and paper, insecticides, weed killers, and pharmaceutical products. The chemical engineer produces a host of "petrochemicals" from crude petroleum, such as ethyl alcohol, ethylene glycol, benzene, toluene, acetylene, and formaldehyde. All of the foregoing materials are produced by the coordinated teamwork of chemists and chemical engineers.

The manufacturing processes in which the chemical engineer engages are usually quite complex and require a series of well-defined steps, some of which are chemical in nature and some of which are essentially physical in character. Typical chemical processes are polymerization, sulfonation, chlorination, nitration, hydrogenation, oxidation, reduction, hydrolysis, and alkylation. Typical physical operations are pumping of fluids, transportation of solids, heating or cooling of materials being processed, crushing and grinding, mixing, filtration, drying, absorption of gases by liquids, solvent extraction, crystallization, distillation, and evaporation. It is the duty of the chemical engineer to select the various chemical processes and physical operations that are needed to make the desired product. Chemical engineers work out the best conditions for each step; they design the equipment needed for each step; they build and operate the complete plant.

In a large company employing many chemical engineers, the type of work carried out by a particular individual may be restricted to one of the following general lines of activity: research, development, production, maintenance, process control, inspection and testing, design of equipment, construction of equipment, technical sales and customer service, and administration. If the company is relatively small, the duties of the chemical engineer probably will encompass several of the foregoing types of work.

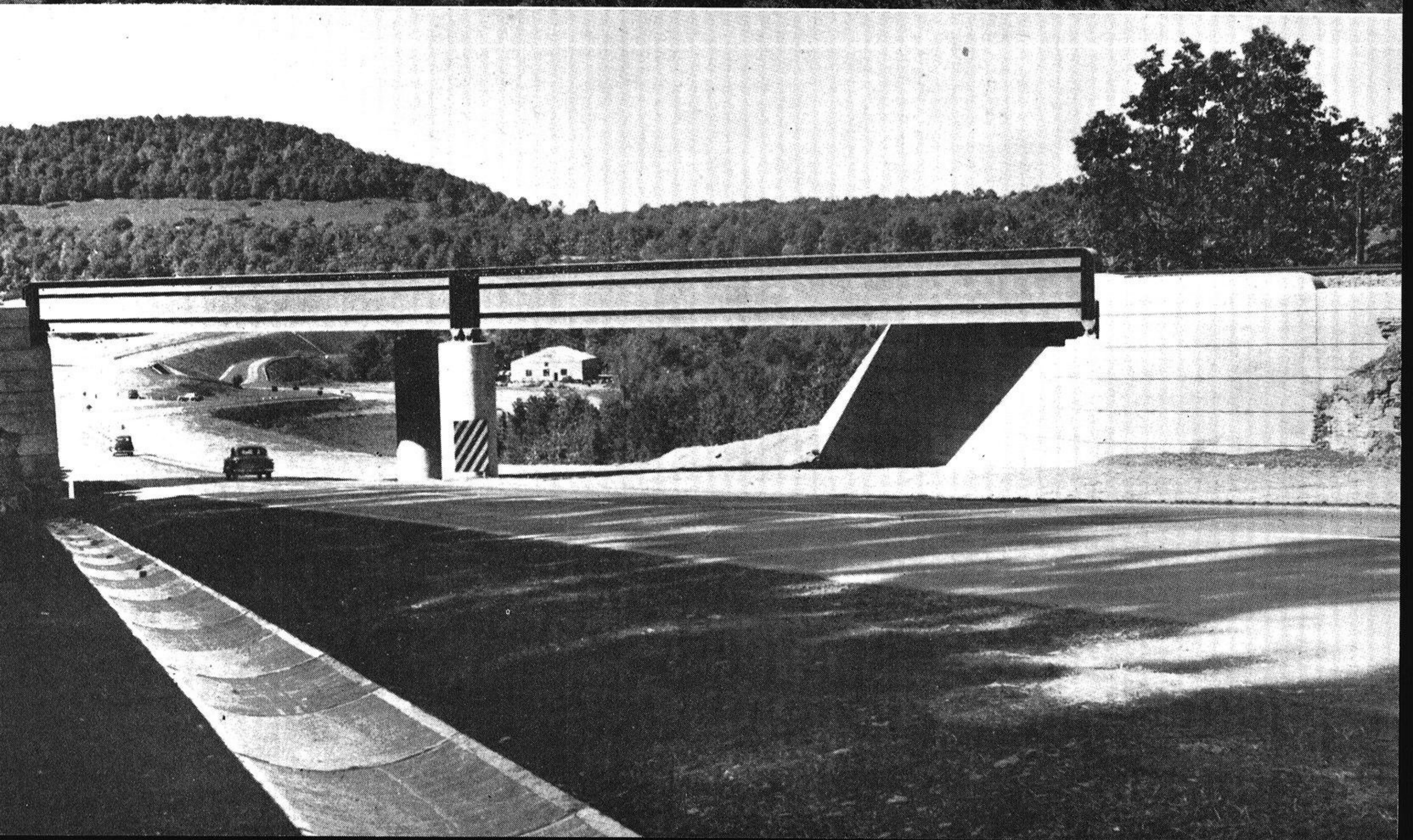
The Department of Chemical Engineering has excellent instructional facilities. The Chemical Engineering Building, occupied in 1952, has modern, well-equipped undergraduate laboratories for instruction in unit operations, chemical manufacture, process measurements and control, applied electrochemistry, plastics, and physical measurements. Laboratory facilities for M.S. and Ph.D. thesis research are also provided.

The curriculum in chemical engineering has been accredited for many years by the American Institute of Chemical Engineers and by the Engineers Council for Professional Development. The curriculum is under constant study, and periodic changes are made as called for by new scientific discoveries and changed conditions in industry.

The tremendous growth of the chemical industry since World War II has created many employment opportunities for graduates of the chemical engineering course. The demand for chemical engineering graduates continues at a high level.

THE END

◀ A distillation tower used for solvent recovery for silicone manufacturing.



Civil Engineering

by Prof. Arno T. Lenz
Chairman, Civil Engineering Department

Professor Arno T. Lenz is in his second year as Chairman of the Department of Civil Engineering. He is a Wisconsin native, having been born in Fond du Lac, and has received four degrees from the University. The last was the doctorate in 1940. His professional work has been in Hydraulic Engineering with special emphasis on water resources studies and model tests of dams. In addition to his teaching and research, he has spent several summers on engineering work for the Tennessee Valley Authority, the U. S. Bureau of Reclamation and Wisconsin industries, and as a consultant in law suits concerned with water problems.

THE Civil Engineer of today must secure very broad training in order to be prepared to solve problems which may confront him. In this age of specialization the Civil Engineer stands almost alone in this respect. He may work for a governmental agency or industry or for himself and tend to specialize somewhat in his job, but even such specialization requires a broad background.

A Civil Engineer may design and build buildings or bridges, but any building he designs must be on an adequate foundation. A thorough knowledge of groundwater conditions at the building site, the mechanical properties of the various soils when wet and dry are needed. When he designs in concrete or steel he must know something of the chemical properties and strength of the material under loads which will vary with the way the building is used and even with the wind forces. The amount of rain which falls on the roof will influence the drainage for the building, and the sun beating down on that roof causes expansion which must be considered so there will be no leaks in the roof.

Bridges over rivers and streams must be large enough to permit the greatest flood to pass beneath and high enough so that the floor will always be dry. They must be strong enough to carry the greatest load today and a century from now. They must be in the right place to carry present traffic and that which will come for the next hundred years.

Planning for this traffic is an important part of the work of the bridge builder and the highway engineer. It is also an important part of the work of the municipal engineer who lays out the city expressways and ordinary streets, the water and sewerage facilities for our communities, and provides the water supply and waste disposal plants. This is all the work of the Civil Engineer.

For his first job, or during summer vacations while he in school, a man may work as a rodman on a survey crew. With a little experience he will quickly graduate to instrument man and chief of party and collect the basic survey data needed to plan civil engineering works. Other young men make streamflow measurements out in the field to determine how much water is flowing down a mountain stream or in an irrigation ditch. They may go into the mountains in winter to measure the depth and water content of the snow pack which supplies irrigation water in the spring.

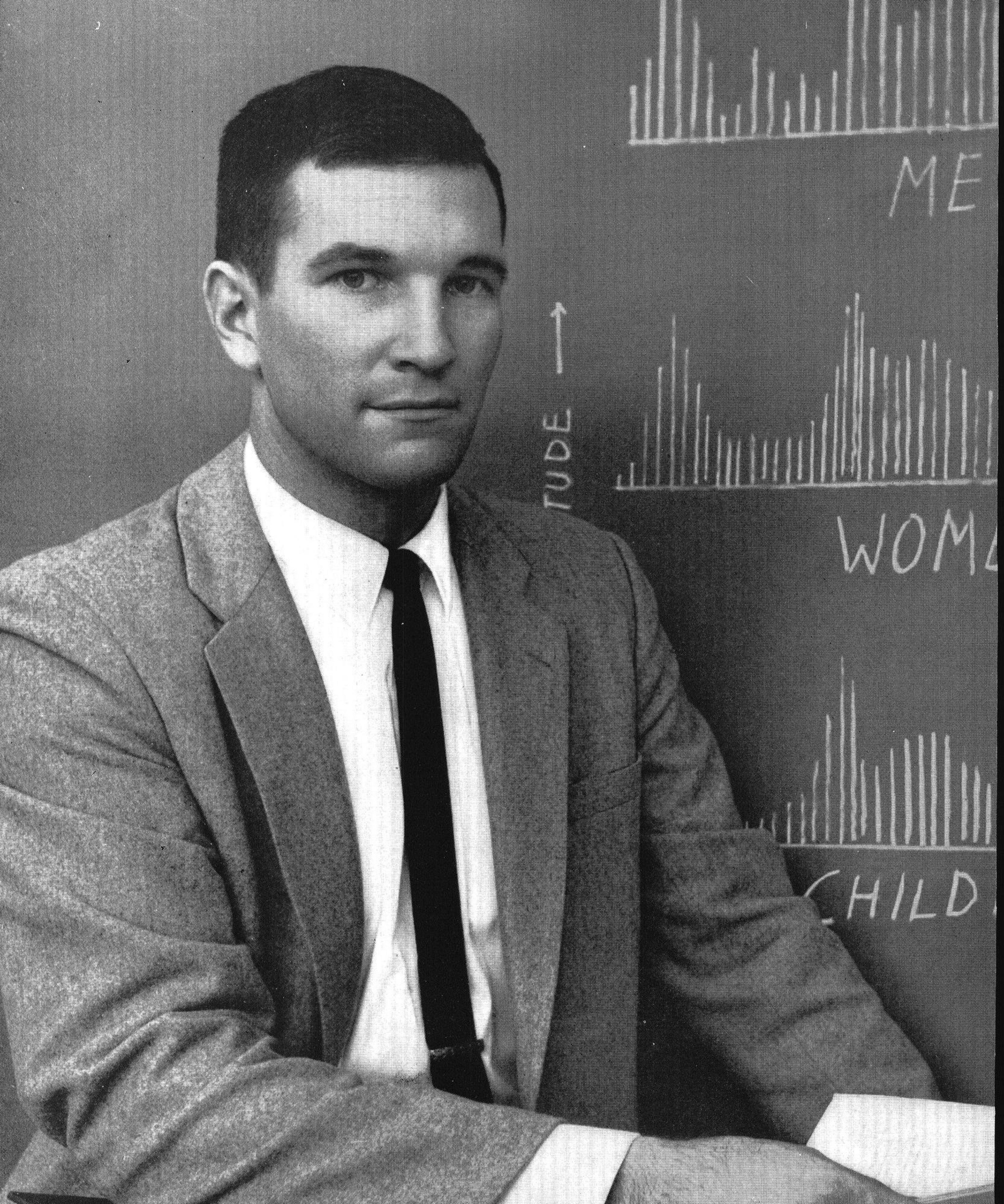
Jobs for young men also include construction work either for the contractor or as an inspector to see the structure is built according to specifications written by another civil engineer. When the engineer has learned his practical lessons, he is assigned greater responsibility, and he may become a project manager supervising hundreds of men and millions of dollars worth of equipment as project manager on huge projects such as the Mackinac Bridge or Grand Coulee Dam.

On the other hand he may start as a small contractor and successfully grow to a size where he can bid and build at least parts of such mammoth structures. Construction takes civil engineers to the far corners of the earth building dams, airfields, highways, industrial plants, pipe lines, and every other type of installation which can be imagined. On the other hand, some engineers do all their building within a single large metropolitan area such as Los Angeles County.

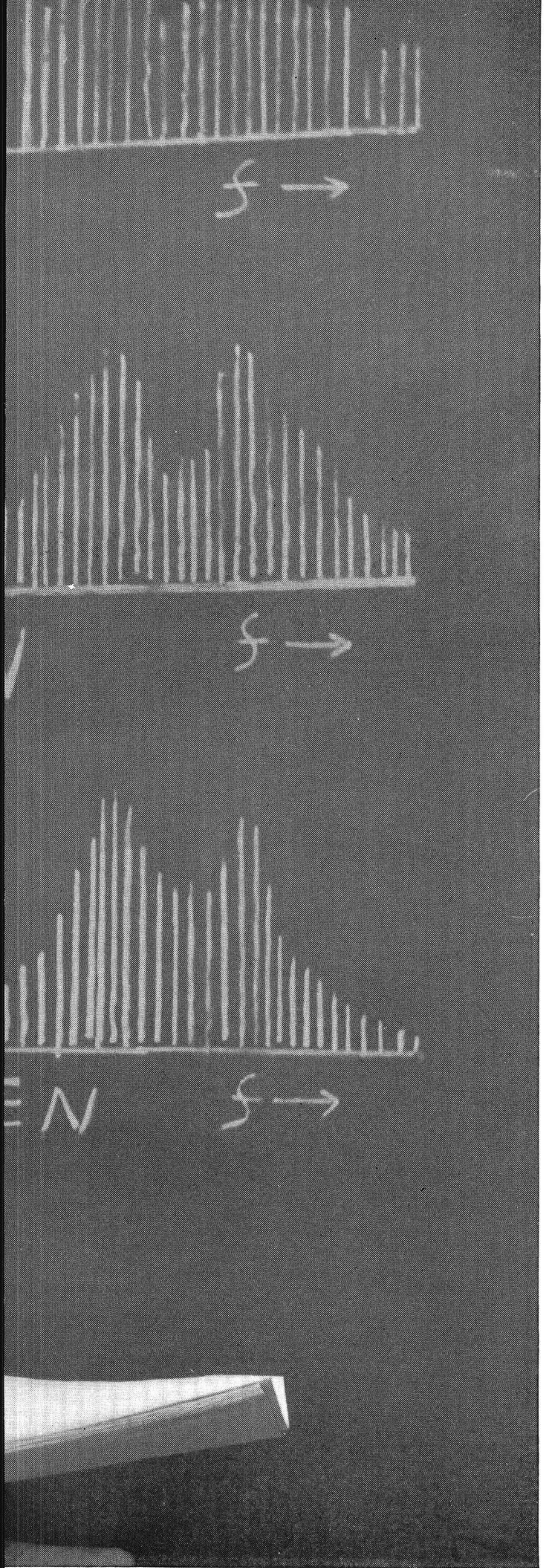
A young civil engineer may start his professional career working for a consulting engineer making the designs for the structures which others build. He will select the depth of the beams or girders to

(Continued on page 45)

Top: Birdseye view of completed Shasta Dam. Bottom: Railroad over Cherry Valley Turnpike in New York State.



James Elam (M.S., Purdue '59) is studying various techniques of speech analysis at IBM. The objective of this work is voice-machine communication.



He's breaking through sound barriers to find new applications of human speech

It is believed that once clear, distinct signals can be obtained from human speech sounds, the human voice can be used for direct communication with machines. James Elam is working in this direction.

Voice-Machine Communication Problems

The problems involved are formidable. Machine "understanding" of human speech will be limited by both the sensitivity and the number of electronic "recognizers" of speech-sound patterns that can be built into the machine. To further complicate matters, the human voice is capable of making an almost infinite variety and subtlety of sound patterns. Only in theory could a machine be built that could recognize all of them.

A Solution in "Phonemes"?

To further this work on voice-machine communication, James Elam is studying various techniques of speech analysis. In one scheme, recordings are made of voices reading words. These are then examined in their frequency spectrum, and a power within discrete bands is plotted. The plots, or spectrograms, are used to break down words into basic sounds called "phonemes." Each phoneme has a separate and distinct pattern and is capable of giving a clear signal. It is hoped that these signals can be used to communicate directly, through an audio input, with machines.

Fascinating Assignments

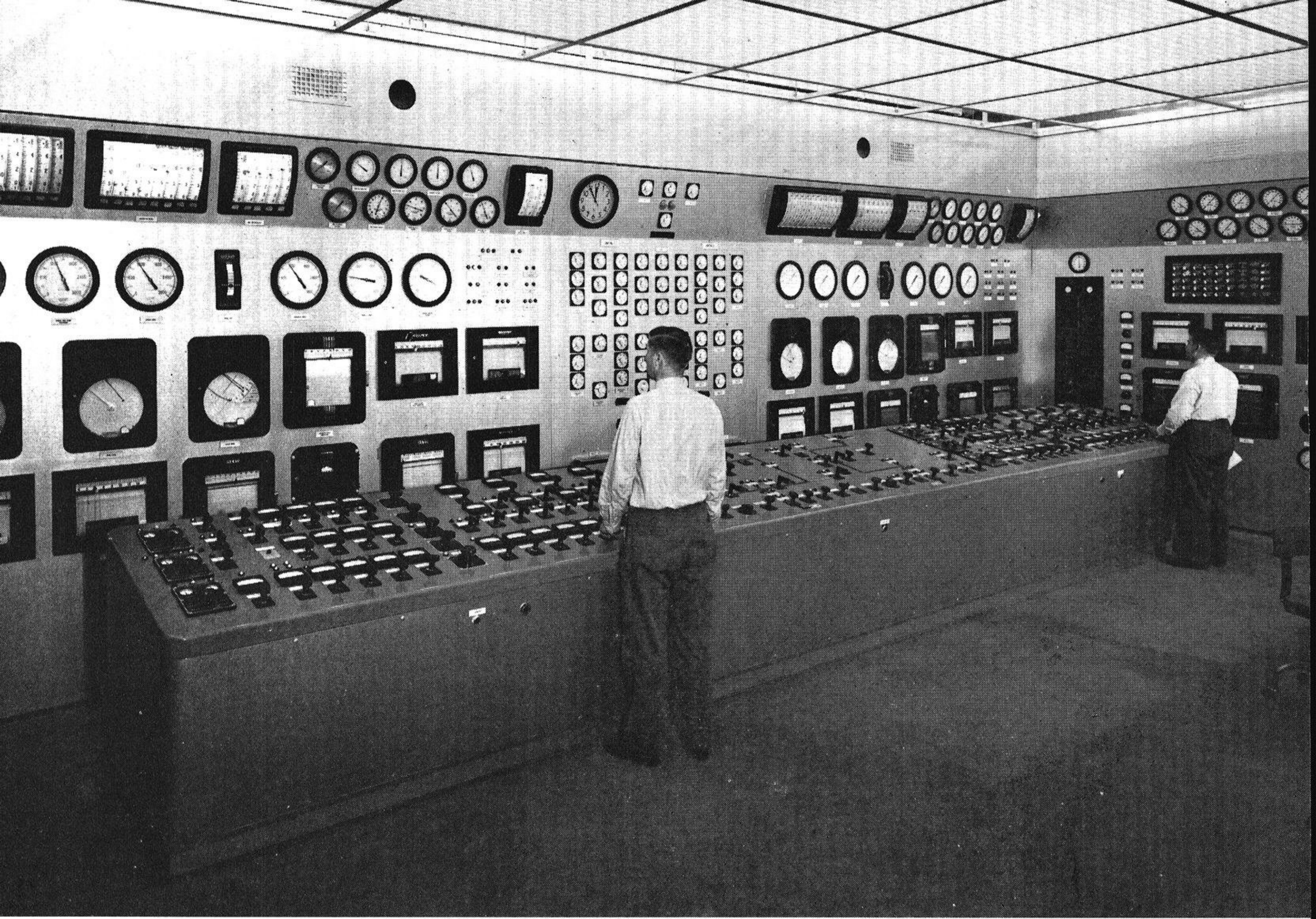
Because of its exciting future possibilities, James Elam finds his work fascinating.

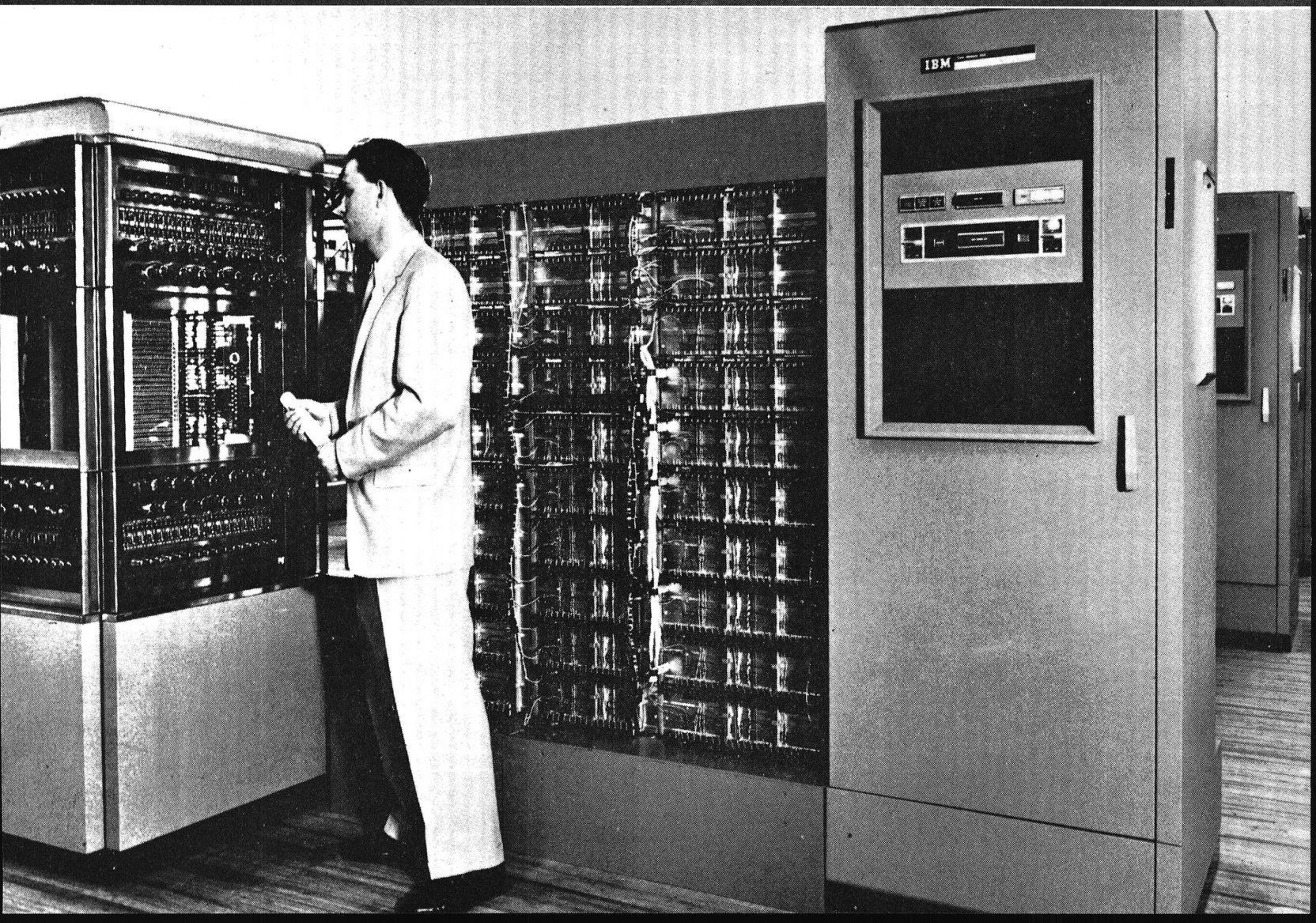
If you would like to employ your talents in areas where exciting future possibilities are all part of a day's work, then you might consider the opportunities offered by IBM. When our representative comes to your campus, he will be glad to give you information about opportunities in research, development, manufacturing and other areas at IBM.

IBM®

INTERNATIONAL BUSINESS MACHINES CORPORATION

Your Placement Officer can tell you when an IBM representative will next visit your campus. Or you may write, outlining briefly your background and interests, to: Manager of Technical Employment, IBM Corporation, Dept. 846, 590 Madison Avenue, New York 22, New York.




IBM

Electrical Engineering

by Professor H. A. Peterson
Chairman, Electrical Engineering Department

Prof. Harold A. Peterson has been Chairman of the Department of Electrical Engineering since 1947. He is from Essex Iowa, and received his B.S. and M.S. (with high distinction) from the University of Iowa. He is a Fellow in AIEE, a Senior Member of IRE, and a member of several other engineering societies. He also holds eight patents in the field of electrical engineering.

ELECTRICAL Engineering is a young profession. With the characteristic vigor of youth, it is growing and expanding rapidly to meet the challenges of the profession in an era which is characterized by the growing importance of space technology.

Only seventy eight years ago, the first waterwheel driven electric generator in this country was put in operation at Appleton, Wisconsin. Since that time, growth and development of the profession have been phenomenal. Today the American Institute of Electrical Engineers (AIEE) has over 54,000 members, not including student members. In addition, there are approximately 60,000 members of the Institute of Radio Engineers (IRE). The IRE membership is growing rapidly at a rate of about 12 per cent per year. It is one of the fastest growing professional technical societies at the present.

A few generations ago, electricity was available in the homes of only a few. Now, it is available in almost every home. Electrical Engineers have been largely responsible for bringing this about. Today, heavy tasks around the farm home and other tasks in all homes, can be done quickly, efficiently, and without drudgery. Radio and television have been brought to most homes. These are some of the more obvious consequences of electrical engineering.

Electrical Engineering has expanded tremendously in scope in recent years. Automatic control theory, information theory, the transistor, new analytical techniques, analog computers, digital computers, extra high voltage power transmission, the tunnel diode, nuclear fusion and fission, and many other developments have been basically important in this expansion. The control of guided missiles, and the very special instrumentation problems associated with the recording of data and transmitting such data back to earth from satellites are largely the responsibility of the electrical engineer. The problems are fascinating and challenging, requiring much imagination and resourcefulness in obtaining solutions. Advanced training in engineering science and mathematics is generally required for creative work in these areas.

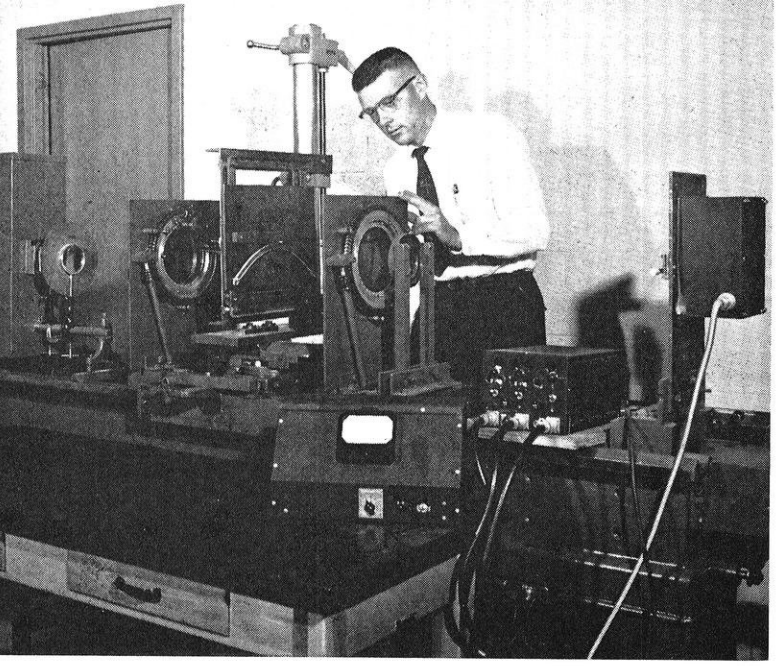
At the University of Wisconsin, our facilities in the Engineering Building are among the best in the country. Our course of study in electrical engineering is constantly under surveillance so that improvements can be made from time to time to keep in step with the needs of industry. We have recently revised our curriculum in order to make it more suitable to the demands of our rapidly changing technology. This new curriculum applies to all those students entering as freshmen in September 1959, and thereafter.

There is a joint student branch of the AIEE–IRE on the campus with a faculty member in charge as branch counselor. This student branch elects its own officers, holds regular meetings, and sponsors activities of interest to student engineers. It affords a means for orienting students with regard to professional activities within the AIEE and IRE following graduation.

The University of Wisconsin offers excellent opportunities for study in electrical engineering. Young men and women with good high school records and a real interest in science and mathematics would do well to consider enrolling in this course of study which leads to a most interesting professional life of basic importance to our economy and security.

THE END

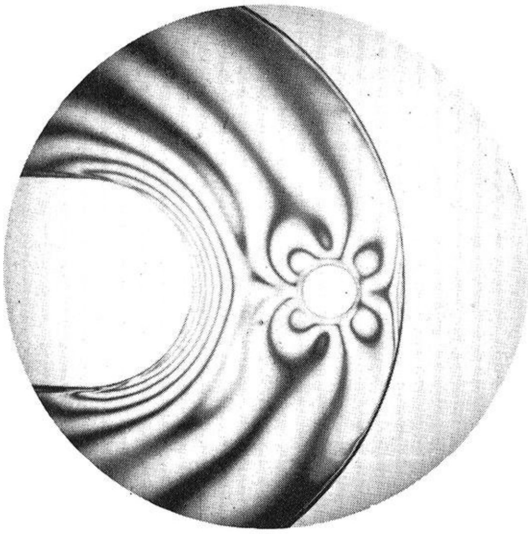
Top: Automatic indicating recording and control instruments used by modern public utilities. Bottom: Memory storage units of an air defense computer.



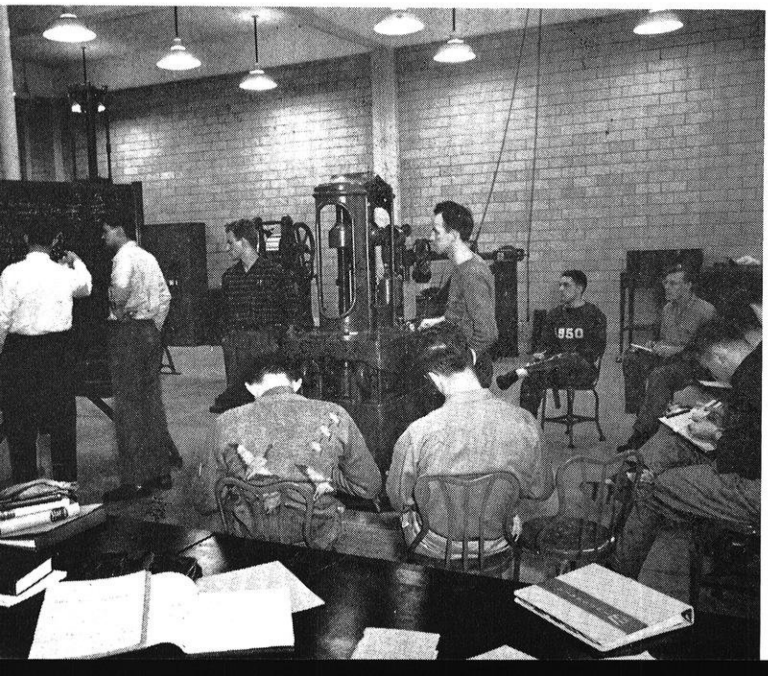
The man above is shown running an experiment in the photoelastic laboratory.

A graduate student is working in the fatigue laboratory.

At right is a photoelastic fringe pattern showing stress variation in a test specimen.



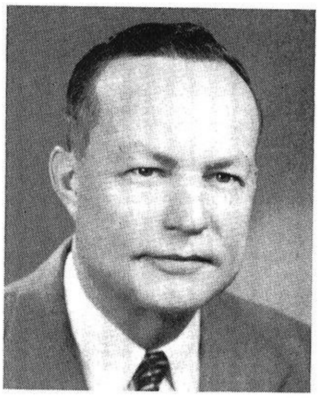
Students are at work in the metal laboratory.



A class is shown working in the soil mechanics laboratory.

Engineering Mechanics

by Professor George W. Washa
Chairman, Mechanics Department



Professor George W. Washa has been chairman of the Department of Engineering Mechanics since 1953. He was born in Milwaukee, Wisconsin, and received his B.S., M.S., and Ph.D. degrees from the University of Wisconsin. He has been very active in ASTM and ACI. He has served as chairman of several ACI committees and has also served on the Board of Direction. He is co-author of two textbooks in Engineering Mechanics.

THE newest undergraduate engineering curriculum at the University of Wisconsin has been started to meet the current need for training in the more fundamental aspects of engineering. It is matched by similar curricula in many of the leading engineering colleges throughout the country. They may not always be called Engineering Mechanics, but similar aims and objectives are present in many curricula such as Engineering Physics and Engineering Science.

What Is Engineering Mechanics?

Engineering Mechanics serves as a bridge between work in the basic sciences—mathematics, physics and chemistry—and the various engineering curricula. The mechanics courses common to all engineering curricula are: *Statics,* concerned with forces and equilibrium of bodies under the action of forces; *Dynamics,* concerned with the motion of particles and bodies and the forces necessary to cause such motion; *Mechanics of Materials,* concerned with the stresses and strains within beams, shafts, columns, and other elements performing their usual functions in structures and machines; *Properties of Materials,* concerned with understanding and measuring the mechanical and physical properties of materials such as metals, plastics, concrete, soils and wood. The new curriculum in Engineering Mechanics provides for more courses in physics, chemistry and mathematics than required in most engineering curricula along with advanced courses in Engineering Mechanics. It includes a course in *Experimental Stress Analysis* which is concerned with the use of photoelasticity and various mechanical and electrical strain gages for the purposes of determining stresses when theoretical calculations are not practical. Graduate courses leading to the Master of Science and Doctor of Philosophy degrees, which have been given by the Department for many years, consider further such fields of study as elasticity, plasticity, plates, shells, and elastic stability.

Why Was This New Curriculum Started?

There are many reasons and a few of the more important are listed below:

First, many engineers now frequently work as a team with chemists, physicists, and mathematicians and must be able to understand them.

Second, many returning graduates have indicated that they thought an undergraduate curriculum in Engineering Mechanics would have been of great benefit to them in their professional activities and recommended strongly that such a curriculum be activated.

Third, most industrial organizations, both large and small, prefer that their men come to them with a broad fundamental scientific background. Generally they themselves prefer to teach the details relating to their specific activities.

Fourth, recent studies of the American Society for Engineering Education have recommended a strengthening of the work in the basic sciences.

Fifth, perhaps the most important reason for the formation of the curriculum in Engineering Mechanics has been the great changes that have taken place in science and engineering during the past years. Among the most important of these have been the rapid diffusion of scientific knowledge and disciplines into engineering, the increasing use of the analytical approach to the solution of practical problems, and the need for a better understanding of the properties and mechanics of materials. While engineering is still both an art and a science, some fields are based largely upon empirical data and experience while others have a highly organized scientific basis.

(Continued on page 45)


30 KW INTERNATIONAL HARVESTER
DIESEL GENERATOR
2 CYL. SUPERIOR DIESEL ENGINE
NATIONAL SUPPLY CO. SPRINGFIELD, OHIO

Mechanical Engineering

by Professor Ralph J. Harker
Chairman, Mechanical Engineering Department

Professor Ralph J. Harker is completing his first year as Chairman of the Department of Mechanical Engineering. He is a native of Madison, Wisconsin, and received his B.S. and M.S. from the University of Wisconsin. His field is machine design, with particular interest in vibration and balancing. He has had considerable experience in the aircraft industry, and is vice-chairman of the Rock River Valley Section of the American Society of Mechanical Engineers.

MECHANICAL Engineering is that phase of engineering which deals principally with the design, analysis, test, production and utilization of mechanical equipment. It is difficult to specify the exact scope of mechanical engineering because of the breadth of activity which is involved; however, the men practicing in this field are concerned with the development of such items as automobiles, engines, turbines, machine tools, household appliances and production machinery. Although many special areas exist in the profession, the field is traditionally divided into three broad activities. They are heat power, design, and industrial engineering.

In the heat power field, engineers are interested in the analysis of liquids, gases, and vapors, as they are used in all types of engineering applications. Thus, the internal combustion engine, the steam turbine, the refrigerator, and the rocket engine are but a few examples of equipment requiring this type of engineering. To be proficient in this area, the engineer must have a knowledge of thermodynamics, heat transfer, fluid flow, combustion, and other related subjects.

At left is a picture of the Heat Power Laboratory at University of Wisconsin.

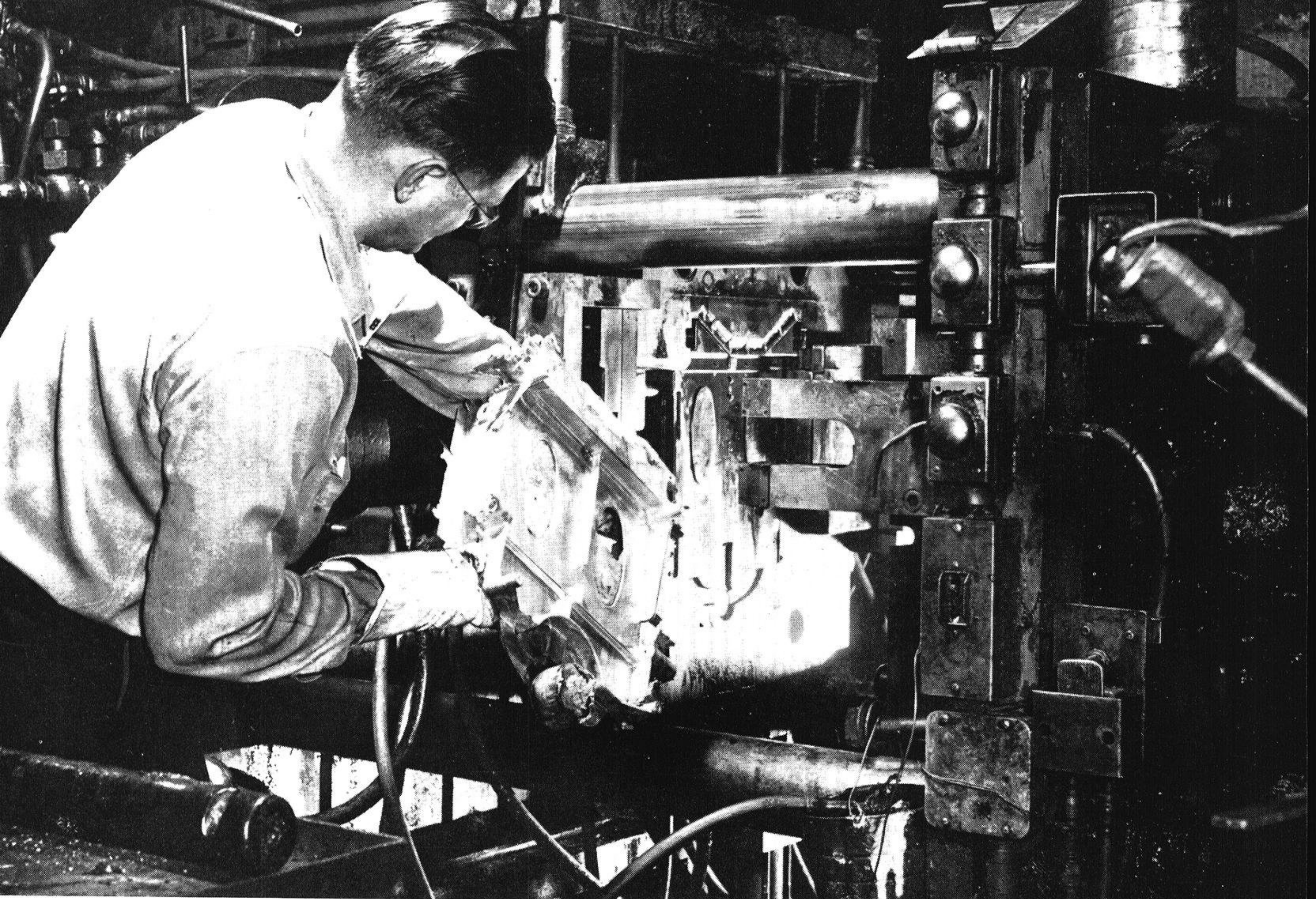
In the design field, mechanical engineers are called upon to conceive new devices and machines, and to refine and improve existing designs. Perhaps no phase of mechanical engineering places greater demands upon the imagination, ingenuity, and judgment of an engineer than that of mechanical design. Design requires the conversion of ideas to physical reality, which is the essence of engineering. The design engineer must be well grounded in mechanisms, machine elements, mechanics, strength of materials, dynamics, vibrations and many other subjects which relate specifically to design.

In the industrial engineering field all types of production problems are encountered. This is the domain of the engineer interested in the manufacture of finished products, usually on a mass-production basis. It is here that engineers are concerned with how a part or machine may be produced in the most economical manner. There are many subjects related to this field, including industrial organization, plant layout, cost analysis, time-and-motion study, materials handling and inspection methods. With the increasing complexity of the mass-production techniques, industrial engineering is a rapidly expanding field.

The mechanical engineer, although contributing to our present technology in every industry and in every phase of equipment production, has played a dominant role in the transportation, power generation, and machine tool fields. He has exerted a major influence in the existence in this country of the highest standard of living in the world. This has been largely achieved by the effective mass-production system which has been developed for durable goods, and by the design and construction of equipment for the efficient conversion of fuel energy.

Because the training of a Mechanical Engineer is rather broad, he is in demand in practically every type of manufacturing organization, and in many research and governmental organizations; however, about two-thirds of the Mechanical Engineering graduates are engaged in corporate employment. He may be employed in the electrical, chemical, petroleum, metal-processing, paper, plastics, or any other of a host of industries which require his services in connection with especially engineered production equipment, for plant engineering, or for administrative responsibilities.

(Continued on page 45)



Mining and Metallurgical Engineering

by Professor P. C. Rosenthal
Chairman, Department of Mining and Metallurgy

This is Professor Rosenthal's fifth year as department head. He received his B.S. and M.S. in Metallurgical Engineering from the University of Wisconsin. He has been very active in the AFS and ASM, being chairman of several committees. He was co-author of "Principles of Metal Casting."

IF YOU were to examine a list of the elements and their properties you would find that the majority of them would be classified as metals. Further investigation into the use of these metals would reveal that almost everyone of them has some commercial application in the pure or alloyed form. A more intensive study, such as would be gained in a mining or metallurgical engineering program of courses, would establish that even many of the non-metals such as oxygen, carbon, phosphorus, etc., play an important part in metal processing and alloying. Thus the mining or metallurgical engineer deals with a wide variety of elements and combinations thereof, and must understand the chemical and physical problems associated with their preparation and use.

Utilization of metals begins with the discovery and development of mineral wealth. This is the work of the *mining engineer.* The curriculum for mining engineering includes, in addition to courses in mine evaluation, development, and ore removal, related courses in geology, mineral concentration and chemical processing. There are also courses in related fields such as hydraulics, surveying, electrical engineering, and heat and power.

Top: Aluminum part being taken from die after casting has been made. Bottom: The metallograph shown provides for inspection and photograph of metals magnified to 50 to 3000 times.

One option of the curriculum in this field concentrates on the geological aspects of mining. The graduate from this program is referred to as a *geological engineer* and would be primarily concerned with finding and exploring new ore bodies or oil fields. He would estimate the economic value of the ore and determine how it might best be extracted from the earth.

The *mining engineer* designs, constructs, and operates mining properties. He, in effect, begins where the geological engineer leaves off because his principal tasks are associated directly with the mining operation. He plans the method of removing the ore, designs the transportation system and handles related problems of ventilation, power supply, etc.

In the petroleum field, the counterpart to the mining engineer is the *petroleum engineer.* His job is to plan and operate the oil-drilling and pumping equipment and arrange for the storage of the crude petroleum. He should also be familiar with methods used to locate new petroleum fields.

The geological, mining and petroleum engineering options are all available at Wisconsin.

Once the ore is removed from the earth, it must be processed further before the metal can be extracted. This is called mineral beneficiation, mineral dressing or mineral concentration. This field represents the link between mining on the one hand and metallurgy on the other. The *mineral dressing engineer* designs and operates plants for the separation of the valuable minerals from the waste products. This field is becoming increasingly more important as the richer ore deposits become exhausted and lower grade ores must be utilized. In Wisconsin, for instance, the use of the available low grade ores awaits development of economical methods for concentrating these ores to higher iron contents. The mineral dressing engineer uses many methods and devices for concentrating ores such as gravity separation, "heavy media" separations, and flotation. His program of study is much the same as that of the mining engineer but usually contains less mining and more metallurgical engineering subjects.

After the mineral dressing engineer has completed his work of concentrating the ore, the metallurgical engineer steps in to reduce the ore to the metallic state. In this work he may utilize heat, electricity, chemicals or a combination of these factors. Since this treatment usually involves chemical reactions, this metallurgical engineer-

(Continued on page 45)

Dean Wendt

(Continued from page 24)

ical and physical changes comprise the field of chemical engineering.

Civil engineering, the oldest branch, at one time included all engineering of a non-military character; today the main divisions are structural, sanitary, hydraulic, and transportation engineering.

Electrical engineering has two main divisions: power engineering, which is concerned with the generation, transportation, and application of electrical energy; and the broad field of communications and electronics which includes telegraph, telephone, radio, radar, television and control.

The mechanical engineer deals chiefly with the design and construction of machines for the generation or transformation of power, the design and production of machine tools, and industrial planning and management.

The mining engineer searches for and extracts all classes of minerals from the earth; the field naturally divides itself into mining geology, mining engineering, and mineral dressing.

The metallurgical engineer extracts metals from their ores and subsequently refines and combines metals to produce alloys possessing special properties.

In the following pages you will find detailed statements about each of these fields of engineering. Many combinations of engineering and agriculture, commerce, city planning, light building industry, or law are also possible and provide unusual opportunities for qualified students. Anyone interested should write for a pamphlet giving further information about "combined programs in engineering," and should plan such programs carefully during the first year at the University.

Regardless of field, many areas of work and a large variety of duties are common to all engineers. For this reason you will find many courses common to all engineering curricula. As in any profession, success in engineering demands integrity, industry, perseverance, courtesy, and good personality. In addition, interest in and strong aptitude for mathematics, the sciences, and written and oral expression are of primary importance. If you possess these qualities and aptitudes, find the duties of engineers attractive, and are willing to work hard, you should and can become a successful engineer. The rewards, materially and in personal satisfaction, are substantial.

Career Opportunities

(Continued from page 25)

along with the increased enrollment of engineering students and the need for engineering graduates. The primary purpose of the Placement Office is to provide facilities and information for seniors when they begin looking for a job and give counsel and advice to those who want help.

Each year, several hundred representatives from companies throughout Wisconsin and all over the country visit the campus to interview seniors. These companies provide literature and other information about the opportunities available. The seniors examine this material and interview companies that are interesting to them and which have expressed a need for people with their particular qualifications. If, after the campus interview, there is mutual interest between the company and the student, he will very likely receive an invitation to visit the company to further discuss employment possibilities. In some cases, seniors must enter military service after graduation but some companies will hire these individuals and grant military leave when they are called to active duty. If the graduate prefers, he may use the Placement Office after returning from service. At any time after graduation, College of Engineering alumni can use the Placement Office if they wish to relocate.

New opportunities are also developing in terms of summer employment for engineering students while still in college. Even after the freshman year it is sometimes possible to find summer work in some phase of engineering. In addition to making it possible to earn money, the student can gain worthwhile experience in summer work and see how engineering theories are applied in industry. And he may discover special interests in a particular phase of engineering and tailor his selection of courses accordingly. As a result he will be better prepared to continue his career after graduation.

University Extension

(Continued from page 28)

Years to Completion

The first point of understanding about the time it takes to graduate in engineering is that the engineering programs at Wisconsin vary from 146 to 152 semester credits. This means that you will have to earn an average 18 hours per semester just to stay abreast of the schedule. If your freshman and/or sophomore programs contain a sufficient number of courses in the required areas of English, mathematics, chemistry, drawing, physics, economics, history, speech, shop, mechanics, you stand a good chance of maintaining pace with your contemporaries in Madison. An excess of credits in music, sociology, philosophy, will simply mean that your total credits upon graduation will exceed the numbers spelled out above by virtue of courses taken outside of the rather rigid engineering requirements. There is not space here to spell out the particular requirements of each degree program or some of the allowable course substitutions that may be made. Nevertheless, it is easy for you to visualize a course in geology being useful to a mining or metallurgical engineer, and a third course in physics being useful to an electrical or a mechanical engineer.

A recent study completed here showed that the average time required to complete a course in engineering is very close to nine semesters. This figure was quite standard from curriculum to curriculum and varied little whether the student spent all of his time on the Madison campus or transferred here after one or two years at Milwaukee, the State Colleges, or the Extension Centers. Returning then to the typical degree requirement of 146 to 152 credits, the average semester load becomes more like 16 to 17 credits. This would appear to be a sensible approach to consider when undertaking an engineering program.

The current favorable career prospects for engineering graduates should supply the incentive for the additional semester's work that is required on the average. The opportunity to effect some overall economies by two to four semesters' study close at home where living costs are lower and part-time and summer employment prospects are better should go a long way toward financing the extra semester's study so many engineering students find to be inescapable. A study of your personal situation may strongly suggest to you that you begin work in one of the Extension Centers of the State Colleges. If you do, there is every reason to believe that time will bear out the overall wisdom of your selection.

Civil Engineering

(Continued from page 35)

support the floor of a bridge or building and the size of columns and abutments needed for support. He will determine the size and location of the reinforcing bars for concrete structures and how much cement, water, and aggregate to use to get maximum strength for the most economical cost. With experience he may become a partner in the firm or start his own consulting firm.

In short, a young man who likes mathematics and science, the tools of all engineering, who has the imagination for planning, the precision for exact design, or the strength for construction will find many satisfactions and rewards when he chooses a career in Civil Engineering.

Engineering Mechanics

(Continued from page 39)

The empirical approach necessarily involves specialization since the results are usually closely related to the specific problem. The methods of the analytical approach are general. For example, problems in electronics, fluid mechanics, elasticity, heat transfer, thermodynamics, and others show remarkable similarity in the form of the differential equations that result from analyses. The analytical phases of engineering are therefore broad and not highly restricted by subject barriers.

Who Should Be Interested in This Curriculum?

Any student who is interested in a broad and basic education in the fundamental sciences and who has enjoyed and has had good success with his courses in mathematics, physics and chemistry in high school should consider this curriculum carefully. This curriculum should appeal especially to students who are interested in research, industrial product and process development, and teaching in engineering colleges and universities, and it will also provide a good background which may be used for future development in many other areas.

What are the Opportunities Open to Graduates of the Engineering Mechanics Curriculum?

As previously noted, this curriculum is designed to prepare engineers for graduate work and for careers in research, industrial product and process development, and teaching in engineering colleges and universities. Publications such as CAREER which list job opportunities indicate special requests from such companies as Aerojet-General Engineering Corporation, Astronautics Systems, Inc., Bell Aircraft, Chrysler Engineering, Chrysler Guided Missiles, Lockheed Missile Systems, Northrop Aircraft, Inc., Ramo-Wooldridge, and Space Technology Laboratories. In the Government, opportunities exist in such organizations as the U. S. Atomic Energy Commission, National Bureau of Standards, and the Naval Ordinance Laboratory.

Mechanical Engineering

(Continued from page 41)

The Department of Mechanical Engineering at Wisconsin has extensive facilities for undergraduate instruction and graduate research, including heat power, heat transfer, internal combustion engine, and machine design laboratories. Well-equipped shops are available for instruction in production processes. Student chapters of the American Society of Mechanical Engineers, the Society of Automotive Engineers, and Pi Tau Sigma, honorary mechanical engineering fraternity, are actively supported by the student body.

Qualified students obtaining college training in any branch of engineering can look forward to a challenging and rewarding professional career. The opportunities for capable, well-trained engineers have never been greater. With the expansion of our economy, the increasing complexity of our technology, and with ever greater emphasis placed upon research, it appears that the demand for trained Mechanical Engineers will continue to increase at any unprecedented rate.

Mining & Metallurgy

(Continued from page 43)

ing field is called *chemical or extractive metallurgy*. An example of an extractive metallurgical operation is the reduction of iron ore in the blast furnace to produce pig iron, the pig iron being subsequently refined to steel. The large metal refineries scattered through the country all depend upon metallurgists for their design and operation. New processes, increasing use of low grade ores, new metal requirements, etc., have all added to the scope and importance of the work done by the extractive metallurgists. When the extractive metallurgist has completed his job of reducing the ore to the metallic state, the physical metallurgist takes over to improve the product.

The alchemists of old were constantly striving to change base metals to noble metals. Had their efforts succeeded they probably would be no less spectacular than the efforts of the present day *physical metallurgists* who have succeeded in greatly improving the mechanical and physical properties of metals by alloying and special treatments. The physical metallurgist finds opportunities in a wide variety of industries.

THE END

What's Your Question?

HIGH school students have many questions concerning requirements and activities of college life. Following are questions and the respective answers pertaining to student life at the University of Wisconsin.

What educational program does the University of Wisconsin offer?

Students have the opportunity to study in almost all major areas of endeavor, including the humanities, arts, sciences, and social studies. In addition, preprofessional and professional opportunities are available in engineering, commerce, teaching, medicine, law, pharmacy, and many allied fields. All told, the University offers over 1,200 courses from which to choose.

What are the admission requirements?

The general method of admission is by presenting a certificate of graduation from an accredited high school with the recommendation of the principal. Sixteen units are the fundamental requirement, which for engineering must include four years of math, including advanced algebra, solid or analytic geometry, and trigonometry.

Does the University have an official grading system?

The University of Wisconsin marks on an alphabetical basis with the grade points per credit as follows:

"A" (Excellent) 4 grade points per credit
"B" (Good) .. 3 grade points per credit
"C" (Fair) ... 2 grade points per credit
"D" (Poor) ... 1 grade point per credit
"F" (Failure) . 0 grade point per credit

What are the semester fees?

In all colleges and schools except Law and Medicine the fees are $110 per semester for a resident of the state and $300 for a nonresident.

What housing arrangements are available?

Housing accommodations for single students include:

University Residence Halls, Independent and Cooperative houses, sororities, fraternities, the University YMCA, the Eagle Heights apartments for married couples, and rooms in private homes throughout the residential sections of the city. The University Housing Bureau is the clearing center for all student housing information and is located at 434 Sterling Court.

Does the student have any supervision in the planning of his courses and program?

Yes, the University operates on an advisory system whereby each new student is assigned a faculty adviser. The adviser is expected to help the student in the choice of his course and in the selection of a well-balanced program.

Is there additional counseling service available to students?

A trained staff is available to counsel students regarding personal, vocational, or academic problems. The Student Counseling Center is located at 740 Langdon Street.

What provisions do the University provide toward the maintenance of the health of the student body?

The services of the Department of Preventive Medicine and Student Health are available to students who are regularly enrolled in the University of Wisconsin. The Student Clinic and Infirmary are located in the West wing of Wisconsin General Hospital.

Are scholarships available for undergraduate students?

There are many scholarships available to deserving students. Scholarship information and application forms may be obtained from the Office of Loans and Undergraduate Scholarships, 114 Bascom Hall, or the appropriate college, departmental office, or committee chairman.

Is there an ROTC program?

All ROTC will be voluntary for at least the next two years. One may select the Army, Navy, or Air Force for basic and advanced training.

Are student loans available?

Loans for educational purposes in amounts up to $250.00 are made for periods of less than a year to students in good standing, who have established a satisfactory academic record of at least one semester at the University of Wisconsin.

What are the possibilities of obtaining part-time work?

The Student Employment Bureau is often able to locate some kind of part-time work for those who desire it. Its address is 435 North Park Street.

Does the University operate any Extension Divisions?

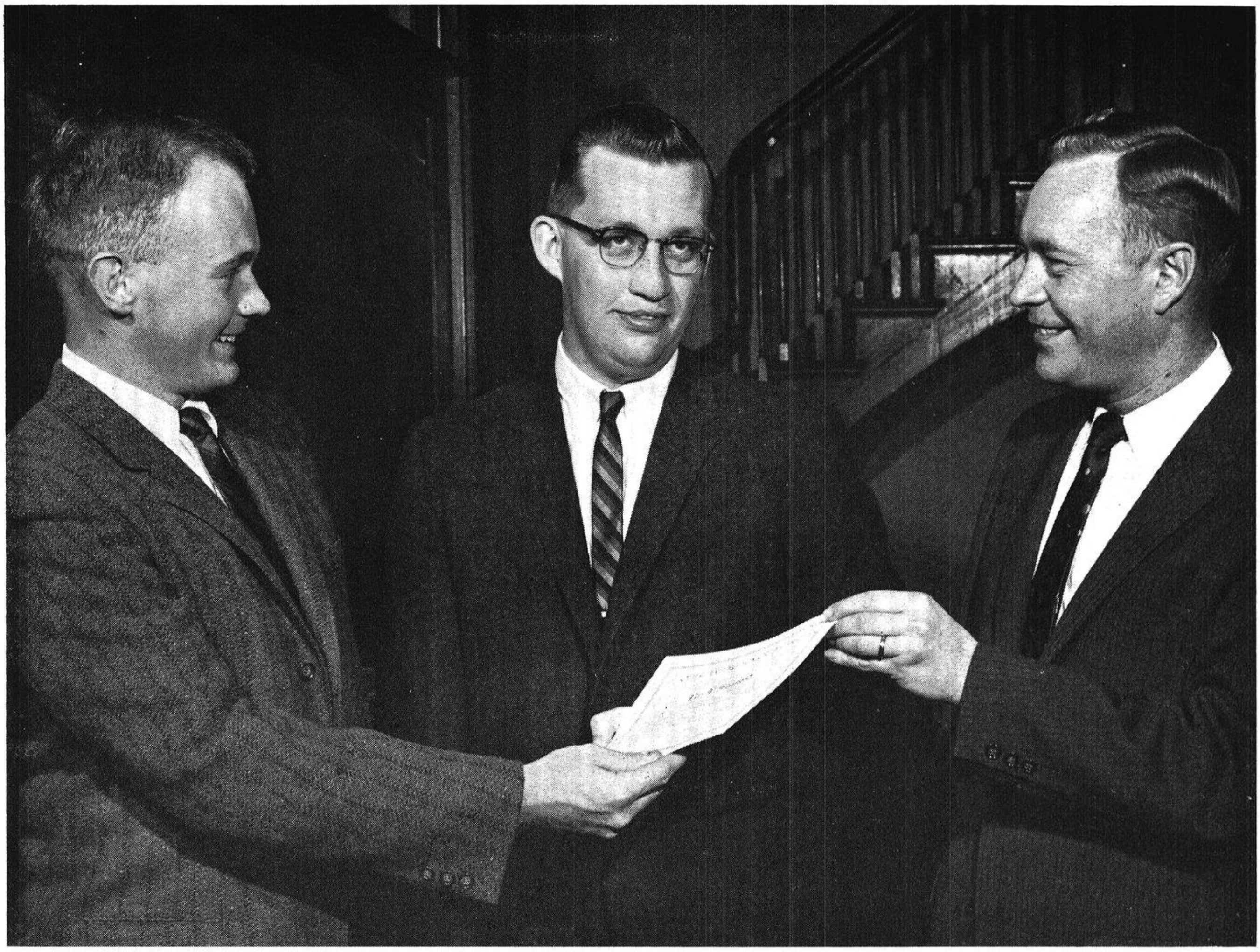
The University of Wisconsin operates Extension centers in Sheboygan, Milwaukee, Racine, Wausau, Green Bay, Kenosha, Manitowoc, Menasha, and Marinette.

How are the library facilities?

There are more than a dozen libraries, the chief among them being the Memorial Library and the Library of the State Historical Society.

Are there sororities and fraternities on campus?

There are fifteen sororities and thirty-three social fraternities on campus, with all but one maintaining resident houses for their members. In addition, there are many professional fraternities.



Robert Onan, Lee Raymond, Professor Marks.

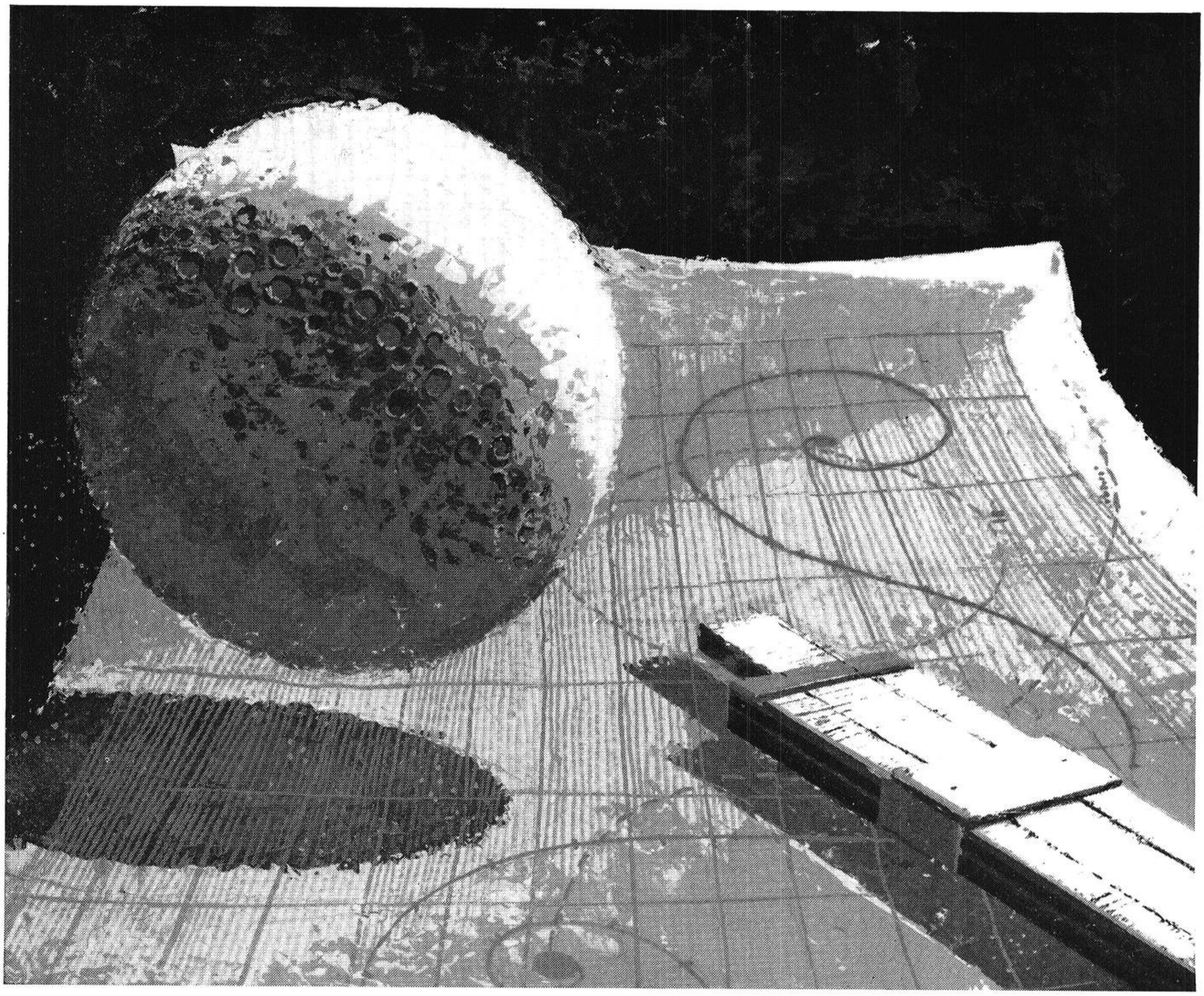
OUTSTANDING SENIOR AWARD

The outstanding senior award sponsored by Polygon this year went to Lee R. Raymond of Watertown, South Dakota. Lee is a Chemical Engineer who will graduate in June.

Sophomore honors, Mace, Alfred Sloan Scholar, Phi Eta Sigma (freshman honorary), Phi Lambda Upsilon (chemistry honorary), Delta Sigma Rho (forensics honorary), Tau Beta Pi (honorary engineering), and Vilas Medal (forensics), include the honors received by Raymond thus far. The activities he has taken part in are: varsity debate (4 years), Wisconsin Forensic Union, president of Delta Sigma Rho, chairman of Wisconsin Annual Intercollegiate Forensic Conference, and secretary and president of Alpha Chi Sigma. With all this Lee has been able to earn a 3.57 over-all grade point.

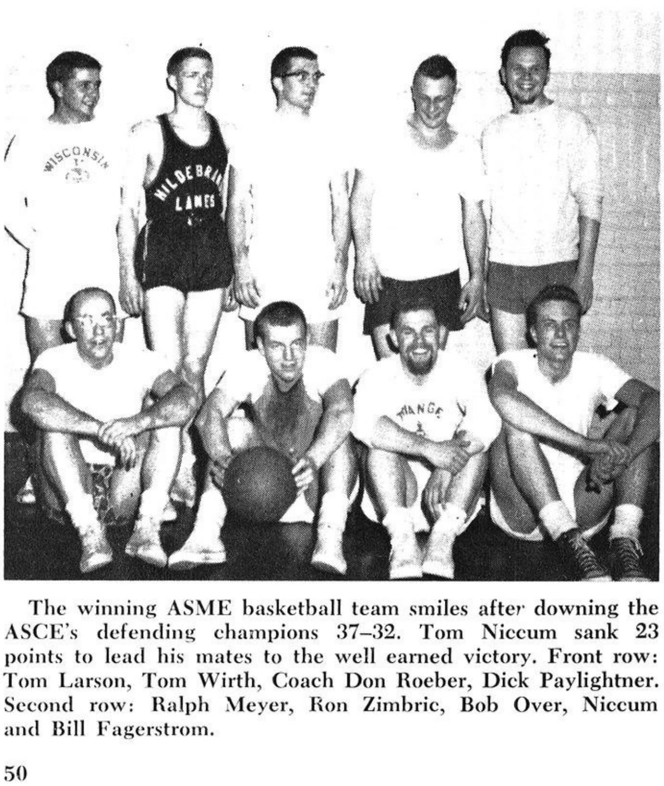
The Senior Award is given each year by the Polygon Board to the engineering student that they feel is outstanding in academics, activities, and personal relations. Students are nominated and their names are given to a committee of two students and two faculty members. The committee reduces the nominees to ten and these are personally interviewed and the winner is chosen.

The award is one of recognition and is the highest award given to any engineering student.

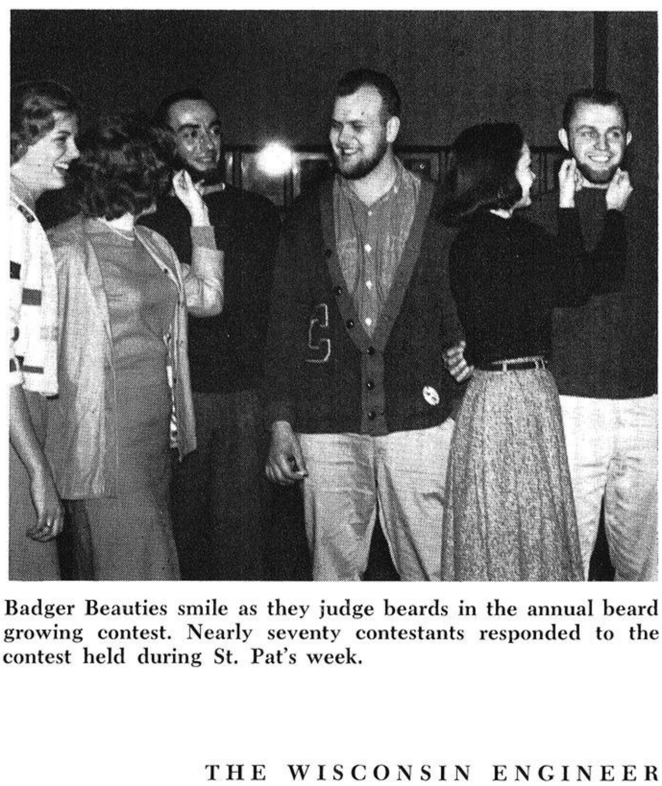


ST. PAT WAS

St. Pat's Chairman George Kerchove presents Beard contest winners, their trophies at the St. Pat's dance. Left to right are George Kuykendall, Bill Hable, Kerchove, and Oscar Dittrich.

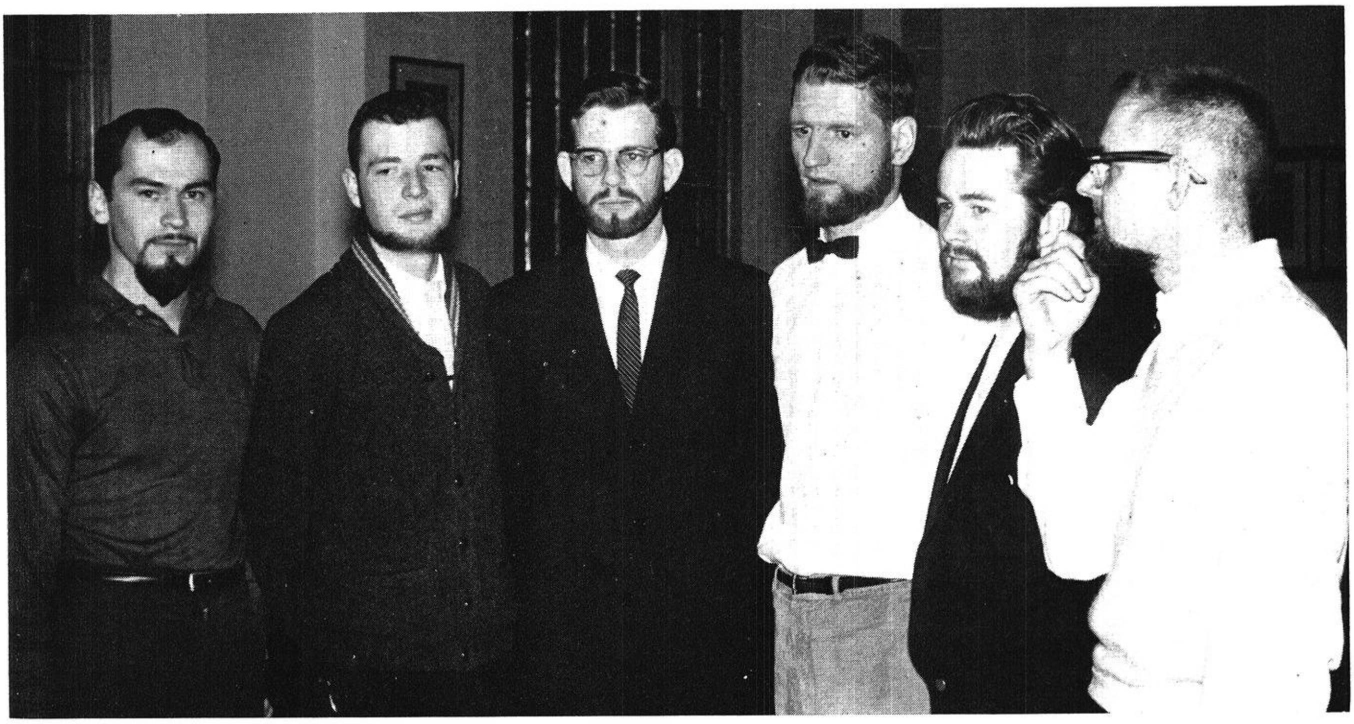


The winning ASME basketball team smiles after downing the ASCE's defending champions 37–32. Tom Niccum sank 23 points to lead his mates to the well earned victory. Front row: Tom Larson, Tom Wirth, Coach Don Roeber, Dick Paylightner. Second row: Ralph Meyer, Ron Zimbric, Bob Over, Niccum and Bill Fagerstrom.



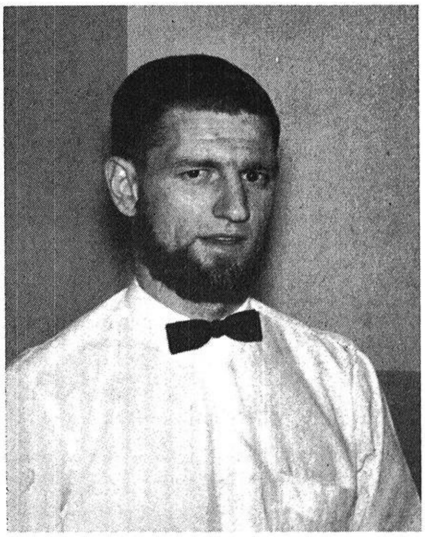
Badger Beauties smile as they judge beards in the annual beard growing contest. Nearly seventy contestants responded to the contest held during St. Pat's week.

AN ENGINEER



Jacob Kuykendall, Most Devilish; Wayne Everts, Most Colorful; Harley Bopray, Most Distinguished; Oscar Dittrich, Most Lincoln-like; Bjarne Helland, Bushiest; and George Schaeffer, Longest; were winners in the beard contest. Not pictured here is Bill Hable, Curliest.

Misses Judy Kinder, Lynne Anselman and Sally Trieloff pose after being disqualified for having false beards. Their antics touched off the note of merryment seen throughout this years St. Pat's activities.



Oscar Dittrich, this years St. Patrick, represented the victorious Civil Engineers who won the St. Pat's contest with the largest accumulation of points in all events.

ENGINE EARS

by Bob Helm, ce'61

TRIANGLE FRATERNITY

Fifteen members of Triangle fraternity made the trip to Evanston for the annual Triangle basketball tournament on April 8 and 9. The games against the other Triangle Chapters and the dance on Saturday night were the highlights of April. Tom Niccum led Wisconsin's Triangle team in the basketball games which were played in the morning and afternoon in Northwestern's Patton gymnasium. The dance and other contests were held in the Merchandise Mart, in Chicago. Miss Sandy Sabish, pinmate of Jim Schwefel, was the Wisconsin chapters contestant, in the annual Triangle sweetheart contest. Wisconsin gave its traditional good showing in the chug-a-lug contest held on Saturday night.

Bill Fagerstrom, Don Roeber, and Al Folkman are among the Triangles who enjoy shaving again. They reluctantly shaved their beards and sideburns after the St. Pat's day festivities. It's hard to recognize the new faces.

Easter vacation took much of April, but that did not stop plans from being completed for the Founders Day Banquet. The banquet, given by every chapter in the spring, commemorates the founding of Triangle Fraternity at Illinois, in 1907, and is attended by both actives and alumni.

KHK NEWS

Sure, we had a Valentine's day party, way back in February. That was the party where all the fellows pinned their dates under the auspices of our own chief matchmaker Don Panzenhagen. The matches were not lasting however because the pins exchanged were valentine hearts.

The Kappa Eta Kappa Founders Day Banquet proved to be just what the alumni wanted. It was jointly sponsored by Delta Chapter of Madison and Theta Chapter of the Milwaukee School of Engineering. One hundred alums, actives and honoraries assembled at the Black Steer in Milwaukee to celebrate the birthday of the fraternity. Those present were enter-

Typical of St. Pat's celebration is this scene from Triangle Fraternity's pre-St. Pat's Dance party. Green beer was the order of the day as Tom Niccum assumes the unlikely position of song leader as Howie Nitskowski, Sue Vanderhey and Dave Cavil join the singing.

tained with a talk on the various aspects of hi-fi spiced by the humerous delivery of Dr. Greiner of our own Electrical Engineering Department. The audience was kept in a gay state of mind by the quips of Master of Ceremonies J. B. Miller also of Electrical Engineering. It was tentatively decided to make the banquet an annual affair in an effort to keep the alumni in touch with the fraternity.

Spring is here and pledging is well under way. KHK has a fine crew of pledges this semester. The two rushing smokers were a great success in acquainting Electrical Engineers with the advantages of fraternity life. The pledges of the Spring Semester are: De Wayne Surguy, Ed Sodowski, Jeff Dunn, Daniel Jorgenson, Robert Dixon, Richard Mading, Jim Maynard, Richard Cary, Howard Abraham, Ken Oestreich, Ralph Noffke, Fred Pospeschil, Les Broderson and Dick Goreal. They will no doubt keep the actives alert during this semester.

S.A.E.

The February meeting of the Society of Automotive Engineers was held at the Memorial Union. The meeting consisted of short business meeting and a lecture on the Ford Falcon. This was then followed by free refreshments and a question and answer period.

Ford's representative, Mr. Prendergast, gave a lecture which explained how the attributes of the Falcon were combined with the general process used to design a new automobile. He also told of some of the problems which were encountered and how they were solved. One example was the fact that two holes did not line up, and a huge sum of money was required to remedy the problem.

A.S.C.E.

At a recent meeting of the student chapter of the A.S.C.E., Dr. Arno T. Lenz spoke on the Bureau of Reclamation. His talk was illustrated with slides showing projects of the Bureau throughout the West.

At another meeting, Mr. Lyman Wood of Forest Products Laboratory gave an illustrated talk on "Structural Applications of Wood." Mr. Wood's slides showed methods of timber testing and timber construction projects.

New officers of the Society are: Donald Graff, president; John Crane, vice-president; Fay Kell, secretary; Garrett Neilsen, treasurer, and Peter Van Horne, Polygon board representative. Oscar Dittrich was elected to represent St. Pat for the society.

Meeting dates and subjects for the remaining meetings are:

April 13—United States Steel Bridge movie.

April 27—Election of officers.

May 11—Picnic.

FOR THE EE'S

The measurement of complex electrical activity in the brain by a University of Wisconsin scientist promises to lead to an understanding of how we are able to recognize minor differences in the pitch of a sound.

Dr. Joseph E. Hind, UW professor of physiology, is measuring the electrical activity of single cells in the brain of cats. Using special microelectrodes, Dr. Hind is able to record the response of brain cells to sounds stimuli received by the ear.

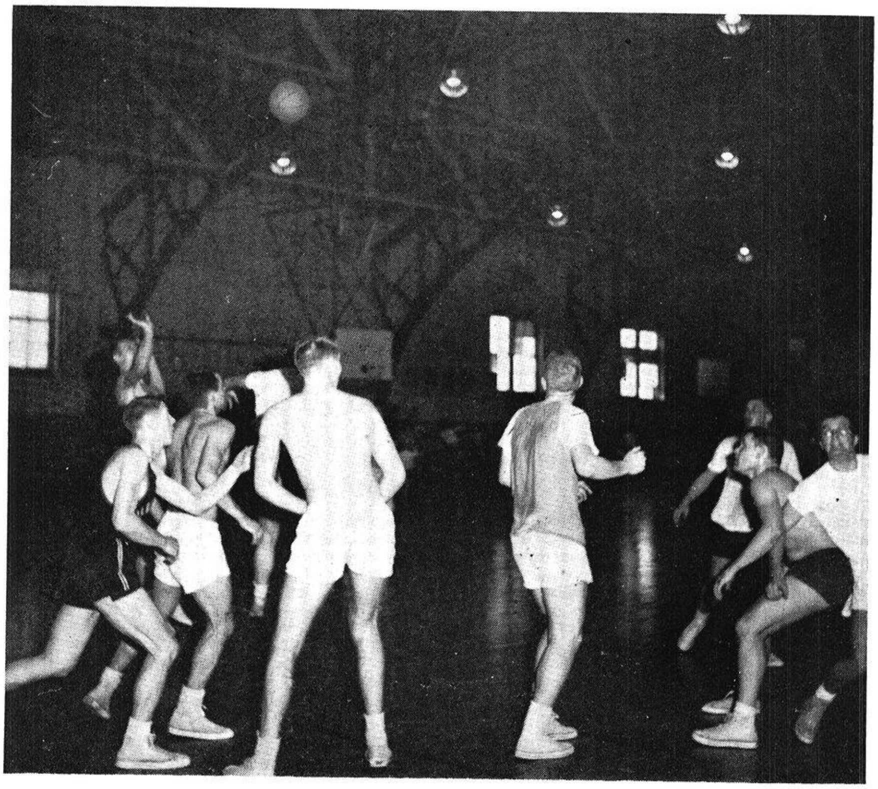
The UW Neurophysiology Group, of which Dr. Hind is a member, has done considerable work on the localization of activity on the brain's surface. In working with hearing, the activity of cells stimulated by varying frequencies of sound is localized on different portions of the auditory cortex, that part of the brain concerned with the reception of information from the ear.

This localization is only relative for there is activity over a wide area of the auditory cortex. However, maximum activity is limited to a small area, the location of which varies with the frequency of sound.

The mechanical properties of the cochlea, that part of the ear responsible for converting sound vibrations into electrical changes, are such that it is only able to make a rough analysis of the sounds received by the ear. The auditory nervous system is able to sharpen this analysis in some manner not completely understood.

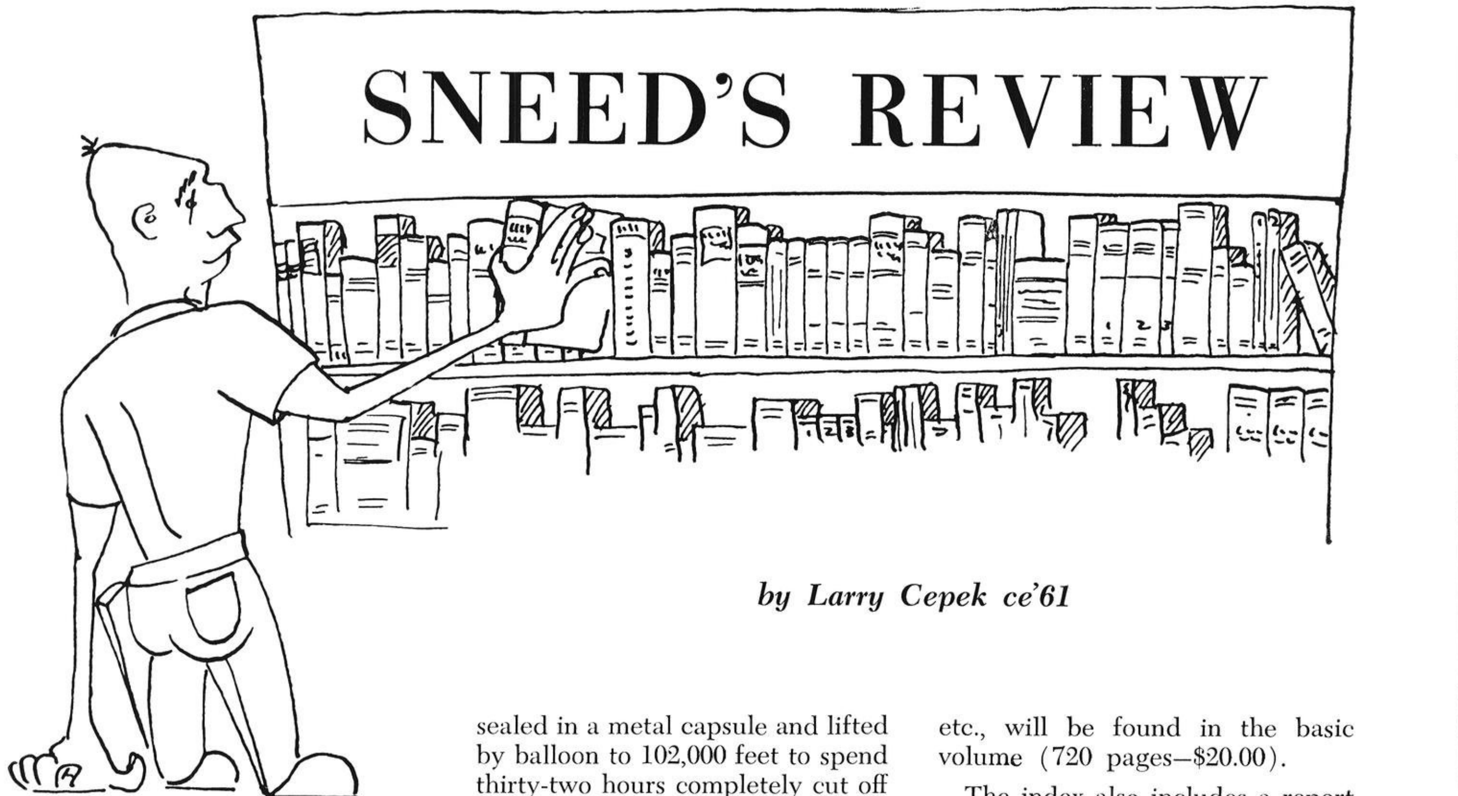
The patterns of response of the brain cells may be the clue to

(Continued on page 58)



Dennis Cook fires a shot as Ron Zimbric, Dick Bautche, Pete Johnson, Tom Wirth and Tom Niccum wait for the rebound. In the right foreground Todd Cayon and Bob Over vie for position. The ASME team defeated the ASCE's to take the society basketball tournament championship. An all star team of engineers downed the lawyers 52–46 with Tom Wirth's 31 points leading the way.

SNEED'S REVIEW



by Larry Cepek ce'61

LOOKING OUT INTO SPACE

Today the pilot is the weakest link in man's attempts to journey farther into space and faster through the air. He must be prepared for the physical punishment of high altitude and faster-than-sound flying. Mentally he has to learn to cope with this new world —a world where he feels cut off from life and all its common sights and sounds, and where the immeasurable loneliness can produce frightening hallucinations and distortions of the mind. In "Man's Reach Into Space" Roy Gallant has written of the problems and the great advances that have been made in space travel. He also gives fascinating glimpses into the experiments and discoveries made in producing aircraft and rockets capable of moving at unlimited heights and speeds.

In Paris, in the year 1875, three explorers in the balloon Zenith ventured higher into the atmosphere than any men before them —28,000 feet. Poorly equipped for their adventure, they overstepped the first of the boundaries that separate man from space, and they died from oxygen starvation. Less than one hundred years later in 1957 an Air Force Colonel was sealed in a metal capsule and lifted by balloon to 102,000 feet to spend thirty-two hours completely cut off from the outside air, and he lived to record his valuable experiences.

To research this book Roy Gallant traveled by bus, car, bomber and jet fighter plane and interviewed the Air Force's leading research scientists. Other books by Roy Gallant include "Exploring Chemistry," "Exploring Mars," and "Exploring the Universe." "Man's Reach Into Space" is published by Garden City Books, and contains illustrations by Lee J. Ames. If interested in purchasing write to Doubleday and Company, Inc., 575 Madison Avenue, New York 22, N. Y.

ENCYCLOPEDIA OF AMERICAN ASSOCIATIONS GEOGRAPHIC INDEX

**Gale Research Company, 34th Floor, Book Tower, Detroit 26, Mich.
174 pages. $15.00**

A new Geographic Index, lists by state and city, all national associations, professional societies labor unions, and other non-profit organizations listed in the basic volume, *Encyclopedia of American Associations,* (arranged by subject).

Each listing in the new index includes the name and address of the association, as well as name and title of the chief official. Further details concerning membership, history, activities, publications, committees, conventions, etc., will be found in the basic volume (720 pages—$20.00).

The index also includes a report summarizing the location of association headquarters. The survey shows that one-half of all national organizations are headquartered in three cities, New York (1921), Washington, D.C. (869), and Chicago (609).

Other large concentrations of associations are in Philadelphia (250), Los Angeles (75), Cleveland (74), Boston (72), Pittsburgh (57), Detroit (53), Columbus (51), St. Louis (50), Minneapolis (44), San Francsico (44), Kansas City (42), Indianapolis (37), Denver (31), Evanston (29), Atlanta (24), Ann Arbor (17), and Honolulu (7).

NEW BOOK FOR BRIDGE PLAYERS

"Common Sense Bridge" by Abe Goldstein is a brand new book that plainly shows and unequivocally states that it will make you a better bridge player. This book is aimed primarily at the intermediate player but the content is such that any player will derive some benefit from the thorough explanations of the principles of the game.

Mr. Goldstein says, "there are twelve plateaus in the bridge world. The beginner and the novice occupy twelve, eleven, and ten. The intermediate, who has mastered the point count and the standard method of bidding, but plays his cards like a novice, occupies the ninth plateau. Numbers eight and seven are those players who play the cards in improved fashion." This book, then, is designed to help numbers, nine, eight, and seven primarily. It does not guarantee that after reading you will become an expert, but it does assert that your bidding will show a marked improvement. If you agree with the author that bidding is 60 per cent of the game, then you will very definitely become a better player.

Opening suit bids, no trump; bidding, competitive bids, preemptive bidding, and the art of defense are a few of the many sections devoted to all types of play. This thorough new book also contains a chapter on manners at the bridge table which are so often overlooked by the average player. It contains 80 pages with illustrations of many different types of hands used in the various bids, is paperbound and sells for $1.50. You may order directly from the publisher, Arco Publishing Company, 480 Lexington Avenue, New York 17, N.Y.

Mr. Goldstein who is a life master of the American Contract Bridge League, has combined years of experience as a player with good, sound explanations of some of the more intricate problems of this intriguing game. With an application of these "common sense" explanations you are well on your way to becoming a much improved player.

ACRONYMS DICTIONARY

Gale Research Company, 34th Floor, Book, Tower, Detroit 26, Mich.
192 pages. $10.00

Acronyms Dictionary is a guide to alphabetic designations for associations, societies, non-profit organizations, international organizations, government agencies, United Nations agencies, business firms, colleges and universities, aerospace and electronic equipment and terms, transport facilities, military terms and general terms.

The wide use of the acronym today is pointed out by the more than 12,000 listings in the book. Some organizations are better known by acronym than by their official title. For example: CARE (Cooperative for American Remittances to Everywhere), DEW (Distant Early Warning), JEEP (General Purpose Truck, new model called MUTT (Military Utility Tactical Truck).

Examples of other acronyms include WAC, NAM, CIO, GOP, MIT, NEA, OGPU, NAZI, RADAR, UNICEF, MAMIE, MANIAC, MOBOT, ECHO, FIDO, MAFIA, ROTC, MOBIDIC, RAMAC, UNIVAC, IBM, HELIOS, YMCA, GNP, F&AM, IOOF, USAR, USN, SAC. An editorial introduction preceding the individual listings traces the origin, historical development and current status of acronym usage.

NEW "HOW TO" BOOKLET ON PHOTOMICROGRAPHY ISSUED BY EASTMAN KODAK COMPANY

A new "how-to" book, "Photomicrography of Metals," a reference guide for metallurgists, has been published by Eastman Kodak Company.

The 46-page data book may also serve as a short course in photomicropgraphy for those metallurigists interested in reviewing the latest techniques in this field. In addition, Kodak points out that the booklet should prove a valuable addition to metal industry technical Libraries as well as serving as a supplemental text for college-level metallurgy students.

It is illustrated with photographs, charts and graphs. Written in layman's language, the booklet contains six major sections which include detailed information on the metallographic microscope, illumination, filters in metallography, photographic materials, exposure determination, and processing and printing.

The profits of metallography are discussed at length, including specific suggestions and recommendations for matching proper equipment to various applications. Practical information is given on determining exposures for both black-and-white and color materials used in photomicrography. Another section probes into filters and their use in connection with various light sources, specimen types and objectives.

Available through many Kodak dealers, the booklet is priced at 50 cents. The booklet may be also ordered directly from Sales Service Division, Eastman Kodak Company, Rochester 4, New York, for 50 cents plus 10 cents for handling.

DIRECTORY OF UNIVERSITY RESEARCH BUREAUS AND INSTITUTES

Gale Research Company, 34th Floor, Book Tower, Detroit 26, Mich.
208 pages. $20.00

Director of University Research Bureaus and Institutes is a reference guide to university research bureaus, institutes, centers, experiment stations, laboratories, etc., set up on a permanent basis and carrying on a continuing program of research in specialized fields.

The book contains 1500 listings in 250 fields including; business, population, education, engineering, public administration, electronics, Slavic studies, tropical meteorology, cosmic rays, personality assessment, insect pathology, folklore, Russian studies, explosives, labor relations, community planning, aeromedical and physical environment, judicial administration, etc.

Each listing includes the following data:

(1) Official name of bureau or institute.
(2) Address.
(3) Name of sponsoring college or university.
(4) Name and title of director.
(5) Year founded.
(6) Size of professional staff and non-professional staff.
(7) Title and frequency of issue of serial publications.
(8) Description of research program and activities.
(9) List of professional meetings, special programs and seminars.

THE END

(Continued from page 53)

understanding how the auditory nervous system sharpens the analysis received from the ear. Dr. Hind said that it is naive to think of cells in the brain simply responding or not responding to a stimulus. Rather, the response is usually in complex patterns and varies from cell to cell.

For example, some cells produce nerve impulses at a certain rate with no stimulation and may increase the rate for one stimulus. This may be compared with excitation. The rate may decrease for another stimulus and this can be likened to inhibition. The inhibition may be so great as to prevent any response at all.

This combination of excitatory and inhibitory responses may allow some cells to respond to a particular frequency while suppressing the response of neighboring cells.

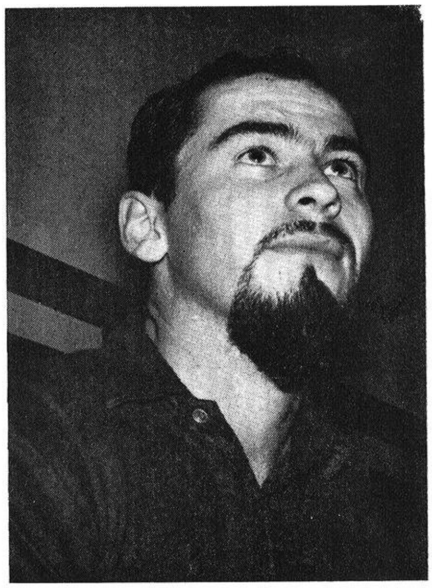
Dr. Hind, who was trained as an electrical engineer, finds that this training stands him in good stead for this work. He is measuring voltages as small as one ten-millionth of a volt. Sensitive electronic equipment is used to accurately measure and record these small voltages.

Special attention also must be paid to interference from outside sources. At these low voltages even local radio and television stations are a considerable source of interference, not to mention the myriads of electrical devices in the building that create disturbances of varying kinds.

To avoid the outside interference, the cat being measured is located in a room that is completely surrounded by copper screen. This serves as a shield to intercept the unwanted electrical signals.

But not all of the technical problems are solved, for the UW researchers have to contend with the movement of the micro-electrode itself. Since measurements are being made in the vicinity of a single cell, some one-thousandth of an inch in diameter, a very minute movement of the electrode can cause a large change in the voltage recorded. Careful manipulations and special equipment are necessary to minimize this problem.

THE END



A portraiture of Jacob Kuykendall, this year's most devilish beard.

IT'S LITERALLY ALL AROUND YOU!

The word *space* commonly represents the outer, airless regions of the universe. But there is quite another kind of "space" close at hand, a kind that will always challenge the genius of man.

This space can easily be measured. It is the space-dimension of cities and the distance between them . . . the kind of space found between mainland and off-shore oil rig, between a tiny, otherwise inaccessible clearing and its supply base, between the site of a mountain crash and a waiting ambulance—above all, Sikorsky is concerned with the precious "spaceway" that currently exists between all earthbound places.

Our engineering efforts are directed toward a variety of VTOL and STOL aircraft configurations. Among earlier Sikorsky designs are some of the most versatile airborne vehicles now in existence; on our boards today are the vehicles that can prove to be tomorrow's most versatile means of transportation.

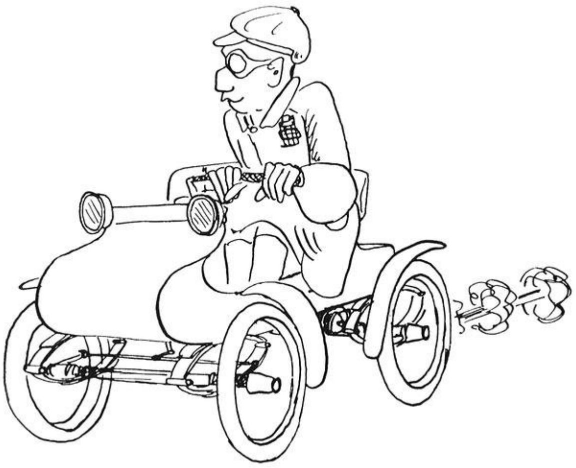
Here, then, is a space age challenge to be met with the finest and most practical engineering talent. Here, perhaps, is the kind of challenge *you* can meet.

SIKORSKY AIRCRAFT

One of the Divisions of United Aircraft Corporation

STRATFORD, CONNECTICUT

For information about careers with us, please address Mr. Richard L. Auten, Personnel Department.



THE ENGINEER OF YESTERYEAR

by Floyd Gelhaus, ee'61

HOW STABILITY WILL BE RESTORED TO PISA'S LEANING TOWER

October, 1928

THE engineers of the Francois Cementation Company, which is to undertake the work of strengthening the foundation of the Leaning Tower of Pisa, will first prepare the ground and subsoil some 50 yards away from the present foundations of the tower to test the resistance of the soil, which is partly mixed with moving sand, gravel, and running water. The process to be used consists of certain chemical applications, followed by injections of specially prepared cement.

It is said that, in the course of the last 50 or 100 years, the famous tower has rather accentuated its inclination, and it is now supposed to be moving slightly at the rate of one millimeter (0.039 inches) per year. According to this estimate, it would take at least 200 years for the tower to fall outside of the perpendicular. One precaution which has been suggested is to drain thoroughly a large area within hundreds of yards of the tower and the cathedral of all water, and to prevent any further possible infiltrations of moisture, which makes the foundation soft and causes them to slowly yield.

CAST-IRON HOUSES FOR ENGLAND

November, 1928

Cast-iron houses are one of the most recent novelties devised in England in the effort, which has now been going on for a number of years, to meet the problem of modern housing for workers, at rentals which are low. The cast-iron house has a concrete foundation, timber doors, steel frame, cast-iron outer plater, an inner shell of fibre board four and a half inches inside the cast-iron, an outside finish of cement and pebble dash, a tile roof, and brick chimney. After the foundation is constructed, it is said that the rest of the house can be "turned out" in two weeks and that the only men needed for the job are two laborers, one "fixer," and two tilers. A cast-iron house of six rooms and bath is reputed to cost about $2,600.

COLOR MOTION PICTURE

1928

A black and white film that produces color movies is one of the latest developments in photography. This is accomplished by using instead of the usual smooth surface film, a film embossed with minute cylindrical lenses which break up the light entering the camera into its various components which are suitably recorded on the light sensitive emulsion according to their intensities in black and white. Based upon this radically new and simple principle, a film is being offered to the amateur photographer. It has been developed in the Eastman Kodak Research Laboratories and is embossed with 559 cylindrical lenses to the inch running length-wise of the film. When used in conjunction with a three color light filter, each section of which lets into the camera only light of its own color, the film may be used with any of the usual amateur movie cameras. When used in the projector, the film acts upon the white light passing through it in such a manner as to separate it into three components of proper intensity and direction which, after passing through the lens and color filter, recombine on the screen to produce a naturally colored picture. The simplicity of the underlying principle is the most significant fact about this new answer to the problem of color movies.

REJUVENATING TUNGSTEN BULBS

May, 1929

The blackening of high intensity tungsten electric lamps, caused by the depositing on cooler parts of the bulb of tungsten volatilized from the filament, can now be removed by a practical method recently announced by the Lamp Development Laboratory of the General Electric Company, and now being incorporated in all high intensity lamps produced by that company. The new deposit remover consists of a small amount of powdered tungsten, a tablespoonful in most cases, which is placed inside the bulb before it is sealed. By removing the blackened lamp from its socket and shaking it, this coarse tungsten powder sweeps off the coating of tungsten on the glass, and restores the lamp to its original efficiency, as good as new. The deposit of tungsten-soot on the glass becomes so high that it undergoes devitrification and deformation. So this new method for removing this deposit will increase greatly the life and usefulness of tungsten lamps, both in length of service and in efficiency while in use.

PROFESSOR ROARK BAGS LION ON AFRICAN TRIP

1927

Prof. R. J. Roark of the mechanics department and Dr. G. S. Bryan of the botany department are back from their trip to the extinct volcano, Norongoro, in eastern Africa. Chief among their trophies is the head of a great lion in whose pursuit they found the greatest thrill of the trip. The beast measured ten feet, six inches from the tip of his nose to the end of his tail. While hunting on the Seringeti plain, the men heard the roar of a lion close by. Rather than wait until nightfall to get the beast when it would come to one of the water holes, they set out in pursuit. Firing both of their guns when they spied their prey, the hunters were rather surprised to see the lion turn and flee instead of attack them. They stalked it by the blood traces on the ground for quite aways when suddenly, without warning, the lion pounced from the bushes ten feet away but before he could spring, Professor Roark shot, the bullet piercing the beast's throat.

Trekking almost 500 miles from the coast of Africa by rail, motor, and on foot, and accompanied by their safari of fifty-five African natives, the men reached the crater region. The specimens were collected on the trip for the university.

AUTOMATIC CLOCK INSTALLED IN STEAM AND GAS LABORATORY

1927

A clockwork mechanism has been installed in Prof. G. C. Wilson's office which automatically rings the bells for readings on the engine tests made in the Steam and Gas Laboratory. It eliminates the old "pipe and gong" with which junior and senior engineers have been working up to this time. The mechanism was designed and built by Mr. Romare, builder of the gridclock, and also of the class bell mechanism. It consists of a Seth Thomas clock which makes electrical contact every half second. The current, when contact is made, operates a relay much like the escapement in the clock, which in turn operates two gears, one making a revolution every ten seconds and the other every five minutes. By means of projections on these gears, the signal bell is rung once every five minutes and two-ring warning is given ten seconds before each ringing. The men working with the clock are very well satisfied with it and are rather proud that it is a product of the Engineering building, both in design and in construction.

HOLLAND TUBE OPENED

1927

At midnight, Saturday, November 12, the Holland Vehicular tunnel under the Hudson River was opened for traffic. It is a 9,250 foot, forty-eight million dollar tunnel which has been under construction for seven years and which connects New York and Jersey City. The safety and success of the tunnel depend principally upon its ventilation and lighting. To insure a continued power supply, there are three circuits on each side of the river at about 13,800 volts, three phase, 60 cycles. There are 42 blowing fans run by motors totaling more than 6,000 horsepower. About 250 kilowatts are required to light the tunnel itself and 150 kilowatts more to light the approaches.

FASTER MOTOR BOATS

1928

The world's speed record for motor boats is 90.56 miles per hour. This was attained only by crowding the record holder with four 450 horsepower engines, and eliminating all load except two people. Other boats capable of carrying a number of passengers have hitherto been able to make only 45 to 50 miles per hour. A new device has been recently perfected in New York which, when attached under the stern of a power boat, gives a great increase of speed while carrying a heavy load. This new device resembles the tail of a whale; it is hollow and constructed of aluminum. It is attached to the rear of the boat so that it swings on a vertical axis. A boat with this attachment starts as an ordinary displacement boat, but after reaching 20 miles per hour, the tail is depressed. On gaining speed, the boat skates over the water, theoretically resting on the bow and the depressed tail instead of pushing uphill as other boats do at high speeds. This gives far greater speed as the propeller is more efficient when it pushes horizontally.

WHA—ITS BEGINNING

1917

Various improvements during the past few months have made the radio station at Science Hall, one of the best known and most complete stations of its kind in the country. With favorable weather conditions, nightly communication is maintained between a great number of stations within a radius of one thousand miles. At the present time, the most extreme cities with which communication has been held are Tampa, Florida, and Lewiston, Montana. The Science Hall station, together with stations at Los Angeles, Denver, and Albany, form the first transcontinental relay of amateur stations and would doubtlessly be taken over by the government in case of war.

STEAM GENERATED FROM HIGH VOLTAGE CURRENT

1929

The Swedish Institute of Industrial and Engineering Research is carrying out experiments in generating steam from high-voltage electric current (50,000 to 80,000 volts). If successful, the great surplus energy of the waterfalls of Sweden could in this way be utilized to advantage. A tension higher than 30,000 volts cannot be used by the electric boilers in present use, but this method of generating steam will become remarkably cheap if the costly transformation from transformation-line voltage can be avoided. Industries which are very large consumers of steam, such as the pulp mills, would benefit by this arrangement.

THE END

Science Highlights

(Continued from page 21)

critical requirements when considering the electronic control or guidance equipment of new aircraft and proposed unmanned vehicles. Out of necessity, component parts have been miniaturized along with their associated circuitry to meet these requirements.

However, the use of these compact designs can present major heat dissipation problems. Cooling of electronic equipment by present techniques is complicated by the nonuniform distribution of heat generated by certain components. The resulting "hot-spots" cause a severe heat rise in the component, and effectively derate the total equipment and limit its maximum operating temperature.

Heat dissipating devices using ambient air improve the heat transfer from the critical components, but these techniques can only limit the temperature rise of the components above ambient temperatures. They cannot cool the component below ambient temperatures.

Thermoelectric cooling, on the other hand, provides a lower local temperature environment for electronic components. As a result, the probability of early component failure due to "hot-spots" can be significantly reduced, and equipment can be operated in higher ambient temperatures with greater reliability.

The Westinghouse thermoelectric cooling modules are rugged and operate with no moving parts, so they can be mounted in any position. For example, by proper orientation, a number of the modules could be constructed to form the walls of a "box," providing a compact space cooler for electronic apparatus. Through use of a variety of specially designed mounting fixtures, the modules can accommodate one or a number of electronic devices such as transistors or diodes.

The heat pumping capacity, or rate at which heat can be removed from the cold surface of the module coolers, depends on the temperature difference between the hot and cold surfaces of the cooler and on the power input to the unit. As an example, a Type WX816 module can maintain a temperature differential of 25 degrees C with a heat load of more than 17 Btu's per hour. To supplement the heat rejection capacity of the module, air or liquid cooling can be applied to the "hot" side of the thermoelectric cooler. The exact amount and type of this cooling will affect the heat pumping capacity and ultimate temperature of the cold surface temperature of the module. In general, the modules require power at high input currents and at low voltage. The current must be supplied from a d-c source or a filtered rectifier output.

In addition to providing the inherent advantage of thermoelectric cooling—compactness with no moving parts—the unique modular construction of these new spot coolers permits a wide range of flexibility in application. This means, in many cases, that electronic equipment need not be redesigned to accommodate the thermoelectric devices.

HIGH-PRESSURE STANDARDS PROGRAM EXPANDED AT THE NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards has expanded its pressure standards program to include development of improved standards and techniques for measuring very high pressures. Changes in the properties of materials will be studied to provide more precisely determined calibration points on the pressure scale, and techniques for measuring high pressure will be investigated.

High pressures offer great promise in treating new materials to meet some of the most severe military and industrial requirements. For example, high pressures cause chemical changes that form new compounds such as polyethylene and boron nitride, and crystalline changes such as occur when graphite is changed to diamond, or quartz to Coesite.

Remarkable changes in physical properties often appear when materials are subjected to high pressures. Some familiar electrical insulators become semiconductors, and some familiar semiconductors become conductors. Brittle substances such as bismuth and quartz become ductile. Tungsten carbide more than doubles in strength when subjected to a hydrostatic pressure of 400,000 psi.

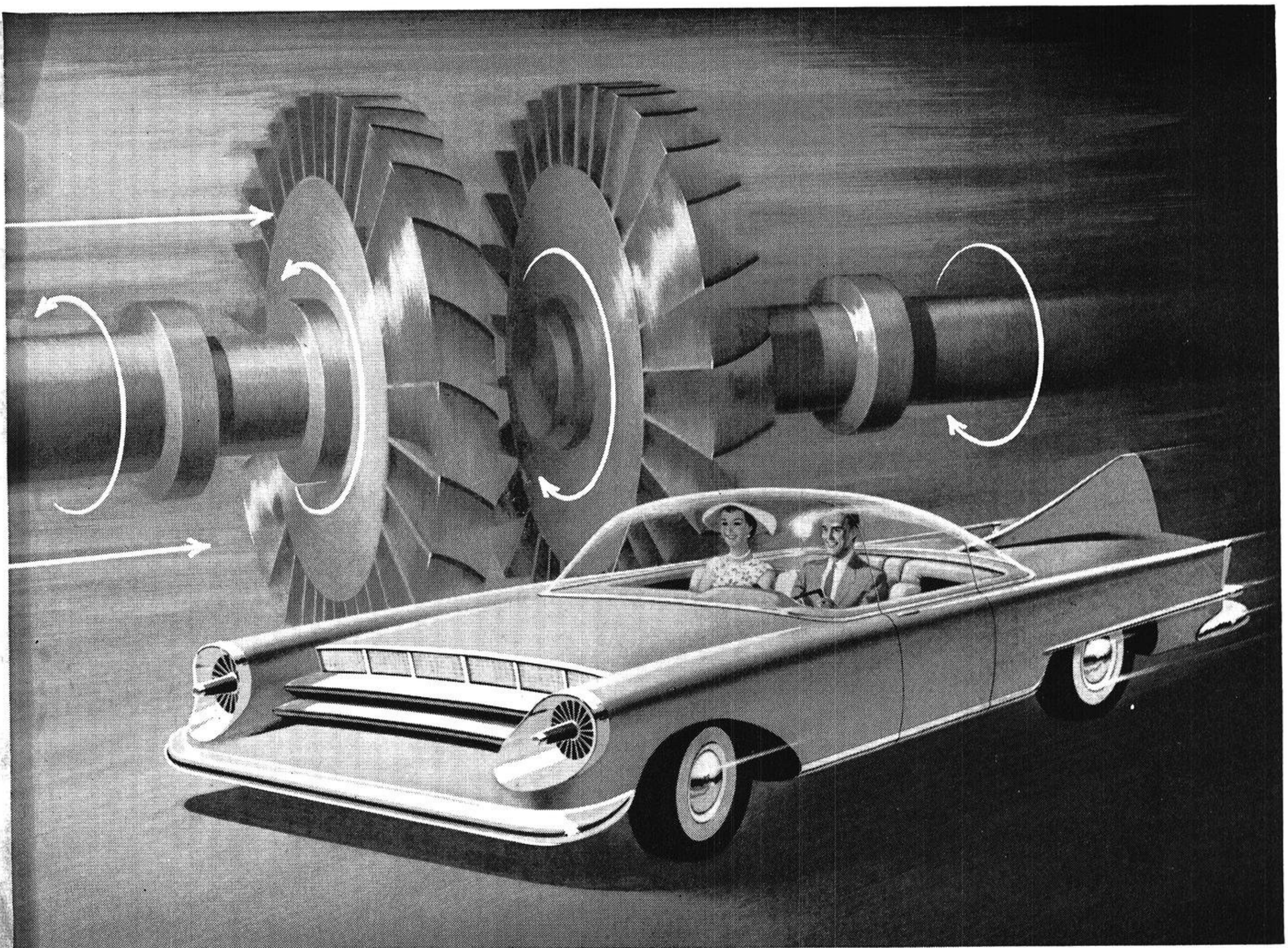
Above 500,000 psi, experimental techniques differ from those at lower pressures because nearly all fluid materials become solid. For example, at room temperature water solidifies at 140,000 psi, mercury at 180,000 psi, and nitrogen at 400,000 psi. In studying materials at very high pressures, the pressure-transmitting media now used are solids that have low shear strength, such as indium, lead, tin, silver chloride, talc, or pyrophyllite.

In the high-pressure program, effort will be directed toward the extension to higher pressures of those techniques that are now used to generate and measure pressures below 200,000 psi. These pressures can now be measured by dead-weight-loaded pistons that are not packed to prevent pressure fluid from leaking. Instead, the clearance between piston and cylinder is made so small that leakage is kept within a few cubic inches per month. This type of apparatus may be found usable, with a fluid pressure medium, at pressures as high as 350,000 or 400,000 psi.

The program will include attempts to furnish more precisely determined basic information. For measurements of pressures above 200,000 psi, scientists now refer to approximately known pressures at which there are changes in phase, volume, or electrical resistance of certain materials. The resistance of bismuth, for example, changes abruptly at 365,000, 385,000, and 1,700,000 psi of thallium at 630,000, and of barium at 1,100,000 psi. Because these values were obtained with different types of apparatus at widely different times, there may be inconsistencies between them.

Various transitions will be studied by use of the Bureau's tetrahedral anvil apparatus, as well as with high-pressure piston-and-cylinder equipment, in an attempt to adjust possible inconsistencies. By refining measurement techniques, Bureau scientists will attempt to improve the accuracy of pressure values at transition points so that they can be used in pressure calibrations.

THE END



This "windmill" or turbine, spun by hot gas, powers the turbocar. For such a hot spot, designers depend on Nickel to help them solve heat-resistance problems.

How Inco Nickel is helping develop the new gas turbine car of tomorrow

It will be power-packed: the gas turbine engine in your dream car of the future and tomorrow's trucks and buses.

Only one spark plug— runs on kerosene

This new engine is much lighter, smaller. It has far fewer parts. No pistons. No water system. Only one spark plug. Runs on lower-grade fuels.

Not yet in production!

Before the car is a showroom reality, engineers face a number of problems.

One problem—the one Inco is helping with —is metals. Strong and economical metals to resist heat and corrosion.

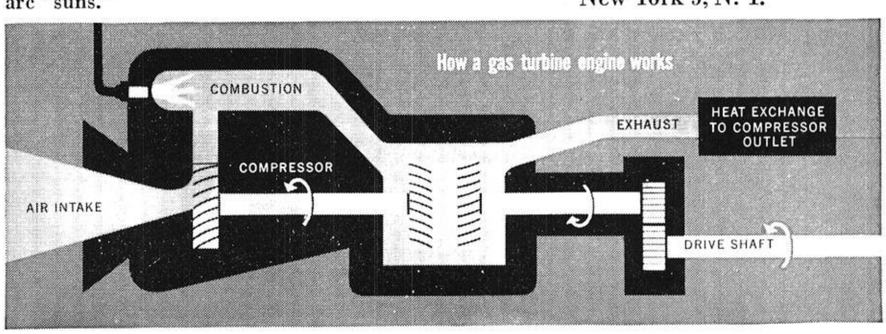
Gas turbines operate at up to 1600°F. These temperatures step up corrosion of metals, promote troublesome distortions. So the job is to develop practical alloys able to carry the load—alloys that can, at the same time, offset the corrosives, resist the distorting forces found at jet-high temperatures.

How far has Inco research gone in its search for practical alloys?

Difficult as they are, the problems of metal performance at high temperature are a familiar story at Inco. Inco research has dealt with them for years. And come up with solutions in the gas turbine and in many other fields. In conventional, atomic, and thermionic power. In petrochemistry. In heat treating. In jet aviation. In missilry. Even in Hollywood's 8000°F carbon-arc "suns."

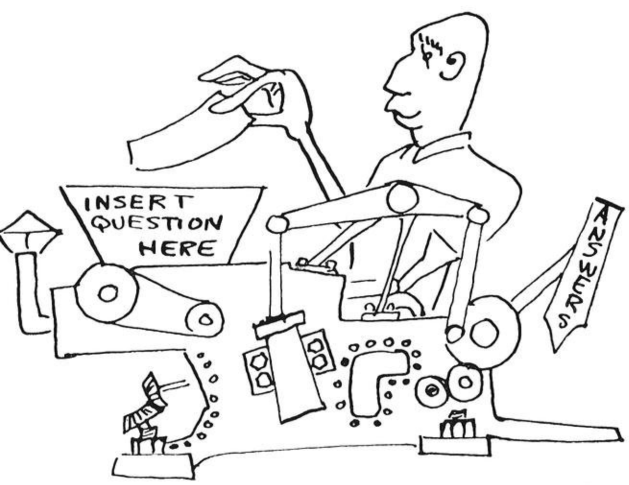
Inco's files contain a wealth of metal information . . . over 300,000 indexed and cross-referenced case histories, for example. Keep this in mind against the day *you* may need information. ©1960, Inco

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



International Nickel

The International Nickel Company, Inc., is the U. S. affiliate of The International Nickel Company of Canada, Limited. Producer of Inco Nickel, Copper, Cobalt, Iron Ore, Tellurium, Selenium, Sulfur and Platinum, Palladium and Other Precious Metals.



FINAGLE FACTORS

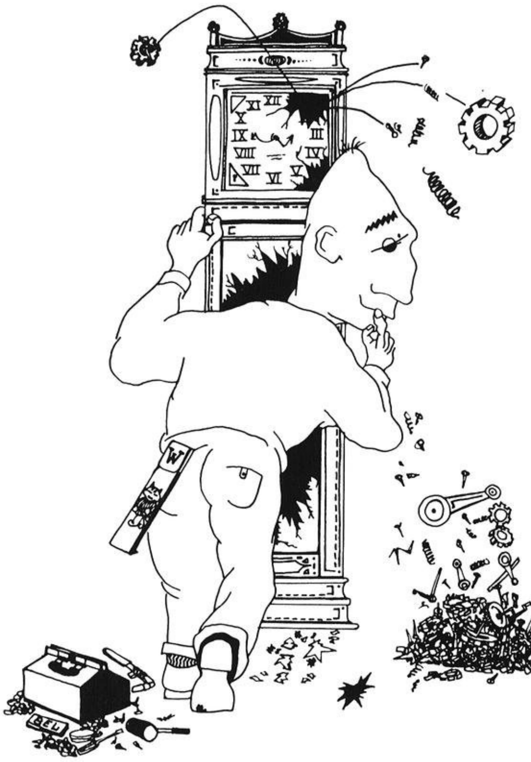
This is the first of a series of two.

Multiply	*By*	*To Get*
Abamperes	10	amperes
Abamperes	$3x10^{10}$	statamperes
abamperes per sq cm	64.52	amperes per sq inch
abampere-turns	10	ampere-turns
abampere-turns	12.57	gilberts
abampere-turns per cm	25.40	ampere-turns per inch
abcoulombs	10	coulombs
abcoulombs	$3x10^{10}$	statcoulombs
abcoulombs per sq cm	64.52	coulombs per sq in
abfarads	10^{9}	farads
abfarads	10^{15}	microfarads
abfarads	$9x10^{20}$	statfarads
abhenries	10^{-9}	henries
abhenries	10^{-6}	millihenries
abhenries	$1/9x10^{-20}$	stathenries
abmhos per cm cube	$1.662x10^{2}$	mhos per mil foot
abmhos per cm cube	10^{3}	megmhos per cm cube
abohms	10^{-15}	megohms
abohms	10^{-3}	microhoms
abohms	10^{-9}	ohms
abohms	$1/9x10^{-20}$	statohms
abohms per cm cube	10^{-3}	microhms per cm cube
abohms per cm cube	$6.015x10^{-3}$	ohms per mil foot
abvolts	$1/3x10^{-10}$	statvolts
abvolts	10^{-8}	volts
acres	43.560	square feet
acres	4047	square meters
acres	$1.562x10^{-3}$	square miles
acres	5645.38	square yards
acres	4840	square varas
acre-feet	43.560	cubic feet
acre-feet	$3.259x10^{5}$	gallons
amperes	1/10	abamperes
amperes	$3x10^{9}$	statamperes
amperes per sq cm	6.453	amperes per sq inch
amperes per sq inch	0.01550	abamperes per sq cm
amperes per sq inch	0.1550	amperes per sq cm
amperes per sq inch	$4.650x10^{8}$	statamperes per sq cm
ampere-turns	1/10	abampere-turns
ampere-turns	1.257	gilberts
ampere-turns per cm	2.540	ampere-turns per in
ampere-turns per inch	0.03937	abampere-turns per cm
ampere-turns per inch	0.3937	ampere-turns per cm
ampere-turns per inch	0.4950	gilberts per cm
ares	0.02471	acres
ares	100	square meters
atmospheres	76.0	cms of mercury
atmospheres	29.92	inches of mercury
atmospheres	33.90	feet of water
atmospheres	10,333	kg per sq meter
atmospheres	14.70	pounds per sq inch
atmospheres	1.058	tons per sq foot
Bars	$9.870x10^{-7}$	atmospheres
Bars	1	dynes per sq cm
Bars	0.01020	kg per square meter
Bars	$2.089x10^{-3}$	pounds per sq foot
Bars	$1.450x10^{-5}$	pounds per sq inch
board-feet	144	cubic inches
British thermal units	0.2530	kilogram-calories
British thermal units	777.5	foot-pounds
British thermal units	$3.927x10^{-4}$	horsepower-hours
British thermal units	1054	joules
British thermal units	107.5	kilogram-meters
British thermal units	$2.928x10^{-4}$	kilowatt-hours
Btu per min	12.96	foot-pounds per sec
Btu per min	0.02356	horsepower
Btu per min	0.01757	kilowatts
Btu per min	17.57	watts
Btu per sq ft per min	0.1220	watts per square inch
bushels	1.244	cubic feet
bushels	2150	cubic inches
bushels	0.03524	cubic meters
bushels	4	pecks
bushels	64	pints (dry)
bushels	32	quarts (dry)
Centares	1	square meters
centigrams	0.01	grams
centiliters	0.01	liters

Multiply	*By*	*To Get*
centimeters	0.3937	inches
centimeters	0.01	meters
centimeters	393.7	mils
centimeters	10	millimeters
centimeter-dynes	$1.020x10^{-3}$	centimeter-grams
centimeter-dynes	$1.020x10^{-8}$	meter-kilograms
centimeter-dynes	$7.376x10^{-8}$	pound-feet
centimeter-grams	980.7	centimeter-dynes
centimeter-grams	10^{-5}	meter-kilograms
centimeter-grams	$7.233x10^{-5}$	pound-feet
centimeters of mercury	0.01316	atmospheres
centimeters of mercury	0.4461	feet of water
centimeters of mercury	136.0	kg per square meter
centimeters of mercury	27.85	pounds per sq foot
centimeters of mercury	0.1934	pounds per sq inch
centimeters per second	1.969	feet per minute
centimeters per second	0.03281	feet per second
centimeters per second	0.036	kilometers per hour
centimeters per second	0.6	meters per minute
centimeters per second	0.02237	miles per hour
centimeters per second	$3.728x10^{-4}$	miles per minute
cm per sec per sec	0.03281	feet per sec per sec
cm per sec per sec	0.036	km per hour per sec
cm per sec per sec	0.02237	miles per hour per sec
circular mils	$5.067x10^{-6}$	square centimeters
circular mils	$7.854x10^{-7}$	square inches
circular mils	0.7854	square mils
cords	128	cubic feet
coulombs	1/10	abcoulombs
coulombs	$3x10^{9}$	statcoulombs
coulombs per sq inch	0.01550	abcoulombs per sq cm
coulombs per sq inch	0.1550	coulombs per sq cm
coulombs per sq inch	$4.650x10^{8}$	statcoulombs per sq cm
cubic centimeters	$3.531x10^{-5}$	cubic feet
cubic centimeters	$6.10x10^{-2}$	cubic inches
cubic centimeters	10^{-6}	cubic meters
cubic centimeters	$1.308x10^{-6}$	cubic yards
cubic centimeters	$2.642x10^{-4}$	gallons
cubic centimeters	10^{-3}	liters
cubic centimeters	$2.113x10^{-3}$	pints (liq)
cubic centimeters	$1.057x10^{-3}$	quarts (liq)
cubic feet	$2.832x10^{4}$	cubic cms
cubic feet	1728	cubic inches
cubic feet	0.02832	cubic meters
cubic feet	0.03704	cubic yards
cubic feet	7.481	gallons
cubic feet	28.32	liters
cubic feet	59.84	pints (liq)
cubic feet	29.92	quarts (liq)
cubic feet per minute	472.0	cubic cm per sec
cubic feet per minute	0.1247	gallons per sec
cubic feet per minute	0.4720	liters per second
cubic feet per minute	62.4	lb of water per min
cubic inches	16.39	cubic centimeters
cubic inches	$5.787x10^{-4}$	cubic feet
cubic inches	$1.639x10^{-5}$	cubic meters
cubic inches	$2.143x10^{-5}$	cubic yards
cubic inches	$4.329x10^{-3}$	gallons
cubic inches	$1.639x10^{-2}$	liters
cubic inches	0.03463	pints (liq)
cubic inches	0.01732	quarts (liq)
cubic meters	10^{6}	cubic centimeter
cubic meters	35.31	cubic feet
cubic meters	61.023	cubic inches
cubic meters	1.308	cubic yards
cubic meters	264.2	gallons
cubic meters	10^{3}	liters
cubic meters	2113	pints (liq)
cubic meters	1057	quarts (liq)
cubic yards	$7.646x10^{5}$	cubic centimeters
cubic yards	27	cubic feet
cubic yards	46,656	cubic inches
cubic yards	0.7646	cubic meters
cubic yards	202.0	gallons
cubic yards	764.6	liters
cubic yards	1616	pints (liq)
cubic yards	807.9	quarts (liq)
cubic yards per minute	0.45	cubic feet per second
cubic yards per minute	3.367	gallons per second
cubic yards per minute	12.74	liters per second

Multiply	By	To Get
Days	24	hours
Days	1440	minutes
Days	86,400	seconds
decigrams	0.1	grams
deciliters	0.1	liters
decimeters	0.1	meters
degrees (angle)	60	minutes
degrees (angle)	0.01745	radians
degrees (angle)	3600	seconds
degrees per second	0.01745	radians per second
degrees per second	0.1667	revolutions per min
degrees per second	0.002778	revolutions per sec
dekagrams	10	grams
dekaliters	10	liters
dekameters	10	meters
drams	1.772	grams
drams	0.0625	ounces
dynes	1.020×10^{-3}	grams
dynes	7.233×10^{-5}	poundals
dynes	2.248×10^{-6}	pounds
dynes per square cm	1	bars
Ergs	9.486×10^{-11}	British thermal units
Ergs	1	dyne-centimeters
Ergs	7.376×10^{-8}	foot-pounds
Ergs	1.020×10^{-3}	gram-centimeters
Ergs	10^{-7}	joules
Ergs	2.390×10^{-11}	kilogram-calories
Ergs	1.020×10^{-8}	kilogram-meters
ergs per second	5.692×10^{-9}	Btu per minute
ergs per second	4.426×10^{-6}	foot-pounds per min
ergs per second	7.376×10^{-8}	foot-pounds per sec
ergs per second	1.341×10^{-10}	horsepower
ergs per second	1.434×10^{-9}	kg-calories per min
ergs per second	10^{-10}	kilowatts
Farads	10^{-9}	abfarads
Farads	10^{6}	microfarads
Farads	9×10^{-11}	statfarads
fathoms	6	feet
feet	30.48	centimeters
feet	12	inches
feet	0.3048	meters
feet	.36	varas
feet	1/3	yards
feet of water	0.02950	atmospheres
feet of water	0.8826	inches of mercury
feet of water	304.8	kg per square meter
feet of water	32.43	pounds per sq ft
feet of water	0.4335	pounds per sq inch
feet per minute	0.5080	centimeters per sec
feet per minute	0.01667	feet per sec
feet per minute	0.01829	kilometers per hour
feet per minute	0.3048	meters per minute
feet per minute	0.01136	miles per hour
feet per second	30.48	centimeters per sec
feet per second	1.097	kilometers per hour
feet per second	18.29	meters per minute
feet per second	0.6818	miles per hour
feet per second	0.01136	miles per minute
feet per 100 feet	1	per cent grade
feet per sec per sec	30.48	cm per sec per sec
feet per sec per sec	1.097	km per hr per sec
feet per sec per sec	0.3048	meters per sec per sec
feet per sec per sec	0.6818	miles per hr per sec
foot-pounds	1.286×10^{-3}	British thermal units
foot-pounds	1.356×10^{7}	ergs
foot-pounds	5.050×10^{-7}	horsepower-hours
foot-pounds	1.356	joules
foot-pounds	3.241×10^{-4}	kilogram-calories
foot-pounds	0.1383	kilogram-meters
foot-pounds	1.286×10^{-3}	kilowatt-hours
foot-pounds per minute	3.766×10^{-7}	Btu per minute
foot-pounds per minute	0.01667	foot-pounds per sec
foot-pounds per minute	3.030×10^{-5}	horsepower
foot-pounds per minute	3.241×10^{4}	kg-calories per minute
foot-pounds per minute	2.260×10^{-5}	kilowatts
foot-pounds per second	7.717×10^{-2}	Btu per minute
foot-pounds per second	1.818×10^{-3}	horsepower
foot-pounds per second	1.945×10^{-2}	kg-calories per min
foot-pounds per second	1.356×10^{-3}	kilowatts
furlongs	40	rods
Gallons	3785	cubic centimeters
Gallons	0.1337	cubic feet
Gallons	231	cubic inches
Gallons	3.785×10^{-3}	cubic meters
Gallons	4.951×10^{-3}	cubic yards
Gallons	3.785	liters
Gallons	8	pints (liq)
Gallons	4	quarts (liq)
gallons per minute	2.228×10^{-3}	cubic feet per second
gallons per minute	0.06308	liters per second
gausses	6.452	lines per square inch
gilberts	0.07958	abampere-turns
gilberts	0.7958	ampere-turns
gilberts per centimeter	2.021	ampere-turns per inch
gills	0.1183	liters
gills	0.25	pints (liq)
grains (troy)	1	grains (av)
grains (troy)	0.06480	grams
grains (troy)	0.04167	pennyweights (troy)
grams	980.7	dynes
grams	15.43	grains (troy)
grams	10^{-3}	kilograms
grams	10^{3}	milligrams
grams	0.03527	ounces
grams	0.03215	ounces (troy)
grams	0.07093	poundals
grams	2.205×10^{-3}	pounds
gram-calories	3.968×10^{-3}	British thermal units
gram-centimeters	9.302×10^{-8}	British thermal units
gram-centimeters	980.7	ergs
gram-centimeters	7.233×10^{-5}	foot-pounds
gram-centimeters	9.807×10^{-5}	joules
gram-centimeters	2.344×10^{-8}	kilogram-calories
gram-centimeters	10^{-5}	kilogram-meters
grams per cm	5.600×10^{-3}	pounds per inch
grams per cu cm	62.43	pounds per cubic foot
grams per cu cm	0.03613	pounds per cubic inch
grams per cu cm	3.405×10^{-7}	pounds per mil-foot
Hectares	2.471	acres
Hectares	1.076×10^{5}	square feet
hectograms	100	grams
hectoliters	100	liters
hectometers	100	meters
hectowatts	100	watts
hemispheres (solid angle)	0.5	sphere
hemispheres (solid angle)	4	spherical right angles
hemispheres (solid angle)	6.283	steradians
henries	10^{9}	abhenries
henries	10^{3}	millihenries
henries	$1/9 \times 10^{-11}$	stathenries
horsepower	42.44	Btu per min
horsepower	33,000	foot-pounds per min
horsepower	550	foot-pounds per sec
horsepower	1.014	horsepower (metric)
horsepower	10.70	kg-calories per min
horsepower	0.7457	kilowatts
horsepower	745.7	watts
horsepower (boiler)	33,520	Btu per hour
horsepower (boiler)	9.804	kilowatts
horsepower-hours	2547	British thermal units
horsepower-hours	1.98×10^{6}	foot-pounds
horsepower-hours	2.684×10^{6}	joules
horsepower-hours	641.7	kilogram-calories
horsepower-hours	2.737×10^{5}	kilogram-meters
horsepower-hours	0.7457	kilowatt-hours
hours	60	minutes
hours	3600	seconds
Inches	2.540	centimeters
Inches	10^{3}	mils
Inches	.03	varas
Inches of mercury	0.03342	atmospheres
Inches of mercury	1.133	feet of water
Inches of mercury	345.3	kg per square meter
Inches of mercury	70.73	pounds per square ft
Inches of mercury	0.4912	pounds per square in.
Inches of water	0.002458	atmospheres
Inches of water	0.07355	inches of mercury
Inches of water	25.40	kg per square meter
Inches of water	0.5781	ounces per square in.
Inches of water	5.204	pounds per square ft
Inches of water	0.03613	pounds per square in.
Joules	9.486×10^{-4}	British thermal units
Joules	10^{7}	ergs
Joules	0.7376	foot-pounds
Joules	2.390×10^{-4}	kilogram-meters
Joules	0.1020	kilogram-calories
Joules	2.778×10^{-4}	watt-hours
Kilograms	980,665	dynes
Kilograms	10^{3}	grams
Kilograms	70.93	poundals
Kilograms	2.2046	pounds
Kilograms	1.102×10^{-3}	tons (short)
kilogram-calories	3.968	British thermal units
kilogram-calories	3086	foot-pounds
kilogram-calories	1.558×10^{-3}	horsepower-hours
kilogram-calories	4183	joules
kilogram-calories	426.6	kilogram-meters
kilogram-calories	1.162×10^{-3}	kilowatt-hours
kg-calories per min	51.43	foot-pounds per sec
kg-calories per min	0.09351	horsepower
kg-calories per min	0.06972	kilowatts
kg-cm squared	2.373×10^{-3}	pounds-feet squared
kg-cm squared	0.3417	pounds-inches squared
kilogram-meters	9.302×10^{-3}	British thermal units
kilogram-meters	9.807×10^{7}	ergs
kilogram-meters	7.233	foot-pounds
kilogram-meters	9.807	joules
kilogram-meters	2.344×10^{-3}	kilogram-calories
kilogram-meters	2.724×10^{-6}	kilowatt-hours
kg per cubic meter	10^{-3}	grams per cubic cm
kg per cubic meter	0.06243	pounds per cubic foot
kg per cubic meter	3.613×10^{-5}	pounds per cubic inch
kg per cubic meter	3.405×10^{-10}	pounds per mil-foot
kg per meter	0.6720	pounds per foot
kg per square meter	9.678×10^{-5}	atmospheres
kg per square meter	98.07	bars
kg per square meter	3.281×10^{-3}	feet of water
kg per square meter	2.896×10^{-3}	inches of mercury
kg per square meter	0.2048	pounds per square ft
kg per square meter	1.422×10^{-3}	pounds per square in.
kg per sq millimeter	10^{6}	kg per square meter
kilolines	10^{3}	maxwells
kiloliters	10^{3}	liters
kilometers	10^{5}	centimeters
kilometers	3281	feet
kilometers	10^{3}	meters
kilometers	0.6214	miles
kilometers	1093.6	yards
kilometers per hour	27.78	centimeters per sec
kilometers per hour	54.68	feet per minute
kilometers per hour	0.9113	feet per second
kilometers per hour	0.5396	knots
kilometers per hour	16.67	meters per minute
kilometers per hour	0.6214	miles per hour
km per hour per sec	27.78	cm per sec per sec
km per hour per sec	0.9113	ft per sec per sec
km per hour per sec	0.2778	meters per sec per sec
km per hour per sec	0.6214	miles per hr per sec

(Final portion will appear in May Issue)



STRIPPED GEARS

by Todd S. Deutsch

"A sense of humor is the oil of life's engine. Without it the machinery creaks, squeaks, and groans. No lot is so hard, no aspect of things so grim, but that it relaxes before a hearty laugh."—TSD

Betch Didn't Know

1) . . . *the healthiest looking conventioneer, on the morning after the big cocktail party, was the guy with the ulcer.*
2) . . . *bubble dancers have plenty behind the ball.*
3) . . . *if you give your husband enough rope, he'll get tied up at the office.*
4) . . . *we Americans aren't afraid to bawl out the President, but we'll always be polite to a policeman.*
5) . . . *more good stories are ruined by eye witnesses.*

* * *

Legally the husband is the head of the house and the pedestrian has the right of way. Both are fairly safe unless they try to exercise their rights.

* * *

"That's right," said the sophomore, "when I first came here I was a pretty conceited guy, but they've knocked that all out of me and now I'm the nicest fellow in college."

* * *

Did you know they even laughed at James Watt, too, until he invented the Watt Schmacallit.

Lawyer, reading the last will and testament to expectant relatives of an M.E.:

"And so, being of sound mind, I spent every last cent before I died."

* * *

Once upon a time there was the truck driver who stopped by a stalled Volkswagon on the highway;

"What's the matter, buddy, need a new flint?"

* * *

Flattery is the art of pretending you like the girl more than the kiss.

Thought of the Month

When solutions catch up with problems, Boredom will exist.

* * *

And then there was the Engineer who went up to the bar very optimistically, and two hours later went away very misty optically.

* * *

There seems to be only two kinds of parking left on the Badger Campus—

Illegal and No.

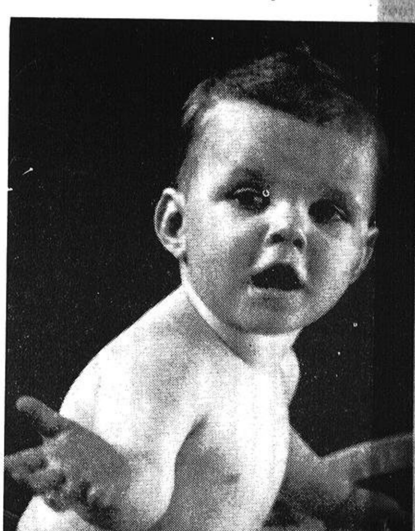
* * *

E.E.: "Ma'm, I've found the trouble with your T.V. set. It's got a short circuit in the wiring.

Lady: Well, for goodness sakes —lengthen it.

Did you hear about the Ch.E. who would never let his wife feed their baby milk at night? It seems, he reasoned, that the baby would toss from side to side. Then the milk would turn to cheese, cheese to butter, butter to fat, fat to sugar, sugar to alcohol. Therefore, it follows the baby would wake up with a hangover!

Sneedly, Jr.



And then I subtracted Item 5 fr[om] Item 2-C, added the balance to col[umn] 6, and . . .

A special message to everyone born between 1938 and 1942

Hey, there! You with the freshly-starched diploma in your hand! Discouraged with your first hard look at this topsy-turvy world? Think someone chopped out the rungs in the ladder of success? Think opportunity is dead?

Don't you believe it! Today, opportunity under America's free enterprise system is more alive than ever! Within the next few years, you'll see space travel programs accelerate and inspire now unheard-of products. You'll see standards of living go up. You'll see exciting new jobs created out of nowhere.

Take our own business, for example. Oil. In the next few years, we *know* Standard Oil will create a cornucopia of new products and new processes. And that means opportunity! But it takes time, work, and study to turn opportunity into advancement. People who are willing to put forth the extra effort to prepare for greater responsibility will find opportunity awaiting them.

Is opportunity dead? Whenever we hear that question, we think of the thousands of people who won promotions last year at Standard Oil and the fact that most of our officers and directors since this company started have come up through the ranks. No Standard job is too big a target for any employee...if he listens for opportunity's knock and is ready for it when it comes.

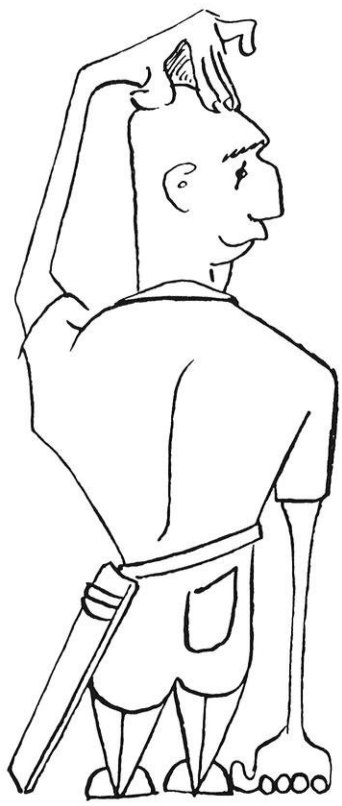
Opportunity dead? Not by a long shot!

WHAT MAKES A COMPANY A GOOD CITIZEN? One way to judge is by a company's economic effect on a community. Is it growing? Is it progressive? Will it provide opportunities for advancement? For the five years from 1954 to 1959, Standard spent $1.4 billion on new facilities. Expenditures like these help to create new opportunities.

STANDARD OIL COMPANY

STANDARD

THE SIGN OF PROGRESS... THROUGH RESEARCH



So You Think You're SMART!

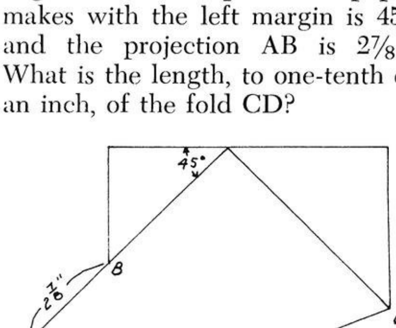
by Sneedly, Law'65

SINCE this issue of the *Wisconsin Engineer* is dedicated to high school students, I have magnanimously decided to reveal to you potential engineering students the secret of success in engineering. I did not know the secret when I entered school as a naive freshman and consequently flunked out three years in row. But since a kindly senior took me aside two years ago and explained the secret to me I have received only one threatening letter from the dean, and that one only tried to intimidate me into attending classes more than every other week.

The secret, of course, is gouging. A gouge is a collection of the work done by other students in bygone years and is useful because the content of a course remains remarkably constant with time. So all you do when you're stuck with some problem or report is simply to refer to the work Joe Genius did back in 1927. If his work rated an A then, chances are better than ever that "your" work will rate an A. Therefore your first week in school is most profitably spent collecting a complete set of gouges. If your set is a good one your scholastic problems for the semester are 99 per cent solved.

Now for this month's problems, worth $10 to the first person sending in the correct answers, and for which, unfortunately, there are no gouges.

1. A piece of typewriter paper $8\frac{1}{2}''$ by $11''$ is folded as shown in the diagram. As you can see, the angle that the top of the paper makes with the left margin is 45° and the projection AB is $2\frac{7}{8}''$. What is the length, to one-tenth of an inch, of the fold CD?



2. My son's age is the same as my father's with the digits reversed. The product of their ages gives the recent year in which my son was married. If I am twice as old as my son, how old am I, how old is my son, and how old is my father? Assume that a recent year is one of the last twenty.

3. An M. E. had eight half dollars, one of which was known to be a counterfeit and slightly heavier than the rest. Assuming that he had had a good pair of scales, how can he find the bad half dollar in only two weighings?

The answers to the problems in the March issue:

1. x = Johnny's speed in water
   y = speed of current

After ¼ hour he was x/4 miles from the glove. The glove took 1/y hours to reach the house, so after he turned, the glove took (1/y — ¼) hours to reach the house. In that time he moved through the water x(4 — y)/4y miles. But we see that he was x/4 miles from the glove, so x/4 = x(4 — y)/4y. Therefore the speed of the current is 2 mph.

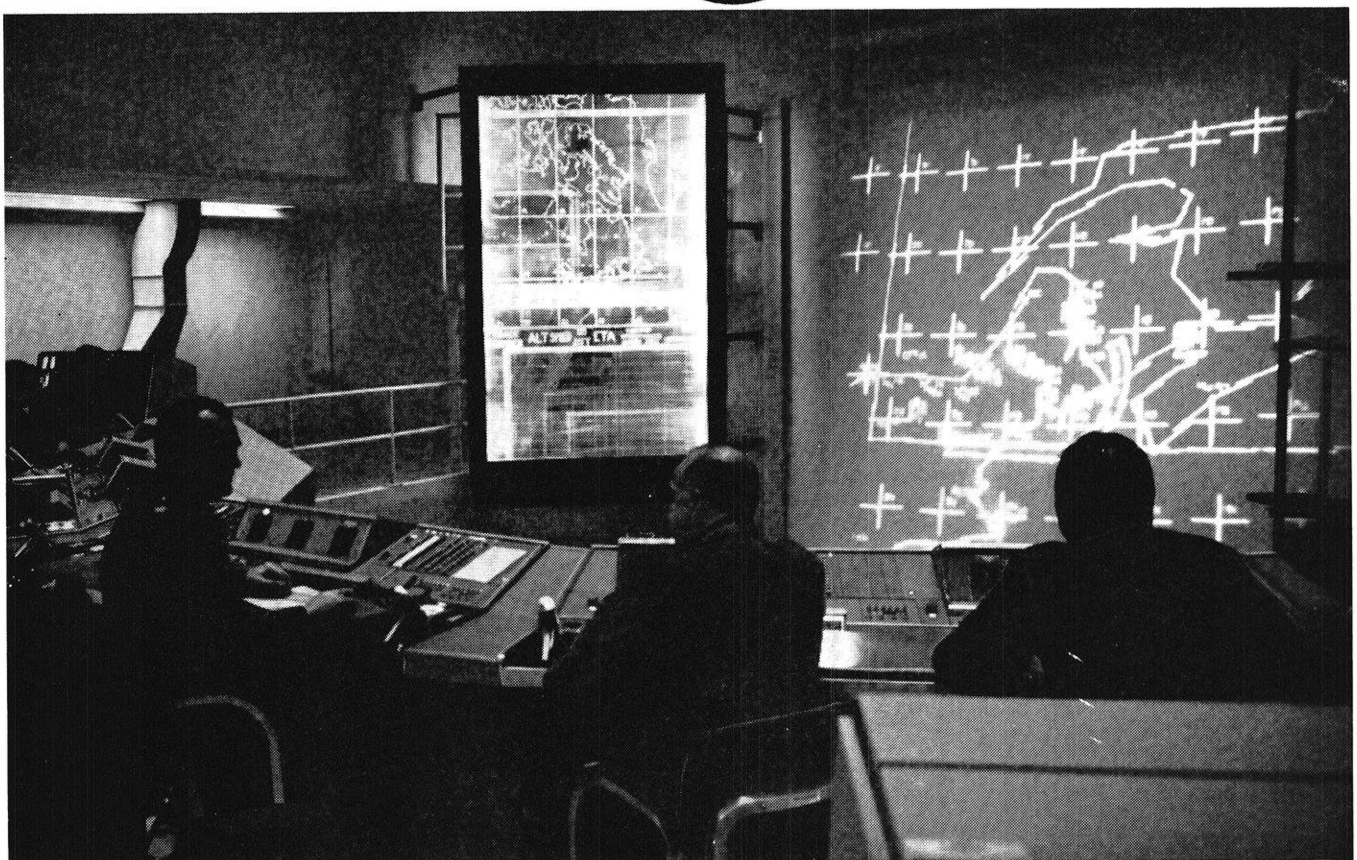
2. The amounts in each glass are equal.

3. If the distance one way is x miles, then the time going is x/30 hours and the overall time is 2x/60 hours. Since these times are equal there is no time available for the return journey. The situation is impossible. So stay in Milwaukee.

Get your answers in fast if you expect to win. Remember that just since October the "Engineer" has actually paid out the amazing sum of 40 dollars. Send your solutions to

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

If your sights are set  on electronics–



With the IBM Sage computer, Air Force personnel view computer-generated displays projected in the Command Post.

–you'll find **Photography at Work** with you

THE engineer working in electronics finds photography one of his most valuable tools. For example, he uses camera and film to capture and study the fleeting transient on the oscilloscope face.

X-rays and film provide him with a check on the internal integrity of sealed components. Even intricate circuits can be printed and miniaturized by photographic methods.

There's hardly a field on which you can set your sights where photography does not play a part in simplifying work and routine. It saves time and costs in research, on the production line, in the engineering and sales department, in the office.

So in whatever you plan to do, take full advantage of all the ways photography can help.

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, sales, and production.

If you are looking for such an interesting opportunity, write for information about careers with Kodak.

Address: Business and Technical Personnel Department,
Eastman Kodak Company
Rochester 4, N.Y.

EASTMAN KODAK COMPANY
Rochester 4, N.Y.

Kodak
TRADEMARK