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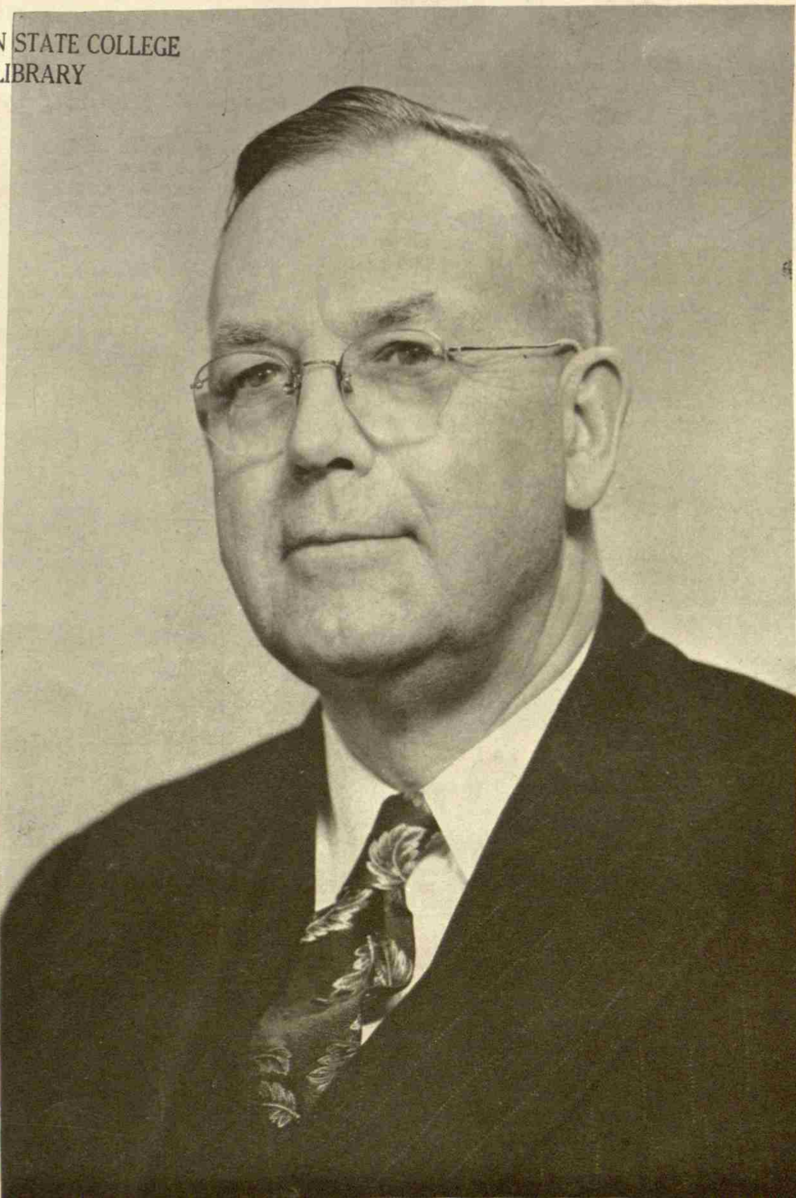

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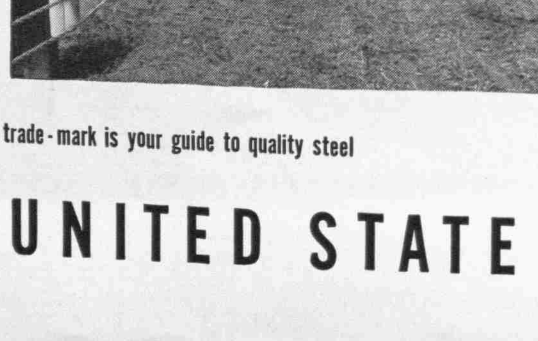

Taking no chances is a good rule to follow on modern highways. Drive carefully—the life you save may be your own. This U·S·S American Multisafty Cable Guard saves many lives, too. Over 140 proving ground impact tests, using cars of all types, have demonstrated that this type of highway guard provides greater protection at high speeds.

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One day of feeling better doesn't mean you're cured

EVER HAVE FLU, feel better, and go out too soon—only to have a relapse worse than the first attack?

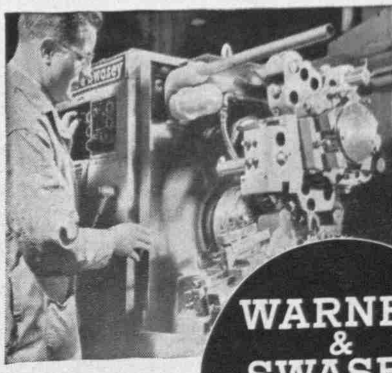
For years the world has been sick. "Something-for-nothing," Welfare State, Socialism, "more-pay-for-less-work"—the disease has different names at different times and places, but it's the same trouble—loss of energy, ambition, faith-in-yourself.

Now much of the world and especially this part of it is feeling better; we think we'll live—as this is written it looks as though more housing, lower prices, lower taxes, and most important of all, less war, are in prospect. BUT—

Don't let's take it too easy too soon. The fever of inflation and debt have wasted the nation's strength and substance which have to be built back. If we continue our tried and true American medicine of hard work, and add the convalescent tonic of thrift, we'll really recover. But as any doctor knows, this first surge of "feeling better" is the dangerous stage:

A relapse could kill us.

Warner & Swasey is always interested in talking future opportunities to young men of ability and character. Write Charles Ufford.



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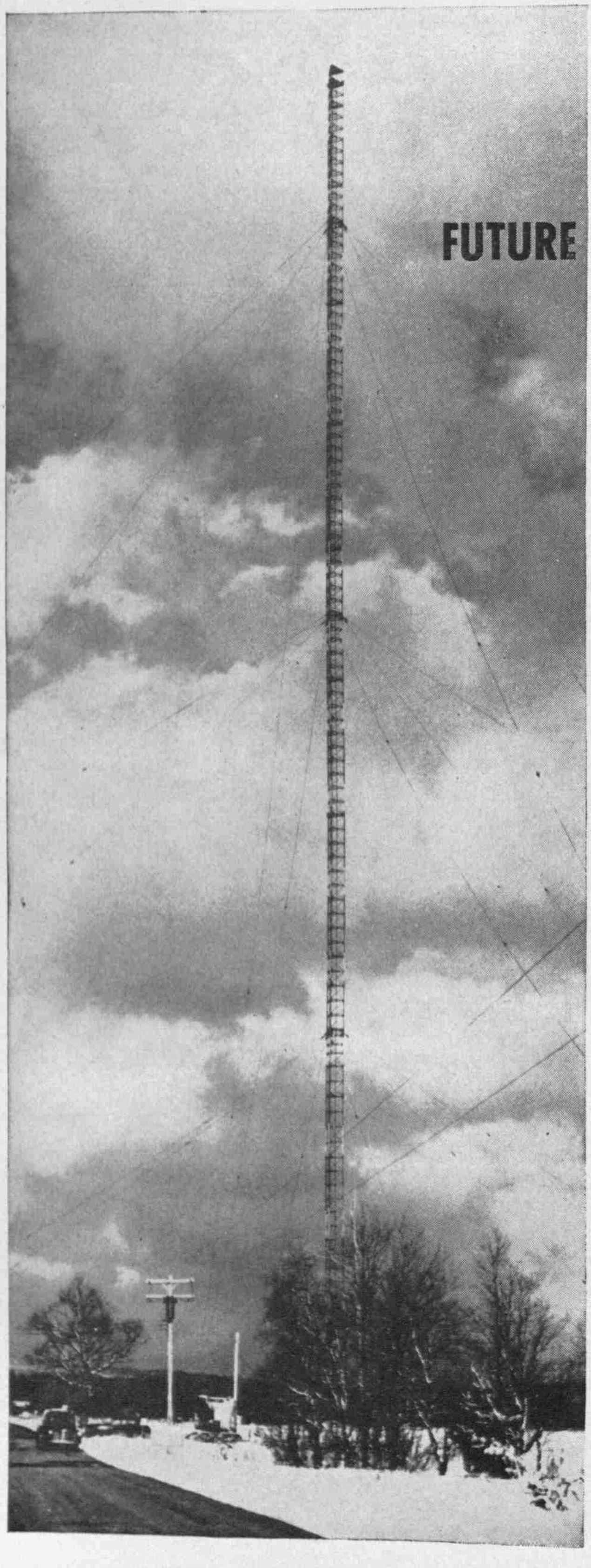

A Quarter Mile Up
FUTURE JOBS ARE BEING ENGINEERED

Your future lies not in the obvious, the complete, the established. It is forming on the drawing boards, in the laboratories and within the minds of men.

Don't look to what is, but to what shall be. Fortune comes from the new.

This Air Force Radio tower, a 1218-foot equilateral steel triangle, is the tallest in the world; second among man-made structures only to the Empire State Building. It was designed and fabricated by Republic's Truscon Steel Division. The operation of this tower is government business. But its stresses and its resistances are Republic's. The engineering of this lacy pinnacle will find adaptations in the near future. They are being shaped now in the metallurgy and design departments of Republic. A quarter mile above the earth, the steel toys with gales and totes an unpredictable burden of ice. And the facts of these achievements shall be translated by men of your generation into the still higher pinnacles of the future.

Republic's Truscon Steel Division leads the world in radio towers. Republic's other divisions push forward other frontiers. No manufacturer makes more kinds of steel, nor any better. But the making of steel is only one phase of Republic. Our many divisions design innumerable products, fabricate thousands of items.

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WORLD'S WIDEST RANGE OF STEELS AND STEEL PRODUCTS

In honor of

Dean Lorin G. Miller,

the

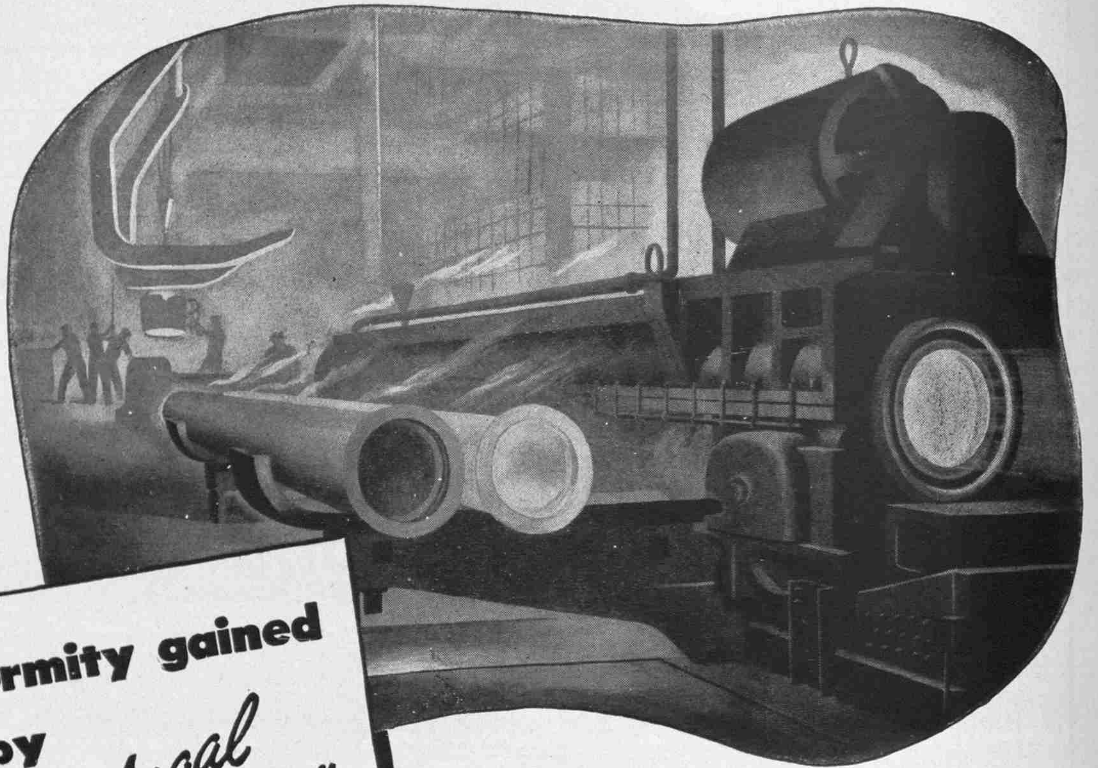
retiring Dean of Engineering,

this, the May issue of the

SPARTAN ENGINEER

is hereby

respectfully dedicated.



Uniformity gained by "Centrifugal Casting"

The great majority of cast iron pressure pipe produced today is cast centrifugally, in metal or sand-lined molds.

When this mechanized process was introduced 27 years ago, its potentialities for improved production controls were evident. For human fallibility was largely replaced by machine accuracy based on scientific principles.

The improved production controls made possible by the centrifugal casting process have long since been realized. Hundreds of millions of feet of centrifugally-cast-iron pressure pipe are now in service. All of this pipe is more uniform in metal structure, in wall thickness, and in concentricity, than pipe not centrifugally cast.

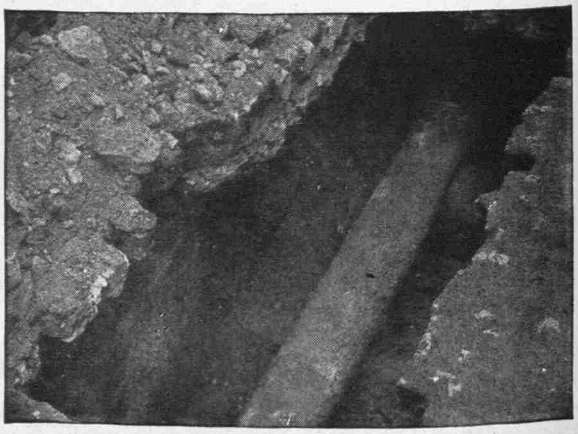
Better production control means better pipe; it results in greater uniformity of quality.

Production controls in cast iron pipe foundries start almost literally from the ground up with inspection, analysis and testing of raw materials; continue with constant control of cupola operation by metal analysis; and end with rigid tests of the finished product.

By metallurgical controls and tests of materials, our members are able to produce cast iron pipe with exact knowledge of the physical characteristics of the iron before it is poured into the mold of a centrifugal casting machine.

Cast iron pipe is the standard material for water and gas mains and is widely used in sewage works construction.

Send for booklet, "Facts About Cast Iron Pipe." Address Dept. C., Cast Iron Pipe Research Association, T. F. Wolfe, Engineer, 122 So. Michigan Avenue, Chicago, 3, Illinois.



Section of 114-year-old cast iron gas main still in service in Baltimore, Md.

CAST IRON PIPE SERVES FOR CENTURIES

Spartan ENGINEER

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COVER

COVER: Dean Lorin G. Miller of the Michigan State College School of Engineering

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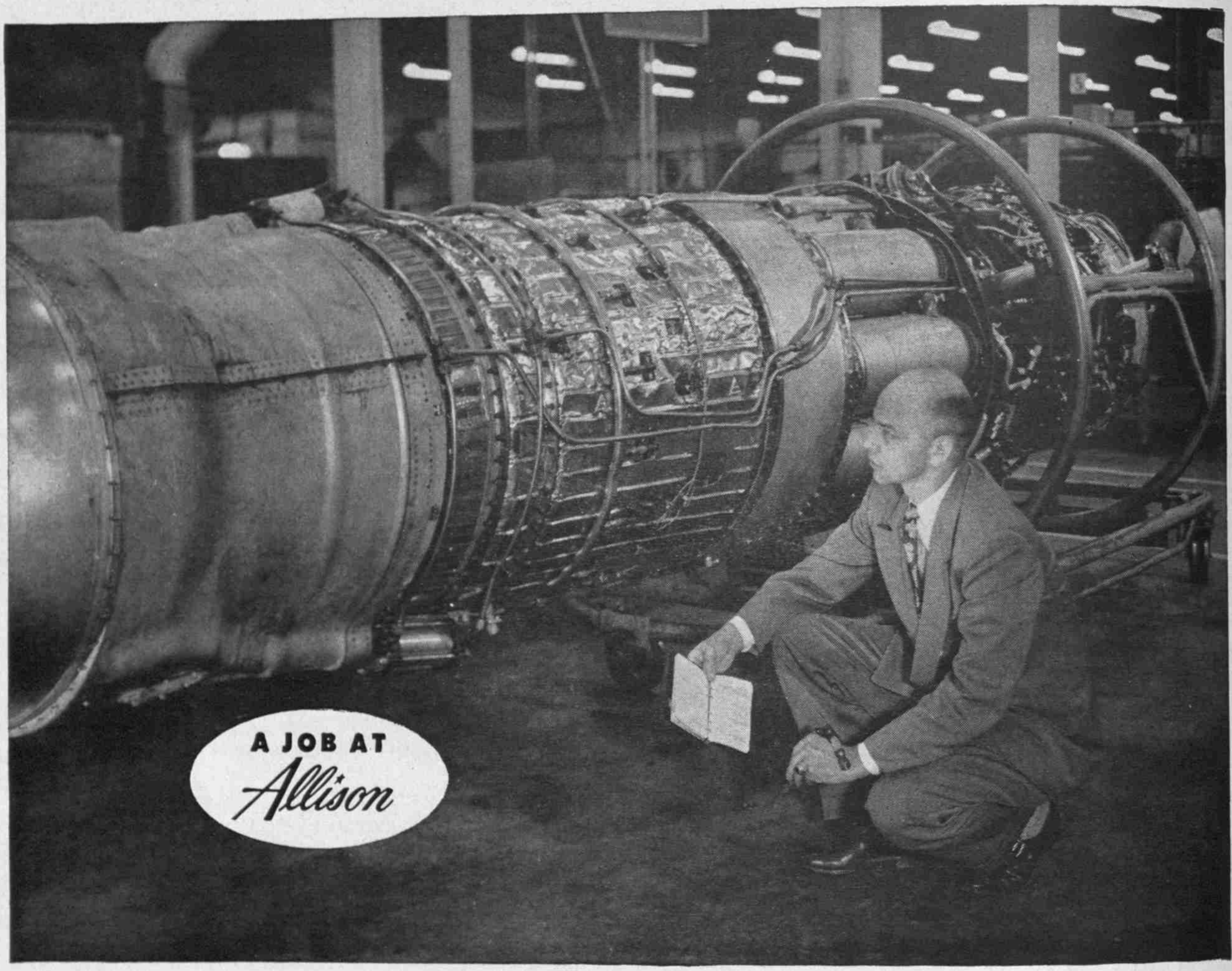

● Earle R. Wall, Jr. was graduated from Virginia Polytechnic Institute in 1941 with a B. S. degree in Mechanical Engineering and after a five year tour of duty with the Army came to Allison to do pioneering work on turbo-jet engines.

Earle today has an important job as an engineer in the turbo-jet design group and he is working on afterburners for some of America's newest jet engines. Allison Division was the first aircraft engine manufacturer to produce turbo-jet afterburners. The afterburner is a thrust augmentation unit for jet engines to give the engine more thrust in take-off, climb and combat emergencies. An additional cone is added after the turbine where more fuel is injected into the exhaust gases of the engine and ignited to give a larger amount of thrust.

Earle's job includes the thermodynamic and mechanical design of afterburners which must diffuse exhaust gases from the turbine at temperatures over 1650 degrees Fahrenheit, with a minimum loss of energy, and consume additional fuel for thrust augmentation. After the correct design has been calculated and drawn, prototypes of the afterburner are tested by the Test Control group and Earle then analyzes results. One of the many problems is the endurance life of the exhaust unit. He must make a choice of present metals or search for new metals to withstand the high temperatures and forces of the gases which pass through.

Earle and many other Allison engineers have interesting, important jobs in the science of jet engines. They are making a direct contribution to national defense and adding to their own knowledge of a subject which offers lifetime careers for engineers.

Allison is looking for young men with degrees in **MECHANICAL ENGINEERING, ELECTRICAL ENGINEERING, AERONAUTICAL ENGINEERING** *and* **INDUSTRIAL ENGINEERING.** *There are also a number of openings for majors in Metallurgy, Electronics, Mathematics and Physics.* Write now for further information: R. G. Greenwood, Engineering College Contact, Allison Division, General Motors Corporation, Indianapolis 6, Indiana.

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- **Research**

  The investigation of problems which daily face any part of the production, distribution or sale of electricity, and making recommendations for their solution.

- **Business Management**

  The coordination of problems related to Company finance, materials, property and personnel for the efficient operation of the business.

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When a graduate joins The Detroit Edison Company, he is assured every opportunity to fit into the job he likes best—and, once there, he knows he will be encouraged to advance as rapidly as his ability and energy will carry him.

Detroit Edison is a fast-growing electric utility company. It is foresighted, too. For example, already Detroit Edison engineers are working with Dow Chemical Company as one of the nation's four atomic research teams. Under investigation is use of nuclear heat in thermal electric generating plants, to produce electric power even more efficiently.

There's a future for graduates at The Detroit Edison Company—a career opportunity best described by the fact that many of the high ranking executives in the organization at this time began their climb to success in positions similar to those offered graduates today.

ANOTHER DETROIT EDISON STORY OF CAREER SUCCESS

Paul Murphy, Jr., received his BSME degree from Purdue in 1941. After four years of service as a Naval engineering officer, he joined Detroit Edison as a junior engineer in the Production Department and progressed in less than seven years to the position of Boiler Room Engineer in charge of all 12 boilers at Detroit Edison's Delray plant, a position of responsibility that includes the supervision of methods, procedures, and maintenance scheduling for boilers and coal handling equipment.

For the full story of your career opportunities at Detroit Edison, simply call or write for a free copy of this new booklet "What about the Electric Power Industry?"

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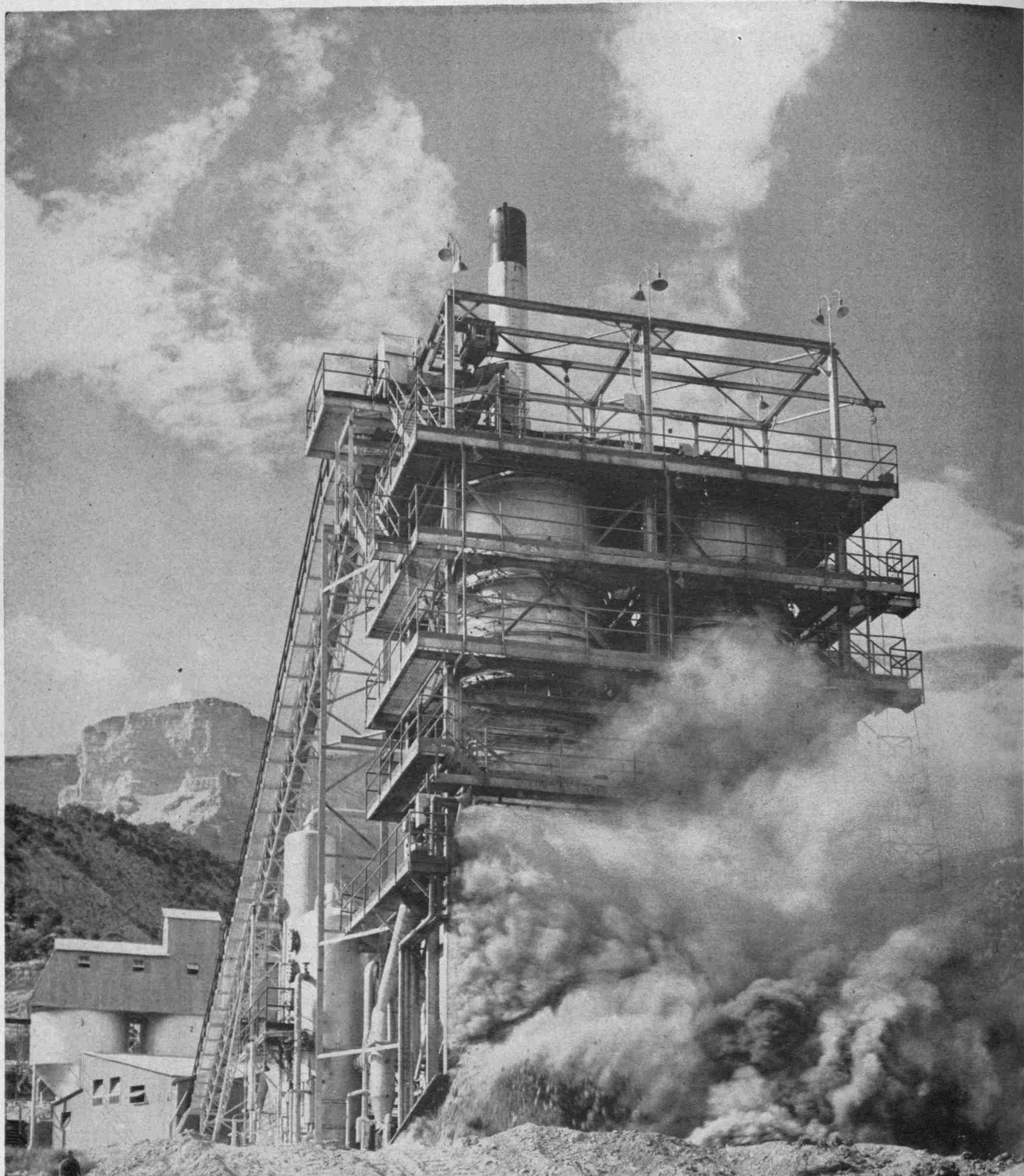


Shale processing, retort plant. Ore is heated in this unit at various periods and temperatures to ascertain the most efficient method of turning the oil shale into oil. After the oil has been retorted, the hoppers are opened and the slag is dumped out on the ground. After cooling it is pushed by bulldozers into a nearby arroyo. The retort plant can accommodate 35 tons of ore.

ROCKY ROAD TO OIL

Reprinted from THE LAMP
Standard Oil Company (N.J.)
Culled by Larry Jackson, Geology '54

The majestic mountains of western Colorado, rising steeply into the sky, contain more than cascading trout streams and tourist scenery. The bare cliffs that stare at the passing motorist are really the faces of tremendous plateaus of a rock known as oil shale. For the second time in this century, scientists are studying those greyish-brown mountains of shale intensively, to see how they fit into the picture of our future oil supply.

America counts its proved reserves of petroleum—its working stocks in the ground—at almost 25 billion barrels and there are other billions in unproved reserves. By the most conservative kind of figuring, the nation has at the same time a potential oil reserve of 250 billion barrels, lying unused in tremendous deposits of oil shale. The richest of these shale beds are in Colorado and neighboring Utah and Wyoming, but other parts of the country contain oil shales as well.

And what do the engineers and chemists think are our chances of converting those oil shales into liquid fuels? The answer to that question is wrapped up in three big **ifs**. The most informed opinion now holds that America will have fuels from shale:

If the cost of mining the ore can be made low enough so that it will be economically practical to handle the vast amounts of rock that will be needed;

If an efficient and economic way can be found to extract the oil from the shale; and

If research can turn up means of refining the crude shale oil into useful products in the price and quality range of petroleum products.

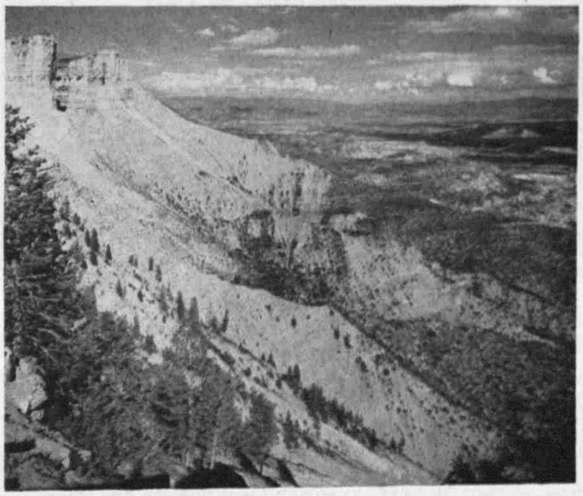
These three **ifs** are by no means insurmountable obstacles. Indeed, progress has already been made toward solving some of the very many problems involved. There is no reason why, given enough intensive research in the coming years, oil from shale should not take over some of the burden now carried by petroleum alone. But first the public will have to erase certain misconceptions about what a shale-oil industry might be, just as the handful of researchers in the field had to revise their thinking on the subject at the very start.

First of all, oil from shales is not a new concept. The French had a shale-oil industry as early as 1838; the Scotch, in 1850. The Japanese fueled part of their navy with shale oil during the recent war. Substantial shale-oil industries operate today in Scotland, Sweden, South Africa, Australia, France, Spain—and perhaps Estonia and Russia as well. Indeed, the United States itself undertook shale experiments during the 1920's when the government, having floated a successful war on oil, began to worry about future supply.

Second, the rock we call rock shale in this country isn't a shale at all; it is a marlstone. Marl is harder than shale—a matter of utmost interest to the engineers who must mine it. (Some of the foreign deposits are true shales; thus the name here. The great Athabaska tar sands of Canada, which are sometimes confused with oil shales, are really quite different.)

Third, oil shale doesn't contain oil. It holds in its pores a substance known as kerogen, which is a general term for organic material that was decomposed down to a certain point and then remained fixed. One theory is that petroleum was formed in ancient times from minute animal and vegetable organisms trapped in silt at the bottom of salt-water seas, whereas kerogen in this country came largely from minute plants that once were deposited at the bottom of fresh-water lakes. In any event, kerogen is a solid substance containing hydrocarbons (molecules of hydrogen and carbon) in combination with sulphur, oxygen and nitrogen. Although it isn't an oil, it can be turned into an oil by heating.

Fourth and perhaps most basic, the crude oil made from shale isn't in any sense petroleum. It looks and smells different, it behaves differently, it must be refined differently.



Eroded bluffs of the Colorado River basin, where beds of oil shale lie a few hundred feet from the cliff top.

In a sense, any industry that rises on the foundations of oil shale will be a new industry. The shale must be mined; but because it contains so little actual fuel per ton of rock the mining cost must be substantially lower than the average cost of producing a ton of, say, coal which is almost all fuel. Shale must also be retorted (or heated) to convert its kerogen into oil; but old methods of retorting haven't proved economical with the vast amounts of shale that must be handled. And the shale crude oil must be refined; but, for chemical reasons, conventional petroleum refining isn't the answer for shale oil.

In dozens of scattered research projects scientists are going after the three big "ifs" in a determined way. A good deal of the experimental work is being conducted

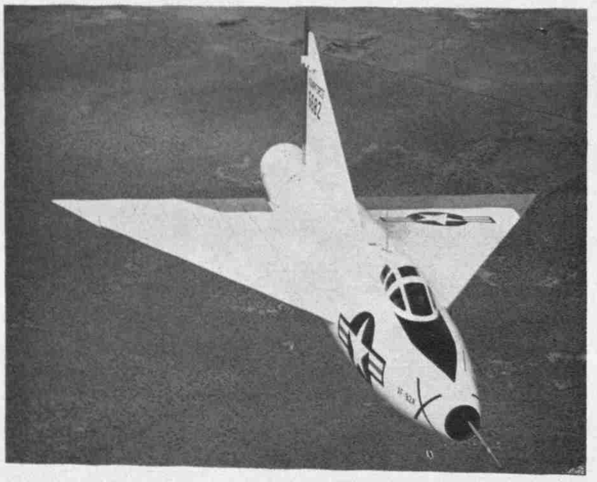
(Continued on Page 36)

ENGINEERING RESEARCH...... CUM LAUDE

By TOM CLARK
Chemical Engineer '54

With the creation of the Air Forces Air Research and Development Command at Baltimore, Maryland on January 23, 1950 by order of USAF's Chief of Staff, General Hoyt S. Vandenberg, engineering research made one of its greatest gains of the century. The Air Research and Development Command was formed to keep up with the new technological advances in the art of air warfare.

As a result of the investigations of the Scientific Advisory Board and the Air University it was found that: Air research and development was being given a priority that was too low to be efficient in its operation. Research and development was diffused throughout the Air Force, both staff-wise and command-wise. Too few Air Force officers and civilian employees had adequate technical qualifications. Existing facilities and resources available to the Air Force were inadequate for the required research and development effort.



XF-92A (Convair) — Nearing completion of Air Force research flight, this delta-wing aircraft will soon be turned over to the NACA for additional tests. XF-92A is forerunner of the XF-102. Operates at service ceiling over 45,000 feet at high sub-sonic speeds and has an Allison J-33 engine with afterburner.

As a result of these findings, the Chief of Staff on January 23, 1950, placed research and development on a policy-making and command level with other Air Force functions. Inasmuch as the Air Force's research and development activity, for the most part, had been under the Air Materiel Command, it was natural for the new organization to be assigned to AMC during its formative stage. During this changeover, policy-making was handled by the office of the Deputy Chief of Staff for Development and finally the Air Research and Development Command. Now, the ARDC has taken its place among the major commands of the Air Force and on the same level as the Strategic Air Command, Air Materiel Command, Tactical Air Command, and other major independent commands.

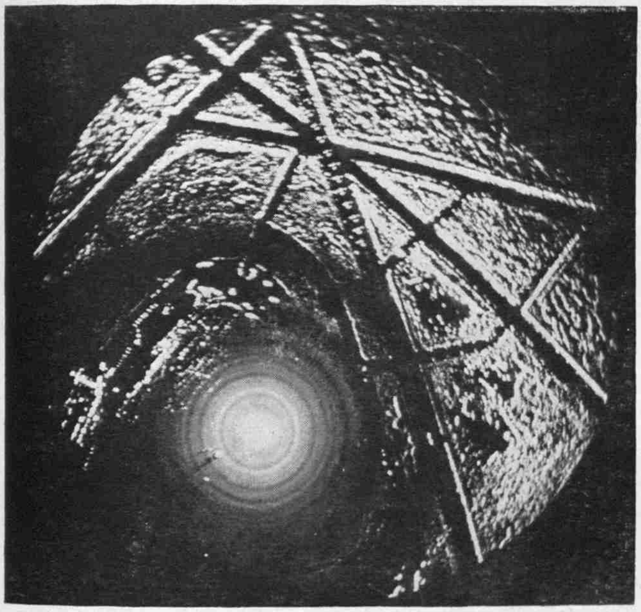
In general, the mission of the Air Research and Development Command is to provide the Air Force with improved devises and systems for the conduct and support of air warfare, including aircraft, guided missiles, weapons and other equipment. In accomplishing its mission, the ARDC is streamlining its relationship with industry by establishing joint project offices at Wright Field, manned by both ARDC project engineers and AMC project officers, to form one central place where industry and Air Force operational commands can present their problems and get their questions answered promptly. The ARDC has also tried to give to industry progressively greater responsibilities for the development of complete weapons systems.

As a result of this new streamlining policy, approximately 87 per cent of the U. S. Air Force's total research and development funds ($525,000.000 for fiscal year 1953) is used to sponsor activities by non-Air Force agencies under research and development contracts. The 13 per cent is used within the Air Research and Development Command's laboratories to work on projects with the "outside" agencies and to conduct "in-house" research and development. The "in-house" activity is mainly evaluating results of sponsored programs with non-Air Force agencies. Approximately 160 non-profit organizations, 1520 industrial organizations and 270 government agencies (e.g., Naval and Army Ordnance, Civil Aeronautics Administration, etc.) are working on Air Force research and development projects.

Basic research projects for the ARDC are largely centered in the following fields: **Fluid mechanics,** where Air Force interest lies in aerodynamics and jet and rocket propulsion systems and devices; **metallurgy,** including investigation of the crystalline structure of solids by x-ray diffraction; **nuclear physics,** with special stress on the perfection of nuclear-powered aircraft engines and on the problem of protection of air crews during the delivery of atomic weapons and in the subsequent process of decontamination of equipment; **theoretical and applied mathematics,** with the focus directed on methods of solving equations arising in aerodynamics and electronics and on statistical analysis aimed at improved techniques for the assessment of bomb damage; **chemistry,** including studies in both liquid and solid aircraft fuels, polymers, and photochemistry; **electronic computation** with the objective of designing and constructing new types of large-scale electronic computers to be used by the U. S. Air Force and its contractors for the solution of complex mathematical problems.

Today, the Air Research and Development Command is a tightly knit organization mass producing engineering technology and know-how at a greater efficiency than any other research organization. There are nine research, development and testing centers, within this organization, located throughout the United States which aid the ARDC in carrying out its mission. These Centers are:

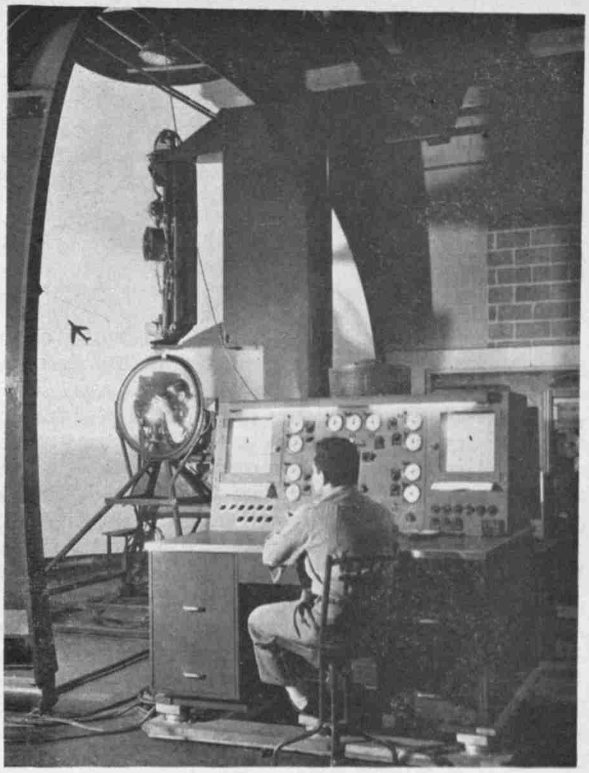
The Wright Air Development Center at Wright-Patterson Air Force Base, Dayton, Ohio, embraces all qualitative engineering aspects of aircraft and missiles, power plants, propellers, armament, airborne and ground equipment and other aeronautical materiel. The Center plans and monitors a broad program of research and development carried out by industry, universities and research institutions. The magnitude of its part in the Air Research and Development Command mission is illustrated by the fact that over 60 per cent of Air Force research and development funds are the responsibility of the Wright Air Development Center. Recently publicized and widely diversified accomplishments of this Center include development by its Aero Medical Laboratory personnel of the T-1 high altitude emergency pressure suit and "Aeroplast", a plastic dressing which can be sprayed on wounds.



A new device, "taxi radar" or automatic surface detection equipment, was developed by the Rome Air Development Center and Airborne Instruments Laboratories, Long Island, N. Y., to make it possible for airports to operate when zero visibility conditions persist. The device, now being tested during daily operations at Idlewild Airport, New York, permits control tower operators to direct taxiing aircraft, as well as all other moving vehicles, under all conditions. Taxi radar overcomes one of the biggest problems in handling air traffic in bad weather.

The Rome Air Development Center at Griffiss Air Force Base, Rome, N. Y., accomplishes research and development in ground-based electronic equipment. Some of the areas covered are: ground radio, detection, tracking and control equipment, including tracking radar for missile control; airport taxi control systems, and crash-rescue communications equipment. It is the site for testing of electronic equipment under simulated operating conditions. This Center's contribution to the development of "taxi radar" currently is receiving national attention. This is a device which guides aircraft and motor vehicles on airfields when limited visibility would otherwise stop operations. Use of "taxi radar" for civil as well as military aviation safety is presently being demonstrated at New York's Idlewild Airport, where one of the first models is being tested under actual operating conditions.

The Air Force Cambridge Research Center at Cambridge, Mass., conducts a broad program of research in electronics, geophysics, and radio chemistry and radiobiology designed to establish basic principles in these fields and to advance their military applications. The geophysics staff of this Center is constantly adding to the nation's atmospheric knowledge through its upper air research studies. Also, its recently concluded study of cloud formations and turbulence in mountain areas should provide civil as well as military authorities with important air safety data. The Air Force Cambridge Research Center provides active USAF support to the Massachusetts Institute of Technology for its participations in a joint Army-Navy-Air Force effort which embraces all aspects of the nation's air defense problem.



A flexible gunnery trainer (Martin), E-27, to train personnel in the use and operation of the remote control turret system used on B-29, B-50 and other aircraft has been developed and is being tested.

The Air Force Flight Test Center at Edwards Air Force Base, Edwards, Calif., handles the major portion of Air Force flight testing of air frames, power plants, components and allied equipment after they are put together as a complete aircraft and also conducts research and development related to such tests. Under this organization is the U. S. Air Force's parachute test group located at the joint Armed Forces installation at El Centro, Calif., site of most military parachute testing. The Flight Test Center's facilities, including the 183,000 acres of the famous Rogers dry lake bed in the Majave Desert, are made available to other members of the Armed Forces, the National Advisory Committee for Aeronautics and members of industry working on government aviation projects. Newest facility is one to test rocket engines. It was at the Air Force Flight Test Center that the sonic barrier was pierced for the first time with the U. S. Air Force's X-1.

The Air Force Special Weapons Center at Kirtland Air Force Base, Albuquerque, New Mexico, carries out the Air Force's responsibilities in the development and testing of atomic and other special weapons, and provides support in the development of nuclear weapons to the Atomic Energy Commission and other governmental agencies. The atomic bomb flight crews at the Special Weapons Center have won recognition for their precision dropping

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Power Industry Looks Ahead

By LEE MAH

Electrical Engineer '54

Ever since Thomas Edison's Pearl Street Station began supplying electricity on September 4, 1882, electrical power has been in great demand in this country. Electricity has aided in improving the standard of living by its use in lights, refrigerators, air-conditioning systems, radios and television sets. Because it can be easily transmitted to almost any desired place through wires, electric power has become the prime mover in industry. Fig. 1 shows that since 1922 the consumption of electric power has increased by 7 per cent annually as compared to a 3 per cent annual rise in overall national production. In fact, a nation's productive capacity and standard of living can be determined by its production of electric power. In the year 1951 the United States produced 432 billion kilowatthours of electricity, while the rest of the world combined produced a total of only 568 billion kilowatthours. This shows that the United States generates approximately 43 per cent of the world's total electric power. It is no wonder that the United States possesses the highest standard of living in the world.

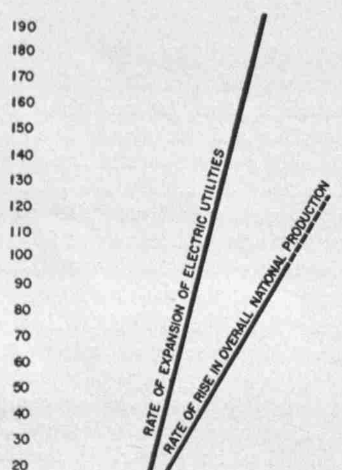

Fig. 1. From 1922 to 1951 the consumption of electric power has increased 7 per cent annually compared to a 3 per cent annual rise in overall national production of the United States.

In 1902 a total of 6 billion kilowatthours of electricity were generated in the United States. Of this amount, 1.5 billion kilowatthours were consumed by the nation's then growing industry. In 1951 the production of electricity as previously mentioned was 432 billion kilowatthours, and 210 billion kilowatthours were consumed by the nation's numerous industries. Thus in the 49 year period between 1902 and 1951, the yearly consumption of electric power by industry has increased by about 24 per cent, and industry is now utilizing nearly 50 per cent of the total electric power produced in the United States. Fig. 2 shows the amount of electricity produced during this period and the amount consumed by industry.

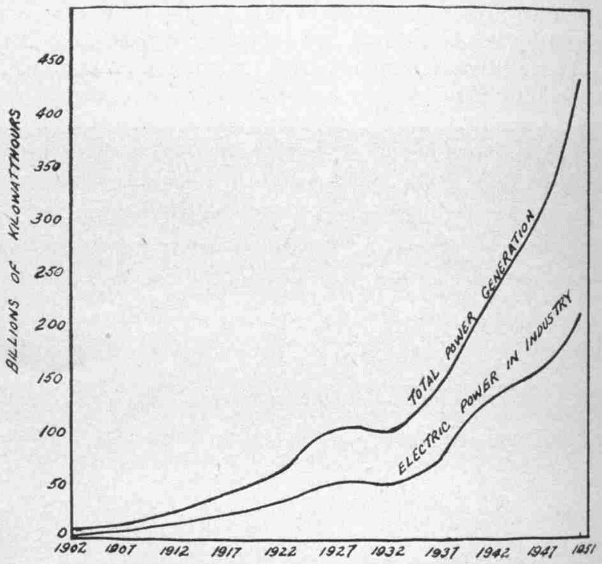

Fig. 2. The increase in electricity generated compared to the increase in power consumption by industry.

Present indications are that the demand for electric power will continue to increase. The Edison Electric Institute's 12th Semi-Annual Electric Power Survey shows that in 1952, the peak load was 76 million kilowatts, and in 1953, it was expected to be 84.3 million kilowatts. By 1954 the peak load is estimated to be 93 million kilowatts. It is predicted to hit the 100 million mark by 1955.

With every new technical development in the future, electricity is needed to supply the necessary power for its production, or operation. For instance, certain of the processes in the production of fissionable materials require great quantities of steam and electric energy. To provide the electric energy to the new uranium refining plant now under construction by the Atomic Energy Commission near Paducah, Kentucky, special plants are being built in Southern Illinois and Kentucky. These plants will have a total capability of over 2 million kilowatts.

To meet the continually increasing demand for electric power, the power industry has begun developments in two directions. The first is toward building larger and more efficient units in order to meet the immediate increase in demand. The second direction is toward developing new methods of generating electric power.

One of the examples of generating plants now being built to meet the increasing power demand is the Justin R. Whiting Plant of Consumers Power Company located near Erie, Mich., (Fig. 3). This plant, which was designed by the consulting engineering firm of Commonwealth Associates, Inc., at Jackson, Mich., went into operation in 1952. Installed in the plant are some of the advancements in steam power generation. The plant has two steam turbine generators of 85,000 kw nameplate capacity in operation, with a third unit of 106,000 kw name-plate capacity scheduled for operation in November of 1953.

These generators are cooled by a hydrogen cooling system, a recent development. Each of the two steam turbines is operated by a boiler of 690,000 lb./hr. capacity capable of producing a steam pressure of 1480 psi superheated at a temperature of 1000° F. The boilers incorporate a reheat system. The steam leaves the boiler at 1480 psi and at 1000° F, passes through part of the turbine and exhausts at about 400 psi and 700° F. It is then brought back to the boiler and reheated to the original 1000° F before passing to the low-pressure section of the turbine. With an overall efficiency of approximately 30 per cent, it is one of the most efficient plants in operation. Power generated at 14,400 volts is raised to 140,000 volts through two three-phase 110,000 kva transformers for transmission.

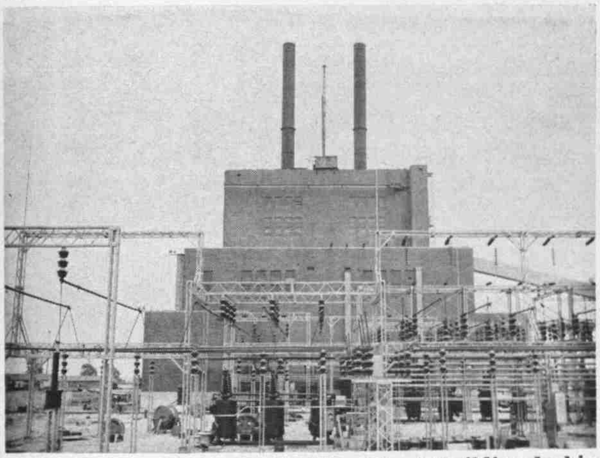

Fig. 3. The Justin R. Whiting Plant Building looking northeast.

With the completion of the 106,000 kw unit, the Justin R. Whiting plant will be capable of producing 276,000 kw to supply Consumers Power's customers. The company has begun work at their John C. Weadock Plant near Bay City to add an 135,000 kw generator, ready for operation by 1955.

Designers are now planning to put under construction steam turbine generators of 200,000 kw rated capacity. To operate these large units, steam boilers capable of producing up to 1,400,000 lb./hr. of steam are being designed. These boiler units will be designed to operate up to 2350 psi at 1100° F. with reheat to 1050° F. Fig. 4 shows the largest steam turbine units in operation.

Other units under design, or construction, are gas turbine units of 15,000 kw, 1500° F, and the recently developed hydroelectric giant, the reversible pump turbine, capable of producing 70,000 kw as a generator and 102,000 hp as a motor. The hydroelectric units will be installed at the Hiwassee Dam of TVA.

These large units were all designed to meet the present need. However, the power industry is also in search of new, more efficient and more economical methods of generating electricity. One of these possible methods is being studied by the Detroit Edison Company. Together with the Dow Chemical Company, the Detroit Edison Company is doing research on the possibility of utilizing atomic energy as a possible source of producing electric power.

The first atomic power plant is now in actual operation in Idaho. It is operated by passing a liquid alloy of sodium and potassium, pumped by an electromagnetic pump through a heat exchanger. In another circuit, a second liquid alloy picks up the heat from the first liquid, which is radioactive. The second liquid is then pumped to an especially designed steam boiler where it generates steam at 400 psi. The steam drives a 250 kw generator. A cutaway of the atomic power generating plant is shown on Fig. 5. Large capacity generating plants of this kind are still years away due to problems involved in a controlled nuclear reaction and the almost prohibitive cost. However, it is an example of the long range planning of the power industry.

The problem of supplying more electric power is not as simple as building more and bigger generating units. Two of the most important problems resulting from the increase in power output are the cooling of generators, and a larger problem of transmitting the tremendous amount of power generated.

As the size of generators increase, designers are faced with a problem of developing more efficient cooling systems. Some of the systems that have been adopted are the forced air and the hydrogen cooling systems. Recently, however, new ideas for generator cooling have been developed involving the use of hollow and specially shaped conductors which bring the coolant in direct contact with the copper in the rotor and stator windings. Thus the heat does not have to pass through successive layers of coils, insulation, iron and slot wedges to reach the cooling medium.

Second to the development of the actual generating units themselves, the most important development in the electric power industry is the development of the transmission systems. A generating plant without transmission equipment is like a water reservoir without water pipes to carry the water out; so must the transmission lines carry the electricity to the ultimate user. In the present transmission systems, the electricity leaves the generating plant at a potential of 140,000 volts maximum. However, with the terrific increase in electric power predicted for the future, the present 140,000 volt lines will not be adequate to carry the load. The transmitting potential is being increased to 330,000 volts in some new generating plants. To carry this voltage, wires of much improved insulation must be used and transformers and relay stations of higher capacity will have to be designed and built.

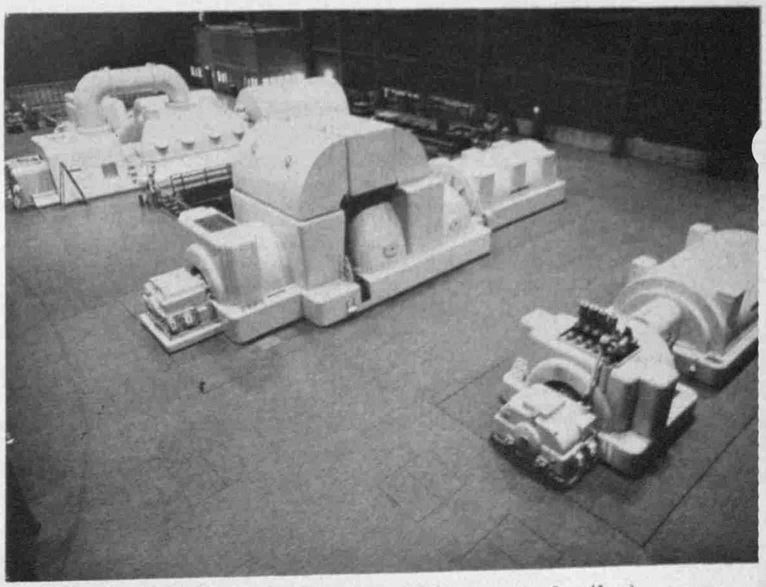

Fig. 4. Two of the first 150,000 kw (nominal rating) cross-compound turbine generators at Ridgeland Station, Chicago.

Another problem which confronts the power industry but which cannot be solved by the designers is the alarming shortage of engineers required in the supervisory and administrative capacities. In an article by Prof. J. D. Ryder, Head of the Electrical Engineering department at the University of Illinois, in the January issue of Electrical Engineering, it was pointed out that due to interest

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The Miracle Fuze

By THOMAS E. BURKE

Electrical Engineer, '53

Editor's note: The following is a reprint of a paper presented at the Great Lakes District Student Meeting of the American Institute of Electrical Engineers at Urbana, Illinois May 8 and 9, 1953. The paper took third place in the annual AIEE contest.

INTRODUCTION

The Navy proximity fuze is considered to be the number two scientific development of World War II, second in importance only to the atomic bomb.

In relation to warfare, a fuze is defined as that part of a projectile which detonates the explosive charge. The proximity fuze, currently in use in the Korean conflict, is, in itself, a miniature five-tube sending and receiving set. Weighing less than two pounds and measuring seven inches in length, the fuze fits directly into the nose of artillery and mortar shells.

Operationally speaking, the transmitter circuit of the fuze sends out electromagnetic waves at the speed of light—186,000 miles per second. The frequency of propogation is constant, and, when impinging on an object such as metal, earth, or water, waves are reflected. The design of the fuze is such that it is possible to explode an artillery shell at any distance from a target and with an accuracy far superior to the outmoded contact-mechanical fuze. Because of this design feature, the fuze is often referred to as the Variable Timed or VT fuze.

DEVELOPMENT

Fear that aerial attacks would soon make naval operations obsolete prompted the undertaking of a program for improving anti-aircraft accuracy. The Navy realized that in order to cope with the new high speed aerial warfare, it was necessary to develop an electronically timed artillery shell which was fast, efficient and independent of human calculation.

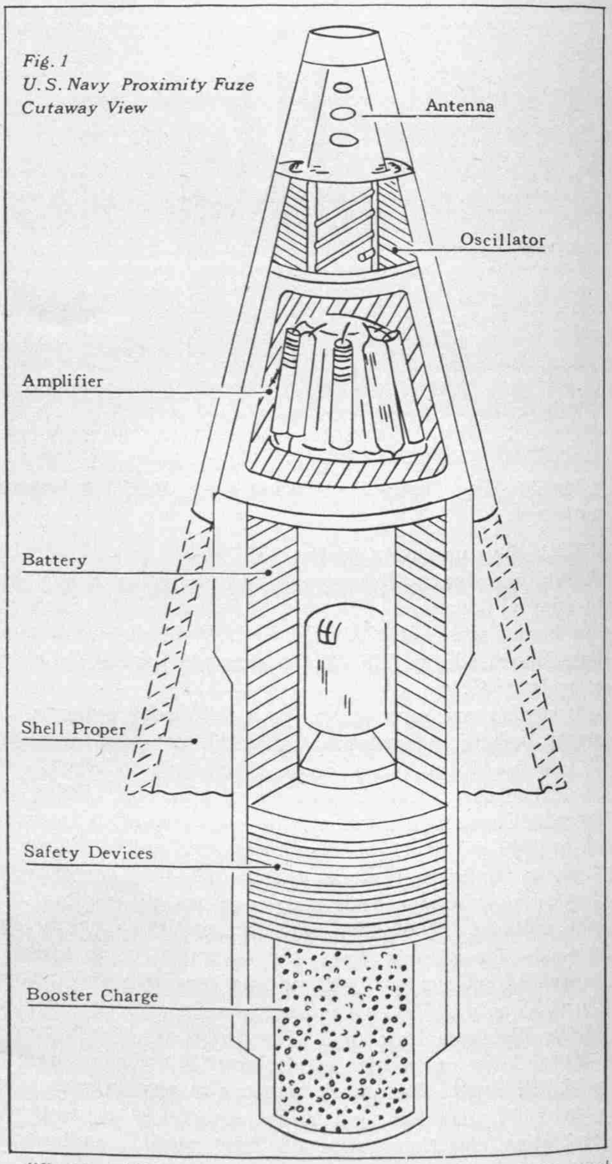
On August 17, 1940, the Office of Scientific Research and Development (O.S.R.D.) established "Section T"—a group of scientists whose purpose was to develop such a fuze for the United States Navy. Dr. M. A. Tuve was appointed head of this group, and facilities for experimentation were made available at both Johns Hopkins University and the Carnegie Institution of Washington.

The Navy established certain requirements and standards for "Section T" to fulfill. The fuze had to be sensitive and rapid but not capable of being triggered by the ground, water, or clouds. It had to be rugged and compact, yet not subject to serious deterioration. Above all, it was necessary that the fuze be designed for large scale production.

To design a fuze which would survive the physical stress and strain of artillery fire required that extreme emphasis be placed on ruggedness. It was necessary that all components withstand velocities of from 0 to 2,000 miles per hour and spins up to 25,000 RPM. The fuze could not fail when subjected to setbacks as great as 20,000 times that of gravity—an acceleration which changes a one-half ounce tube into a 75-pound weight!

Besides the radio fuze approach to the problem, three other types of fuze triggering were investigated: photoelectric, acoustic, and electrostatic. Each of these methods of firing was thoroughly studied and tested. Research proved that the radio VT fuze was the most practical and promising, with the result that "Section T" concentrated all its efforts on this particular approach to the problem.

Fig. 1
U. S. Navy Proximity Fuze Cutaway View



"Section T" directed its development program to meet the required high Navy standards. Various spinning devices were devised to simulate the motion of the shell itself. In turn, tubes were mounted in wax and dropped in steel containers against thick armor plate blocks. Conventional tubes failed these setback tests, but, through design improvement, the ruggedness of the miniature tube was increased, and in February, 1941, three tubes were developed which survived firing from a five-inch Navy gun. As further improvement was shown, the majority of laboratory experimentation was replaced by actual field testing. These initial field tests revealed the presence of a great number of undesirable prematures and duds, but through extensive testing and study of recovered units, these weaknesses were eliminated.

Assembling a VT fuze to the required specifications in a laboratory is one accomplishment, but mass-producing the same fuze under factory conditions is an entirely different accomplishment. Over 87 companies were engaged for this huge production task. The majority of these companies devoted their resources to specific phases of the fuze program, but a few companies undertook production of all the required elements. At one plant, secrecy was attained by handling different phases of production in divided sections of the plant, with only the final assemblers viewing the finished product.

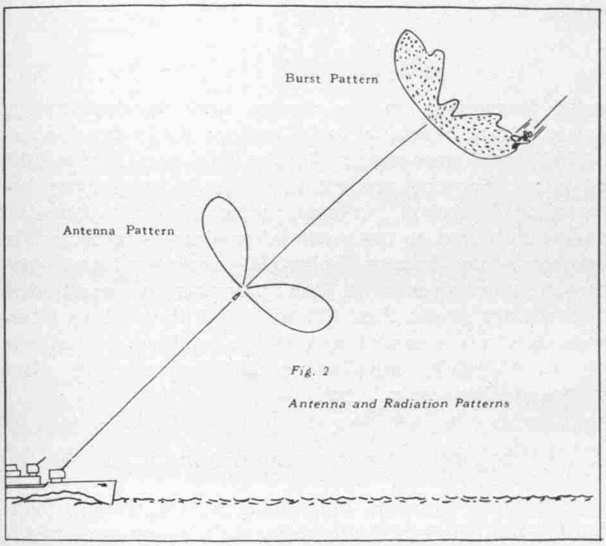


Fig. 2
Antenna and Radiation Patterns

The tube was put into mass-production in the spring of 1942. A tube standard of 98 percent was established, and a strict inspection and production instruction program was inaugurated to accomplish this tolerance. Besides statistically sampling all the manufactured elements, each tube was individually spun with an acceleration 20,000 times that of gravity. A total of over 130 million rugged miniature tubes were produced during the war, and the cost of producing each tube was reduced from ten dollars to forty cents by the end of hostilities.

The potentiality and efficiency of American industry is well illustrated in the fact that by December, 1944, over 40,000 complete VT fuzes were produced each day, and at a cost of only eighteen dollars each. This is compared to the output in September, 1942, of 400 units per day, at a cost of forty dollars per fuze. By the end of the war 25 percent of the electronics industry and 75 percent of the plastics facilities were directed toward the VT fuze program.

COMPONENTS AND OPERATION

The complete proximity fuze unit incorporates six main components, each of which performs an important and separate function. These main parts, as illustrated in the cutaway view of Figure 1, are as follows:

1. Antenna
2. Oscillator
3. Audio Amplifier
4. Reserve Battery
5. Safety Devices
6. Firing Charge

Of the six components the most ingenious device is the miniature reserve battery. The reserve battery was designed to contain within the battery itself a small glass vial of electrolyte. As the shell is fired, the glass is shattered; this allows for the distribution of electrolyte through the plates of the battery while the shell spins in flight. Voltages are established which in turn activate both the oscillator and amplifier units. The designed energizer unit is relatively free from storage deterioration and at the same time is operable under extreme weather conditions.

The proximity fuze operates in a manner similar to that with which a bat is guided in flight. It might be said that the bat originated the proximity fuze principle. In flight the bat gives out shrill chirpings, the echoes of which return to the bat's ears from the surfaces of near objects and provide a warning of impending collisions. With the bat, the reaction is a swerving motion; with the proximity fuze, the reaction results in the detonation of the explosive charge.

As soon as the operating voltages are established by the reserve battery, the oscillator begins to operate, and a constant frequency wave is radiated from the antenna on the nose of the fuze. The radiation pattern is indicated in Figure 2, and it should be noted that this pattern closely resembles that of the fragmentation or burst pattern. In free space the radiation of electromagnetic waves results in no receiver action, but as the target is approached, a signal reflects back to the shell.

The audio amplifier is of such a design that it "detects" this weak reflected signal. As the missile-to-target distance decreases, the phase of the returning signal varies, changing the radiation resistance of the antenna. This varying load establishes pulses in the plate circuit of the oscillator, and an audio frequency variation results.

Subsequently the pulses are directed through the audio amplifier, and when they reach a certain intensity, a miniature thyratron tube triggers. The simplified firing circuit is illustrated in Figure 3. In the plate circuit of the thyratron is a squib unit which consists of a resistance wire and a small explosive charge. When triggered, the thyratron condenser discharges. The plate current then rises sharply, and the resistance wire of the squib is heated. The heat generated by the wire is sufficient to ignite the firing charge, which in turn detonates the main charge in the shell.

The electrical design is such that the fuze can be exploded at distances of 10 to 70 feet from the target. As compared to the ordinary contact fuze, the relative size of a target to a proximity fuzed shell is over 50 times that of the older hand-set type fuze. Whereas the contact fuzed shell has a lethal burst area of only 60 square feet, the proximity fuzed shell is lethal for approximately 5,000 square feet.

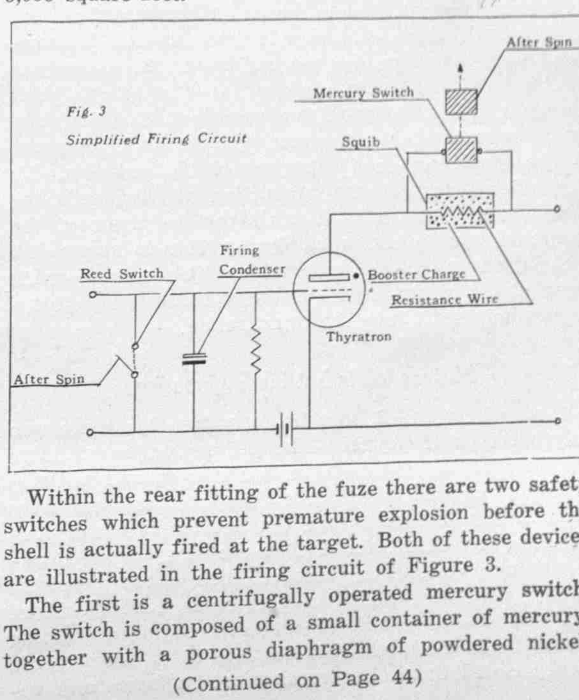


Fig. 3
Simplified Firing Circuit

Within the rear fitting of the fuze there are two safety switches which prevent premature explosion before the shell is actually fired at the target. Both of these devices are illustrated in the firing circuit of Figure 3.

The first is a centrifugally operated mercury switch. The switch is composed of a small container of mercury, together with a porous diaphragm of powdered nickel.

(Continued on Page 44)

Your Future In Industrial Engineering

By JAMES M. APPLE
Associate Professor of
Industrial Engineering

What Is Industrial Engineering?

Industrial engineering is one of the newest branches of the engineering profession.

Industrial engineering deals with the application of engineering principles to the efficient operation of business and industry. It is most commonly concerned with production work in manufacturing plants. Through the use of industrial engineering techniques, production is planned so that each operation is performed as efficiently as possible, so that the materials and parts flow smoothly through the plant, and so that the final product is produced at the lowest practicable cost.

Industrial engineering practices help to furnish products and services people want, at prices they can afford to pay. Such practices also enable the businesses to operate at a profit, so that there will be satisfactory return on the money people have invested in the enterprises.

The application of industrial engineering techniques has aided greatly in advancing mass production methods so that it is possible for the average person in America to live in the greatest comfort and comparative luxury ever known. Only through mass production of manufactured products can the cost be kept so low that such items as radios, refrigerators, telephones, automobiles, etc., which were once considered luxuries, are now commonplace in most American homes.

Industry makes use of many kinds of engineers. Each is a specialist in a given line of work. Some design products; some design machines, some provide power, heating and lighting; some design and construct factory buildings. In fact, engineers in industry can be compared with members of a football team. Each engineer has his specific duty to perform. A quarterback plans the plays, calls the signals, and sees to it that the plant functions smoothly, as a **team.** The industrial engineer can be considered as a "quarterback" in industry. He makes the plans for the production activity, calls the signals, and sees to it that all the members of the industrial team work smoothly together to accomplish the objectives of the enterprise. The accompanying chart shows where some of the various kinds of engineers might fit into the organization.

History of Industrial Engineering

It may be recalled, that in days gone by, there was only one type of engineer—the military engineer. After the days of the Roman wars were over, and military problems became less acute, the military engineers turned their talents toward the development and construction of facilities for civilian use—they called themselves civil engineers, because their work consisted mostly of building viaducts, dams, roads, canals, bridges, etc. Later on, certain of the civil engineers became specialists in the mechanical features of "civilian" goods—they called themselves mechanical engineers and devoted themselves to the design and development of power plants, machine tools, and products for the use of individual consumers. In the late part of the 19th century, when the production of goods in quantity became an important problem, some of the mechanical engineers turned to the study of production problems in industry—they became industrial engineers, and concerned themselves with the planning of economical methods for production. They found themselves interested in such areas of activity as motion study, time study, materials handling, production control, plant layout, quality control, etc.

The Work of the Industrial Engineer

As indicated above, industrial engineering is concerned with the application of certain techniques to the operation of industry and business. The most common of these techniques are briefly described below:

1. Process Engineers

   Process engineers analyze the blue prints or drawings furnished by the Product Design Department. Each part is studied in order to determine: (1) what operations must be performed on the raw material, (2) what sequence of operations is best, and (3) what machinery or equipment is best suited to the process. Such work requires a study and knowledge of manufacturing processes, production equipment and methods, jig and fixture design, etc.

2. Motion Study

   Motion Study is concerned with the study and analysis of operator methods in order to find the most economical way of doing each specific task. Proposed jobs, or jobs already being performed, are studied in order to determine the minimum number of motions required by an operator to perform the work. Motion picture equipment is used extensively in studying production work methods, and improving their effectiveness.

3. Time Study

   After the method has been established and standardized, the time study engineer takes over. It is his responsibility to determine the time required by a qualified operator to perform the task, while working at a normal pace. He works out a production time standard which is used as a basis for making up production schedules, setting delivery dates, determining equipment and manpower needs, and arriving at production costs.

4. Plant Layout

   Plant layout is concerned with the effective arrangement of the physical facilities necessary for production. In plant layout work, the materials flow pattern is studied and planned in such a way that the parts of the product will progress in an orderly fashion, through the production processes. Around the flow pattern, efficient work stations are

GENERAL MANAGER

Product Engineering	Purchasing	Accounting	Production	Sales and Advertising	Industrial Relations
Research and Development (ME, EE, IE, Ch E, Met. E, CE)	Vendor Contract (ME, IE)	General Office		Sales (all Engrg.)	Personnel Management (IE)
Design and Drafting (ME, CE)	Clerical	Accounting		Advertising and Sales Promotion	Labor Relations (IE)
Test and Experimental (ME, EE, IE, Ch E)	Traffic	Cost Accounting (IE)		Market Research	Public Relations
Administrative (ME, IE, EE)	Expediting (IE)	Budgeting (IE)		Service (ME, EE, IE Ch E)	
Legal (ME, IE, EE)	Records	Tax		Export	
	Salvage (ME, IE)	Payroll			
		Auditing			
		Statistical (IE)			

Production

Industrial Engineering	Plant Engineering	Manufacturing	Production Control	Quality Control
Process Engrg. (ME, IE, Ct E)	Power and Utilities (EE, ME)	Machining	Production Planning (ME, IE)	Quality Standards (ME, EE, IE, Ch E)
Material Handling (IE)	Maintenance and Repair (EE, ME, IE)	Sheet Metal	Production Routing (IE)	Inspection (ME, IE)
Production Methods (IE, ME)	Plant Protection	Foundry	Production Scheduling (IE)	Statistical Control (IE)
Production Time Standard (IE)	Planning and Controlling (ME, IE)	Assembly (ME and IE as production supervision or technical staff)	Production Dispatching (IE)	
Plant Layout (IE)			Production Follow-up and Control (IE)	
Technical Training (IE)			Materials Control (IE)	

CE = Civil
Ch E = Chemical
EE = Electrical
IE = Industrial
ME = Mechanical
Met E = Metallurgical

FUNCTIONAL CHART OF A TYPICAL MANUFACTURING ORGANIZATION placed for each operation. Necessary materials handling equipment is worked into the plan in order to assure the smooth flow of materials.

5. Materials Handling

   Materials handling activities are concerned with the efficient movement of materials through the plant. Since it is a commonly accepted fact that 25 to 30 per cent of the cost of production goes for material handling, this is a most challenging area of activity. It is probably the fastest growing field of work in the industrial engineering field today, and holds great promise for the future. This is primarily due to the fact that materials handling was overlooked as a possibility for cost reduction in the rush for the development of better and more economical production machines and methods. Materials handling work deals primarily with the selection, design, and installation of mechanical equipment to replace the "hand" work in handling.

6. Production Control

   Production control work is concerned with the problem of keeping up the flow of materials worked out by the plant layout and materials handling people. In other words, production control puts the material into the flow pattern, and then sees to it that the materials move through the plant as planned, and are turned out in the form of finished products, on time, and in the proper quantity. Effective production control involves: (1) planning the production requirements in terms of materials and the rate of flow through the plant; (2) determining the exact path and machines to be used for a specific order, lot, or part; (3) setting up a schedule of materials flow so that each part or order will be started in time to meet other parts for assembly and so that the finished products will be completed on schedule; (4) issuing jobs to operators in proper sequence, so that the schedule will be met; and (5) following up the plans to see that they are being carried out, and taking steps to correct the situation if necessary.

7. Quality Control

   Up until fairly recently, quality was maintained primarily by "inspection"—after work was completed. Defective parts were separated out and disposed of with a loss of time and materials, and waste of production facilities. Then, shortly before World War II, the use of statistical methods came into common use in the field of quality control. Statistical techniques have been worked out to enable production personnel to **control** quality **during** the manufacturing process. This makes it possible to predict results in terms of quality of product, and to make necessary adjustments and changes in the process itself, before parts become scrap.

Related Work Frequently Done by Industrial Engineers

Because industrial engineering work is so closely concerned with men, jobs, materials, methods, costs, wages, etc., the industrial engineer frequently finds himself at work in many other areas of activity. Those related fields in which he most commonly finds himself are described briefly below:

1. Job Evaluation—the study of characteristics of individual jobs in order to rate each job in relation to other jobs and to help establish a basic wage rate to be paid for a certain type of work.
2. Merit Rating—the rating of individuals on the basis of personal qualities, as a means of determining eligibility for wage increases and/or production.
3. Wage and Salary Determination—the study of wage rates in relation to the community, the cost of living, and the work performed, in order to set up an orderly schedule of wages and salaries for all classes of work in an organization.
4. Labor Relations—handling the technical details in wage negotiations, in collective bargaining, and in settling grievances.
5. Product Development—the study of the product, from an engineering viewpoint, in order to discover simpler design, better materials, easier production methods, and more saleable products.
6. Safety—the work involved in making the plant a safe place to work, through the study of past accidents, planning for accident prevention, and the design and installation of safety devices.
7. Packaging—the study of packaging methods, in order to find easier, safer, more economical methods of packaging, so that products can be conveniently handled and shipped.
8. Organization Methods—the study of the organization of the business structure in order to plan more effective working relationships between persons, activities, and organizational groups.
9. Cost Accounting—the study of the various phases of manufacturing costs in order to establish cost standards and to set up controls to aid in checking on the effectiveness of operation.
10. Survey work—because of his intimate knowledge of the various phases of plant operation, the industrial engineer is often called upon, by management, to make studies and surveys of production costs and operating conditions, to be used as a basis for management planning, reports, and controls.

Scope of Industrial Engineer Work

It may have been assumed up to this point, that industrial engineering is practiced only in manufacturing plants. This is not at all true. Industrial engineering techniques have been successfully used in many fields of activity; to mention a few: farm management, dentistry, home economics, hospital work, surgery, hotel work, restaurant operation, construction work, crop harvesting, architecture, retail store operation, and mail order selling. Every day more new and interesting areas of activity are being studied with the help of industrial engineering techniques.

Industrial Engineering at Michigan State College

Michigan State College offers work in industrial engineering as a senior option in the mechanical engineering department. The first three years of study are the same as for the mechanical engineers. However, about one-half of the course work in the senior year is given over to the study of industrial engineering principles, techniques, and practices. Course titles are listed below, and an idea of their content may be obtained by reviewing the areas described previously:

1. Motion and Time Study
2. Plant Layout and Materials Handling
3. Production Control
4. Job Evaluation and Merit Rating
5. Industrial Organization
6. Elements of Supervision
7. Manufacturing Problems

Michigan State College has some of the finest facilities available for the study of industrial engineering. In the machine tool lab, students actually produce air compressors; in the foundry, steel and aluminum castings for the compressor parts are made; in the wood shop, patterns are made for the parts produced in the foundry;

and in the sheet metal processing lab, several of the compressor parts are made.

In the classes, much of the work is related to the manufacturing done in the shops. You will find yourself always looking for better, easier, and more economical ways of doing things. In Motion and Time Study you will be concerned with individual job methods; in Plant Layout and Materials Handling, you will work out plans for a real factory; in Production Control you will study methods of setting up schedules for the factory; in Manufacturing Problems you will consider the cost of production and financial aspects of factory operation. In other courses, you will deal with the problems of people in the factory.

In both practical and theoretical work, you will learn much about production techniques. You will learn how things are done, as well as why. Many problems will be carried over from the lab. area into the classroom for discussions of the reasons behind what is done in the shop. You will find yourself preparing for an interesting career in the field of industrial engineering—the newest, most rapidly growing, and one of the most challenging branches of the engineering profession.

Qualifications Necessary for Success in Industrial Engineering Work

The industrial engineer is first, last, and always an engineer. His work, however, brings him much closer to people than that of many other kinds of engineers. He is constantly studying the relationships of people to the successful operation of an enterprise. Therefore, besides having the qualities necessary for success in engineering, he must also possess those qualities which will help him to get along with people. He must have tact, a pleasant disposition, integrity, sincerity, persistence, and the ability to sell his ideas to others. He must have an analytical mind. He must be able to spot a problem, gather the facts relating to it, work out a solution, and present it in effective written or oral form to his superiors. He should also have an unending curiosity—a desire to know why something is being done—and whether there is a better way.

Opportunities in Industrial Engineering

The opportunities in industrial engineering are nearly unlimited, when one considers the application of any or all of the techniques previously mentioned to the various fields indicated. By far the larger number of engineering college graduates are absorbed by industrial concerns. However, there is an increasing realization on the part of other types of businesses that they, too, need the services of the industrial engineer.

Let us assume, however, that the average college trained industrial engineer enters industry. After a period of orientation he will most probably find himself working in one of these fields: Time Study, Motion Study, Plant Engineering, Production Engineering, Production Control, Personnel Work, or Production Supervision.

His work may consist of activities such as:

1. layout of plant facilities
2. organization planning
3. utilization of equipment and personnel
4. planning flow of materials
5. improvement of operating methods
6. material utilization
7. management controls
8. cost studies
9. special projects
10. cost estimating
11. production planning and scheduling
12. inventory control
13. cost control and information
14. labor relations problems
15. operating performance control
16. methods engineering studies
17. application of wage incentives
18. development of work standards
19. job specification and evaluation
20. wage rate surveys
21. quality control
22. product development
23. process engineering
24. materials handling planning

It should be pointed out, that in many of the types of work mentioned above, the young engineer has, so to speak, the "run of the plant." That is he will not be tied down to physical location. His work will most likely carry him from one end of the plant to the other. This helps to give him a comprehensive, overall understanding of the plant and its work, and provides an excellent background of broad plant knowledge to serve as a basis for higher positions in management.

It is possible that when he finds the type of work he likes best the industrial engineer may progress in that field to the top position in that field, in his organization. That position may be: Personnel Director, Chief of Standards, Chief Industrial Engineer, Superintendent of Plant Layout, Methods or Time Study Supervisor, Production Control Superintendent, Process Engineer, or many others.

From any of these positions it is possible to work up the remaining steps to the top—to factory manager, to production manager, to general manager.

Of course it is entirely possible that, by nature of his plant experience, the industrial engineer will find himself in other positions as well.

The results of a survey by a large engineering school, shows that 2012 out of 5504 graduates were in administrative positions. And it may be assumed that the proportions of industrial engineers should be higher than this 36.6 per cent of all engineers. In fact, a survey of over 1000 Pennsylvania State College graduates in industrial engineering showed that 78 per cent were in management positions in business and industry.

The future holds tremendous opportunities in industrial engineering. It is a new and relatively young field. It is finding broader applications every day and should continue to expand in the years to come, as more and more people become aware of the importance of the application of industrial engineering techniques to an ever-increasing number of activities in business and industry.

She had resisted his affectionate advances all evening, but finally, as he was saying goodnight, she gave in and favored him with a restrained kiss. "That's your reward for being a gentleman," she murmured.

"For all my wasted labors," he groaned, "That's no reward—just workman's compensation!"

★ ★ ★

Hubby (at the movies): "Can you see all right?"
Wifey: "Yes, this is fine."
"Is your seat comfortable?"
"Oh, yes."
"Is there a draft on your feet?"
"No, I don't feel any."
"Change places with me, will you?"

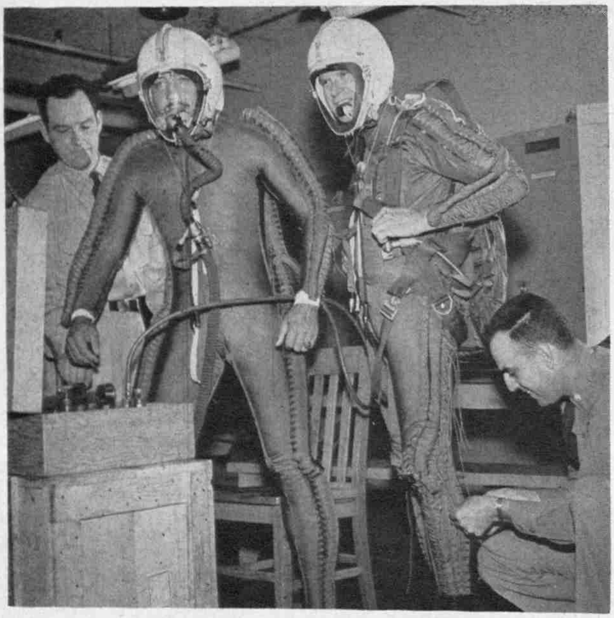
Problems of Supersonic Flight

By JAMES A. GUSACK

Mechanical Engineer '53

The world of today is rapidly accelerating in complexity. Compare the development of the automobile from the spindly Model T Ford to the magnificent high powered Cadillac of today. The simple airplane flown by the Wright Brothers has evolved into a mechanism that travels many times faster than sound. This rapid advance of knowledge has created problems which must be solved by engineers and scientists in the future.

Let us look at some of the inherent problems of high speed flight. The modern pilot has to have superior physical stamina, coordination, mental stability, and ability to manipulate the many gadgets necessary to fly the airplane. Even now he needs the automatic pilot, an electrical device that automatically controls the aircraft's course at the pilot's setting. Power flight controls, radar tracking, and computing armament also help him to control the airplane. Unfortunately, at the higher speeds and altitudes the pilot's body is actually a handicap to the airframe.



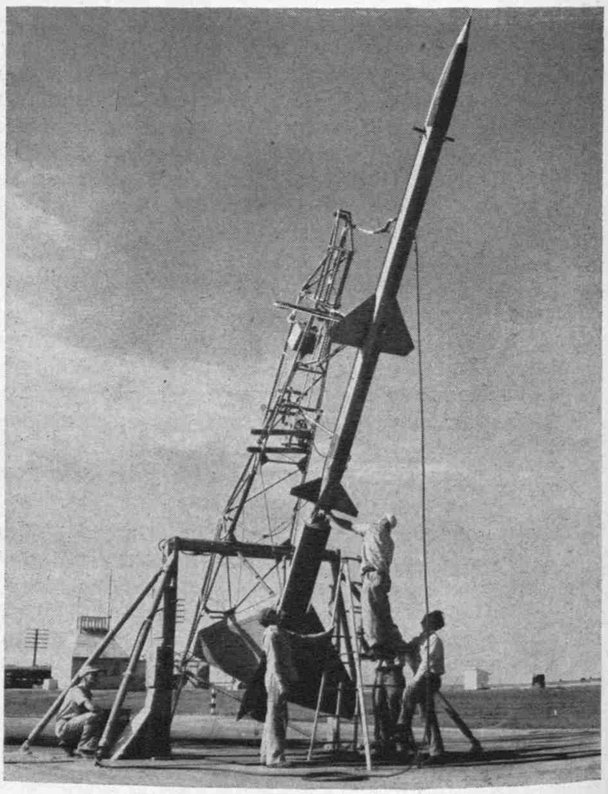
The new Air Force high altitude emergency suit in a pressure test prior to take off.

At a height of 63,000 feet, a loss of cabin pressure will cause the pilot's body fluids to boil, causing instant death. This unpleasant situation is being eliminated by a high altitude suit designed to save the lives of airmen, should the pressurized cabin fail above 47,000 feet. The suit's job is to apply pressure to the surface of the flyer's body, compensating for the air pressure which is necessary to prevent his body from rupturing.

The effects of high speed on the pilots are serious, but the effects on the physical airframe are also serious. At high altitudes, the outside temperature is below zero, but inside the aircraft, the temperature rises. This temperature rise is caused by the "skin" friction at supersonic speeds, and the heat given off by the mechanisms and electronic equipment within. A cooling system is therefore needed. Ordinarily, to cool a motor, cool air is blown over it. However by trying to utilize the cool atmospheric air by catching some of it in a duct, the air is compressed by ram action at the supersonic speeds. The final air temperature is hotter than the original temperature of the motor. Cooling is a serious problem that will have to be solved.

Structural metals are subjected to vibration, high temperatures, and acceleration forces far above conditions found in ordinary applications. The thin and therefore flexible wings necessary in supersonic flight are subject to "flutter". Flutter is spontaneous low frequency vibrations of large segments of a structure. The airplane must not develop flutter at any speed within the airplane's designed speed range or the structure may fail due to the endurance limit of the metals.

The acceleration forces due to the mighty thrust of the jet engines are very large. One of the eight jet engines in the B-52 Stratofortress is reported to be able to sustain a B-50 heavy bomber in level flight all alone. The centrifugal forces in turning are also large. Since centrifugal force is equal to mass times velocity squared divided by the radius of curvature ($F = \frac{MV^2}{r}$) when the velocity is constant, the force is proportional to the velocity squared. Therefore as the speed increases from say 300 mph to 600 mph, the stress on every component increases four times due to centrifugal forces alone. As new aircraft are being designed to maneuver at speeds of two, three, and more times the speed of sound (approximately 750 mph at sea level), serious design problems arise.



A guided missle poised for a test flight. (Courtesy Boeing Airplane Co.)

One solution is to replace the human pilot with his oxygen, pressurized cabin, ejection seat, and other necessities with a gyroscopic, fully automatic electronic pilot.

(Continued on Page 46)

Education at the American University of Beirut

By IBRAHIM D. KHALAF

Civil Engineer, '54

The leading institution in Lebanon and indeed in the whole Arab world is the American University of Beirut. Founded in 1866 as the Syrian Protestant College, the name was changed in 1920 to its present one.

The university draws students not only from all the countries of the Near East, but also from Asia, Africa, Europe, and a few from North and South America. As a rule some twenty-five or more nationalities are enrolled. Many of its graduates have occupied and are now occupying leading positions in the political, economic, and cultural life of the Arab world.

The university has a beautiful campus on the promontory of Ras Beirut overlooking the Mediterranean Sea and the city of Beirut, with a view of a large part of the Lebanon Mountains. The campus comprises no less than thirty buildings of major size and a large number of smaller buildings, the whole interspersed with groves, wooded slopes, and playing fields.

The university comprises a School of Art and Sciences, a School of Medicine, a School of Pharmacy, a School of Nursery, an Institute of Music, and the recently added School of Engineering. The lower division of the University is known as International College, and is separately administered and financed. International College comprises: the intermediate section, covering the first two years of college; the preparatory section, an American type high school, and the section Secondair, a French type high school. Each section has its own director and committee.

The intermediate section, composed of freshman and sophomore classes is under the supervision of the School of Arts and Sciences of the university as to the curriculum and academic standards. For admission to the intermediate section, a student must have fifteen units of credits from an approved secondary school or must pass an entrance examination. Entrance examinations are held in four groups of subjects:

(1) English and Arabic or the vernacular language of the student are required.

(2) A required examination in geography and history in any particular field.

(3) Tests include arithmetic, algebra, and plane geometry, all required.

(4) Tests include elementary science as a required subject, and either biology, chemistry, or physics.

The freshman program is uniform, with Arabic, English, history of the Arabs, mathematics, science, sociology, and compulsory physical education. A choice is given of engineering, music, or political science.

The sophomore class is divided into two sections: The Art section, which comprises courses in Arabic or English, economics, history, philosophy, and political science, and the Science section, which comprises required courses in chemistry, mathematics, physics, and philosophy, with a choice of biology, more mathematics, or engineering.

The School of Arts and Sciences covers the junior and senior college years. It offers two types of academic programs: a general course and a specialized honor course. To be admitted to the honor course, a student should have an extraordinarily high average. No student is admitted for engineering unless he maintains such a high average. This makes it increasingly difficult to get into such classes due to the great competition.

Work in the arts or sciences in the general courses leads to the Bachelor of Arts pass degree.

The course in Engineering is a completely required curriculum including surveying, and practice courses during summer years. Graduates receive the Bachelor of Arts degree with first, second, or third class honors and an additional year of required courses leads to the Bachelor of Science in Engineering.

Students at University of Beirut.

It would be impractical to detail the courses offered in the various departments of the School of Arts and Sciences; suffice it to say that the system followed is very similar to that in American universities and colleges.

Graduate Study

Graduate work is offered in the School of Arts and Sciences leading to the degree of Masters of Arts, Masters of Business Administration, and Masters of Science for students in the medical sciences preliminary to entering the School of Medicine.

Graduation with first or second class honor is customarily required for admission to graduate classes, and the student must also pass a written comprehensive examination in his major field of study. Studies usually extend over an academic year, except where students have teaching fellowships, in which case two years may be required. A thesis and a final oral examination are required.

Division of Medicine: The School of Medicine is composed of the school of medicine, school of pharmacy, and the school of nursing. To be admitted to the School of Medicine the student must have satisfied the premedical education requirements of his own country, and must have completed the junior year of School of Arts and Sciences.

(Continued on Page 46)

The Alumni Page

BROTHERLY LOVE

By AGNES McCANN
Engineering Enrollment Officer

We all know that "Brotherly Love" exists where there are two or more boys in the same family. However few of us realize how deep this common interest penetrates into their every day lives. As the brothers become young men ready to decide upon the type of work for which they are best fitted and in which they are most interested, we find brotherly love for Engineering very much in evidence.

It is a pleasure to tell you about some of the brothers who are now alumni of Michigan State College.

I believe the Scheid Brothers have the special distinction of all four graduating from Mechanical Engineering. Louis was the first to get his degree in June 1927. He is Superintendent of the Watervliet Paper Mills, and lives at Forest Beach Road, Paw Paw, Michigan. Charles graduated in 1930, and is Sound Technician for M.G.M., in Hollywood, California. George finished in 1932 and is with the S. M. Jones Company at Mt. Pleasant, Michigan. Paul received his degree in 1937 and owns his own heat treating plant in Jackson, Michigan.

All three of the Smith boys graduated from Mechanical Engineering. Louis finished in 1927. He is Sales Manager for the Tubular Stud and Rivet Company, and resides in Wellesley Hills, Massachusetts. Harold finished in 1933 and is in New York City with the Tubular Stud and Rivet Company. Bill completed his work in 1940 and lives at 1934 N. Limestone, Springfield, Ohio. Then came the three Mitzelfield brothers all majoring in Mechanical Engineering. Louis got his degree in 1942. He is in Detroit, but I do not know his business connection. Marvin, better known as "Jack" finished in 1944 and is Asst. to Chief Engineer, National Twist and Drill Company, Detroit. He lives at 920 Gunn Rd., R. 2, Rochester, Michigan. Tom graduated in 1948. He is with General Motors and lives at 32355 Arlington Dr., Birmingham, Michigan. Three of the six Vandervoort boys chose Mechanical Engineering at Michigan State. Bob received his degree in 1947 and is with Hager-Fox Heating Company. He lives at 705 Grove, East Lansing. William graduated in 1948. He is with the Clarage Fan Company, and lives at 14 West Elm, Chicago 10, Illinois. John got his B.S. in 1949. He is with the Ingersol Steel Division of Borg Warner, and lives at 323 Humbolt Ave., Wausau, Wisconsin. Ward and Joe Brundage both elected Mechanical Engineering. They are with the Brundage Company in Kalamazoo. Ward, 1936, is General Manager and lives at 2259 Tipperary Rd. Joe, 1938, is Factory Manager and resides at 1406 Maple St. Howard, 1934, and Paul, 1937, Brinen are both Mechanical Engineering majors. Howard is Chief Research Engineer, and Paul is Chief Design Engineer for the Young Radiator Company, Racine, Wisconsin. Howard lists 2226 Kinzie Ave., Racine, as his home address, and Paul lives at 811 Munroe, Racine, Wisconsin. Bob and Don Waalkes are two more M.E. majors. Bob graduated in 1942 and is now Asst. Prof. of Mechanical Engineering at M.S.C. His country home address is Route 4, Box 58, Mason, Michigan. Don received his degree in 1950. He is with Allis-Chalmers and lives at 6122 W. Lisbon, Milwaukee, Wisconsin. The two Barthold boys elected the same Mechanical Engineering major. Paul, 1935, is Purchasing Agent for Beach Products, 2001 Fulford St., Kalamazoo 24, Michigan, and Robert, 1938, lives at 227 Edgemore Ave., Kalamazoo. Two more M.E. majors were Wilfred and Robert Shedd. Bob graduated in 1944 and is with Kennedy-Van Saun Power Plant in Grand Rapids. He lives at 45 College Ave. S.E. Wilfred, a World War II veteran, returned and received his degree in 1950. He is back in the service and is now stationed in Seoul, Korea. The Kincade boys both graduated from Mechanical Engineering in 1940. Norman is Lt. Col. in the Air Force, and Wilbur is with the Burroughs Adding Machine Company. He lives at 4402 Groveland, Royal Oak, Michigan. Ray and Wayne Edwards are both M.E. graduates. Ray received his B.S. in 1942. He is Product Engineer for Allis-Chalmers and resides at Elm Grove, Wisconsin. Wayne, 1948, is Research Engineer with Duo-Therm in Lansing. His residence address is Route 2, Box 287, Lansing. The two Lill brothers, Melvin, 1951, and Gregg, 1948, are both graduates in Mechanical Engineering. They own their own company known as the Melvin-Gregg Company. Gregg lives at 516 Highland, East Lansing, and Melvin resides at 4942 Dawn, in the College City.

Brothers like majors other than Mechanical Engineering too for Frank and Alvin Gaines majored in Chemical Engineering. Frank graduated in 1937, and is Chief Engineer for Creole Petroleum Company, Caracas, Venezuela. Alvin returned after World War II and finished in 1947. He is with Aerojet at Numbus, California, and lists his home address as Route 2, Box 474, Loomis, California. Sandborn and Seymour Eldridge also majored in Chemical Engineering. Sandborn graduated in 1941 and is with Eastman Kodak Company. He lives at 64 Everett, Rochester 13, New York. Seymour finished in 1938. He owns his own business the Glendale Camera Shop and lives at 14637 11th Ave. S.W., Seattle 66, Washington.

Robert and Samuel Bair were both Civil Engineers. Robert finished in 1937 and is Sanitary Engineer for U. S. Air Force, Langley Field, Hampton, Va. Sam, 1941, is with O. W. Burke Co., and lives at 1036 Grove St., Royal Oak, Michigan. Chris and Cornell "Corky" Beukema are both Civil Engineers. Chris who finished in 1940 is now General Manager of Michigan Limestone and will soon be located in Detroit, Michigan. Corky is Bridge Design Engineer for the State Highway Department and lives at 3202 Alden Dr., Lansing 15, Michigan. John and Herman Vanderveen both took Civil Engineering. John finished in 1927 and lives at 1038 Wren, Grand Rapids. Herman, "Red", got his B.S. in 1929, and lives at 49 Bayton, N.E., Grand Rapids, Michigan. Both are in the construction field. Kenneth and John Cosens majored in Sanitary Engineering. Kenneth, 1938, is Assoc. Prof. of Civil Engineering at the University of Ohio, Columbus. John, 1951, is with the Public Health Department, and lives at 1507 Glenhaven, East Lansing, Michigan. Charles and Robert Miller followed the profession of their father, Prof. C. A. Miller, and majored in Civil Engineering. Charles, 1934, is with the Datama Construction Company, and lives at 346 Bel-Air Dr., Grand Rapids. Robert, 1948, is with the Standard Oil Company with a home address at 202 Waldron, S.W., Grand Rapids. Both Leo and Jack Nothstine earned degrees in Civil Engineering. Leo, 1939, is Assoc. Prof. of Civil Engineering at Michigan State, and lives in a new home at 4637 Nakoma Dr., Okemos, Michigan. Jack, 1950, has just changed positions and is doing consulting work in Seattle, Washington. We do not have his new address.

Taking Engineering but not the same majors were four of the Theroux boys. Their father, Prof. Frank Theroux, is Professor of Civil Engineering at State. Louis received his degree in Electrical Engineering in 1940. He is Research Engineer, U. S. Air Force, Wright Field, and lives at 4028 Elliott St., Dayton, Ohio. Paul finished in C.E. in 1947, and is with the Boston Mutual Life Ins. Co., New York City. He lives at 2214 Thoda Place, Scotch Plains, New Jersey. Robert, 1942, Sanitary Engineer, is with a consulting firm and lives at 535 Niagara Ave., Los Angeles, California. Frank, C.E. 1949, is with the Colorado River Board of California, and his home is 2417½ N. Cheremoyer Ave., Los Angeles, California. Harold and Melvin Nuechterlein elected different majors. Harold finished in Chemical Engineering in 1947, and is with the Minnesota Mining Co., Detroit. He lives at 220 N. Maple, Royal Oak, Michigan. Melvin, M.E. 1949, is with the Public Service Electric and Gas Co., Newark, N. J., and lives at 624 N. Grove, East Orange, New Jersey. John and George Sangster, whose father was for many years in our Mechanical Engineering Department, majored in different options. John finished from M.E. in 1938, and is with the Navy Department in Washington, D. C. He lives at 4627 S. 34th, Arlington, Va. George who was a Civil 1949 graduate, is with Owen-Ames-Kimbell Company, with his home address listed as 607 Crescent, N.E., Grand Rapids, Michigan. Kenneth and Norman Lawless liked different fields. Ken finished in Ch.E. in 1950. He is with Bowser Co., Inc. of Detroit, Michigan. His home address is 207 Thurbert St., Fenton, Michigan. Norman got his E.E. degree in 1951. We do not know his present location. Michael Hoover followed the footsteps of his brother Andrew by taking Engineering, but not the same major. He got his B.S. in E.E. in 1950 and is with the Electric Sorting Machine Co., in Grand Rapids, Michigan. His residence is 1639 Chamberlain, S.E. Andy was a 1933 M.E. graduate. He is Asst. to the Chief Engineer in Metallurgy at Oldsmobile, and resides at 307 Memphis, Lansing.

There is a limit even to brotherly love and no doubt by now you feel that you have had enough for one reading. My apology to the brothers I have not mentioned, and my best wishes to all of you.

New Developments

Edited by

HARLOW NELSON
Mechanical Engineer, '56

BEER MUST BE ON THE LEVEL

A tiny crystal of cadmium sulfide, about the size of a match head, acting on signals from an 80,000-volt x-ray tube, is acting as a "watchdog" for several major breweries. Its job: to insure, automatically, that all cans of beer are tightly sealed and contain exact measure.

Known as a high-speed level checker, the unit is capable of inspecting cans or cartons at rates greater than those at which any processing line presently operates. It can work at a speed of 900 containers per minute within an accuracy of 30 drops of beer (about 1/64 in.)

In operation the hothouse-grown cadmium crystal is placed on one side of the production line, the x-ray unit on the other. When an under- or over-filled can passes by, the x-ray beam gives the detector crystal an extra jolt, starting an electrical circuit in operation. This is relayed to an automatic air blast unit which blows the faulty container off the line.

BIASED TRAFFIC LIGHT

An electronic "policeman" which automatically gives the right-of-way at a street intersection according to the changing demands of traffic may soon be standing on your street corner.

The new device is, in effect, an electronic brain with an IQ on the level of "genius." When it senses heavy traffic over a particular street leading into an intersection, it automatically extends the green light "go" period for that street. When traffic decreases, the brain shortens the period.

Key to the system are special vehicle detectors, placed under the pavement at all approaches to an intersection. These evaluate the traffic flow. Sustained periods of dense traffic over one street actuate the detector which, in turn, relays an electric signal to the controller. A timer automatically converts this signal into an extended right-of-way.

The folks who developed this device expect it to reduce, substantially, present traffic problems at critical intersections, especially when the flow of traffic is spasmodic or difficult to predict.

PNEUMATIC DE-ICERS

The first pneumatic De-icers for use on high speed aircraft are helping to keep the nation's fastest commercial airliners on schedule this winter.

The new De-icers consist of a network of small inflatable rubber tubes which expand enough to crack off ice, yet not enough to materially distort the shape of wing or tail surfaces. The new De-icer is the result of seven years' research by scientists, with much of the development work done on top of frigid Mt. Washington, N. H.

More than half a mile of the sensitive tubing is needed to protect airliners from ice forming on vital surfaces. The tiny tubes are imbedded in thin panels of rubber which are cemented to leading edges of the plane. Even at speeds above 300, the new De-icers remain flat against the surface.

(Continued on next page)

NEW DEVELOPMENTS

(Continued from preceding page)

Made from rubberized nylon high-stretch fabric, the tiny tubes are only one-sixth the size of those used in earlier De-icers, yet operate at three times the pressure and complete the inflation-deflation cycle three times as fast.

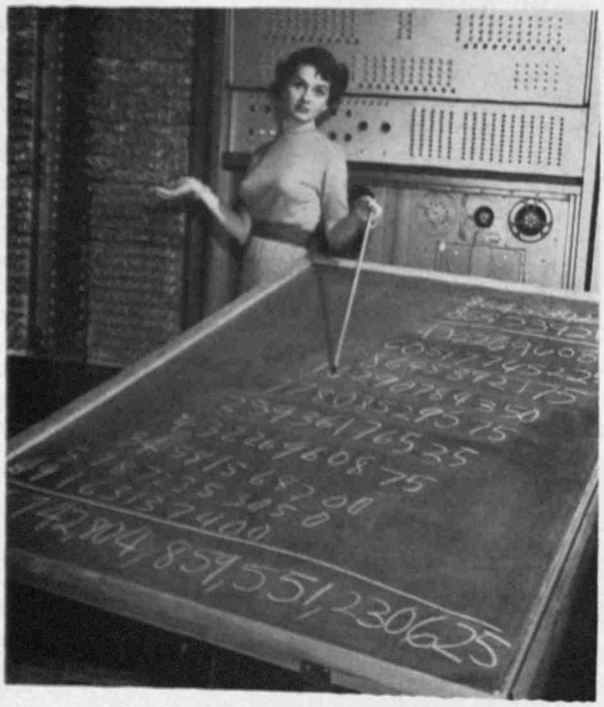
The smaller tubes make it possible to apply ice-cracking pressure at exactly the right points, reaching many small but vital areas which could not be protected by the earlier, larger De-icers. Small tube construction gives De-icers twice the service life of previous constructions.

NEW "OARAC" COMPUTER

A new electronic computer with one of the largest "memories" yet incorporated in any computing device is ready for shipment now.

The brain of the computer is a metallic drum which can hold pulses representing ten-thousand ten-decimal numbers on its magnetized surface until the numbers are called into use.

The new digital computer, known as the "OARAC," (which stands for Office of Air Research Automatic Computer) can deliver rapid-fire answers in typewritten form to mathematical puzzles which would take expert mathematicians years to solve. It can make as many as 100 calculations per second.



Syracuse housewife Connie Hodgson dropped a one and lost a trillion in a test of skill against the new electronic computer, "OARAC."

She was one of half-a-dozen intelligent adults who pitted their multiplication skills against the computer.

OARAC can multiply 8,645,392,175 by 8,645,392,175 in about four one-thousandths of a second.

Average time for the six human contestants was more than eight minutes, the fastest, four and one-half minutes. None of their answers coincided. Like Mrs. Hodgson, who forgot to carry a one in the row to which she is pointing and came out one-trillion off, none of the them got the right answer—which is 74,742,805,859,551,230,625, in case you have a pencil handy.

The new computer will be used by the United States Air Force's Research and Development Command at its Flight Research Laboratory, Wright Air Development Center, Dayton, Ohio.

OARAC will save valuable research and development time, equipment and money by eliminating much costly flight testing of experimental aircraft equipment. For example, OARAC will decrease the flight test time required in the development of improved auto-pilots.

Brig. Gen. Leighton I. Davis, Director of Armament at Air Research and Development Headquarters in Baltimore, accepted OARAC recently for the Air Force. In the Spring of 1949, General Davis worked out the final details for production of OARAC.

One typical problem that has been used to test the computer here is so complex that 212 8-by-10 inch pages of numbers are needed just to state the problem. In solving it, so many millions of operations are involved that without the aid of a computer it would probably never be solved.

Engineers say that an expert mathematician working with a desk calculator eight hours a day for about 45 years might be able to solve the problem.

The OARAC can do the job in about 10 days, working eight hours a day.

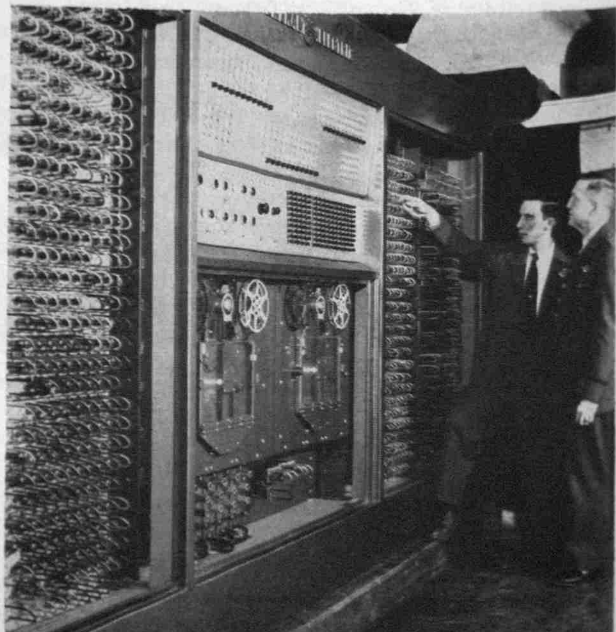
There is more to solving a highly-complex problem than merely feeding in numbers and getting an answer, however. Each problem must be carefully programmed in advance so that the instructions on what to do and how to do it will be fed in in a logical sequence. With some problems, the programming may take longer than the actual solution.

The memory cylinder, which holds the numbers until they are ready for use, also holds instructions telling what to do with the numbers when they are called into play.

Both the numbers and instructions can be wiped off or left on the drum as long as desired.

Information—that is, numbers and instructions—is fed into the machine by typewriter on an input unit which puts the information on magnetic tape, from which it is transferred to the memory drum. Answers coming out of the computer are received on magnetic tape and printed on an automatic typewriter.

(Continued on Page 50)



The OARAC Computer

Clubs and Societies

Editor's Note: The SPARTAN ENGINEER welcomes contributions to this column. Send them c/o Box 468, East Lansing, Mich., or bring them to the SPARTAN ENGINEER office, Third Floor, Union Building.

A. S. A. E.

Dancing to the music of Ralph Sordyl's orchestra and promenading to the calls of Professor Kenneth Brown started the spring term for the Agricultural Engineers, on April 10. The farm machinery lab in the Agricultural Engineering Building was the setting, with decorations consisting of tractors, balloons, and crepe paper light covers and stringers. Fun was had by all students and by the faculty attending. Refreshments included cookies, punch and ice cream.

On April 17 the student branch submitted its annual report to the Farm Equipment Institute. The report covers club activities, membership, and officers. It is entered into competition with reports from other A.S.A.E. student branches throughout the United States.

Plans are now being made for the annual student faculty spring banquet to be held at the Union in May. This year plans are being made to also include the alumni.

A.I.E.E.-I.R.E.

The election of officers and planning for the Engineering Exposition of May 1 and 2, was the order of business at the latest meeting of the American Institute of Electrical Engineers—Institute or Radio Engineers.

The newly elected officers are: President, Gene Lazarz; Vice-President, Wayne Scutt; A.I.E.E. Secretary, Dick Pfeil; I.R.E. Secretary, Bill Bartley; Treasurer, John Clark, and Engineering Council Representative, David Pfaff.

With the elections completed and the new officers having assumed their respective positions, the group turned to the assigning of Exposition projects to the seniors and their junior helpers. Some of the new displays that the Electrical Engineering department sponsored were the Cloud Chamber, the Standing Waves, and the Radio-Controlled Car. Chairman of the Electrical Engineering displays this year was Vern Lynch.

PI TAU SIGMA

Pi Tau Sigma finished out winter term with the election of a new set of officers. This was in accordance with a new policy adopted by Pi Tau. By holding elections at the end of winter term, the new officers can take over their responsibilities spring term under the guidance and acquired wisdom of the old officers. The new president is Bruce Harding with Bill Clark as the vice-president. John Lindenfeld has the position of corresponding secretary. Dick McClaughry is the recording secretary. George Pence has taken over Pi Tau's job of treasurer. Dick Sedlak is the representative to the Engineering Council.

A. S. M. E.

Erik Brogren, the winner of the American Society of Mechanical Engineers speech contest, and three other Michigan State students attended the ASME Region 5 meeting at Ohio State University, April 27 and 28. Erik competed in the regional speech contest.

The May meeting of ASME on campus had as its feature a talk, by Mr. Francisco of Dow Corning of Midland, Michigan, on various types of silicones. A field trip for May is being planned with Great Lakes Steel in Detroit as a possible site for the trip.

Committees are working now on the annual ASME picnic and ball game. The faculty will again provide the opposing ball team, hoping to avenge last year's defeat.

A. S. C. E.

Spring activities of the American Society of Civil Engineers have included participation in the Engineering Exposition, the student chapter-parent chapter banquet May 1, the annual picnic and ball game, May 15 and the regular bi-weekly Thursday night meetings.

Among other exhibits at the Exposition, the Society sponsored displays in the concrete lab, the hydraulics lab, the sanitary engineering lab and in surveying. Several industrial exhibits were also displayed, which included geooptic surveying equipment, examples of photogrammetry, and many of the machines used in highway work.

Dr. Austin Moore of the college's department of History of Civilization was the featured speaker at the regular meeting of April 23. Dr. Moore showed slides taken while he was traveling through parts of Africa, southern Europe, and the Near East. Of particular interest were slides of the Sphinx, the Parthenon in Athens, several outdoor theaters, and the reconstructed ruins left by the lava of Mount Vesuvius.

ETA KAPPA NU

In an election held this term, the following men were elected to office for the 1953-54 school year:

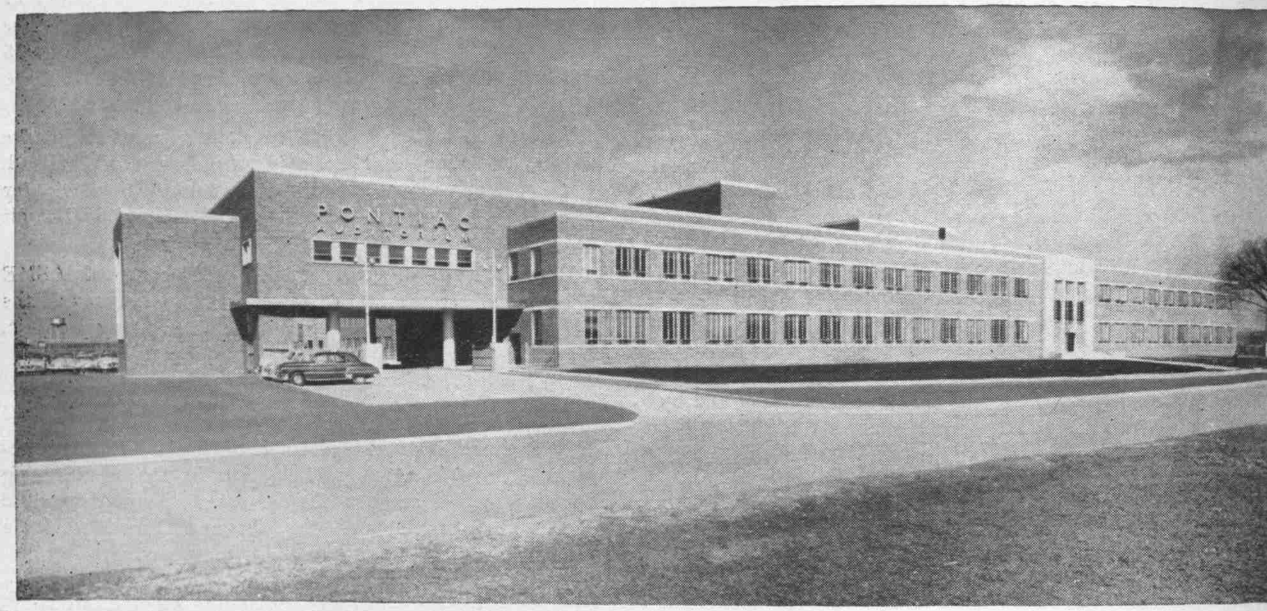
President—Howard Newcomb
Vice-president—John Clark
Corresponding Secretary—John Cheney
Recording Secretary—William Crampton
Treasurer—Leslie Wolsey

ENGINEERING COUNCIL

The new officers of the Engineering Council for the 1953-54 school year are:

President—George Pence
Vice-president—Joe Myers
Secretary—Dave Pfaff
Treasurer—Jim Rief
Publicity Chairman—Jim Masterson
Sergeant at Arms—George Fox

All of these new officers are now juniors, two of them having served as officers in other capacities this year. George Pence was secretary of the organization the past year, while Joe Myers served as Sergeant at Arms during the same time.



Starting Point for a Great Career!

WITHIN a few weeks Pontiac Motor Division will be welcoming engineering graduates from all parts of the country—young men who have chosen Pontiac as the starting point for an engineering career.

Most of them will start out in designing, for this has been shown to be one of the most practical ways to engineering success. In fact, a recent survey found that a majority of the top jobs in the automotive industry are now held by men with broad engineering training—by men whose basic training was in designing.

But in addition to a splendid opportunity, Pontiac will also offer these young men the most efficient facilities in its new air-conditioned, well-lighted, 200,000 square foot engineering laboratories—among the industry's most modern, with every conceivable facility for designing better and better Pontiacs.

To those engineering graduates who will soon join Pontiac—and to all others who are about to start on a career—we wish you success.

PONTIAC

MOTOR DIVISION · PONTIAC, MICHIGAN

GENERAL MOTORS CORPORATION

Developed by RCA Victor, the new "45 Extended Play" record gives music lovers more music for less money plus a perfect medium for playing shorter classical works and multiple popular selections.

Twice as much music on the same size record

Another RCA achievement in electronics:

A challenging question was asked RCA engineers and scientists in 1951. How can we increase the playing time of a 7-inch "45" record, *without using a larger disc?*

Sixteen months of research gave the answer, "45 EP"—Extended Play. Public response confirmed this as *the most important achievement in the new recording speeds.* More than 2 million RCA Victor "45 EP" records were bought in the first four months of their existence!

Research leadership—your guide to better value: the ability of RCA Victor to solve the problem of more music on a "45 Extended Play" record accents the importance of research *to you.* Whether you plan to buy television, radio or any other electronic instrument, research leadership adds more value to all products and services trademarked RCA or RCA Victor.

CONTINUE YOUR EDUCATION WITH PAY—AT RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

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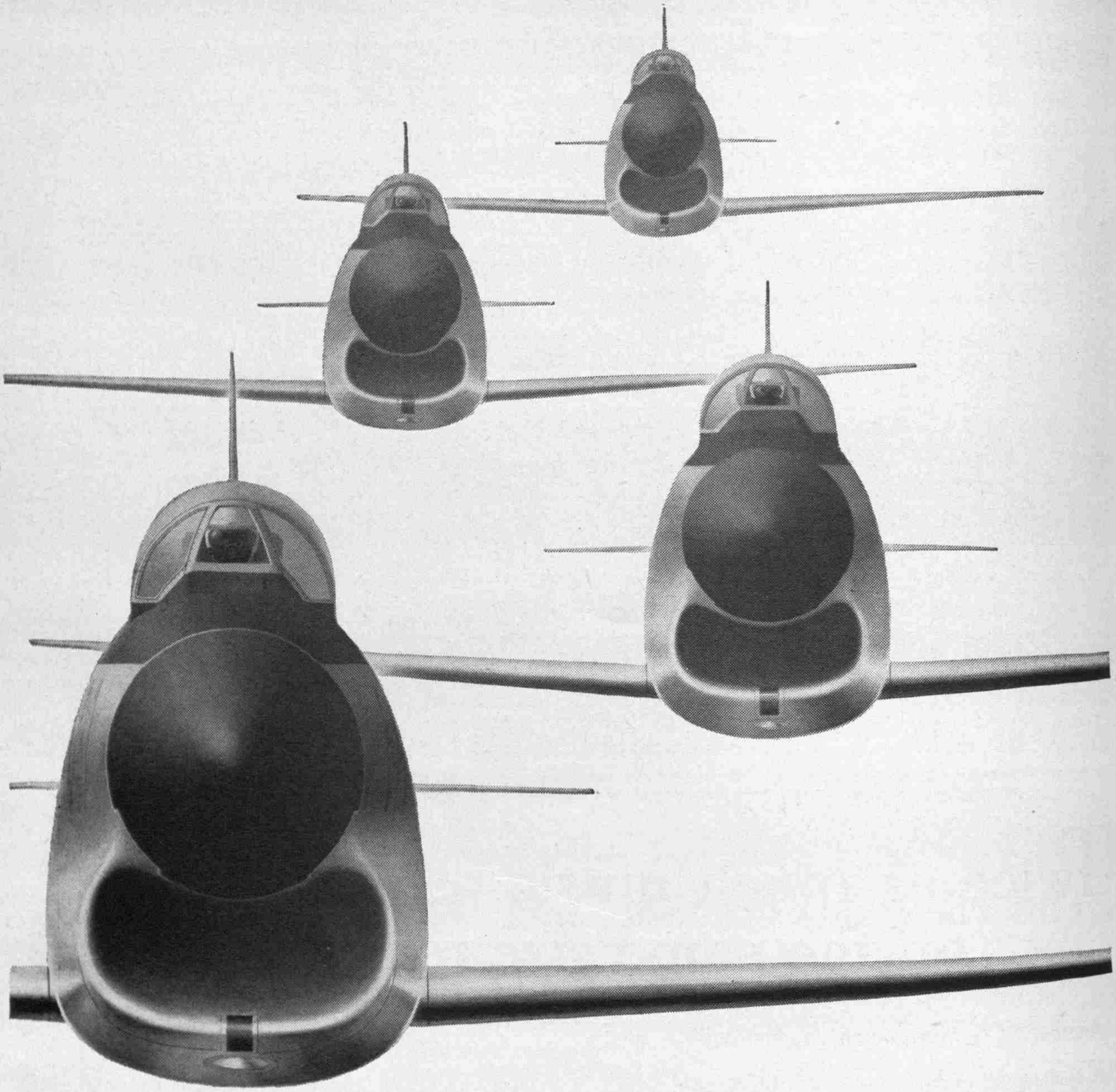

How would you like to make history?

The men who designed the F-86D *Sabre* Jets you see above made history. And so did the North American engineers who designed and developed the leading planes of World War II—the B-25 Mitchell and F-51 Mustang—and the other advanced planes in the *Sabre* Jet series. For 24 years North American engineers have been making history, because North American thinks in terms of the future. That's why North American always has career opportunities for young engineers who do fresh thinking, for young engineers with new ideas.

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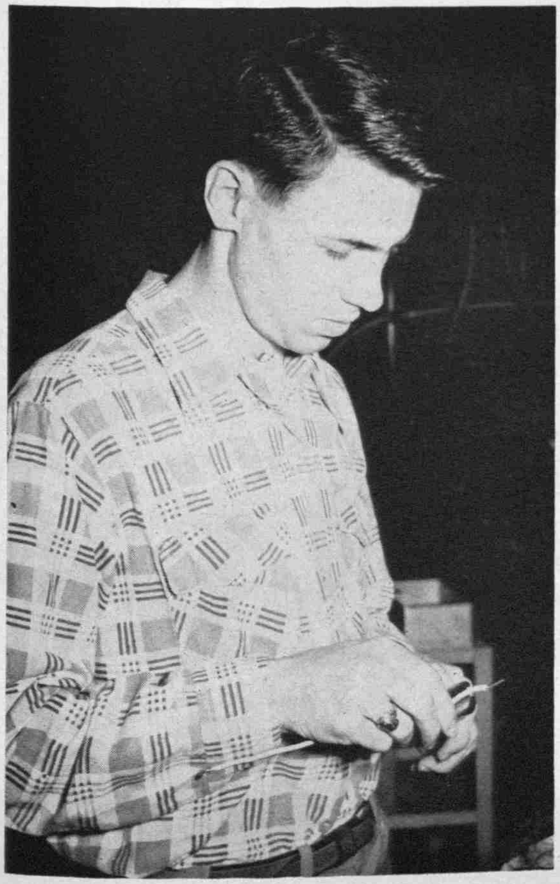
Metallography Laboratory

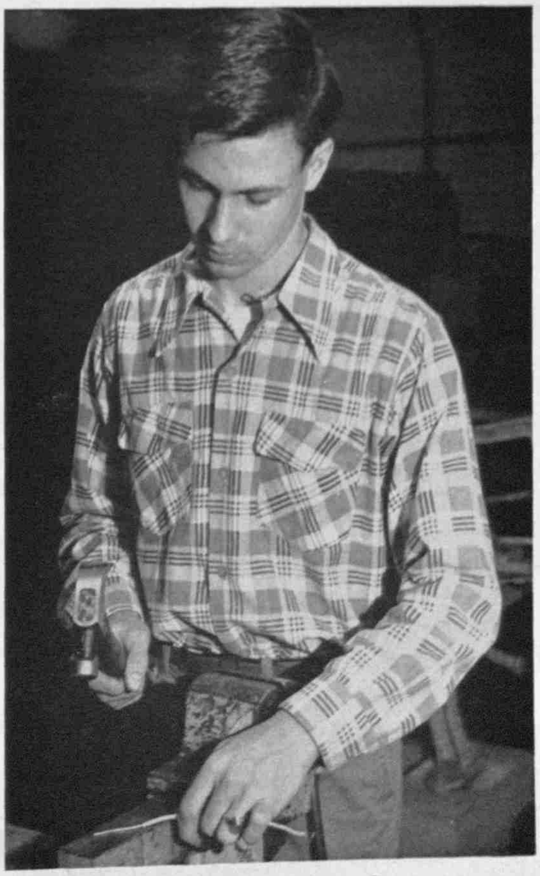
Photos by Ray Steinbach

Metallurgical Engineer, '55

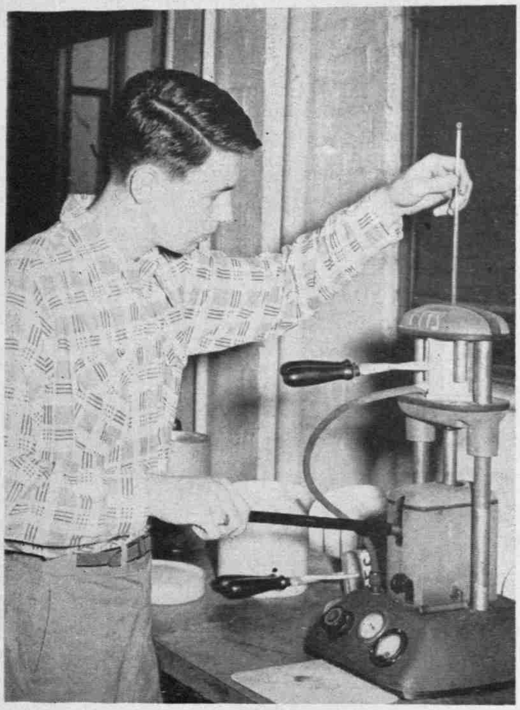
This is the story, in pictures, of a laboratory experiment, which is typical of the work done, in the field of metal and alloy microstructure analysis. Such analysis is one of the tools used by the metallurgical engineer in his work. In this experiment, a normal copper wire and a greatly deformed copper wire are being examined. The experiment is demonstrated by Van Burmeister, a junior metallurgical engineer.



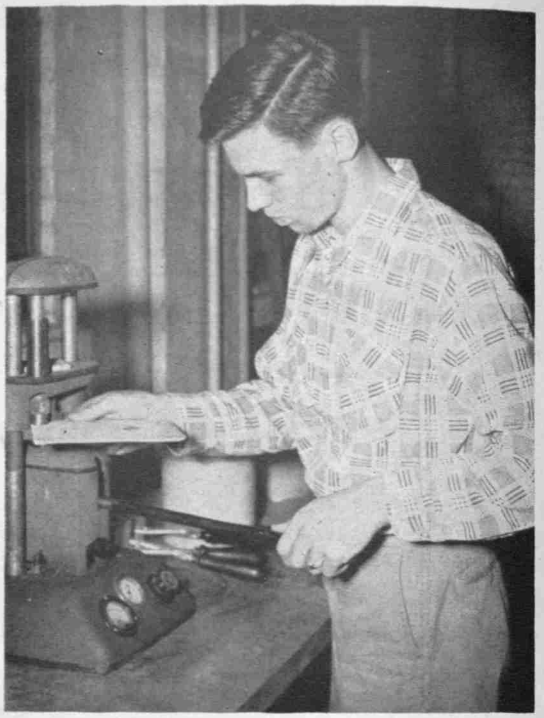
1. A sample is cut.



2. A second sample is deformed.



3. The two samples are mounted in clear bakelite.



4. The mounted sample is ejected from the mounting press.

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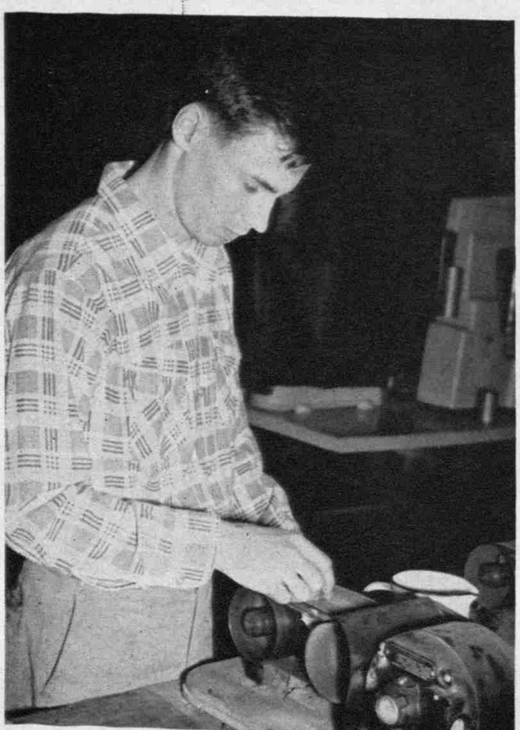
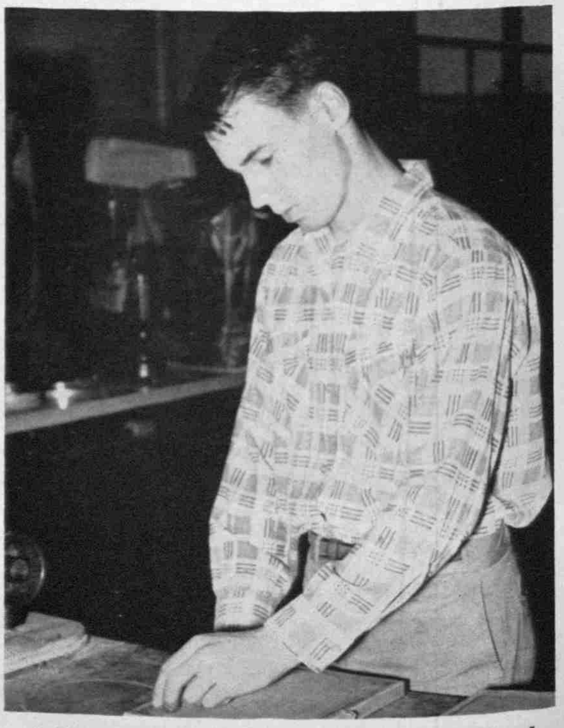
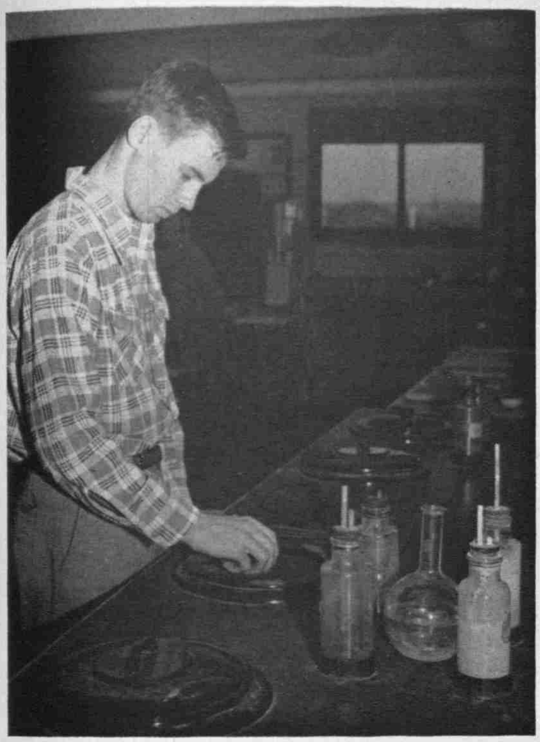
★ ★ ★ ★



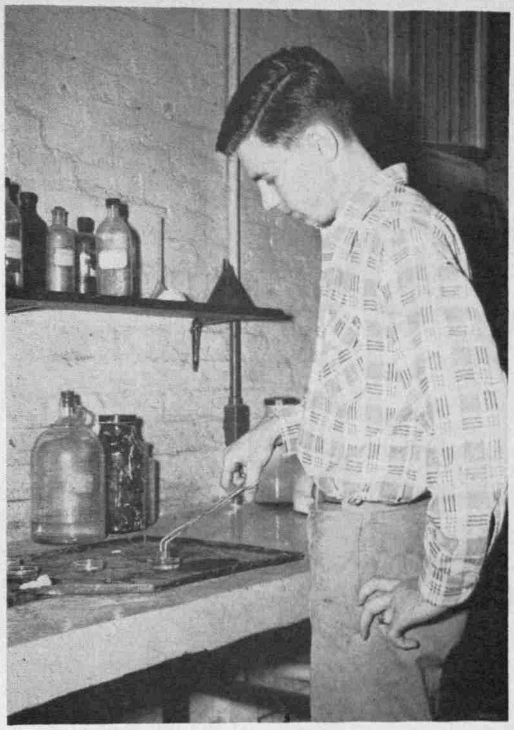
5. The sample is rough polished on a belt type sander.



6. The next stage of polishing is done by hand.



7. Final polishing is done on cloth covered wheels.



8. Etching the sample; this time, a mixture of ammonia and hydrogen peroxide was used.

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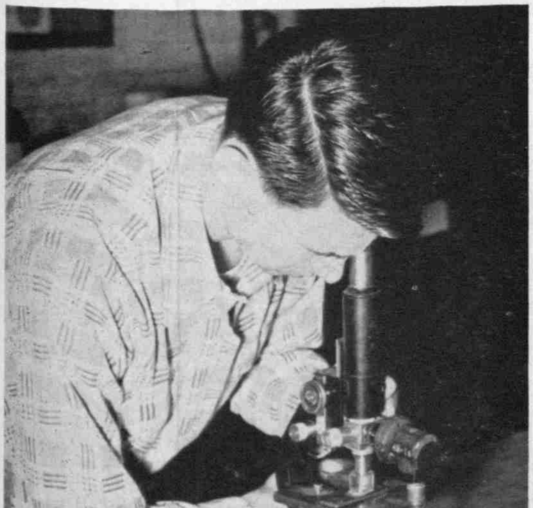
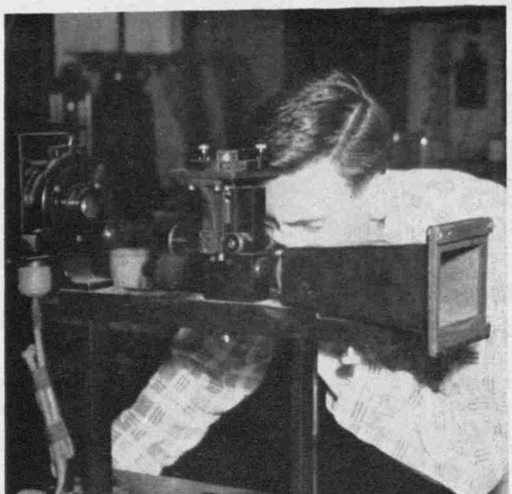
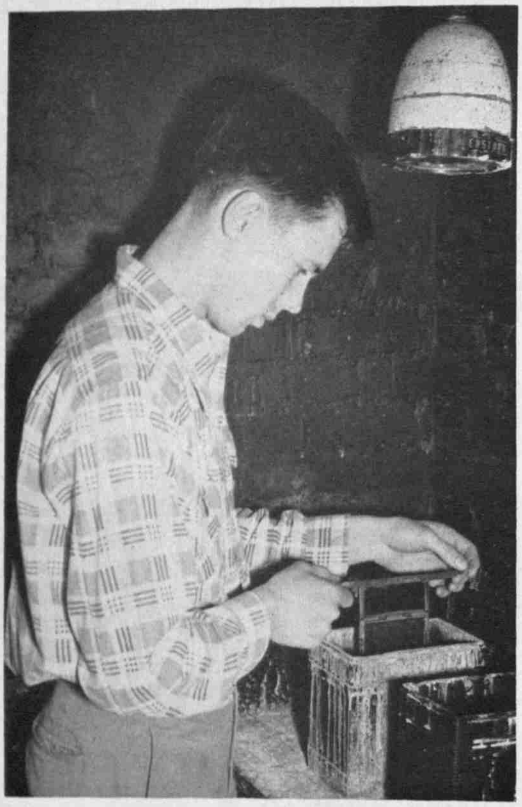


9. Preliminary examination of the sample under a microscope.



10. The sample is adjusted on the metallograph, in preparation for being photographed.

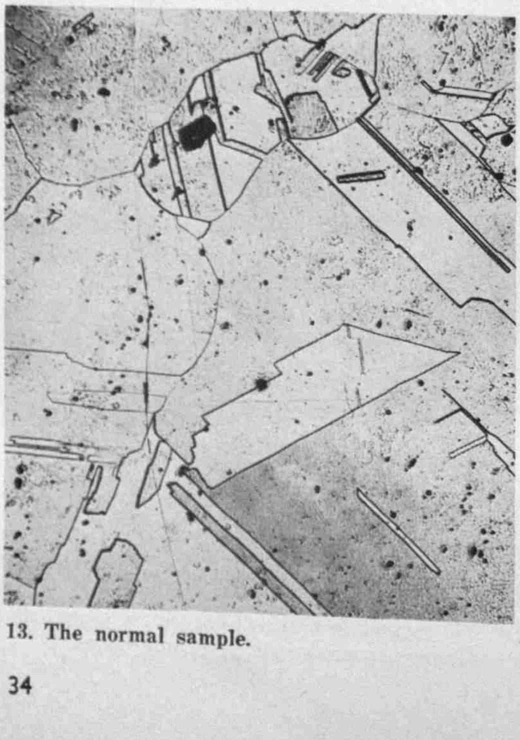


11. The glass plate negatives are developed.

12. The prints are made, and below is what we have.

★ ★ ★ ★

★ ★ ★ ★



13. The normal sample.

14. The deformed sample, the change of direction of the lines in the white band is an indication of deformation.

A NEW RELAY RECORD

RELAYS—which are high-speed switches—are the nerve centers of the dial telephone system. In a split second, they set up a connection and then are off to direct the next call. In a large city, more than 1000 relays are used every time a number is dialed.

Now a new wire spring relay—devised by the Bell Laboratories—is at work. With only 11 instead of 70 parts, it is twice as fast, uses less power, and costs less to make and maintain than its predecessor. Result: calls go through faster and switching is done with less equipment.

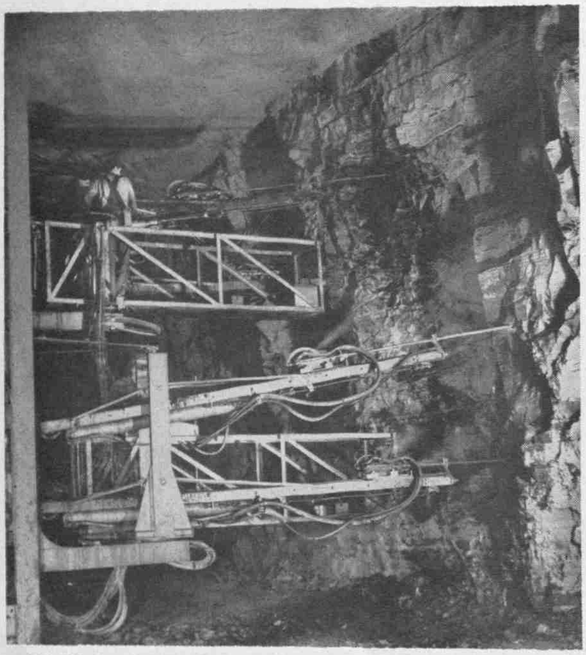
Men and women of the Bell System—in operating, manufacturing and laboratory work—continually seek new ways to improve telephone service. Qualified engineering graduates can find well-paid and interesting careers in the telephone business. Your placement officer can give you details about opportunities for employment in the Bell System.

BELL TELEPHONE SYSTEM

ROCKY ROAD TO OIL

(Continued from Page 11)

by the United States Bureau of Mines but a number of private companies, including Jersey Standard's technical organization, Standard Oil Development Company, are also on the job.



Multiple drilling unit used in the underground quarries, where the government is experimenting with various methods of mining oil shale.

The first concern is getting the shale out of the ground. Bureau of Mines engineers have found that a ton of shale will yield from a few gallons to well over fifty gallons of oil. For economic reasons, engineers will have nothing to do (right now anyway) with shales that give much less than thirty gallons to a ton. Thus, to take a broad average, the miners will have to produce a ton and a half of shale to make a barrel of oil. That implies rock-moving on a tremendous scale.

On a Navy shale reserve in Colorado, the Bureau of Mines has set up a demonstration mine to learn how shale can best be brought out to the open. The shale in that area runs hundreds of feet thick. The bureau's engineers have opened their mine in a section seventy feet thick, selected as an average shale because it yields about thirty gallons of crude oil to a ton of rock. A road has been blasted out of the side of a shale mountain to a spot 8,200 feet above sea level. There a great hole opens into the mountain. That is the mine.

The mining techniques are unorthodox. Because the marlstone is so hard it isn't necessary to shore up the roof with timbers. Instead, columns of the stone are left in place to support the roof. Speed is the essence of the actual mining, for through speed the engineers hope to cut costs. Pneumatic drills bore a series of holes at one time for the blasts that shake loose the shale. A big electric shovel, deep inside the mine, loads the rock on Diesel trucks that haul as much as fifteen tons in a load.

It is too early to quote any precise figures on the cost of digging into that Colorado mountain. Bureau of Mines engineers say that recent test runs show it is possible now to blast out the shale and deliver it to the mine portal for about 60 cents a ton, provided there are no further increases in cost of labor and materials. Engineers conclude, therefore, that the problem of mining—the first big if—already is well on the way to being solved. However, lower costs may be anticipated from further experiments.

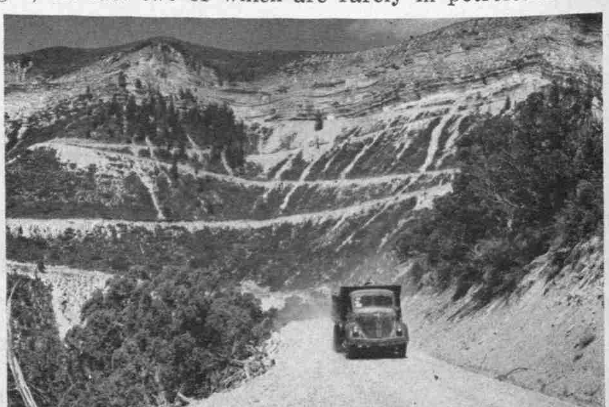
Even though it may be granted that millions of tons of oil shale can be blasted out of the hills cheaply, it will be still necessary to put that mass of material through some kind of retort to heat it to more than 800 degrees Fahrenheit—the temperature at which kerogen cracks into oil. To produce oil for today's research, the Bureau of Mines demonstration plant at Rifle, Colorado, is using two "batch" retorts. These units must be loaded, heated and then unloaded, a slow cycle considering how much shale will have to be handled, and one that admittedly can't do the job economically. However, the bureau anticipates better results from a new continuous gas-flow type retort recently placed in operation at Rifle.

The problem of retorting is also getting prime attention among the experiments being conducted by the bureau in collaboration with a large number of petroleum and chemical companies. The approaches are varied, but mostly they seek to replace the single-batch system with some sort of continuous-flow process.

One of the more promising experiments along this line is being conducted by the Esso Laboratories at Baton Rouge, Louisiana, in cooperation with the Bureau of Mines, which is supplying oil shale from Colorado for the work. Engineers at Baton Rouge have adapted a small fluid catalytic cracker so that it is, in effect, a fluid retort. A mass of finely ground, heated spent shale is mixed with the hot flow, and is thus exposed to the heat required to crack its kerogen into shale oil. The process has worked in a small pilot plant. This winter's experiments should demonstrate whether it will work as well on a larger scale.

While the engineers are progressing toward an efficient method of retorting oil shale, chemists are also making headway with the problem of what to do with the oil that comes from the retorts—how to refine it into usable products.

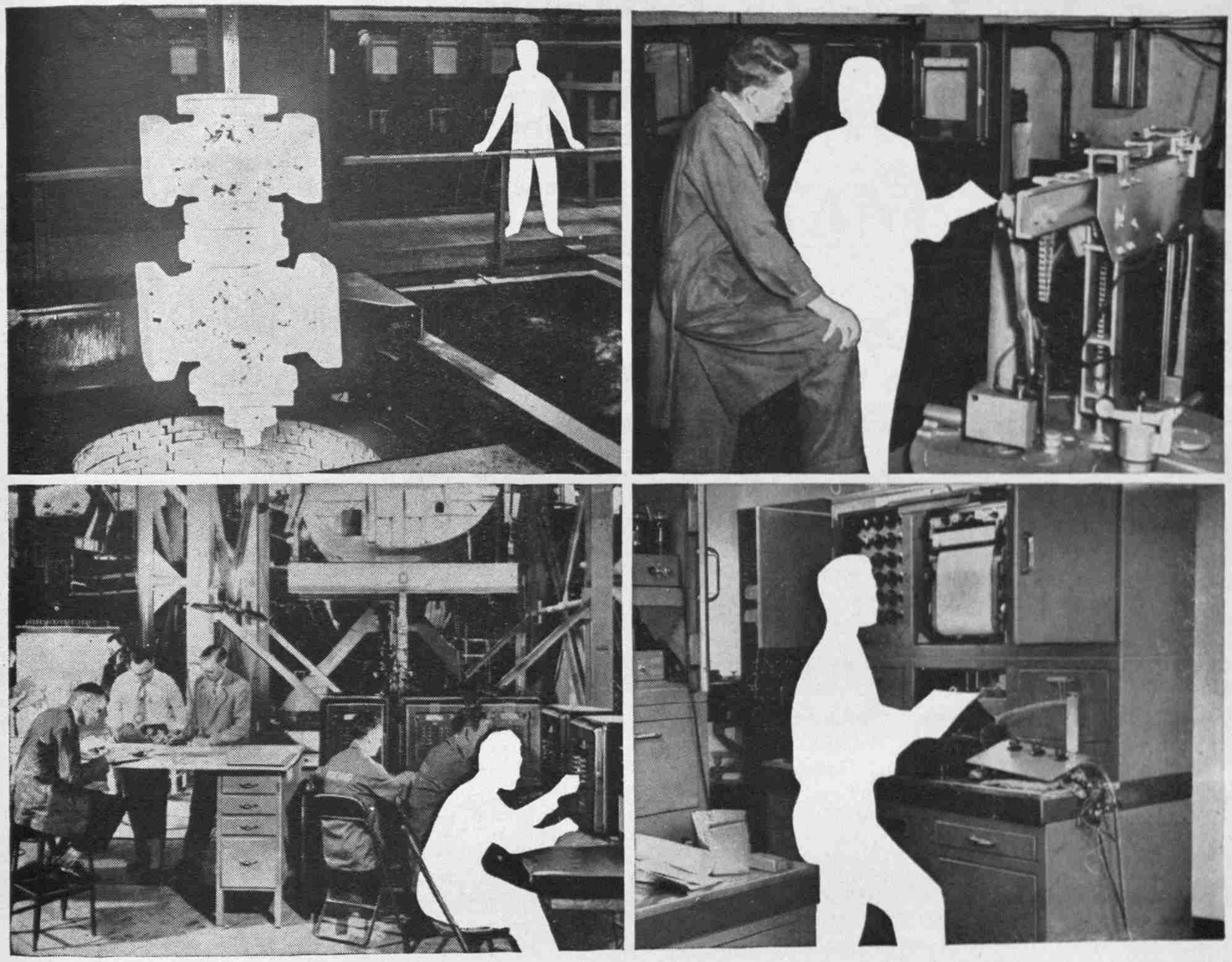
The chemical make-up of shale oil is its big drawback. Its molecules have a peculiar structure; they do not have enough hydrogen atoms to match up with their carbon atoms, but instead they have excessive quantities of unwanted elements, particularly sulphur, oxygen and nitrogen, the last two of which are rarely in petroleum.



Oil shale is quarried rather than mined, for the cost of removing the ore by mining techniques would be prohibitive. Under ground electric shovels dump the ore directly into Diesel trucks for removal from the underground quarry.

The result of this molecular structure is that shale crude oil is unstable, causing it to deposit gum and sludge and sediment. It also has a disagreeable odor. All these unhappy characteristics of shale oil pose a problem for the refiner. There are ways, however, of removing the sulphur, oxygen and nitrogen from the hydrocarbons.

(Continued on Page 48)



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Our Greatest Natural Resource

By BRUCE HARDING
Mechanical Engineer '54

This essay, part of the required pledge activities of all Tau Beta Pi aspirants, was chosen the best of the Winter term initiation class. The winning essay has been sent to the national Tau Beta Pi Board for competition on a nation-wide level.

As engineers, our purpose is to convert natural resources into useful products. Strange then, isn't it, that we fail to use the greatest resource of all to its fullest capacity! Our greatest natural resource isn't iron, or coal, or oil—it is people! Though many marvelous machines have been made, and many more are yet to come, there will never be a machine to equal people.

Certainly we have machines which can perform many tasks which humans cannot, but for working on men there is no better tool than people; for what can make a man happier than his friends and loved ones can, or give him such peace of mind as he finds in doing things for others?

People are an opportunity for us to improve ourselves. We spend so much time and money trying to amuse ourselves, and what have we to show for our efforts? Think how much happier we would be if we were to use these things to make others happy; and we would have friendship, a lasting and wonderful thing which money cannot buy. Albert Einstein puts it this way:

> "From the standpoint of daily life . . . there is one thing that we do know: that man is here for the sake of other men—above all, for those upon whose smile and well-being our own happiness depends, and also for the countless unknown souls with whose fate we are connected by a bond of sympathy."

Here, indeed, is a truly educated man, for he has supplemented his great scientific knowledge with an understanding of people.

The biggest part of our education is people. There is no course in school which offers such variety or which poses such complex problems. Nor is there another subject which is of such importance to all men. From people the mathematician learns to differentiate—to differentiate between the significant and the trivial aspects of life, and to integrate—to integrate the ideas and experiences of other men into a code of his own. The civil engineer can find no more sound a foundation to build on than faith in his fellow man. The mechanical engineer has yet to build a stronger link than that between friends, and the "double-E" man will search in vain to find a resistance lower than that of a friendly atmosphere. For every other engineer and for every other man there is no greater nor more rewarding achievement than in sincere love of his fellow man.

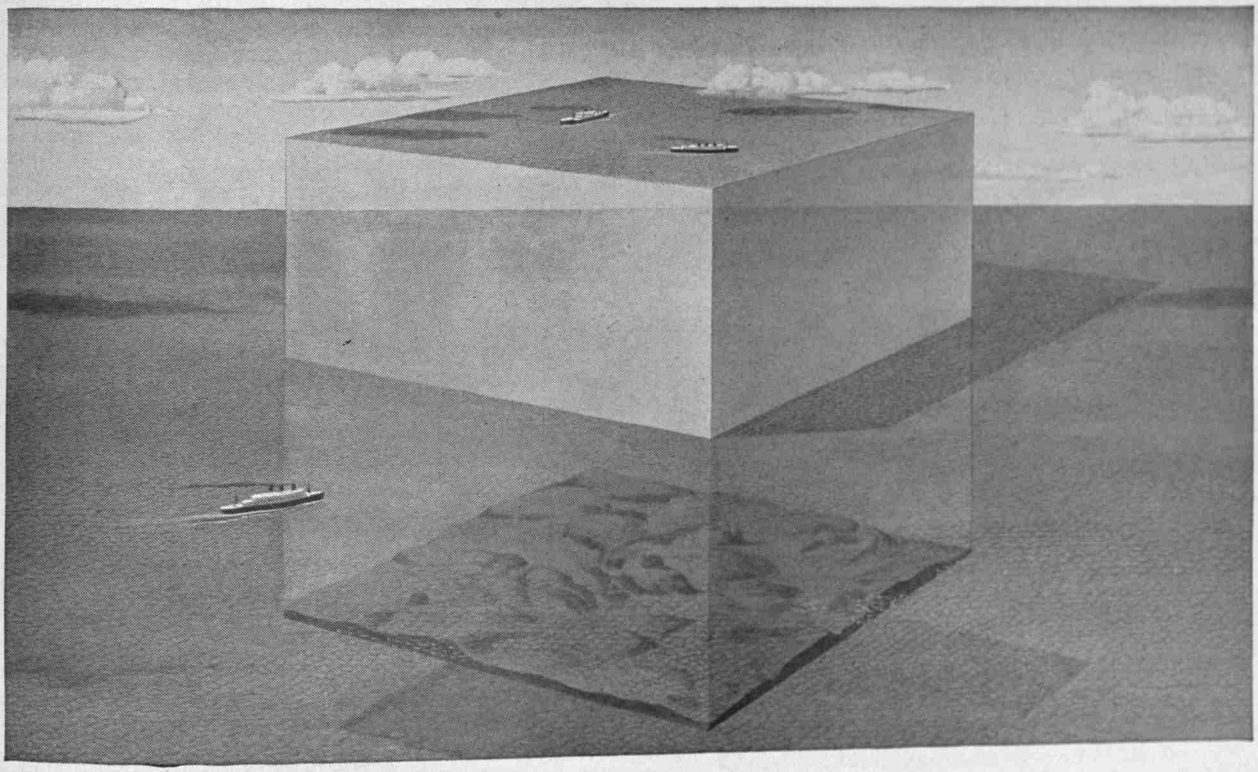
People's ideas, experiences, and opinions are like books in that they may be collected—only in a type of mental library. Some are simple and some are collectors' items, yet each contributes to the completeness of the group. The more of them we become familiar with and understand, the better we are able to cope with and comprehend other and more complex editions. As the literary man reflects his knowledge in his speech and in his writing, so too the man who has a keen interest in people reflects it in his actions and in his attitudes towards them.

We owe it to ourselves to become friendly with each and every man we meet, and to go out of our way to meet more of them. Each of us has something to contribute to the other man's education, and he to ours, and each new friend is an opportunity for us to exercise our helping hand. There is no man so high above or so far below us that he cannot be reached through friendliness.

As members of Tau Beta Pi, we have attained a goal of scholastic achievement; now let us strive to reach one of humanitarian achievement, for then only can we call ourselves educated. It's a job worth doing and doing well, and the best tool for the job is people, our greatest natural resource.

THE SEA IS AN INEXHAUSTIBLE SOURCE OF AN IMPORTANT METAL

Each cubic mile of sea water contains six million tons of MAGNESIUM, the lightweight metal of many uses



Today, when this nation is confronted with a crisis in our supply of many raw materials, it is of immense significance that the sea around us contains an almost unlimited supply of Magnesium. For Magnesium is light, strong, practical and versatile—the answer to many manufacturers' needs.

Dow began research on the extraction of Magnesium from brine over forty years ago. In 1941, at Dow's Freeport, Texas Plant, *the first commercial extraction from sea water was begun.* Dow pioneered in the production and development of Magnesium and its alloys and remains the leading producer and fabricator today.

Magnesium is only one of more than 600 chemicals produced by Dow. From Dow's many rapidly expanding plants throughout the nation flows an increasing abundance of chemicals and chemical products. Besides Magnesium, these include Industrial, Agricultural, and Fine Chemicals as well as Plastics.

Dow's Booklet, "Opportunities with The Dow Chemical Company," especially written for those about to enter the chemical profession, is available free, upon request. Write to THE DOW CHEMICAL COMPANY, Technical Employment, Midland, Michigan.

you can depend on DOW CHEMICALS DOW

(Continued from Page 13)

of nuclear devices at the Nevada Proving Ground tests of the Atomic Energy Commission.

The Air Force Missile Test Center at Patrick Air Force Base, Cocoa, Fla., tests long range guided missiles and pilotless aircraft over its more than one-thousand mile proving ground from Cape Canaveral, Fla., to a point off the coast of Puerto Rico. Its facilities are available to the Army, Navy and industry for development testing of missiles. Equipment at "down-range" instrumentation stations measure, record and evaluate performance characteristics of missiles, components, and vehicles for weapons systems. At this Center the "Matador" pilotless aircraft is being tested and the first USAF squadrons are being trained to man "Matador" units.

The Arnold Engineering Development Center, Tullahoma, Tenn., started as a dream in the mind of the late General H. H. Arnold and was dedicated by President Truman in June, 1951. Facilities at this Center which are now under construction will provide the nation with the means for testing and evaluating the supersonic aircraft, guided missiles, and aircraft engines of various types required for future air power. Nearing completion is the engine test facility which will make possible acceptance-testing of ramjet and turbojet power plants, the aerodynamic-testing of power plant components up to simulated altitudes of 80,000 feet, and the development-testing of jet engines larger than any now in use. Also under construction are a propulsion wind tunnel, larger than any known one in existence, with a test range which extends up to Mach 3.5, and a gas dynamics facility which is intended for developmental testing of aircraft models up to hypersonic speeds at very high Reynolds Numbers.

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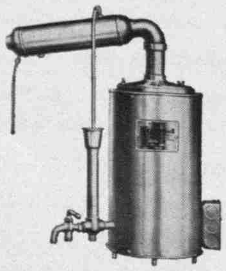

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The Air Force Armament Center at Eglin Air Force Base, Fla., works on the development and testing of armament systems, including guns, turrets, control systems and rockets. Typical of projects at this installation is the program to improve continually the accuracy and destructive power of rockets and gunfire which are guided to ground and air targets by electronic fire control systems. Continuous improvement of Air Force technical know-how in getting bombs, conventional or atomic, on the target is also a key objective of the Armament Center.

Holloman Air Development Center at Holloman Air Force Base, Alamogordo, New Mexico, operates as a part of the White Sands Proving Ground, a joint Armed Forces command under the primary control of the U. S. Army. The Center performs development and testing in electronics, atmospherics, and allied instruments and equipment. Its 38-by-64 mile range is the setting for testing of all types of rockets and missiles of the shorter range type.

Supervising and coordinating activities of the Centers with over-all research and development objectives of the Command is the function of Air Research and Development Command Headquarters in Baltimore. Two staff agencies, the Office of Scientific Research and the Office of the Deputy for Development, have the main responsibility for the research and development activities, while the other staff agencies provide them with the required support. The Office of Scientific Research accomplishes basic research projects in scientific fields of interest to the Air Force, surveying, contracting for, and monitoring projects with "outside" agencies. The Office of the Deputy, Development implements the systems approach to USAF development activities through its "systems" directorates as noted above. Providing support to these systems directorates with the required developments are seven "technical" directorates: Human Factors, Equipment, Aeronautics and Propulsion, Armament, Electronics, Geophysics, and Nuclear Applications. All the directorates work closely with those Centers whose responsibilities are in its sphere of activity. For example, the Geophysics Directorate does a major share of its work in close cooperation with the Air Force Cambridge Research Center; likewise, the Electronics Directorate with the Rome Air Development Center.

Close, constant communication between the Air Research and Development Command and the Air Force's major combat commands—e.g., the Strategic Air Command—enables Air Force requirements to be accomplished on time and effectively. Handling this function is the Office of Operational Readiness, whose personnel working with the major commands spend more time in the field than at headquarters.

A special field liaison office is attached to the Far East Air Force to get first-hand information on what lessons of the Korean Conflict must be applied to the Air Force's future research and development program; to assist the fighting commands in solving problems which arise from combat operations, especially when using newly developed weapons and equipment.

The Air Research and Development Command of the United States Air Force is one of the greatest engineering research organizations of its kind in the world. It is therefore fitting to bestow upon it and its members the honor of "Engineering Research—Cum Laude."

A man eating dinner in a hash house found that he could not possibly cut his steak, no matter how he jabbed at it. He said to the waiter at last, "You'll have to take this steak back and get me another piece. I can't even begin to cut it."

"Sorry, sir," replied the waiter, examining the steak closely, "I can't take this back now. You've bent it."

THE DU PONT DIGEST

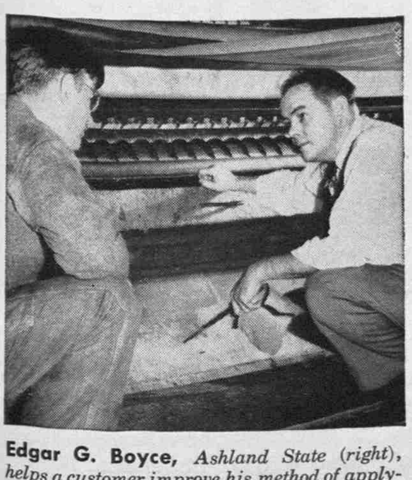
DU PONT SCIENCE AND ENGINEERING GRADUATES MEET THE PUBLIC IN

Technical Sales

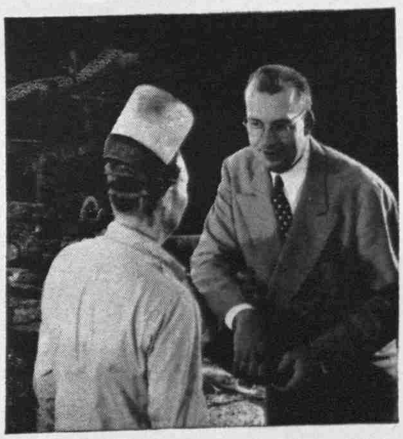
More and more, industry is on the lookout for technically trained men and science majors who have an interest in and aptitude for selling. A number of departments at Du Pont prefer men with such training for sales positions. A technical understanding of the properties of a substance helps a man do a better selling job—and offers the customer better service.

Because of the diverse applications of Du Pont's many products, there is a need for sales representatives with widely varying technical backgrounds. There are problems involving chemistry and many types of engineering in such fields as plastics, ceramics, textiles and many others.

Technical men may work in direct sales, sales service, or sales development groups, depending on departmental organization. In some cases technical men handle all phases of selling. In others they deal mainly with customer problems. Some departments also maintain a sales development section that works on technical problems connected with the introduction of a new product or a new application for an established one.



Edgar G. Boyce, *Ashland State (right), helps a customer improve his method of applying silicate adhesive in the manufacture of corrugated boxboard.*



Ivan R. Smith, *B.S. in Ch.E., Kansas State University '40 (right), advises the operator of a galvanizing machine on the efficient use of a Du Pont flux.*

Here are examples of the kind of problems attacked by technical men in Du Pont sales groups:

1. Find a more economical way to apply sodium silicate used in making corrugated paperboard. Du Pont men, as in many other instances, were able to make substantial savings for the customer.

2. Introduce fabrics of "Orlon" acrylic fiber for use in dust filtration. This involved evaluation and modification of filter fabrics in cooperation with makers of dust-control equipment, and with plant personnel having serious dust-recovery problems.

James A. Newman, *B. S. in Ch. E., North Carolina State '40, discusses study of optimum settings and conditions for carding nylon staple with Prof. J. F. Bogdan of North Carolina State's Research Division.*

3. Reduce the time needed for processing motion-picture film used by race tracks. Technical service men carried the problem to a research group which developed an emulsion that could be processed in about one-third the former time.

Technical men interested in sales work at Du Pont usually acquire needed background in a laboratory or manufacturing plant. Depending on their interest and abilities, they may then move into technical sales service, sales development, or direct sales.

In any of these fields, the man with the right combination of sales ability and technical knowledge will find not only interesting work but exceptional opportunities for growth in the Company.

College graduates with many types of technical training find opportunities at Du Pont. Write for your copy of "The Du Pont Company and the College Graduate." Address: E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington, Delaware.

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AUTHOR'S PAGE

TOM CLARK

"Engineering Research — Cum Laude," p. 12

Junior Chemical Engineer — has been with the SPARTAN ENGINEER staff now for a year. During this time he has written articles on color TV, silicones and aromatic hydrocarbons. His latest article — "Engineering Research—Cum Laude" — was inspired by his active interest in the Air Force and the AFROTC program at Michigan State College. His other campus activities include the Engineering Council, the American Institute of Chemical Engineers, Phi Lambda Tau and Alpha Chi Sigma.

LEE MAH

"Power Industry Looks Ahead," p. 14

Junior Electrical Engineer — Lee was born in Canton, China, and came to the United States 13 years ago. He was graduated from high school in Battle Creek, Mich., where he worked on the school newspaper and yearbook staff. In his third year at Michigan State, Lee is vice president of Tau Beta Pi, a member of Eta Kappa Nu, Scabbard and Blade, Arnold Air Society, and an associate editor of the ENGINEER.

JIM GUSACK

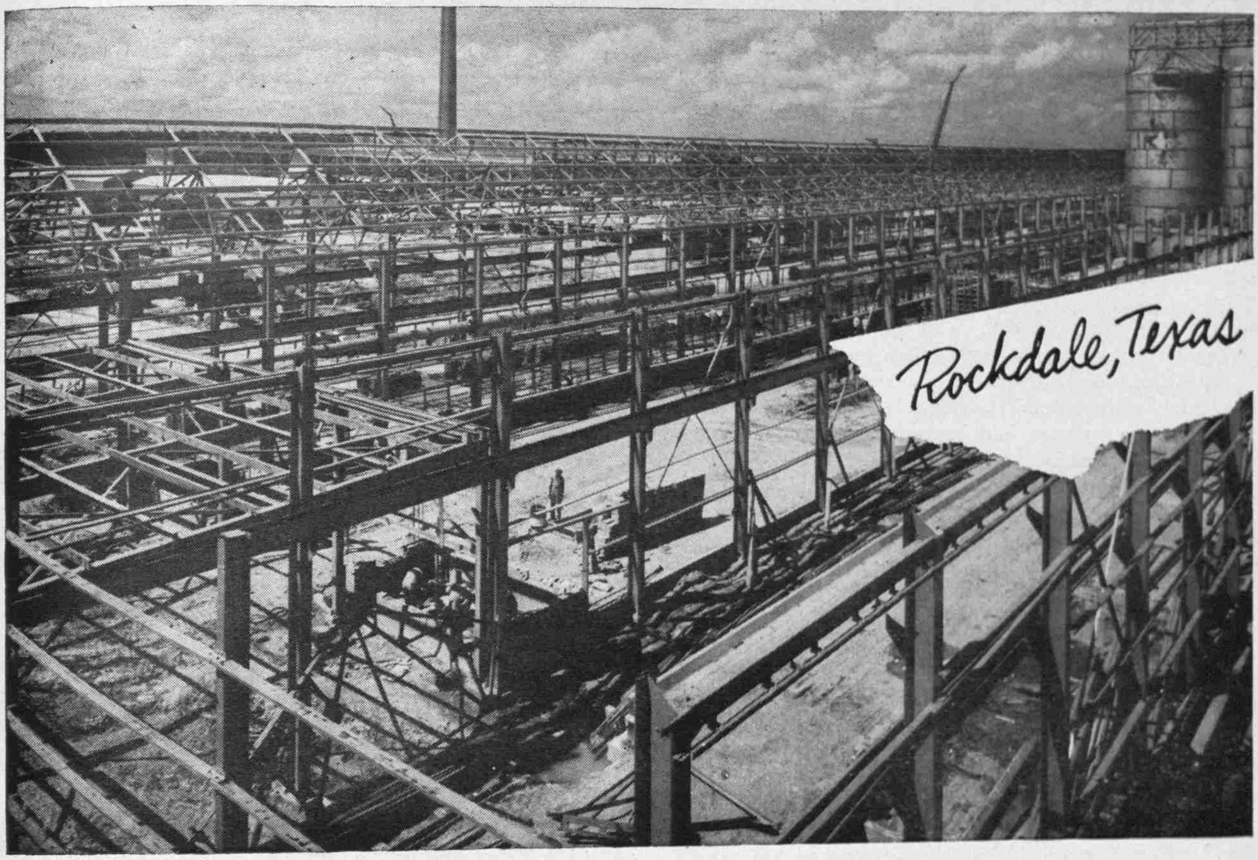
"Problems of Supersonic Flight," p. 22

Senior Mechanical Engineer — Jim is a senior from Grand Rapids. Besides having served as business manager of the SPARTAN ENGINEER the past year, Jim's activities at Michigan State have included membership in Tau Beta Pi, Pi Tau Sigma, the American Society of Mechanical Engineers, and on the Engineering Council.

IBRAHIM KHALAF

"Education at the American University of Beirut," p. 23

Junior Civil Engineer — "Abe" was born in Jerusalem, Palestine (which is now known as Jordan). He graduated from St. George's High School in Jerusalem in 1948. Two years later he came to the United States to study civil engineering. Michigan State was his first choice of colleges, and he reports being extremely pleased with his choice. Among his activities at college, Ibrahim lists being a member of the American Society of Civil Engineers and Vice-President of the M.S.C. Arab club.



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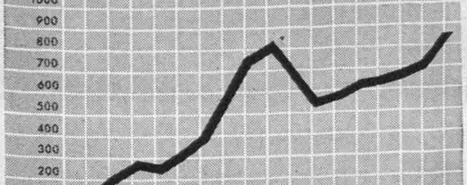
This is a production chart—shows the millions of pounds of aluminum produced by Alcoa each year between 1935 and 1951. Good men did good work to create this record. You can work with these same men, learn from them and qualify yourself for continually developing opportunities. And that production curve is still rising, we're still expanding, and opportunities for young men joining us now are almost limitless.



Ever-expanding Alcoa needs engineers, metallurgists, and technically minded "laymen" for production, research and sales positions. If you graduate soon, if you want to be with a dynamic company that's "going places," get in touch with us. Benefits are many; stability is a matter of proud record; *opportunities are unlimited.*

For more facts, consult your Placement Director.

Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA

THE MIRACLE FUZE

(Continued from Page 17)

The switch is connected to shunt the resistance wire of the squib. If, by rough handling, the electrolyte vial is broken and the unit put into semi-operation, the switch provides a low resistance short-circuit path for the thyratron current to pass through. Under normal operation of shell rotation, however, the mercury is forced through the porous diaphragm by centrifugal action, removing the short from the squib and enabling the squib to fire—if and when the thyratron is triggered by a reflected signal. Once the shorting action of the mercury switch is removed by spin, the fuze is said to be in the "armed" condition.

The second of the safety devices incorporates a normally closed reed switch which shunts the thyratron firing condenser rather than the plate circuit squib. Before spinning, any voltage built up across the condenser is automatically shorted out. As the shell is fired and attains a specified speed of rotation, this switch opens and unshorts the firing condenser. The action of the reed switch serves not only to prevent detonation during handling but also to provide the necessary time delay in eliminating fatal muzzle bursts.

ROLE IN WORLD WAR II

The VT fuze was used in three critical stages of the war: the Kamikase attacks of the Japanese, the buzz bomb attacks on England, and the German Battle of the Bulge.

The first VT fuze was fired in actual combat on January 5, 1943, from the guns of the cruiser "Helena." The target was a Japanese Aichi plane, attempting a suicide crash on the naval vessel; the plane was completely destroyed. The fuze proved to be extremely effective in checking subsequent suicide attempts by Japanese pilots, especially in the Okinawa theater of war.

Of equal importance was the use of the fuze against the German buzz bombs. Six months before the Germans fired their first rocket on England, the British Intelligence Department received word that preparations were being made to launch a buzz bomb attack on the English coastal area. Working in collaboration with the Americans, they set up a system of defense which incorporated radar and electrical predictors in combination with the proximity fuze. By July, 1944, at the onset of the buzz bomb assault, all heavy weapons on the channel coast were fuzed with the VT unit. The attack lasted about 80 days. During the last four weeks of this period, the percentage of targets destroyed increased from 24 to 79 percent.

The Army realized the devastating effect which the fuze would have on light equipment and military personnel in foxholes and narrow trenches. The detection circuit of the fuze could be designed to detonate its deadly burst at any predetermined height above ground. However, fear that the Germans would discover the device demanded that precautions be taken to keep specimens from the enemy. It was fired only at enemy aircraft over water or over land controlled by the Allies. The time necessary for the Germans to produce the fuze, should they obtain a specimen, was calculated by the military authorities. On October 24, 1944, permission was granted for its use over German territory. The effect which the VT artillery fire had in checking German advances during the Battle of the Bulge is now military history.

PRESENT AND FUTURE USE

The American taxpayer might well ask, "Was the 800 million dollars spent on this war time project worth the

(Continued on Page 46)

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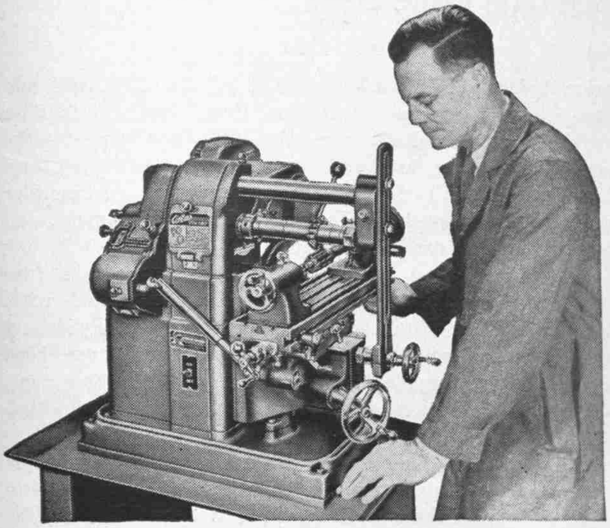
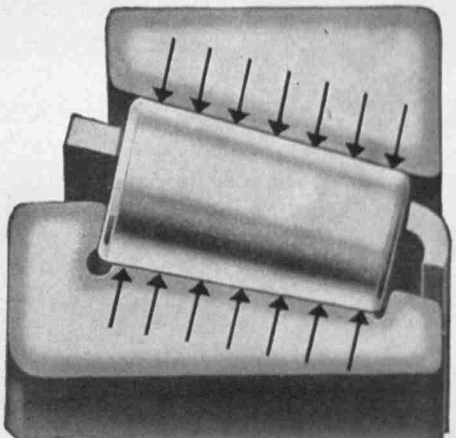


How to give an 8-speed miller greater spindle accuracy

This milling machine has 8 speeds, from 62 to 2870 RPM. To hold the spindle in accurate alignment at these various speeds, design engineers mount it on Timken® precision bearings. Long-lasting milling precision is assured. Spindle accuracy can be controlled because Timken bearings are adjustable. And they provide more than enough capacity for any tool load.

Line contact of TIMKEN® bearings keeps spindles rigid

Because Timken bearings carry the load along the line of contact between rollers and races, they give a wider, more rigid support to the shaft. And the tapered construction of Timken bearings enables them to take radial and thrust loads in any combination. End-play and deflection in the shaft are practically eliminated.



Want to learn more about bearings or job opportunities?

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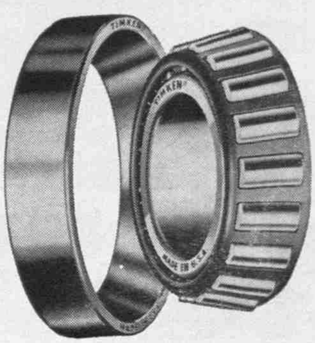


Some of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken Bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, Ohio.

NOT JUST A BALL ○ NOT JUST A ROLLER ⊂⊃ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION

PROBLEMS OF SUPERSONIC FLIGHT

(Continued from Page 22)

This has been done in the "guided missiles" which are rapidly being developed. These missiles may be controlled by radio, proximity fuse, or a pre-flight coded tape fed into the automatic pilot.

The problem of cooling is being solved by more efficient heat exchangers and by using the fuel as a "sink" for the heat from the evaporator refrigerator.

The tough problem of providing metals that can stand high stress at elevated temperatures is being solved by research in metallurgy. This research has introduced titanium alloys, beryllium alloys, and aluminum alloys that can be used in these extreme environments.

The future is bright for engineers and scientists in the Aircraft and related fields. Engineers must however prepare themselves for the responsibilities the complex future holds as a challenge.

AMERICAN UNIVERSITY . . .

(Continued from Page 23)

Admission is selective and is restricted to forty students a year. The five year course meets the standards of schools rated class "A" by the American Medical Association. Upon the successful completition of the course the degree of Doctor of Medicine and Surgery is awarded.

This survey of the system of education in the American University of Beirut gives a clear idea of one of the systems of higher education not only in Lebanon but also in most of the Arab world.

The tendency in national universities is now to put into practice theories of both the American and Continental systems. Such policies have been followed in Arab universities such as the ones founded in Syria and Egypt. The survey which is given above covers that of a pure American college system which differs very little from the average American college in this country.

THE MIRACLE FUZE

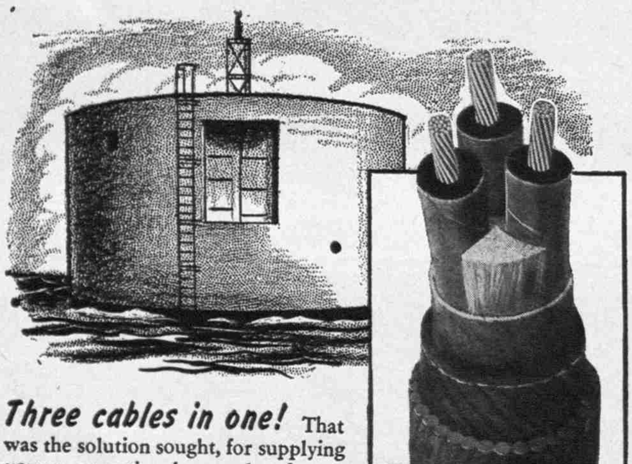
(Continued from Page 44)

price?" Besides hastening the end of the war itself and thus saving countless American lives, two outstanding developments resulted from the VT fuze project—the rugged miniature tube and the compact reserve battery. The future application of these components in smaller radio receivers, pocket sets, walkie-talkie equipment, and hearing aids is easily foreseen.

Since the end of World War II, the use of the fuze for fighting forest fires has been experimented with. Surplus auxiliary fuel tanks, filled with fire-extinguishing chemicals and equipped with VT-type fuzes, have been dropped on man-made fires. Exploding at the tree tops, the bombs have proved successful in subduing the timber-destroying flames.

Progress has been made in the use of the VT principle for the detection of motion. Through the use of frequencies higher than those of the war-time VT fuze, the principles are being applied to objects moving as slow as one mile-per-hour.

It should be stated, however, that the major portion of the present day VT research is neither commercial nor industrial, but is for national defense purposes. Whether some day the proximity fuze will be obsolete for use in warfare remains to be seen. In any case, the "miracle fuze" has established a record which well justifies its ranking as one of the key weapons of World War II.



Three cables in one! That was the solution sought, for supplying power, operational control and communication to a pumping house 4½ miles off shore in Lake Okeechobee, Florida.

As usual, Okonite engineers were consulted on the problem. Their studies showed that it was possible to combine a three-fold function in one cable. This was accomplished by the use of Okolite high-voltage insulation whose electrical characteristics permitted carrier current to be superimposed on the power conductors.

The result was a single Okonite-insulated cable—steel-armored for the 4½ underwater miles, with a non-metallic sheath for an additional 2½ miles underground—which supplies not only power and operation control, but a communication circuit as well.

• • •

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE *insulated wires and cables*

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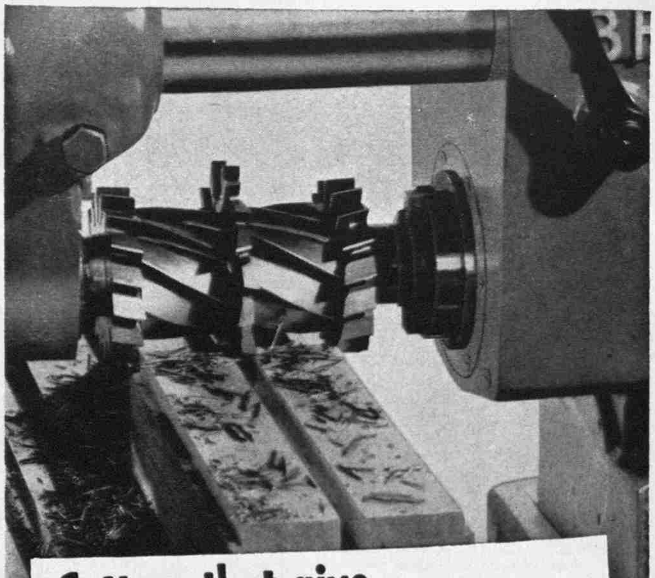

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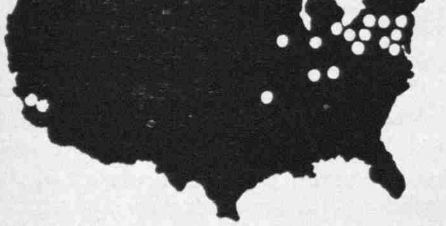

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ROCKY ROAD TO OIL

(Continued from Page 36)

It would seem that hydrogenation—the petroleum industry's technique of adding hydrogen atoms to the hydrocarbon molecule—might be a way to turn more of the shale crude into marketable products.

Adding hydrogen atoms would serve two purposes. First, hydrogen would combine with the unwanted sulphur, oxygen and nitrogen, making their removal fairly easy and, at the same time, eliminating the obnoxious odor. Second, this process would make the shale crude more like petroleum crude by providing hydrogen atoms to combine with carbon atoms in something like conventional hydrocarbon molecules. The resulting shale crude would be the equivalent of a high-quality petroleum crude which the refiner knows how to convert into gasoline, Diesel fuel, heating oil, or other products.

Vista from the oil shale quarry looking down 3000 feet into the Colorado River valley, where the oil shale recovery plant lies.

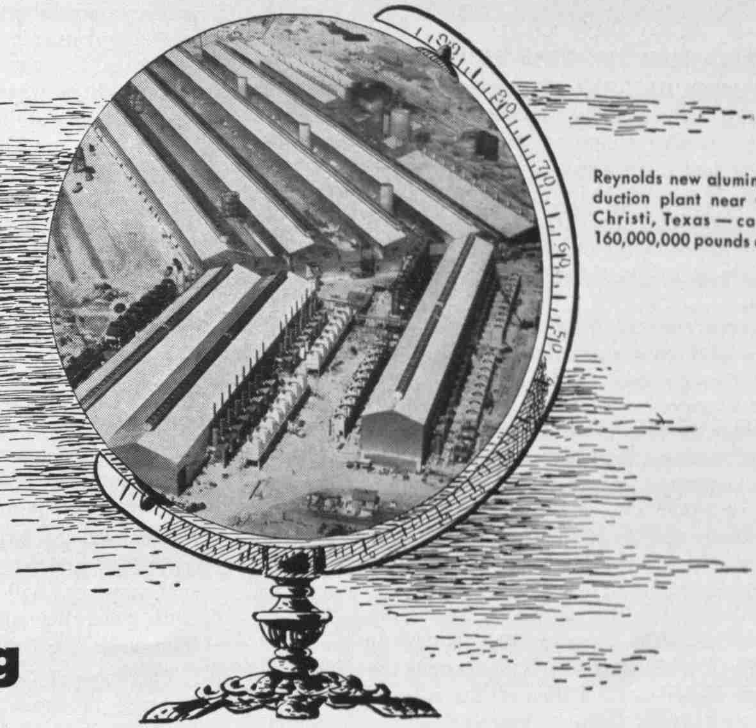
But hydrogenation is not cheap. On top of the cost of mining and retorting the shale, the cost of hydrogenation would come to more than the products could absorb and still compete in the current market. (Naturally, cost would not be a factor in the event of national emergency.)

None of the problems of shale oil refining is believed insoluble. American technicians have overcome greater chemical and engineering handicaps in many industries.

In time of emergency, a large, new shale-oil industry could turn out certain low-grade fuels, which might relieve some of the pressure on the petroleum industry. But much remains to be done to products from shale oil before they will have the qualities demanded by American homeowners and motorists.

It now seems quite definite that shale oil will cost more than liquid fuel made from natural gas, but not necessarily more than similar fuel made from coal. There is this thought to ponder, however:

Natural gas and coal are fuels in their own right. But our oil shales—thousands of square miles of them in several parts of the land—are wasted resources unless they are used as a great new source of liquid energy and are converted into oil. That fact alone would seem to indicate that some day we will have an American shale-oil industry, even though no one can yet say how near that day may be.



Reynolds new aluminum reduction plant near Corpus Christi, Texas — capacity 160,000,000 pounds a year.

A World of Expanding Opportunity!

In a land noted for rapid expansion of free industrial enterprise, few companies have matched the swift and continuing growth of the Reynolds Metals Company. Now operating 27 plants in 13 states, and still expanding, Reynolds offers the ambitious engineering graduate a world of opportunity.

Reynolds operations include bauxite mining in domestic and foreign locations...chemical and electrolytic processing to produce aluminum pig ...sheet rolling...drawing and extrusion of mill and structural shapes ...foil rolling and printing...powder and paste production...finished parts and products fabrication. In these and in the allied sales and marketing operations promising careers exist for graduates in virtually any phase of engineering.

On-the-job training is the Reynolds policy—after preliminary orientation which may include basic experience in production plants for sales personnel, and sales office work for technical trainees. Liberal insurance, hospitalization and retirement programs are maintained.

For important background information on "your future in Aluminum," *mail the coupon.* If you are definitely interested now, write direct to General Employment Manager, Reynolds Metals Company, 3rd and Grace Streets, Richmond 19, Va.

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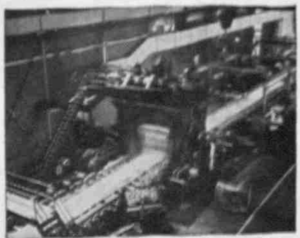
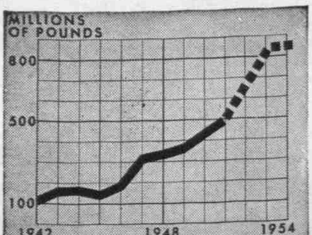


Sheet rolling—reverse hot mill in operation

REYNOLDS ALUMINUM



Reynolds expanding production — historic chapter in 33 years of continuing growth.

Reynolds Metals Company, Employment Dept.
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NEW DEVELOPMENTS

(Continued from Page 26)

WHEEL-BALANCER SMOOTHS ROUGH RIDES

A new MERCURY-REACTOR attachment for automobile wheels will combine several advantages to give motorists smoother riding comfort. This is accomplished by a set of four discs which can be attached to the wheels of any car. Each disc has a number of radially positioned cylinders containing mercury, and is mounted inside the wheel rim around the axle. The discs are attached to the same lugs which hold the wheels and are covered by the hub caps.

The mercury-loaded discs eliminate the need for balancing weights on car wheels. Weights have never been fully satisfactory because the balance is lost every time a tire is changed or a wheel transposed. Furthermore, uneven wear on tires soon offsets the balance. With the new discs, however, the wheels are constantly dynamically balanced regardless of other factors. This not only produces a smoother ride, but also has proved in tests to extend greatly the life of the tires, because they are made to wear evenly.

The tremendous centrifugal force built up in a rotating car wheel magnifies any unbalance and develops a hammering action. The mercury disc builds up an equal counter force to this and completely cancels the unbalance.

Another important function of the mercury weighted discs is their vertical shock-absorbing action. The mercury reacts instantly against chatter and shocks due to road roughness before they reach the axles and thereby save considerable wear on chassis points. All other cushioning devices on the car pick up the shock after it has passed the wheel.

The mercury stabilizers also control lateral action. Since the mercury is free to move from side to side, as well as up and down in the chambers, any tendency of the wheels to wobble or shimmy is countered, saving wear on wheel bearings and king pins.

The gyroscopic force built up by the mercury also stabilizes the car's forward line of motion. This helps to straighten wheels out after turns, eliminate drifting, and prevent side-hopping on rough roads.

The discs are the invention of Stuart D. Ormsby. His test models are made of aluminum, but he believes that they can be produced in plastic to retail for about fifty dollars per set of four. The discs will be adaptable to any make of car.

GENERATOR WITH LIQUID-COOLED CONDUCTORS

Industry will manufacture the first large generator with liquid-cooled conductors in the history of the electrical industry soon.

A new method of circulating a liquid through hollow conductors will be used in the stator of a turbine-generator set for a new power plant near Cleveland.

The unit, consisting of a tandem-compound turbine rated at 208,000 kilowatts and a generator rated at 260,000 kilovolt-amperes, will be one of the largest in the world. This generator, alone, will be capable of supplying the household electrical needs of 600,000 people.

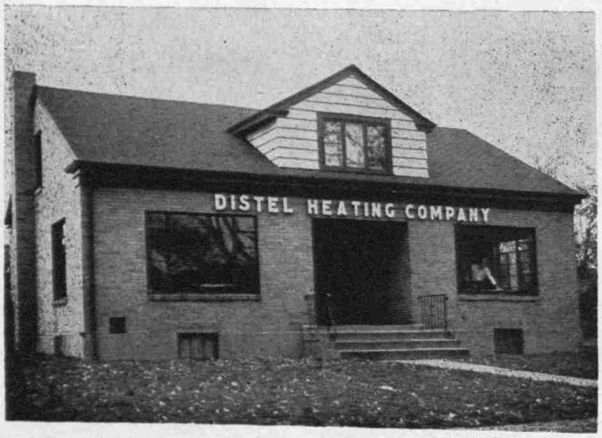
This type of liquid cooling makes possible a significant increase in capability of generators without increasing physical dimensions of the units. The higher capability results from more efficient removal of heat produced during the generation of electricity.

The present method of cooling large generators is to circulate hydrogen gas through passages in the magnetic portions of the rotor and stator. This method is highly

(Continued on Page 54)

DISTEL HEATING COMPANY

Established 1922



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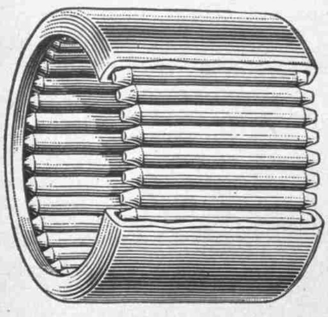
The Torrington Needle Bearing

...shaft hardness determines effective load capacity



The economy of the Torrington Needle Bearing is due in part to the fact that the shaft usually serves as the inner race. Thus, since the shaft is an integral part of the bearing, its load capacity limits the capacity of the bearing assembly. In order to obtain the full rated load capacity of the Needle Bearing, it is necessary that the shaft be at least surface-hardened to the equivalent of Rockwell C-58.

Loads and Speeds Related to Shaft Hardness

Because of material or design limitations, it is sometimes desired to run Needle Bearings on shafts softer than the recommended Rockwell C-58. This can be done safely providing the bearing loads and speeds are not too severe. However, the capacity of the bearing assembly is only as great as the load capacity of the shaft, regardless of the rated load capacity of the bearing as indicated in the catalog. The shaft capacity decreases very rapidly as the surface hardness is reduced below the recommended Rockwell C-58 minimum hardness.

Figure 1 shows this very clearly. It can be seen that reducing the shaft hardness to Rockwell C-52 gives a resulting load factor of .5. In this case, the catalog rating must be multiplied by .5 in order to obtain the true capacity of the bearing assembly.

Unheat-treated, cold rolled shafting will only carry 2%-3% of the bearing's rated load capacity.

The speed of the application is also important in determining proper hardness to assure satisfactory shaft life. The chart in Figure 2 illustrates this effect.

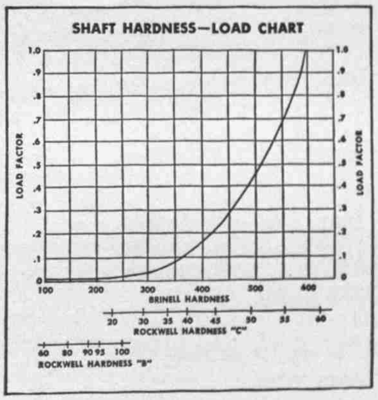


Figure 1. If the surface hardness of the shaft, its tensile strength, or the per cent of carbon is known, the load factor can be read either right or left from the intersection of the curve. The load factor, multiplied by the rated capacity of the bearing, will give the shaft capacity and the capacity of the application.

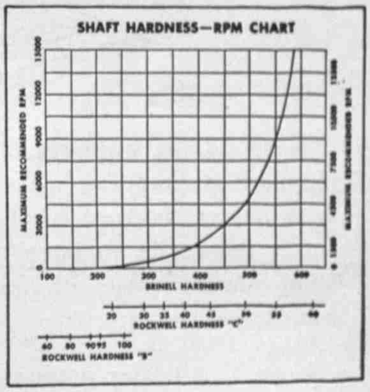


Figure 2. As the speed increases, it is desirable to increase the shaft hardness. For a given rpm, read across to the curve and down to the proper hardness. Conversely, if hardness is known, read up to the curve and across to the maximum rpm for that shaft.

Hardened Inner Races Available

When it is either impossible or impractical to harden the shaft, it is necessary to use an inner race which will provide the required surface for Needle Bearing operation. Inner races are available for all sizes of Needle Bearings. When used, inner races should be securely fastened to the shaft by clamping against a shoulder, by snap ring, or by press fit.

When designing Needle Bearings into a piece of equipment where shaft hardness is a question, the economics of using inner races as compared to a properly heat treated shaft should be carefully analyzed. When all factors such as inner race cost, securing devices, and actual assembly time are considered, it is usually found more economical to heat treat the shaft.

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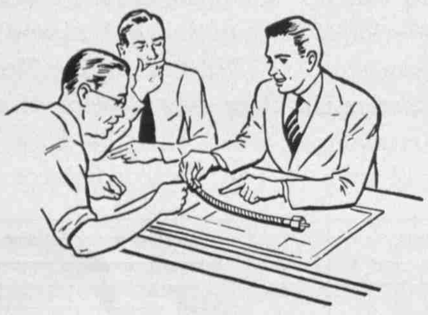

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POWER INDUSTRY LOOKS AHEAD

(Continued from Page 15)

in other fields and to the national military commitment, there are fewer power engineering graduates available. It was pointed out by Prof. Ryder that this is not due to the lack of opportunity, or stimulating problems in the power field, but due mainly to the poor selling job done by the power companies' college interviewers and the graduates' dislike of the power companies' training program. Because of the fact that there is no simple solution to the problem, this is possibly the most serious problem facing the power industry.

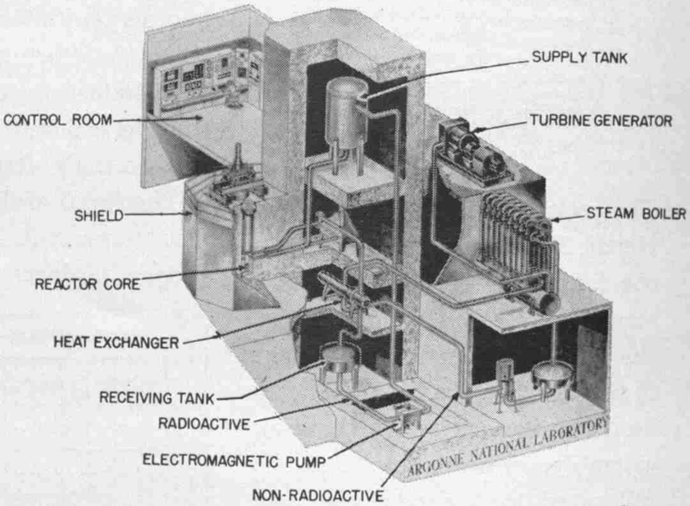


Fig. 5. Section through first atomic power plant using experimental breeder reactor, coolant circuits, boiler, and turbine generator.

It can be seen from the facts presented here that the power industry has grown at a tremendous, steady pace since Thomas Edison first introduced the use of electric power in 1882. With the development of the American industry and the rise in the standard of living, it is evident that electric power is indispensable to industry and to the private consumer. As industrial and technical development increases, so must the power production increase to maintain the supply. Mr. B. L. England, president of the Edison Electric Institute, predicts that by 1970, the power industry will be thinking of a trillion kilowatthours yearly.

In order to maintain the increase in power production, more efficient and economical methods of generating electric power must be developed. Transmission systems capable of carrying the large power load to the consumers will have to be devised. More efficient cooling systems must be invented to dissipate the heat in the large generators and transformer. The result is similar to a chain reaction as a development in one phase of the system requires a parallel development in another phase of the system.

Even more important than these developments is the development of the engineers who will design, and supervise the construction and operation of this equipment. The engineers must be made aware of the opportunities available to them.

★ ★ ★

"Look at that man swimming out there. Isn't he afraid of sharks?"

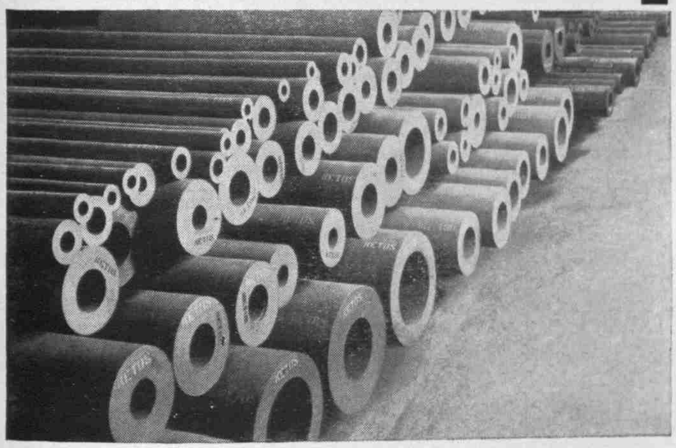
"No, he has 'U of M is the best college in the United States' tattooed on his chest, and even a shark couldn't swallow that."

Purdue Engineer

What's Happening at CRUCIBLE

about hollow tool steel

Crucible is now making its high quality tool steel available in hollow form. Bars of Crucible Hollow Tool Steel can now be obtained with machine finished inside and outside diameters and faces — in three famous grades: KETOS, AIRDI 150 and SANDERSON. Already its use has effected substantial savings for makers of tool steel parts with cutout centers.



typical applications

The ring shaped tools that can be fabricated from hollow tool steel are virtually limitless — beading rolls, bearings and bushings, blanking and briquetting dies, cam dies and followers, chuck jaws, circular knives and shears, cutters, die holders and inserts, engraver and edging rolls, extrusion dies, feed and flue rollers, forming rolls, nozzles, saws, sleeves, slitters, stamping dies, wheels . . . and many others.

how it cuts costs

Crucible Hollow Tool Steel permits a toolmaker to bypass drilling, boring, cutting off and rough facing operations. Naturally, this results in less production time per unit, greater machine capacity, and a reduction in scrap losses. In some cases material costs alone are cut 20% by the use of Crucible Hollow Tool Steel instead of regular bar stock.

availability

All grades and sizes of Crucible Hollow Tool Steel are carried in stock in Crucible warehouses conveniently located throughout the country.

CRUCIBLE HOLLOW TOOL STEEL

Sizes (inches)	GRADES		
	Sanderson	Ketos	Airdi 150
2 O.D. x 1 I.D.	x	x	
2½ O.D. x 1½ I.D.		x	
3 O.D. x 1½ I.D.		x	
3¼ O.D. x 1¼ I.D.	x	x	x
3¼ O.D. x 1½ I.D.		x	
3½ O.D. x 1½ I.D.	x		
3½ O.D. x 2 I.D.	x	x	x
4 O.D. x 1½ I.D.			x
4 O.D. x 2 I.D.		x	x
4¼ O.D. x 1¾ I.D.			x
4½ O.D. x 2 I.D.	x		x
5 O.D. x 2 I.D.	x	x	x
5 O.D. x 2½ I.D.		x	x
5 O.D. x 3 I.D.	x	x	
5½ O.D. x 1¾ I.D.			x
5½ O.D. x 2 I.D.		x	
5½ O.D. x 2½ I.D.	x		x
6 O.D. x 1¾ I.D.			x
6 O.D. x 2 I.D.		x	
6 O.D. x 3 I.D.	x	x	x
6½ O.D. x 3¼ I.D.			x
6½ O.D. x 3½ I.D.		x	
6½ O.D. x 4 I.D.			x
7 O.D. x 2¼ I.D.			x
7 O.D. x 3 I.D.	x	x	
7 O.D. x 3½ I.D.			x
7 O.D. x 4 I.D.	x	x	
7½ O.D. x 3 I.D.	x	x	
7½ O.D. x 3½ I.D.	x	x	
7½ O.D. x 4 I.D.			x
8 O.D. x 3½ I.D.	x	x	
8 O.D. x 5 I.D.	x	x	x
8¼ O.D. x 3½ I.D.			x
8½ O.D. x 5¼ I.D.	x	x	x
9 O.D. x 4 I.D.	x	x	
9 O.D. x 5 I.D.		x	x
9 O.D. x 6 I.D.	x		
10 O.D. x 4 I.D.		x	
10 O.D. x 5 I.D.	x	x	
10 O.D. x 6 I.D.	x	x	x
11 O.D. x 4 I.D.	x	x	
11 O.D. x 6 O.D.	x	x	
11 O.D. x 7 I.D.		x	x
12 O.D. x 5 I.D.	x	x	x
12 O.D. x 6 I.D.	x	x	
12 O.D. x 7 I.D.	x	x	
12 O.D. x 8 I.D.		x	
13 O.D. x 6 I.D.		x	x
13 O.D. x 7 I.D.	x	x	
13 O.D. x 8 I.D.			x
13 O.D. x 9 I.D.		x	
14 O.D. x 7 I.D.	x	x	x
14 O.D. x 10 I.D.		x	
15 O.D. x 9 I.D.		x	x
15 O.D. x 10 I.D.		x	
16 O.D. x 10 I.D.	x	x	x
16 O.D. x 12 I.D.	x	x	

technical service

If you make tools with machined-out centers and wish additional information on Crucible Hollow Tool Steel, or technical assistance in solving an application problem, call in a Crucible representative. Our experienced staff of tool steel specialists is always available.

CRUCIBLE first name in special purpose steels

53 *years of* Fine *steelmaking*

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

Spring Works, Pittsburgh, Pa. • Park Works, Pittsburgh, Pa. • Midland Works, Midland, Pa. • Spaulding Works, Harrison, N. J. • Trent Tube Company, East Troy, Wisconsin • National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y.

HOW TO DESIGN PRODUCTS TO SAVE MATERIAL AND COST

MOST products can be built stronger, more rigid with welded steel construction than possible any other way. Steel is 3 times stronger and twice as rigid as traditional gray iron. As a result, usually less than one-third the actual weight of metal is required.

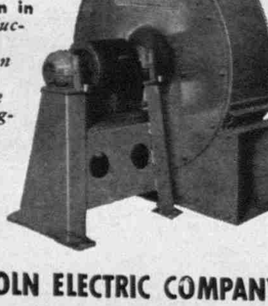
Pound for pound, steel sells for a third of what gray iron costs at the cupola. This lower cost per pound plus fewer pounds needed to carry equivalent load means that initial material costs can be cut as much as 85% of prices charged for castings alone to which fabrication, of course, must be added.

In addition to its inherent superior physical properties, steel is easily formed to efficient engineering shapes such as I beams and channels. Thin wall structural sections are possible by concentrating material at outer edges in load carrying members where each pound of metal does the most good. When steel is utilized to the fullest, a product of welded construction generally can be manufactured for half the cost.

The examples show how a typical machine part was changed over from cast iron to welded steel construction. The cost saving of 50% resulted from less material and expense by eliminating several machining operations such as milling and drilling. Cleaning and painting operations in the former cast design were also avoided. The new welded steel base is both stronger, more rigid and has a clean streamlined appearance to improve selling appeal.

Latest information on designing structures to save steel and lower cost is presented in 1200 page "Procedure Handbook of Arc Welding Design and Practice". Price only $2.00 postpaid in U.S.A.

Original Cast Construction *required 41% more material. Heavier weight increased handling costs in manufacture, shipment and installation.*



Present Design in Steel *cut production cost 50% . . . New design is actually stronger, more rigid than original. Modern appearance has greater selling appeal.*

THE LINCOLN ELECTRIC COMPANY

Cleveland 17, Ohio

THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

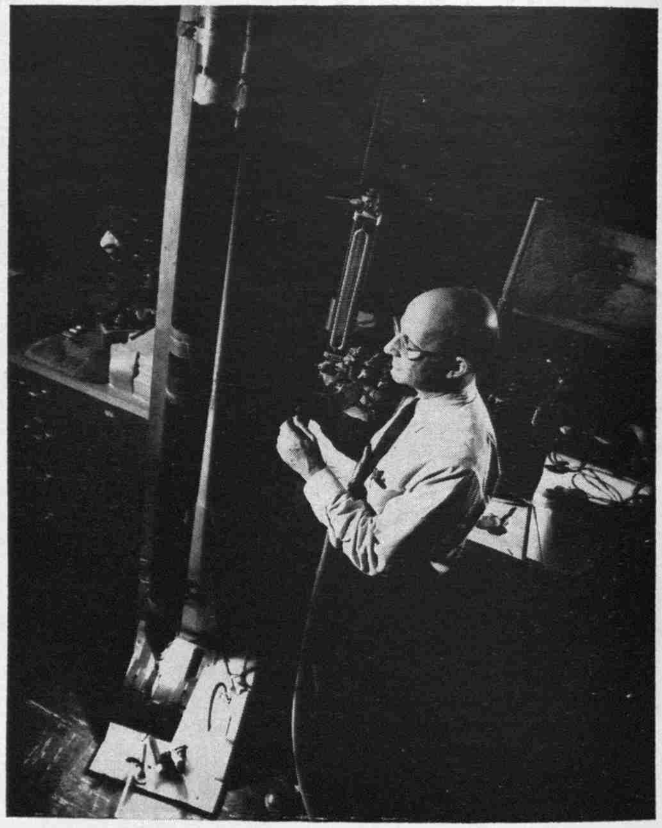
NEW DEVELOPMENTS

(Continued from Page 50)

efficient for units up to approximately 230,000 kilovolt-amperes capacity at 3600 RPM.

The liquid cooling method makes possible the design and manufacture of generator armatures having much higher capacity than present units.

Other technical features of the Cleveland machine include direct cooling of the rotating field winding with hydrogen, a new and improved grain-oriented strip steel in the magnetic portion of the armature, and an improved type of insulation.



Dr. Lewis R. Koller and his "air sieve" which sorts out powders many times finer than can be obtained with any wire sieve.

"AIR SIEVE"

Superfine powders, composed of uniform particles so small that more than a thousand could line up single file across the head of an ordinary pin, are being separated here with a moving air stream, using a device developed by Dr. Lewis R. Koller.

One application of such powders, more than ten times as small as any which can be sifted through standard sieves, could be to increase detail and brilliance of pictures shown in television receivers, he said.

According to Dr. Koller, the finest sieve commercially available has about 325 wires to the inch and will pass all particles smaller than about a two-thousandths of an inch in diameter. Finer sieves are very fragile and difficult to use.

With Dr. Koller's "air sieve" there is no wire screen. The original powder, of particles of assorted sizes, is blown upwards through a vertical seven-foot glass tube, four inches in diameter. All the powder is lifted, but the smallest grains rise highest and are blown into a container at the top.

In using the device, technically termed an "elutriator," the original mixing powder is placed in a flask at the bottom and shaken mechanically. Then the air is gradually

(Continued on Page 56)

Boeing's great new tunnel can help you

Whatever engineering field you enter, you'll get ahead faster if the company you join possesses outstanding research facilities. Boeing's newly redesigned 54,000-hp. wind tunnel – the only privately owned trans-sonic tunnel in the country – is an example of the research advantages that could help you get ahead in this famous company. Other research tools at Boeing include acoustical, hydraulic, pneumatic, mechanical, electronics, vibration and physical research laboratories, among others.

No industry matches aviation in offering young engineers such a wide range of experience, or such breadth of application – from pure research to production design, all going on at once. Boeing is constantly alert to new techniques and materials, and approaches them without limitations. Extensive sub-contracting and major procurement programs – directed and controlled by engineers–afford varied experience and broad contacts with a cross-section of American industry.

Aircraft development is such an integral part of our national life that young graduates can enter it with full expectation of a rewarding, long-term career. Boeing, for instance, is now in its 36th year of operation, and today employs more engineers than at the peak of World War II.

Boeing engineering activity is concentrated at Seattle in the Pacific Northwest, and Wichita in the Midwest. These communities offer fine fishing, hunting, golf, boating and other recreational facilities. Both are fresh modern cities with fine residential and shopping districts, and schools of higher learning where you can study for advanced degrees.

There are openings in ALL branches of engineering (mechanical, civil, electrical, aeronautical, and related fields), for **DESIGN, DEVELOPMENT, PRODUCTION, RESEARCH and TOOLING.** Also for servo-mechanism and electronics designers and analysts, and physicists and mathematicians with advanced degrees.

For further information,
consult your Placement Office, or write:

JOHN C. SANDERS, Staff Engineer—Personnel
Boeing Airplane Company, Seattle 14, Washington

BOEING

NEW DEVELOPMENTS

(Continued from Page 54)

turned on, the speed being adjusted with the aid of a flow meter.

At first, only the finest particles, which may be less than a ten-thousandths of an inch in diameter, reach the top. Here they pass through a tube that bends over to the side, and into a small collecting vessel. After this is removed and replaced with another such vessel, the air velocity is increased. Then larger grains, perhaps from one to two ten-thousandths of an inch in diameter, are collected. Repeating this process several times, with still higher air speeds, the original unclassified powder may be sorted out into uniform samples.

A possible application of these ultrafine powders is in television picture tubes. If the luminescent coating inside the face, on which the picture appears, is very thin, said Dr. Koller, greater brilliance may be obtained. The finer and more uniform the powders from which the coating is prepared, the thinner the coating may be, he pointed out.

UNDERWATER SUN

Twice the world's present supply of radium, which if obtainable would cost $130,000,000, would be needed to equal in intensity the rays from a powerful radiation source recently installed at the Knolls Atomic Power Laboratory, Schenectady, N. Y., which is operated for the Atomic Energy Commission.

So intense is this radiation that it causes a bluish-white glow in the nine-foot depth of protective water under which the source is kept. When the room is darkened, the tank and the surrounding area are illuminated by this glow.

According to Dr. Kenneth H. Kingdon, technical manager of the laboratory, the source consists of about 2.5 pounds of a radio-active form of the metal cobalt, known as cobalt 60. The radiations emitted are gamma rays or high-energy X rays.

The laboratory will use the new installation in connection with its work on the design and construction of a full-scale, land-based model of an atomic power plant for U. S. Navy submarines, Dr. Kingdon explained.

Physical properties of many materials to be used in constructing such a plant may be altered by the powerful rays generated in the atomic reactor, or "furnace." By lowering samples of these materials into the water, and exposing them to rays from the cobalt 60, such effects may be tested on a small scale, he said. Other testing of the effects of irradiation on materials is done in nuclear reactors.

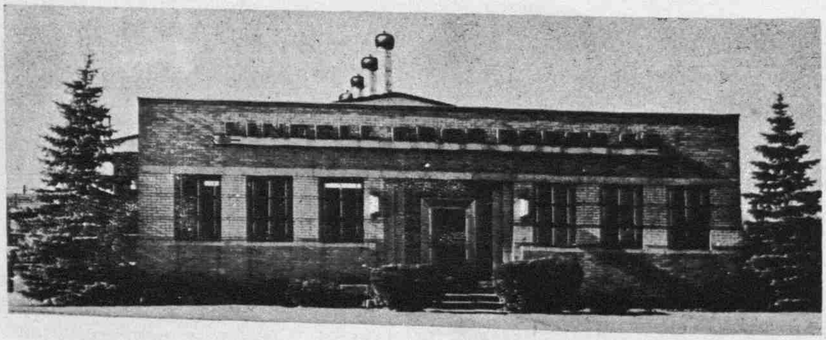
Common glass is one material that is markedly changed by the rays; it turns a deep brown. One engineering assistant at the laboratory took advantage of this to make a pair of sunglasses, by exposing an ordinary pair of glasses to the rays over-night. Such coloration of glass, however, is not permanent, but gradually fades out. Baking at a relatively high temperature very quickly restores the glass to its original clarity.

The radioactive cobalt is contained in ten cylindrical capsules, mounted in holes in a steel plate. They are kept at the bottom of a concrete pit and, with the aid of submerged lights, may be clearly seen through the nine feet of water covering them. Remote control devices permit them to be handled at a distance if necessary, and allow test samples to be placed in position around them.

Ordinary cobalt, a metal closely resembling nickel and not radioactive, may be made radioactive when it is placed in an atomic reactor and bombarded with particles called neutrons, Dr. Kingdon said.

LINDELL

Established 1910 DROP FORGE COMPANY Incorporated 1923



Manufacturers of

HIGH GRADE DROP FORGINGS

2830 SOUTH LOGAN

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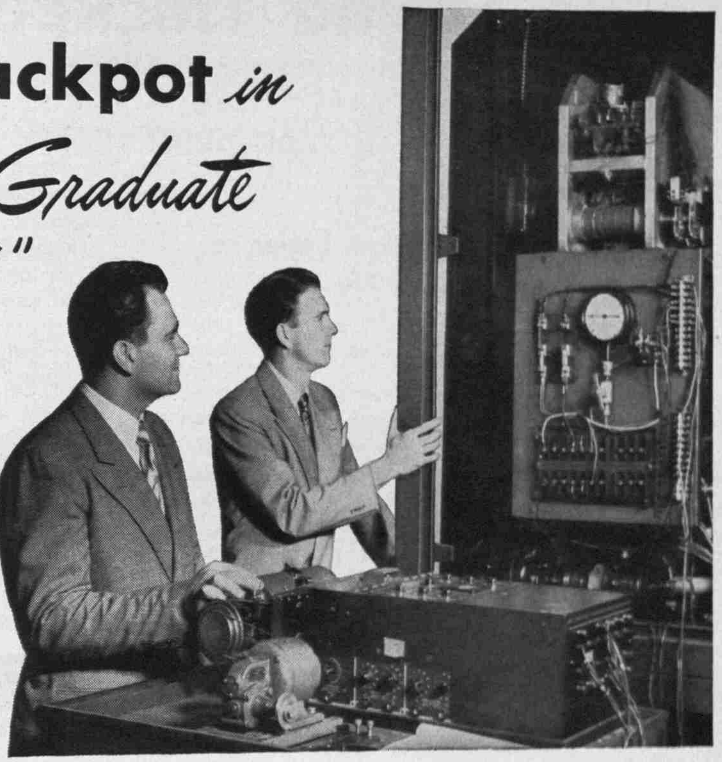
"We Hit the Jackpot *in Allis-Chalmers Graduate Training Course!*"



say N. W. MORELLI

Oregon State College, B.S.,M.E.—1950

and

E. R. PERRY

Texas A. & M., B.S.,E.E.—1950

WHILE taking the course, two engineers developed a revolutionary new circuit breaker mechanism.

"Our experience shows what *can* happen if you work with people open to suggestion. We found men of this kind at Allis-Chalmers, and it has given us a special pleasure in our job.

"We started out like most other graduates with a hazy idea of what we wanted to do. After working in several departments, we requested that part of our training be at the Boston Works of Allis-Chalmers, where circuit breakers are made."

New Design Principle

"Circuit breakers soon became an obsession with us, and we got the idea of designing a hydraulic operator and triggering mechanism for these breakers. Most operators for big breakers are pneumatic.

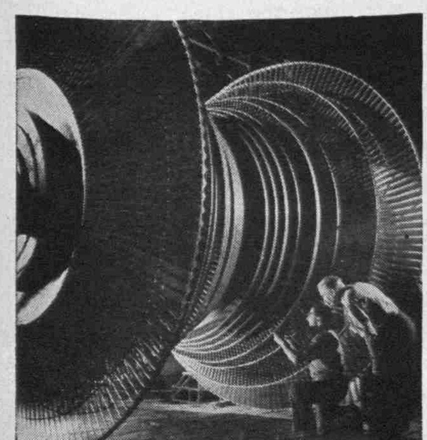
"Unsuccessful attempts had been made in the past by all circuit breaker manufacturers to build hydraulic operators. The important thing is that no one at Allis-Chalmers said, 'Don't try it—it won't work.' "

Start New Era

"To make a long story short, our study of the problem led us to the hydraulic accumulator and high speed valves being used by the aircraft industry. These had not been available when earlier attempts were made to build a hydraulic operator. With these highly developed devices to work with, we were able to build an operator that combined the best features of pneumatic and hydraulic operation. We call it the *Pneu-draulic* operator. Engineers are saying it starts a new era in circuit breaker actuation.

"This fact is important to us, but it is even more important to know that Allis-Chalmers Graduate Training Course is full of opportunity . . . and as we found out, there's opportunity right from the start."

Pneu-draulic is an Allis-Chalmers Trademark.



Low-pressure spindle for a 120,000 kw steam turbine generator. Said to be one of the largest ever built in the United States, this spindle is nearing completion in the Allis-Chalmers West Allis shops.

Facts You Should Know About the Allis-Chalmers Graduate Training Course

1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

2. The course offers a maximum of 24 months' training.

3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, or specialized equipment with which he will work, such as: steam or hydraulic turbo-generators, circuit breakers, unit substations, transformers, motors, control, pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

7. For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

C-5675

Side Tracked No. 1

These Jokes Were Stolen

Big Cash Reward:

Are you so homely that you always look at the reverse side of a pocket mirror to keep from scaring yourself to death? Do you sleep with your face in your pillow just to be kind to burglars? Do men Dodge you when you walk down the street instead of Packarding or Rolls-Roycing you? Are you knock-kneed, cross-eyed, pigeon-toed, and hawk-nosed? Do you have to pretend that every day is Halloween before you have the courage to go downtown? Are you the kind of girl that jealous wives like their husbands to go out with? Are you lantern-jawed and droop-lipped? Do you pray for rain so you can hide behind an umbrella? Are you sweet sixteen and never been kissed? Do crooners swoon when you look at the radio? Do your hands dangle below your knees and do your pair of shoes equal one cow? Are you called to the phone every five minutes to turn down a side-show offer? Do you protect yourself from peeping Toms by leaving the shades up?

Now then, take stock of yourself. Get a toe-hold on the carpet and crack the mirror with one good stare. Are you the female described above? If so, sister, I'll pay you fifty dollars spot cash for an answer to this article. All you have to do is drop me a line and tell me the hiding place of that dizzy, long-eared bum who dug you up for me in a blind date last Saturday night.

★ ★ ★

The bright student looked long and thoughtfully at the second examination question, which read, "State the number of tons of coal shipped out of the United States in any given year." Then his brow cleared and he wrote:

"1492—None."

★ ★ ★

Engineer's son: "Daddy, give me a nickel to buy an ice cream cone."

Engineer: "Shut up and drink your beer."

★ ★ ★

At the stroke of twelve the irate father stomped to the head of the stairs and shouted, "Young man, haven't you a self-starter?"

"Don't need one," answered the young suitor, "as long as there's a crank in the house."

The members of a hunting party had been specifically requested to bring only male hounds. One indigent member, however, owned only a female, and out of courtesy was finally permitted to include her. The pack was off in a flash. In a matter of seconds they were completely out of sight. The confused hunters stopped to question a farmer in a nearby field.

"Did you see some hounds go by here?"

"Yep," said the farmer.

"See where they went?"

"Nope," was the reply, "but it was the first time I ever saw a fox runnin' fifth."

★ ★ ★

"Hello, is this the Home Economics school?" asked Mrs. Swift, a Christmas bride.

"Yes, it is," came the reply.

"Well, those biscuits you taught me to make, I don't think they are very good."

"Why not?"

"Keith sat down at the table days ago, and ate six of them. Then he just sat back and smiled."

"Smiled, eh?"

"Yes, and he's still sitting there smiling."

★ ★ ★

TWELVE L'IL BOTTLES

I had twelve bottles of whiskey in my cellar and my wife made me empty the contents of each and every bottle down the sink, so I proceeded to do as my wife desired and withdrew the cork from the first bottle, poured the contents down the sink with the exception of one glass, which I drank.

I extracted the cork from the third bottle, emptied the good ol' booze down the bottle, except a glass which I drank.

I pulled the cork from the fourth sink and poured the bottle down the glass when I drank some.

I pulled the bottle from the cork of the next and drank one sink out of it and then threw the rest down the bottle.

I pulled the sink out of the next cork and poured the bottle down the sink, all but one sink, which I drank.

I pulled the cork from my throat and poured the sink down the bottle and drank the cork.

When I had them all empty I steadied the house with one hand and counted the bottles, which were twenty-four, so counted them again and I had seventy-four and as the houses came around I counted them and finally I had all the houses and bottles counted and I proceeded to wash the bottles, but I couldn't get the brush in the bottles, so I turned them inside out and washed and wiped them all, and went upstairs and told my other half about what I did and oh boy! I got the wifest l'il nice in the world.

230 MINUTES COAST TO COAST
. . . WITH A PRATT & WHITNEY ENGINE

Three hours and fifty minutes from California to Florida . . . that's the almost incredible cross-country record set by a Lockheed Starfire.

Now our engineers are developing the powerplants for the outstanding aircraft of the future, both military and commercial.
They are working on far more powerful jet engines . . . even a nuclear engine.

If you would like to work for a company with a future . . . serving an industry with an unlimited future . . . set your sights on Pratt & Whitney Aircraft.

MORE AIRCRAFT ENGINES BEAR THIS EMBLEM THAN ANY OTHER.

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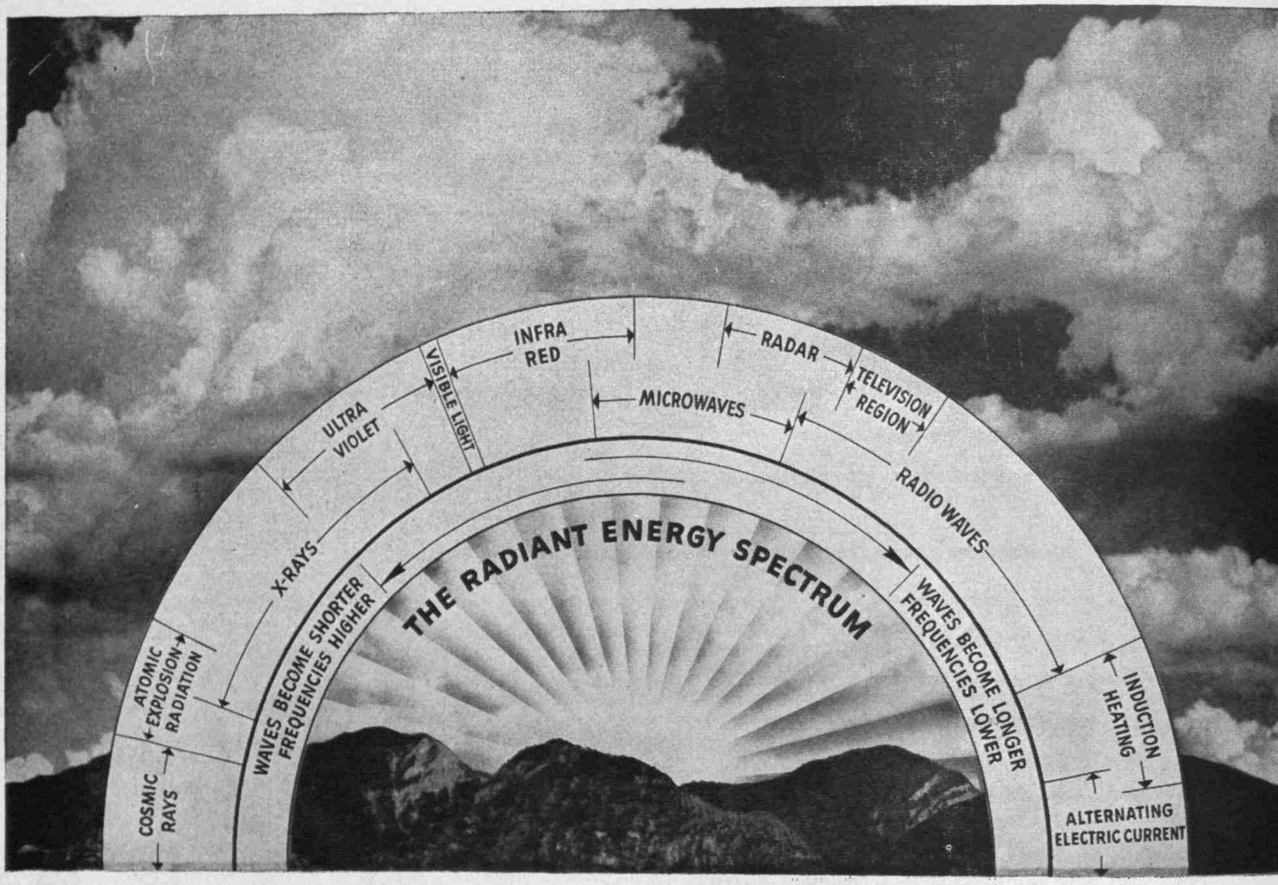
DIVISION OF UNITED AIRCRAFT CORPORATION

EAST HARTFORD 8, CONNECTICUT U.S.A.



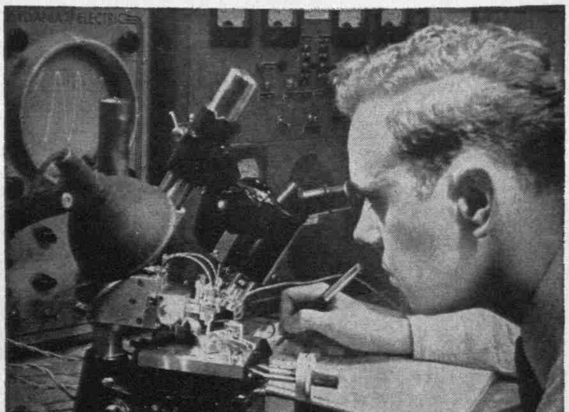
This is our HORIZON

This is the "radiant energy spectrum" — the horizon for the 1600 professional engineers engaged in research and development work at Sylvania's more than a dozen laboratories.

The research and development under way at Sylvania's laboratories reaches, in some way, into virtually every phase of this spectrum. In the broad fields of *lighting, radio, electronics, television*, Sylvania engineers are constantly finding new challenges to stimulate their imagination, new opportunities to further their careers in a steadily growing company.

Sylvania offers college graduates expanding opportunities to build a truly successful and challenging professional career.

For information on Sylvania's program for graduating engineers, see your Placement Office today — or you may write directly to Sylvania's Supervisor of Technical Employment.



A Sylvania scientist uses a micro-manipulator to adjust a transistor.

FREE copies of the Radiant Energy Spectrum, illustrated in greater detail and full color, are available by writing to Dept. "C".

SYLVANIA

Electric Products Inc. 1740 Broadway, N. Y. C.

LIGHTING • RADIO • ELECTRONICS • TELEVISION

THIS NEW AUTOMOTIVE LABORATORY at Standard Oil's Whiting Research Laboratory is now in operation testing and developing new and improved gasolines and lubricants.

They help design the future

• In the laboratories of today, the world of tomorrow is taking shape—test by test, experiment by experiment.

What man will be capable of in years to come, how he will work and play, how he will travel, all depend to a large extent on the fuels and lubricants that will power the machines of the future.

More than a quarter of a century ago Standard Oil opened its first automotive laboratory, and from time to time has enlarged the facilities.

Now Standard Oil has added still another unit. The new building located at Whiting, Indiana, is devoted entirely to the testing and development of automotive fuels and lubricants.

Full-scale testing is conducted in a room containing every needed facility for the measurement and control of operating conditions. The test engines include the principal types used today or anticipated for the future. Each of 16 engines, with its dynamometer, is mounted on a separate concrete foundation, isolated from other parts of the building to eliminate vibration.

In the expansion of our laboratories, young technical men find evidence that the challenge of the future, with its stimulation and rewards, is being met at Standard Oil.

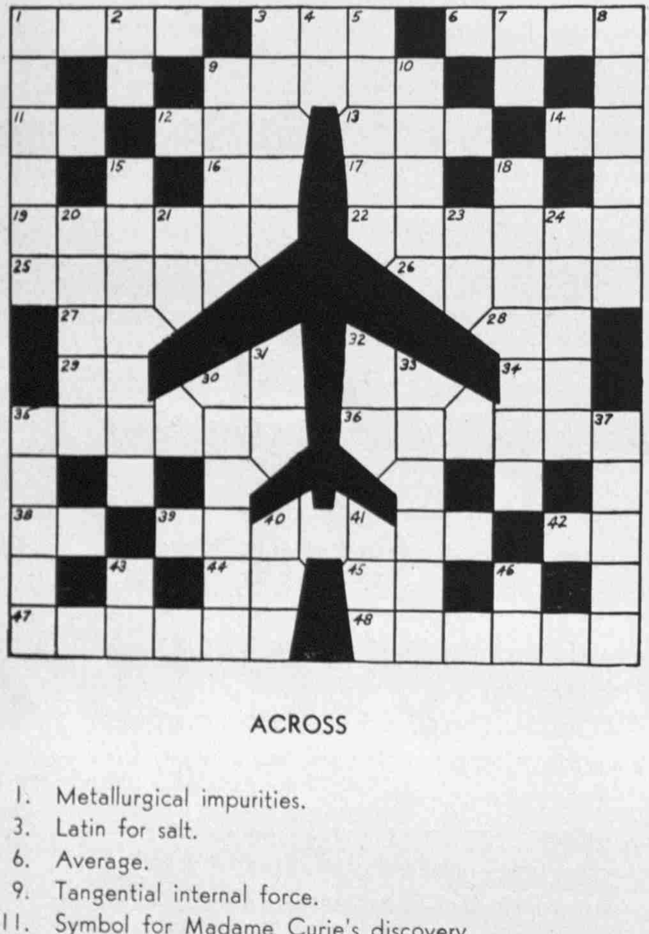
Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

STANDARD

CROSSWORD FOR ENGINEERS

Borrowed from the Purdue Engineer



ACROSS

1. Metallurgical impurities.
3. Latin for salt.
6. Average.
9. Tangential internal force.
11. Symbol for Madame Curie's discovery.
12. To mock.
13. Condensed moisture.
14. Symbol for an element named for the northern European countries.
16. Symbol for an element resembling manganese.
17. Abbreviation for left.
19. A temperature scale.
22. To flow from an aperture.
25. To oust.
26. Minute.
27. Indicating juxtaposition.
28. Symbol for the lightest rare earth metal.
29. Abbreviation for a unit of electrical potential.
30. Symbol for a basic element in glass.
32. Symbol for a very poisonous element.
34. The neuter pronoun of the third person, singular.
35. Open mouth container.
36. A part of a vacuum tube used to absorb oxygen.
38. Symbol for a light structural metal.
39. A hypocycloid of four cusps.
42. Symbol for a principal element in Stellite.
44. Symbol for element no. 70.
45. Prefix denoting back to original position.
47. A form of yarn after it is taken from the reels.
48. A compound which may be regarded as being formed by the replacement of the acid hydrogen of an acid by a hydrocarbon radical.

DOWN

1. A movement of a piston from one end of a cylinder to the other end.
2. To the same extent (adv.).
3. Luster.
4. Abbreviation for an engineering school at State.
5. Receptacle for molten metal.
7. Symbol for a rare earth element which has 30 electrons in its fourth electron shell.
8. Principal element in monel metal.
9. Boom on the front of a sailing ship.
10. A chain of rocks in water.
15. An alloy whose elastic modulus is constant with temperature changes.
18. A measure of steam wetness.
20. To summon forth.
21. Abbreviation for a British military decoration.
23. Abbreviation for a type of radio carrier-wave modulation.
24. A dense, fine-grained rock used for roofing.
30. A servo-mechanism.
31. Symbol for the element between osmium and platinum.
32. Symbol for a metal which has a high conductivity.
33. The sum of a sequence of numbers.
35. A zinc-copper alloy.
37. A quantity which, taken as a factor a number of times, produces another quantity.
40. Abbreviation for tablespoons.
41. A usable mineral.
43. Symbol for an element used in rectifiers.
46. Symbol for an element similar to sulphur and selenium.

to the

ELECTRICAL ENGINEER

or

PHYSICIST

with an interest in

RADAR

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ELECTRONICS

Hughes Research and Development Laboratories, one of the nation's leading electronics organizations, are now creating a number of new openings in an important phase of their operation.

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Scientific and Engineering Staff
Culver City, Los Angeles County, California

See your Placement Office for appointment with members of our Engineering Staff who will visit your campus. Or address your resumé to the Laboratories.

Side Tracked No. 2

So Were These

A middle-aged woman lost her balance and fell out of a window into a garbage can.

A Chinese passing by said: "Americans so wasteful. Woman good for ten years yet."

★ ★ ★

A couple of officials were walking by Oak Ridge, when they discovered a strange unidentified object lying on the ground. They decided to take it up in an airplane and drop it to see what would happen. They flew over some woodland in the South and dropped it. When it hit the ground it blew up. Just then a long-bearded old man wearing a Confederate uniform and shouldering a musket came running out of the woods. As he looked up and saw the atomic mushroom he said, "I don't know what Lee's going to do, but I'm going to surrender."

★ ★ ★

"Did you hear about the wreck?"

"No."

"Yeah, four professors and one student were killed."

"Poor fellow."

★ ★ ★

Nurse (in an insane asylum): "There is a man outside who wants to know if we have lost any male inmates."

Doctor: "Why?"

Nurse: "He says that someone has run off with his wife."

★ ★ ★

Beginner at fishing: "Oh, I've got a bite. What do I do?"

Her husband: "Reel in your line."

Beginner: "I've done that, the fish is tight against the end of the pole. What do I do next?"

Helpful husband: "Hold it, I'll climb up the rod and stab it."

★ ★ ★

A young governor in an Eastern state was asked to address the prisoners at the State Penitentiary. It was his first speech after election and he was somewhat nervous.

He started off, "Fellow Citizens." Then he realized that the prisoners were deprived of their citizenship during their imprisonment. He stopped and started again, "Fellow Prisoners."

He realized too late his second mistake, so he continued, "Well, anyway, I'm glad to see so many of you here."

Ruth: "How do you know he was drunk?"

Doris: "Well, he shook the clothes tree and then started to feel around the floor for some apples."

★ ★ ★

"Boy, oh boy! That was some blonde with you last night. Where did you get her?"

"Dunno. I just opened my billfold and there she was."

★ ★ ★

"Oh, what a strange looking cow!" exclaimed the young model from New York while visiting on the farm. "But why doesn't she have any horns?"

"Well, you see," replied the farmer, "some cows is born without any horns and never had any, and others shed theirs, and some we dehorn, and some breeds ain't supposed to have horns at all. There's a lot of reasons why some cows ain't got horns, but the reason that cow ain't got horns is because she's a horse."

★ ★ ★

A lady bought a parrot from a pet store only to learn that it cursed everytime it said anything. She put up with it as long as she could, but finally one day she lost her patience. "If I ever hear you curse again," she declared, "I'll wring your neck."

A few minutes later she remarked rather casually that it was a nice day. Whereupon the parrot promptly said, "It's a hell of a fine day."

The lady immediately seized the parrot by his head and spun him around in the air until he was almost dead.

"Now, then," she said, "It's a fine day today, isn't it?"

"Fine day!" exclaimed the parrot. "Where in hell were you when the cyclone struck?"

★ ★ ★

No so long ago, a disheveled E.E. walked into a psychiatrist's office, tore open a cigarette, and stuffed the tobacco up his nose.

"I see that you need me," remarked the startled doctor.

"Yeah," agreed the student, "do you have a match?"

★ ★ ★

The lunatic who, after a very exemplary record of sanity was discharged from the asylum, was returned home, and on the following morning decided to shave as every sane man does. He nailed the mirror to the wall, stood before it, lathered his face, then selecting an old-fashioned razor, proceeded to shave; at this moment the nail slipped and the mirror fell to the floor. He stood gazing at the blank wall before him, then remarked bitterly: "Just my luck, second day out, and I've cut my blooming head off."

PHOTOGRAPHY AT WORK No. 2 in a series:

Knitting mill solves help shortage, attracts and keeps full staff

Hand Knit Hosiery Company of Sheboygan, Wisc., knitters of Wigwam Socks, found many potential employees resisted jobs simply because they didn't know the sort of opportunities offered.

To explain job opportunities, to enlist an efficient staff, here's how this company used photography

Like most businesses today, the knitters of Wigwam Socks found the getting and keeping of good people on jobs a major problem. Especially since some of the work had names strange to highly desirable personnel—such as looping, box drying, etc.

But Hand Knit's industrial relations director knew the potency of photography—used it to show applicants *what* their work would be, what they wear, what their boss looked like. From then on an efficient factory force was more easily lined up—and *kept*. Any business profits when cameras and film get to work.

There are so many new uses for photography being found, that many well-qualified graduates in the physical sciences and in engineering have been led to find positions with the Eastman Kodak Company.

If you are interested, write to Business and Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

6 WAYS TO BEGIN A SUCCESSFUL CAREER

TEST ENGINEERING PROGRAM—offers engineering graduates opportunities for careers not only in engineering but in all phases of the Company's business. Includes rotating assignments plus opportunities for classroom study.

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If you are interested in building a G-E career after graduation, talk with your placement officer and the G-E representative when he visits your campus. Meanwhile, for further information write to College Editor, Dept., 2-123, General Electric Co., Schenectady 5, New York.

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