COLORADO Engineer

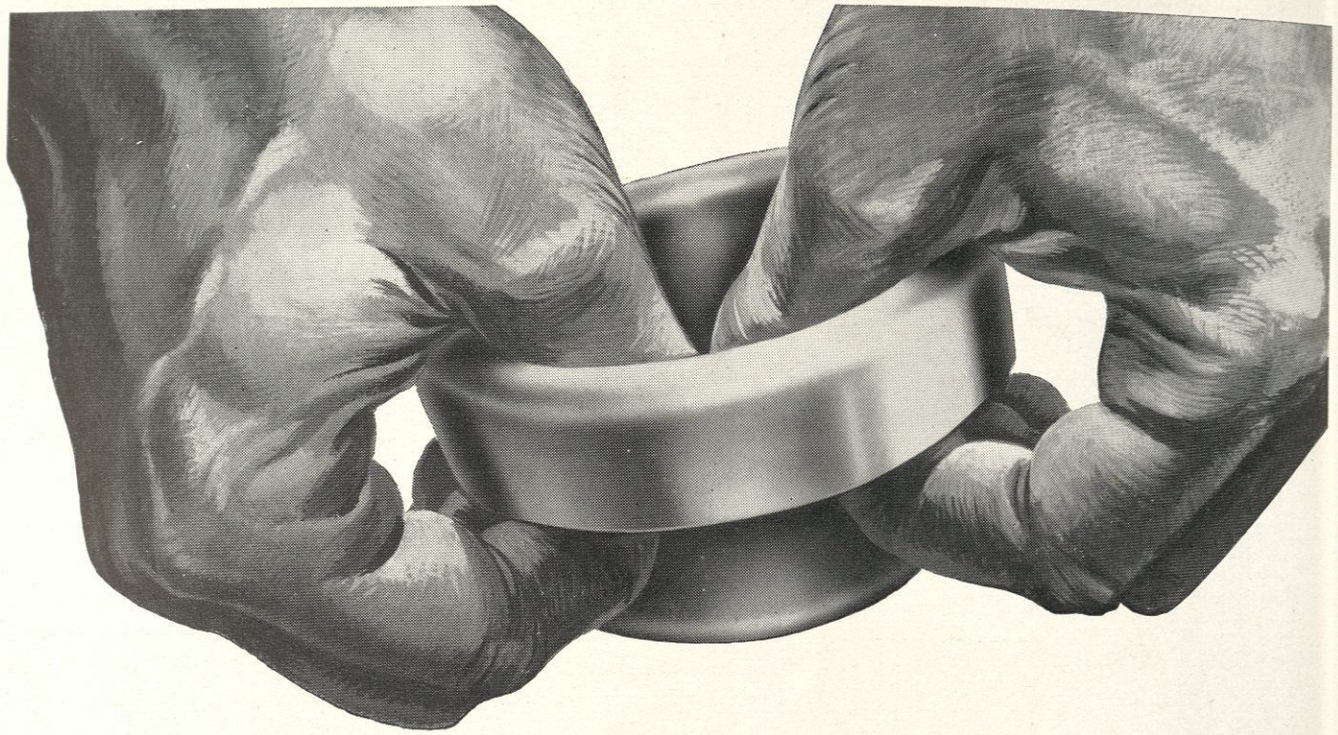
Stepping Stone
To Production

Van De Graaff
Generator

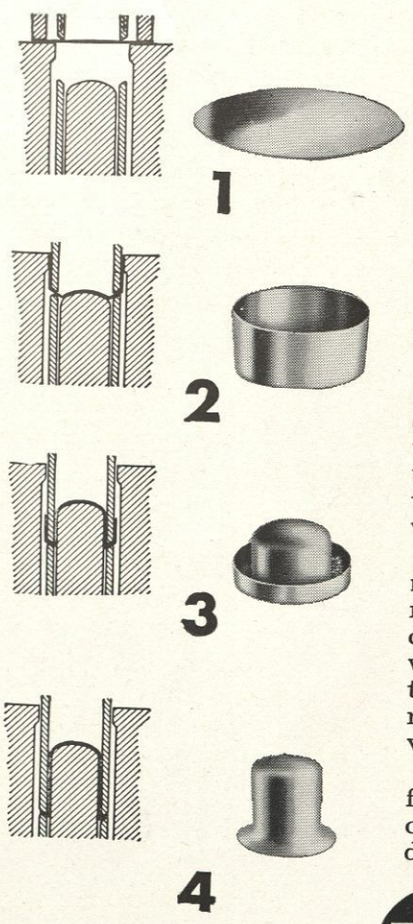
Recovering Gold
The Hard Way

Cybernetics

March 15, 1953



How to turn a high strength steel cup inside out, cold



OFFHAND, anyone familiar with high strength steels would say it couldn't be done. But one of our customers does it every day.

Employing a unique reverse-drawing method and using a U·S·S High Strength Steel especially adapted for this process, they turn out cylindrical containers of various kinds that are not only stronger than those made from carbon steel but weigh substantially less.

To accomplish this, the steel has to meet two entirely opposite requirements. It has to be so strong that it can be used in thinner gages to reduce weight, and yet must have enough ductility to satisfy the drastic fabrication method that would be considered severe even for carbon steel.

This method is used to draw cups for large, low-pressure cylinders. These cups, 14½ in. in diameter and 24½ in. deep, are drawn cold, from 12-gage steel blanks in one continuous stroke in a reverse draw press. The diagrams at left show how it is done.

Starting with a 38 in. diameter steel blank (Fig. 1) the press first draws the steel into a shallow cup (Fig. 2). As the stroke continues, the cup is literally *turned inside out* (Fig. 3) to form the finished cup (Fig. 4) which has very uniform wall thickness. Two of these cups are then welded together to make a cylinder.

Made with high strength steel, cylinders weigh about 20 lbs. less. The maker gets 26% more cylinders from each ton of steel used. Lighter weight makes cylinders easier to handle, and also pays off in lower freight costs—both on the steel from our mills and on cylinders shipped. (A customer 500 miles away saves as much as $100 per carload.)

Developing special steels for special customer needs is an important job of United States Steel metallurgists and engineers. With their tremendous background of practical experience, they are ready to work on any problem that involves the more efficient use of steel. United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

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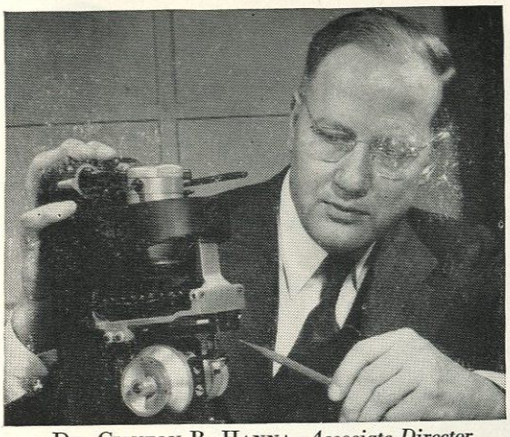
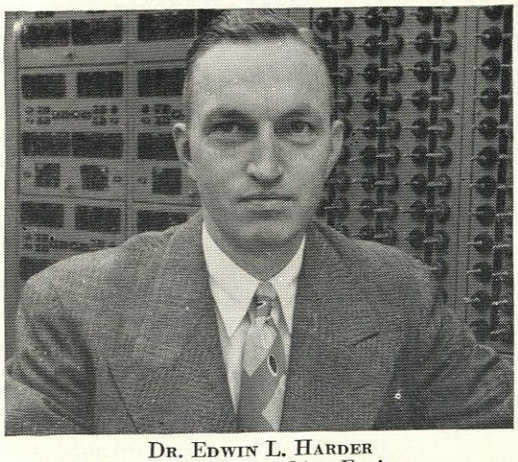
UNITED STATES STEEL



DR. CLINTON R. HANNA, *Associate Director*
Westinghouse Research Laboratories
Enrolled in Westinghouse Graduate Student Training Course after graduation from Purdue University in 1922. Dr. Hanna, with over 100 patents to his credit, is one of the nation's leading authorities on gyroscopically controlled regulating devices.

CARROLL V. ROSEBERRY, *Manager*
Westinghouse Electric Utility Department
Upon graduation from Oklahoma A & M in 1934, he enrolled in the Westinghouse Graduate Student Training Program. Assigned first as a salesman, he was advanced to district Assistant Electric Utility Manager, branch Electric Utility Supervisor, and in 1951 was appointed to his present post.



DR. EDWIN L. HARDER
Westinghouse Consulting Engineer
Enrolled in Westinghouse Graduate Student Training Course after graduation from Cornell University in 1926. Dr. Harder has become nationally known for his analytical and development work in power systems. He is co-developer of the Anacom, an electric analogue computer.

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Phillips has been and still is primarily a producer of motor fuels and lubricants. But today's rapid expansion in new fields of petrochemicals and high polymers offers unique opportunities for ambitious engineers and chemists.

We invite qualified men to write to our Employee Relations Department for information about opportunities with our company.

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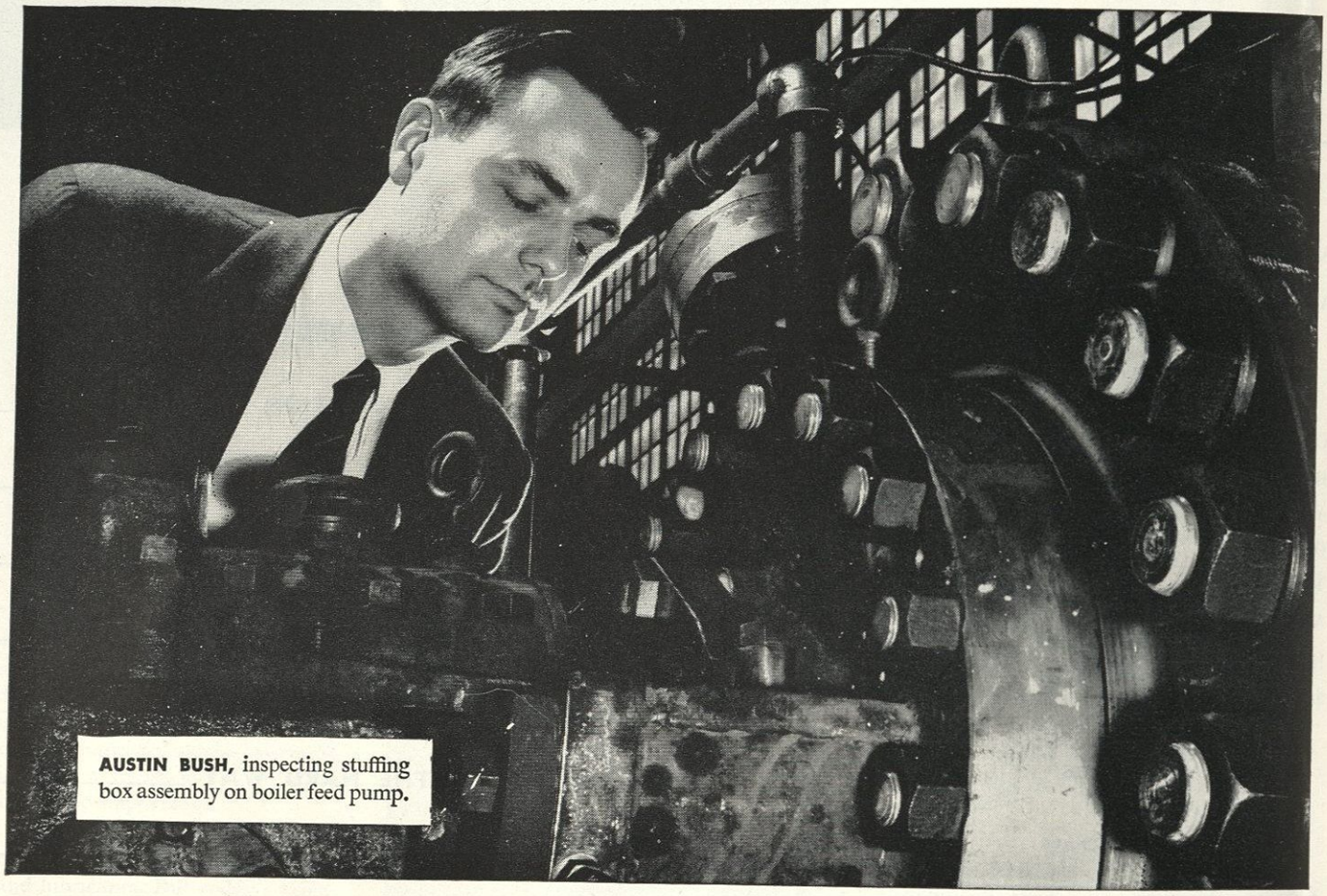
MEMBER OF
ENGINEERING COLLEGE MAGAZINES ASSOCIATED

John Paustian, Chairman
UNIVERSITY OF NEBRASKA

PRICE: $1.50 PER YEAR

Austin Bush, Rensselaer, '50, Helps Develop New Pump



AUSTIN BUSH, inspecting stuffing box assembly on boiler feed pump.

Reports interesting project engineering assignments at Worthington

"Despite its size as the leading manufacturer in its field," says Austin Bush, "I have found Worthington pays considerable attention to the interests of the individual. The company's excellent training program consists of several months of working with the various types of equipment manufactured, augmented by technical lectures, and talks on the organization of the corporation.

"Following this training, I was given an opportunity to choose the department in which I wanted to work—engineering, sales, or manufacturing. My choice was the engineering department where I have already been assigned to several interesting projects.

"In addition to the training program, the members of our engineering department hold monthly seminars at which engineering topics of general interest are discussed.

"Opportunities for advancement are good, and pleasant associates make Worthington a fine place to work."

When you're thinking of a good job, think *high*—think *Worthington.*

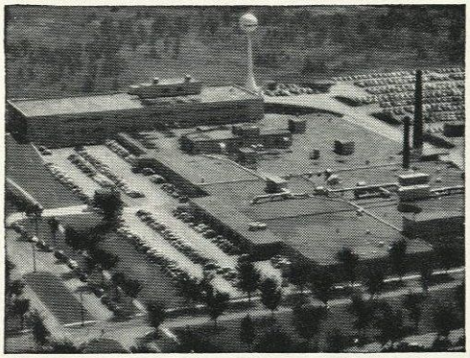
FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, New Jersey.

WORTHINGTON

The Sign of Value Around the World

2.54X

There's great new opportunity for Engineers in Honeywell's growing Aeronautical Division



The delicately balanced glass of water below clings to its perch, despite the plane's sharp banking turn.

That's because a Honeywell electronic autopilot is in command . . . the human pilot nowhere near the controls.

So precisely are the control surfaces coordinated, that all displacing forces are instantly equalized.

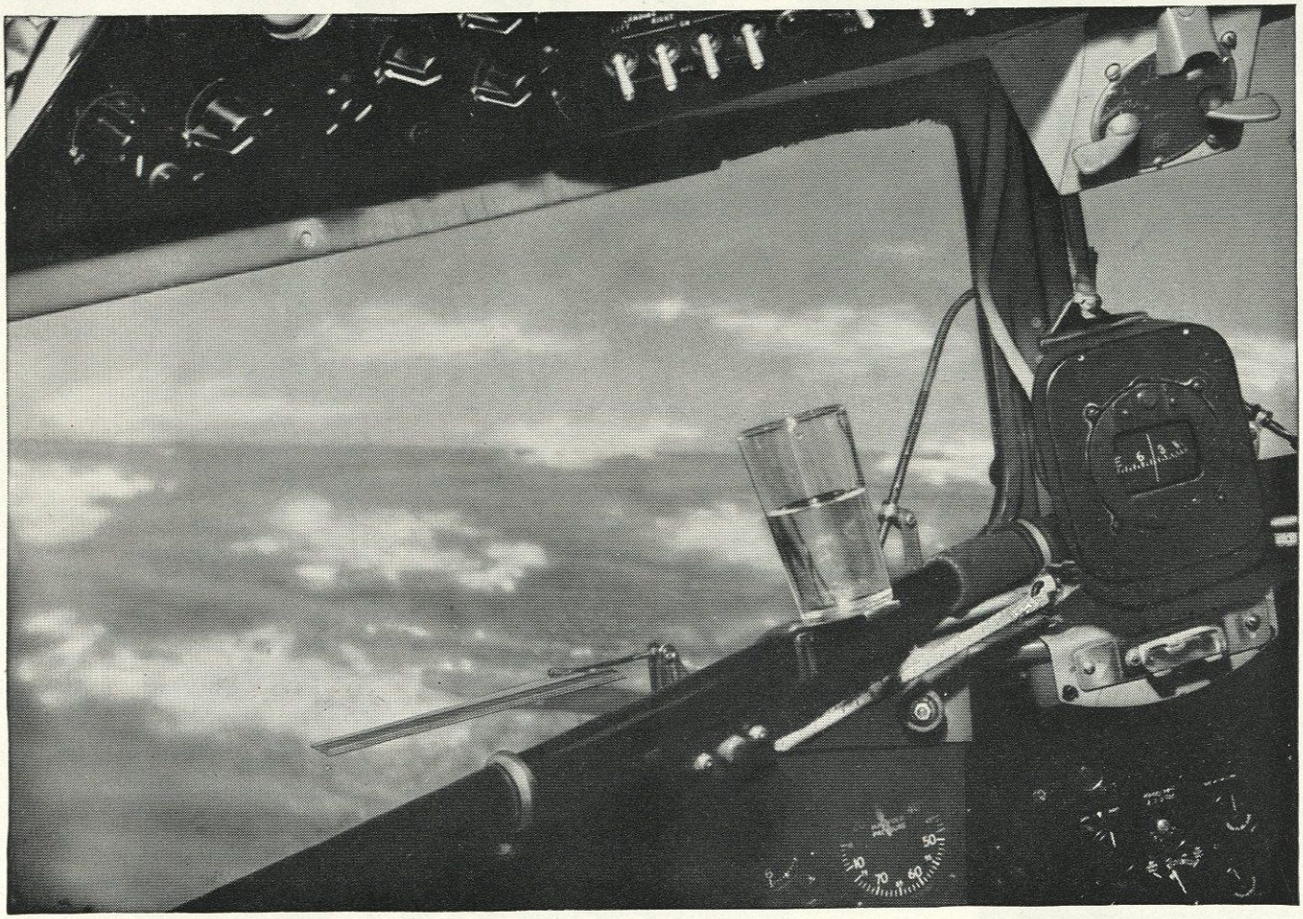
There simply can't be any skidding or side-slipping to upset the glass.

This is typical of aircraft performance made possible by controls produced in Minneapolis by Honeywell's expanding Aeronautical Division.

Besides autopilots, Honeywell's list of current aero products includes electronic fuel measurement systems, dozens of different kinds of gyros, actuators and many other controls.

Today, with aircraft and rockets flying even higher and faster, demands for new controls are being met in the new Honeywell aero plant pictured at left. In developing these new controls, the men in our expanding engineering and research sections often must work in the realm of pure science.

There's real opportunity for engineers at Honeywell—for this is the age of Automatic Control. And Honeywell has been the *leader* in controls for more than 60 years!



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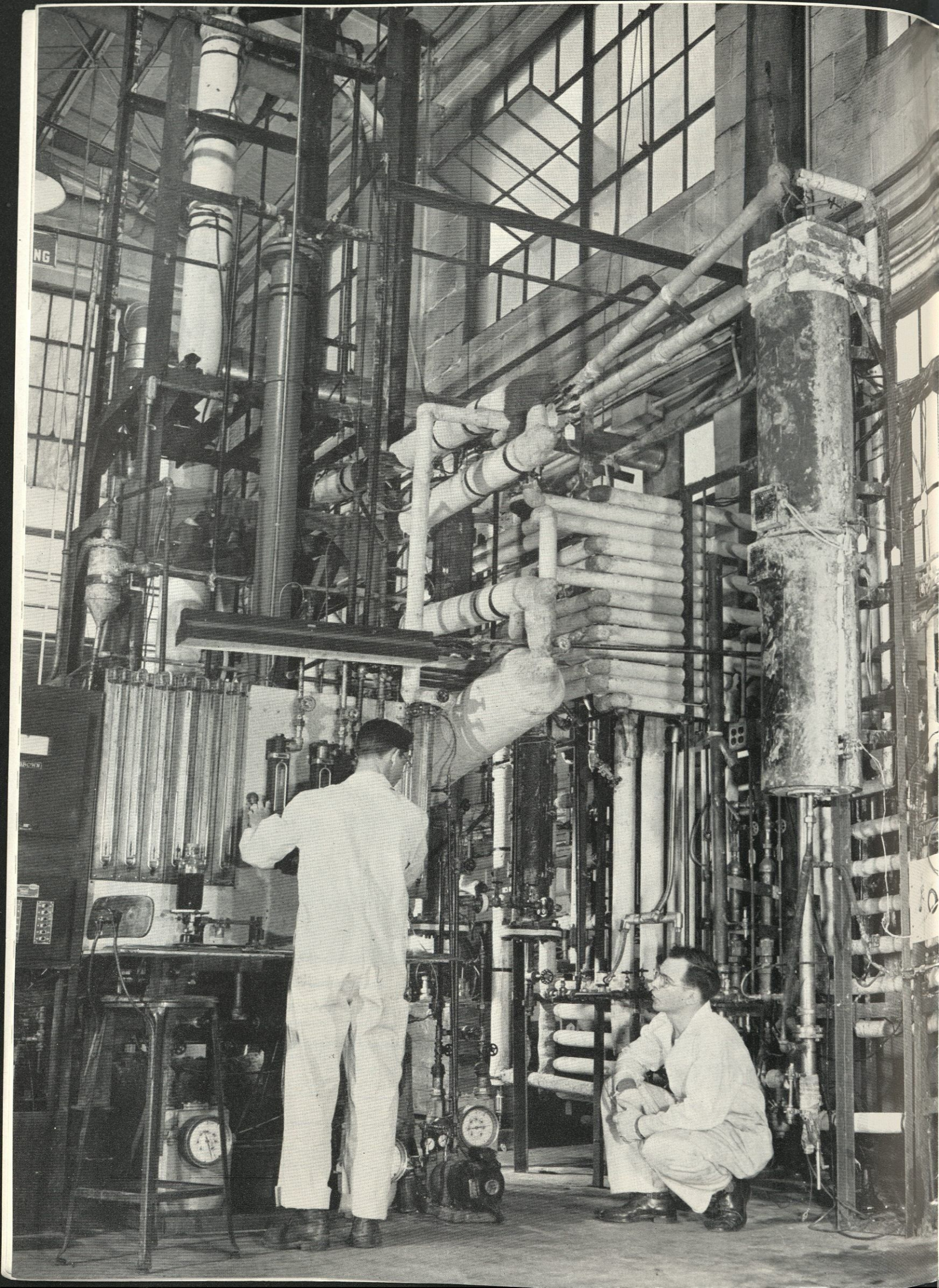


STEPPING STONE TO PRODUCTION

By JAMES I. MORGAN, Ch. E. & Bus., '55

"Construction of $1,200,000,000 Uranium Plant Started," "$400 Million Plant To Produce Aluminum," "Plans Drawn for Cortisone Plant," "$100 Million Chemical Plant proposed," "New Plant to Produce Acrylonitrile."

Headlines such as the above are becoming increasingly more common in the magazines and newspapers of our country, for the American chemical industry presently is undergoing an accelerated wave of expanson. Not scheduled to show signs of leveling off until 1955, the present wave of expansion will increase the production capacity of chemicals by 2½ times compared with the 1935-39 average.

Evidence of the expansion is shown in the approximately 1,000 new plants and facilities that were planned, under construction, or completed during 1951-52. In addition, during these two years about 300 new chemical processes and new technological developments were announced or commercialized. Further evidence of the rapid growth of the chemical industry is the figures which show that since 1925 the industry has expanded at about 3 times the rate of all other American industry.

Hidden beneath the headlines and oftentimes unnoticed is the story of pilot plants and their importance in the expansion of the chemical process industries. The pilot plant is an experimental plant constructed of the same type of equipment, on a smaller scale, that is expected to be used in the final plant. The equipment is arranged to perform the same functions expected of it in the final plant.

The principal reason that it is necessary to construct a pilot plant is that the performance of chemical reactions in large equipment is difficult to predict on the basis of laboratory data. As our knowledge of chemistry and other sciences increases, possibly some day the use of the pilot plant will be eliminated. Until that day, however, the pilot plant will continue to be an important part of the chemical industry.

A junior majoring in chemical engineering and business, Jim is 20 years old. He comes to the University from Denver where he was graduated from South high school. His interest in pilot plants stems from his job as foreman of the levulose pilot plant of the chemical engineering department. Among his activities are alumni news editor of the COLORADO ENGINEER, FLATIRON staff writer, and recorder of Alpha Chi Sigma. He is an active member of A.I.Ch.E., Alpha Phi Omega, Phi Epsilon Phi, and the Pep Club. He also holds a Norman Baker scholarship.

The primary purposes of a pilot plant are to determine if the construction of the final plant will be profitable and, if so, to yield information which will be used in designing the final plant. The pilot plant is used also for research investigation, operator training, and small scale production. It is the most important step in the development of a new, unproven chemical process, for it is usually at this stage that the process will either prove itself or fail. Although used primarly in the development of new processes, it also is used in improving old processes.

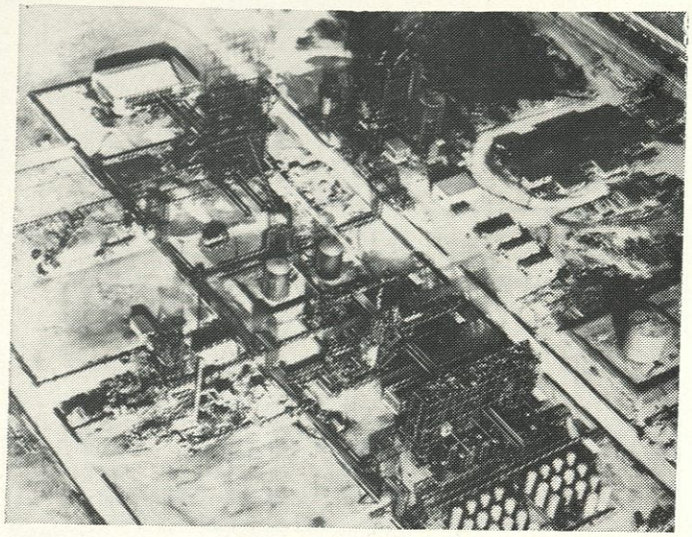
The cost of a pilot plant runs into thousands and in a few cases, millons of dollars. It is, therefore, necessary to determine from laboratory data that both the chemical and economic aspects of the process indicate a profitable return before plans for the pilot plant can be drawn up. Likewise, data gleaned from the pilot plant must indicate that the construction of the final plant will be feasible.

Each specific use of the pilot plant is aimed to accomplish one major purpose—the lessening of the economic risk involved. Although there are numerous

(Contined on next page)

—Courtesy Du Pont

← **A $25,000 reactor used in the development of a successful nylon salt process.**



An aerial view of the $11 million "coal-hydrogenation" chemicals unit at the Institute, West Virginia plant of Carbide and Carbon.

cases in which the pilot plant development was omitted due to haste or warranted willingness to gamble, and in which the final outcome has justified the omission, there still exists a great faith in the pilot plant as insurance against the loss of invested capital.

For the complete design of the final plant, two types of data are needed—chemical and mechanical. For both types, the basic information and general requirements will have been obtained by laboratory research.

In the pilot plant the selection of the materials of construction is made. Numerous failures are expected, for one aim of the pilot plant is to experiment by using the various materials.

Process data are among the prime benefits of pilot plant operation, for variations in the chemistry of the process between small scale and large scale operation is often considerable. The limits of operating conditions, with the determination of optimum temperatures, pressures, and catalysts, are best ascertained in the pilot plant.

Among the process data established in the pilot plant are flow diagrams, material balances, heat balances, and raw material specifications. The flow diagram is of aid in the utilization of available space and the favorable placement of the series of operations with respect to one another.

Material and heat balances are necessary for the accurate knowledge of material and utility costs, conversions, yields, purity, and the by-products, each of which is a determining factor in the production cost and the market price of the finished product. Labor and utility costs, including steam, water, and power, are usually the most important running expenses of operation, usually being much higher than raw material costs. For this reason the efficient utilization of steam and water, the conservation of power, and the elimination of operations requiring labor are important factors in the lowering of costs.

Information concerning raw material and product markets is more easily gathered through pilot plant demands and output. It is usually necessary that a product be available in usable quantity before prospective buyers are able to make use of it and properly evaluate its merits. The moderate quantity output of pilot plant operation enables this evaluation to be done with the minimum investment risk.

The pilot plant is the most advantageous point in the process development to convert from laboratory batch operations to continuous methods. Both continuous processes and continuous series of operations may be best evaluated as to practicability and worth in the pilot plant. Also there is the necessity for long and careful trial of alternative starting materials and methods of synthesis in order to secure the highest yield consistent with lowest cost and the specified standards of purity.

The separation of either waste impurities or useful

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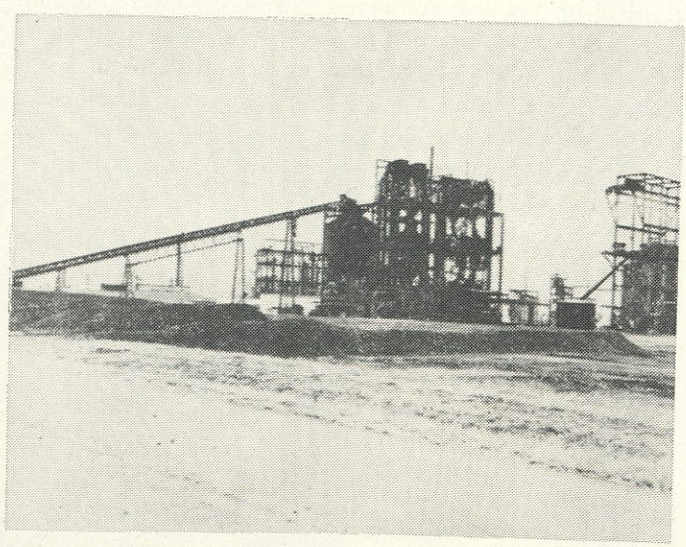
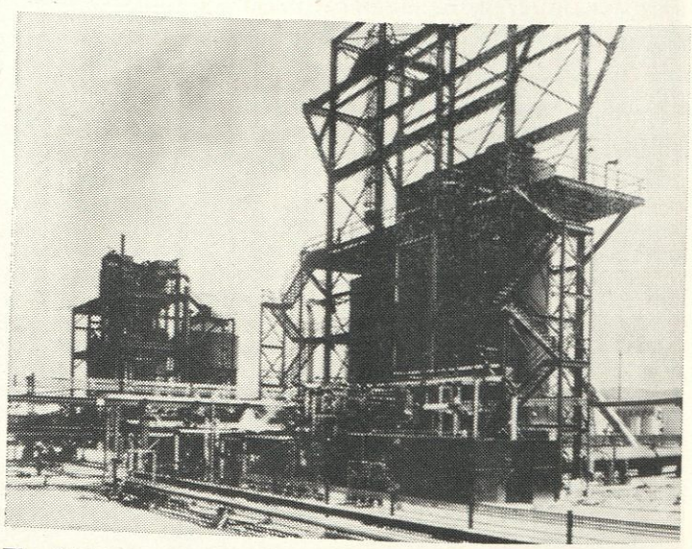


The coal handling and paste preparation building is the start of the Carbide coal hydrogenation process.

—Photos courtesy Carbide and Carbon Chemicals Co.



The high pressure structure contains equipment to convert the coal paste into hydrogenated liquid products and sends them to the coal-hydrogenation chemicals separation units and the recycle oil still.

CAMPUS NEWS

DR. WARD DARLEY

New C.U. President Named

Dr. Ward Darley, vice-president of the University and dean of the department of medicine, has been named president of the University of Colorado. Dr. Darley will assume his presidential duties July 1, the effective date of the resignation of President Robert L. Stearns. President Stearns, who has headed the University since 1939, is leaving to become president of the Boettcher foundation.

Born in Denver, Oct. 30, 1903, Dr. Darley attended elementary school near Monte Vista and graduated from North high school in Denver. He received his B.A. degree from the University of Colorado in 1926 and his M.D. in 1929. After his internship he engaged in private practice, teaching part time at the University medical school. In 1943 he became associate professor of medicine and a full time teacher. Named dean of the medical school in 1946, he became dean of the department of medicine and vice-president of the University in 1949.

Dr. Darley is president of the Association of American Medical Colleges. He is a fellow of the American College of Physicians, and is a member of the American Clinical and Climatological association, the American Heart association, the American Medical association, the Association of American Physicians, the American Rheumatism association, Phi Beta Kappa, Delta Sigma Rho, Alpha Omega Alpha, Phi Kappa Tau, and Sigma Xi.

He will continue to serve as director of the University's Denver medical center until he takes over in July as the seventh president of the University.

6,000° C or 30,000° C?

Finding the answer to that question about the sun's atmosphere is part of the job of the High Altitude Observatory of Harvard University and the University of Colorado. The laboratories and the shops of the observatory are situated on the Boulder campus of the University of Colorado, while the solar observatory is high in the "Rockies" near Climax, Colorado.

The question of the temperature of the chromosphere, the thin lower layer of the sun's atmosphere, finds solar scientists divided into two schools of thought: one holding that the temperature is probably about six-thousand degrees (the temperature of the surface of the sun) and the other that the temperature is more nearly thirty-thousand degrees centigrade. The High Altitude Observatory, with the approval of the Naval Research Laboratory, undertook to obtain data which would contribute to the solving of this mystery.

Since during an eclipse is the only time in which the study of the chromosphere is possible, the High Altitude Observatory and the Naval Research Laboratory decided to try for simultaneous optical and radio observations of the February, 1952, eclipse in Khartoum, Anglo-Egyptian Sudan. Although the total eclipse lasted only three minutes, the particular observations in which the High Altitude Obscervatory was interested were to take place in two brief periods of nine seconds each at the start and finish of the eclipse.

The object was to obtain as many photographs as possible in these nine second periods. Each exposure was to last three-tenths of a second, and the maximum time allowable for automatic resetting of the cameras was to be no longer than one-tenth of a second. Numerous mechanical methods were tested, but the extreme acceleration and rapid movement always resulted in torn film, stripping of gears, or other parts failures. The ultimate design eliminated all moving parts except shutters and film, the complete operation being accomplished by air pressure and vacuum. The heart of this power system was a battery of eight Lewyt vacuum cleaners which through an intricate, electronically controlled valving system, literally blew the shutters open and shut and the film through the film gate.

The days before the eclipse were filled with drama. With two weeks to go, the expedition leader, Dr. John

(Continued on page 56)

The Dean's Page

by C. L. ECKEL

On other occasions I have called attention to the tremendous contributions of the engineering profession to our national economy and to our standard of living. The engineering contributions to our national security and welfare as reflected by our defense program have been equally significant.

The Engineer and Society

Engineers are a prime essential in the development, direction, and management of both the nation's defense and its non-military industry. The scientist discovers some basic or fundamental law of nature but usually he is not interested in, or concerned about, the use of this principle for the betterment of mankind. In recent years the frontiers of science have been pushed back, and the engineer, in his effort to adapt scientific principles for the betterment of mankind, has never been so crowded and challenged as by these new discoveries in science. Because of these developments, especially those of the past decade, we are likely to think of ourselves as living at the peak of the technological age. It would undoubtedly be far closer to the truth to realize that we may be only approaching such a great climax.

The engineer's assignment in this civilization of ours is to apply the known principles of the so-called physical sciences in a creative manner for the good of society. In this function, engineering may have aspects of an art, a profession, a science, or even a business. Primarily, and usually, engineering is considered to be a profession, and in the College of Engineering we believe that our task is to educate for the engineering profession. Practical engineering training must come during a period of internship subsequent to graduation.

Early Engineering Training

Immediately after graduation, an engineering graduate usually enters some form of training program which involves duties such as analysis, testing, drafting or some other form of more or less routine work designed to acquaint the neophyte with the area of his probable future interest. After this period of internship, large numbers of engineering graduates enter the fields of research, development or design. Particularly in industries where engineering procedures are important, many find use for their engineering training in positions involving administration and management.

For years to come, young men and women who have the interest and aptitude for engineering are therefore likely to continue to find favorable job opportunities upon graduation. As a student in the College of Engineering, you have a wonderful opportunity to pass this word on to your friends, especially when you go home during vacation periods. You can also give your friends an opportunity to inspect the University's facilities for teaching engineering by inviting them to visit the campus on May 15 and 16 when we celebrate Engineers' Days.

Engineers' Days

You, as a student in the College of Engineering, will be host to your parents and friends on the occasion of the Engineering Open House. Invite your relatives and friends and then see that they visit all of our engineering departments.

Engineers' Days will be observed at the University on May 15 and 16, 1953. The exercises will start with the Engineering Honors Convocation at 10:50 A.M. on Friday, May 15th. The purpose of this convocation is to honor outstanding students in the College of Engineering. Although this convocation is primarily for engineering students; practicing engineers, parents, and friends are cordially invited to attend. A. E. Perlman, executive vice-president of the Denver and Rio Grande Railroad, and one of the leading railroad executives in the country, will be the principal speaker at this convocation.

Engineering Open House will be held on Friday evening, May 15 and on Saturday morning, May 16. On Friday evening, students of the College of Engineering will be hosts to parents and friends who live in Boulder or nearby communities and to their friends across the campus. Many of these cross-campus students can thus have an opportunity to broaden the base of their own education by visiting the College of Engineering.

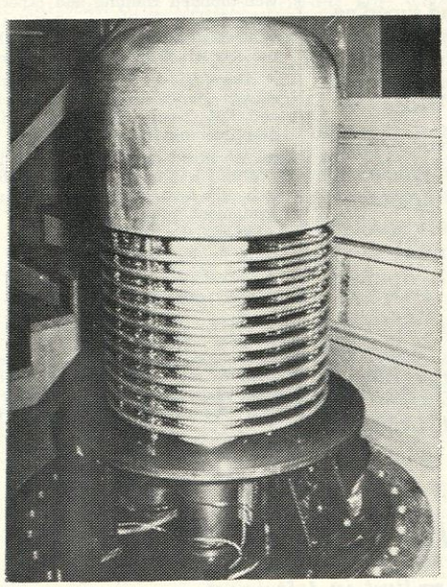
The Open House on Saturday morning is intended to give high school seniors and their parents an opportunity to become acquainted with the faculty of the College of Engineering and to know more about the University's facilities for teaching engineering. The new physics building will house some interesting exhibits and will be included in the tour of inspection. Many of our visitors may have questions about some branch of engineering or about one of the ROTC units on the campus. Members of the faculty and representatives of the Army, Navy, and Air Force ROTC units will be available and glad to be of assistance to our visitors. Urge your high school friends and their parents to visit the College of Engineering on May 16 as your guests.

The Van de Graaff Generator

By MARY T. FOLEY, E.Phys. '53

A high voltage electrostatic generator of the Van de Graaff type will be found in many large laboratories in which nuclear disintegration is being investigated, or in which a high voltage source for the production of X-rays is required. This generator, a practical means of producing high potential differences for the acceleration of atomic particles, is capable of producing potential differences up to 12 million volts. Its ability to provide continuous high intensity beams of monoenergetic particles has made it applicable to many fields. The accuracy with which the energies of these particles can be determined has made this machine of great advantage in nuclear research work. Other accelerators such as the betatron, cyclotron, and synchroton are capable of producing particles of much higher energy than the Van de Graaff is capable of producing. Particles with energies up to 300 million electron volts are available with these devices. Unfortunately, because of the cyclic nature of the acceleration, in these other accelerators, particles arrive in groups or pulses; and the energies of these particles cannot easily or accurately be determined.

The principles of this electrostatic generator are remarkably simple. A high potential is established between a conductor and ground by mechanically transporting charges and storing them on the outside of the conductor. The high potential terminal, a large hemispherical shell called a corona cap, is supported from ground by an insulating tower. Enclosed in this insulating column is an endless conveyor belt. At the ground end of the insulating tower, charges are sprayed onto the belt by an electric discharge maintained across two electrodes between which the belt passes. These charges which have been sprayed onto the belt are transported up into the corona cap. By a fundamental theorem of electrostatics, the charged belt inside the corona cap will always be at a higher potential than the cap. The charges, therefore, will pass readily from the belt to a series of metal points. The metal points are connected to the corona cap and the charges are transferred from the belt to the points in a discharge and then flow to the ouside of the cap. The potential which is built up is limited by two things: the breakdown potential of the air surrounding the corona cap, and the leakage current flowing down the column which, at equilibrium, must equal the charge carried up the column.



1 M.E.V. Van de Graaff Generator—the University hopes to acquire this in the near future.

Mary is from Denver, Colorado, 22 years old, and a senior in Engineering Physics. She is employed part time as a student trainee at the National Bureau of Standards Radio Propagation Laboratory. Mary, one of the fortunate few in the physics department who has no fear of being drafted, hopes to do Technical Editing after graduation.

Greater maximum potential can be effected through operation of the apparatus in a high vacuum or in air at pressures much greater than atmospheric. The difficulties of operating such a large apparatus in a high vacuum make operation in a vacuum impractical. It has been found practical, however, to operate the apparratus in air or other gases under high pressure. Modern installations of today utilize the insulating properties of gases of high dielectric strength and the properties of certain electro-negative gases. Electro-negative gases due to a deficiency in electrons, can, by attachment, convert free electrons into harmless negative ions. Freon and sulphur hexafloride having strengths nearly three times the dielectric strength of air, are the most widely used gases for the purpose of insulating electrostatic generators.

The particles for acceleration are produced in a small chamber at the high potential terminal. A small belt-driven generator, operated from the upper pulley of the charge belt, provides power for an electric discharge through the chamber. The chamber is filled with a gas which will produce the type of particles

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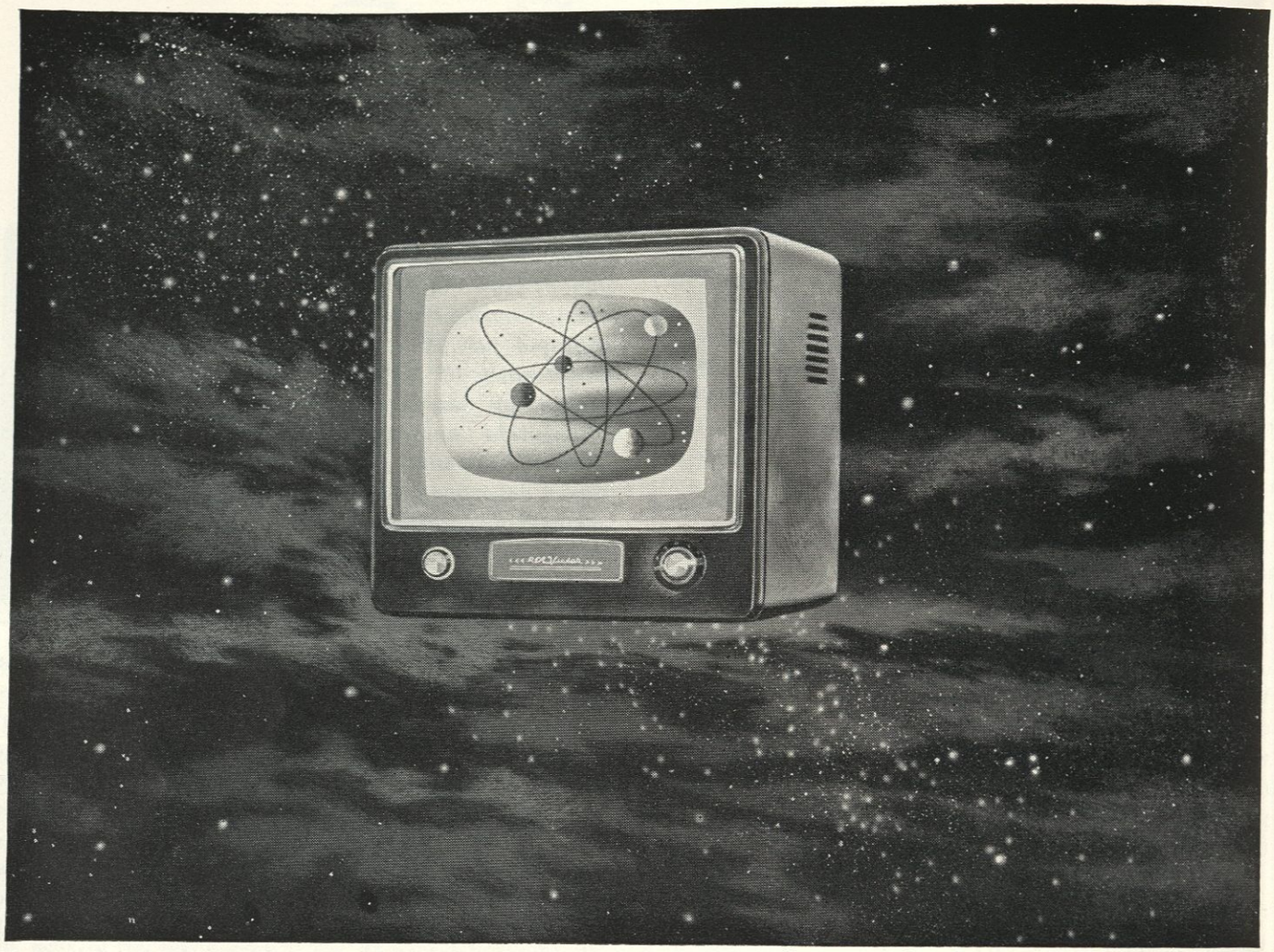

Basic research and engineering advances make RCA Victor's 1953 TV receivers the finest you can buy.

First with the major advances— since Television began!

Families living in television areas have seen from the beginning why more people buy RCA Victor television sets than any other brand. As television spreads to new communities, millions more learn the same.

Enthusiastic reception of the 1953 RCA Victor sets proves that advanced research and engineering means finer TV. You see it in the new "Magic Monitor" circuit system which *automatically* screens out interference, steps up power, tunes the best sound to the clearest picture.

Further proof of this leadership is the new RCA "Deep Image" picture tube with its micro-sharp electron beam and superfine phosphor screen which ensures the finest picture quality. It is also seen in reception at a distance—as well as in *automatic* tuning of all channels, both VHF and UHF.

Today's RCA Victor receivers result from the same research and engineering leadership that perfected the *kinescope* picture tube, the *image orthicon* TV cameras, reflection-free metal-shell picture tubes – and which opened UHF to television service.

* * *

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THIS TODAY

What Tomorrow?

LAST OF THE CORSAIRS

Corsair 12,571 was delivered to the Navy during January, closing out final production on a proud line of aircraft that is still flying and fighting after campaigning from Guadalcanal to Korea. No fighter in military history has been in first-line combat as long as the Corsair. Even though production has reached an end, the useful life of "old bent-wing" is far from over.

As recently as last summer new versions of the airplane, AU-1's, were reaching the fighting front. Now as a final guarantee that the "bent-wing birds" are long removed from the retired list, the latest and last of the Corsair models—the new F4U-7's—will be turned over to the French Navy.

The Japanese called them "whistling death" and, after the war, admitted they feared the Corsair more than any other aircraft. Corsairs had been the first American fighter to top 400 miles an hour, the first to house a 2,000 horsepower engine, and the first to out-perform the vaunted Japanese Zero.

To meet the constant demand for increasing performance and versatility during that time, a total of 981 major engineering changes and 20,000 production changes were incorporated in the various Corsair models between 1940 and the war's end. At the time of its design the outstanding fighter housed the world's most powerful engine swinging the world's largest propeller, a three-bladed type. The gull-wing, which was unmistakably to stamp the appearance of all F4U's, was used for many reasons. Aerodynamically, bending up the wings inboard of the landing gear made possible a right angle wing-fuselage intersection, keeping drag to a minimum. A long landing gear would have been required to give the huge prop enough ground clearance if a straight wing had been used. Also engineers wanted to retract the landing gear straight aft, as integral fuel tanks were in the wing. Because the plane was slated for carrier duty, it was limited on the folding height of the wing—an economy dictated by hangar deck restrictions.

Largely because of a stiff landing gear that made the prancing Corsairs bounce when they landed on a deck, the F4U's were ruled off the Navy's carriers until late in 1944, when this built-in bounce was eliminated.

Corsairs established an aerial combat victory ratio of more than eleven to one. They have also been credited with taking off from water without floats, going into combat with a crew of two in the single seat, shooting down an enemy plane without ever seeing it, and chewing the tail off of a Japanese photo plane with the propeller.

The old "U bird" will probably fill out its life span for the Navy and Marine Corps in the role of an attack plane. How long that span will be remains to be seen.

* * * *

SLICK

A super-smooth, dust-free surface is being sought by scientists at the General Electric Research Laboratory. The surface is needed for tests to determine why various insulating materials break down under high electric voltages. These invesigations require electrodes free from invisible bumps and the tiniest dust specks. One speck may cause the breakdown voltage to vary as much as 10,000 volts on successive tests.

The laboratory staff began their search by polishing stainless steel mechanically to a gloss that outshone highly-burnished silver and chrome. Particles of the polishing powder, much finer than the best tooth powder, measured only one-millionth of an inch in diameter. Even with meticulous polishing the steel was too uneven, so the scientists turned to liquids, choosing mercury as the most suitable. It proved an execllent electrode, with a surface smoother than highly-polished telescope reflectors, but the mercury surface also distorted under

(Continued on next page)

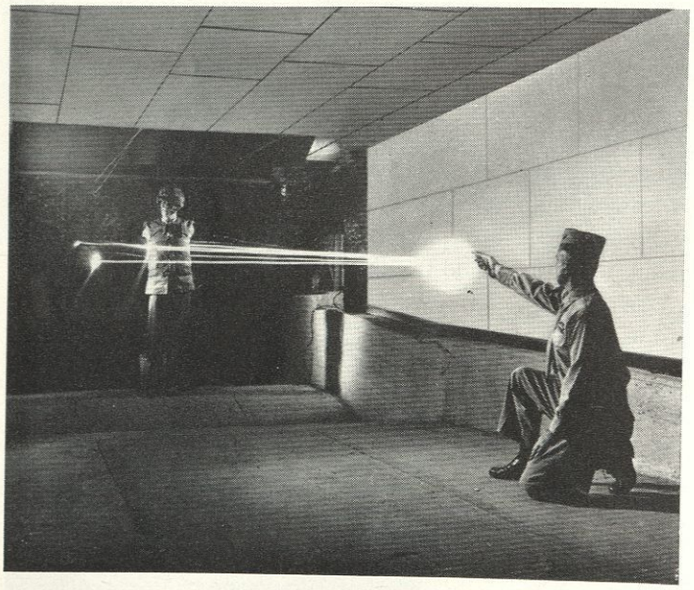
an electric field. Recently, the scientists turned to glass, as a near approximation of a liquid surface. Then they coated the glass with vaporized gold. The result—the smoothest surface found so far.

To make certain the surfaces remain clean during experiments, a laboratory staff member keeps constant watch through a miscroscope.

* * * *

MARINE CORPS BODY ARMOR

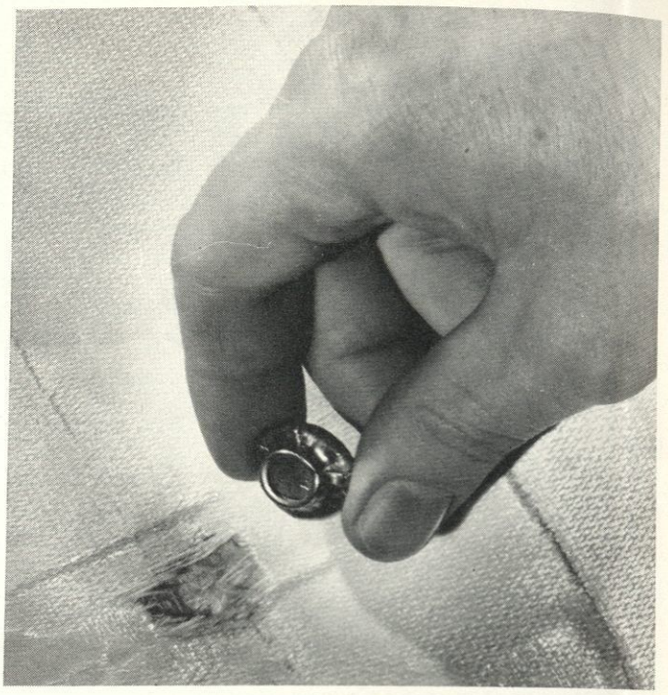
United States Marine Corps body armor—called "shrap jackets" by American fighting men—is being produced in quantity by the Westinghouse Corporation. The "shrap jackets" get their life-saving properties from three things—the way they are made, and their two basic ingredients, glass cloth and a synthetic resin. This combination enables the material, known as Doron, to actually stop deadly mortar and grenade fragments and similar low velocity missiles. When a fragment or a small caliber bullet strikes the material, the layers of impregnated glass cloth separate as the missile attempts to smash its way through. This delamination actually



Armor vest stops .45 caliber bullets.

sets up a cushioning effect that instantly reduces the velocity of the fragment to practically zero.

Doron has been in volume production for only two years but it has already won the confidence and gratitude of the thousands of American soldiers and marines who wear it for protection in the front lines. Reports indicate that the armor has been ninety to ninety-five per cent successful in preventing serious wounds of the torso. Early versions of the armored vests consisted of flat Doron plates. However, tests proved that the flat plates afforded less mobility so it is now curved to fit the contour of the body. The plates themselves, one-eight of an inch thick and five inches square, are sewn into the pockets of heavy nylon vests. About twenty



Mushroomed bullet is removed from plate which was badly dented, but had no holes in it.

plates go into each vest and overlap each other like fish scales.

Doron is made by applying heat and pressure to layers of resin-impregnated glass cloth. The layers are not pressed together tightly. If they were, the plates would lose some of their effectiveness against the missiles they are intended to stop. The present model weighs less than eight pounds.

* * * *

SUN-SEEKER

A precision instrument designed by University of Colorado scientists and mounted in the nose of a rocket traveling more than fifty miles above the earth has taken the first pictures of the sun's spectrum in the far ultra-violet regions. The rocket was fired from Holloman Research and Development Center, New Mexico.

Dr. W. B. Pietenpol, head of the University's department of physics and supervsior of the upper atmosphere research program, said that physicists at the University have been working on a sun-seeking device or pointing control for installation on high high altitude rockets for the past three years. An exceedingly complicated electronic and mechanical device, the sun-seeker has twenty-one photoelectric cells that peek from doors opened in the nose of the rocket as it climbs toward the atmosphere. Sunlight falling on the cells tells them just where the sun is located. They take note of this information and keep a spectrographic camera pointing straight at the sun, even though the rocket may be rolling. The instrument also had to be rugged enough to withstand high acceleration and operate satisfactorily so the film could be exposed. The first three Aerobee rockets sent up with this apparatus were failures (which surprised no one in the tricky rocket business).

The film, recovered undamaged from the wreckage of the rocket, showed a sharp spectrogram of the sun-

light taken at fifty miles altitude, above nearly all the atmosphere. The bulk of the ultra-violet was at just the place on the sun's spectrum where the scientists thought it would be: at 1,216 Angstroms.

It is a well-established fact that solar radiation is the cause of ionospheric layers in the upper atmosphere. These stratified concentrations of electrons can be observed by reflection of radio waves and are an important factor in radio propagation. The upper atmosphere absorbs highly the ultraviolet radiation from the sun and so gives rise to the ionosphere. The absorption of light in the extreme ultraviolet also has great meteorological significance. Ultraviolet energy heats the top of the atmosphere, causing air movements that affect the weather all over the world. The information also will be used in the study of the ionized air layers, which reflect many kinds of radio signals.

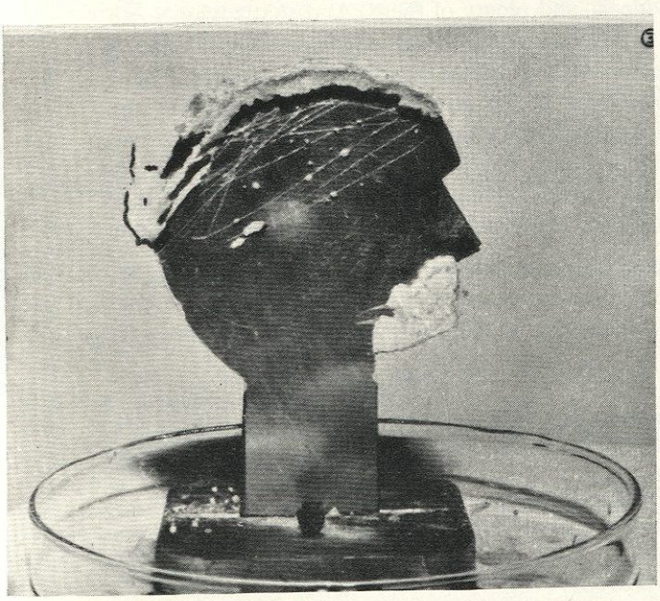
The normal eye is sensitive to light of wavelengths between red light, which is 7900 Angstrom units—about three hundred-thousandths of an inch—to extreme violet light at about 3,900 Angstrom units. Light of shorter wavelength in the ultraviolet may be observed by photographing by means of a spectrograph, or by certain types of electrical detectors. To detect light in the far ultraviolet, observations must be made at high altitudes where the radiations are not completely absorbed by the earth's atmosphere.

The sun-seeker itself will probably move into the guided-missile field. It can be made to measure the light that is emitted from lower levels of the atmosphere. By keeping headed toward this light, it can steer a high-flying missile on a steady horizontal course.

★ ★ ★ ★

ALUMINUM AL

Science has not yet discovered how to grow hair on a billiard ball, but chemists can grow a handsome head of white "hair" or a beard on "Aluminum Al," who is nothing more than a sheet of pure aluminum cut out in the shape of a man's head.

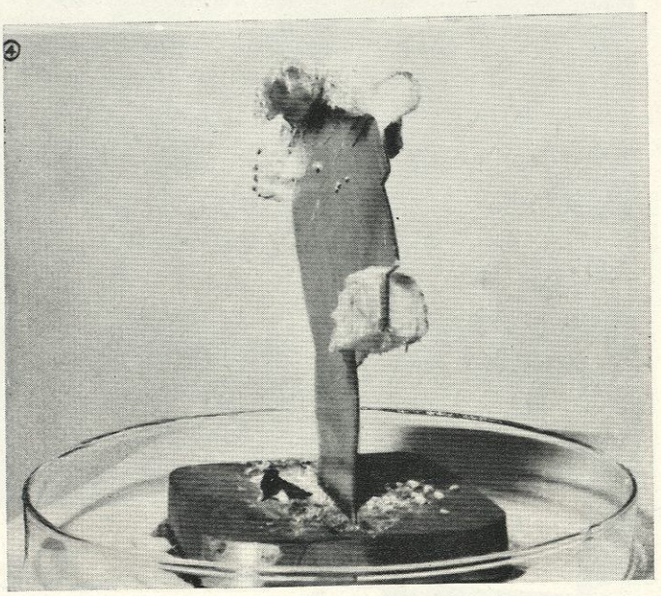


Actually, "Al's" hair is aluminum oxide, which forms in a moist atmosphere after the metal has been scratched while held under mercury.

Amusing though he is, "Al's" purpose is a serious one of helping to provide a better understanding of the most effective ways of using aluminum, which is replacing copper in many critical applications.

Aluminum is very active and could not be used were it not obliging enough to furnish its own protective coating. This is a thin film of aluminum oxide which forms immediately over a freshly-cut surface of exposed air. The film keeps air away and prevents further oxidation.

"Al" demonstrates a condition under which this does not occur. When the aluminum surface is scratched under mercury, the film does not form. Instead, the oxide sprouts out along the scratches in an uncontrolled hairlike growth.



2 + 3 = 6

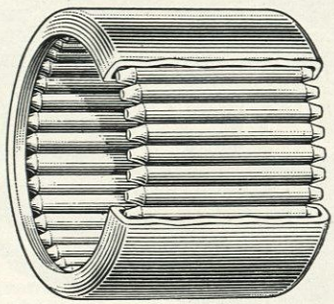
It may take you 180,000 times longer to solve a relatively simple arithmetic problem than it does General Electric's new electronic computer. That is the result of a small contest held in which half-a-dozen intelligent adults pitted their multiplication skills against "OARAC," the computer which will be delivered to the United States Air Force's Research and Development Command. "OARAC" completed, in four one-thousandths of a second, a problem which took an accountant four and one-half minutes, a secretary twelve minutes, and the engineer responsible for the design of "OARAC" five minutes.

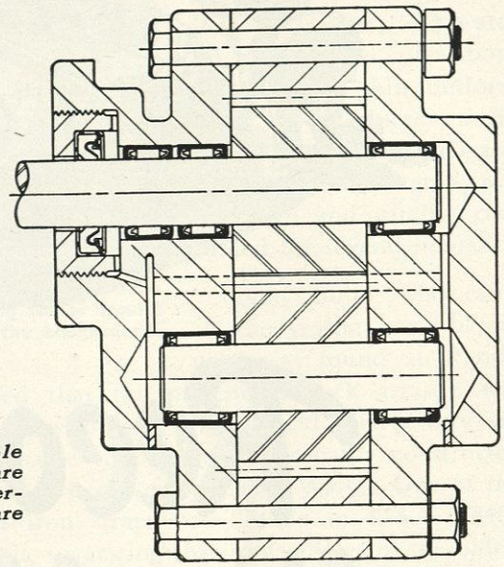
The new electronic computer has one of the largest "memories" yet incorporated in any computing device. The brain of the computer is a metalic drum which can hold pulses representing ten-thousand ten-decimal numbers on its magnetized surface until the numbers are called into use. "OARAC" can deliver rapid-fire answers in typewritten form to mathmatical puzzles which would take expert mathematicians years to solve.

The Torrington Needle Bearing

proper housing design is essential to proper performance

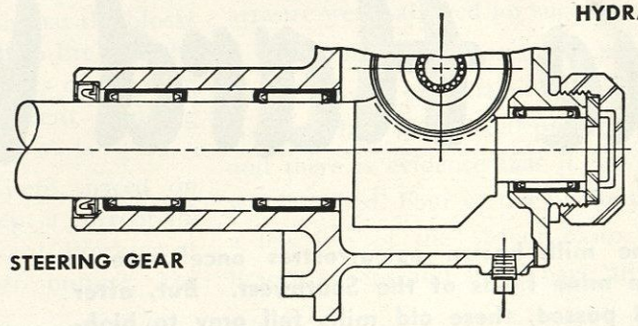
The Torrington Needle Bearing offers many design and operational advantages for a great variety of products and equipment. For example, a Needle Bearing has greater rated radial load capacity in relation to its outside diameter than any other type of anti-friction bearing. It is extremely light in weight. And it is easy to install and lubricate.





HYDRAULIC PUMP

Needle Bearings require simple housings. If the housing bores are held to proper size, accurate operation and high radial capacity are assured.



STEERING GEAR

Housing Maintains Bearing Roundness

The housing is an essential part of the Needle Bearing assembly. Care should be taken to provide a straight, round housing bore to the recommended tolerances.

The thin, surface-hardened outer shell of the Needle Bearing acts as the outer race surface as well as a retainer for the rolls. This shell assumes the shape of the housing into which it is pressed. Consequently, the housing bore should be round, and the housing so designed that it will carry the radial load imposed on the bearing without distortion.

Housing Material Determines Bore Size

The specified housing bore dimensions for any given material should be maintained in order to give the proper running clearance between the needle rollers and the shaft, and to assure sufficient press fit to locate the bearing firmly.

When designing housings of materials that are soft or of low tensile strength, allowance should be made for the plastic flow of the material when the bearing is pressed into place. Bore dimensions in such cases should be less than standard. Needle Bearings can be pressed directly into phenolic or rubber compounds, although metal inserts are recommended.

The new Needle Bearing catalog will be sent on request.

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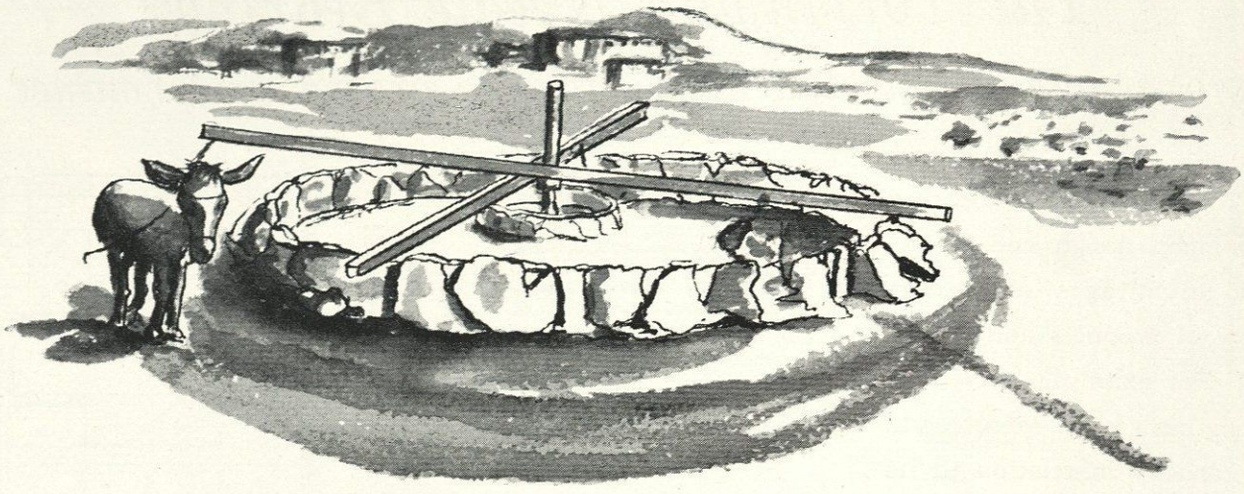


Recovering Gold the Hard Way

Rude drag-stone mills known as arrastres once were a familiar sight in the mine fields of the Southwest. But, after their usefulness had passed, these old mills fell prey to high-graders who dismantled their machinery and swept the stone basins clean of escaped gold dust.

By POWELL AND EDNA JENKINS
Photographs by the authors

REPRINTED FROM DECO TREFOIL

Three hundred fifty years ago, a burro plodded around a 30-foot circle, drawing a weathered wooden sweep around with him. The sweep operated a grinding mill, and the prospectors who fed ore to be pulverized under its revolving stones were as excited as the burro was indifferent.

The first of these mills was built 350 years ago in barren Mexico and was given the name, arrastre. In 1850 arrastres appeared in Grass Valley, California, and as early as 1855 they had become important to miners throughout the Southwest. During the years they were used, their circular basis ground out a large proportion of the world's silver and much gold.

Then, by the 1920's, they were gone.

There might be many yet in the desert, but someone too smart for future historians' benefit realized that between the paving blocks of those bandoned arrastres lay escaped trickles of gold. So, for $50 or $100 worth of dust, the mills were uprooted, the stones flung about and the wooden sweeps chopped to warm a can of beans.

In spite of the pessimistic observation of one modern historian who said, "There were some (arrastres) to be found as late as the 1920's," several still stand today in moderately good condition on the Mojave Desert.

One is at Garlock, California, hardly 100 feet from a paved highway and only a few miles from Last Chance Canyon, a site familiar to rockhounds. Its fortunate survival is the result of factors which, at the time, must have seemed decidedly unfortunate. It was built after a prospector picked up a handful of ore flecked with gold. Unfortunately the ore pocket soon pinched out

and the mill never was used enough for any amalgam to filter down between the paving rocks. This saved it from later high-graders. It remains now very much as it was left, minus a few of the more portable parts, carried off by souvenir hunters.

Arrastre at Garlock, California. The vertical sluiceway in the near wall controlled the flow of thin mud, and the four wooden arms below the bevel gears dragged the grinding stones around on the pavement inside. Ruins of Garlock in the background.

The Garlock arrastre is so typical it might serve as a textbook illustration of a drag-stone mill. It has a stone and cement basin 13½ feet across inside and two feet deep. Wooden arms pulled heavy granite blocks around on the flat pavement inside. The blocks are still there, complete with thick iron eyes wedged with wood into holes in the stones. Some of the tow chains remain attached. The blocks, the paving and the walls are scoured smooth, and circular scratches indicate the path of the cumbersome grinding stones.

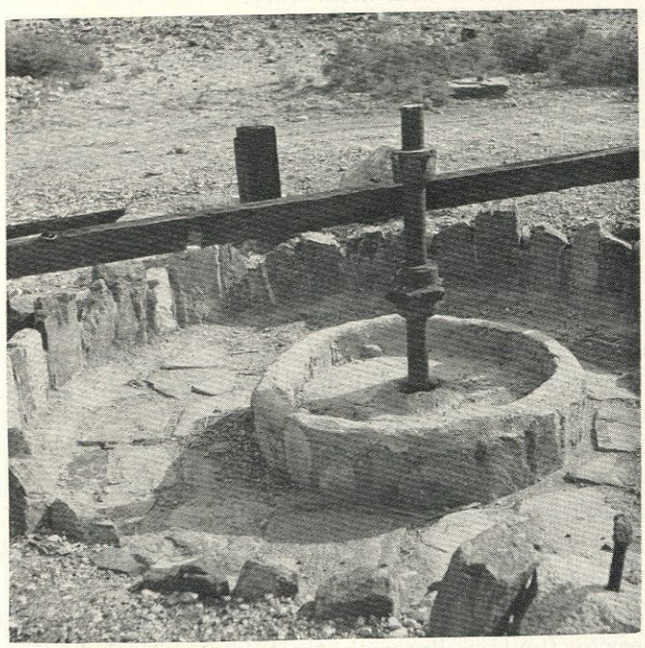
The eyes in the stones were placed so that the blocks slid on the largest plane side and tended to lift over the small, hard pieces of ore. The front edges of the drag stones were rounded also to aid efficient grinding action.

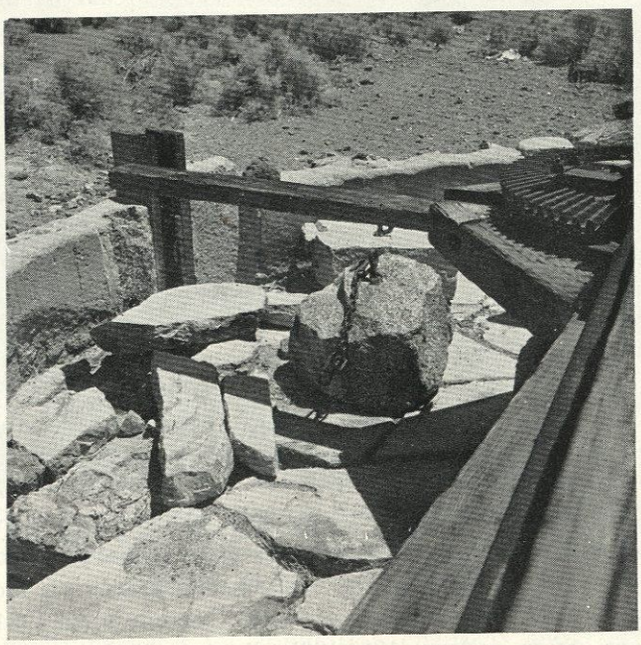
The drag-stone chains generally were spaced on the wooden arms so that one stone swept a current inward and the following one swept outward. Working at from four to a dozen revolutions per minute, the stones might have lasted a couple of months; the pavement itself commonly did not last more than twice that long.

Ore was fed in a little at a time, in pieces ¾ of an inch or smaller, and water was added until, after about six hours, a thin uniform mud was produced. Sufficient mercury to amalgamate all the free gold was mixed in, and grinding continued for several hours.

Finley Buhn, who came to the region even before gold was found at Randsburg, guessed that the present Garlock arrastre was built about 20 years ago. There had been a very old one on the same site, however, probably constructed when gold was discovered in Goler Wash. One of the handworked iron straps has "Made in U.S.A. 1840" stamped on it, suggesting that some pieces of the oldest arrastre were salvaged for successive constructions.

Another easily accessible arrastre stands today in the south end of Panamint Valley seven miles south of Ballarat. It is not as well preserved as the one at Goler, and there is evidence that it has been rebuilt since it was last used. Four or five of the drag-stones are within a few feet of the 12-foot basin, but the drag arms, braces, sweeps and sluice have all vanished.





Little more than the paving remains of this arrastre in Panamint Valley, left. There is evidence it was rebuilt after last being used. Right, although some rocks have been torn up, the pavement in Garlock arrastre remains almost as level as the day it was laid. Heavy granite dragstones lie beneath the wooden arms which pulled them around. Several tow chains still are attached to iron eyes firmly pegged into the stones.

ALUMNI

1911

GEORGE MATTHEWS, B.S. (E.E.), is now comptroller and business manager for the Emma Willard School, Troy, New York. He was formerly with the Niagara Mohawk Power Corporation in Troy.

1914

JOSEPH L. GIGER, B.S. (E.E.), is a construction engineer in the engineering distribution department of the Public Service Co. in Denver. He has been with Public Service since 1929. After graduation he worked for the Western Light and Power Co. in Boulder for three years before serving in the Army during World War I. After the war he worked for the American Smelting and Refining Company and the New Light and Power Company before joining Public Service.

1921

KENYON C. VAIL, B.S. (Ch.E.), is now in Turkey helping to build a modern road system as part of our Marshall Plan aid to Turkey. He is one of several University of Colorado engineering college graduates who are in Turkey working for the mutual security agency.

1924

NEIL P. BAILEY, B.S. (M.E.), Russell Sage professor of mechanical engineering and head of the department at Rensselaer Polytechnic Institute, has been awarded the Melville Prize Medal by the American Society of Mechanical Engineers at their 1952 meeting. The medal was presented to Professor Bailey in recognition of an original paper of exceptional merit that the presented before the society. The paper, "Flow and Combustion Stability," is one of a number of articles that have been written by him since his graduation. He has also written several textbooks and has contributed to Kent's *Mechanical Engineers' Handbook*. After graduation he took the General Electric test and advanced engineering courses. From 1925 to 1929 he was engaged in teaching in the mechanical engineering department at the University of Idaho, where he received his M.S. degree in 1927. During summer vacations he did plant-design work for the Washington Water Power Co., Spokane, Wash. Since 1929, he has taught mechanical engineering successively at the University of North Carolina until 1934, Iowa State college, 1934-1935, Rutgers University to 1942, and Rensselaer since 1944. He engaged in research on flow and combustion for General Electric from 1942-1944.

1926

G. ELBERT MESSER, B.S. (E.E.), is working for the General Electric Company in Kansas City, Mo. He is the apparatus marketing division regional manager.

1927

RALPH E. PECK, B.S. (C.E.), C.E. 1942, M.S. (C.E.) 1948, formerly with the U. S. Bureau of Reclamation, is now chief engineer for the Heron Engineering Company, Denver. In 1946 he copyrighted a rule which is used for designing reinforced concrete beams. He specializes in designing ski lifts. Among the structures he has designed is the dome of the new Sommers observatory of the University of Colorado.

1928

RALPH P. AGNEW, B.S. (C.E.), is now with the mutual security agency helping to build a modern road system in Turkey.

CONSTANT MARKS, B.S. (C.E.), is now vice-president of the Ambursen Engineering Corporation, Houston, Texas. He was formerly chief design engineer.

1930

WILLIAM J. DOWIS, B.S. (E.E.), manager of the design and planning division of General Electric's Hanford Works, was the guest speaker at the January 8 meeting of the American Institute of Chemical Engineers student chapter. He spoke on "The Aspects of Chemical Engineering in the Nucleonics Field." After graduation Mr. Davis was employed by the U. S. Bureau of Reclamation in Denver. Later he joined General Electric and has been with them since.

1932

WILLIAM E. DRINKARD, B.S. (M.E.), has been appointed assistant chief engineer of the engine department of the Chrysler Corporation's engineering division in Detroit, Mich. His new job will be to head laboratory work in engine development and testing.

WILFRED A. LYALL, B.S. (E.E.), is an engineer for General Electric in Pittsfield, Mass.

1936

THOMAS G. MORRISSEY, B.S. (E.E.), a Denver television consultant, was one of the speakers at the Colorado Society of Engineers' annual convention held in Denver, January 22-24.

1937

MELVIN E. CLARK, B.S. (Ch.E.), has been promoted to general manager of product sales, Michigan alkali division, Wyandotte Chemical Corporation, Wyandotte, Mich.

ARNOLD A. BOETTCHER, M.S. (M.E.), an engineer for the U. S. Bureau of Reclamation in Washington, D. C., was a recent Boulder visitor.

1939

WILLIAM F. FRANK, B.S. (C.E.), a lieutenant

NEWS

colonel in the U. S. Marine Corps, is presently on duty with the department of the Navy office of the Chief of Naval Operations, Washington, D. C.

ARTHUR V. WILLIAMSON, B.S. (C.E.), is head of the road group that is now helping Turkey to build a modern road system. He has been in Turkey since August, 1951 and will return to the United States in August, 1953. He reports that he is enjoying his stay in Turkey, is learning many things about Turkey, and is seeing many interesting places. He adds that there is room for much improvement in Turkey and if some of the more restrictive laws and regulations are removed, he believes that the country will show considerable growth in the next ten or twenty years.

1940

CHARLES W. BURRELL, B.S. (E.E.), has been promoted to division supervisor with Sandia in Albuquerque, N. M. After graduation he joined the Public Service Company of Colorado as a junior electric distribution engineer. After a year with Public Service he joined the Mountain States Telephone and Telegraph Company. Twelve months later he went into the Navy where he served for four years. Upon discharge he returned to the telephone company as a communications power engineer. In 1951, after six months there, he went to Sandia.

1942

GEORGE W. RODGERS, B.S. (E.E.), is with Sandia in Albuquerque, N. M. He was recently promoted to division supervisor. He joined Sandia in 1948 after two years with Westinghouse Electric Company, Bloomfield, N. J., where he was assistant engineer in the design and development section of high-powered radio tubes. Prior to working for Westinghouse he served four years in the U. S. Army.

1943

JACQUES W. CURWEN, B.S. (C.E.), has been promoted to supervisor of structural engineers for the Girdler Corporation in Louisville, Ky. He is also the proud father of a daughter born October 18, 1952.

1944

L. JACK KABELL, B.S. (E.E.), an employee of Sandia in Albuquerque, has been with the Bell Laboratories where he has been studying the new electronic invention which is called the "transistor." Before joining Sandia in 1947, he was with Majestic Radio and Television Company, Elkin, Ill.

WARREN D. TILTON, B.S. (E.E.), M.S. (E.E.) 1949, an employee of the Hathaway Instrument Company since 1946, is presently the engineer in charge of the electronics division of the Hathaway Research and Development laboratory. He served in World War II as a signal corps radar and telephone operator, spending 10 months in special training at the radar school at the Massachusetts Institute of Technology.

1945

Two 1945 graduates have recently been awarded the Charles A. Coffin Award—the highest honor the General Electric Company can pay an employee—for engineering work of "outstanding merit" during 1952. They are JACKSON F. FULLER, B.S. (E.E.), an electric utility application engineer with General Electric in Denver, and JOHN M. ROBERTS, B.S. (M.E.), M.S. (M.E.) 1949, a mechanical engineer in the nucleonic division at General Electric's Hanford Works. The award, named after General Electric's first president, is recognized by industry as a unique way to honor employees for outstanding accomplishments beyond their normal line of work. Since 1923, when the awards were established, a total of 1,013 General Electric employees have received the award. This year, the company bestowed 40 awards.

Fuller received the award for many outstanding contributions to the electrical art, but the focal point of the honor was his development of a portable d.c. network analyzer. He is shown with the analyzer in the accompanying picture. The citation for the award read: For his sound engineering and practical ingenuity in developing and constructing portable network analyzers for studying power systems. These analyzers are efficient time-savers for application engineers and power system engineers." Upon graduation from the University, Fuller immediately went to work for General

Coffin Award Winner, Jackson F. Fuller explains some of the finer points of his d.c. network analyzer to General Electric's Rocky Mountain District Engineer John L. Bauer, B.S. (E.E.), 1938, and District Manager L. M. Stauffer.

—Photo courtesy General Electric

(Continued on page 40)

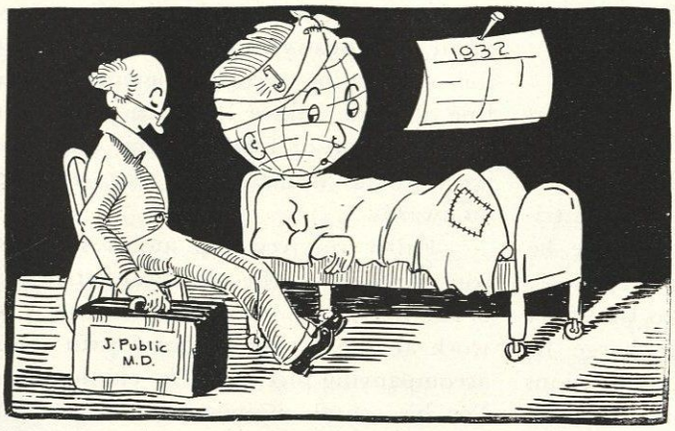
Editors' Page

The Cycle of a Headache

Shown on this page are two cartoons which were used in the March 1932 issue of the **Colorado Engineer.** These cartoons, depicting the political situation twenty-one years ago, are just as applicable today.

During the interim, the world has gone through depression and inflation, war and peace, and has ushered in the era of atomic energy. Still, having experienced all of this it is again sick and unchanged — with the "Red" head screaming his venemous doctrine.

The world passed through a crisis, and thought it was cured. Is it now suffering a relapse?—**h.h.h. jr.**



This old world has a big headache.

Katie's Korner

This small portion of the magazine is directed to that select group of brave females who have dared to enroll in the college of engineering.

You are to be commended for your choice of a way to get a degree of Mrs. You can, of course, in any event, always be a career woman provided that you don't flunk out.

We want you to know you are not alone in having a feeling of being disappointed because you are not the only female in an engineering college, thus losing the chance of becoming famous through an article in a national magazine — but do not give up hope — just have patience; you may be the only one left yet!

By the way if you have not yet set up your dating bureau, do so immediately! You cant' overlook a chance such as this to get even with your enemies.

Is your boy-friend still waiting for that pair of arguyles for Valentine's day? They can be finished in a matter of two or three lectures, besides, balls of yarn rolling down the aisle and the clicking of knitting needles are good diversion for the rest of the class. If the boy next to you is bored, ask him to find the amount of tension the toe and heel of the sock will withstand. At least it's something different in the way of a problem.

Do you need extra money? Sell window space on the second floor of Ketchum, south side, to your girlfriends — eyeball the eyeballers!

Evidently the women engineers are on their toes. Not one of them has even been under consideration for an oil can contribution. Can it be possible that you do not make faux pas, or are you paying blackmail money?

Have you heard about the club strictly for women architects and engineers, reorganized under the sponsorship of Mr. Tovanni? This is an opportuinty to get to know the other girls in the engineering college. Further details about this organization can be found in the societies section of this magazine.

If you have any complaints, comments, additions, questions, or anything else— please address all letters to Katie, **Colorado Engineer** office.

BOOK REVIEWS

Statically Indeterminate Structures

By Dr. Chu Kia Wang, Associate Professor of Civil Engineering, University of Colorado. First Edition. Pub. by McGraw-Hill Book Co., 424 pp., $7.50.

A new book in the field of statically indetermine structures has been published this year. This book, *Statically Indeterminate Structures* written by Dr. Chu Kia Wang, is recognized as one of the best in the field of structures. The text was written with a great deal of thought with regard to the problems encountered by the structural student and gives a clear, logical treatment of the subject.

In his book, Dr. Wang gives thorough coverage to the defelection of such structures as beams, rigid frames, and trusses. Dr. Wang analyzes the above mentioned structures by the method of consistent deformation, the three-moment equation, the slope-deflection and moment-distribution methods, and the method of column analogy. He also discusses the analysis of fixed arches, secondary stresses in trusses with rigid joints, and composite structures. These methods are amply covered by illustrative problems throughout the text. The answers to all of the exercises are supplied as a help to the student.

The author has introduced new and original methods of finding truss deflections and checking the problems of moment distribution involving side sway. The material pertaining to the method of column analogy is presented in a new and different way.

This book will prove to be invaluable not only to the student majoring in structural engineering, but will also be of value to the practicing engineer. Any person dealing with statically indeterminate structures will find this book worthwhile for use as a quick and accurate reference.

The civil engineering department of the University of Colorado is very fortunate in having Dr. Wang on its staff as an associate professor. The students at the University have been using this book for several years in three paper bound editions, but they are now able to obtain this text entirely in one volume.

Writing the Technical Report

By J. Raleigh Nelson, Professor Emeritus of English in the College of Engineering, University of Michigan. Third Edition. Pub. by McGraw-Hill Book Co., 356 pp., $4.50.

Professor Nelson is probably one of the best qualified men to write a handbook on technical reports. He started publishing material on this subject when there was a great need for definite standards to be established for reports. Because of this history, his book carries weight, though we doubt that this book justifies the notation "Third Edition," since there are so few changes over the preceding edition.

For a student or engineer desiring a book which will teach him conservative, useful styles of writing technical reports, this book is a practical answer for his needs. The text tends to be turgid, however, and the organization of the material makes pinpointing a definite subject difficult.

Direct-Current Machinery

By Charles S. Siskind, Assistant Professor of Electrical Engineering, Purdue University. First Edition. Pub. by McGraw-Hill Book Co., 319 pp., $6.00.

This book is particularly adapted for use in a one semester d.c. machinery course. It presents a clear, up-to-date summary of fundamental theories of generators and motor operation, uses of auxiliary and control equipment, applications of d.c. devices and machines, and the development of many of the specialized machines now in use.

This text is written clearly and understandingly for the student. Every topic is carefully discussed in terms of fundamental principles and its applications to present-day practices. Sketches and wiring diagrams are given special treatment, with emphasis on the arrangement of machine and circuit elements and simplification of complex wiring circuits.

Principles of Radar

By members of the Massachusetts Institute of Technology Radar School Staff. Third Edition by J. Francis Reintjes and Godfrey T. Coate. Pub. by Mc-Graw-Hill Book Co., 985 pp., $7.75.

A thorough revision and extension of what has become a standard reference, this third edition includes a chapter of radio-frequency transmitting and receiving systems. Beginning with basic principles and basic circuits, the book progresses through typical radar systems, with ample illustrations throughout.

Structure of Metals

By Charles S. Barrett, Professor, Institute for the Study of Metals, University of Chicago. Second Edition. Pub. by McGraw-Hill Book Co., 661 pp., $10.00.

In the second edition of his book, Dr. Barrett has extensively revised and expanded the material to bring it abreast with current theories, methods, and techniques. He has added discussions of many recent advancements in the field of crystallography while retaining the same general plan of the previous edition.

This book should continue to serve as an excellent text for graduate courses in crystallography and for advanced undergraduate courses in applied X-rays, crystallography, and physical metallurgy. It is also a valuable up-to-date reference book.

it's 1958 today!

...in jet engine design

As far as our engineers are concerned 1953 started 5 years ago. Today they are designing and developing dependable engines for the aircraft of 1958 or later. They are working on more powerful jet engines . . . even on a nuclear engine.

This kind of engineering in advance of the calendar has made Pratt & Whitney Aircraft the world leader in flying engines.

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Highways To Achievement

SOCIETY OF WOMEN ARCHITECTS AND ENGINEERS

The newly reorganized Society of Women Architects and Engineers held its first meeting on Thursday, February 12, in room 134 Ketchum. Future meetings will be held in the same place. Officers have not yet been elected.

The group and its sponsor, Mr. Tovanni, discussed problems and planned activities that are of particular interest to women architects and engineers. The activities will include field trips, movies and speakers. Among the speakers will be graduate women engineers and architects, several of whom are past members of the society.

The society was reorganized with the idea of giving social, educational and service activities to its members. Other aims of the society include the encouraging of women high school graduates to enter the field of enginering and to give moral support to those already in engineering.

ALPHA CHI SIGMA

Alpha Chi Sigma is a professional chemical fraternity with 56 collegiate and 29 professional chapters. It is a charter member of the Professional Interfraternity Conference which is an association of thirty of the country's leading professional fraternities. Associated with the National Safety Council and the American Association for the Advancement of Science, Alpha Chi Sigma has initiated over 25,000 men since it was founded at the University of Wisconsin on December 11, 1902.

Nationally the fraternity supports two major activities: a national safety program aimed toward accident prevention in chemical laboratories, and the American Chemical Society Award in Pure Chemistry to which it gives financial backing.

Eta chapter, University of Colorado, was founded in 1908 and since that time has initiated over 620 men. Because of the prominence of the fraternity, most of the outstanding chemical graduates from the University are members of the fraternity. Eta chapter has scheduled several activities for the spring semester. Two of these activities will be open meetings. All chemical engineers and chemistry majors are cordially invited to attend these meetings.

ETA KAPPA NU

Colorado Rho chapter of Eta Kappa Nu held initiation ceremonies on January 18. The new initiates include the following junior and senior electrical engineering students: Herman J. Bauer, Richard T. Behrendt, David W. Braudway, Thomas E. Connor, Jr., Lee W. Forker, E. Joseph Gozzi, George N. Halpin, Ralph W. Kelley, Ernest P. Moore, Richard Palmer, Russell Riley, Melvin Schauerman, and Robert G. Williams.

Following the initiation a banquet was held at The Alps lodge in Boulder Canyon. Featured speaker for the evening was Professor Thomas L. Hansen, head of the department of architecture and architectural engineering at the University of Colorado. His entertaining and enlightening talk concerned the design and planning of the recently built University of Mexico.

M. E. S.

On February 16, R. M. Schafer presented a talk on "Automatic Transmissions and Torque Converters" to a combined meeting of A.S.M.E. and S.A.E. in the physics lecture hall. Mr. Schaefer graduated from the University of Munich in 1926 with an M.E. degree. After working for the Federal Motor Truck company of Detroit, he transferred to Hercules Motors in Canton, Ohio. He then went to work for Ewin-Disc Clutch company where he was in charge of the torque converter program. During the war, he was connected with the automatic transmission program for General Motors which was building transmissions for light and medium tanks and tank destroyers. At the present time he is manager of the transmission department at the Allison Division of General Motors. After the talk, refreshments were served.

PI TAU SIGMA

The national mechanical engineering honorary, Pi Tau Sigma, held its fall initiation banquet on January 11 at the Brass Lantern. Ninety-four actives, pledges, faculty members, wives and dates attended.

Seventeen new members were honored, including: David Blanchard, Cloman Bogart, Bondi Brown, Virgil Burks, Jr., Jerome Cohen, Ronald Grenda, Pritpal Grewal, Wilber Grisham, Fred Grometer, James Kidd, Leif Lömo, David McCutchan, Harry Mulliken, James Polosky, John Reiva, William Selby, and Richard Simmons.

(Continued on page 36)

Engineers' Ball

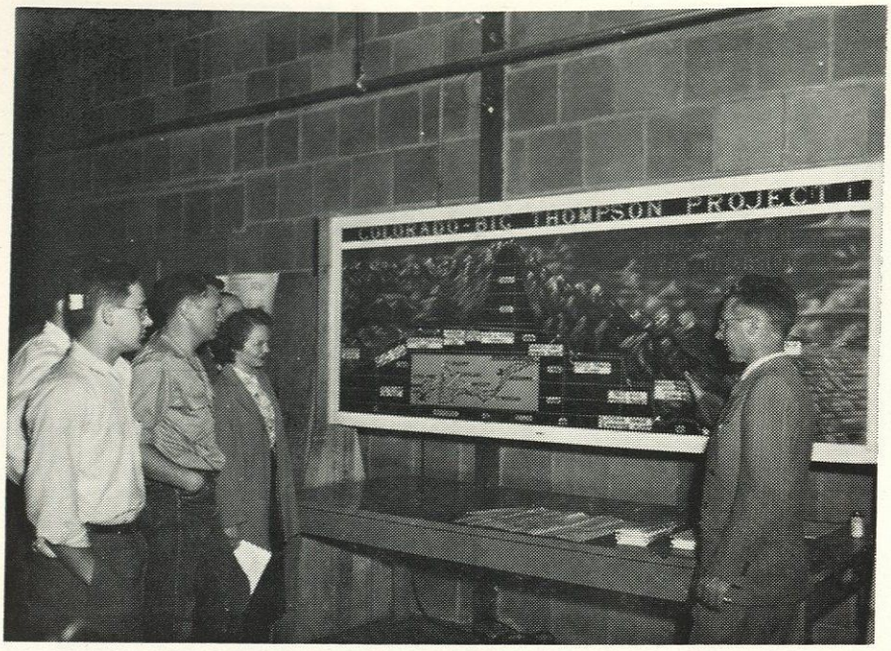
On the night of St. Valentine's Day Engineers put aside their slide rules, and held a dance which was one of the outstanding affairs of the year. The theme of the Ball was Sweetheart Fantasy. The men's gym was lavishly decorated in honor of the occasion. Coronation of Queen Harriet Schwartz was performed by last year's Queen, Sue Tresh, shown presenting the crown to her successor in the picture at the left.

Below, the queen finalists — Nancy Nelson, Barbara Bethune, Joyce Converse, Shirley Arnott, and Harriet Schwartz are in the mechanical engineering laboratory.

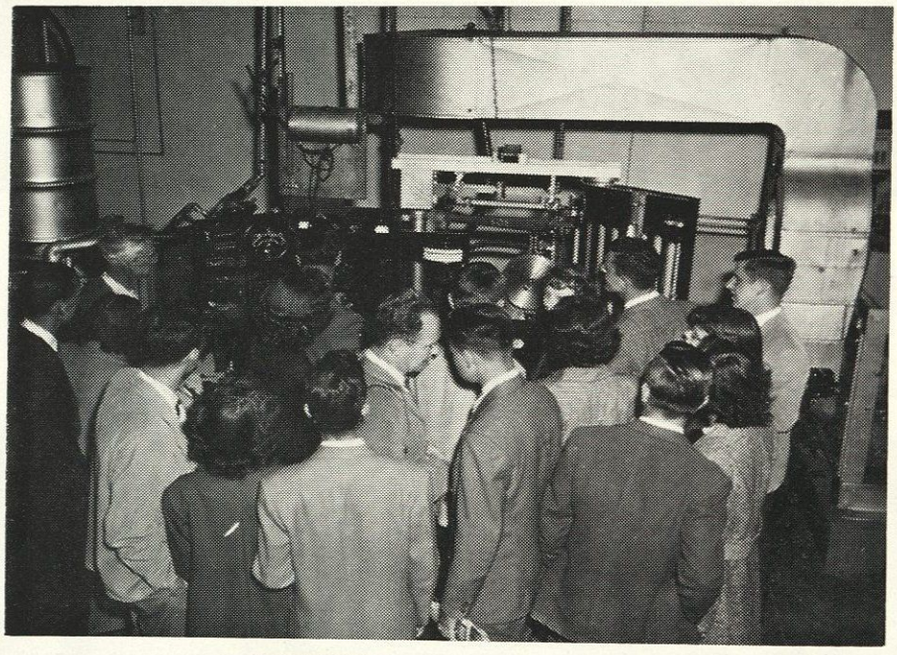
Photos by Ray DeArgon

Part of the "Sweetheart Fantasy" crowd as seen from the bandstand.

The queen and her court after receiving gifts and flowers at the Ball. Left to right: Barbara Bethune, Joyce Converse, Queen Harriet Schwartz, Shirley Arnott, Nancy Nelson.



ENGINEERS' DAYS



Engineers' Days this year will be May 15 and 16. Pictures of some of the outstanding departmental exhibits are shown on these two pages. The upper picture is a Civil Engineering exhibit showing the Big Thompson Project. In the center is shown a Mechanical Engineering exhibit of a dynamometer test on a Diesel Engine. A miniature railroad is shown on the bottom of the page. This was a Civil Engineering demonstration. This year's Engineers' Days promises to be a real success.

Photos—University Photo Dept.

Top: This is the Architectural Engineers' display. The Architectural Department is the newest addition to the College of Engineering. This is a scale model of a modern airport.

Bottom: This is the Civil Engineers' display. Shown, is a model of the Broomfield clover leaf. A student is describing its function.

CYBERNETICS— *The Newest Science*

By ARNOLD GASSAN, E.Phys. '56

CONTROL AND COMMUNICATION IN THE ANIMAL AND THE MACHINE

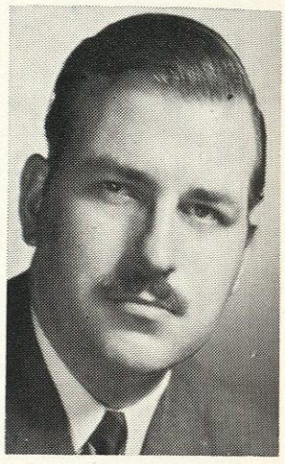
A group of men sat around a table after dinner. They discussed any scientific idea that came to mind. There was no standing on dignity or on professional reputation—and most of the men had names well known in scientific circles—for if an incomplete idea, a half-baked notion, were brought forth, it would be torn apart and handed back to its creator with a smile.

Out of such a series of discussions, informal yet intense, grew the roots of cybernetics, the newest science, whose eventual fruit may easily have more effect on your life than nuclear physics.

1

What is cybernetics? What does the name mean? To answer these questions, let's go back to the discussions around the dinner table. Two of the men involved were Dr. Norbert Wiener, of M.I.T., and Dr. Arturo Rosenbuleth, then of the Harvard Medical School. Old friends, they had for many years shared the conviction that the most fruitful areas for the growth of the sciences were those which had been neglected as a no-man's land between the various established fields. In his first published book concerened with the new science, Wiener points out that since Leibniz there has been no man with a full command of the *sciences*, of all the intellectual activity of the day.[1] Wiener says, "A man may be a topologist or an accoustician or a coleopterist. He will be filled with the jargon of his field, and will know all its literature, and all its ramifications, but, more frequently than not, he will regard the next subject as something belonging to his colleague three doors down the corridor, and will consider an interest in it on his own part as an unwarrantable breach of privacy."[2] He goes on to argue that it is the boundary regions of science which offer the richest opportunities to a qualfied investigator.

Dr. Rosenblueth insisted that a proper, thorough exploration of the blank spaces on the map of scientific research could only be explored by a team of scientists, each a specialist in his own field, but each with certain qualifications; each would have to have a working acquaintance with his neighbor's own field, an ability to understand what he is talking about, and the ability to talk intelligently in his own terms. The mathematician need not have the mechanical skill to undertake a physiological analysis of an organism, but he must have the skill to understand, criticize, and even suggest one.



Born in Nebraska in 1930, Anold Gassan has lived in Colorado most of his life, though he was educated in California and Wyoming as well. He attended the University of Colorado in 1947-48, then enlisted in the U.S. Air Force. He was an instructor in the Air Force Radar School and then worked on experimental telemetry equipment on Eniwetok Atoll during an AEC atomic energy test.

The question arises, "Why must he have this skill?" Because, in the past several years there have been large areas of science which have been explored from the different approaches afforded by pure mathematics, statistics, electrical engineering, and physics, to name a few; and the data gained by each has been duplicated by the others, sometimes triplicated or quadruplicated, while all the time other important work is delayed and stalled because techniques or experimental data are lacking—data and techniques which have already been learned, but are unknown to a physicist, say, because they were determined by a biologist.

Perhaps with this background material the question, "What is cybernetics?" can be answered. Wiener subtitled his first book "Control and Communication in the Animal and the Machine," but that doesn't mean much unless it is illuminated by the text itself. Referring back to the comment by Wiener about the various branches of science, one looks for some link between them, a terminology perhaps, which will enable the scientists from various fields to solve common problems. In the last few years a thorough analysis of methods of

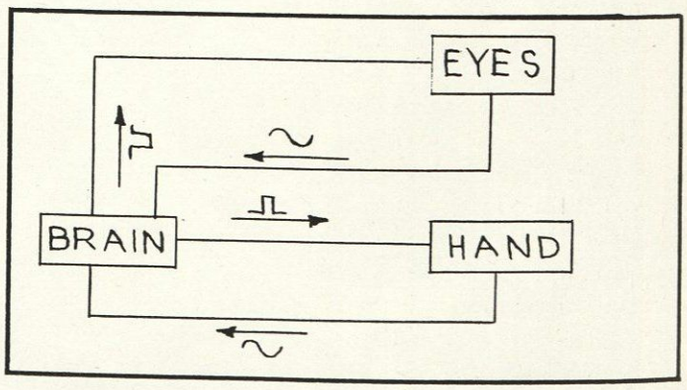


Fig. 1.

communication has been published,[3] and from this analysis certain facts appear: (1) intelligence (i.e. data, information of any sort) can be transmitted, or communicated, by means of a series of simple symbols; (2) in all transmission of intelligence there are recurring factors—noise, similarity and difference of the symbols, and the presence or absence of a carrier. Also in the last dozen years new studies of servo-mechanisms have been made, and certain prerequisites have been made which seem to be valid for any control-response network. Simply stated, there are: (1) transmission of control data to the acting unit; (2) reception of the data and proper interpretation of the symbols used; (3) feedback indicating work accomplished as against work yet to be done to satisfy the original control data.

There is one thing in all the sciences which combines them: there are the problems of *communication* and *control.* In mathematics there is the problem of symbols—their interpretation, their interlocking relationships, the necessity for precision. In physiology there are the problems of animal control, of the symbols used by the sensory and motor nerves, the feedback circuits involved, enabling, for example, hand to reach and grasp as the mind directs. In psychology there are problems of recurrent trauma, of "trigger" actions which activate old, unknown and forgotten, responses which may be useful or damaging, and of terminology. Going beyond these particulars to general technology, are the problems of incorporating into machines the most efficient control and communication equipment. In fact, the word cybernetics grows from a Greek word meaning *steersman,* and the most immediately practicable manifestations of cybernetics has been the development of better control, or steering, machinery.

II

You are sitting before a table. On the table is a glass of water. You desire that water. Without even your apparently thinking about it, your hand reaches out, grasps the glass, moves it to your mouth, tips it gently, takes it away, and puts it back where it was. Perfectly simple, and almost unconsciously done. Yet, if you suffered from *ataxia,* your hand would move toward the glass, slip past it, move back, slip past—a little further than the first time—move back . . . and in an instant your arm would be trembling violently, out of control. Or, another condition: as you sat quietly, your hand would tremble, useless. As you felt you would like the water, the hand would quietly reach out, grasp the glass, etc. These variations are apparently opposite, yet they are linked by the same theory. Look at the normal action first. Here it is diagrammatically (see fig. 1): The mind sends a signal (indicated by an arrow, showing direction, and by a square wave, showing a signal with motional directions) to the hand. The eyes, which have received another symbol commanding them to focus on the glass and by focusing to return data to the mind which will be interpreted as distance-direction co-ordinates, are also aware of the hand and of its position in relation to the glass. As the hand moves in the general direction indicated in the original motor impulse transmitted along the nerves from the mind, the eyes return new data to the brain, indicating the closing distance between the hand and the glass. The brain transmits new data to the hand, causing slight changes in direction, and rate of motion, and when the hand finally approaches the glass the rate is decreased so that the hand does not knock the glass over when it makes contact. All these actions in an adult are nearly unconscious; but watch the effort a child, a victim of cerebral palsy, or anyone who has incomplete motor control makes to complete a simple mechanical act. It should be noticed that the hand itself returns data to the brain, especially as its skin touches the glass, which prompts a new signal from the brain, indicating a cessation of forward motion, and the beginning of a grasping motion.

In this schematized description of a normal motion there is an important factor: the concept of error. The eyes produced data which was interpreted as error of direction, first, and of magnitude, second. When the tips of the fingers touched the glass they produced sensosry reactions which were interpreted as errors of velocity.

From this highly simplified narration one could develop certain statements. In this control system there has to be a system of control symbols or else separate circuits for each type of motion needed. In this system there has to be a method of sensing error of position, direction, and velocity. In this system there has to be a co-ordinating network which will accept all the returned data, correlate it, and then formulate new patterns of control symbols for the hand in motion.

Let us take a second example of a normal, or stable, control circuit, before attempting to understand the

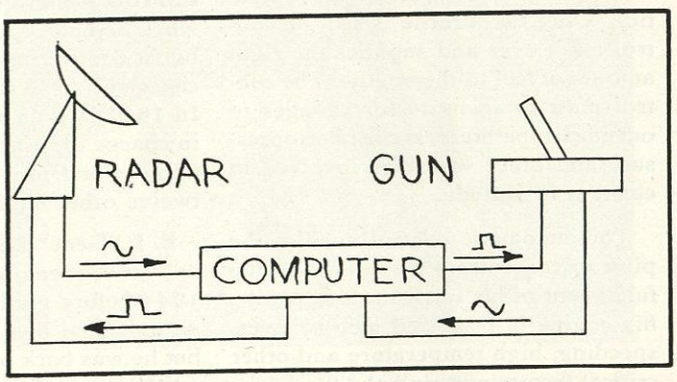


Fig. 2.

abnormalities of the victim of Parkinson's disease. Figure 2 is a simple block diagram of gun-laying system for anti-aircraft fire control. The radar set at the left searches the skies until it finds an aircraft; then it transmits the intelligence of altitude, azimuth, and distance to the computer. Assume a human element at the computer which determines whether the aircraft is friendly

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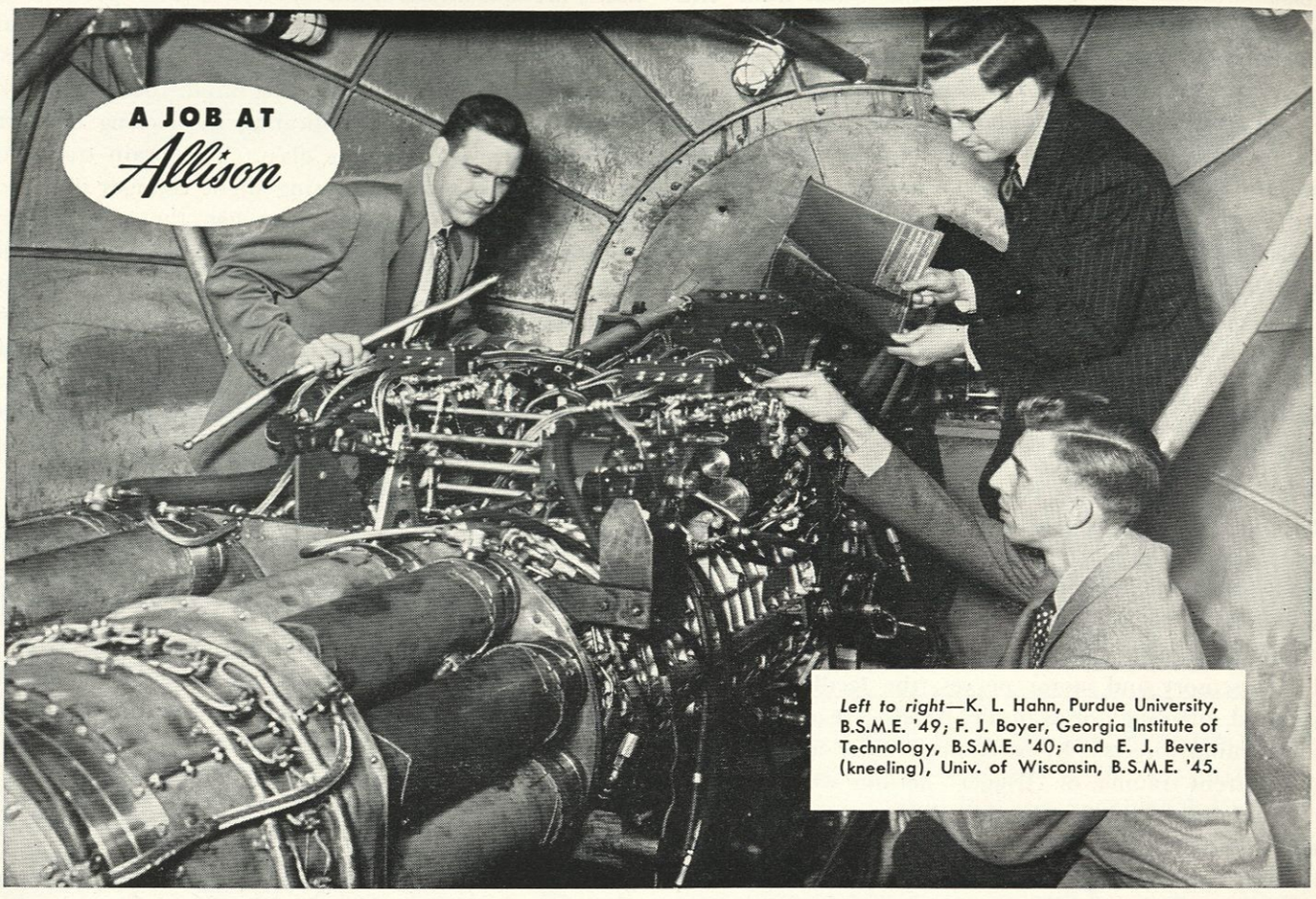


Left to right—K. L. Hahn, Purdue University, B.S.M.E. '49; F. J. Boyer, Georgia Institute of Technology, B.S.M.E. '40; and E. J. Bevers (kneeling), Univ. of Wisconsin, B.S.M.E. '45.

● Young Allison aircraft engineers, who not so long ago were in engineering schools as you are now, are playing an important part in development of controls for today's high-powered turbine engines.

Their job is to design an instrument which will relieve the pilot of much of the manual control in engine operation. Once the throttle is set, the control takes over and supplies the right amount of fuel to the engine. The control must compensate for changes in outside temperature, atmospheric pressure and other variables involved in changes in altitude.

This automatic control enables the pilot to concentrate his efforts on the fulfillment of his mission. Meanwhile, his engine is protected against overspeeding, high temperature and other critical factors affecting the life of the powerful turbine engine and the pilot's ability to perform the assigned job.

Floyd Boyer is a Montana boy who came to Allison from Georgia Tech in 1940 as a junior test engineer. By early 1944 he had been advanced to experimental engineer and in 1948 to senior project engineer. His work on engine controls began during World War II when he helped develop the automatic boost control for the two-stage supercharged V1710 reciprocating engines. In 1951 he was made group engineer in charge of turbo-prop control development and now guides the work of twelve other engineers.

E. J. "Gene" Bevers worked with us as a student engineer in the summer of 1944 before graduating in 1945. The Army called him for a two-year hitch but he was back on the job in January, 1947. One of his most interesting assignments while in our test department was as engineering representative during four months of cold weather engine tests in Alaska in the winter of 1951. Today, as Project Engineer in charge of turbo-prop fuel controls, he looks after the application and development engineering on these devices.

Kent Hahn spent his first year with Allison working in several departments and is now a project engineer in the controls development group, working on propeller coordinating controls. He also has had assignments on engine deicing controls, and on controls for the turbo-prop engines in the Allison Turbo-Liner where the commercial advantages of turbo-prop engines are now being demonstrated.

Let's check together on a job for *you* with the world's most experienced manufacturer of turbo-jet and turbo-prop engines.

Allison is looking for young men with degrees in **MECHANICAL ENGINEERING, ELECTRICAL ENGINEERING, AERONAUTICAL ENGINEERING.** ***A lesser number of openings exist 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.

Allison **DIVISION GENERAL MOTORS CORPORATION • Indianapolis, Ind.**

Design, development and production—high power TURBINE ENGINES for modern aircraft . . . heavy duty TRANSMISSIONS for Ordnance and Commercial vehicles . . . DIESEL LOCOMOTIVE PARTS . . . PRECISION BEARINGS for aircraft, Diesel locomotives and special application.

It took a lot of engineering to make a better "grasshopper"

Engineers at Western Electric's St. Paul Shops are well pleased with their new-style "grasshopper" fuse—a small fuse used in Bell telephone central office equipment. The former model—in production for years—had been gradually refined 'til it seemed almost beyond further improvement. It was simple, inexpensive, efficient, came off the line fast. But . . .

It's an old Western Electric engineering custom to keep trying to make Bell telephone equipment still better, at still lower cost. The "grasshopper" was studied by a young engineer out of the University of Minnesota, Class of '40, who joined the Company in 1946. His studies indicated the most effective way to improve efficiency and cut costs further was to change the design.

Pursuing this lead the engineer and his group saw their opportunity to make an important contribution. They investigated the latest tooling techniques, new metals, finishing materials and methods, all of which are constantly under study by engineers at Western Electric plants. A simplified design, which permitted the use of the most modern tooling methods, resulted in a better fuse at lower cost that is saving thousands of dollars a year for Bell telephone companies.

There's an endless stream of such challenging assignments at Western Electric. Engineers of varied skills—mechanical, electrical, civil, chemical, metallurgical—find real satisfaction in working together on the important job of providing equipment for the best telephone service on earth.

How the grasshopper fuse works

Small fuses like this are used by the millions to protect certain telephone central office circuits against current overloads. Odd in appearance, the fuse is called the "grasshopper" because of its spring which is released when the fuse blows, displaying an indicator "flag" in open view and tripping an alarm so the trouble can be spotted and corrected at once.

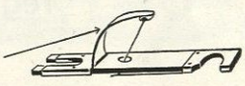
NEW DESIGN

ONE-PIECE FORMED SPRING WITH INDICATING FLAG—MADE BY STANDARD PUNCH PRESS METHODS.

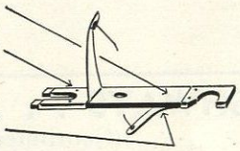
FIBRE STRIP SPRAYED WITH COLORED LACQUER FOR CODE IDENTIFICATION.

INDICATOR SPRING HELD BY AND STAKED TO FLAT TERMINAL—SOLDERING ELIMINATED.

PRE-FORMED RADIAL BEND IS NOT VULNERABLE TO DEFORMATION BY IMPROPER HANDLING—NO ADJUSTMENT FOR TENSION NECESSARY.



ASSEMBLED FUSE



BLOWN FUSE

• *Engineer and punch press operator check production of parts for newly designed grasshopper fuse.*

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

AN INVITATION TO HIGH SCHOOL STUDENTS UNIVERSITY ALUMNI, AND FRIENDS

ENGINEERS' DAYS – 1953

May 15 and 16

CONVOCATION—Macky Auditorium — May 15, 10:45 A.M.
Speaker — Mr. A. E. Perlman, Executive Vice President
Denver and Rio Grande Railroad.
Presentation of Honor Awards.

EXHIBITS — Engineering and Physics Buildings, May 15, 7-10 P.M., May 16, 9-12 A.M.

SCHOLARSHIPS — Interviews given on morning of May 16 for five 4-year engineering scholarships to outstanding high school graduates.

TRACK MEET — Colorado State High School Meet.

For further information regarding general activities and registration for scholarship tests, write:

C. L. Eckel, Dean

University of Colorado -- College of Engineering

Boulder, Colo.

HIGHWAYS . . . .

(Continued from page 27)

Pi Tau Sigma Banquet, seated clockwise from left foreground: Mrs. Hardy, Mr. Hass, Prof. Beattie, Mrs. Beattie, Prof. Brown, Mrs. Brown, Mrs. Jones, Mr. Jones, Dr. Hogge, Mrs. Hogge, Mr. Garrison, Mrs. Garrison, Mr. Hardy.

The banquet speaker was Dr. George Hoge, a local member of the Toastmasters Club, who gave a very interesting talk on two subjects. First he gave an illustrated talk on the use of hypodermic injections entitled "I Get a Kick if You Get the Point," and he concluded with a discussion of the customs of the African Bushman entitled "Big Troubles of Little Brother."

S. A. E.

On February 26, T. A. Boyd, a General Motors research laboratories consultant, gave a talk on "Solomon's House," an organized research laboratory which Sir Francis Bacon described fictionally in the Elizabethan age as "The New Atlantis." Solomon's House is so called because of the suggestion of wisdom contained in that name.

Mr. Boyd received a B.S. (Ch.E.) degree from Ohio State in 1918 and later the professional degree of Chemical Engineer. In 1939 Ohio State awarded him the Lamme Medal for meritorious achievement in engineering. With several associates, he was a pioneer in the study of fuel composition and combusion. Out of the researches came tetraethyl lead, now used as an antiknock agent in nearly all gasolines.

In 1950 he received the Horning Memorial Award from the S.A.E. and in 1952 he was granted the honorary degree of doctor of engineering from the University of Detroit.

On January 14th, a film on the "Cummins Diesel in the Indianapolis 500 Mile Memorial Day Race" was shown to a large gathering of members. After the film, refreshments were served.

Promise of a golden future

Yellow uranium ore from the Colorado Plateau is helping to bring atomic wonders to you

Long ago, Indian braves made their war paint from the colorful sandstones of the Colorado Plateau.

THEY USED URANIUM—Their brilliant yellows came from carnotite, the important uranium-bearing mineral. Early in this century, this ore supplied radium for the famous scientists, Marie and Pierre Curie, and later vanadium for special alloys and steels.

Today, this Plateau—stretching over parts of Colorado, Utah, New Mexico, and Arizona—is our chief domestic source of uranium. Here, new communities thrive; jeeps and airplanes replace the burro; Geiger counters supplant the divining rod and miner's hunch.

From hundreds of mines that are often just small tunnels in the hills, carnotite is hauled to processing mills. After the vanadium is extracted, the uranium, concentrated in the form of "yellow-cake," is shipped to atomic energy plants.

A NEW ERA BECKONS—What does atomic energy promise for you? Already radioactive isotopes are working wonders in medicine, industry, and agriculture. In atomic energy, scientists also see a vision of unknown power—which someday may heat and light your home, and propel submarines, ships, and aircraft. The Indian's war paint is on the march again—toward a golden future.

UCC TAKES AN IMPORTANT PART—The people of Union Carbide locate, mine, and refine uranium ore. They also operate for the Government the huge atomic materials plants at Oak Ridge, Tenn., and Paducah, Ky., and the Oak Ridge National Laboratory, where radioisotopes are made.

STUDENTS and STUDENT ADVISERS: *Learn more about the many fields in which Union Carbide offers career opportunities. Write for the free illustrated booklet "Products and Processes" which describes the various activities of UCC in the fields of* ALLOYS, CARBONS, CHEMICALS, GASES, *and Plastics. Ask for booklet B-2.*

UNION CARBIDE
AND CARBON CORPORATION
30 EAST 42ND STREET UCC NEW YORK 17, N. Y.

UCC's Trade-marked Products of Alloys, Carbons, Chemicals, Gases, and Plastics include

ELECTROMET Alloys and Metals • HAYNES STELLITE Alloys • EVEREADY Flashlights and Batteries • NATIONAL Carbons
ACHESON Electrodes • PYROFAX Gas • PRESTONE and TREK Anti-Freezes • PREST-O-LITE Acetylene
BAKELITE, KRENE, and VINYLITE Plastics • DYNEL TEXTILE FIBERS • LINDE Oxygen • SYNTHETIC ORGANIC CHEMICALS

CYBERNETICS . . . .

(Continued from page 33)

or not. Assume it is not. The computer sends back a series of symbols which indicate that the radar is to track the aircraft. It does so and soon gives the computer information which it can correlate into velocity and direction-of-flight terms, as well as renewed absolute azimuth, altitude, and range data. The computer can then transmit action signals to the gun, telling it to point to a certain direction. As the gun moves toward that direction it, in turn, sends signals to the computer telling to what direction it is pointing at any given instant; in other words, it returns a signal which is a function of error—error in relation to the co-ordinate signals the computer has given it. Thus, as the gun moves "on target," the amplitude of the error-indicating feedback decreases, until finally the gun is aligned with the co-ordinates of command, and *at that instant the error signals cease, the gun stops moving, and the system is at rest.* Now, what would happen if a few wires were crossed, and the gun, instead of returning signals to the computer indicating that it was moving clockwise and up, told the computer it was moving counter-clockwise and down. The computer would interpret the information as an increasing error signal, send a stronger (or larger) signal for clockwise rotation; the gun would rotate further clockwise, meanwhile returning signals of a counter-clockwise rotation; the computer would send further signals, etc. The system has now become unstable. Theoretically the gun would begin spinning and continue spinning until the circuit was broken.

Instability! In a tremendous number of fields the strange actions of mechanisms or organisms can be explained in terms of a feedback network that is returning the wrong signals, or is returning no signals. The cases of abnormality of hand control described above can be discussed in terms of an electrical circuit analogy similar to that of the gun-laying system, and what would happen if the wires were crossed.

The first case of instability described here was a case of *ataxia,* in which part of the feedback circuits from the hands and eyes either were not functioning or were destroyed. The *oscillation* of the hand which started when it shot past the glass occurred either because the brain was not receiving error information, or else because the brain could not use the information it was getting, and thus could not transmit control information varying with time and the position of the hand. Now a new term has been added, *oscillation.* Oscillation may be defined, in relation to the knowledge we have gained above, as an element's periodic motion, arising from random motion, and building to an amplitude limited by the power and freedom of the element. The "random motion" mentioned in the last sentence can also be equated to *noise,* that is to an un- or a-periodic motion of slight amplitude, and normally not noticed, since it is so familiar and of such slight intensity.

Oscillation is not always an unwanted action, and

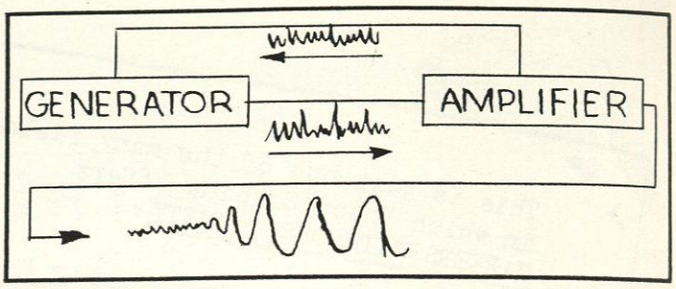


Fig. 3.

in many cases is specifically desired. When it is desired, it almost always is desired at a particular frequency, which is to say that the periodic motion should complete one cycle in a given time. Any circuit, electrical or mechanical, which contains sufficient amplification, can be made to oscillate. Negative feedback has a tendency to decrease the total resultant motion, and positive tends to increase it, is a simple way of stating the difference between the two. Now if one specifically desires oscillation, then all that is necessary is to feed back the random noise from a generator (see fig. 3) in such a way that instead of acting against the generator, it acts with it. At some frequency the noise signals will coincide, and be amplified more than at other frequencies. This one frequency will then be fed back into the generator, reinforce itself again, and before long there will be a periodic motion apparent, which will increase to a constant applitude. The only way to stop the oscillation is to stop the positive feedback, or "break the loop."

There are still two major points to be covered before showing the work that cybernetics is doing, and what it may do. These are the aspects of *noise, communication of data,* and of a *carrier.* Lately, through the work of Claude E. Shannon, it has been determined that any type of intelligence, or data, may be communicated by means of symbols. These symbols are dependent, in many cases, on a carrier and can be distorted or lost due to noise. To take the concept of a carrier first, let us present an analogy taken from western history. On the arrival of a pony-express rider, the citizens of a town would know that there was news available. That news might not be for them. Nevertheless, the carrier would be present and so would the intelligence. In this case the carrier is aperiodic, and the presence of the carrier contains much information in itself. Now in the more common electronic case when

(Continued on page 46)

Do you own everything you would like?

If not, perhaps the problem of worker lay-offs could be solved

EVERY MAN, woman and child in America knows of many things he would buy if he could afford them—that is, if the price were low enough. Cutting prices to the point retailers and manufacturers lose money and go bankrupt is no answer. Cutting *costs* is.

Suppose every producer (mine, farm, factory) equipped itself with the most modern productive equipment—and fair tax laws let them save enough to pay for that equipment. Then let every worker use that equipment at maximum efficiency.

Costs would tumble.

Then let business pass those savings on to the public.

Prices would tumble.

Finally, suppose the consumer did his part, and bought. There would be such business as the world never dreamed of. More store clerks would be needed to handle the demand, more transportation workers to haul the goods, more workers to produce them. The more demand and production, the lower the costs and prices; the lower the costs and prices, the more the demand and production. And everyone would have more and more of the things he wants.

Why isn't it done? Greed, fear, misunderstanding.

Honesty, hard work, unselfishness would do it, for the principle has been proven a thousand times. We've tried laws, contracts, strikes, slowdowns—and all we've got is hatreds, shortages, and periodic lay-offs. Is there a leader great enough to rally all America to put this *positive* approach to work? The approach that every honest man knows in his heart is *right.*

ALUMNI NEWS . . . .

(Continued from page 23)

Electric and has worked for them since.

In making the award to Roberts, officals cited him "for his alertness, resourcefulness and initiative in prevention of a substantial interruption of production and a very large expenditure of money at Hanford Works." General Electric operates the plant at Richland, Washington, as a prime contractor to the U. S. Atomic Energy Commission. Roberts started service at the Hanford Works in 1951 and is a member of the pile technology unit. He was formerly an instructor in the engineering drawing department at the University of Colorado.

RICHARD GERKE, B.S. (C.E.), is president of the junior section of the American Society of Civil Engineers, Los Angeles, Calif.

1947

KENNETH D. KNIEVEL, B.S. (M.E.), has recently returned from Venezuela where he spent four years working for the Creole Petroleum Corporation. He is now doing graduate work at the University.

1948

TERRY TRIFFET, B.S. (Arch.E.), M.S. (C.E.) 1950, is working on his doctorate in civil engineering at Stanford university. He has been appointed GS-12 in charge of the architectural design section of the public works department, Naval Ordnance Test station, Inyokern, Calif.

1949

HAROLD G. AUSTIN, JR., B.S. (C.E.), who is with the U. S. Bureau of Reclamation at the federal center in Denver, is the proud father of a daughter, born November 21, 1952.

HUGH C. MacDONALD, B.S. (C.E.), a junior engineer with the Brick Manufacturers' Association of Southern California at Los Angeles, was recently elected secretary of the junior section of the American Society of Civil Engineers, Los Angeles.

JOHN M. MANN, B.S. (M.E. & Bus.), has completed the requirements for a law degree at the Georgetown Law school in Washington, D.C. He plans to take the bar examination in Illinois and practice in that state. He is now living in Hinsdale, Ill.

1950

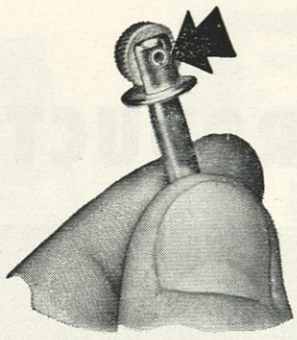
JAMES R. ANDERSON, B.S. (Aero.E.), is a sergeant in the U. S. Army doing photointerpreter work with the 24th Infantry division in Korea and Japan.

ROBERT J. KLESSIG, B.S. (E.E.), an engineer for Western Airlines in El Segundo, Calif., is the proud father of a daughter, born October 18, 1952.

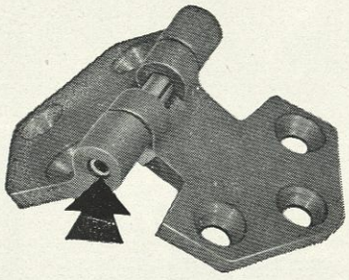
1951

JOHN F. ALLEMAN, B.S. (C.E.), is a captain in the U. S. Air Force stationed at Ladd Air Force Base, Seattle, Wash.

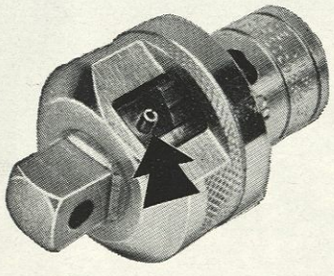
(Continued on page 52)



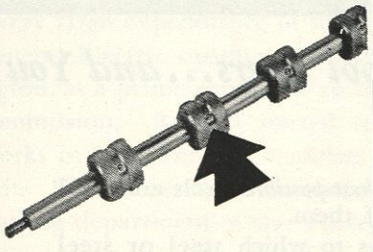
Replacing a rivet



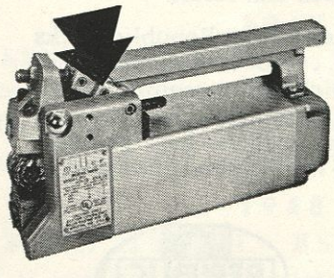
. . . a hinge pin



. . . a stop pin

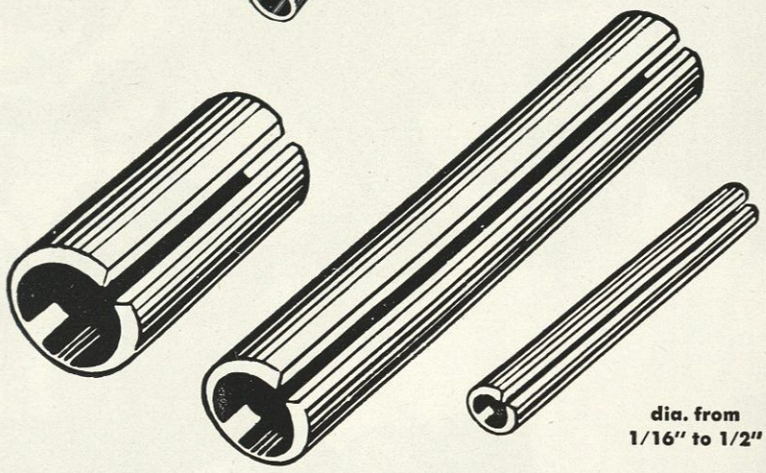


. . . a set screw



. . . a bolt and nut

ROLLPIN



dia. from 1/16" to 1/2"

. . . a modern fastener that saves time and money on thousands of applications

Rollpin is a hollow, split, cylindrically formed pin with chamfered ends. It is simply driven into holes drilled to normal production tolerances. Because Rollpin is slightly larger than standard sized holes, it compresses as inserted. It is self-locking—and vibration-proof—because of the constant pressure it exerts against hole walls. Its shear strength exceeds that of a cold rolled pin of the same diameter. Rollpin is readily removed with a drift or pin punch—and can be reused.

Because of its versatility—and the production economies it makes possible—Rollpin is finding wide usage in almost every phase of manufacturing activity. Write for design information on the Rollpin. It will enable you to cut costs for many applications where use of rivets, set screws, dowels, and straight, serrated or cotter type pins create installation or performance problems.

ELASTIC STOP NUT CORPORATION OF AMERICA

2330 Vauxhall Road, Union, New Jersey

Elastic Stop Nuts with the famous red collar are another ESNA product

Engineers get ahead at Boeing

A major guided missile program is just one of Boeing's many projects-with-a-future. Other programs, which offer *you* plenty of room to get ahead in engineering, are America's first-announced jet transport project, research in supersonic flight and nuclear-powered aircraft, and development of the B-47 and B-52 jet bombers, the airplanes that have given Boeing more experience with multi-engine jets than any other company.

No other industry approaches this one 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.

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. Both communities offer fine fishing, hunting, golf, boating and other recreational opportunities. Both are fresh, modern cities with fine residential and shopping districts, and schools of higher learning where engineers can study for advanced degrees.

There are openings in ALL branches of engineering (mechanical, civil, electrical, aeronautical and related fields) for work in aircraft **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

Salesman—"Sir, I have here something that's guaranteed to make you the life of the party, allow you to win friends and influence people, help you forge ahead in the business world, and in general make life a more pleasant and invigorating experience."

Engineer—"I'll take a fifth."

Mother is always having trouble with either Father or the furnace. Every time she's watching one, the other goes out.

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

Then there was the E.E. who called his girl "Carbon" because her resistance went down as she warmed up.

She: And what would you be if it weren't for my money?

He: A bachelor!

Through the smoke and ozone fumes the student slowly rises;
His hair is singed, his face is black, his partner he despises;
He shakes his head and says to him, with words so softly spoken,
"The last thing that you said to me was, 'Sure, the switch is open.'"

A man walked into a Chicago restaurant and ordered rabbit stew; after tasting it, he asked the waiter suspiciously: "Isn't there a little horsemeat in this stew?" "Well yes, sir," replied the waiter, "It's half and half—one horse and one rabbit."

Little girl to her mother: "Will I walk to Heaven on a golden bridge? — the minister said so."

"He's wrong dear, there are no bridges in Heaven—it takes engineers to build bridges."

Professor: A fool can ask more questions than a wise man can answer.

Student: No wonder so many students fail your exams.

Dear Pop:

Everything fine at school. I'm getting lots of sleep and am studying hard. Incidentally, I'm enclosing my fraternity bill.

Your son,
Pudge.

Dear Pudge:

Don't buy any more fraternities.

Your pop.

He asked for burning kisses,
She replied in accents cruel:
"I may be a red-hot mama,
But I ain't nobody's fuel!"

ROTC Sergeant: Does your uniform fit satisfactorily?

Frosh: Well, the jacket is okay, sir, but the pants are a bit snug under the armpits.

Friend: My good man, why don't you take the train home?

Drunk: It's no use, my wife wouldn't let me keep it in the house.

Professor: A textbook wired for sound.

Not 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?"

Professor to noisy class: "Order, please."

A voice from the rear of the room, "Two beers."

He: What's the difference between a taxi and a bus?

She: I don't know.

He: Good. We'll take a bus.

Prof. Pietenpol: If, in going down this incline, I gain four feet per second per second, what will be my condition after 25 seconds?

Smart sophomore: You'll be a centipede.

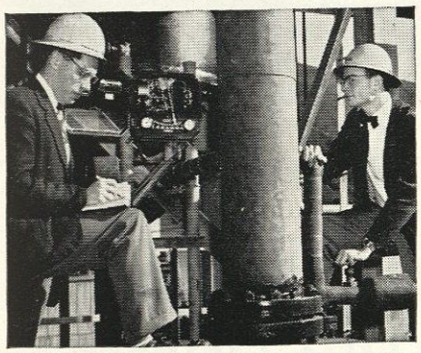
Nurse: I think he's recovering consciousness doctor —he's trying to blow the foam off his medicine.

THE DU PONT DIGEST

THE ENGINEER'S PLACE IN

Plant Development

Another phase of Du Pont production activities offers challenging work for the technical man



E. H. Ten Eyck, Jr., *B.S. in Ch.E., Syracuse '43, Ph.D. in Ch.E., Brooklyn Polytech '50, and W. H. Stevens, Jr., B.S. in Ch.E., Yale '50, take recordings on a new nylon unit.*

D. S. Warner, *B.S. in M.E., Purdue '47, and G. R. Prescott, B.S. in Met. E., Columbia '49, discuss improvements for stainless steel liners in tubes carrying corrosive materials.*

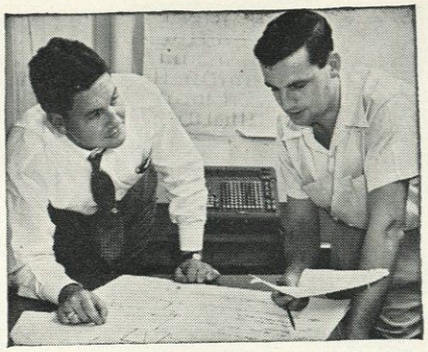
In most Du Pont manufacturing plants you'll find two groups of engineers working side by side to make operations more efficient—to reduce costs and improve quality. The specialized work of one group, the production supervisors, has been rather fully discussed in the *Digest*.

Equally vital is the work of development men—the men responsible for advising management when operational changes should be made for economic or technical reasons.

Engineers from several fields of training are employed in development activities at Du Pont. It seems to have a special appeal for the man who can take on a big problem, analyze its parts, and come up with a thoughtful, reasoned solution.

Individual development studies may begin in a number of different ways. Often they are sparked by the imagination of the engineer himself, who, of course, must be familiar with production costs, activities of competition, and recent or impending technical improvements.

Studies also may be inspired by suggestions of production supervisors or sales personnel, obsolescence of equipment, advances in competitive products, or the presence of unsatisfactory profit margins.



John Purdom, *B.S. in Ch.E., Ohio State '49, and Kenneth Kehr, North Carolina State '50, discuss diagram of a process for improved recovery of an intermediate for high polymers.*

In a single study, the engineer may draw data from laboratories, semi-works and plant-scale experiments, prepare an estimate of profits and investments and consult with numerous specialists on various phases of the problem, both within the Company and outside.

Having collected data from these many sources and perhaps from an independent study of his own, the plant development engineer must then assemble and evaluate the material and prepare a recommendation that is based on sound engineering judgment.

Whether a product or process improves from the standpoint of competition, profit and efficiency depends, in great degree, on the quality of its plant development work. The development engineer's job is a responsible one at Du Pont, and the work of a good man is soon noticed.

CYBERNETICS . . . .

(Continued from page 38)

the carrier is periodic, for example when it is a radio-frequency carrier, the first cycle of the carrier contains the maximum amount of information, i.e. its presence, and each succeeding cycle less. When a series of data symbols is super-imposed on the carrier, the carrier is filtered out, or separated and discarded, and only the intelligence is saved.

When the form of the data symbols is similar to the form random noise might take, as illustrated in figure 4 (a & b), then the equipment designed to use the symbols may easily become confused and read line "c" rather than "a," due to the juxtaposition of the two lines, and the similarity of the high noise peaks to the rectangular wave-shapes indicating intelligence. Then, line "c" would appear, when translated into words, perhaps, as a normal line of letters forming a coherent whole, broken by idiotic errors, or nonsense letters.

Worse than "c," perhaps, is line "d," where the signal and the noise are of similar amplitude. They are shown superimposed. In this case the machine translating these symbols into letters either types complete nonsense, or refuses to function until a clearer pattern is given it. Variations of this can occur, such as the noise only intermittenly destroying the validity of the intelligence. To transpose these terms to everyday usages, the idea of noise is immediately apparent. If two people are talking in a low voice in a noisy restaurant, many of their words are either lost in the noise or distorted. Yet, the human ear and mind being what they are, if only fifteeen per cent of the original intelligence gets through, sense can be made of the statements.

The terminology used above concerning noise and communication symbols has other applications as well as in electronic circuits. These terms are carried over to discussions of psychology, physiology, and neurology.

This adaption of terminology is of increasing importance in our world where the same symbols are

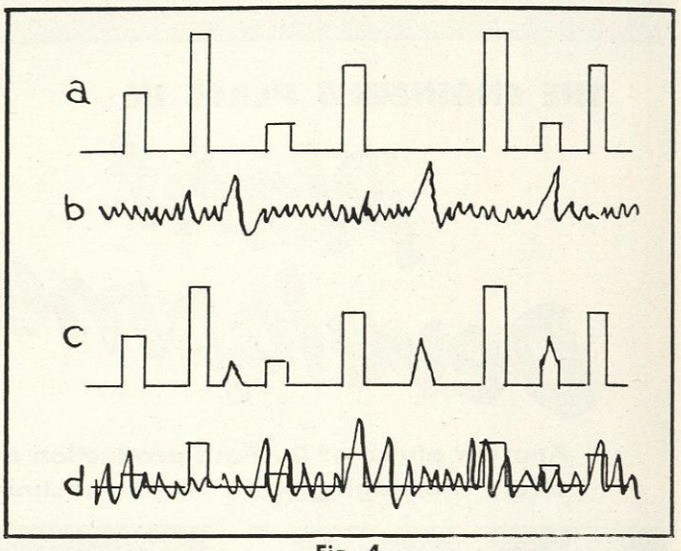
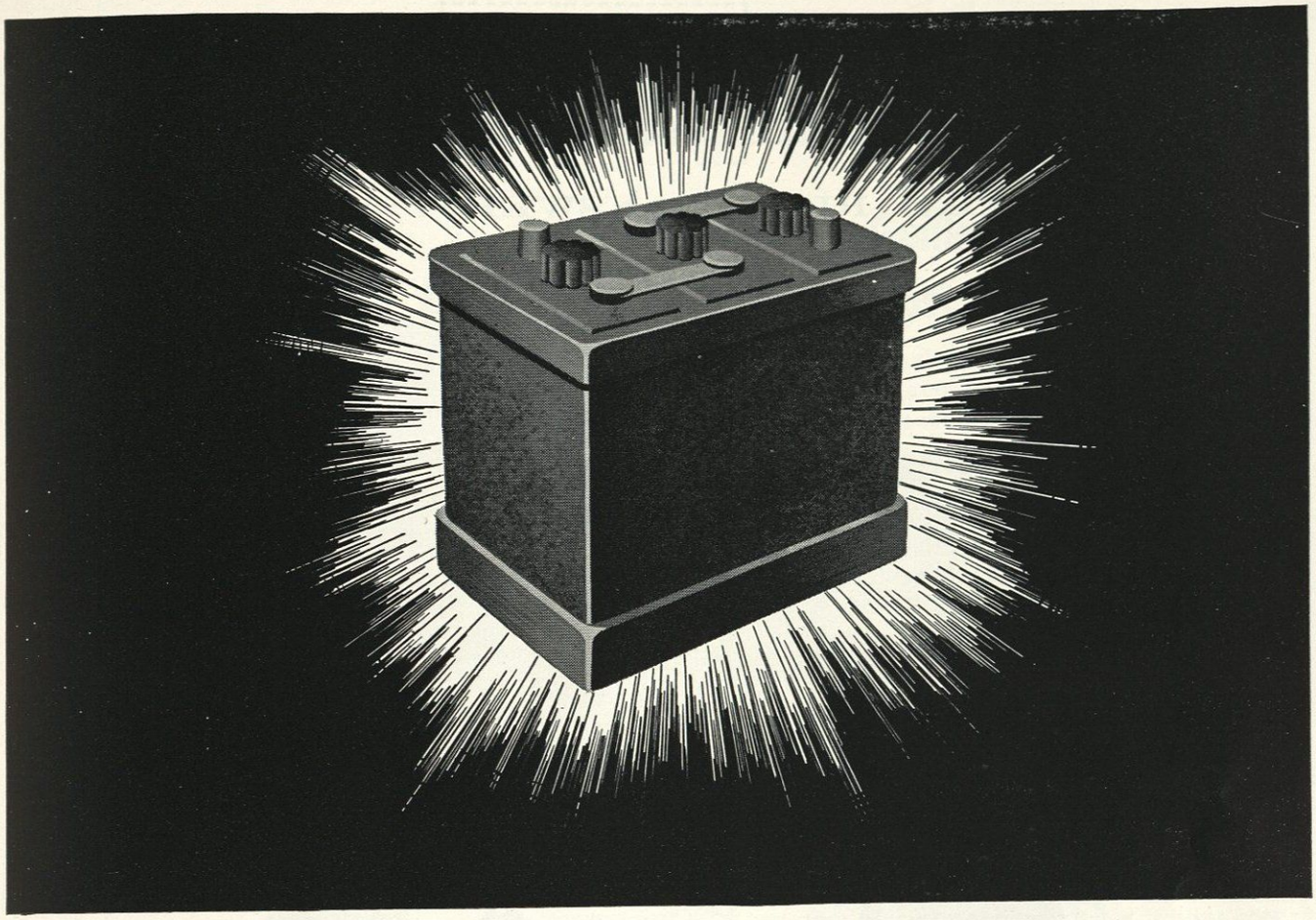


Fig. 4.

used over and over again, varying from one technical field to another, until the workers in one are deaf to the

(Continued on page 50)



PICKLED AMPERES...

That was the term used to describe the first storage batteries. For a score of years they were considered laboratory playthings, for they were crude, undependable, and required months or years to charge.

Their counterpart today is a reliable source of electrical energy . . . to start cars . . . to operate submarines, mine cars, materials handling equipment . . . and to perform over 200 other regular and emergency functions on land, sea and in the air.

CELLS—BRAIN AND BATTERY...

Storage batteries were conceived in France and England . . . but grew up in America. For Americans foresaw their commercial usefulness. Scientists performed experiment after experiment—thousands of them—to find the elements and chemicals with the best electro-chemical behavior . . . investors helped get production started . . . industry developed new applications . . . and today they build batteries by the millions.

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Each spark of genius electrifies dreamers, designers, engineers, executives, producers and purchasers. And the power behind our progress is America's all-seeing, all-hearing and reporting Inter-Communications System.

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The McGraw-Hill publications are a part of this American Inter-Communications System.

As publishers, we know the consuming insistence of editors on analyzing, interpreting and reporting worthwhile ideas.

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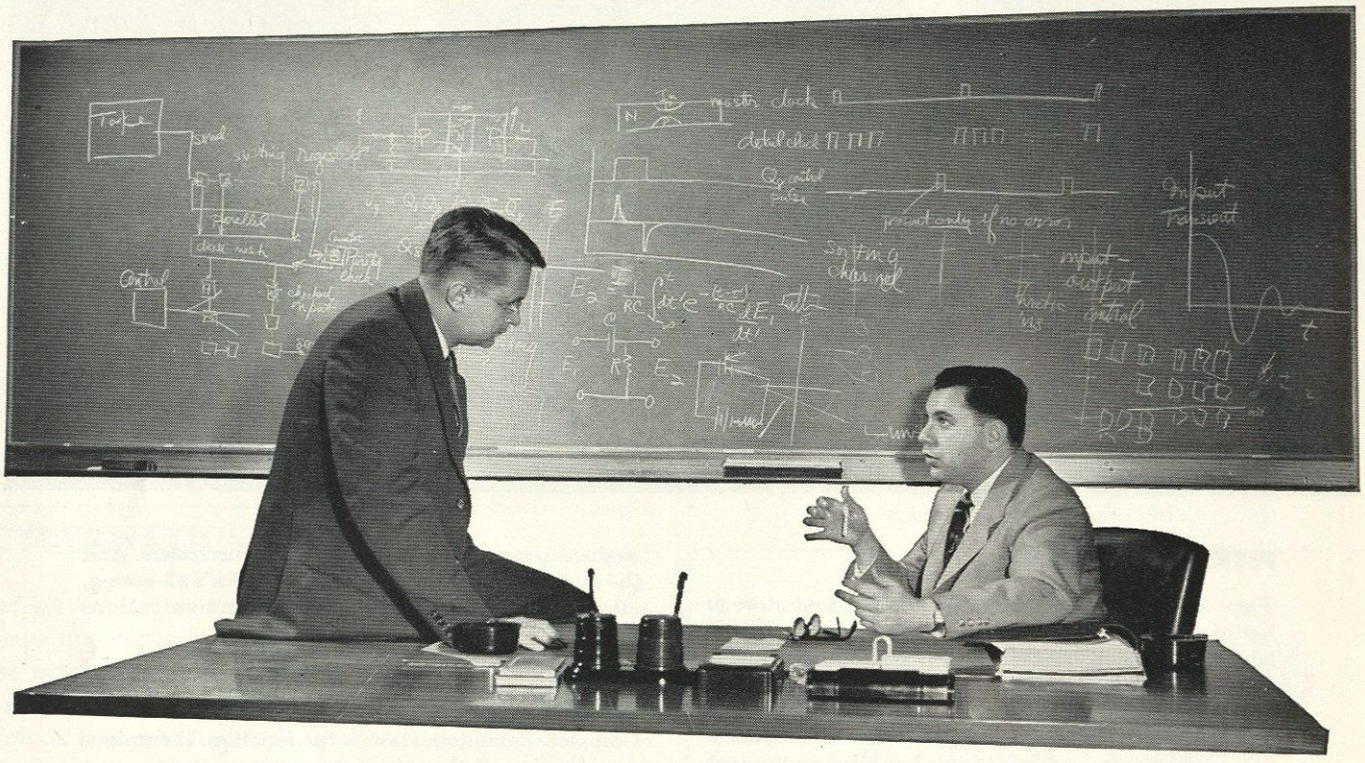
PLANNING THE RIGHT ANSWERS

The complexity of modern air defense—extreme aircraft speeds, highly complex weapons, new combat strategies, the advanced state of today's technology—poses serious problems for the scientist and engineer.



One significant solution lies in the extensive use of airborne automatic equipment, including electronic digital computers, to augment or replace the human element in aircraft control.

AT HUGHES Research and Development Laboratories each problem is attacked basically, beginning with systems planning and analysis. This consists of an exhaustive examination of the requirements of a problem, together with an evaluation of the best means for satisfying these requirements. The objective is to design the simplest possible mechanization consistent with a superior performance.

These techniques, employing many special talents, are responsible at Hughes for the successful design, development *and* production of complexly interacting automatic systems for all phases of electronic control of interceptor navigation, flight control, and fire control. Similar accomplishments may be pointed to in the guided missile field.

Methods of systems planning and analysis responsible for achievements in the military area are also being applied at Hughes to adapt electronic digital computer techniques for business data processing and industrial controls.

Dr. E. C. Nelson (left), Head of Computer Systems Department, and J. H. Irving, Head of Systems Planning and Analysis Department, discuss a problem in the systems planning and analysis stage.

PHYSICISTS
AND
ENGINEERS

Hughes activities in the computer field are creating some new positions in the Systems Planning and Analysis Department. Experience in the design and application of electronic digital computers is desirable, but not essential. Analytically inclined physicists and engineers with a background in systems work are invited to apply.

Address:
SCIENTIFIC AND
ENGINEERING STAFF

HUGHES
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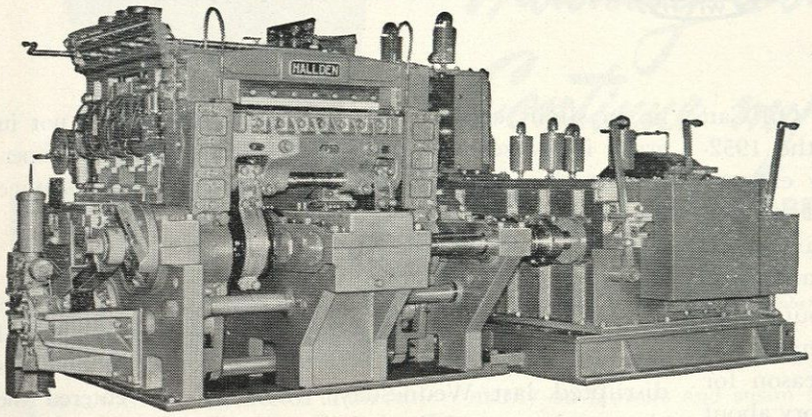
Laboratories

CULVER CITY,
LOS ANGELES COUNTY,
CALIFORNIA

Another page for **YOUR BEARING NOTEBOOK**

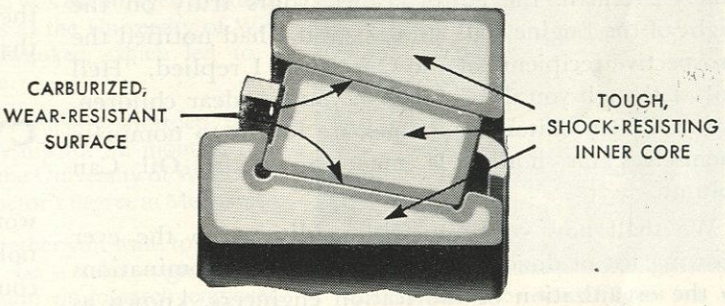


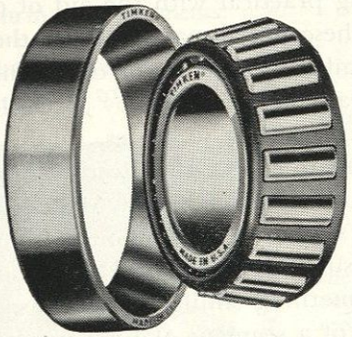
Guillotine shear cuts cost of cutting steel

To carry the terrific shock loads imposed on pinions and gears in this flying shear, engineers mount them on Timken® tapered roller bearings. Maintenance and repair costs are cut, costly breakdowns prevented, accuracy insured. Because of their tapered construction, Timken bearings take radial and thrust loads in any combination. They minimize friction, reduce wear — normally last the life of the machine.

Why TIMKEN® bearings can take the toughest loads

In Timken bearings, the load is carried on a line of contact between the rollers and races instead of being concentrated at a single point. Made of Timken fine alloy steel, the rolls and races are case-carburized to give a hard, wear-resistant surface with a tough core to withstand shock.





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TAPERED ROLLER BEARINGS

Want to learn more about bearings?

Some of the engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. Clip this page for future reference, and for a free copy of the 270-page General Information Manual on Timken bearings, write today to The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

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

OIL CAN

THE HONORARY SOCIETY OF LUBRICATION ENGINEERING

Lubricity shall lack no champion . . .
Friction shall not thrive unopposed

We were exceedingly proud to present the Oil Can awards to the outstanding lubricationists of the 1952-1953 school year. Obviously, two of the oily experts, Chuck Crandall and Gilbert Mull, were well pleased with their accomplishments, and we wish to convey, once more, official congratulations to Chuck and Gill.

It was equally obvious that the chief spout wiper wasn't present to receive his award. This person was Mickey Barko, who is a Double "E." The reason for Mick's non-appearance reminds us of the old story about the two drunks who drove their car off the cliff and then pointed to each other and said, "My God, I thought you were driving." The fact of the matter is that Harry Herman, the editor, called yours truly on the night of the Engine Ball, and asked if I had notified the prospective recipients of the Oil Cans. I replied, "Hell no! I though you did." And so you see, dear children, even Oil Can editors sometimes are forced to nominate themselves for honorable mention in the Oil Can column.

We shall now continue with additions to the ever growing list of donors of boners, with new nominations to the organization of lubrication engineers, known as the Oil Can.

First of all, we want to mention just why Mickey was bestowed with the title Chief Spout Wiper. Mick gave this answer to Prof. DuVall's query about what advantages were derived from improved lighting in factories. Mick promptly answered: "Improved lighting raises the workers morals."

See!

It seems that Howard D. Larcom's handwriting is highly illegible. As a matter of fact Major White of the AROTC asked Larcom why he didn't print in order that his papers might be read. Larcom thought that this might be a good idea because he himself often finds that he can't read his own writing. When we heard this, we immediately sent a letter north and asked Santa to leave a pocket size LeRoy in Howard's stocking next December.

And in the E.E. department, we find another little gem: David Braudaway, a junior E.E., wrote this on an E.E. 321 final: "The errors stated in this problem are only approximations, and, although I have reasonably good reason to believe they are reasonable, they might be in slight error." We feel sure that we are not in error in presenting Dave with a sub-miniature paper-weight oiler and hoping that he will come in sometime and tell us just what he meant.

And now we wander over to the M.E. rendezvous to find this item about a Mr. Bob Brown. The usual peaceful calm of the 8:00 o'clock contracts class was disrupted last Wednesday, when Mr. B. entered the class and proceeded to draw an A. S. T. M. fuel distillation curve on the board. Upon noting that the students were staring at their watches or rubbing their eyes in amazement, he confessed that he had spent half the night working out the curves and had forgotten that his I. C. E. class did not meet until 10:00 o'clock.

CYBERNETICS . . . .

(Continued from page 46)

workers in another. By developing a common technological vocabulary, great good can be done for the country and the world.

III

What does cybernetics hope to accomplish? Here is a long quotation from Wiener's book: "There are two . . . fields where I ultimately hope to accomplish something practical with the aid of cybernetic ideas. . . . One of these is the matter of prosthesis for lost or paralyzed limbs. The ideas of communication engineering have already been applied by McCulloch to the problem of the replacement of senses, in the construction of an instrument to enable the blind to read by hearing. Here the instrument suggested by McCulloch takes over quite explicity some of the functions of, not only the eye, but of the visual cortex. There is a manifest possibility of doing something similar in the case of artificial limbs. The loss of a segment of limb implies not only the loss of the purely passive support of the missing segment, or its value as mechanical extension of the stump, and the loss of the contractile power of its muscles, but implies as well the loss of all cutaneous and kinaesthetic sensations originating in it. The first two losses are what the artificial-limbmaker now tries to replace. The third has so far been beyond his scope. In the case of a simple peg-leg this is not important; the rod that replaces the missing limb has no degrees of freedom of its

(Continued on page 54)

"Allis-Chalmers Graduate Training Course Helped me Continue my Studies."

says ROBERT D. BAIRD, Ph. D.

University of Illinois, B. S.—1942 • University of Wisconsin, M. S.—1949
University of Wisconsin, Ph. D.—1951
and now a member of Engineering Calculations Group

"I'VE ALWAYS been interested in the *basic* problems of engineering. But when I got out of school, I needed additional courses to do the things that interested me. More mathematics—more mechanics were required. Since joining Allis-Chalmers, these gaps have been filled."

Variety of Experience

"I became interested in the Allis-Chalmers Graduate Training Course during a plant tour in my Senior year. As I watched men building steam turbines, electric motors, transformers, pumps, rotary kilns, crushers, and many other products, I was impressed by the variety of experiences to be obtained at A-C. It looked to me like a cross-section of heavy industry. When I found that GTC students choose the departments they work in, as well as the type of work, I decided to join Allis-Chalmers.

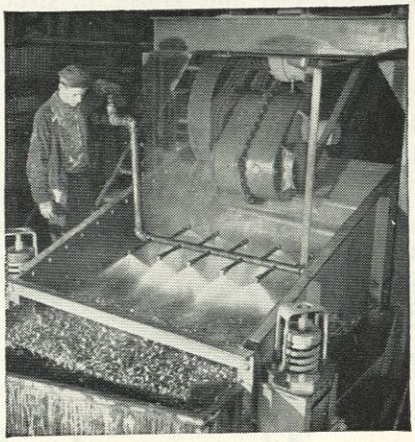
"As a GTC student, I was given every opportunity to work in many departments. However, the basic problems involving aerodynamics, mechanics and elasticity appealed to me and I chose to work primarily on blowers and steam turbines."

Aided by Experts

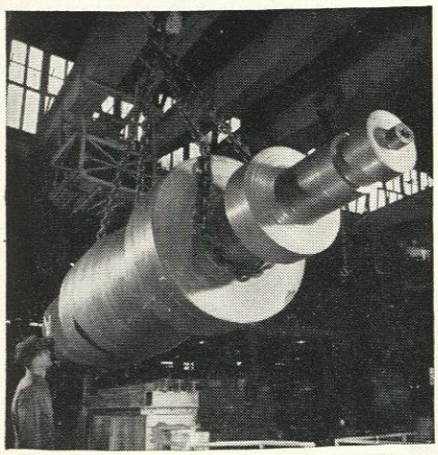
"Since joining A-C, I have had the opportunity to work with the company's leading consultants, and was encouraged to attend evening courses at the University of Wisconsin, in Milwaukee, which led to a Master's degree.

"In 1949 the company awarded me a graduate fellowship for 12 months' residence study at the University of Wisconsin and I got my Doctor's degree in Mechanics.

"So you see, whether you want to do basic engineering or be a sales engineer, designer, production or research engineer, Allis-Chalmers Graduate Training Course offers a wonderful opportunity."



Vibrating screens by Allis-Chalmers are found throughout the world, wherever coal and ore are mined and rock is quarried.



Rough-machined turbine spindle for 120,000-kw steam turbine. Calculating torsional stress and critical speed on shafts like these is part of Baird's job.

Facts Graduates Should Know About 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

ALUMNI NEWS . . . .

(Continued from page 40)

J. C. REECE, B.S. (Arch.E.), is working with Hensen, McLung, and Halstead, structural engineers of Chicago.

RAYMOND A. JUMP, B.S. (M.E. & Bus.), who is in the sales engineering department of the Caterpillar Tractor Company in Peoria, Ill., is the proud father of a son, born November 8, 1952.

1952

DUANE BALL, B.S. (C.E.), an engineer at the Boeing Aircraft Company in Seattle, Wash., is now the father of two boys, the latter being born on November 23, 1952.

She: "Don't you think dancing makes a girl's feet larger?"

He: "Yes."

She: "I rather think that swimming gives a girl awfully big shoulders, don't you?"

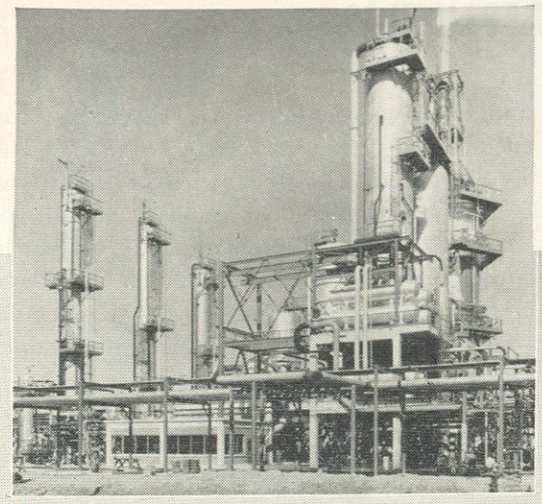
He: "Yeah."

Pause.

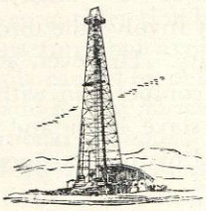
He: "You must ride quite a bit, too."

What's happened to good old Atlas?
He took it on the lam,
And left his world-supporting job
To good old Uncle Sam.

ENGINEERS are planning to transform this flat Dakota prairie into what probably will be North Dakota's largest industry. A new Standard Oil refinery, with equipment similar to that shown, is scheduled to be operating at this Mandan site before the end of 1954. Capable of refining 30,000 barrels a day, it will provide the first major outlet for the Williston Basin production.



OIL is making a prairie plant grow!



Before the close of 1954, a new Standard Oil refinery is scheduled to be operating at Mandan, North Dakota.

Behind this lies a story of Standard Oil's willingness to back its scientists' judgment with millions of dollars.

Two years ago oil was discovered in the Williston Basin. How much oil this basin eventually will produce is anybody's guess, but the current rate is only about 10,000 barrels a day. However, geologists, geophysicists and engineers, working in field and laboratory, have estimated that the basin holds a total of two and a half billion barrels.

On the basis of this estimate, Standard Oil has let a contract for the construction of a new refinery at Mandan and a 215-mile products pipeline from Mandan to Moorhead, Minnesota. A crude oil pipeline of 170 miles will be completed by the time the refinery is ready for operation and a pipeline gathering system of about 40 miles already has been built.

Construction activities such as these and the tireless search for oil are jobs that never end in the petroleum industry.

Young technical men at Standard Oil have found that there still are many exciting frontiers to explore with a company that is constantly building, constantly looking to the future.

Standard Oil Company

910 South Michigan Avenue
Chicago 80, Illinois

STANDARD

CYBERNETICS . . . .

(Continued from page 50)

own, and the kinaesthetic mechanism of the stump is fully adequate to report its own position and velocity. This is not the case of the articulated limb with a mobile knee and ankle, thrown ahead by the patient with the aid of his remaining musclature. He has no adequate report of their position and motion, and this interferes with his sureness of step on an irregular terrain. There does not seem to be any insuperable difficulty in equipping the artificial joints and the sole of the artificial foot with strain or pressure gages, which are to register electrically or otherwise, say through vibrators, on intact areas of skin. The present artificial limb removes some of the paralysis caused by the amputation, but leaves the *ataxia*. With the use of proper receptors, much of this ataxia should disappear as well, and the patient should be able to learn reflexes such as those we all use in driving a car, which should enable him to step out with a much surer gait."

There is one example of what is hoped for. Another was started in a review, in which Wiener presented the experimental data about a device that would help a deaf person to monitor his own speech, thus making it more intelligible to his listeners. A person who is almost completely deaf usually has a small segment of the audible spectrum still somewhat usuable, and will tend to confine his voice to that region. This causes his voice to sound unnaturally harsh, and often un-intelligible, to listeners. The theory of the device is quite simple: some sort of microphone (see fig. 5) picks up the sound of the deaf person's voice and feeds it into a system of filters, each of which will pass frequencies of less than one octave. Since the human voice rarely covers four octaves, and then only with effort, this means that bands of frequencies can be well defined. As long as there are appreciable amounts of sound energy in a given frequency range, what passes through a particular filter will activate a vibrator, which contacts a given finger. By knowing which finger corresponds to which frequency band-pass filter, the deaf person can modulate

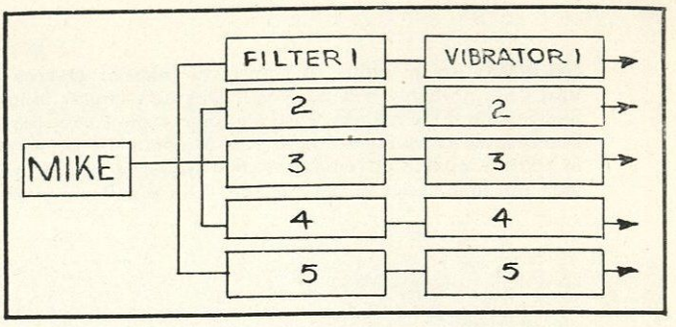


Fig. 5.

his voice more readily and cause it to be more intelligible. All this system does is create a feedback path, with reduced sensitivity, naturally, to replace the lost circuit of the ear.

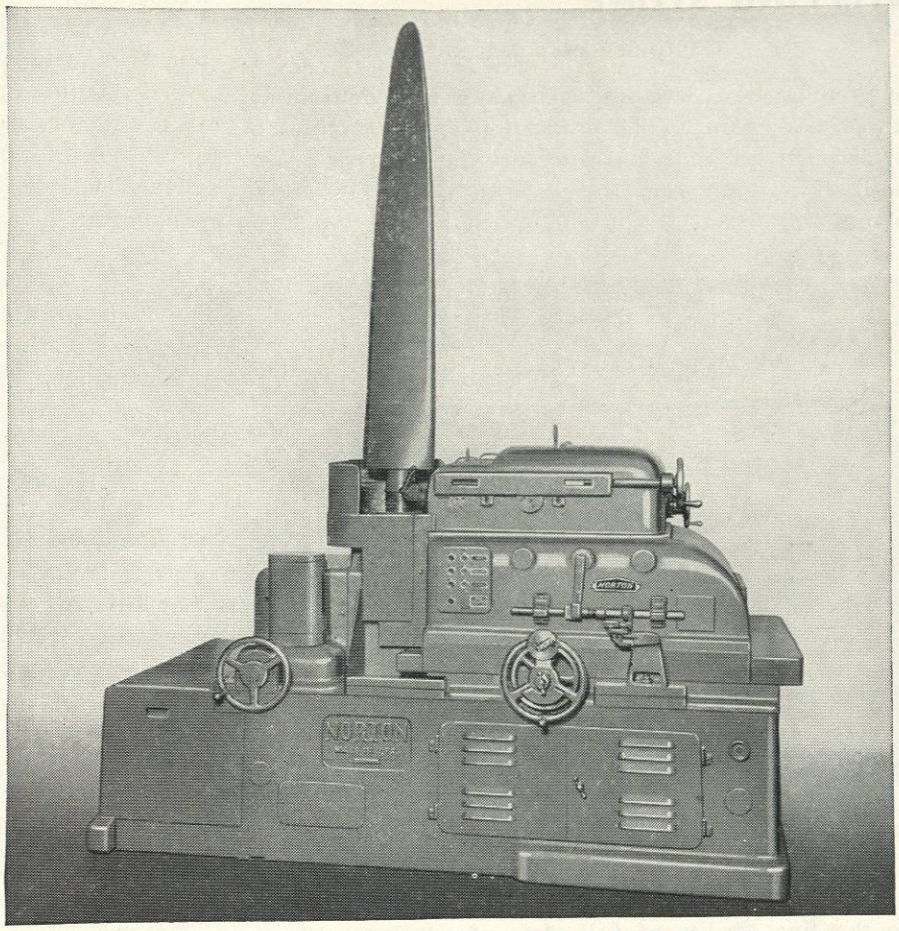
Perhaps the most important, possibly immediate, practical application of cybernetic theories is in the field of manufacturing plants. A computer of the present electronic type is in principle an ideal central nervous system by which a vast array of position-indicating devices—servo-mechanisms, strain gages, pressure gages, and photo-electric gages, motors, solenoids, and similar devices, could be co-ordinated and controlled. With the aid of these agencies to provide "sensory" data, and to do work, we are already in a position to construct machines of almost any degree of elaborateness of performance. "The automatic factory and the assembly-line without human agents are only so far ahead of us as is limited by our willingness to put such a degree of effort into their engineering as was spent, for example, in the development of the technique of radar in the second World War," says Wiener. "It gives the human race a new and most effective collection of mechanical slaves to perform its labor. Such mechanical labor has most of the economic properties of slave labor, although unlike slave labor, it does not involve the direct demoralizing effects of human cruelty. However, any labor that accepts the conditions of competition with slave labor, accepts the conditions of slave labor and is essentially slave labor. The key word of this statement is *competition*.

"Perhaps I may clarify the historical background of the present situation if I say that the first industrial revolution, the revolution of the 'dark satanic mills,' was the devaluation of the human arm by the competition of machinery. There is no rate of pay at which a United States pick-and-shovel laborer can live which is low enough to compete with the work of a steam shovel as an excavator. The modern industrial revolution (which will occur when there is sufficient pressure to force the development of automatic factories out of present theory into future reality, as hapened in an amazingly short time with radar—*author's note*) is similary bound to devalue the human brain at least in its simple and more routine decisions. Of course, just as the skilled carpenter, the skilled mechanic, the skilled dressmaker have in some degree survived the first in-

(Continued on page 62)

What Is this Machine?

- ☐ *a vertical miller*
- ☐ *a grinding machine*
- ☐ *a broaching machine*
- ☐ *a contour shaper*



It is a grinding machine — specifically, the new Norton Propeller Blade Hub Grinder, used to grind the external surfaces of the hubs of aircraft propeller blades

A Typical Norton Development

This specialized Norton machine brings unusual efficiency to propeller grinding operations. As shown, the propeller blade is held *vertically* — by a workholding fixture on a work spindle with an anti-friction bearing — a new departure that avoids the errors normally caused by deflection when the blade is held *horizontally*, as in conventional methods.

The new Norton grinder has many other improved features adding up to greater speed, accuracy and simplicity of operation. And it requires considerably less floor space than do horizontal machines adapted for the same purpose.

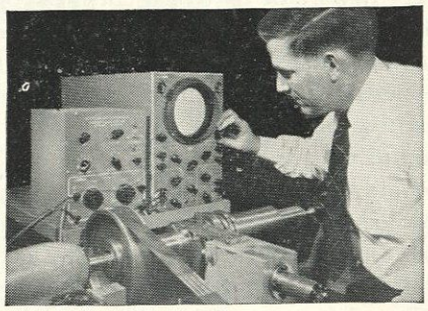
The Broadest Line

The Norton line of grinders and lappers is the most complete offered by any single manufacturer. It runs from small machines for the tool room to high precision, high volume units for heaviest production line duty. Equipped with Norton abrasive wheels these machines form unbeatable combinations for efficient, economical grinding.

To Future Technicians

As the world's largest manufacturers of abrasives and abrasive products, Norton supplies basic tools to all industry. To young men now planning ahead, a career with Norton offers exceptional opportunities for "making better products to make other products better."

Free Booklet describes and illustrates representative types of Norton grinding and lapping machines. Write for your copy.



Guy D. Metcalf, B. S., E. E., Worcester Polytechnic Institute '49, checks smoothness of master cam spindle with specially designed electronic equipment — in connection with his work on Norton cam and contour grinders.

NORTON

TRADE MARK REG. U. S. PAT. OFF.

Making better products to make other products better

ABRASIVES · GRINDING WHEELS · OILSTONES · ABRASIVE PAPER & CLOTH

REFRACTORIES, POROUS MEDIUMS & LABORATORY WARE · NON-SLIP FLOORING

GRINDING & LAPPING MACHINES · BORON CARBIDE PRODUCTS

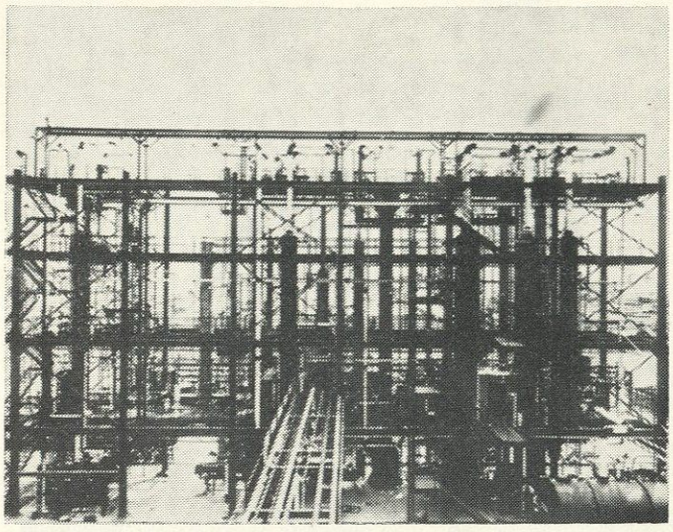
NORTON COMPANY, WORCESTER 6, MASSACHUSETTS

BEHR-MANNING, TROY, N. Y. IS A DIVISION OF NORTON COMPANY

STEPPING STONE . . . .

(Continued from page 10)

by-products by economical methods is first determined in the pilot plant. The production and separation of by-products in sufficient quantity for favorable disposition is a problem first met in the experimental plant.



The chemicals separation unit, shown here, is the last step in the Carbide process.

The pilot plant is indeed a vital stepping stone to the final reality of full scale production. It is a very important part of a chemical process development. The development of a chemical process is a skilled job—perhaps the highest form of scientific and technical expertise—for it requires the exercise of a highly inventive imagination coupled with the adherence to sound practical principles. The basic rules are common to most processes, but the development of a successful prototype requires the specialized knowledge which can be found only among a group of men with a wide variety of scientific and technological backgrounds. Pilot plant work offers chemical engineers a challenge—a challenge to help raise our standard of living through the tools of chemistry.

CAMPUS NEWS . . . .

(Continued from page 11)

Evens, fell from the instrument and fractured his leg. He returned just in time to spend the last three days giving oral instructions for adjusting the optical components. This job was completed just four hours before the eclipse. Another crisis arose when the electronic guiding system failed just four minutes before deadline. Everything had been built in duplicate for just such an emergency, and a simple turn of a switch threw in a standby guider.

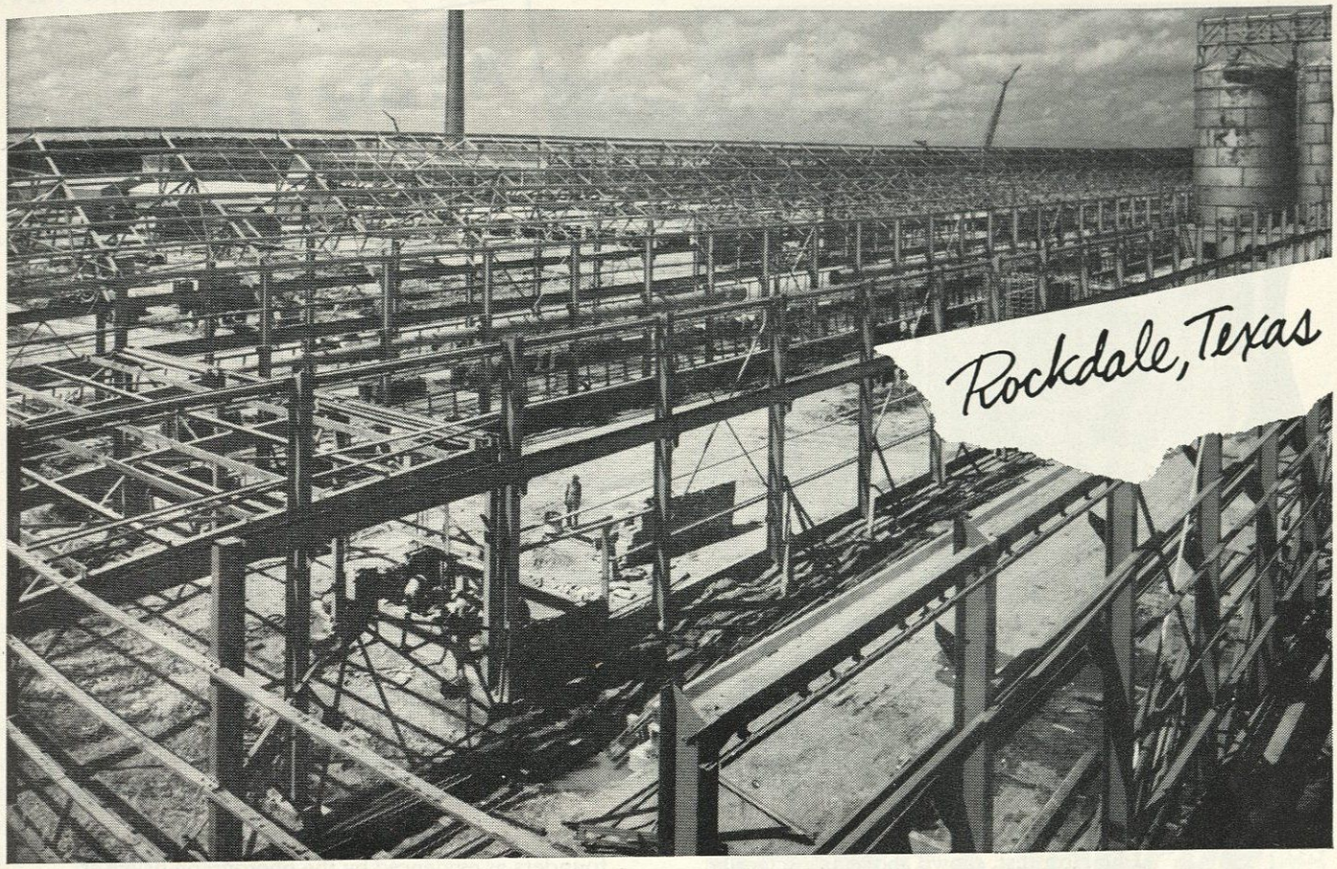
The important result of the expedition is that it succeeded in obtaining many spectra of very high quality, though not all that had been planned. Many months will be required for analyzing the spectrograms, but it is quite certain that the High Altitude Observatory staff obtained data never before recorded. When all the factors are finally sorted out and evaluated, it is quite possible that the evidence will settle the controversy between the "low temperature" and the "high temperature" solar scientists.

Pictures of coeds in gym bloomers may cause a few snickers but the bloomer girls had more stamina than today's coeds. That is the belief of Clare Small, director of women's physical education at the University of Colorado. Although there has been much progress made in physical education for women, the vitality and stamina of coeds have decreased during the years because of fundamental changes in the way people live and work. Today's young women have less stamina because they ride everywhere instead of walking; they also sit too much and live less active lives than their parents. Furthermore, many college girls work in the summer instead of going to the mountains or the seashore for a month of recreation as they used to do. The stamina of our young people may decrease even more, Miss Small warned. Our children spend a great deal of their time reading comic books, going to movies, and looking at television instead of playing the outdoor or indoor games that develop healthy bodies, stamina, and character. This inactivitity is a threat to our national vitality, she believes.

By observing a coed play a game, much can be learned about her personality. Is she fair about rules? Does she do her part to win? Do her teammates like her? Miss Small says that if you really want to know a coed you should play a game with her.

The booming science of physics has a new setting this year in the recently completed $655,000 physics building. In the building's four floors and sub-basement are twenty-eight laboratories covering everything from electronics to optics. One of the outstanding features of the new building is a large lecture room with a capacity of 300 people. The classrooms in the new building seat up to thirty students. Laboratory capacity ranges from fifteen for graduate to twenty-eight for undergraduate students. There are about ten small, individual research rooms for graduate students.

About 140 physics students are enrolled at Colorado university, including eighty engineering physics majors, thirty-five arts and sciences, and forty-five graduates. Among research efforts handled by the physicists at Colorado for the government is a large contract for study of the upper atmosphere. Approximately twenty-five scientists are in this project regularly.

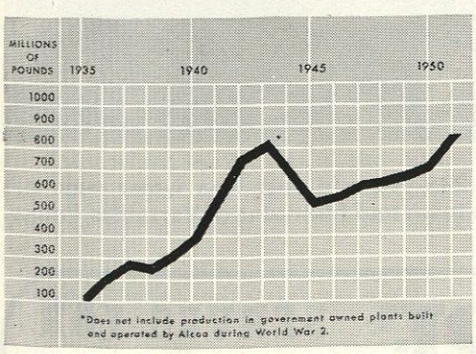


Is part of your future being built here?

Here you see the beginning of another addition to Alcoa's expanding facilities. This plant, at Rockdale, Texas, will be the first in the world to use power generated from lignite fuel and will produce 170 million pounds of aluminum a year. This and other new plants bring Alcoa's production capacity to a billion pounds of aluminum a year, four times as much as we produced in 1939. And still the demand for aluminum products continues to grow. Consider the opportunities for you if you choose to grow with us.

What can this mean as a career for you?

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.

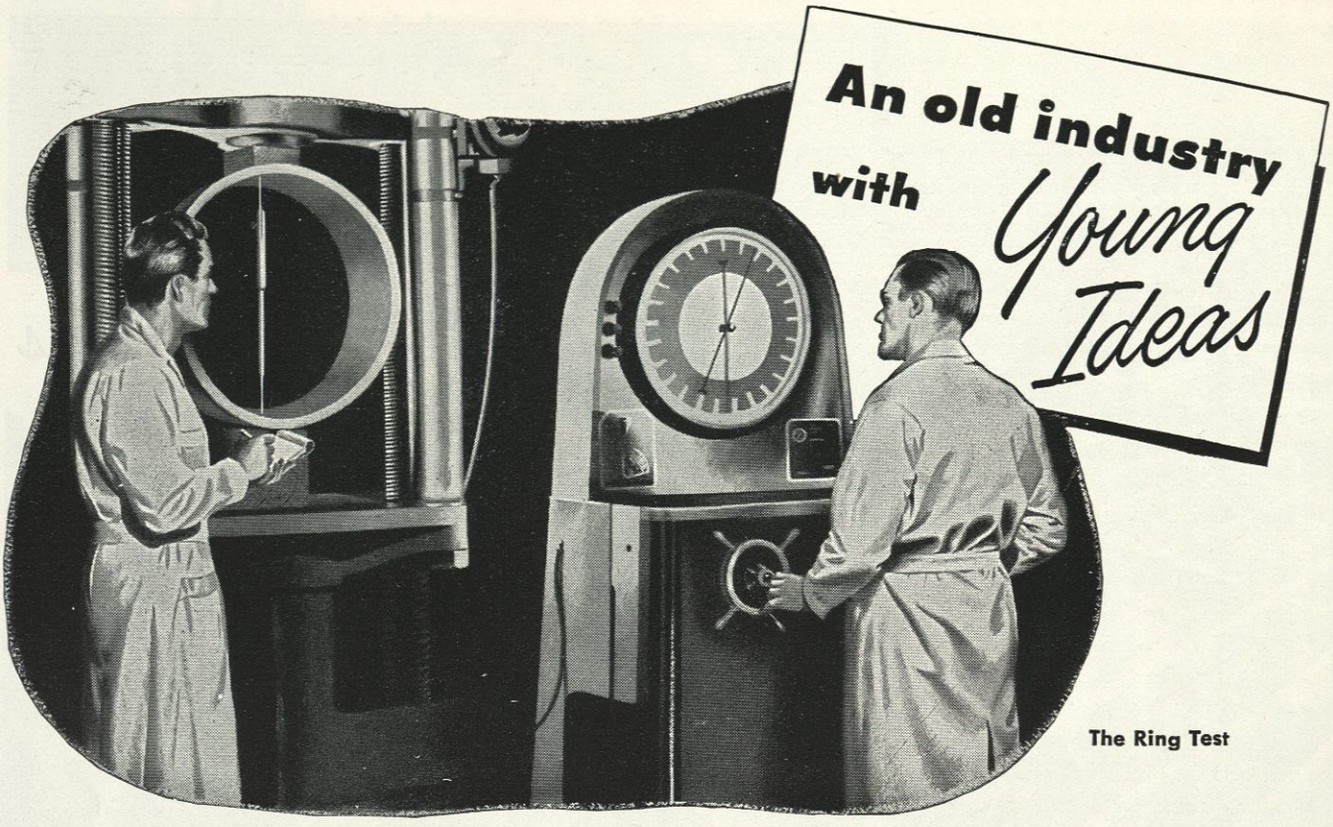


Ever-expanding Alcoa needs engineers, metallurgists, and technically minded "laymen" for production, research and sales positions. If you graduate soon, if you want to be with a dynamic company that's "going places," get in touch with us. Benefits are many; stability is a matter of proud record; *opportunities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

For more facts, consult your Placement Director.

Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA



The Ring Test

The ring test, shown above, is a scientific method for determining the modulus of rupture of pipe. It is not a required acceptance test but one of the additional tests made by cast iron pipe manufacturers to ensure that the quality of the pipe meets or exceeds standard specifications.

A ring, cut from random pipe, is subjected to progressively increased crushing load until failure occurs. Standard 6-inch cast iron pipe, for example, withstands a crushing weight of more than 14,000 lbs. *per foot.* Such pipe meets severe service requirements with an ample margin of safety.

Scientific progress in the laboratories of our members has resulted in higher attainable standards of quality in the production processes. By metallurgical controls and tests of materials, cast iron pipe is produced today with precise knowledge of the physical characteristics of the iron before it is poured into the mold. Constant control of cupola operation is maintained by metal analysis. Rigid tests of the finished product, both acceptance tests and routine tests, complete the quality control cycle. But with all the remarkable improvements in cast iron pipe production, we do not forget the achievements of the early pipe founders as evidenced by the photograph below of cast iron pipe installed in 1664 to supply the town and fountains of Versailles, France and still in service. 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 Ave., Chicago 3, Illinois.

Section of 285-year-old cast iron water main still serving the town and fountains of Versailles, France.

CAST IRON PIPE SERVES FOR CENTURIES

VAN DE GRAAFF . . . .

(Continued from page 13)

desired. If the chamber is filled with helium, alpha particles will be produced. A tank of deuterium is used to produce deuterons, and a tank of hydrogen is used to produce protons. If the machine is to accelerate electrons, these are produced by thermoionic emission at a heated tungsten filament.

The control of the variable quantities about the ion source has always presented a great problem because it operates between ground potential and the ion source which is at several million volts. It was once proposed that the scientists themselves work in the corona cap and regulate the ion source, because there is no electric field inside the corona cap even though it may be at several million volts. This idea was discarded because there is often a stray flux of neutrons which would represent a health hazard. Strings and rods of insulating material were developed to use in the control, but these were not only a disadvantage because they occupied a large amount of the limited space around the ion source, but they presented a difficulty in that they were moving parts that had to be brought from ground to high potential in the sealed tank. An even greater disadvantage was that the strings, subjected to such high potentials, often caught fire and were destroyed. In more recent generators, the ion source is controlled by a photoelectric unit. A light beam modulated by an audio-oscillator is transmitted to a phototube located at the ion source and from there is channeled into a group of frequency selecting units. Each of these units adjusts one of the variable quantities.

The Van de Graaff generator is being utilized in many fields because of its simplicity and versatility. One of the many uses of this accelerator is in physics research. Atomic nuclei can be bombared with high energy particles to produce still other particles. A convenient source of neutrons for neuclear reactions is had by bombarding deuterium (in the form of frozen heavy water or other deuterated hydrocarbons) with acceleration deuterons. Neutrons produced in this manner are nearly monoenergetic, and their energy may be controlled by controlling the deuteron energy.

Some elements can be transformed into others by bombarding them with neutrons and protons. A practical example of this is the production of radioisotopes used as tracers by chemical and medical researchers.

High energy particles produced by such an accelerator are also used in the systematic investigation of the force fields which exist around the nucleus of the atom. In this study, the angular distribution of particles bombarding a thin scattering foil is measured as a function of the energies of the particles.

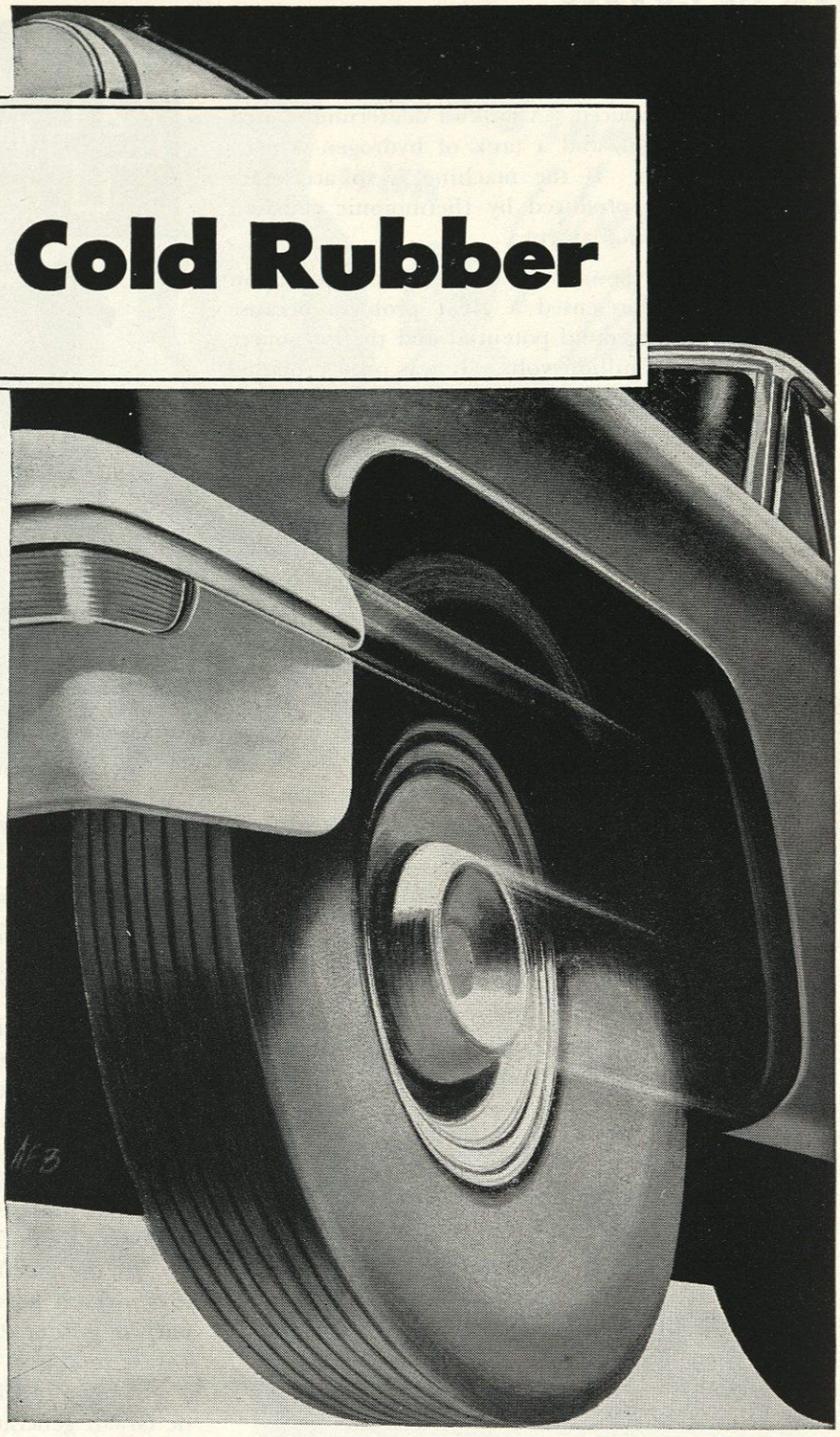
Medical and industrial radiologists are using the Van de Graaff type generator because of its compactness and simplicity. When accelerated electrons are stopped by a target of an element with a high atomic number, X-rays are emitted. The high voltages available with the electrostatic generator of this type make it possible to obtain a well collimated beam of deeply penetrating radiation. Medical radiology uses these X-rays of greater penetrating ability to treat deep seated malignant growths. Not only are theses X-rays able to reach tumors located deep within the body, but the scattering produced in the first layers of the skin is not so great as with the lower voltage source radiations. This diminished scattering effect makes possible the administration of greater dosages of radiation, before limited by the radio-sensitivity of the skin.

In the metals industry, these more penetrating X-rays make it possible to X-ray castings and other metal parts of greater thicknesses than could be examined with X-rays produced by lower voltage sources.

Among other uses, electrons accelerated in the Van de Graaff generator may be used in the future to sterilize foods and drugs which would otherwise be harmed by heat treatment. Streams of electrons can be used to destroy bacteria without heating the substance in which the bacteria are present.

In recent years large industrial laboratories have shown an increasing interest in the tools of physics for the development of better products and better methods of production. The Van de Graaff generator is one of these tools, and today these generators are manufactured and sold in a number of sizes and styles to suit needs of a wide range of commercial, medical, and research applications.

Shift to Cold Rubber



CHEMICAL PROBLEM . . .

. . . automobile tires that last longer under the heat and abrasion caused by today's higher operating speeds.

SOLUTION . . .

. . ."cold rubber," so called because it is made at 5° C. Cold rubber production requires a special emulsifier to bring together its basic ingredients—butadiene and styrene—under refrigerated conditions. The emulsifier found most satisfactory today, as when GRS-10 was introduced in World War II, is Dresinate®—one of many chemical materials produced by Hercules for the rubber industry.

COLLEGE MEN . . .

This is but one example of the far-reaching chemical developments in which you could participate at Hercules—in research, production, sales, or staff operations. It suggests the ways Hercules' products serve an ever-broadening range of industries and end-uses.

Hercules' business is solving problems by chemistry for industry . . .

. . . insecticides, adhesives, soaps, detergents, rubber, plastics, paint, varnish, lacquer, textiles, paper, to name a few, use Hercules® synthetic resins, cellulose products, chemical cotton, terpene chemicals, rosin and rosin derivatives, chlorinated products and other chemical processing materials. Hercules® explosives serve mining, quarrying, construction, seismograph projects everywhere.

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an AIRCRAFT engineer?

But I haven't majored in aeronautical engineering

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It's your aptitude, your knowledge of engineering principles, your degree in engineering that count.

Those—plus the opportunity Lockheed is offering you—are all you need for a career as an aircraft engineer. In Lockheed's special program for engineering graduates, you may go back to school, or you may convert to aircraft work by doing—on-the-job training. But whichever it is, you receive full pay while learning.

But Lockheed offers you more than a career. It offers you a new life, in an area where living conditions are beyond compare. Outdoor living prevails the year-'round. Mountains, beaches are an hour from Lockheed.

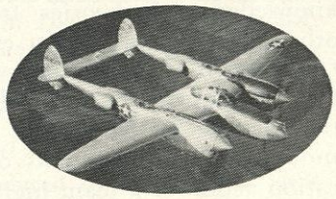
See your Placement Officer today for the details on Lockheed's Aircraft Training Program for engineers, as well as the better living conditions in Southern California.

If your Placement Officer is out of the illustrated brochures describing living and working conditions at Lockheed, write M. V. Mattson, Employment Manager

Lockheed Aircraft Corporation

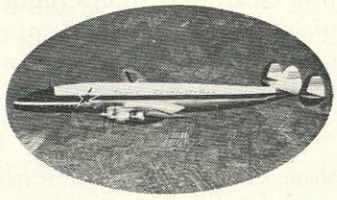
Burbank, California

This Plane made History



The P-38 Lightning – first 400 mile per hour fighter-interceptor, the "fork-tailed Devil" that helped win World War II.

This Plane is making History



The Super Constellation – larger, faster, more powerful; the plane that bridges the gap between modern air transport and commercial jet transport.

This Plane will make History

The jet of the future—the plane you will help create—belongs here.

This plane – which exists only in the brain of an engineer like yourself – is one reason there's a better future for you at Lockheed. For Lockheed will always need engineers with ideas, engineers with imagination, engineers who build the planes that make history.

CYBERNETICS . . . .

(Continued from page 54)

dustrial revolution, so the skilled scientist and the skilled administrator may survive the second. However, taking the second industrial revolution as accomplished, the average human being of mediocre attainments or less has nothing to sell that is worth anyone's money to buy."[5] Wiener predicts this development in fifty years under normal conditions, five to ten years under wartime pressure.

There are more pleasant aspects of the science than the last quotations. In "Conference on Cybernetics"[6] there are presented several papers on as many different aspects of our life. Each paper is followed by a transscription of the discussion which took place among those present: those people were outstanding members of their own profession or field, such as Margaret Mead, F.S.C. Northrup, John Stroud, Leonard J. Savage, and Norbert Wiener. The papers and discussions covered such diverse subjects as "The Psychological Moment of Perception," "Neurotic Potential and Human Adaptation," "A Quantum Theory of Memory," "Recall and Recognition," and "Sensory Prothesis." The participants, in discussing those papers, fought out matters of terminology and relative meanings of words among the sciences they represented, and they carried over knowledge and theories from their own fields into other branches of human experimentation. They carried away knowledge which will be disseminated through their own work into the fields they represent. Eventually, the concepts of the various sciences, the methods, techniques, and developments of each, through the codification action of a team highly skilled men and women, working together for common interest, will do much to change the world as we know it. It carries all the threats and temptations of the second industrial revolution Wiener discusses, to the eventual joys of effective joys of artificial limbs, understanding of the mechanism of human memory, reason, control, and its possible concommitants in terms of a world which understands itself, in all its diversity of science, language, and habits.

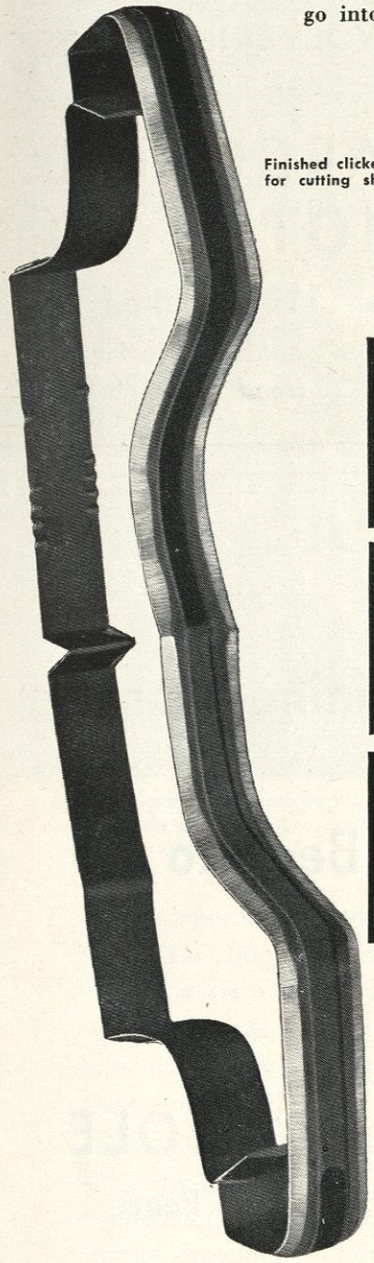
1. *Cybernetics,* Norbert Wiener, Wiley.
2. *Ibid.* p. 8.
3. *A Mathematical Theory of Communication,* by Claude E. Shannon, Bell Monograph B-1598.
4. *Op. Cit.* Wiener.
5. *Ibid.*
6. *Conference on Cybernetics,* 1949 ,John R. Wiley and Sons.

What's Happening at CRUCIBLE

about clicker die steel

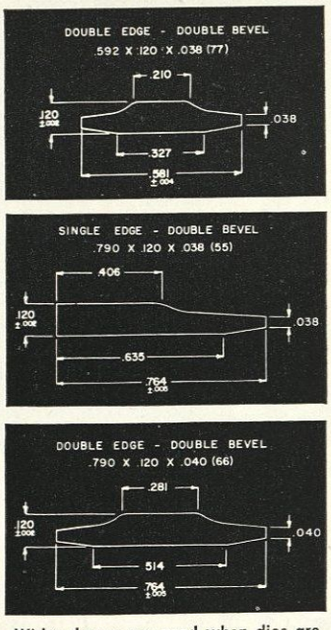
what it is

Clicker die steel is a special cold rolled alloy steel. It is used in making clicker dies for cutting leather, rubber, plastic, felt and fabrics of other compositions that go into the making of shoes and similar products.



Finished clicker die ready for cutting shoe leather.

Some of the clicker die steel standard shapes.



Wider shapes are used when dies are sized by surface grinding after forming and welding. Standard widths are provided when the dies are not to be surface ground.

how it is used

Clicker die steel is furnished to the die maker in either single or double edged form in one of several standard shapes. The die maker first shapes the die by bending the die steel to a pattern that provides the desired configuration, and then welds the two ends at a corner. He finishes the die by grinding a bevel on the outside of the cutting edge and filing the inside edge. Before the finished die is hardened and tempered, the die maker forms identification marks — combinations of circles and squares — in the cutting edge so that the material cut from it may be easily identified as to its size and style.

In the cutting operation, the leather or other material is placed on an oak block in the bed of the clicker machine. Then the die is placed by hand on the material which is cut as the aluminum faced head of the machine presses the die through it. The clicking sound which the head makes as it strikes the die is where the term "clicker machine" derived its name.

what it is composed of

Clicker die steel as produced by the Crucible Steel Company of America is a controlled electric steel in which the combination of carbon and alloy is designed for maximum toughness and proper hardness after heat treatment.

Experience has proved that cold finished clicker die steel is superior to hot rolled material for sizes approximately $\frac{3}{4}$ inch and narrower because of its lower degree of surface decarburization which permits the use of slightly thinner sections. Cold finished material also has a better surface finish with closer width and thickness tolerances and thinner edges that require less grinding and filing to complete the die.

CRUCIBLE'S engineering service

As with clicker die steel, the Crucible Steel Company of America is the leading producer of special purpose steels. If you have a problem in specialty steels, our staff of field metallurgists with over 50 years experience in fine steel making is available to help you solve it. Crucible Steel Company of America, General Sales and Operating Offices, Oliver Building, Pittsburgh, Pa.

CRUCIBLE first name in special purpose steels

53 years of Fine steelmaking

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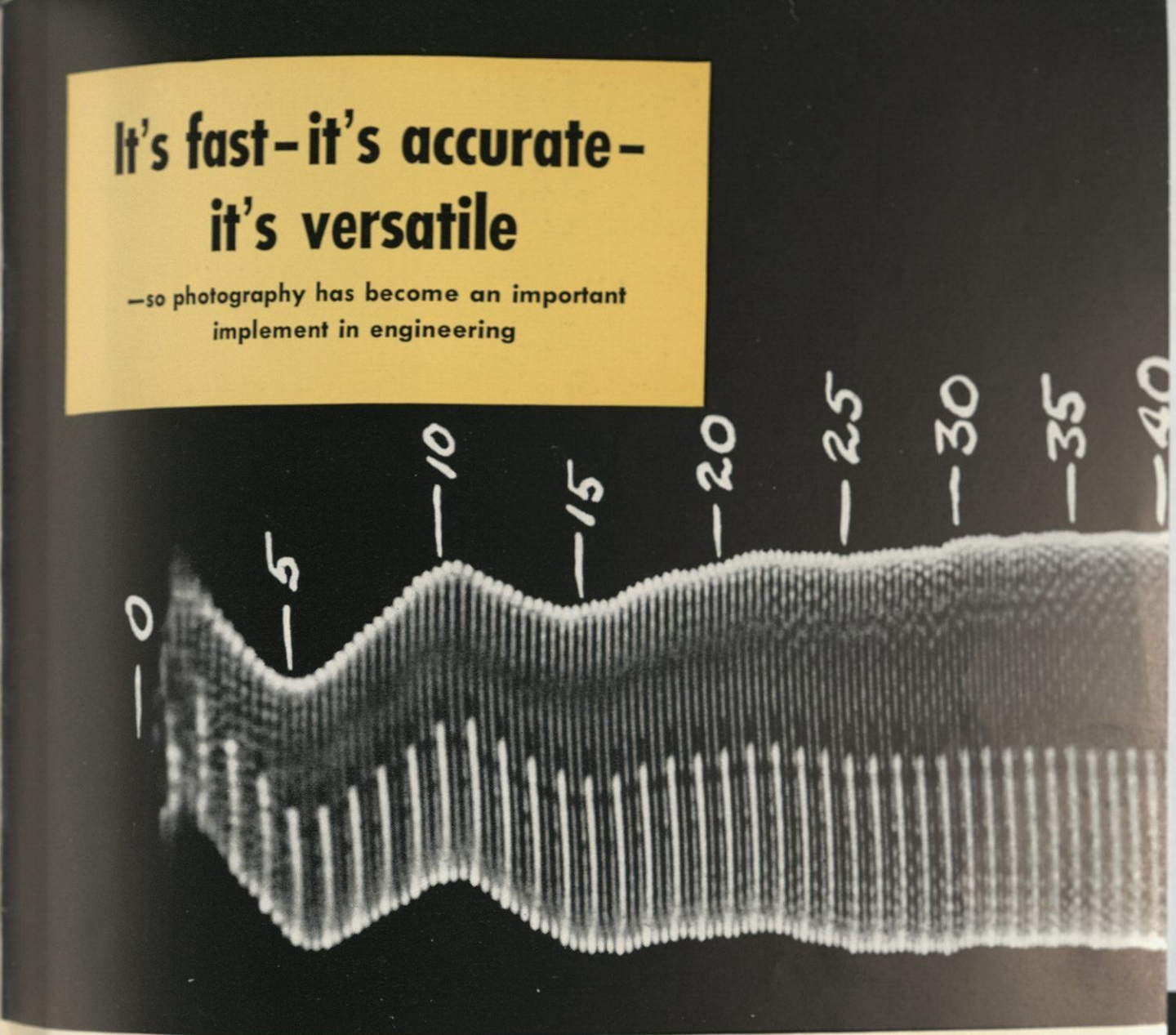
—so photography has become an important implement in engineering



This picture is a photographic recording of a cathode ray oscilloscope trace which shows the speed of the reaction of lithium borohydride with an aqueous acid solution.

PHOTO COURTESY OF THE DEPARTMENT OF CHEMISTRY, ILLINOIS INSTITUTE OF TECHNOLOGY, CHICAGO, ILL.

• In the laboratory, in the design department, the production shop and assembly line, in fact all through modern engineering operations, photography is revealing new information, recording facts, aiding new developments, saving time and conserving effort.

Photography can capture the fleeting flick of the cathode ray, trace, and record important engineering information. It can reproduce engineering drawings—microfilm valuable data for easy transportation or space-saving storage. And high speed movies can slow down fast motion so that it can be seen and studied.

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MY QUESTION TO THE G-E STUDENT INFORMATION PANEL:

"How does your business training program prepare a college graduate for a career in General Electric?"

...CHARLES O. BILLINGS Carnegie Institute of Technology, 1954

The answer to this question, given at a student information meeting held in July, 1952, between G-E personnel and representative college students, is printed below. If you have a question you would like answered, or seek further information about General Electric, mail your request to College Editor, Dept. 123-2, General Electric Company, Schenectady, New York.

R. J. CANNING, *Business Training Course* . . . General Electric's business training program offers the college graduate the opportunity to build a career in the field of accounting, finance, and business management in one of the most diversified companies in the country.

Since its beginning in 1919, more than 3,000 students have entered the program—one of the first training programs in business to be offered by industry.

The program's principal objective is to develop men well qualified in accounting and related business studies, men who can become administrative leaders in the financial and general business activities of the Company.

Selection of men for the program is based on interviews, reviews of students' records, and discussions with placement directors and faculty members. Selection is not limited solely to accounting and business administration majors. A large number of men in the program are liberal arts graduates, engineers, and men with other technical training.

When a man enters the program he is assigned a full-time office position in accounting or other financial work and enrolled in the formal evening education program. This planned classroom work is a most important phase of the program. The material presented is carefully selected and well integrated for the development of an adequate knowledge of accounting and business theory, procedures and policies followed by the Company, acceptable accounting and business practices of the modern economic enterprise, and as a supplement to the practical experience provided by the job assignment.

In general, the program trainee is considered in training for three years during which time advancements are made to more responsible types of accounting work. After completing academic training the trainee's progress and interests are re-examined. If he has demonstrated an aptitude for financial work he is considered for transfer to the staff of traveling auditors or to an accounting and financial supervisory position. From here his advancement opportunities lie in financial administrative positions throughout the Company. Trainees showing an interest and aptitude for work other than financial, such as sales, purchasing, community relations, publicity, etc., are at this time considered for placement in these fields.

Today, graduates of the program hold responsible positions throughout the entire organization. Management positions in the accounting and financial field throughout the Company, such as Comptroller, Treasurer, finance managers, secretaries, and others, are held in large part by graduates of the course. Men who have transferred to other fields after experience in financial work include public relations executives, managers of operating divisions and departments, presidents of affiliated Companies, officials in personnel, employee relations and production divisions, and executives in many other Company activities.

This partial list of positions now filled by former business training men is indicative of the career preparation offered by the business training program, and of the opportunities that exist for qualified men interested in beginning their careers in accounting and financial work.

You can put your confidence in—

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