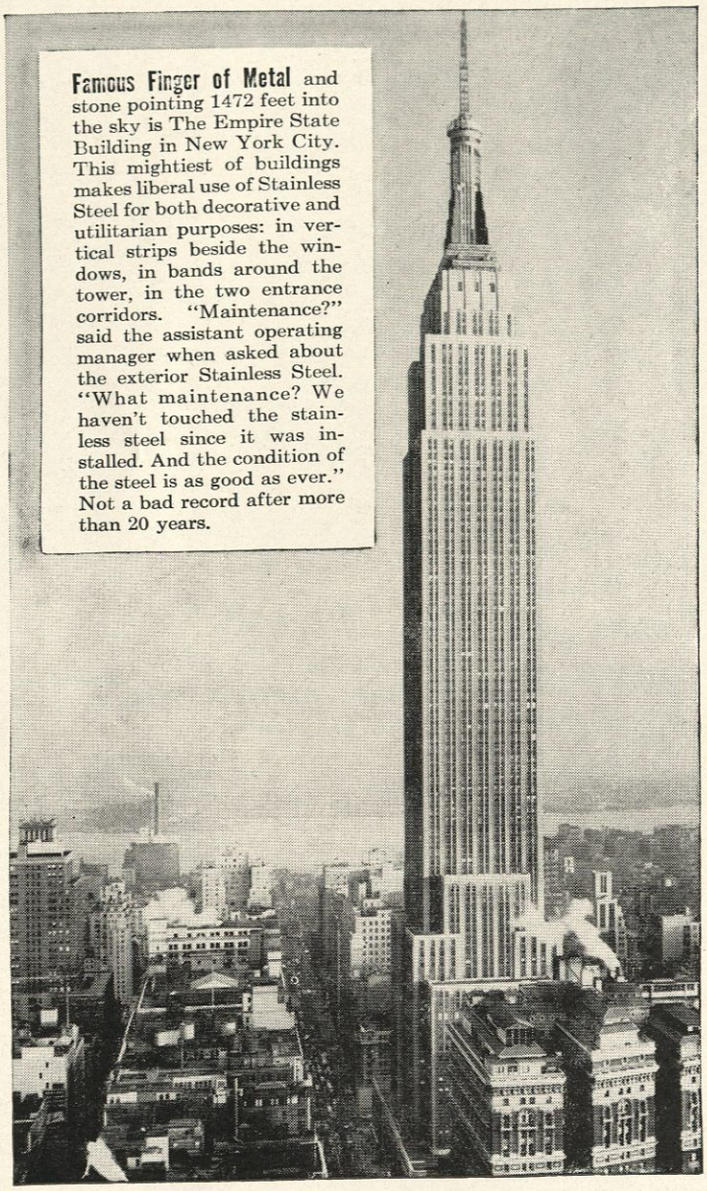
COLORADO Engineer

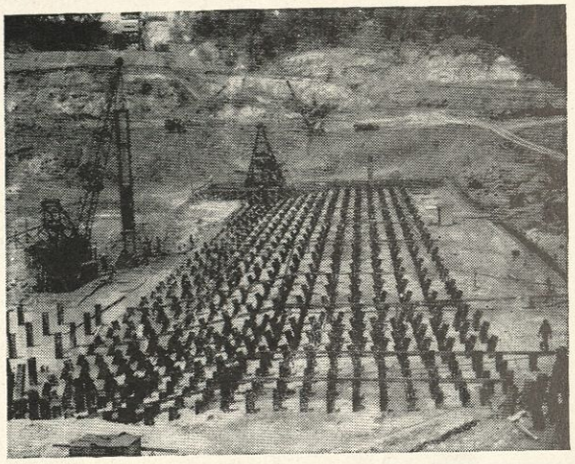
Denver Grows

NOVEMBER 15, 1954

Only STEEL can do so many jobs so well



Famous Finger of Metal and stone pointing 1472 feet into the sky is The Empire State Building in New York City. This mightiest of buildings makes liberal use of Stainless Steel for both decorative and utilitarian purposes: in vertical strips beside the windows, in bands around the tower, in the two entrance corridors. "Maintenance?" said the assistant operating manager when asked about the exterior Stainless Steel. "What maintenance? We haven't touched the stainless steel since it was installed. And the condition of the steel is as good as ever." Not a bad record after more than 20 years.



Dragon's Teeth Sprouting? No, these are steel bearing piles in the foundation of a dam spillway. When the dam is finished, you'll never know the steel piles are there. But they'll be working just the same, for strength and safety, as enduring steel so often works unseen in buildings, highways, pipelines and power plants.

This Baby Sitter is Galvanized! In truth, a sturdy, good-looking Cyclone Fence is a dependable baby sitter. For it makes a safe home playground out of your yard. It keeps youngsters, absorbed in play, from stepping accidentally into the path of passing traffic. It prevents stray dogs from molesting your children or flowers. Cyclone Fence, made by U. S. Steel, is further evidence that only steel can do so many jobs so well.

MANUFACTURED FROM USS STEEL UNITED STATES STEEL

This trade-mark is your guide to quality steel

OPPORTUNITIES WITH U. S. STEEL

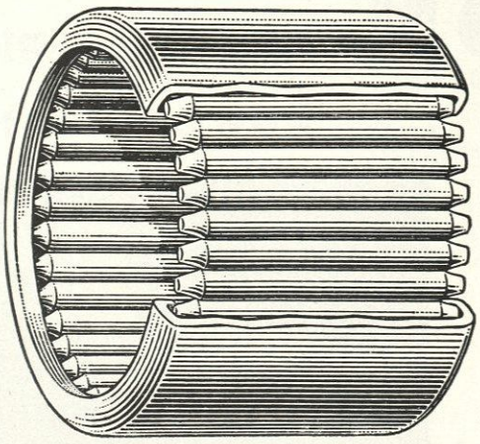
If you're thinking about what you're going to do after graduation . . . if you're interested in a challenging, rewarding position with a progressive company . . . then it will pay you to look into the opportunities with United States Steel. Your placement director can give you more details, or we'll be glad to send you the informative booklet, "Paths of Opportunity." United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

UNITED STATES STEEL

For further information on any product mentioned in this advertisement, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

AMERICAN BRIDGE . . AMERICAN STEEL & WIRE and CYCLONE FENCE . . COLUMBIA-GENEVA STEEL . . CONSOLIDATED WESTERN STEEL . . GERRARD STEEL STRAPPING . . NATIONAL TUBE
OIL WELL SUPPLY . . TENNESSEE COAL & IRON . . UNITED STATES STEEL PRODUCTS . . UNITED STATES STEEL SUPPLY . . *Divisions of* UNITED STATES STEEL CORPORATION, PITTSBURGH
UNITED STATES STEEL HOMES, INC. • UNION SUPPLY COMPANY • UNITED STATES STEEL EXPORT COMPANY • UNIVERSAL ATLAS CEMENT COMPANY

4-1074



This is a Torrington Needle Bearing

Designed for Today's Needs and Tomorrow's Trends—
Needle Bearings Offer A Unique Combination of Advantages

The Torrington Needle Bearing has two component parts—the full complement of relatively small diameter, thru-hardened, precision-ground rollers and a case hardened retaining shell by which they are held.

The bearing is a complete unit in itself, and is easily pressed into position in a bore machined to proper dimensions. The advantages of this unit construction in simplifying installation and speeding assembly are readily apparent.

High Radial Capacity

Of special importance is the high capacity of the Torrington Needle Bearing. This efficient anti-friction unit can carry a greater radial load than any other bearing of comparable outside diameter due to the large number of rollers. The small cross section of the bearing allows a large shaft which permits a rigid design with minimum shaft deflection.

Efficient Lubrication

The method of lubrication is another feature of the Torrington Needle Bearing. The retaining shell with its turned-in lips provides a natural reservoir for the lubricant. Thus the needle rollers turn in an oil or grease bath and continually bring up a fresh film of lubricant—insuring rotation of all moving members on a fluid film.

Low Cost

The size of the Torrington Needle Bearing, coupled with the simplicity of its construction, makes it a comparatively inexpensive anti-friction unit. Its compact size encourages simplified design which requires less material in surrounding components. This also contributes to further cost reduction.

The shaft serves as the inner race in the majority of Needle Bearing applications and therefore should be hardened and ground to proper dimensions. However, where it is desirable to use an unhardened shaft, an inner race can be supplied.

For Modern Design

Where the efficiency of anti-friction operation is desired, and where space, weight and cost are vitally important considerations, Needle Bearings provide a logical answer. That's why you will find them used in an ever-growing list of applications.

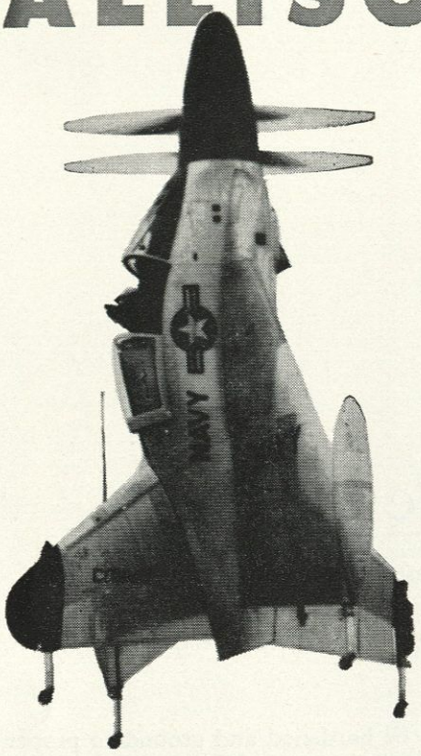
This is one of a series of advertisements designed to give you the latest engineering information on Needle Bearings. Should you have occasion to work with bearing design or wish more information, write our engineering department.

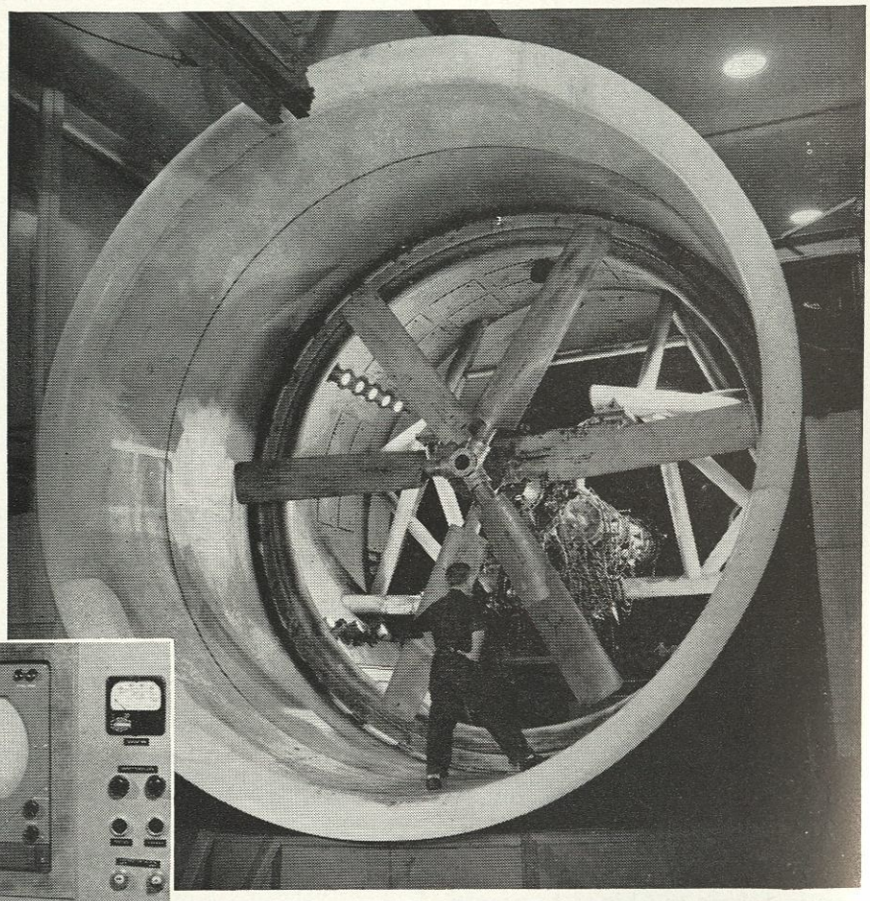
THE TORRINGTON COMPANY
Torrington, Conn. • South Bend 21, Ind.
District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON NEEDLE BEARINGS

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE ROLLERS

ALLISON Engineers Pioneer VTO Power Plant Development





GEORGE D. KEMP, who received his B.S. in Mechanical Engineering from Colorado A. and M. last June, is shown recording data on the engineering log sheet from the industrial TV screen in the VTO test cell. George—now in the Test Operations group in the Experimental Test Section at Allison—is working on the T40 turbo-prop engine which powers the Convair XFY-1 and the Lockheed XFV-1 vertical take-off aircraft.

● Early in '51, Allison undertook the power plant development for vertical take-off airplanes following the Navy's request for a high-power, low-weight turbine engine which could be adapted to vertical operation.

With modifications, the Allison T40 turbo-prop engine—with its extremely high power-to-weight-ratio—was selected to do the job. The vertical operation necessitated basic design changes, such as changing the oil system so it would function in both vertical and horizontal positions. Too, it was necessary to modify the reduction gear, giving a higher propeller RPM and increased thrust. And, with the specially designed propellers required by the VTOs, the control system was redesigned.

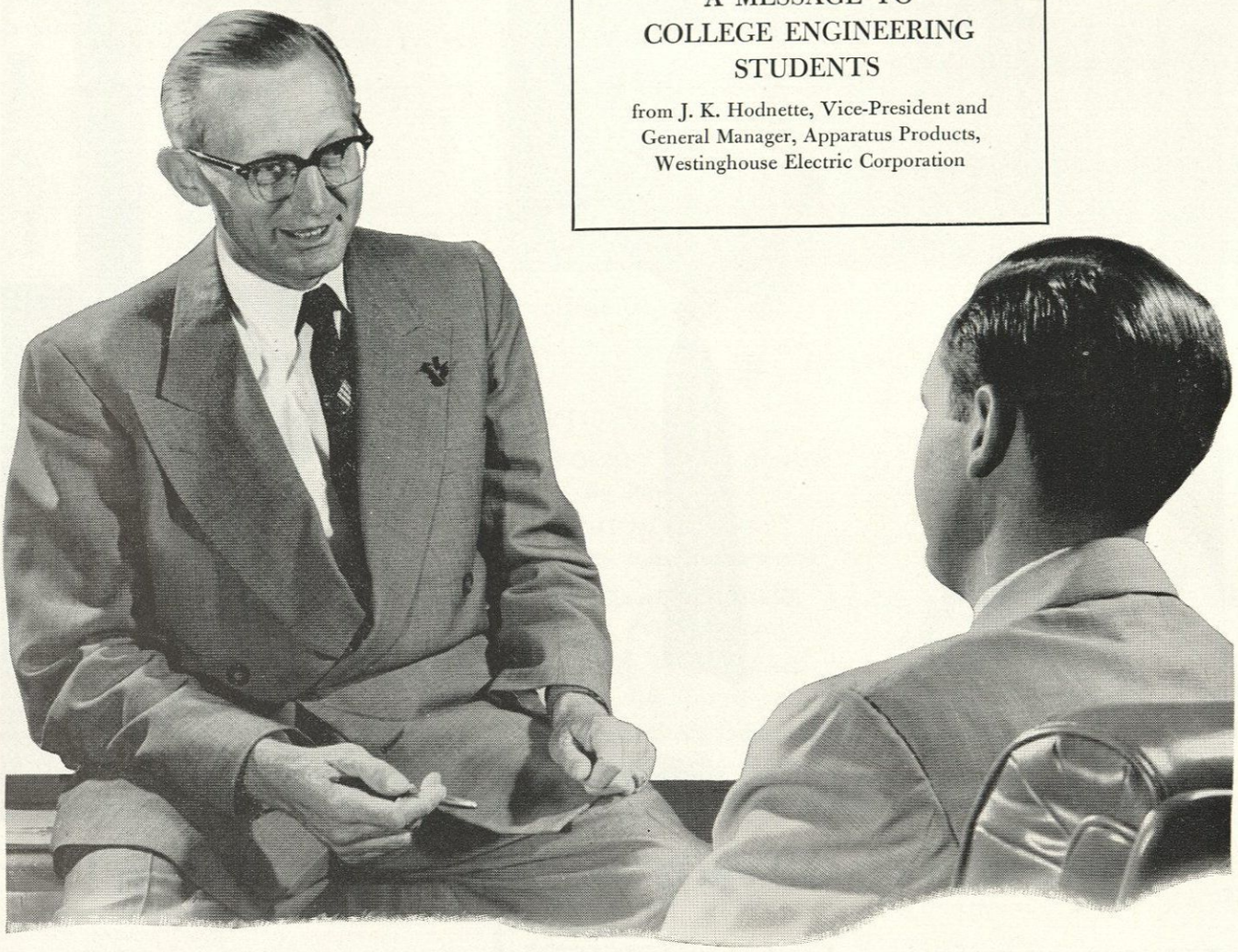
Then, to test the engine, a radically new test stand was designed and built. Allison engineers converted a test stand previously used for low horsepower reciprocating engines to one (shown above) capable of accommodating VTO engines in the various positions from horizontal to vertical. With the huge 72,000 pound tunnel completely enclosing the engine and propeller, a television was installed in the control room so engine operation could be observed in any tunnel position.

The VTO power plant project is typical of the variety of challenging problems handled by the Allison Engineering staff. And, because it is continually pioneering in advanced engineering developments, Allison needs additional technically trained men, especially young graduate engineers. Why not plan now for your engineering career at Allison. Write for information:

R. G. GREENWOOD, Engineering College Contact,
ALLISON DIVISION, General Motors Corporation,
Indianapolis 6, Indiana.

A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from J. K. Hodnette, Vice-President and
General Manager, Apparatus Products,
Westinghouse Electric Corporation



To the young man with a vision of success

Success means different things to different men. It can mean professional recognition, or great achievement, or exciting work, or many other things. Whatever its special meaning to you—keep its image in your mind, for you are already well on the way to achieving it!

If you are *determined* to become a research scientist, you *can* be. If you have a burning ambition to become a sales engineer, you can be. If you have your sights set on a top executive spot, you'll be there someday. One might think a large company like Westinghouse would have more pressing things to think of than the ambitions of its young engineers. On the contrary, nothing is more important . . . for our professional people are our biggest asset.

Here at Westinghouse, intensive efforts are made to help our professional men realize their individual goals —through extensive training programs, study programs leading to advanced degrees, leadership programs, and guidance in professional development. You are treated as an individual at Westinghouse.

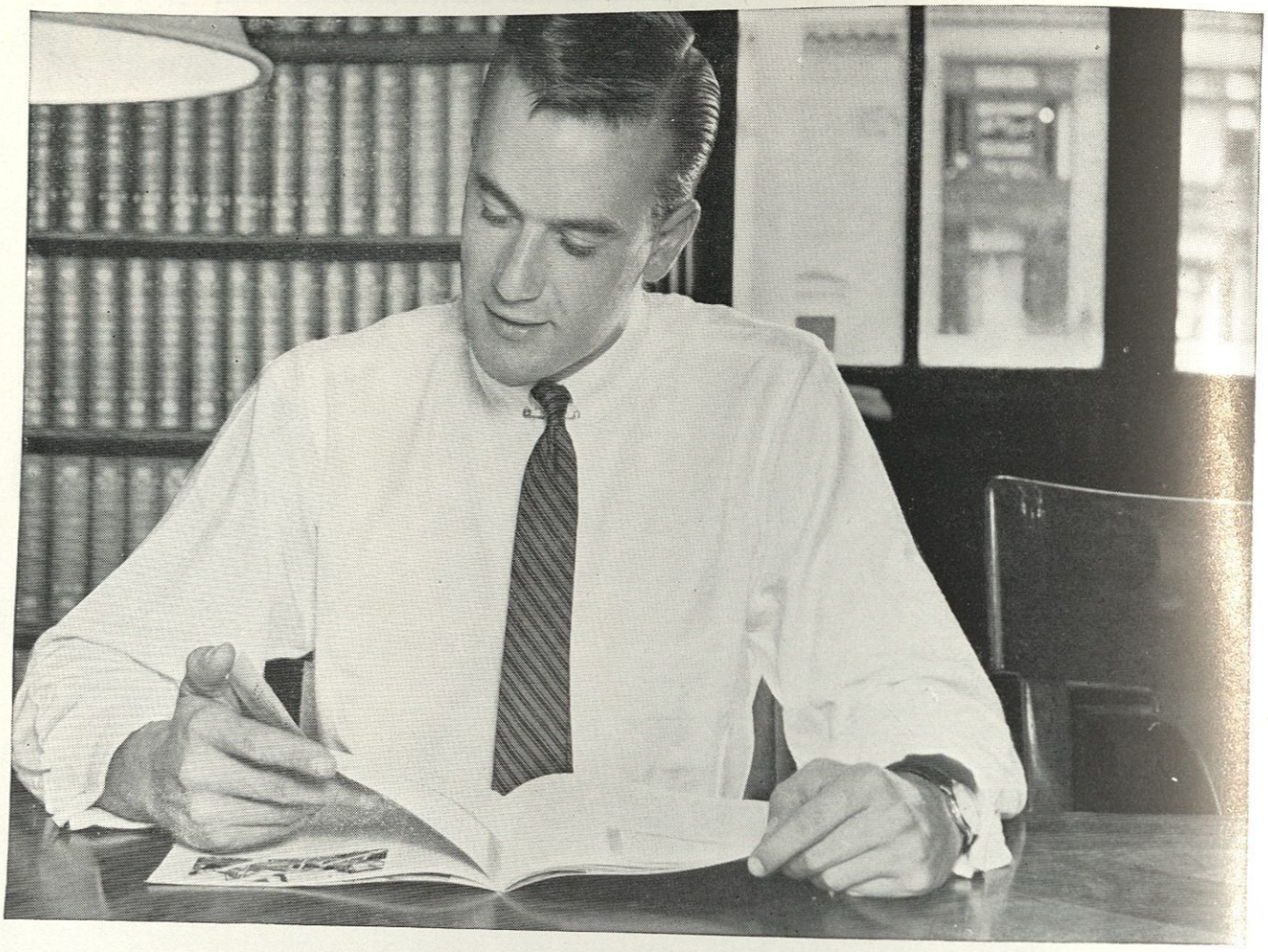
If you have the will, and are prepared, we can show you the way.

G-10271

YOU CAN BE SURE...IF IT'S
Westinghouse

For information on career opportunities with Westinghouse, consult Placement Officer of your University, or send for our 34-page book, *Finding Your Place in Industry*.

Write: Mr. R. H. Thach, Regional Educational Co-ordinator, Westinghouse Electric Corporation, 411 N. Seventh Street, St. Louis 1, Missouri.



HE'S STUDYING A GM TEXTBOOK

YES, ever since our first issue—*June-July 1953*—the *General Motors Engineering Journal* has been welcomed by engineering faculties and students alike as an excellent contemporary source book.

And we suggest, if you are not familiar with this latest of GM publications, that you check your college library.

But—this is not a "circulation advertisement" for the *Journal*.

We mention it here—because we think a glance through any issue will give you a pretty clear picture of the high standards and advanced viewpoints of our GM engineers. And of the intellectual climate they find in which to think and to work at GM.

Certainly such standards, such viewpoints—and such a climate—must be weighed among the assets of a GM career.

So, again, may we suggest you glance at the *Journal* (copies are supplied free to all faculty members and school librarians who request them). We hope it will inspire you to write us for another important GM publication—"The College Graduate and General Motors." And to think seriously of making yours a GM career.

GM Positions Now Available In These Fields:

MECHANICAL ENGINEERING
METALLURGICAL ENGINEERING
ELECTRICAL ENGINEERING
INDUSTRIAL ENGINEERING
CHEMICAL ENGINEERING

GENERAL MOTORS CORPORATION

Personnel Staff, Detroit 2, Michigan

COLLEGE OF ENGINEERING

UNIVERSITY OF COLORADO

The COLORADO Engineer

VOLUME LI, NO. 1 NOVEMBER 15, 1954

CIRCULATION: 1800

Published Four Times a Year, on the Fifteenth of November, January, March, and May by the Students, Faculty, and Alumni of the College of Engineering.

Publisher's Representative — Littell - Murray - Barnhill, Inc., 101 Park Avenue, New York 17, N. Y., and 605 North Michigan Avenue, Chicago 11, Illinois.

Entered as second-class matter March 9, 1916, at the Post Office at Boulder, Colorado, under the Act of March 3, 1879.

In This Issue

ARTICLES

SPECIAL FEATURES

SECTIONS

COVER

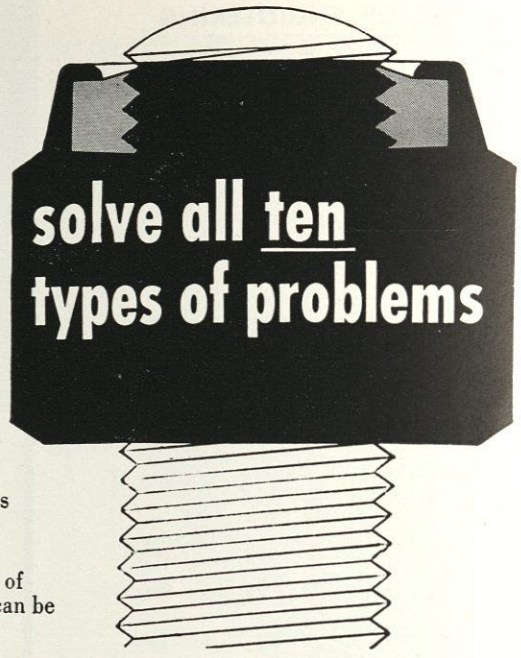
An artist's conception of the Mile-High Center which is nearing completion in Denver. A description of this building and others under construction in Denver is given in the article **Denver Grows** in this issue.

FRONTISPIECE (Page 14)

The Hermes A-1 rocket being prepared for launching at the General Electric testing station, White Sands Proving Grounds, New Mexico. This type of missile was not successful and is no longer in use.

MEMBER OF
ENGINEERING COLLEGE MAGAZINES ASSOCIATED
Thomas Farrell, Chairman
State University of Iowa
Iowa City, Iowa

elastic stop nuts solve all ten types of problems

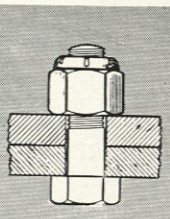


Here are ten typical fastening problems. One device, the ELASTIC STOP nut, solves them all—without additional parts or operations. Deliberately undersized in relation to bolt diameter, the red elastic collar grips the bolt with a perfect fit, exerting a continuing self-locking pressure against the threads, and holding the nut securely in place at any point on the bolt. It also provides a tight seal against the bolt threads, which prevents seepage and wear-producing axial play. And because the bolt threads are protected against moisture from without, the nuts are not "frozen" to the bolt by corrosion.

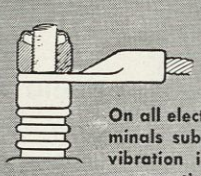
ELASTIC STOP nuts stay tight, right where you put them, in spite of vibration and stress reversals. Yet they are not jammed in place, and can be removed with a wrench and reused many times.

For further information on ESNA self-locking fasteners, mail the coupon below.

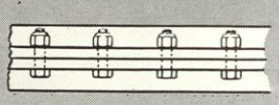
TIGHTENED AGAINST THE WORK



Wherever a vibration or impact proof bolted connection is desired.

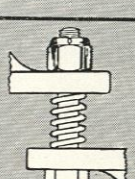


On all electrical terminals subjected to vibration in transit or operation.



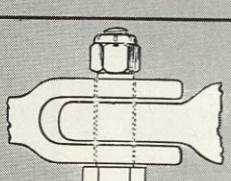
For uniform and precise prestressing of multiple bolt assemblies . . . adjusted by predetermined wrench torques.

LOCATED ANYWHERE ON THE BOLT

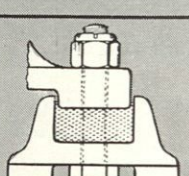


Spring-mounted connections or dynamic balancing, where nut must stay put yet be easily adjusted.

On make-and-break adjustment studs where accurate contact gaps are required.

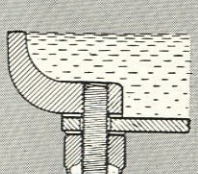


For bolted connections requiring predetermined play.

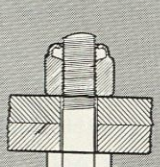


For rubber-insulated and cushion mountings where the nut must not work up or down.

FOR MANY SPECIAL APPLICATIONS



To seal bolt threads where elimination of leakage past stud threads is necessary.



To seal bolt threads where it is necessary to protect them from corroding elements.

To obtain delicate adjustments for applications such as bearing locknuts where precise adjustment is essential.

ELASTIC STOP NUT CORPORATION OF AMERICA

ESNA® TRADE MARK

ROLLPIN TRADEMARK

Dept. N40 , Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey

Please send the following free fastening information

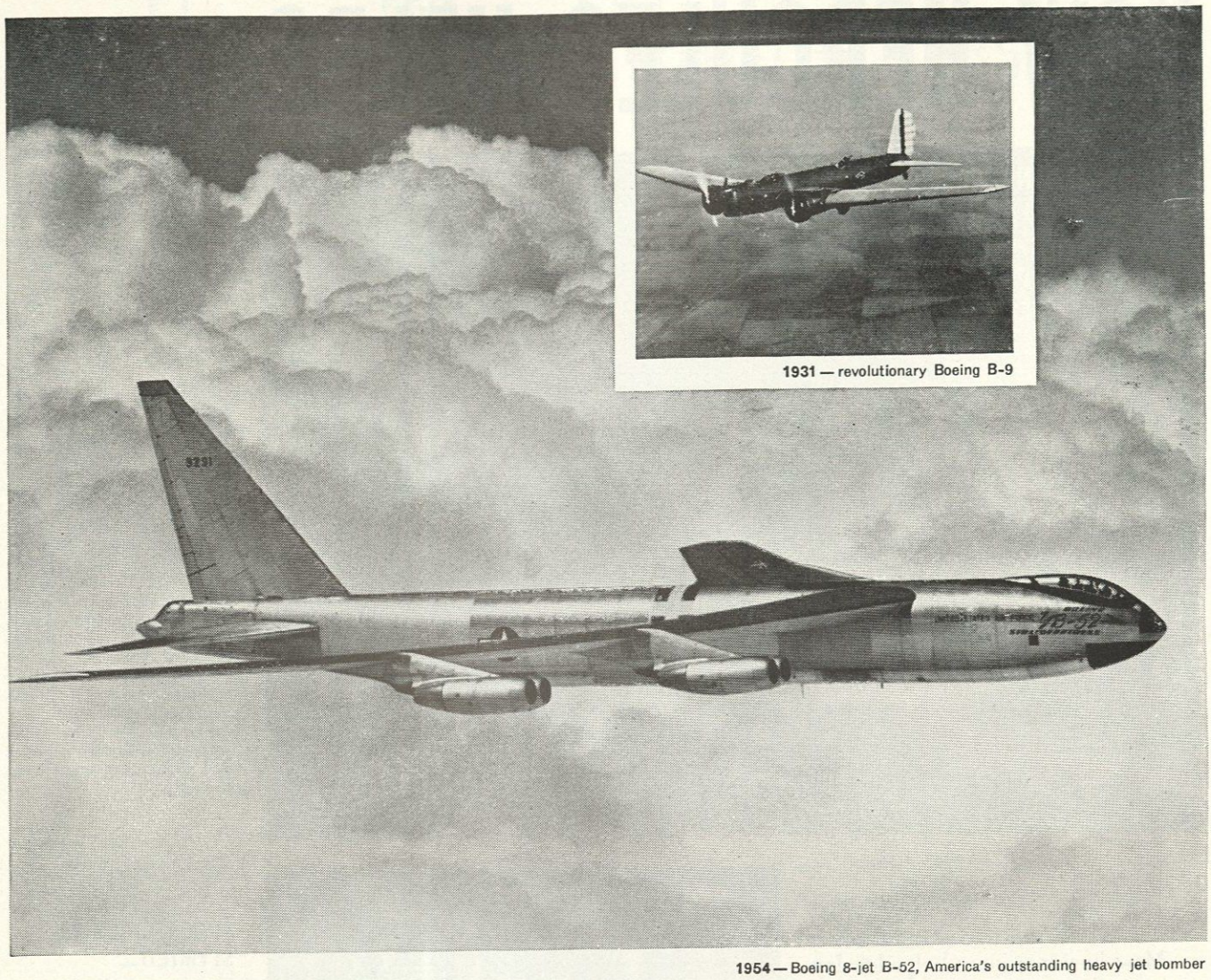
☐ Elastic Stop nut bulletin
☐ Rollpin bulletin
☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____

Firm_____

Street_____

City_____ Zone_____ State_____



1931 — revolutionary Boeing B-9

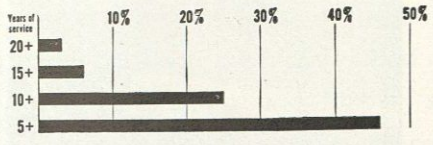
1954 — Boeing 8-jet B-52, America's outstanding heavy jet bomber

Leadership is a long-time tradition at Boeing

In 1931, Boeing engineers designed the B-9, a revolutionary low-wing bomber that could outdistance any contemporary pursuit plane.

Today, they've produced the free world's outstanding heavy jet bomber, the B-52, and America's first jet transport. Boeing also builds the record-breaking B-47 medium jet bomber, conducts a major guided missile program, and research in nuclear power for aircraft.

These growing programs mean expanding opportunities at Boeing for engineers of virtually EVERY type, including mechanical, civil, electrical and aeronautical. It also means plenty of room for advancement. Boeing, which now employs more engineers than even at the peak of World War II, promotes from within, and holds regular merit reviews to give you individual recognition.



As the chart shows, 46% of Boeing's engineers have been here for five years or more; 25% for 10 years; and 6% for 15 years, and many have been with the company 25 years or longer.

Boeing offers engineers an unusual variety of experience, from applied research to production design, from work with new materials and techniques to co-ordination of a vast subcontracting program which provides contacts with a cross-section of U. S. industry.

Boeing also helps engineers continue their graduate studies, and reimburses them for tuition expenses.

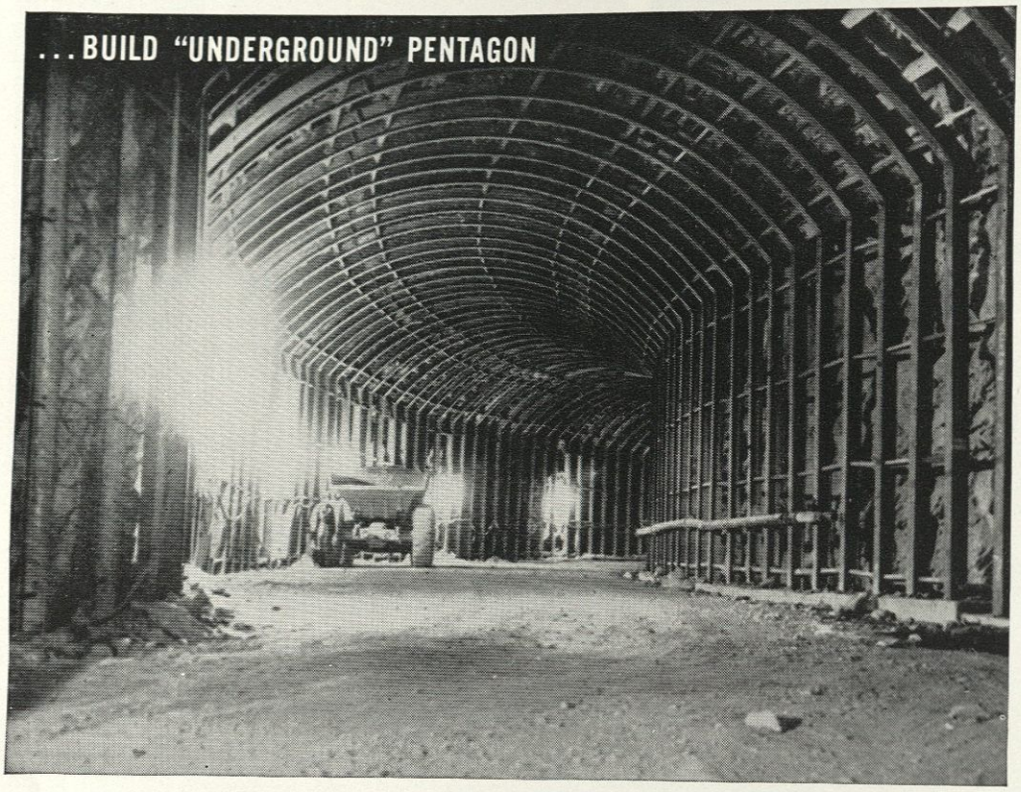
For further Boeing career information, consult your Placement Office, or write:

RAYMOND J. B. HOFFMAN, Admin. Engineer
Boeing Airplane Company, Wichita, Kansas

BOEING

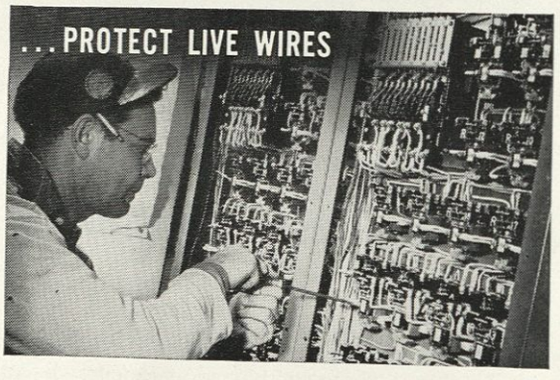
SEATTLE, WASHINGTON WICHITA, KANSAS

HOW HERCULES HELPS...



MUSCLE FOR MOUNTAIN MOVERS—
More than 1,000,000 lbs. of Hercules® dynamite were used by S. A. Healy Co., Chicago, to hollow out a mountain near Washington, D. C., in the construction of an alternate global communications center for use in case present Army, Navy, and Air Force facilities are knocked out by enemy attack. The task of carving this top-secret headquarters out of solid rock would have been impossible without industrial explosives and excavating know-how.

Most businesses are helped today by Hercules' business . . . the production of synthetic resins, cellulose products, chemical cotton, terpene chemicals, rosin and rosin derivatives, chlorinated products, and many other chemical processing materials—as well as explosives. Through close cooperative research with its customers, Hercules has helped improve the processing or performance of many industrial and consumer products.



SHORT CIRCUITS STYMIED—
Complicated electrical installations give longer, more dependable service when vinyl wire insulation is made with Hercules Hercoflex® 150. Hercoflex 150 is one of the Hercules family of vinyl plasticizers that are used in products ranging from toys to garden hose.

EASY TO HANDLE —
These kitchen utensils not only make a woman's job easier, but their brightly colored handles add a decorative touch as well. The handles are molded with Hercules Hercocel® cellulose acetate. In sales, design, and production, Hercules' services to the plastics industry keep products on the move.

HERCULES POWDER COMPANY INCORPORATED *Wilmington 99, Del.*
Sales Offices in Principal Cities

G54-1

HERCULES

From The Editors' Desk

SINK OR SWIM

With the beginning of another school year, the students of the college of engineering might well cry, "SINK OR SWIM." This saying may pertain to classwork, for in order to succeed in school one must study; however, let us apply this idea to the extra-curricular activities in the college of engineering. If the students fail to support their own activities they are very apt to lose the endorsement of the administration. What administration is going to continue to sponsor traditional engineering events unless the student body supports them? Thus we shall sink as we lose our interest and neglect our responsibilities.

The first engineering activity of the year, The Engineer's Smoker, was a good indication of student interest. Out of a total of 1900 engineering students only 10 applied for work on the five administrative committees. Truly an expression of genuine interest by the student body. By now we all know that the Smoker no longer features a Sliderule Queen or the traditional apples of days gone by. These eliminations had purpose, but what is to refill the void left by their omission. Will the committee of next year's smoker look in vain for a student staff, and, receiving no response, continue to feel that the student body desires no improvements or changes? This is our fate unless we elect to swim.

Engineers Days has also felt the tug of the undercurrent. Our cherished Friday afternoon of freedom, which has degenerated to an abusement of a privilege, is in danger of bidding us adieu. Why? Because it is felt that the majority of liberated engineers take no part whatsoever in the activities offered by the student committees during the afternoon; thus, another tradition slips away.

What can we do to help ourselves? Is there anything that we can do to regain the pride which we once had when we said, "I'm an engineer"? Yes, we can justify the trust which the administration has placed in us by supporting our student government, the Combined Engineers, and the activities it sponsors. We can support and further school activities by "sounding-off" in our society meetings and aiding in committee work.

We must assume our responsibilities as students who have been given a voice in our government. Then and only then will we be able to point to the activities of the college of engineering with pride.

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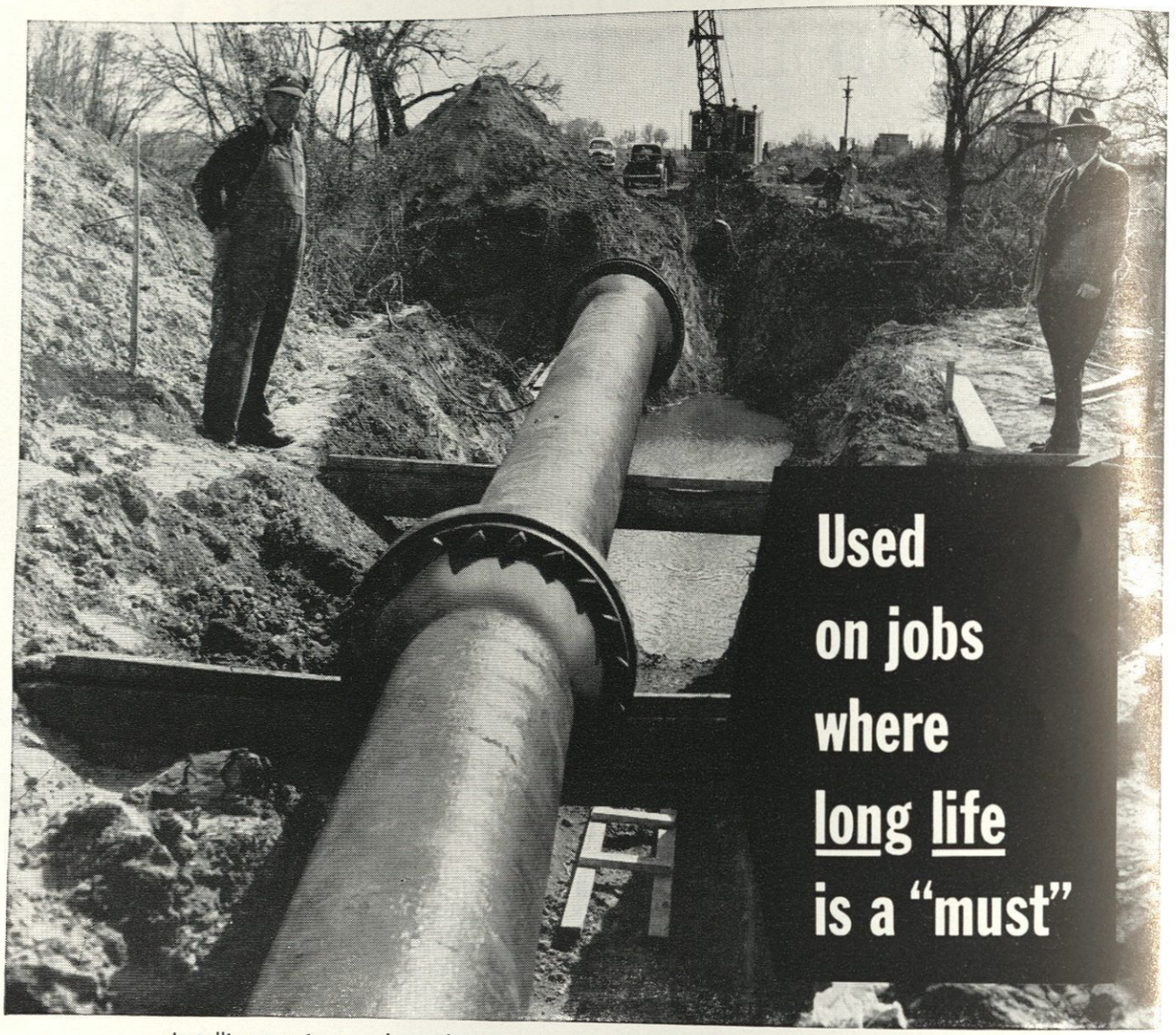
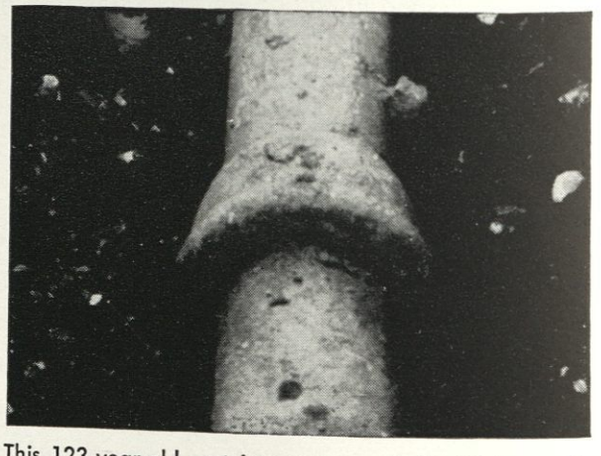


Installing cast iron mechanical joint pipe across river at Salina, Kansas, for sewer main.

When an installation, once completed, should be as trouble-proof as planning and materials can make it — engineers rely on cast iron pipe. It has high beam-strength, compressive-strength and shock-strength. Its effective resistance to corrosion ensures long life, underground or underwater. These are reasons why cast iron pipe is so widely used for water lines in tough terrain, pressure and outfall sewers, river crossings, and encased piping in sewage treatment and water filtration plants. Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 122 So. Michigan Ave., Chicago 3, Ill.



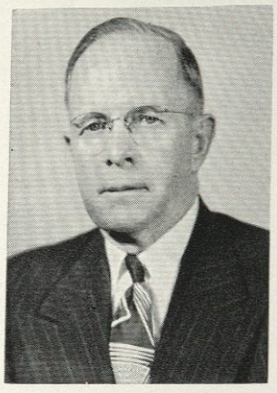
This 123-year-old cast iron water main is still in use in the distribution system of St. Louis, Mo.

CAST ® IRON

CAST IRON PIPE SERVES FOR CENTURIES

The Dean's Page

by C. L. ECKEL



By this time, every student in the College of Engineering must surely know that he is a welcome member of the University community.

Somewhat to our surprise, but nevertheless in conformity with the pattern that seems to fit the better known colleges of engineering, there was a marked increase in our engineering enrollment in September. Actually, the increase amounted to nearly four hundred students, an increase of about twenty-five per cent over the engineering enrollment in September, 1953. Approximately half of this growth was in the freshman class. Former students and transfers account for the rest of the increased enrollment.

Because of the difficulty in finding additional competent teachers, particularly in mathematics, English, and drawing, many of our sections in these courses are larger than they should be. I want to assure our new students, however, that we have competent instructors who are anxious to be of all possible assistance to engineering students. After an assignment has been covered in class, any student who does not clearly understand the principles involved should arrange for additional help by making an appointment with his instructor. Never have I heard of a single instance involving a member of the engineering faculty who has been unwilling to give assistance to any conscientious student.

We believe that every student who has been admitted to the College of Engineering has potential capacity to do acceptable academic work in the University. Naturally, we hope that every student enrolled in the College of Engineering is genuinely interested in engineering, and that he will make good in his chosen field. Perhaps at a later date some students will come to the conclusion that they are not sufficiently fired-up or interested to find a career in engineering. Any student facing this problem should dicuss his situation with his advisor or the dean. In such an event, it is likley that the University Counseling Service can also be of assistance in helping to find a career more compatible with his interest and ability.

Some may feel that an increase in engineering enrollment will mean that the profession will soon be overcrowded. I do not forsee this possibility. In 1900, there were approximately 40,000 engineers in this country; in 1940, the number was about 260,000; and today, there are some 500,000 engineers. The number of engineers has not only increased, but the ratio of engineers to industrial workers has also increased. For instance, in 1900, American industry as a whole employed one engineer for every 250 employees. At the present time, the ratio at the General Electric Company is one technically trained employee for every fifteen employees. When one considers the tremendous advances in the basic engineering sciences and considers the complexity of modern technology, there is every reason to believe that the supply of competent engineers may never really catch up with the demand. Engineers also provide the critical talents for defense and this shortage should be of real concern to the nation. At the University of Colorado, we have never been able to satisfy the demand for above-average graduates.

An increasing number of engineering graduates are going into research, others go into the application of the results of research and design; and large numbers work on problems incident to production, such as developing new processes and new products, or improving old products. The fields of engineering sales, construction, management, administration, and consulting services likewise afford interesting opportunities.

Just this year, the electrical industry has celebrated the 75th anniversary of Edison's invention of the incandescent lamp. It is a far cry from Edison's first lamp to the lighting facilities commonly available today. Many wonderful advances in every aspect of human living which are just as phenomenal as the development of lighting, have occurred in virtually all fields of engineering in the past three quarters of a century—within the memory of many people who are still living.

Running water in our homes is taken for granted, but we should remember that it just did not happen that way. A tremendous amount of engineering is involved in collecting, storing, treating, and transmitting water to the home or plant where it is used and in disposing of the wastes so that this vital resource can be used again and again.

Stop and think about almost anything connected with modern civilization. Invariably, it will be found that an engineering accomplishment has raised our standard of living.

A career in engineering involves the adoption of a philosophy of hard work, but at the same time, it provides a professional participation in all the great advances incident to making important scientific discoveries available for the use of man. The advancement of our civilization is a tremendous challenge and should stimulate every student in the College of Engineering to always do his best.

The members of the faculty of the College of Engineering want to do everything they can to contribute to your professional development. They want to share their knowledge, training, and experience with you. They wish you well—not only during the year just ahead, but in the years to come. They confidently expect that you will make the most of your present opportunity to increase your capacity for service, good citizenship, and professional accomplishment.

Rocket Development

by PAUL BROWN

Rockets and solid fuels date back to about 1200 A.D., when the Chinese used "fire arrows". In the early 1800's, rocket-type ordnance was used in most armies. During the War of 1812, Francis Scott Key wrote of the "rocket's red glare". Early modern day experiments on rocket propulsion were conducted by an engineer named Paulet of Peru, South America. His experiments which started in 1895 began a series of developments that have been climaxed by piloted aircraft traveling in excess of 1600 miles per hour in level flight; and missiles and rockets obtaining speeds several times greater.

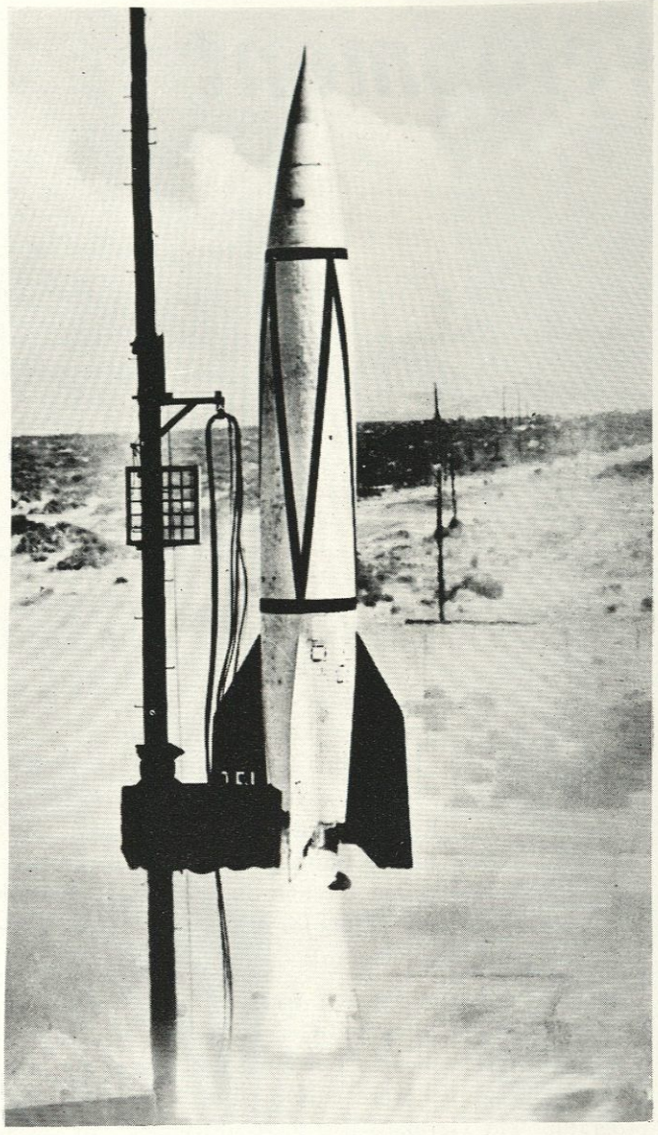
Little progress was achieved until 1930 when a German society for space travel began experimentation with liquid propellent fuels. They constructed a testing ground and began working with various types of small rocket engines. The American Rocket Society was established in 1932 and started testing new rocket types in 1934. A large number of difficult problems were encountered. The greatest of these was a cooling system which could keep the combustion temperature of 5000°F from breaking down the metal structure of the engine. Some of the cooling methods attempted were: fins, lining the combustion chamber with Alundum, jacketing the engine in water, and constructing the fuel tanks around the engine to absorb the heat. This obstacle was eventually conquered with what is today called the regenerative motor. This type of motor has a jacket around the combustion chamber through which fuels flow to the motor. This dissipates enough heat so that the outside operating temperature of modern rocket engines is around 150°F. Also, it helps to vaporize the fuels before they are actually injected into the combustion chamber. American Rocket Society member, James Wyld, built and successfully tested a regeneratively-cooled rocket motor in 1938.

Another problem encountered was the proper injection or mixing of the fuels. This still isn't completely solved and is a major experimental project in rocket development today. Methods of injection range from mixing the fuel before it is sprayed into the engine to a system used in the German V-2 rockets which entailed the use of over one thousand spray injections. Through progress in the injection systems, the gas velocity from the engines has been increased from less than four thousand feet per second to over seven thousand feet per second. An increase in the combustion chamber pressure has also aided in increasing the jet velocity. With increased pressure, better fuel injection, and a more efficient cooling system, jet velocities of 9000 feet per second are anticipated. All of these values do not mean that the speed of the rocket will be limited to the jet velocity of the engine. It is possible to exceed this limit although it has never been done in actual practice because pure space travel has not yet become a reality.

Using an engine with a jet velocity of 4500 miles per hour, the present record speed for a single-stage rocket is 4,100 miles per hour. This particular engine, having 20,000 pounds thrust, is being built by Reaction Motors Inc., and is used in the "Viking" research rocket. This rocket, in addition to the speed record, holds the altitude record of 136 miles for a single-stage rocket. This corporation was started in 1941 by four members of the American Rocket Society, and since that time has been the outstanding liquid-propellent rocket power research and development center in the United States. It has supplied power plants for all of the experimental supersonic rocket planes built by the United States .

German rocket research received a boost in 1931 when the privately operated German research was taken over by the government. The same testing grounds and the same personnel were employed in the accelerated program. The Germans had many difficulties in developing an even remotely successful liquid propellent engine. An 'A' series of liquid fuel rockets propelled by regenerative engines was begun, the first of which was completed in 1933. The A-1 never left the ground; but an improved version, the A-2, was a spectacular success. The A-2 climbed to 6500 feet which served to convince the Germans of the value of the rocket. The German Army Ordnance created the A-3 and the A-5. Both were large rockets but they were only design studies which led to the A-4, which was called the V-2 by the Allies. Specifications for the A-4 were set in 1936, but it wasn't until 1942 that the first prototype roared into the sky. Then followed a failure, a success, and thirteen more failures. This was very discouraging to a Germany at war. Production was commenced in 1943, and all was going well until an experimental rocket fired over the Baltic Sea strayed over Sweden and found its way into British hands. This destroyed the all-important element of surprise in the otherwise invulnerable rocket.

The V-2 was a giant, high-altitude rocket and the largest ever built. It was the only one to be mass produced. The V-2 rocket was forty-seven feet long, seventy-



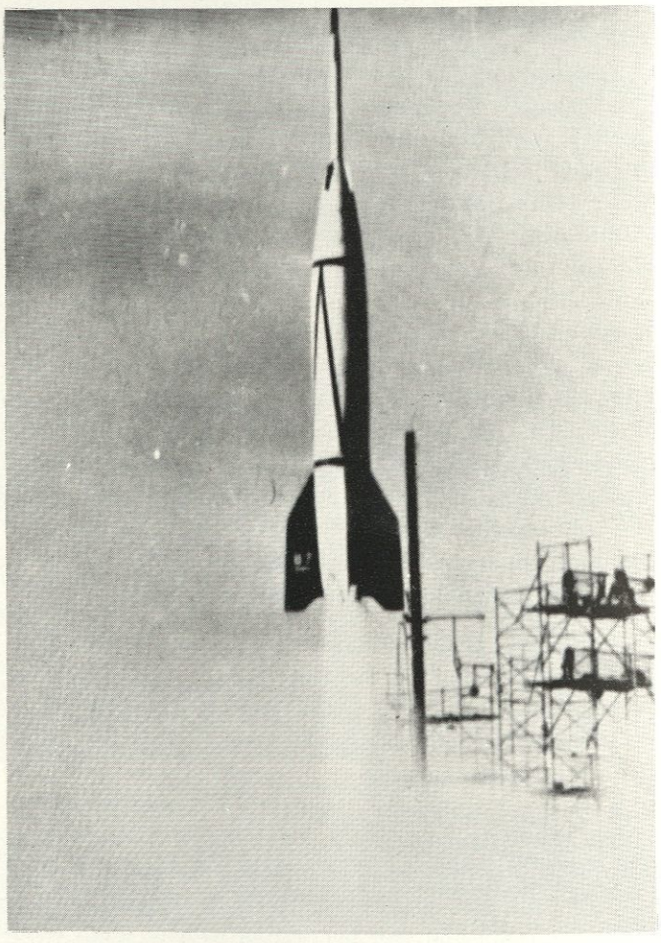
A captured German V-2 rocket being launched at the White Sands Proving Grounds. Sixty-seven of these missiles were tested, 21 being classified as failures.

seven inches in diameter, and weighed fourteen tons including one ton of amatol in the warhead. Its range was 200 miles. The powerplant was the largest rocket motor built up to that time, using alcohol and liquid oxygen for fuels. It exerted a thrust of thirty tons for its sixty-eight second fuel supply. This is compared to the thrust of ten tons supplied by the power plant in the record holding "Viking". Other current developments in the United States exceed the V-2 thrust substantially.

Another significant German development was the A-9 + A-10 rocket project, and given another year it might have become a reality. The A-9 was a V-2 size winged rocket which would have been carried in the nose of the A-10. Total length of the two stages would have been 112 feet, and the weight would have been ninety-four tons. The predicted range was over 3,000 miles which would have enabled the missile to strike the United States. A few A-9s were built but the A-10 existed only in design form as far as we know. If, as is likely, the A-9 + A-10 would have performed as predicted, it could have hit targets in the United States. Another German development, the V-3, is of interest because its performance was about the limit that can be expected from a dry fuel rocket, and also because it is a good example of a multi-stage rocket. Thirty feet long, it had three stages and a booster which gave it an ultimate velocity of 3600 miles per hour. It had a range of 137 miles, but was not too useful as a weapon since it could carry only an eighty-eight pound warhead. The invasion of Europe brought German rocket production to a decisive halt, and our present knowledge is limited to rocket research in the United States.

The regeneratively-cooled "Wyld" rocket motor, first tested by members of the American Rocket Society in 1938, provided the basic information used in developing the Reaction Motor's Model A6000C4 rocket engine. This is the basic power plant that has been successfully used to propel American rocket-powered supersonic aircraft such as the Bell X-1, the Douglas D-558-II Skyrocket, the Republic XF-91, and the Bell X-1A. The relatively small, highly powerful unit is of the generative type, and develops a total thrust of over 6000 pounds; or portions of total thrust in increments of 1500 pounds. To give a concept of thrust, it is stated

(Continued on page 48)



A two stage rocket being launched: a WAC Corporal, in the nose of a V-2. After the V-2 burned out, the WAC Corporal fired and ascended under its own power. One such combination reached a velocity of 5000 m.p.h. and a height of 250 miles, both records for man made objects.

DENVER GROWS

by BOB ADELSTEIN, C.E. and Bus. '58

It was dead until pushed, and then started to grow as it picked up speed. Sounds a little like a snowball rolling down a hill doesn't it? Well, it isn't. Rather it it is what happened to construction in Denver. Construction did not pick up until the latter part of 1952. During November of that year there was an announcement which stated that Denver's construction level had fallen below that of the previous year. A few weeks later, however, tentative plans for a 23-story office building were announced. With this announcement construction in Denver started to grow. Whether this was a start of something big could not actually be determined because all plans were said to be tentative. It was not until the spring of 1953 that these plans were to become realities; these realities being backed up by the sound of pile drivers at work. In September of 1953 construction permits had increased more than eleven thousand dollars over the year before. The "snowball" had gained momentum.

One year has now passed since the sound of the pile driver was first heard; since then Denver has had many new changes. A few of the major changes can be seen from the tower of the Daniels and Fisher's building, which was once Denver's tallest building. Looking east from the tower, which is located downtown, you can see the gray, aluminum, glass covered Mile-Hi Center. To the left of the Center you can see the Denver Club building which is nearing completion. South of the Denver Club is the Petroleum Club and beyond this cirlce of buildings, further east, can be seen the Farmer's Union building, which is still under construction.

Looking down from the tower to the "old" buildings below, it is possible to see the buildings don't show their age. Over one-hundred million dollars have been spent on changing the fronts of these "old" buildings into the 1954 style.

Only a few of the changes in Denver can be seen from the tower. All over Denver new shopping centers are springing up, and around these centers housing projects are being developed. Since last year the TV stations have found the old buildings inadequate, so new quarters for Denver's four TV stations have been built.

But wait; instead of telling you about these changes, let's show a few of them to you. In the next few pages that are to follow you will see pictures and articles of Denver's' "snowball." After once viewing them, you too, must admit Denver is growing.

Mile-Hi Center

The Mile-Hi Center is a 15-million dollar project which, when completed, will consist of three buildings covering a 80,006 sq. ft. area. The first of the buildings to be constructed was the 23-story 1700 Broadway Building; this building is now nearing completion. An airline terminal building and a four-story bank are the other buildings of the project; their construction started a few months ago.

The 23-story office building is one of the first buildings to be designed around an air conditioning system. Looking at the building (cover) there can be seen many light-colored opaque strips running vertically and horizontally completely around the building. The air-conditioning units and risers are beind these light-colored panels. The strips or panels, which consist of one-inch glass-fiber insulation between two thick abestos-cement-boards are mounted to one story high aluminium frames. These frames, in turn, are attached to the building. The risers for the air-conditioning system are behind the strips which start at the second floor and rise to the top of the building.

The equipment for the air conditioning is located in two different places. The steam generating plant, the water cooling units, power and lower air distribution apparatus will be found in the basement. The rest of the equipment, which consists of the cooling towers, water storage, and upper air distribution equipment, is housed in the penthouse. In these two centers are located all moving parts of the building. Not only do these centers supply the heat and air for the office building, but they will also supply the heat and air for the other two buildings on the center once they are completed.

The dark strips are gray, anodized surfaced, one-fourth inch thick, aluminum castings which are mounted on the aluminum frame. The dark-colored aluminum strips cover the spandrel beams and columns. Be-

A view of the Farmers Union buliding which is soon to be completed.

tween these dark-colored aluminum strips and the building there are one-eight inch strips of glass-fiber insulation.

The six-foot-high windows are mounted between the filler spandrels and the spandrel panels. The openings between the filler spandrels are sealed off by double glazing.

The 4700-ton steel frame building is resting on piles which have been driven sixty feet below that of the grade. The building rises 294 feet above the grade. In the building there are eight elevators, four of which are low-rise, and four righ-rise. The Center is a joint venture of Webb and Knapp, Inc. and George A. Fuller Co., owners and builders. The 1700 Building, and other buildings on the project are somthing new in construction. No doubt, there will be many new buildings built with the same ideas in design as the Mile-Hi Center.

Denver Club

In the spring of 1953 the sounds of pile drivers at work told the people of Denver a new building, the first in a series, was under construction. In 1950 plans were announced that some firm would buy the old Denver Club building, tear it down, and replace it with a new super structure. These plans, however, were delayed because of the Korean war. In April of 1952 the negogations for the sale of this building were reopened. The sale was finally completed with the understanding that the Denver Club would have permission to lease space in the new building which would be 23-stories high. Of these 23 stories, 16 of them will be used for general office space, two will be used to house the mechanical and electrical equipment, four floors are to be used by the Denver Club, and the last floor of the building is a penthouse. The total height of this building above the sidewalk grade is 280 feet and it covers an area of 15,625 sq. ft.

Before carrying out the plans to tear down the old building, a series of test holes were made to establish the load carrying capacity of the soil. From the data it was found that a load of 20,000 psf could be used for design purposes. Because Denver was once in the path of the South Platte River, many problems arise in construction due to the sandstones and shales by the river.

Special bell-bottomed, drilled piers were used in the construction of the Denver Club. The diameter of these piers vary between 36 to 54 inches, and the shafts extend into the Denver formation for an average of 26 feet below basement grade.

The lower portion of the building is covered with polished green granite which extends from the corner to the top of the structure. The facading on the street sides is covered with custom-made aluminum. This aluminum covers the spandrels and makes up the window frames. Behind these panels, to act as insulation, are rigid glass-fiber pads together with aluminum foil. The sash panels are glazed with green-tinted, heat-absorbing plate glass. Each of these panels is supported by shelf angles which are attached to the spandrel beams.

A new method was used in laying down the floor system. Units of high tensil strength corrugated steel were used to support the lightweight concrete as it was poured. These units then became part of the floor. The units go by the name of Cofar and were laid down and welded to the structure before pouring was done.

An underfloor duct system for electrical and telephone system was placed in the slabs and outlets located every two feet. In the building 2650 tons of steel were used. The floor area covers 313,000 sq. ft. with 88 per cent of this usable for rental space.

Petroleum Club Building

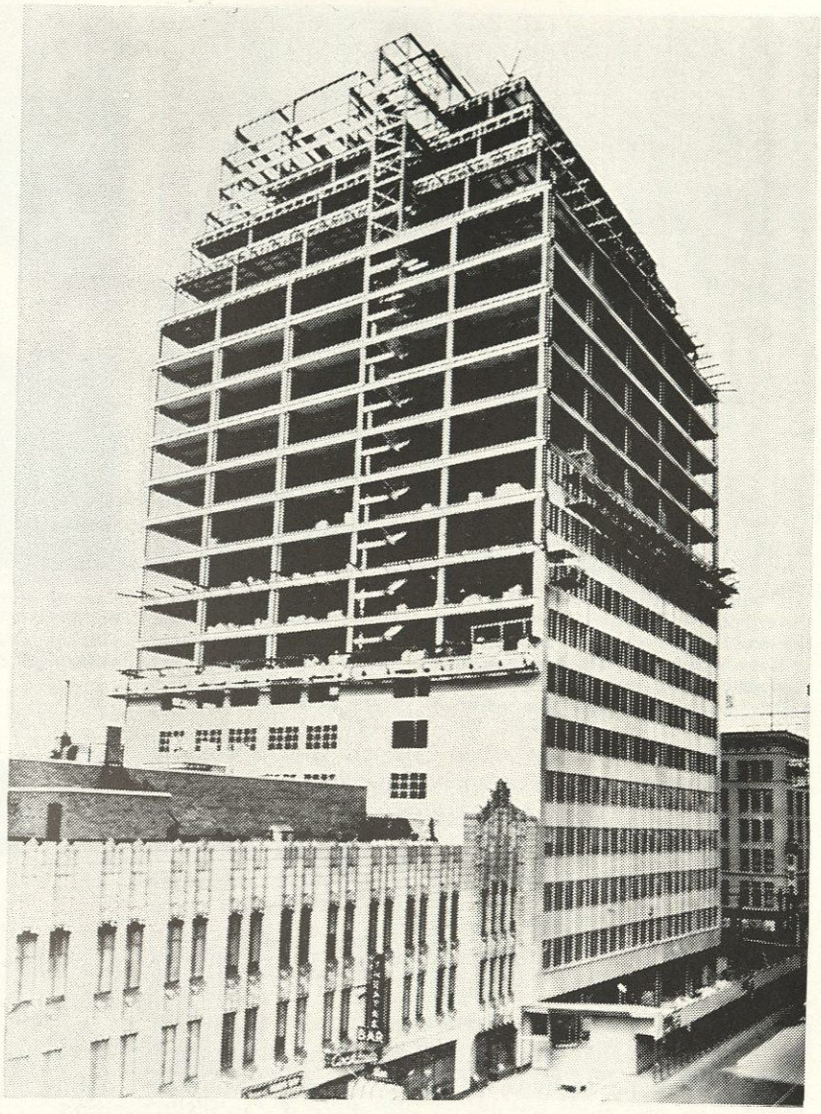
In June of 1953 it was rumored in Denver that a new hotel would be built and financed by a weathly Texas oil man. Soon after the rumor was started it was learned a building for the use of the oil industry and its affiliates would be built instead of the hotel. The building construction is nothing unusual for it will, when completed, consist of a 14-story building of reinforced concrete with a lime stone exterior.

The outstanding item about this building is the facilities which it has to offer. When first walking into the building a visitor will see a large mural portraying the oil industry. If the day is warm when our visitor enters the building, he will find that wherever he goes he will be comfortable because of the air conditioning. In the building there is an auditorium with stage arrangement, movie projection room, a lunch room and coffee shop.

The two top floors of the building will used by the Petroleum Club. These two floors will provide space for a dining room with a cocktail lounge, private dining rooms, club offices, card room, reading rooms, library, TV room, and banquet and ballroom facilities. Another outstanding feature about this building is the fact that it will have a nine-foot celing height in the office areas. The office areas are so designed that requirements for large or small areas, with luxurious decorations, can be obtained. The building, though nothing different in its construction, will definitely be a toast to the city of Denver.

Farmers Union Building

When completed in November, the Farmers Union Building will be one of the world's first atomic-proof buildings. When designing the building the architect took into consideration everything that could happen to a building after an atomic bomb blast, and then did his designing accordingly.



The Denver Club building as seen when nearing completion this Fall.

The building has the shape of a cube with its center of gravity located at the center of the building; this being approximately at the third floor level. A cube was used because a lower center of gravity could be obtained; therefore giving the building greater stability to the forces that would hit it in the event of an atomic bomb blast. To help in giving the "cube" greater stability, footing were placed twenty feet below that of the grade. In order to keep the floors in place when the shock waves hit the building, a series of vertical braces, making right angles with the building floors were built. To add still more strength to the building more steel than usual was used in building the floors and walls. The floor slabs are reinforced top and bottom by steel which continues, at right angles, into the walls which are reinforced by steel. By using this method the walls strengthen the floors, and the floors strengthen the walls.

In pouring the building it was decided a greater strength could be obtained by pouring a section at a time; each section consisting of the floor, wall, spandrels, and columns. Each section extends from one window head and sill to the one above. When each section was cast it was mounted, or connected to the section below it with steel dowels, bars, and shear transfer units.

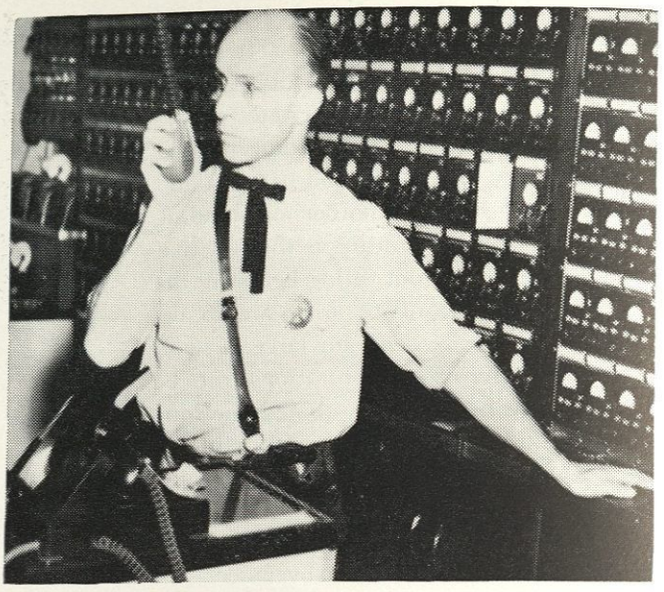
In the center of the building there is a special reinforced core which contains two stairways, the elevator shafts, the telephone equipment, and rooms designed to act as bomb shelters for personnel working in the building.

In the case of an explosion all windows in the building will be broken, and most of the partitions which subdivided the offices would be destroyed. This, in a way, is good because when a shock wave hits the building, instead of hitting something that will not give, and causing the building to take all of the shock, some of the shock will be able to pass from one side of the building to the other.

In the winter filtered air will be drawn into the building and warmed, and in the summer the air will be cooled. When the building is completed the outside surfaces will be painted two colors: green and white. The green will cover the spandrel wall units, while the white will cover the rest of the building. Window frames are of aluminum, and all exterior trim will consist of stainless steel. To the best knoweldge of the designers this building will withstand an atomic bomb blast. All that remains is a test—a test we hope will never come.

Engineer to roommate: "Gad! Here it is—only three in the morning, and I'm getting tired already!"

The burglar, after breaking the glass in the door of this grocery store, reaches inside to unlock the door latch. Unknown to him, the building is wired for burglar alarm protection. Tape wiring, as seen above his left hand on the window, was torn and the closed circuit was broken when the window was smashed.



Central station is given a signal that the closed circuit in the building is broken on one of these panel receivers. The dispatcher checks a card and finds that the building was not scheduled to be opened at this time and radios a company patrol truck and the police.

BURGLARS

by PAUL

The time has come when burglars find it next to impossible to loot many of the country's burglary targets. Burglar Alarms have become too perfected; entrance into "protected buildings" means certain detection and probable apprehension if the thief is not smart or quick enough to flee at once.

When a thief "jimmies" a door or breaks a window of a building which has Burglar Alarm protection, a signal is sent to a central alarm receiving station and the police are contacted immediately. Patrol cars and guards rush to the scene, many times before before the would-be burglar has gained complete entrance to the building. He is given no warning he has been discovered until caught "red-handed."

One of these central stations is the Denver Buglar Alarm Company, owned and operated by Mrs. Sara Jackson. The business was started in 1892 and has been under the present ownership for more than 40 years.

The company guards more than 1,700 business firms and homes in the Denver area. Mrs. Jackson took over full time management five years ago upon her husband's death, and the youngish grandmother now combines engineering and business knowledge in dealing with burglars and their apprehension.

How The Alarm Works

A building is wired with a closed circuit covering all windows, doors and other possible spots a burglar may enter. When the circuit is broken, a signal is sent automatically to the central station by leased telephone lines.

The operator at the central station then contacts the police by a direct telephone line to the dispatcher, who immediaely radios the patrol car nearest the scene of the crime. The whole process takes only about 30 seconds.

"We apprehend an average of two thieves per week by this system," reports Mrs. Jackson. The company has about 12 police guards on duty each night and has 11 radio equipped squad trucks ready for action 24 hours daily.

"This system also gives a psychological protection for our subscribers," says Mrs. Jackson. "Why break into a protected building when an unprotected building is safer." Only one out of every 30 alarm protected premises had an attempted attack in 1951 according to an Underwriters' Laboratories report.

Trapped On Roof

Some burglars try to gain entrance to a protected building through the roof.

Not long ago two thugs climbed to the roof of a wholesale liquor house by route of a boxcar on a railroad track next to the building. They entered through a skylight window and broke the Alarm circuit.

When they tried to escape, the boxcars had been moved. Police arrived and the men were trapped on top of the building. The fire department ladder truck had to be summoned to deliver the men from the roof and into the arms of waiting policemen.

Other Services

In addition to burglar alarms, the company offers automatic fire alarms, Protectowire, a heat sensitive cable, is wired throughout the building. When a fire

A police guard in a radio equipped patrol truck receives the message along with the city police from the dispatcher. If the guard or police is close to the target, it's just a matter of seconds before they arrive at the scene.

And the thief is caught "red-handed." He wonders how the police got there so fast, even before he got into the store. Notice the tape on the door window and where the glass was broken just at the right of the handle. The protective tape adds to the looks of the building and windows besides acting as a perfect watchman.

BEWARE

McMATH

breaks out and the wire is heated sufficiently, a coded signal is flased to the central station.

The operator calls by direct line to the fire department and trucks get to the fire before it has had a chance to spread and do a great deal of damage. This service is of particular value to large warehouses, lumber yards, factories or other property where a great deal of loss would result from fire.

In addition, those buildings having sprinkler systems may have them supervised by the company. This service keeps tab on the water flow, pressure, and temperature in the sprinkler system. If the pipes are frozen, the master vavle turned off, or the water pressure low, the operator at the central station is given a signal.

New Burglar Systems Being Used

Besides the direct line burglar alarm, where a signal is sent directly from the building to a panel receiver at the central station, a loop circuit is also in operation.

A series of 10 or 15 buildings are wired on each loop. When the circuit in one of the buildings is broken, the signal is given in special code on a single receiver for the entire loop. Each building on the loop has a different coded signal on the receiver.

Photoelectric equipment, or electric eyes, are used to cover large areas both indoors and out. The beam is protected and reflected by one or more mirrors into a receiver. When the beam is broken the central station knows it.

Microphonic equipment may be located around safes or valuables. Sound or vibration sets off this type of alarm. Supersonic space alarms electrify the air so any type of movement is detected. This type is used when there is concentrated value in a building.

Safes and vaults may be lined inside or out with special material, which will "tip off" the central station to a burglary.

The local alarm, where a gong rings, is still used to a great extent; but is being replaced by the newer type alarms. The gong only scares the thief and causes him to flee while the central station alarm leads to capture in most instances.

Electric Eye At Work

Mindful of alarm connections on the doors and windows, thieves had wormed thier way in through an air conditioning fan in the skylight of a laundry plant. But they had not been aware of a photoelectric cell planted inside. The electric eye flashed a signal to the central station that someone was moving around inside. Police were summoned instantly on the telephone line from central alarm station. Officers caught the burglars still inside the plant.

Inside Jobs

"About 95% of all burglaries are inside jobs," says Mrs. Jackson.

Burglars sometimes try to hide inside the building when they hear their apprehenders coming. If the thief is familiar with the building, he may be successful in avoiding the searchers. But modern burglar alarm systems generally bring about his apprehension anyway.

After the police lock the building and leave, the intruder waits until he thinks the "coast is clear" and starts his exit. But in doing this he'll trip another alarm. Then guards waiting nearby are radioed, and the thief is captured.

A view of the three radiometers trained on the sun. Boulder is to the right of the antenna in the foreground.
—Photos Courtesy National Bureau of Standards

RADIO ASTRONOMY

by JIM TEBAY and BILL CIELINSKI

Highly directive radio systems permit montoring of UHF radiation from specific points on the sun and in interstellar space. Results show promising correlation between solar noise and radio communication, while calactic noise measurements provide a new tool for astronomers.

The photograph at the top of the page of this issue of the *Colorado Engineer* is that of the radio telescopes being used by the National Bureau of Standards for research in radio astronomy.

Although this new branch of science is widely assumed to have been derived from advances in electronics during the last war, actually its history is somewhat older. In 1932 K. G. Jansky of the Bell Telephone laboratories detected the first cosmic radio waves coming from the center of our own galaxy in the constellation of Sagittarius in the Milky Way. Observations were made on a frequency of 20 ms during measurements of the direction of arrival of atmospheric static, one of the limiting factors in long-distance radio communication.

Radio waves have been found associated with at least two well-known solar phenomena. One is solar flares, the brilliant eruptions on the surface of the sun that apparently are due to the ejection of very hot material from the interior. There are two possible ways in which flares might cause radio outbursts. It may be that the exceedingly hot material in a flare simply radiates more energy at all wave lengths, radio as well as visual. The other more probable explantion is that the mechanical energy of the hot flare, during its motion through the surrounding bases in the solar atmosphere, is converted into electro-magnetic energy.

The second solar phenomenon with which radio waves are connected is sunspots. To the eye or camera,

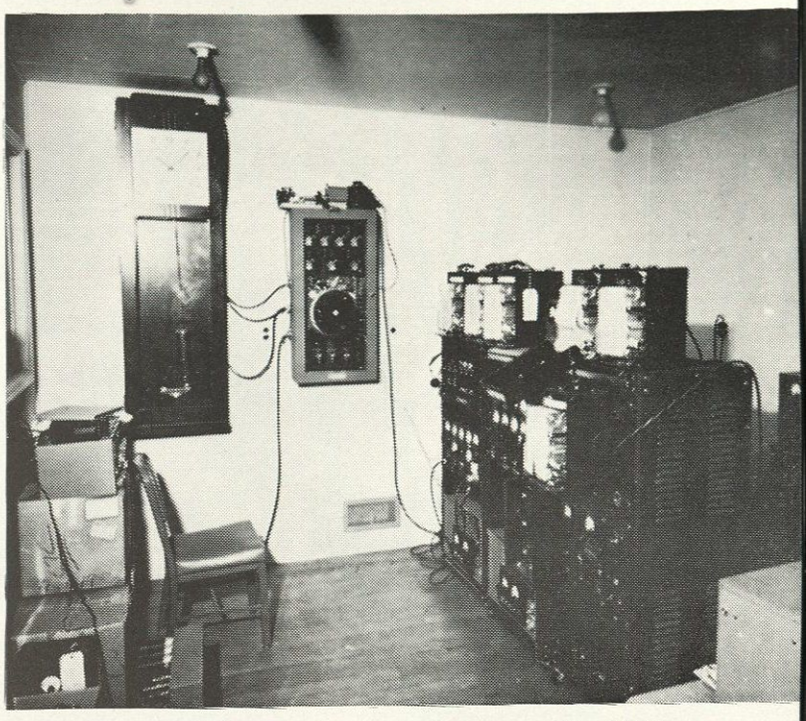
a sunspot appears dark because it is at a lower temperature than its surroundings. At radio frequencies, contrarily, the spot appears bright. This is primarily because the spot has a magnetic field. The field fans out from the spot somewhat like water out of a lawn sprinkler. It reacts with the surrounding ionized gas and creates a little radiant bulb over the spot. The bulb sends out strong radio waves. The size of the bulb over any given spot depends on the size of the spot, and the strength of its magnetic field and the radio frequency at which it is observed. At very high frequencies, the bulb contracts or disappears. At low frequencies, the bulb becomes more faint, expands, and finally is lost in the turbulence of the inner corona.

In spite of the obviously important practical application of the knowledge of intensity and distribution of galactic noise, no further investigations were carried out on the interfering effect of this new type of noise until after World War II, when the National Bureau of Standards undertook a systematic investigation of the time-frequency distribution of galactic noise and its limiting effect on communication by radio waves.

The National Bureau of Standards Radio Astronomy project is located on Gunbarrel Hill, about 7 miles east and 4 miles north of Boulder, Colorado. The equipment used is a combination of three German "Giant Würzburg" radar antennas converted for use as radio telescopes or radiometers to study the electromagnetic radiation from the sun. The antennas were taken over by the Army after the surrender of Germany at the close of World War II and turned over to the National Bureau of Standards as radio telescopes. The three big radiometers are the only ones of this type now in operation in the United States. The antennas, which are of the parabolic reflector type and have a diameter of twenty-five feet, extend nearly fifty feet into the air atop their concrete pillar bases.

Each radio telescope consists of an antenna system, a radio receiver, and a recording device. The prime requisites for this type of equipment are that the antennas have a high gain, the receivers have a low noise figure, and the receivers be so designed that measurements may be made below the spatial noise level. Since for recording purposes speed of response need not be faster than ¼ second for ordinary measurements, the Esterline Angus recorder permanently records all normal activity. To minimize all voltage fluctuations, conventional regulating devices for both AC and DC voltages have been used. The rf sections have a specially designed regulator for minimizing tube conduction fluctuations due to heavier voltage variations. The use of a noise diode reference provides full band-width hourly calibration rather than a spot check such as would be provided by the usual C-W signal generator.

Since the power level of the received signals at the antenna may be as low as 10^{-22} watts per square meter per cycle per second, unusual care must be taken not to introduce any extraneous signals and to cut transmission line losses to a minimum. The equipment is designed



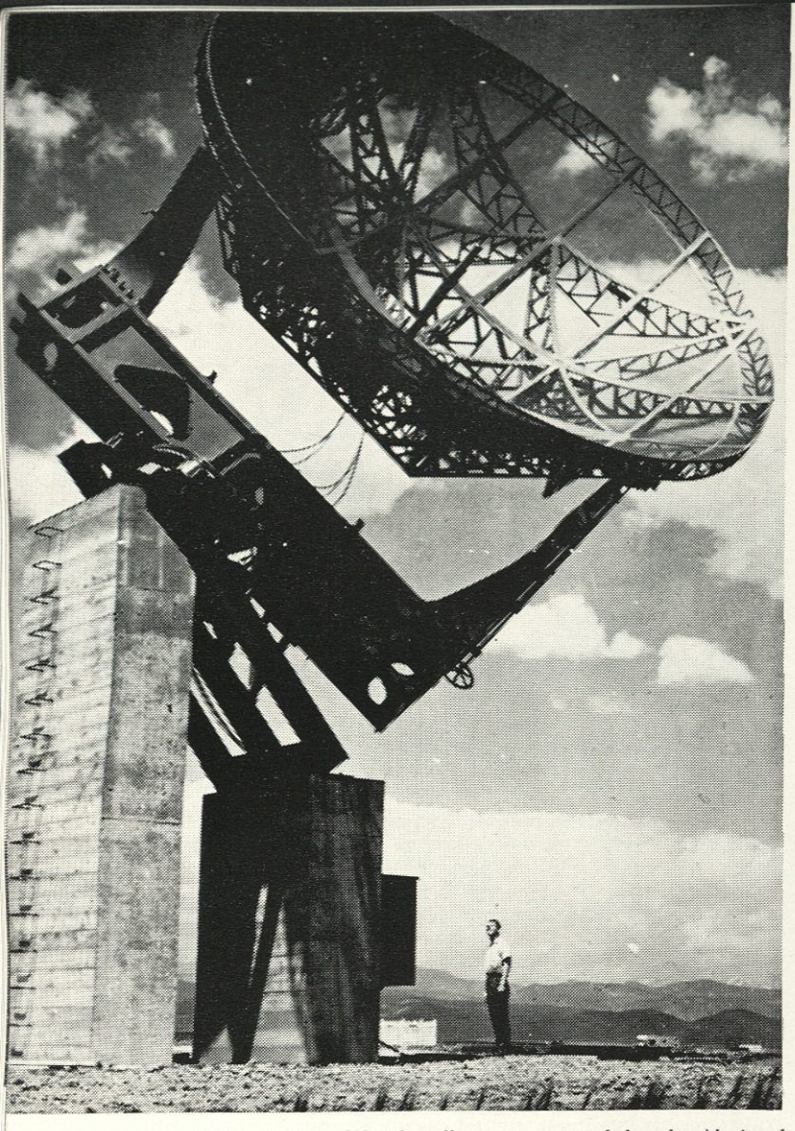
An interior view of the control and recording room. The I.B.M. clock and programming device are on the wall. The consoles to the right contain the recording milliammeters, power supplies, DC amplifiers, and related equipment.

to make measurements at power levels from well below the normal radiation of the quiet sun to well above the maximum levels of the radiation from an active sun.

The frequencies used are 55, 167, and 450 mc. At present the 55 mc equipment is not in operation, but construction has been started on an 80 mc antenna. This antenna will consist of a 55 foot square ground plane on which the 16 helices are mounted, eight of which will be right-hand wound and eight left-hand wound. Since the energy coming from the sun is circularly polarized according to the hemisphere from which the radio energy is originating, it is hoped to be able to determine the hemisphere of the sun from which radio energy originates.

Both the 167 and 460 mc. receivers are of the superheterodyne type. They are essentially a radio frequency amplifier and mixer followed by a high grain intermediate frequency amplifier, second detector, DC amplifier, and recording millammeter. The 460 mc. receiver has a band width of 2 mc. while the 167 mc. receiver has a band width of 167 kc. The use of this lower band width in the 167 mc. receiver is partially to eliminate television interference from channel 7 which is 174 mc.

Features of the present equipment are: the use of automatic controls for starting daily operation and tracking the sun from sunrise to sunset, one point noise diode calibrations at selected intervals, cutoff at sunset and return to the sunrise start position, and time marks every 15 minutes on the records. This programming is made possible through the use of an I. B. M. electric clock times, checked against radio station WWV, and a complicated system of relays and switches. Where possible the equipment is kept at a constant temperature



One of the "Giant Wurzburg" antennas used by the National Bureau of Standards. A dipole at the focal point of the paraboloid reflector receives the radio energy from the sun.

—Photo Courtesy National Bureau of Standards Boulder Laboratories

in order to minimize frequency drift and changes in receiver generated noise.

Radio Communication Aspects

From solar noise measurements it is hoped that more will be learned about the sun and how it affects radio-wave propagation. Radiation from the sun provides the ionizing energy for the formation of the ionosphere which makes long-distance radio communication possible. It has been known for a long time that there is a good correlation between solar activity and variations in radio-wave propagation conditions. Sunspots, magnetic storms, auoras, earth currents, and radio-wave propagation are all related.

Measurements of enhanced solar noise have already shown there is an intimate relation between it and sunspots. Interferometer measurements made of enhanced solar noise at a time when there was a single large sunspot group showed that the enhanced solar noise came from the same part of the sun in which the sunspots were located. Other measurements on this type of solar noise have shown it to have a component that is circularly polarized, just as would be expected if it were caused by

SIGNIFICANCE

For radio engineers: more accurate predictions of optimum operating frequencies, since activity on the sun affects the inosphere.

For astronomers: a more accurate means of measuring the plane of our galaxy and making heretofore impossible measurements contributing to knowledge of the universe.

For meteorologists: a means of monitoring the complete thickness of the earth's atmosphere, in contrast to sounding measurements that go only to the height of maximum ion density.

electrons moving in the magnetic field of the sunspot.

Noise measurements during a solar eclipse showed good correlation between the intensity of enhanced solar noise and the area of prominences and flocculi. During totality of the visual eclipse the solar noise was reduced to only 0.4 of its uneclipsed value, indicating radiation from the uneclipsed prominences. These prominences increased the effective diameter of the sun at 200 mc. to 1.35 times its optical diameter.

Besides providing us with a new means of observing solar phenomena, the solar noise is in fact a measurement of radio-wave propagation through the earth's atmsophere. This, then, gives us a means of measuring the propagation of a radio wave that has transversed the entire inosphere instead of one that goes only to the height of maximum ion density and back, as with the usual inospheric sounding measurements. Accordingly solar-noise experiments shed light on the earth's atmosphere.

Astronomy Aspects

The contribution of radio astronomy to the knowledge of our galaxy may be even greater than to the knowledge of the sun. Our galaxy is thought to be a flat disc-shaped group of stars somewhat similar in shape to the Andremeda Nebula. Our sun is situated near the edge of this disc, roughly one-third of the distance to the center. Estimations of the mass of the galaxy require corrections for the absorption of light by interstellar matter. In fact, there is some doubt that we can observe the center of the galaxy at optical frequencies because of this absorption.

The absorption that predominates at optical frequencies decreases rapidly with frequency and should be negligible at radio frequencies. This makes possible more accurate determination of the plane of the galaxy by measurements of the intensity of galactic noise as a function of direction.

There are many questions about both our sun and galaxy that can be answered by the new field of radio astronomy. This branch of science is not at the point where astronomy was when Galileo invented the optical telescope. Scientists in this new field are just asking themselves the pertinent questions that will be answered in the years to come.

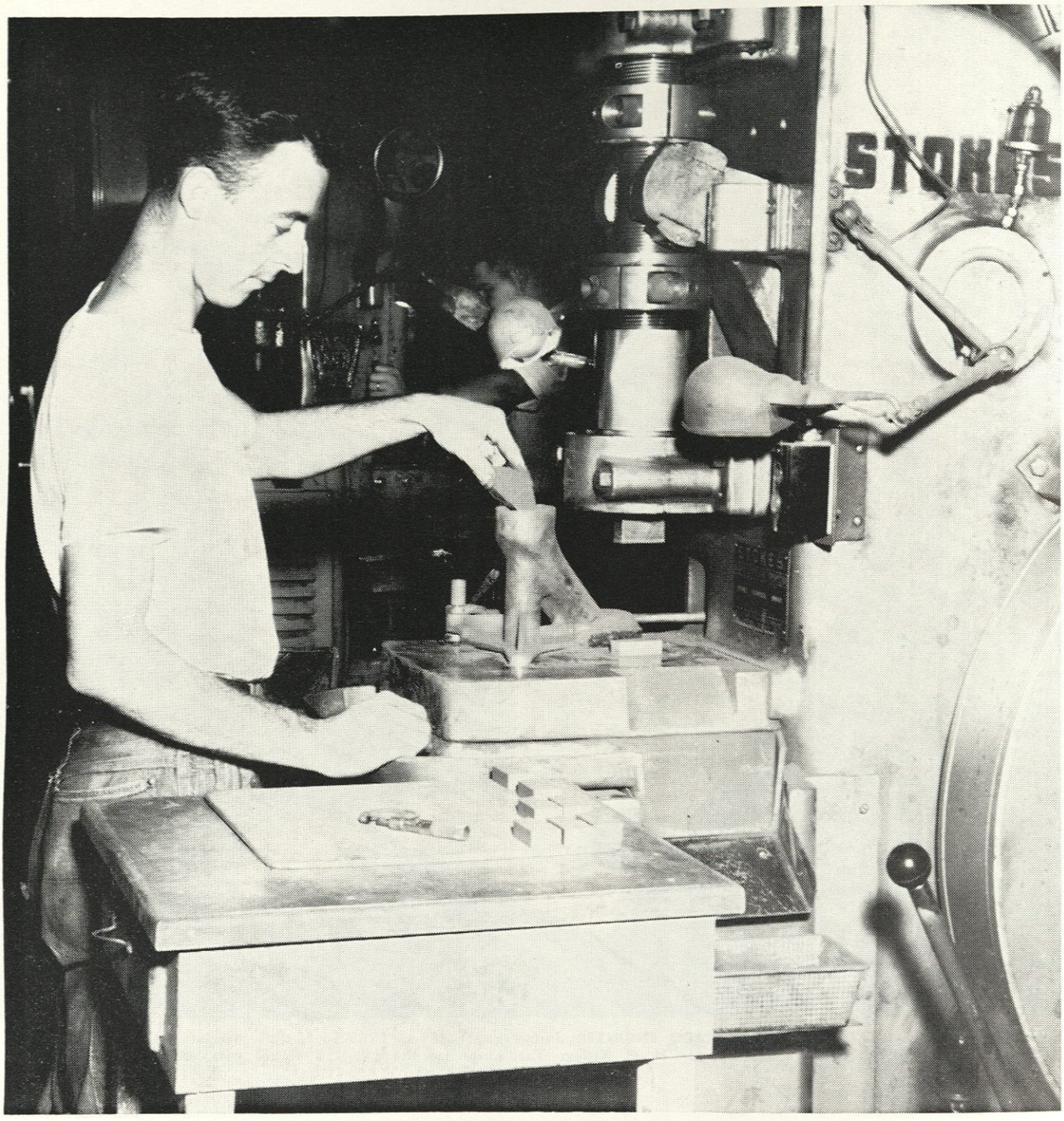
Jim Morgan, Editor-in-Chief of the COLORADO ENGINEER during the school year 1953-54, is shown receiving the E.C.M.A. award from the editorial advisor of the magazine, Mr. H. H. Kelley. The editor for the 1954-55 school year, Dave Evans, is shown looking on.

E.C.M.A. AWARD

The Engineering College Magazines Associated recently awarded the *Colorado Engineer* a third place in the Best-Written magazine division of the associations annual magazine competition. The *Colorado Engineer* also received an honorable mention for the Best Student article. Neither the name of the article nor that of its author has as yet been released by the association.

Jim Morgan, now president of the Combined Engineers, was the Editor-In-Chief of the magazine during the recent competition of the school year 1953-54.

The award was received by the representatives of the magazine at a recent convention of the association in Minneapolis, Minnesota. The E.C.M.A. represents thirty-eight college engineering magazines which annually meet to discuss mutual business and editorial problem. The representatives of the *Colorado Engineer* who attended the convention were Mr. H. H. Kelley, editorial advisor of the magazine, and Dave Evans, the new editor.



The press operator measures out a quantity of metal powder in preparation for the pressing operation. Note the use of a micrometer, an indication of close tolerances.

POWDER METALLURGY

by FRED GROMETER

If someone were to tell you that he could produce a gear or a bearing simply by pressing together and heating minute particles of metal, you would probably scoff at the idea. However, this is what is being done today in the rapidly expanding field of powder metallurgy. "Powder metallurgy," as defined by the American Society for Metals, "is the art of making objects by the heat treatment of compressed metallic powders, with or without the addition of nonmetallic substance."

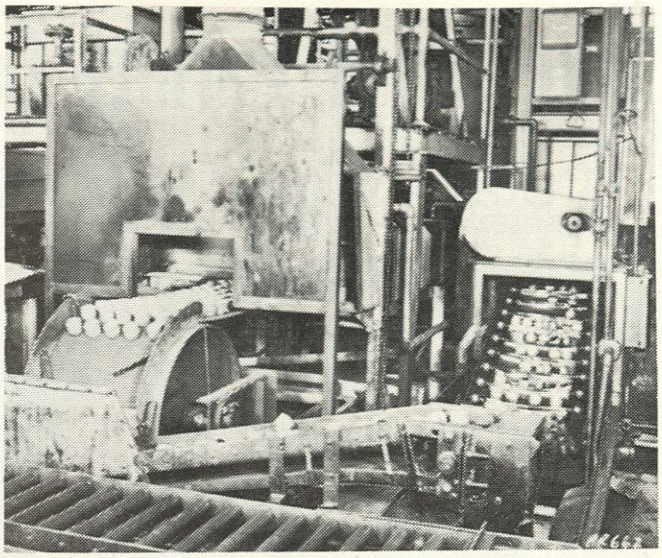
Now that we know what powder metallurgy is, let us investigate briefly its history, theories, and uses.

As early as 3000 B.C. the Egyptians were able to reduce a lump of iron oxide to a spongy mass of iron metal by means of a charcoal fire. This spongy mass was then hammered into a usable shape. This method was used because no furnaces capable of producing high enough temperature for melting the pure metal were available. For the same reasons, the ancient Incas were unable to melt the precious metal, platinum, consequently they stumbled onto the powder technique. This same method of producing platinum metal, with refinements, was carried through the nineteenth century in this country. Thomas Edison's introduction of the incandescent lamp created a need for a high melting point metal for a filament. Several refractory metals were considered, and tungsten (melting point, 6170°F) was found to be the most feasible. The same problem that confronted the Egyptians was present here. Again a powder technique was the answer.

The compacting of the powder into a part requires tremendous pressures. Pressures now range from five tons per square inch to 200 tons per square inch. Values of this magnitude seem to lose their meaning; imagine four railroad cars, loaded with coal, resting on an area equal to that of the face of your wrist-watch! As the pressure is applied, the powder particles are pushed closer together. Ratios of final specific weight to initial "apparent" specific weight may be as high as eight to one; values of three to one are more common, however.

Many interesting problems arise in the design of dies and punches to be used in compacting powders. The powder is neither a solid nor a fluid, hence the pressure and density are not uniform throughout the compact. Because the powders will not flow as a fluid flows, the designer has no idea of forces normal to the direction of compression. This same lack of fluidity limits the compacting to parts of simple geometry, *i.e.*, no undercuts, internal threads, grooves, or abrupt changes in thickness are possible.

After pressing, the brittle "green compact" is heated to a temperature below its melting point. This heating is known as sintering. Having been forced into intimate contact during compacting, the particles adhere to one another by the forces of attraction between the atoms of the respective surfaces. At the higher temperatures of sintering, yield strengths are reduced such that these forces will give a more intimate contact. The time and temperature of sintering are both important, there being

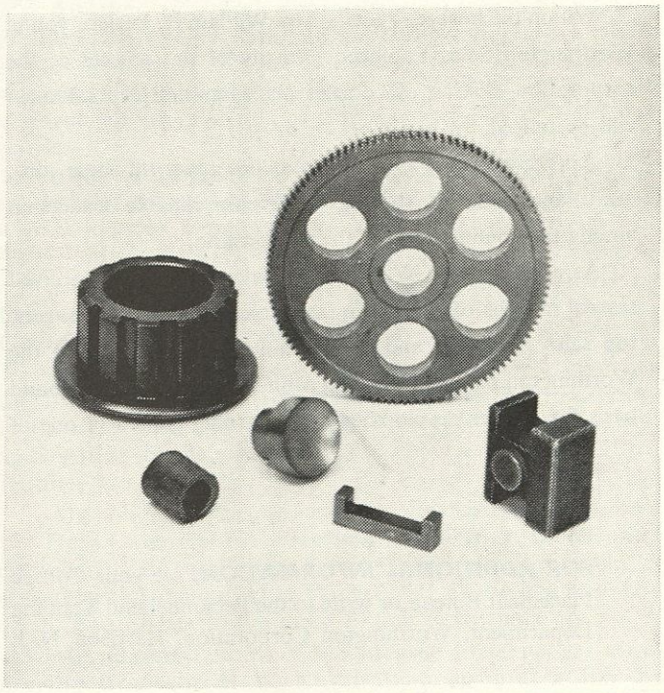


The finished parts are being conveyed from the sintering furnace. Note the large quantity of parts produced.
Photo courtesy of Amplex Division, Chrysler Corporation

an inverse relationship between them. The general magnitudes of temperature for various metals are 1470°F for brass and bronze, 1740°F for iron, 5160°F for the refractory metals. Oftentimes the compacting and sintering are combined into one operation, hot pressing.

The powder metallurgy technique has been used in many applications. As mentioned above, powder techniques are suitable for forming the high-melting metals. Cemented carbide tool bits, which are sintered, have done much to speed production by their high-speed, high-temperature cutting properties. The porosity of sintered products may be controlled quite easily by

(Continued on page 48)



Stress bearing machine parts produced by the powder metallurgy technique.
Photo courtesy of Amplex Division, Chrysler Corporation

William R. Parlett, Cornell '48, Sets Sights on Executive Sales Job

BILL PARLETT has learned that helpful engineering suggestions promote good customer relations.

"Within the next ten years", says William R. Parlett, young Worthington Sales Engineer, "many of the officers of the corporation, district office sales managers and top salesmen will be retired.

"Appreciating the fact that someone must fill these jobs, our management is striving to develop capable leadership among the younger men of the corporation.

"As a prospective Worthington Sales Engineer, I received several months of classroom instruction by works managers, top sales personnel and application engineers at all of the Worthington plants. The background I obtained was a sound basis for further development and learning gained in one of the product sales divisions and then in a district sales office. After obtaining sufficient product knowledge and sales training, I was ready to sell directly to industry. As more important sales assignments are available, I feel I will progress in proportion to my own development and sales performance.

"As a Worthington salesman I contact a class of trade with which it is a pleasure to do business. The company's reputation is a key to a welcome reception by my customers.

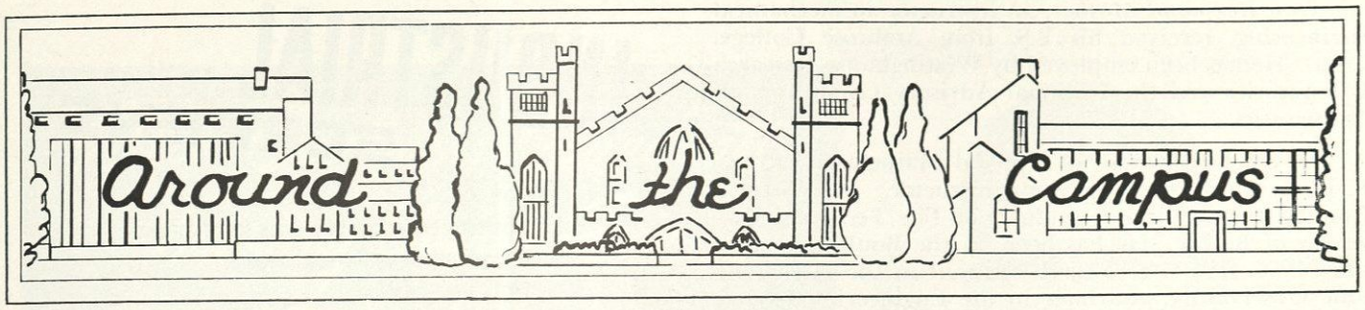
"I have found that with Worthington you have job satisfaction, adequate compensation, and unlimited opportunity."

When you're thinking of a good job, think *high*—think *Worthington.* 3.6

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

WORTHINGTON

The Sign of Value Around the World



1954 ENROLLMENT

The enrollment in the College of Engineering soared to 1,908 this fall, compared to 1,519 in 1953. The total enrollment on the Boulder campus is 8,178, nine hundred sixteen over last year. These totals are about two years ahead of the previous estimates made by the Office of Admissions. Figures from several other universities around this region show a similar increase.

No one factor can be given which will account for this rise. Besides a larger freshman class, there has been a greater percentage of transfer enrollments; and many more previous students than usual have returned.

The enrollment in the aeronautical engineering department is 203 this year, including 21 who are taking the five-year combined business and engineering course. Architecture has 193, with 7 in the combined course. The chemical engineering department has an enrollment of 235 of which 33 are combined engineering and business majors.

By far the largest is the electrical engineering department with a total of 438, including 51 five-year students. The civil engineering department numbers 279 with 31 students working toward combined degrees. There are 135 students in engineering physics including 14 business and engineering majors. The second largest enrollment, 353, is in the mechanical engineering department, 51 of these being in the five-year course. Sixty-nine students are in the general engineering classification.

NEW LAB EQUIPMENT

Several thousand dollars worth of new equipment is being added to the engineering laboratories this fall.

A General Electric axial flow fan and dynamometer has been shipped to the mechanical engineering laboratory. The machine was designed for the study of several of the variables involved in the fluid flow and energy transfer encountered in turbo-machinery. The dynamometer scale readings provide for the direct measurement of the horsepower required by the fan for all test conditions.

The electrical engineering department has installed several new General Electric machines in the power laboratory. Among these are two motor-generator sets, four automatic motor controllers, two amplifiers, and several electrical instruments.

A second jet engine has been acquired for the aeronautics laboratory. It is a Westinghouse, J34-WE-11 engine which was procured through the State Surplus Agency from Edwards Air Force Base, Muroc, California. The engine developes 3,200 lbs. of thrust; it has been flight tested with afterburner for a total of 81 hours.

NEW FACULTY MEMBERS

Over twenty new instructors have recently joined the faculty of the College of Engineering. This is the first of two articles designed to introduce these new members to the C.U. engineering students.

In the Department of Engineering English, *Robert E. Chapdu* has been added as an instructor. Mr. Chapdu recently received his M.A. degree from Miami University. Before this, he served in the Army Engineering Corps.

Douglas Nichols, another English instructor, received his M.A. degree from the State University of Iowa, after which he taught at Bates College and Ohio State University. Mr. Nichols has had several of his writings published.

Also in the Department of Engineering English, *Howard Zettler,* a C.U. graduate, is employed as a part-time instructor. Mr. Zettler taught at the University of Connecticut and the Virginia Episcopal School; and has served three years in the Air Force. He is a member of Phi Beta Kappa honorary fraternity.

Another University of Colorado alumnus, *Robert Ruehle,* is an instructor in the electrical engineering department. Prior to joining the staff here, Mr. Ruehle had been connected with Westinghouse Electric Corp.; he is now in a year's leave of absence from the Los Alamos Scientific Laboratory in New Mexico.

John H. Blake is an assistant professor in chemical engineering. He served in the Air Force as a First Lieutenant. Dr. Blake received his B.S. from Princeton, M.S. from Stanford, and Ph.D. from the University of California. He is a member of The American Chemical Society, Sigma Xi, and Phi Beta Kappa.

Another chemical engineering instructor, *Edward J. Hoffman,* received an M.S. degree from the University of Michigan. Prior to coming here, Mr. Hoffman was an instructor at Oklahoma A. & M. College and a research engineer with Continental and Carter Oil Companies.

Edward Sampson, Jr., an assistant professor, is also in the Department of Chemical Engineering. He holds a M.S. degree from Princeton University, and has recently taught at Colorado College.

New teachers in the Department of Engineering Drawing and Machine Design include *Ray L. Hauser, George Nicholls* and *Edson Hartzell.*

Mr. Hauser holds a B.S. degree from the University of Illinois and a M.S. from Yale. Besides having served in the army and the navy, he has recently been employed as a senior project engineer for the Connecticut Hard Rubber Co.

Mr. Nicholls has worked at the Sandia Corp. and the Dow Chemical Co. He is a graduate in mechanical engineering of the University of Colorado. Mr. Nicholls served in the army during World War II; he is a member of Pi Tau Sigma and Sigma Tau fraternities.

Mr. Hartzell holds a B.S. degree in electrical engineering from the U. S. Naval Academy and a B.S. in mechanical engineering from the University of Colorado. Mr. Hartzell taught at C. U. from 1946 to 1951 when he joined the Monsanto Chemical Company.

Don Raymond Mosher, an instructor in mechanical engineering, received his B.S. from Ambrose College, Iowa. He has been employed by Westinghouse Research Laboratories and the National Advisory Committee on Aeronautics.

In the Department of Applied Mathematic, *Bruno F. Witte* is now working as an instructor. Mr. Witte is from Germany, and is a graduate of The Technical University of Berlin. He has been on the Boulder campus since 1950, first as a research assistant in the High Altitude Observatory, and later in the Engineering Experiment Station.

The students of the College of Engnieering are fortunate to have these new additions to the faculty.

"Allis-Chalmers Graduate Training Course Gave me a head start"

says GERALD SMART

Marquette University, BS—1948
and now Supervisor of Plant Engineering,
Allis-Chalmers, Norwood, Ohio, Works

"MOST MEN graduating from college don't have a clear idea of what they want to do. These individuals are helped by Allis-Chalmers Graduate Training Course to find the right job whether it be in design, sales, engineering, research or manufacturing.

"My case is a little different, however. I started the course with all my interest centered on tool design and 'in-plant' service. The reason is that I started getting vocational guidance from some very helpful Allis-Chalmers men back in 1940."

Served Apprenticeship

"At their suggestion I had gone to school part time while working full time. This not only gave me the chance to serve an apprenticeship as a tool and die maker, and earn money, but I learned what I wanted to do after graduation.

"Then came the war and service in the Navy. After the war I finished school. By the time I started on the course in 1948, I knew what I liked and seemed best fitted to do. As a result, my entire time as a GTC student was spent in the shops.

"The 18 months spent in the foundry, erection floor and machine shop have all proved valuable background for my present job.

"As supervisor of plant engineering at the Norwood Works, I am concerned with such problems as: Plant layout, material handling equipment and methods, new construction, new production methods to be used in building motors, centrifugal pumps, and *Texrope* drives. It's an extremely interesting job.

"From my experience, I'd say, whether you're a freshman or a senior it will pay you to talk to an Allis-Chalmers representative now. You can't start planning your future too soon. And you can't plan starting at a better place, because Allis-Chalmers builds so many different products that you'll find any type of engineering activity you could possibly want right here."

Facts You Should Know About the ALLIS-CHALMERS Graduate Training Course

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

2. The course offers a maximum of 24 months' training. Length and type of training is individually planned.

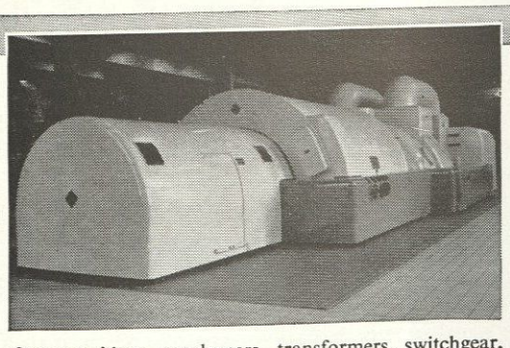
3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, specialized equipment or industrial apparatus 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.

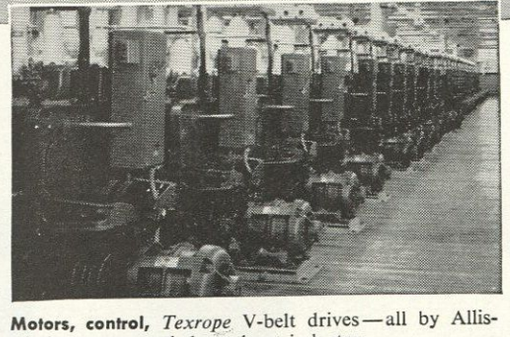
5. He will have individual attention and guidance of experienced, helpful superiors in working out his training program.

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.

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, Wisc.



Steam turbines, condensers, transformers, switchgear, regulators are built for electric power industry.



Motors, control, *Texrope* V-belt drives—all by Allis-Chalmers are used throughout industry.

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ALLIS-CHALMERS

Texrope is an Allis-Chalmers trademark.

C-5678

THIS TODAY

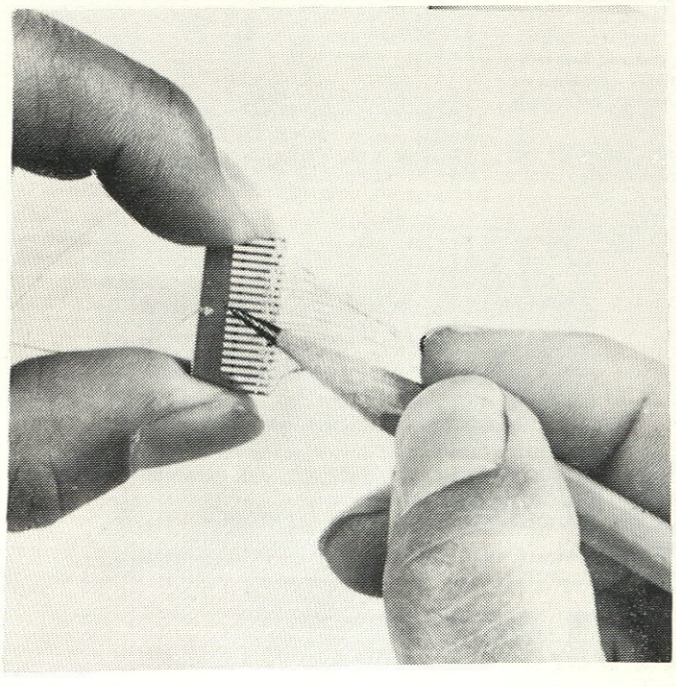
What Tomorrow?

SENSITIVE CELLS

These little slips of glass coated with lead sulfide can give 10,000 times as much sensitivity to certain infrared rays as previous laboratory instruments. Known as a Kodak Ektron Detector, it is now being produced after a decade of research by the Eastman Kodak Company. The tiny black specks lying under the pencil point are the cells themselves, which reach the peak of sensitivity in the invisible heat rays of the near-infrared. It is also highly sensitive to all colors of visible light and on into the ultraviolet.

As a demonstration of the new cell, Kodak representatives have been exhibiting a small box that emitted squeals whenever the Ektron Detector on it "saw" the bit of hot ash on the end of a cigarette. It also squealed loudly when a flashlight was pointed at it with battery cells so weak that the lamp filament scarcely glowed. The pinpoint specks of lead sulfide on the glass are intended to operate complex combinations of electrical circuits in response to projected patterns of light or heat radiation.

In the chemical plant applications, the cells could automatically monitor the exact composition of fluids flowing through pipes and process vessels on the basis of the characteristic infrared "color" of the various components. Water and gasoline, for example, are both colorless liquids to the human eye, but look entirely different to a sensitive infrared detector. Very fine differences between chemicals can be detected in this way.



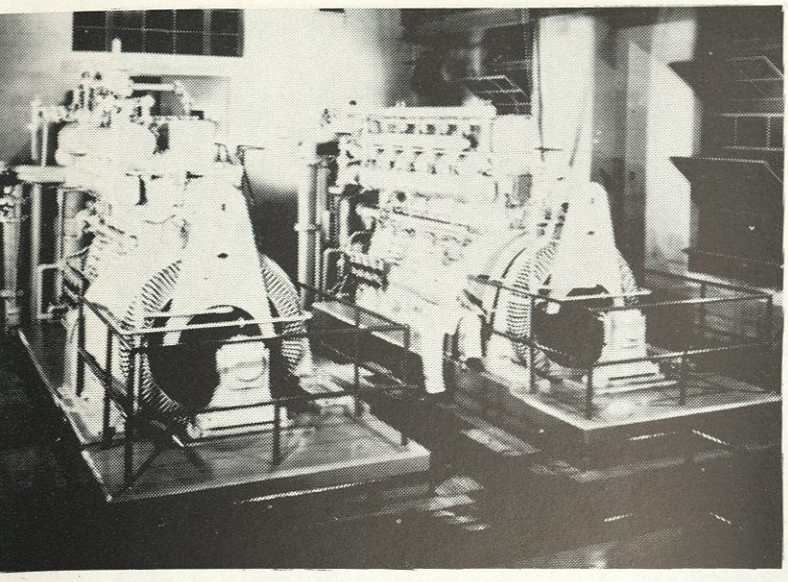
MINING MACHINE

This newly developed continuous mining machine that vibrates coal from the mining face is now in operation in several mines of the United States Steel Corporation. The new machine minimizes and in some cases eliminates the need for blasting. With the machine a mine section can be operated with a three or four man crew consisting of an operator and two or three helpers.

The vibratory force is applied to the coal face through two electric hammers mounted on a telescopic carriage. At a cyclic speed of 1800 blows per minute with 15 tons of force packed behind each blow the vibrating hammers can be utilized to trim roof and break down coal at the face.

Power for the electric hammers is supplied through a nine-conductor cable, from an explosion-tested motor-generator set consisting of a 15 horsepower, direct-current motor directly coupled to a 28.8 kva, 160 volt, 30 cycle generator and a 3 kw exciter for generator excitation.

The bottom bars and chains serve the dual purpose of undercutting the coal and conveying it from the mine floor to the discharge conveyor. The coal is discharged by the combination conveyor-cutter chains into a hopper located in the center of the main body of the machine. The coal is moved from the hopper to the shuttle car by a single-type conveyor boom which extends 8 feet beyond the rear bumper of the machine.



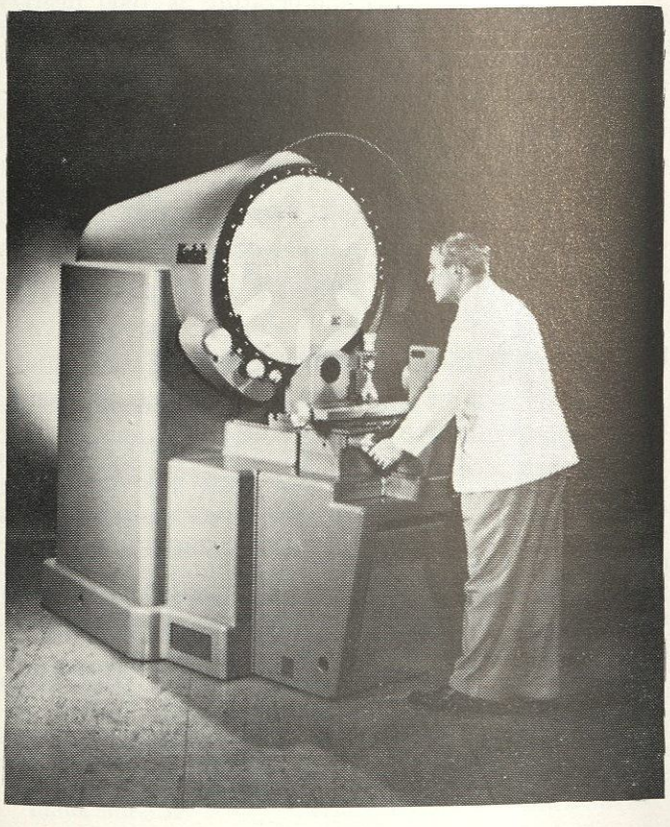
ECONOMIC FUEL

Florida's largest sewage treatment plant is located in Tampa, where the fast-growing population has almost doubled since 1947. The electric power for their latest plant is supplied by these two Worthington engines driving Electric Machinery Company generators. Both engines operate on sewage gas produced during the treatment of the raw sewage.

★ ★ ★ ★

BIG PICTURE

This big new contour projector featuring a 30-inch viewing screen has been introduced by the Eastman Kodak Company. It is intended for use both in precision micrometry and on the production line. In either of these fields its size permits easier inspection of complete parts, or greater ease and convenience in inspecting portions of very large parts.



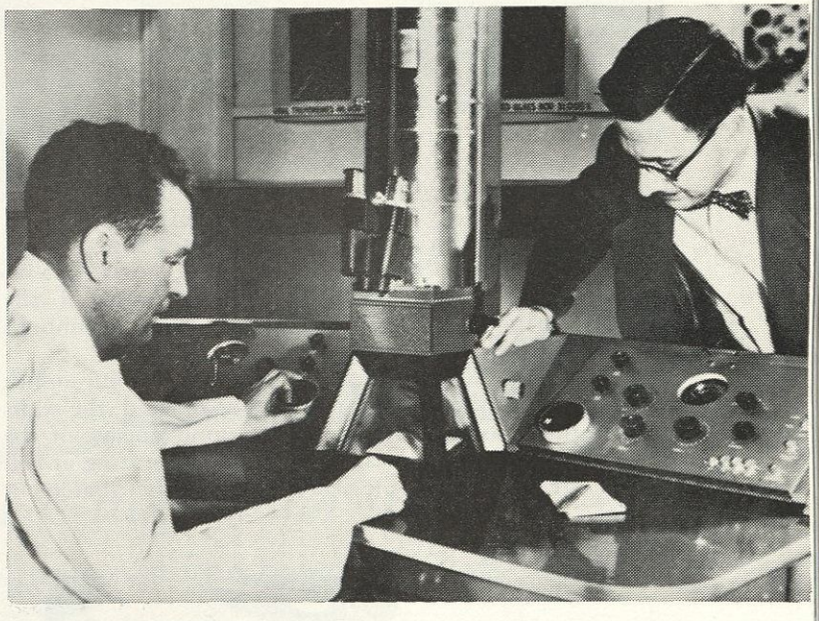
Outstanding features include a choice of either shadow or surface illumination at the flick of a switch: ordinary room-light operation; instant changes in magnification without refocusing; and unvarying 8-inch distance between the lens and the plane of the object under observation.

A built-in 1,500 watt light facilitates the surface inspection of cavities, blind holes, and surface details. Illumination for shadow projection is provided by a 500 watt light source which gives a sharp, easy-to-read screen image across the full 30-inch diameter. Instant change of magnification from 10x through 100x is possible without focusing or other adjustment.

★ ★ ★ ★

NEW ELECTRON MICROSCOPE

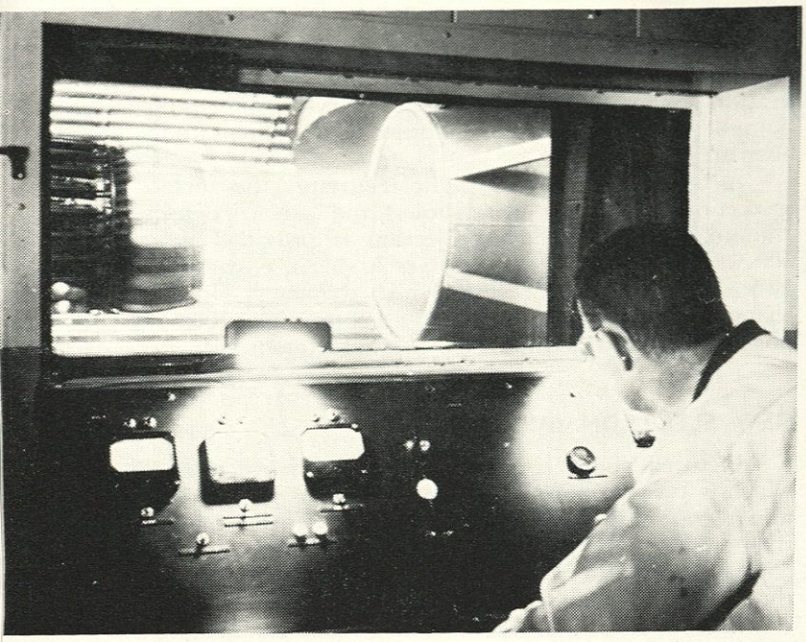
Pictured above is a new type electron microscope which is twice as powerful as any now in use. This new miscroscope will permit the study of particles smaller than one ten-millionth of an inch in diameter. Equipped with an automatic camera, enlargements of 200,000 times the size of the specimen can be made. At this scale one thin dime would measure two miles across its diameter.



The development of the electron microscope, with which the polio virus was observed for the first time, has opened up many new fields of study in biology. With the new electron microscope the range of the human eye is again pushed forward.

The electron microscope operates by directing a concentrated beam of electrons through the specimen which is placed in a small column about half way between the viewing screen and the electron gun at the top of the column. The viewing screen is built into the column at desk level with windows on three sides to permit several persons to see the enlargements at the same time. As the electrons pass down through the specimen, they are affected by its density and composition, and the beam emerging on the other side bears the pattern of the specimen which is then magnified by magnetic lenses.

The ordinary optical microscope is limited in its range by the wave-length of visible light. Objects smaller than this wave-length do not interrupt or reflect the light, but the electron beam which has a wave-length only 100-thousandths as great as visible light will interrupt or reflect far smaller particles.

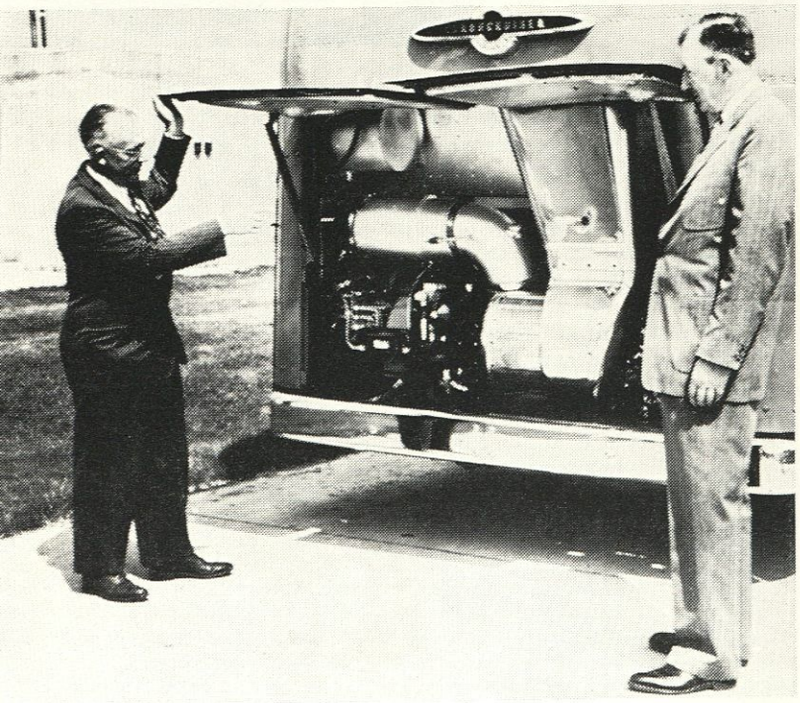


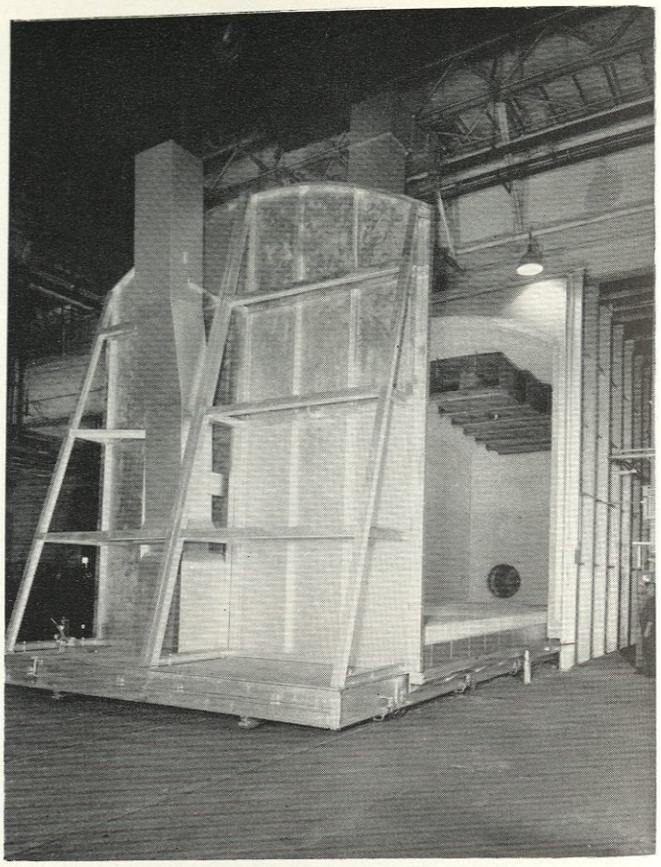
QUIET PLEASE

A bright bar of flame cuts through the darkened chamber of North American Aviation's newest sound abatement facility during after-burner operations in acceptance tests of an F-100 Super Sabre's J-57 jet engine. The sound of careful pre-flight operations, the last production step for F-100's, is sharply reduced in this sound abatement chamber.

The tail-pipe of the super-sonic fighter juts through an opening in the silencer unit where it is fitted with a nearly sound-proof asbestos collar. Sound of the engine during run-ups is contained by the chamber's three feet thick walls.

Constructed of corrugated steel plates one-eighth of an inch thick and separated by tons of sand, the walls are slightly elastic and absorb the sound energy of the sound energy of the operations. Engines operating at full power are barely audible 250 feet from the abatement unit.





GIANT FURNACE

Westinghouse has built a mammouth, single chamber, heat treating furnace which will be used for stress relieving of large weldments. The usable space in the furnace is 30 feet long, 18 feet wide, and 16 feet high, large enough to contain a modest one story bungalow. Parts weighing up to 100 tons may be treated at one time.

Maximum operating temperature is 1600 degrees Fahrenheit, but most stress relieving will be performed at 1175°F. Heat for the furnace is provided by four gas burners with a rating of 7 million Btu's per hour. Air passing through the combustion chamber is heated by the burning gas and enters the furnace through ducts at the rear and sides, assuring uniform heat throughout the space. When the air reaches the front of the furnace it is drawn out and recirculated through the combustion chamber. A program control automatically regulates the heat up, soaking, and cool back cycle.

* * * *

NEW POWER FOR MOTOR VEHICLES

One of General Motors latest developments in the field of transportation is a gas turbine power unit for use in cars and buses. The gas turbine, shown above in a GM bus, requires the same space that the Diesel engine would normally occupy, and no change in design was necessary except for a larger exhaust stack to take care of high volumes of gas. The 370 horsepower Whirlfire unit, as the turbine has been named by the GM engineers, delivers twice the power that the Diesel engine gives plus a weight saving of 1500 pounds.

In the rear of the bus there is a test panel from which all important data can be obtained. The laboratory on wheels will be used to help the GM engineers in their research to make the gas turbine a usable power unit for commercial transportation.

The metal that makes time stand still

Thanks to chromium, steel now serves you with strength and beauty that lasts a lifetime

IN TIME, one of man's most useful materials—steel—is often the victim of such destructive forces as rust, corrosion, heat, or wear.

THESE NATURAL ENEMIES of steel now are mastered by the metal called chromium. When the right amount of chromium is added to molten steel, the result is strong, lustrous stainless steel that defies the ravages of time.

IN HOMES, TODAY, stainless steel is a shining symbol of modern living. It brings us care-free sinks, gleaming tableware and kitchen utensils—all with beauty that lasts a lifetime.

IN INDUSTRY—Food is prepared in super-sanitary stainless steel equipment. Streamlined trains and buses are made of this wonder metal. Vital parts of jet planes that must withstand both blazing heat and sub-zero cold are made of tough, enduring stainless steel.

SERVING STEEL...AND YOU—The people of Union Carbide produce alloys of chromium for America's steelmakers. This is another of the many ways in which UCC transforms the elements of nature for the benefit of everyone.

STUDENTS AND STUDENT ADVISERS: *Learn more about career opportunities with Union Carbide in* ALLOYS, CARBONS, CHEMICALS, GASES, *and* PLASTICS. *Write for booklet G-2.*

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Members of the Combined Engineers Executive Council as seen during a recent meeting. The members from left to right are Tom Hirtle, Bill Eager, Reid Rundell, and Jim Morgan.

Campus Profiles

Your Combined Engineers

Combined Engineers, an organization to which any engineering student may belong, sponsors all the social activities of the College of Engineering.

Membership is gained by paying a two dollar fee. Membership enables students to attend the various engineering functions and to participate on the committees which plan them. They also have a voice in the school government and a chance to bring forth any opinions they may have.

Executive Council

Combined Engineers is headed by an Executive Council which is composed of four members. Jim Morgan is the president, and the three councilmen are Bill Eager, Reid Rundell and Tom Hirtle. The activities sponsored by the Combined Engineers include the Engineers' Round-up, Engineers' Smoker, Engineers' Ball, Engineers' Days and the *Colorado Engineer* magazine.

The council members are elected by the students every spring for a term of one year, which begins at the beginning of the fall term. When the outcome of the elections are announced at the Engineers' Days honors convocation, each of the officers is presented with a gold key inscribed "Combined Engineers."

Other Committees

Under the Executive Council is a Nominating and Control Committee over which the president of the Combined Engineers presides. This committee is composed of a voting and non-voting group. The voting group consists of the Executive Council, the editor and business manager of the *Colorado Engineer* and the presidents of the engineering societies and honoraries. The Dean of the College of Engineering, the department heads, and the Faculty Combined Engineers' Activity Committee make up the non-voting group.

The Nominating and Control Committee is a representative body which makes nominations for the Executive Council each year and listens to student opinion. It also puts out the bi-monthly "Poopsheet" which contains the news of the Combined Engineers' activities, notices of meetings and a few choice jokes.

The Faculty Combined Engineers' Activity Committee which serves on the non-voting committee of the Nomination and Control Committee, also acts as an advisory group. The activity committee consists of faculty members who alternate their services each year. This year it is headed by William J. Hanna who is an assistant professor in the electrical engineering department. All financial disbursements of the Combined Engineers must be approved by the committee, and two of their members act as consultants to the chairman of each activity planned.

Members Entitled To Activities

The Engineers' Round-up is the first activity of the Combined Engineers each year. Immediately following the homecoming football game the alumni, faculty and students have a get-together which offers an excellent opportunity for students to meet and talk with the men who are already working in the field they may some day enter.

The only all male activity of the year is the Engineers' Smoker which consists of a variety of competitive skits and other entertainment. During this function the students have a chance to get to know one another better.

The Engineers' Ball, a big social event of the school year, is held in mid-winter. The Engineers' Queen is coronated at this occasion.

In May the students in the school of engineering hold open house to exhibit the models they have built to illustrate the applications of their various fields of engineering in industry. A honors convocation, competitive sports events, and a picnic round out the Engineers' Days activities.

Combined Engineers is an organization designed to bring each and every engineering student the kind of government that he wants and the type of activities that he desires. Its object is "to plan and execute all activities appropriate to the interests and tradition of the College of Engineering."

QUARTZ CRYSTALS

How a 1¼ hour "gem-cutting" operation became an 8-minute mechanized job

PROBLEM: Preparing quartz crystals for use as electronic frequency controls calls for the highest degree of precision. So much so, in fact, that prior to World War II skilled gem-cutters were employed to do the job.

But during the war, there were not enough gem-cutters to keep up with the demand for crystals in radar, military communications and other applications.

Western Electric tackled the job of building into machines the skill and precision that had previously called for the most highly skilled operators.

SOLUTION: Here is how quartz crystals are made now—by semi-skilled labor in a fraction of the time formerly required:

A quartz stone is sliced into wafers on a reciprocating diamond-edged saw, after determination of optical and electrical axes by means of an oil bath and an X-ray machine. Hairline accuracy is assured by an orienting fixture.

The wafers are cut into rectangles on machines equipped with diamond saws. The human element is practically eliminated by means of adjustable stops and other semi-automatic features.

The quartz rectangles are lapped automatically to a thickness tolerance of plus or minus .0001". A timer prevents overlapping. Finally, edges are ground to specific length and width dimensions on machines with fully automatic microfeed systems.

Most of these machines were either completely or largely designed and developed by Western Electric engineers.

RESULTS: With skill built into the machines —with costly hand operations eliminated— this Western Electric mechanization program raised production of quartz crystals from a few thousand a year to nearly a million a month during the war years. This is just one of the many unusual jobs undertaken and solved by Western Electric engineers.

Quartz stones are cut into wafers on this diamond-edged saw, with orientation to optical axis controlled by fixture. This is just one of several types of machines designed and developed by Western Electric engineers to mechanize quartz cutting.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

Manufacturing plants in Chicago, Ill.; Kearny, N. J.; Baltimore, Md.; Indianapolis, Ind.; Allentown and Laureldale, Pa.; Burlington, Greensboro and Winston-Salem, N. C.; Buffalo, N. Y.; Haverhill and Lawrence, Mass.; Lincoln, Neb.; St. Paul and Duluth, Minn. Distributing Centers in 29 cities and Installation headquarters in 15 cities. Company headquarters, 195 Broadway, New York City.

Highways To Achievement

A. I. Ch. E.

A large, successful party held in the Tower Room of the Memorial Center got the A.I.Ch.E. off to a good start. The highlight of the evening was the amazing antics of Bob Bergheim, magician. Preceding Bob's show was the introduction of the officers for the year. The officers are: Colin Couper, president; Bob MacBrayer, vice-president; Arne Landsberg, treasurer; Carl Chamberlin, secretary; and Darrell MacKay, program chairman.

The second meeting on October 21 featured an interesting talk by Mr. Van Valkenburgh, noted patent attorney. Preceding the talk was an important business meeting.

All members are urged to attend the interesting meetings held by the A.I.Ch.E., this year.

A. I. E. E. AND I. R. E.

The highlight of the fall semester for the American Institute of Electrical Engineers and Institute of Radio Engineers was a talk and demonstration on color television given by Dr. Hoyler of the RCA Sarnoff Laboratory. Future programs will include talks and demonstrations on microwaves, high frequency radio propagation and transistors.

S. A. E.

The Society of Automobile Engineers started the fall semester by taking a field trip through the Climax Molybdenum Company's mines. The trip was sponsored by the Denver branch of SAE. The second meeting, also sponsored by the Denver SAE organization, featured an interesting talk about the automobile industry in Europe by Floyd Clymer.

A. S. C. E.

The American Society of Civil Engineers began the school year with a well planned program of speakers, field trips, and activities. The first meeting featured student speakers who spoke on their summer engineering jobs. Students who related their summer experiences included: Dick Jones, Jim Kreigh, and Jack Allen.

Mr. Leo C. Novak, associate professor in the civil engineering department, spoke at the second meeting on the motor trip he and his family took to Alaska. He illustrated his talk with colored slides which traced his route to Whitehorse, Alaska, and back again to Boulder.

On October 8 and 9 the society went on a field trip to Reservoir No. 22. Thirty-eight members visited the area which is being developed by the Denver Water Board.

Intramural football, the "Smoker" skit, and the annual picnic provided activity for all the members during the early part of the semester. The picnic was held on November 6 at the Boy Scout cabin on Flagstaff mountain. A good time was enjoyed by all who attended.

M. E. S.

The first meeting of the Mechanical Engineering Society was a very successful one which fifty-eight members and guests attended. The first item on the agenda was the introduction of new officers for the year. After the officers were introduced and old business taken care of, two movies were shown. The movies were "Banshee", a film of the Navy's J34 jet fighter, and "Spin Dizzy", a movie about auto racing. The meeting was co-sponsored by ASME and SAE.

SIGMA TAU

Sigma Tau is an all engineering honorary which recognizes juniors and seniosr who have maintained high scholastic averages and at the same time exhibiting the qualities of practicability and sociability.

The officers for this semester are Darrell Mac Kay, president; Jim Morgan, vice-president; Reid Rundell, recording secretary; Fred Grometer, corresponding secretary; Dean McKinnis, historian; and Charles Wagner, faculty sponsor and treasurer.

All interest so far this semester has been centered around the selection of a group of eligible men to be invited to join. Just recently a meeting of prospective members and present members was held to acquaint the new men with those in the chapter and to explain the purposes and objectives of the group.

CHI EPSILON

Chi Epsilon, civil engineering honorary, has as its purpose the recognition of those students who have demonstrated their worthiness for membership through high scholastic achievements and such qualities as character, sociability and practicality. Chi Ep also promotes friendship and comradeship between the faculty and students of the civil and architectural engineering departments.

It is required that a candidate for membership be in the upper third of his class. Election is by the members. Chi Epsilon is open to juniors, seniors, graduates, and faculty of the civil and architectural departments.

Meetings are held when necessary for election of members, pledging and planning of social funtions.

The officers for 1954-55 are: Melvin Peters, president; Bill Eager, vice-president; Birl Britt, secretary, Don Danielson, treasurer; and Tom Mosher, associate editor of the *Transit*. Professor Roland C. Rautenstraus is faculty advisor.

ETA KAPPA NU

Eta Kapp Nu, electrical engineering honorary, started the new semester by electing new members and sending personal letters to these new electives to notify them of their acceptance. Officers for the year were also introduced at the meeting. Gordon Messick, official delegate for the Rho Chapter to the Eta Kappa Nu National Convention, gave his report to the chapter. As a result of the report, Rho Chapter is now undertaking several new projects to aid students in electrical engineering. Carl Bird and J. Edward Belt accompanied Messick to the convention which held in Urbana, Illinois, on October 15 and 16.

ALUMNI NEWS

ELECTRICAL ENGINEERS

JOHN BAIRD, B.S. (E.E.) 1933, visited the campus on May 30, 1954. He is manager and engineer at the Advanced Electrical Center of the General Electric Corporation.

FRANCIS F. SPINDLER, B.S. (E.E.) 1945, is an engineer in the Industrial Engineering Department of the Westinghouse Electric Company.

GORDON DILLE, M.S. (E.E.) 1948, has been appointed manager of Public Relations for the Westinghouse Electric Corporation's Lamp Division. In his new post Mr. Dille will be responsible for the public relations activities of the division plants in other sections of the country.

RICHARD PALMER, B.S. (E.E.) 1953, spent the latter part of July in Boulder while vacationing. Palmer is an engineer with the International Business Machine Company in Poughkeepsie, New York.

RALPH DOUGLAS, B.S. (E.E.), B.S. (Bus.) 1953, is an engineer with the IBM Company in Poughkeepsie, New York. He and Dick Palmer are in the same group.

ENGINEERING PHYSICS

CARTER DORRELL, B.S. (E.Phys.) 1953, is employed by the IBM Company in Poughkeepsie, New York. Dorrell is the son-in-law of Stuart Hill in the Business Office.

JOHN O. SIMPSON, B.S. (E.Phys.) 1954, has joined Northrop Aircraft, Inc. as an engineering assistant.

CIVIL ENGINEERS

WILLARD W. RUSH, B.S. (C.E.) 1916, has retired as Vice-President of the Amarillo Oil Company. He now resides at Cortez, Colorado.

ELMER O. BERGMAN, B.S. (C.E.) 1925, is a Research Engineer with the C. F. Braun Company located at Alhambra, California.

EARNEST CLARK, B.S. (C.E.) 1944, is District Chief Engineer for the Mene Grande Oil Co. located at San Tome, Venezuela.

WILLIAM ROBERT HAUGHTON, B.S. (C.E.) 1946, has been with the Gifford-Hill Company in Dallas, Texas, for the past eight years.

JERVIS CHINN, B.S. (C.E.) 1948, is an assistant Professor of Civil Engineering at the University of Texas.

TOM MASON, B.S. (C.E.) 1949, is attached to the Chief Engineer's office for the Santa Fe Railroad. He has been selected for special training which will lead to a supervisory position with the Santa Fe.

CURTIS R. BAKER, M.S. (C.E.) 1951, transferred from the position of Junior Civil Engineer to that of Cost Analyst in the Final Estimates and Cost Analysis Section of the Construction Division of the Oregon State Highway Department.

GERALD LEON PRIOR, B.S. (C.E.) 1954, who graduated with honors in August, has accepted a position in the Structural Research Division of Boeing Aircraft Company, Seattle, Washington.

AERONAUTICAL ENGINEERING

WILLIAM R. BELL, B.S. (Aero.E.), has joined Northrop Aircraft, Inc., as an engineering assistant.

ALFRED EDWIN ANDREOLI, B.S. (Aero.E.) 1954, has joined the Northrop Aircraft, Inc., as an assistant engineer.

CHEMICAL ENGINEERING

ROY DAVID EDDINGTON, B.S. (Ch.E.) 1948, is a research engineer for the Merco Centrifugal Co., San Francisco, California.

MECHANICAL ENGINEERS

JOSEPH KAHN, B.S. (M.E.) 1923, is Assistant Manager of the Indiana Sales for People's Light, Gas and Coke Co., Chicago, Michigan.

DAVID WARREN MILLER, B.S. (M.E.) 1947, is an engineer with the C. F. Braun Co., Alhambra, California.

MARVIN LEADERSMAN, B.S. (M.E.) 1950, is a process engineer for the Merco Centrifugal Co., San Francisco, California.

HARRY HERMAN, B.S. (M.E.) 1953, is a 2nd Lt. in the Air Force on duty at Kirkland AFB, Albuquerque, New Mexico. He is a project engineer in the Special Weapons Center. He visited the campus in July, 1954.

CARROLL D. BEAMAN, B.S. (M.E.) 1953, is an engineer with the Sandia Corp., Albuquerque, New Mexico.

WILLARD C. HASS, B.S. (M.E.), B.S. (Bus.) 1954, who graduated with special honors, has joined the Meletron Corporation located at Los Angeles, California.

ENGINEERS

or

PHYSICS GRADUATES

To those interested in advanced academic study while associated with important research and development in industry, Hughes offers two separate practical programs:

HUGHES COOPERATIVE FELLOWSHIP PROGRAM

for Master of Science Degrees

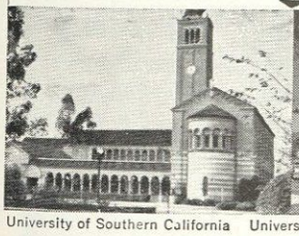
A program to assist outstanding individuals in studying for the Master of Science Degree while employed in industry and making contributions to important military work. Open to students who will receive the B.S. degree in Electrical Engineering, Physics or Mechanical Engineering during the coming year, and to members of the Armed Services honorably discharged and holding such B.S. degrees.

Candidates must meet entrance requirements for advanced study at the University of California at Los Angeles or the University of Southern California. Participants will work full time during the summer in the Hughes Laboratories and 25 hours per week while pursuing a half-time schedule of graduate study at the university.

Salary is commensurate with the individual's ability and experience. Tuition, admission fees and books for university attendance are provided. Provision is made to assist in paying travel and moving expenses from outside Southern California.

HOW TO APPLY

for the Hughes Cooperative Fellowship Program: Address all correspondence to the Committee for Graduate Study



University of Southern California

University of California at Los Angeles

THE HOWARD HUGHES FELLOWSHIPS

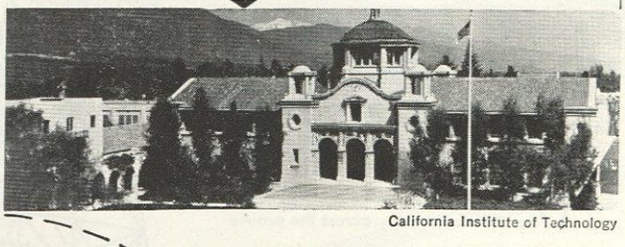
in Science and Engineering

Eligible for these Fellowships are those who have completed one year of graduate study in physics or engineering. Successful candidates must qualify for graduate standing at the California Institute of Technology for study toward the degree of Doctor of Philosophy or post-doctoral work. Fellows may pursue graduate research in the fields of physics or engineering. During summers they will work full time in the Hughes Laboratories in association with scientists and engineers in their fields.

Each appointment is for twelve months and provides a cash award of not less than $2,000, a salary of not less than $2,500, and $1,500 for tuition and research expenses. A suitable adjustment is made when financial responsibilities of the Fellow might otherwise preclude participation in the program. For those coming from outside the Southern California area provision is made for moving and transportation expenses.

HOW TO APPLY

for the Howard Hughes Fellowships in Science and Engineering: Address all correspondence to the Howard Hughes Fellowship Committee



California Institute of Technology

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

OIL CAN

THE HONORARY SOCIETY OF LUBRICATION ENGINEERING

DOWN WITH FRICTION

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

With the beginning of a new school year, The Society of Lubricating Engineers, commonly known as the Oil Can, once again throws out the welcome mat for all students of the College of Engineering, particularly to potential new members of the Society. The Oil Can is an honorary society dedicated to the opposition of friction. Its purpose is to recognize those students and instructors who rise beyond the bonds of convention to develop new and startling theories in science and engineering. The motto of the Oil Can is "Lubricity shall lack no champion, Friction shall not thrive unopposed."

Many oustanding engineers have received recognition in the past through this society. It is hoped that many more will receive well-deserved recognition this year. Anyone who knows of another qualified for Oil Can membership is urged to bring, mail, or phone the applicant's name and qualifications to the *Colorado Engineer* Office.

Three instructors head the list of new members to be added to the membership rolls this year.

Mr. Hutchinson qualified himself for membership when he referred to the slide rule made by Pickett & Eckel as the Pickel & Eckett in his differential equations class.

★ ★ ★ ★

"Y" $= \frac{2}{X^3} = 0$ has no point of infection," wrote instructor Ben Kriegh on the blackboard in his calculus class one Monday morning.

The class, discovering his error in spelling, responded in suppressed snickers. Mr. Kriegh finally saw the cause of their amusement, corrected it hurriedly, and said: "Things are a little foggy this morning." Thanks to Mr. Kreigh, though, things were well lubricated.

★ ★ ★ ★

To an anonymous mathematics instructor goes a pocket sized oiler for his contribution. Side-lighting one of his classes on the subject of chess he concluded: "My wife can play chest too, but not as good as I can."

FAMOUS LAST WORDS

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
"I'm sure the switch is open."

★ ★ ★ ★

EPITAPH

There is a student in our midst,
Whose head is hung in shame;
For what he did there's no excuse,
He knows he is to blame.
Although he's smart and knows about
The armature and rotor
He did the thing no one should do,
"Line-start" a D.C. motor.

★ ★ ★ ★

AMEN

A young student one time
Grabbed a 440 line
And soon on the floor he did lay.
The instructor came by
As he heaved his last sigh
And gave him an "F" for the day.

★ ★ ★ ★

I told him that I worshipped my figure and he tried to embrace my religion.

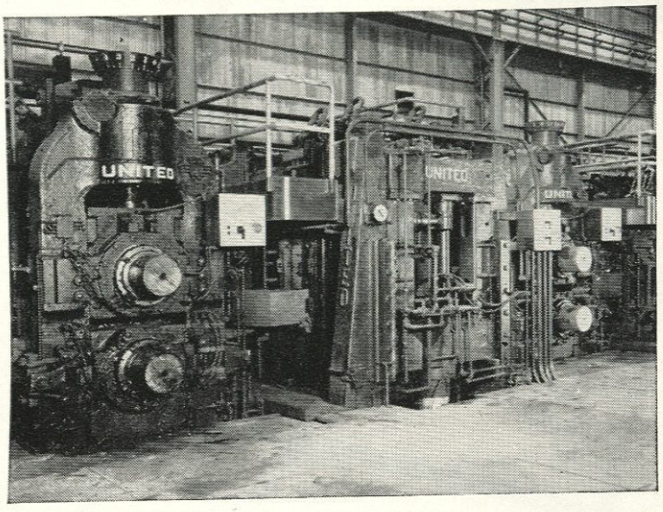
★ ★ ★ ★

She: "I'm an Oriental dancer."
He: "Shake."

★ ★ ★ ★

"Your girl is spoiled, isn't she?"
"No, it's just the perfume she's wearing."

Another page for **YOUR BEARING NOTEBOOK**

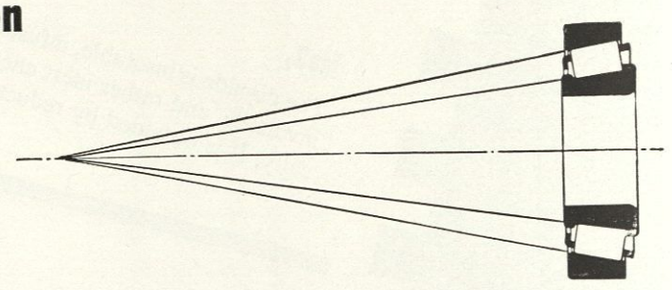


How billet mill gets extra bearing capacity in same space

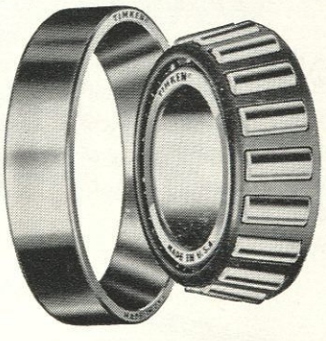
Engineers who designed this 10-stand billet mill specified that the roll necks be mounted on Timken® Balanced Proportion bearings. That's because Timken Balanced Proportion bearings have load ratings up to 40% higher than same-size bearings of older designs. And they make possible a 50 to 60% increase in roll neck strength which means greater rigidity and higher rolling precision.

True rolling motion, high precision practically eliminate friction

All lines drawn coincident with the working surfaces of the rollers and races of Timken bearings meet at a common point on the bearing axis. This means Timken bearings are designed to give true rolling motion. And they are precision manufactured to live up to their design. Result: Timken bearings practically eliminate friction, save power.

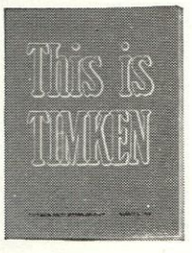


TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

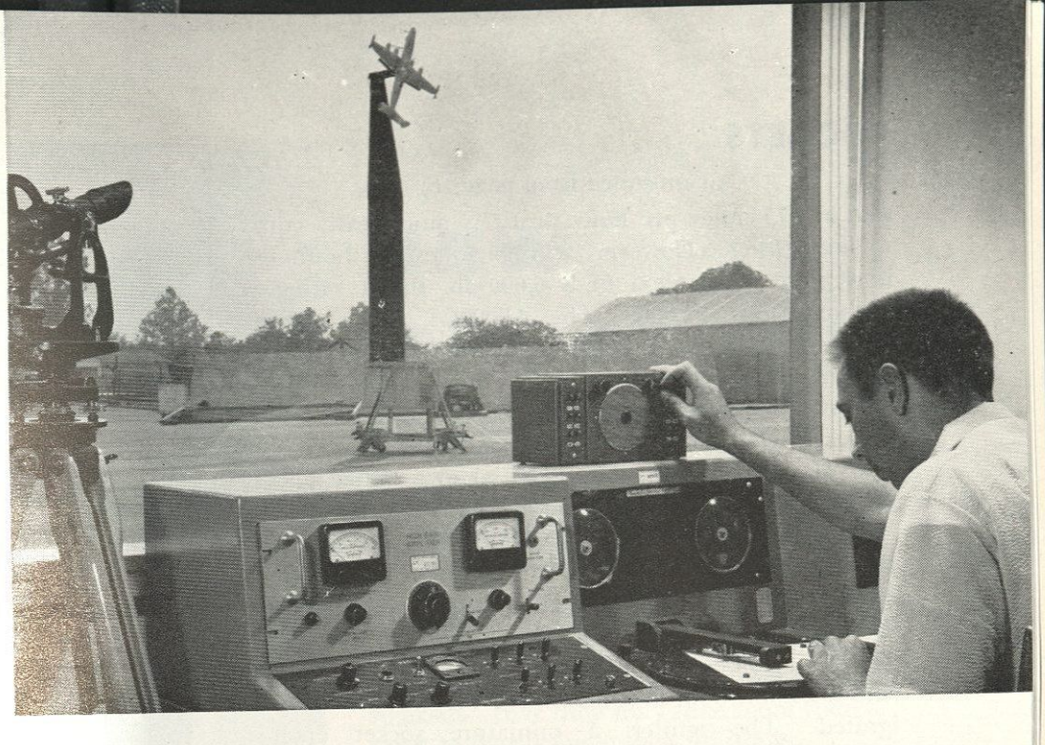


Want to learn more about bearings or job opportunities?

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

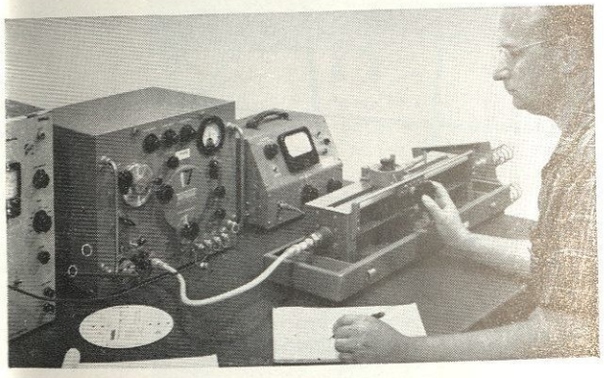


NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◎ AND THRUST —◎— LOADS OR ANY COMBINATION ✳



Electronics Research Engineer Irving Alne records radiation antenna patterns. Twenty-two foot plastic tower in background eliminates ground reflections, approximates free space. Tower is of Lockheed design, as are pattern integrator, high gain amplifier, square root amplifier, logarithmic amplifier.

Antenna development program at Lockheed expands



Electronics Research Engineer F. R. Zboril measures input impedance of a scale model helical antenna array used for ground tracking of missiles. Most of Lockheed's other antenna work involves advanced research studies on flush mounted antennas.

Lockheed's diversified development program presents Electronics Engineers qualified for airborne antenna design with a wide range of assignments in communication, navigation and microwaves. Antenna design is one of the fastest growing research and development areas at Lockheed.

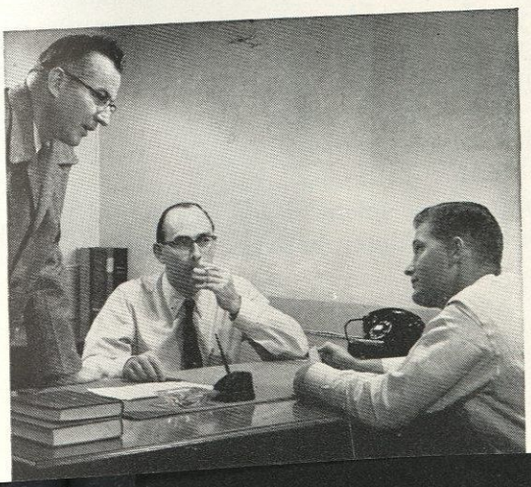
Studies embrace virtually all types of aircraft, including the Super Constellation radar search plane—a type of aircraft developed and produced exclusively by Lockheed.

Career Positions at Lockheed

Lockheed's expanding development program has created a number of positions for Electronics Engineers and Physicists to perform advanced work in antenna design.

In addition Lockheed has a number of positions open for engineers in aerodynamics, thermodynamics, flight test analysis, structures and design to perform advanced studies on such diverse projects as: Applications of nuclear energy to aircraft, turbo-prop and jet transports, bombers, trainers, supersonic aircraft with speeds surpassing Mach 2, and a wide range of classified activities.

Program for Advanced Study—To encourage members of its engineering staff in study leading to advanced degrees, Lockheed reimburses 50% of the tuition fee upon successful completion of each course relating to the engineer's field at the University of Southern California and University of California at Los Angeles. Both universities offer a wide night school curriculum in science and engineering.



E. O. Richter, Electronics Research department manager (seated), W. R. Martin, antenna laboratory group engineer (standing), and J. L. Rodgers, electronics research engineer, discuss design of corrugated surface antenna.

LOCKHEED

AIRCRAFT CORPORATION

BURBANK **CALIFORNIA**

ROCKETS . . . .

(Continued from page 16)

that at 375 miles per hour thrust is numerically equal to horsepower. However, at 1400 miles per hour, the horsepower equivalent of a 6,000 lb. thrust rating is approximately 22,000. The A6000C4 rocket engine weighs 210 pounds, is nineteen inches in diameter, and fifty-six inches long. Only a few minutes are required to install the engine in an airplane.

A brief description of the operation and construction of the power plant is essential to a better understanding of the rocket principle. Basically the engine consists of four thrust chambers plus all the required piping, wiring, and controls. It operates from the controlled combustion of a fuel and an oxidizer. An alcohol-water mixture is the fuel and liquid oxygen is the oxidizer. These propellants are injected under pressure into a combustion chamber where they are mixed and ignited. The igniter, a miniature rocket engine, sets off the mixture and the resulting mass of hot gases roar out through the exhaust nozzle at tremendous velocities of about 6500 feet per second. The igniter is fed the same fuel as the engine, and is operated with a sparkplug because the fuel mixture does not ignite spontaneously. A requirement in designing the engine was that it should be capable of repeated stops and starts under various conditions and in different positions. As an example, positive ignition has been obtained when, previous to starting, the combustion chambers of all the cylinders were tilted up and filled with water.

Despite the outstanding success of the A6000C4 and other rocket engines in use today, progress to date is only in the initial phase in the development of rocket power. In the field of rockets the speed of rocket development appears also to be stimulating the speed of the rockets.

POWDER METALLURGY . . . .

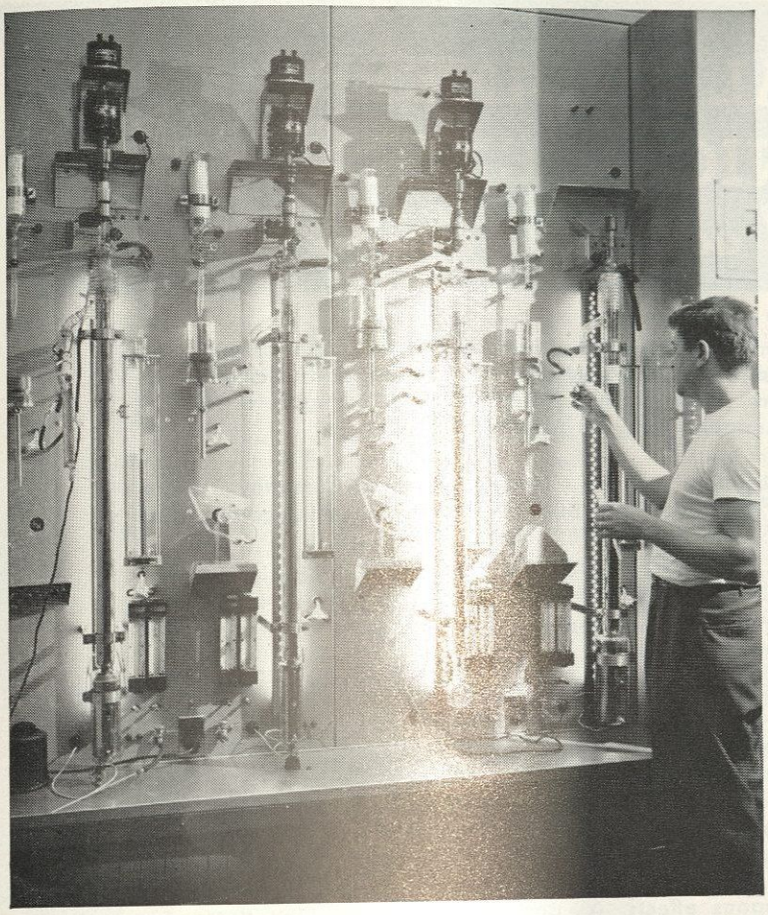
(Continued from page 27)

the addition of nonmetallic material to the powder. Porous products have many applications in filtering and "oilless" bearings.

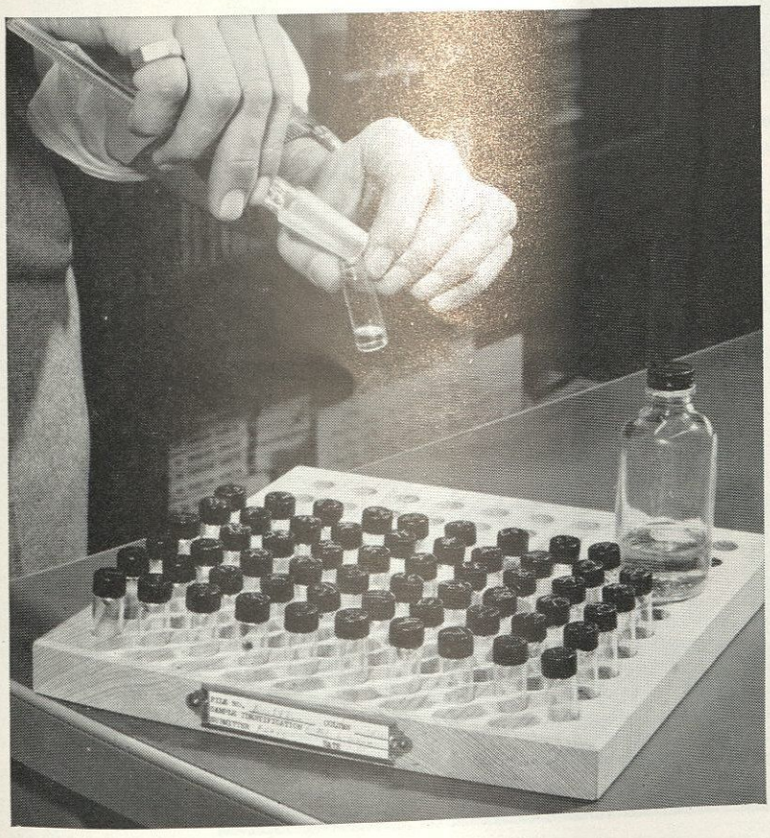
In many cases, one material may not be used with another by ordinary methods, because either one material will not melt (copper and graphite) or the two liquids are immiscible (copper and lead). However, by the physical mixture of the two or more powders involved, several superior products have been developed. A few of these products are copper-graphite motor brushes, silver-tungsten electrical contracts, and bronze-graphite bearings.

For some small machine parts, powder metallurgy technique is the answer because of economic factors. That is, once a die has been formed, many structural parts such as gears, lock bodies, cams, sprockets, and splines may be formed with no further machining operations needed. This represents a tremendous saving (up to 85%), not only in labor and machinery, but also in material which would otherwise end up as chips on the floor. These machine elements may be held within tolerances as small as .0005 to .001 inch. In order for powder metallurgy to be practical, many parts must be produced, ten thousand being an absolute minimum.

Although powder metallurgy doesn't offer an answer to all metallurgical and design problems, it does have many interesting aspects which should be considered in the solution of your particular problem. Each day new products are made, and new processes are developed in powder metallurgy. Keep an eye on it; it's a leader.



A laboratory assistant (above) takes a fraction from one of the new miniature stills at Standard Oil's Whiting laboratories. The small charge in the large bottle (below) can be separated into 60 fractions in these exact stills.



NEW MINIATURE STILLS

Valuable Laboratory Aids

Some stills in oil refineries are gigantic devices which process 30,000 barrels of petroleum a day. Others are so small—and so exact—that they may take more than a week to distill five ounces of liquid.

Scientists at Standard Oil's Whiting laboratories now are working with eight new miniature stills so precise they are considered the finest of their type in the world. These stills, installed last year, are used to study liquids produced during research on such things as aviation gasoline, synthetic lubricants and detergents, plastics and plasticizers, and petrochemicals.

Laboratory men often work with only an ounce of liquid which may be made up of hundreds of different chemical compounds. Technicians usually wind up with individual "fractions" of about 1/50 of an ounce to be examined with mass and infra-red spectrometers, chromatography and other aids.

Another new research still at Standard Oil's Whiting laboratories has a packed column one inch in diameter and 16 feet high. It is probably the most efficient packed column ever built.

Such precise up-to-the-minute laboratory equipment helps Standard Oil scientists in their never-ending search for new and better products. And it offers young technical men the assurance that Standard Oil is a sound, progressive place to build a scientific career.

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Sandia Corporation, a subsidiary of the Western Electric Company, offers outstanding opportunities to graduates with Bachelor's or advanced degrees, with or without applicable experience.

Sandia Corporation engineers and scientists work as a team at the basic task of applying to military uses certain of the fundamental processes developed by nuclear physicists. This task requires original research as well as straightforward development and production engineering.

A new engineer's place on the Sandia team is determined initially by his training, experience, and talents . . . and, in a field where ingenuity and resourcefulness are paramount, he is afforded every opportunity for professional growth and improvement.

Sandia engineers design and develop complex components and systems that must function properly under environmental conditions that are much more severe than those specified for industrial purposes. They design and develop electronic equipment to collect and analyze test data; they build instruments to measure weapons effects. As part of their work, they are engaged in liaison with the best production and design agencies in the country, and consult with many of the best minds in all fields of science.

Sandia Laboratory, operated by Sandia Corporation under contract with the Atomic Energy Commission, is located in Albuquerque — in the heart of the healthful Southwest. A modern, mile-high city of 150,000, Albuquerque offers a unique combination of metropolitan facilities plus scenic, historic and recreational attractions — and a climate that is sunny, mild, and dry the year around. New residents have little difficulty in obtaining adequate housing.

Liberal employee benefits include paid vacations, sickness benefits, group life insurance, and a contributory retirement plan. Working conditions are excellent, and salaries are commensurate with qualifications.

A limited number of positions for Aeronautical Engineers, Mathematicians, and Physicists are also available.

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Or contact through your Placement Office the Sandia Corporation representative with the Bell Telephone System College Recruiting Team for an interview on your campus.

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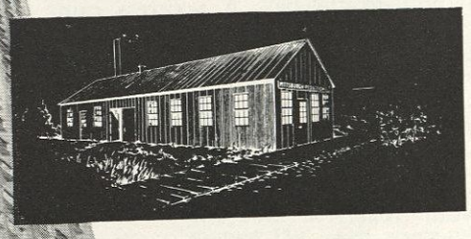
THE ALUMINUM INDUSTRY WAS BORN ON SMALLMAN STREET

▶ In 1888, the aluminum industry consisted of one company—located in an unimpressive little building on the east side of Pittsburgh. It was called The Pittsburgh Reduction Company. The men of this company had real engineering abilities and viewed the work to be done with an imagineering eye. But they were much more than that. They were pioneers . . . leaders . . . men of vision.

A lot has happened since 1888. The country . . . the company . . . and the industry have grown up. Ten new territories have become states, for one thing. The total industry now employs more than 1,000,000 people—and the little outfit on Smallman Street? Well, it's a lot bigger, too—and the name has been changed to Alcoa. ALUMINUM COMPANY OF AMERICA . . . but it's still the leader—still the place for engineering "firsts".

As you prepare to trade textbooks for a position in industry, consider the advantages of joining a dynamic company like Alcoa—for real job stability and pleasant working conditions—where good men move up fast through their association with the recognized leaders in the aluminum industry.



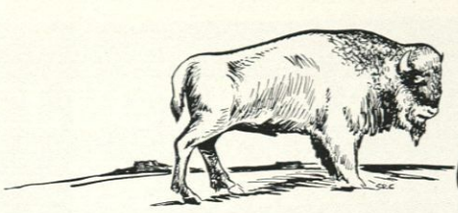
Alcoa's new aluminum office building

We have fine positions for college graduate engineers—in our plants, sales offices and research laboratories from coast to coast. These are positions of responsibility in production supervision, plant and design engineering, industrial research or sales engineering. Right now it may be quicker than you think from a seat in the classroom to your career with Alcoa. Why not find out?

Your Placement Director will be glad to make an appointment for you with our personnel representative. Or just send us an application yourself. ALUMINUM COMPANY OF AMERICA, 1825 Alcoa Bldg., Pittsburgh 19, Pa.

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA



Chips

Into every life, let there come humor.

A lucky man was made very rich overnight when oil was found on his farm. All his life he had said that if he ever had the money, the first thing he would buy would be a Cadillac automobile.

So bright and early that morning, he headed for the big city and the Cadillac dealer. He was shown several cars, but none of them was just what he wanted.

"Well, sir," the dealer was not impressed with his dress, "here is our largest and finest car, but the price is a little high."

"How much is it?" the man inquired.

"5000 dollars."

"Oh, I say that is high. I am prepared to pay cash for it. Will I get a discount?"

"Why of course, sir," the salesman brightened up considerably. "We will give you a 10 per cent discount for cash."

The buyer was not good at figures and he couldn't decide how much he would have to pay for the car, so he told the salesman he would go around the corner and eat his breakfast while he considered the deal, but that he would be back presently.

He walked into a cafe and sat down, trying hard to figure what his discount would be. A waitress came up, and he looked at her and asked, "If I were going to give you 10 per cent of $5000 how much would take off?"

"Would my ear rings bother you, bub?"

★ ★ ★ ★

He who laughs last has found a double meaning.

★ ★ ★ ★

Dean: "Is this your likker?"

Freshman: "No, sir."

Dean: "So that's your likker then?"

Second Freshman: "No, sir."

Dean: "Well, I don't give a damn whose likker it is; I'm going to take a drink."

★ ★ ★ ★

Early to bed and early to rise,
Your gal goes out with other guys.

(Enter: Mama, dragging Willie, who carries: 1 balloon, 7 bags of peanuts, a mouthful of popcorn, and 1 peashooter.)

Willie: "Mama, do elephants swear and say damn when they sit down?"

Mama: "No—Don't be foolish! — I wish I could find your father."

Willie: "Mama, do elephants sort of 'gurgle' when they sit on their hind legs?"

Mama:: "Stop that foolishness at once, Willie, and help me find your papa!"

Willie: "Well, if elephants don't swear, I guess that was pop's shoe sticking out under the elephant's tail!"

★ ★ ★ ★

Passenger: "Porter, get me another glass of ice water."

Porter: "Sorry, suh, but if I takes any more ice, dat corpse in the baggage car ain't going to keep."

★ ★ ★ ★

It was a P.T.A. meeting. There was a big appeal going up for more milk for the smaller children. The speaker was a large and obviously a city-bred gentleman. He had been talking for a long time and his face was quite flushed with excitement. He finally came to his crowning last line: "Ladies and gentlemen, we must take the bull by the horns and demand more milk."

★ ★ ★ ★

Style note: I understand they're wearing the same things in sweaters this year.

★ ★ ★ ★

"Was it very crowded at the cabaret last night?"

"Not under my table."

ADVERTISING INDEX

James B. Walker received his B.S. in mechanical engineering from North Carolina State College in June 1954, and he's presently working for his M.S. at the same college. By asking pertinent questions, Jim is making sure that the position he finally accepts will be the right one for a fellow with his training.

Jim Walker asks:

Can a mechanical engineer make real progress in a chemical firm?

H. M. Pickering, Jr., received a B.S. in M.E. and E.E. from the Univ. of Minn. in 1940. He gained valuable technical experience at Hanford Works, in Richland, Washington, and in Du Pont's Fabrics and Finishes Plant at Parlin, N. J. Today he is Works Engineer for Du Pont's Seaford, Del., plant, where nylon comes from.

"Pick" Pickering answers:

Well, Jim, that's what the lawyers call a leading question, and the answer leads right into my bailiwick. I came to Du Pont in 1940, after taking a combined mechanical and electrical engineering course. So I had what you might call a double reason for wondering about my future with a chemical firm.

I soon learned that the success of a large-scale chemical process is vitally dependent upon mechanical equipment. And the success of this mechanical equipment—especially for a new process—depends on (1) Research, (2) Development, (3) Plant Engineering, and (4) close Supervision. The net result is that a mechanical engineer at Du Pont can progress along any one of these four broad highways to a top-level position.

My own Du Pont experience includes mechanical engineering work in fields as varied as atomic energy, fabrics and finishes, and nylon manufacture. Every one of these brought with it a new set of challenging problems in construction, instrumentation, and power supply; and every one provided the sort of opportunities a man gets in a pioneering industry.

So, to answer your question, Jim, a mechanical engineer certainly has plenty of chances to get somewhere with a chemical company like Du Pont!

Want to know more about working with Du Pont? Send for a free copy of "Mechanical Engineers at Du Pont." This 24-page booklet describes in detail the four broad categories of jobs mentioned by "Pick" Pickering. Typical pioneering problems in each of these four categories are outlined. This booklet briefs a young mechanical engineer on how some of the newest and most challenging problems in his field were solved. Write to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Bldg., Wilmington, Del.

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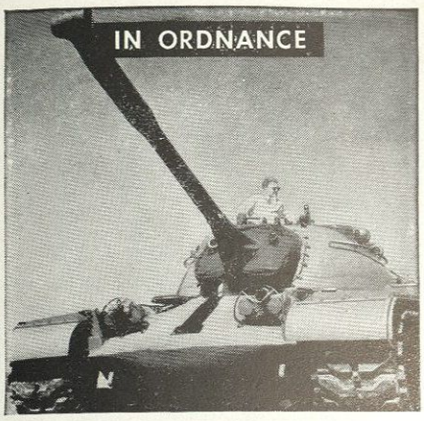
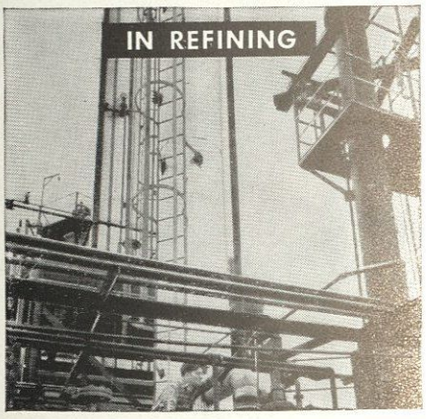
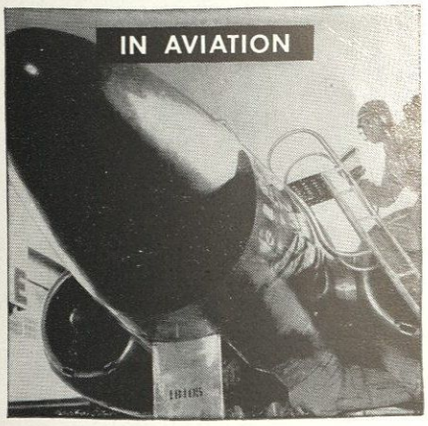
BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

WATCH "CAVALCADE OF AMERICA" ON TELEVISION







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THE challenges and problems for the engineer in the automatic control field are unique in their variety and in the insight provided into all of the industries of today's modern world.

The development and manufacture of tiny transistors for electronic control . . . the design and construction of giant control valves for oil refineries . . . the challenge of finding fish with underwater sonar . . . of providing automatic flight for supersonic jets . . . temperature controls for today's modern home . . . for atomic piles . . .

These are a few of the fields in which Honeywell's several divisions are engaged, providing automatic controls for industry and the home.

These controls are made possible by the creative imagination of highly trained engineers working with the very latest research and test facilities.

With nine separate divisions located throughout the United States and with factories in Canada, England and Europe, Honeywell offers unlimited opportunities in a variety of challenging fields. Based on diversification and balance between normal industry and defense activities, Honeywell will continue to grow and expand because automatic control is so important to the world's progress. And automatic control is Honeywell's business.

That is why we are always looking for men with ideas and imagination and the ambition to grow with us. In addition to full time engineering and research employment we offer a Cooperative Work Study program, a Summer Student Work Study program and Graduate Fellowships. If you are interested in a career in a vital, varied and diversified industry, send the coupon for more information.

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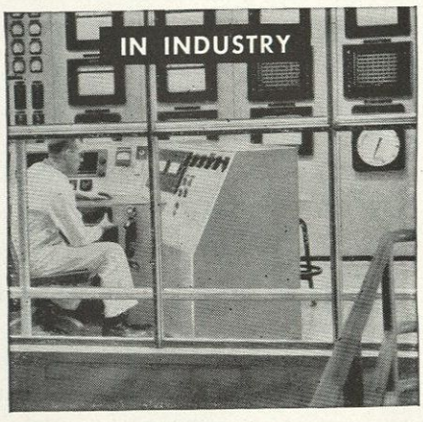

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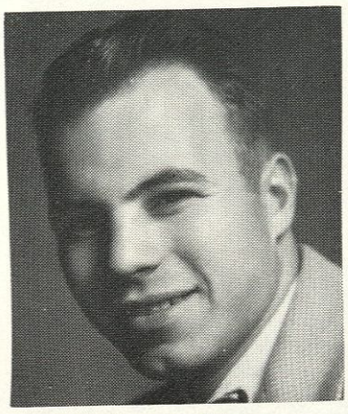
Meet the Authors

ROCKET DEVELOPMENT
PAUL BROWN, Eng. Phys. '56



Paul is 23 years old and a native of Colorado Springs. Before coming to the University of Colorado, Paul served a year and a half in the U. S. Marines. Besides maintaining a high grade average, Paul finds time to hold the position of feature writer for the *Colorado Engineer*. In his third year on the staff, he is one of its more active members.

POWDER METALLURGY
G. FRED GROMETER, M.E. and Bus. '55

Fred, a former member of the office staff of the *Colorado Engineer,* is a graduate of Boulder high school. He is secretary of Tau Beta Pi, Sigma Tau, and Delta Sigma Pi, professional business fraternity; he is a member of Pi Tau Sigma and the Mechanical Engineering Society. His particular interest is in the mnaufacturing engineering field as related to cost accounting and cost control.

BURGLARS BEWARE
PAUL McMATH, E.E. '57

Paul is a nineteen year old sophomore who has been a frequent contributor to the *Colorado Engineer*. In addition to serving as an assistant editor of the Magazine, Paul has found time to act as public relations director for the Combined Engineers. A member of Acacia fraternity, he has in the past, served on the publicity committees of the Engine Ball, Welcome Week, Engineers' Day, and C.U. Days. At the present time he is acting as assistant publicity chairman for the Campus Chest drive. Paul is also an active member of the *Colorado Daily* staff.

RADIO ASTRONOMY
BILL CIELINSKI, E.E. '56

Bill is a 24 year old junior in electrical engineering. Prior to entering the University of Colorado he served as an Aviation Electronics Technician 1/C with the U. S. Navy. After his discharge from the Navy he worked for the Lockheed Aircraft Corporation and Holloman Air Research and Development Center, Alomogordo, N. M., as an electronic technician. Since his arrival at C.U., Bill has been working as an engineer for station KBOL and just recently has accepted employment as a student trainee (electronics engineering) at the U. S. National Bureau of Standards.

JIM TEBAY, Eng. Phys. '56

Jim is a 24 year old native of Spring Valley, Minnesota, majoring in Engineering Physics. He served four years as an instructor in the Air Force and one year as an instructor supervisor in electronics and radar at Lowry Air Force Base. Jim is married and has an eighteen month old daughter. He is presently employed as an announcer for radio station KBOL and as an engineer for the National Bureau of Standards.

The art student was painting in the country early one morning when he noticed a farmer watching him.

"Ah," said the artist, "perhaps you too, are a lover of nature's beauties. Have you seen the golden fingers of dawn spreading across the sky, the rugged clouds at midnight blotting out the shuddering moon?"

"Not lately," said the farmer, shifting his wad of tobacco. "I've been on the wagon for better than a year."

* * * *

Engineer: "I love your figure!"
Girl: "Must you go over that again?"

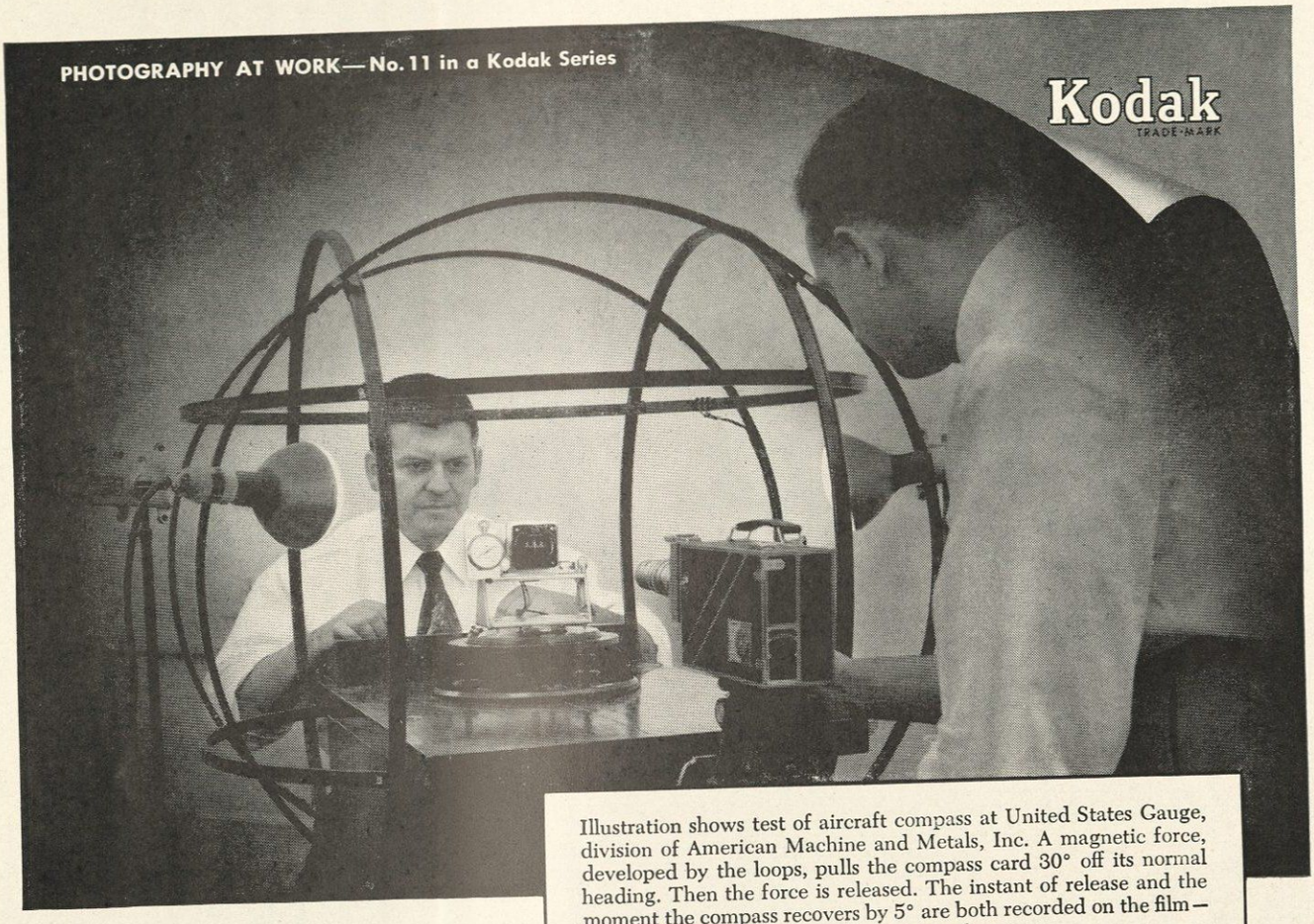


Illustration shows test of aircraft compass at United States Gauge, division of American Machine and Metals, Inc. A magnetic force, developed by the loops, pulls the compass card 30° off its normal heading. Then the force is released. The instant of release and the moment the compass recovers by 5° are both recorded on the film—become positive evidence of proper performance.

Wanted: an inspector with a split-second eye —*photography got the job*

A difference of 2/10ths of a second means the compass passes or fails. So the maker pits it against a stop watch—gets definite proof of performance with movies.

Uncle Sam said this aircraft compass must respond by 5 degrees in not less than 1 second or more than 1.2 seconds. That's only 2/10ths of a second leeway—far too little for human hands and eyes to catch the action accurately.

So, side-by-side, the stop watch and compass act their parts before the movie camera. Then individual frames along the film show the precise instant that the 5-degree mark is reached.

Product testing and quality control are naturals for photography. They are typical examples of the many ways photography works for businesses, large and small. It is improving production, saving time, reducing error, cutting costs.

Graduates in the physical sciences and in engineering find photography an increasingly valuable tool in their new occupations. Its expanding use has also created many challenging opportunities at Kodak, especially in the development of large-scale chemical processes and the design of complex precision mechanical-electronic equipment. Whether you are a recent graduate or a qualified returning service man, if you are interested in these opportunities, write to Business & Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

Eastman Kodak Company, Rochester 4, N. Y.

45,000 G-E people working on jobs created by new products since 1945 could almost fill Princeton's Palmer Stadium.

In 9 years, new products created G-E jobs for enough people to fill a football stadium

Coming years promise even more progress.

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We can see new and exciting possibilities in many different fields. Atomic energy, jet engines, electronics, silicones—all promise to create new products, new processes and new jobs.

As we see it at General Electric, America's industrial progress in a free economy is not only continuing, it's rapidly accelerating.

Progress Is Our Most Important Product

GENERAL ELECTRIC