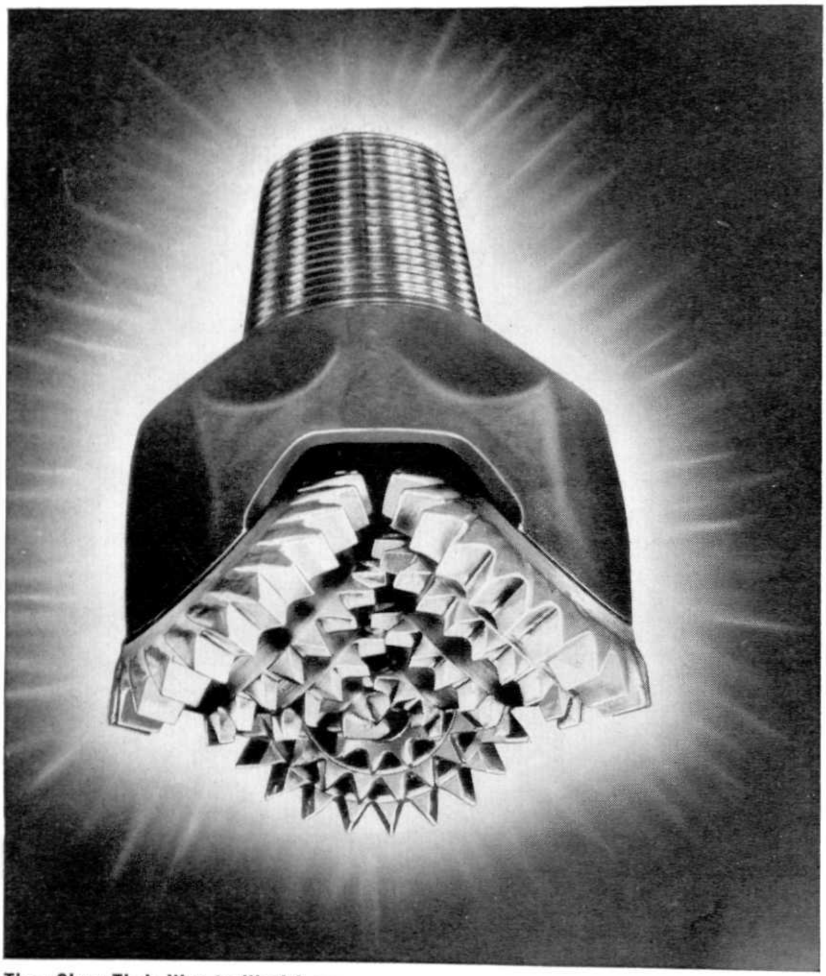
Spartan Engineer

VOL. 7 NO. 4 MAY, 1954

Only STEEL can do so many jobs so well



They Chew Their Way to Wealth. These teeth are capable of chewing through earth, sand and rock for thousands of feet until they reach Nature's buried treasures of gas and oil. Rock bits like this need super-strength, amazing toughness, high resistance to impact, abrasion, and shock. So, many of them are made from USS Alloy Steels. And United States Steel also provides many other essentials for oil drilling, such as wire lines, drill pipe, cement, drilling rigs.

Scoop! And a big one, too . . . it can scoop out 21.5 cubic yards of earth per minute, has a boom 215 feet long! The drag lines, boom support cables and hoisting ropes on a behemoth like this must have great strength, durability, flexibility, fatigue resistance. Tiger Brand Wire Ropes, made by U.S. Steel, meet all requirements.

A Man Needs a Cookie once in a while! And when cookies are kept in a tight cookie tin like this, they'll be fresh and appetizing for him. The can is steel, of course . . . made out of the same USS Tin Plate that is produced by U.S. Steel to make millions of "tin" cans every year for the protection of food, oil, paint and countless other things.

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, Pennsylvania.

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

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4-890

A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from Dr. J. A. Hutcheson, Vice-president
and Director of Research,
Westinghouse Electric Corporation
University of North Dakota, 1926

To the young man bent on conquering the unknown

Behind every successful career, there's a driving force. An inspiration, an ambition—call it what you will—that spurs a man on.

It has been interesting to me to watch the progress of the young men in our research departments . . . watch their ambitions take shape. Men, who only yesterday, it seems, came to us from the universities, and are now engaged in vital projects in our applied and fundamental research programs. These young men are exploring the unknown—looking for something better than ever before. It's a challenging life—and a rewarding one.

But what does this mean to you as a graduate? It means your abilities, your education, *and your ambitions* may carry you to undreamed of heights. Here at Westinghouse, we recognize ambitions as well as abilities, and do everything in our power to encourage them. You are assisted in reaching your goals by means of carefully developed training programs. You are given the opportunity to pursue graduate work toward Masters' and Ph.D. degrees. Here, you are treated as an individual.

You who are bent on conquering the unknown are welcome at Westinghouse.

G-10274

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

For information on career opportunities with Westinghouse, consult the Placement Officer of your university, or send for our 44-page book, *Finding Your Place in Industry.*

Write: Mr. R. A. Warren, Regional Educational Co-ordinator, Westinghouse Electric Corporation, 306 Fourth Ave., Pittsburgh 30, Pennsylvania.

EDITORIAL

Design Engineering Experience Is Valuable Executive Training

The ever increasing demand for executive leadership is being met successfully in many industrial organizations by recognizing the capacities and potentials of the design engineer. The validity of this method of selecting company leaders is justified when you analyze the every day problems that parallel the designer and a company executive.

The pivotal point in your engineering career will occur when you visualize the results of your work by observing the characteristics of the finished product. The realization is attributed to the decisions you have made regarding the basic design of the component parts, cost analysis and availability of materials, production procedures adapted to your company's manufacturing facilities, maintenance considerations when the finished product is subjected to customer service, and proto-type units designed for the replacement market when the original equipment reaches obsolescence. In directing the company's overall activities, the executive is faced with the same basic types of problems, in addition to other duties required of him regarding the correlation of product priorities and budgetary measures.

As the design engineer becomes experienced, he realizes that the academic solution to an engineering problem does not completely satisfy all of the requirements of competitive product design. In many cases the final decisions are determined by the economic structure relating to the proposed design and its market potential. The achievement of creating an acceptable design demands a thorough analysis as well as sound judgement and competence from the designer. These characteristics are also important prerequisites for executive leadership.

Ernest J. Massard

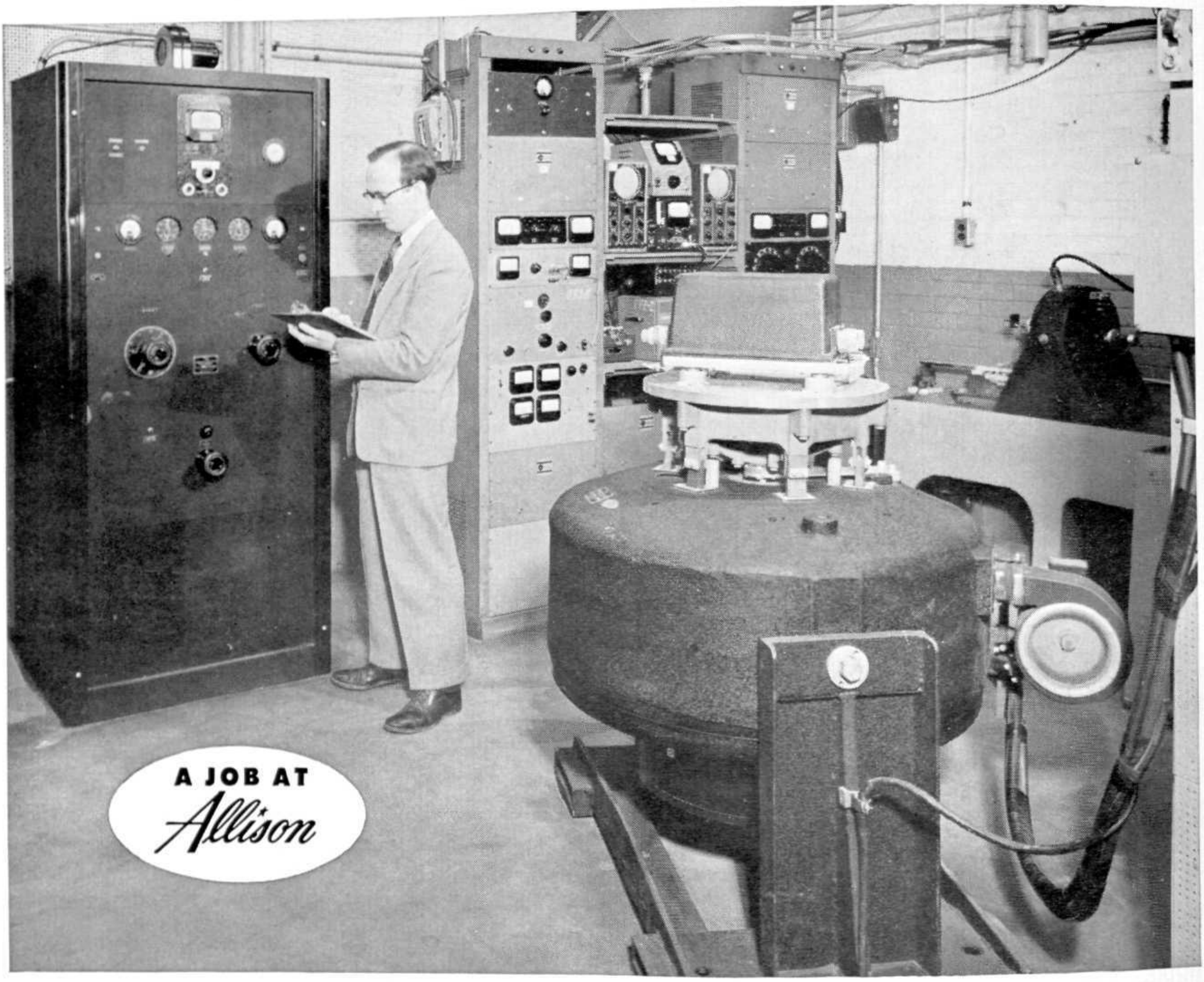
DESIGN NEWS—JUNE 15, 1953

...design for your future with Pontiac

Men who look forward to leadership will give thought to the ideas expressed in this editorial from *Design News*. And men who want the *rewards* of leadership will look for broad opportunity, the kind of opportunity that Pontiac can offer you—with the challenge of automotive design as your steppingstone to a future virtually unlimited.

Automotive engineers know no finer "home" than Pontiac's new Engineering Building—200,000 square feet of air-conditioned, well-lighted, completely modern offices and design rooms, testing laboratories and workshops. It contains every conceivable facility for designing ever-better Pontiacs.

PONTIAC MOTOR DIVISION, GENERAL MOTORS CORPORATION



● Cort Kegley received his Masters Degree in Physics from Connecticut Wesleyan in 1951.

When the above picture was taken he had been on the job less than a month, and was one of a group of young graduates then in training at Allison.

Much of the experimental and test equipment at Allison is entirely different from any other. And, Cort—like other new engineers on the job—must first learn about these various facilities which he will be using in instrumentation and testing.

He is pictured here getting acquainted, so to speak, with some of the equipment used in vibration and shock qualification testing. One of the many electronic accessory units used with the Allison jet engines is here undergoing a "shake test" on the large MB vibration exciter shown in the foreground.

A turbo-propeller governor is bolted to the shake table of the exciter, which is controlled from the panel at the left, to determine if simulated engine vibration will cause the unit to malfunction. The large MB exciter has the capacity to exert a vibratory force of 2500 pounds, with a frequency range up to 500 CPS. A smaller MB exciter, shown on the bench in the background, is rated at 50 pounds peak force available to 2000 CPS.

• • •

Our long range program calls for additional engineering personnel. Why not plan early for your engineering career at Allison where unlimited opportunities are offered to young graduates, especially to those with degrees in Mechanical Engineering, Electrical Engineering, Aeronautical Engineering and Industrial Engineering.

For further information about YOUR engineering career at ALLISON, discuss it with your Placement Counselor and arrange for an early interview with the ALLISON representative the next time he visits your campus. Or, write now for further information: R. G. Greenwood, Engineering College Contact, Allison Division, General Motors Corporation, Indianapolis 6, Indiana.

Allison DIVISION GENERAL MOTORS CORPORATION • Indianapolis, Ind.

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

Spartan Engineer

ARTICLES

FEATURES

COVER: Looking up at stained glass windows of MSC Chapel

Published four times yearly by the students of the SCHOOL OF ENGINEERING, MICHIGAN STATE COLLEGE, East Lansing, Michigan. The office is on the third floor of the Union Building, Phone ED 2-1511, Extension 251. Entered as second class matter at the Post Office in Lansing, Michigan, under the act of March 3, 1879.

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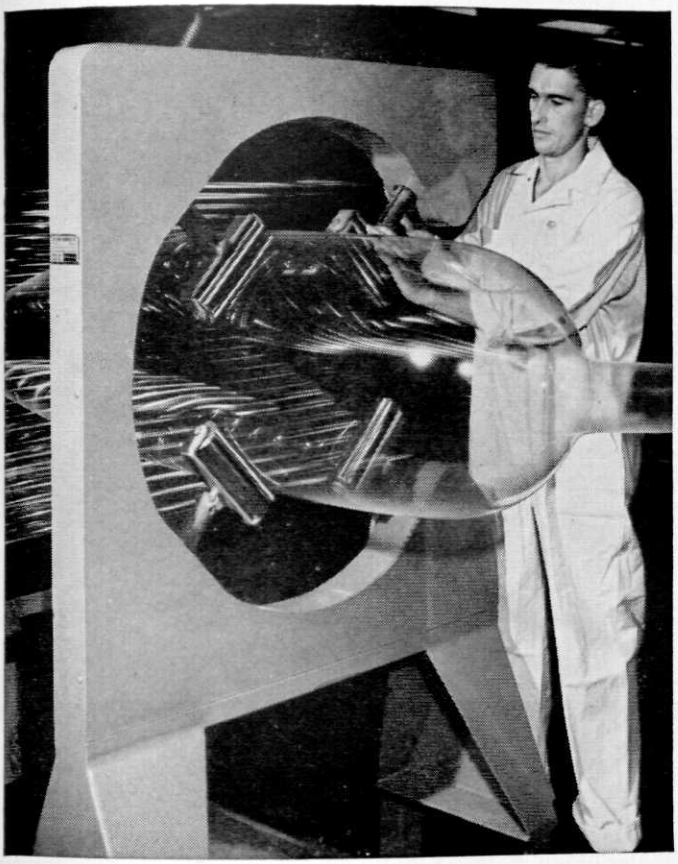
Single copies 25 cents.

Ball-and-socket joint cast iron pipe for water main crossing river at Newark, Ohio.

Where installations are planned for long-term service to assure low cost per service year, engineers rely on cast iron pipe as a dependable and adaptable material. Consequently, it is specified for a wide variety of applications, both utility and industrial, including water supply, sewerage, fire protection, process industries and many forms of special construction. Long life and low maintenance cost are *proved* results of the high beam-strength, compressive-strength, shock-strength and effective resistance to corrosion of cast iron pipe. Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 122 So. Michigan Ave., Chicago 3, Ill.

Cast iron water main still functioning in Philadelphia after 135 years of service.

CAST IRON PIPE SERVES FOR CENTURIES



One of the early steps in the production of Saran-Wrap—the "bubble" that becomes a film after being deflated in a series of rollers.

Colorful display bins are an important part of consumer sales strategy and explain the advantages of Saran-Wrap.

TAKING CHEMICALS TO MANY MARKETS...

Dow succeeds through the careful coordination of group effort in research, marketing and sales

The high consumer acceptance gained by Saran-Wrap is a current example of what happens when extensive research and production planning is followed by coordinated marketing and sales strategy in launching a new product.

This amazing new plastic food wrap is certainly a useful product—but it is much more than that. For Dow it marks another milestone in a continuing effort to move into new fields of endeavor and to increase the variety as well as the size of its operation. Well-planned and executed projects, introducing varied industrial and consumer products, have been responsible for Dow's rapid growth to a position of prominence in the chemical industry.

Whether you choose research, production or sales, you can find a challenging career with Dow. Write to Dow's Technical Employment Department today for the booklet, "Opportunities with The Dow Chemical Company"—you'll find it interesting. THE DOW CHEMICAL COMPANY, *Midland, Michigan.*

you can depend on DOW CHEMICALS

DOW

Foreground: Boeing RB-47E, world's fastest day-or-night long-range reconnaissance plane. *Background:* Standard B-47E six-jet bomber.

Spring thoughts on the subject of...

rambunctious sheepskins

AN engineering senior can hardly be blamed for feeling rambunctious now that the years of hard study are nearly over and the sheepskin's in view.

But the sheepskin comes at Commencement. Commencement means you're set to start on your career. And that's certainly worth some serious thought.

To help you decide which job to pick, you'd do well to weigh the many reasons for choosing an engineering career at General Motors—reasons like these:

• At GM, an engineer has a real chance to follow his natural bent and work in the field of his choice. That's because GM produces a variety of products – automobiles, trucks, Diesel engines, refrigerators, bombsights, just to mention a few.

• At GM, you get the chance to work closely with top engineers, sharing their knowledge and experience. That's owing to GM's decentralization: 34 manufacturing divisions, 117 plants in 57 towns and cities. Yet each division draws upon GM's vast central research laboratories.

• At GM, there's a congenial climate for the personal and professional advancement of engineers. We respect the engineering point of view, as shown by the number of key GM executives in both divisional and top management who began their careers as engineering graduates on GM drafting boards.

Naturally, all this spells genuine opportunity for the young man who has what it takes. Your College Placement Office can arrange an interview for you with our college representative. Or you can write direct to us.

GM positions now available in these fields:

MECHANICAL ENGINEERING
ELECTRICAL ENGINEERING
METALLURGICAL ENGINEERING
INDUSTRIAL ENGINEERING
CHEMICAL ENGINEERING
BUSINESS ADMINISTRATION

GENERAL MOTORS CORPORATION

Personnel Staff, Detroit 2, Michigan

Editorially Speaking

The goal of the Spartan Engineer staff, as expressed in this space six months ago, was to make ours the finest engineering college magazine in the country.

With this final issue of the 1953 - 54 school year, we feel that we can truthfully say we have come a long way towards achieving that goal. To do so, however, we needed — and received — your help. In the form of friendly criticisms, comments, and suggestions for specific topics for us to cover, you have all helped us on our way.

* * * *

As editor of this publication for the past school year, I would like to take this opportunity to thank you, the reader, for the help you have given us; and to urge you to continue to support this magazine in the same fine way under its new editor, Ray Steinbach.

Ray may set up for himself and his staff a different set of goals than was ours in the past; but whatever they are, I'm sure they're worthy of your support and active participation in their achievement.

So, I'll say thanks in advance for Ray, thanks again for your past support, and so long to you all.

PLS

PROGRESS AND SCIENCE GO HAND IN HAND

OUR recently published annual report to stockholders tells more than the financial story of the progress of Standard Oil and its subsidiary companies in 1953. Its facts and figures also reflect the achievements of engineers and chemists.

For example, the report points out that:

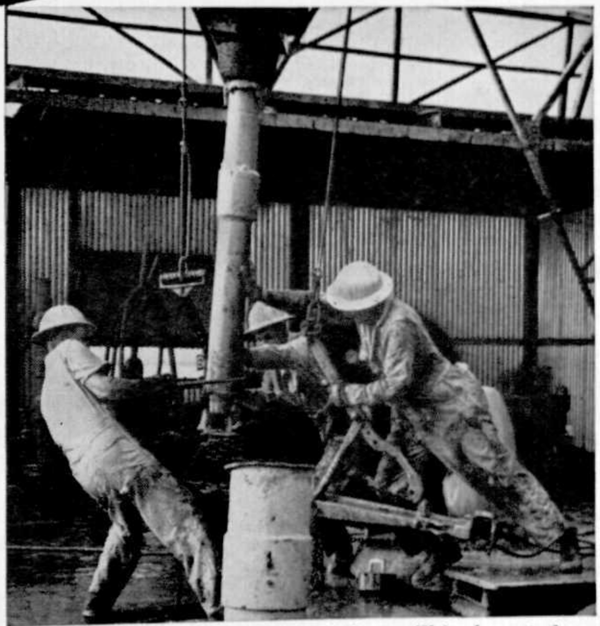
More new and improved products were introduced by our company last year than in any other year since World War II.

Our scientists developed the Ultraforming process, a new and better catalytic reforming method for improving the quality of the straight-run portions of gasoline.

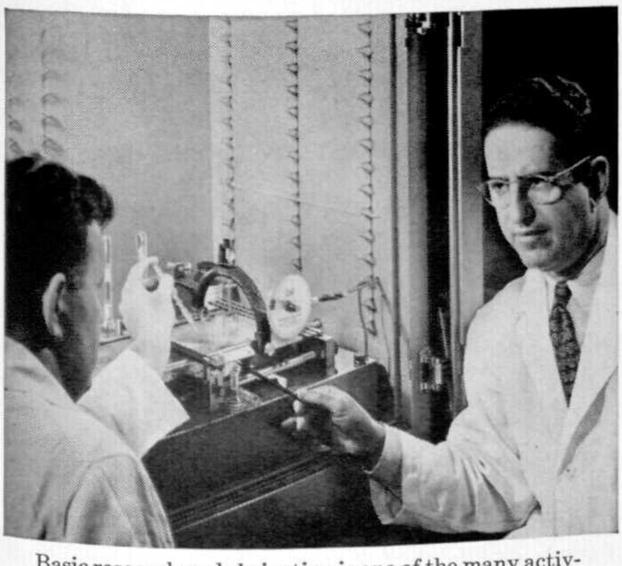
Three new research laboratories were completed.

More than $200 million was invested last year in new and improved facilities. (This year and next we expect to invest a total of about half a billion dollars.)

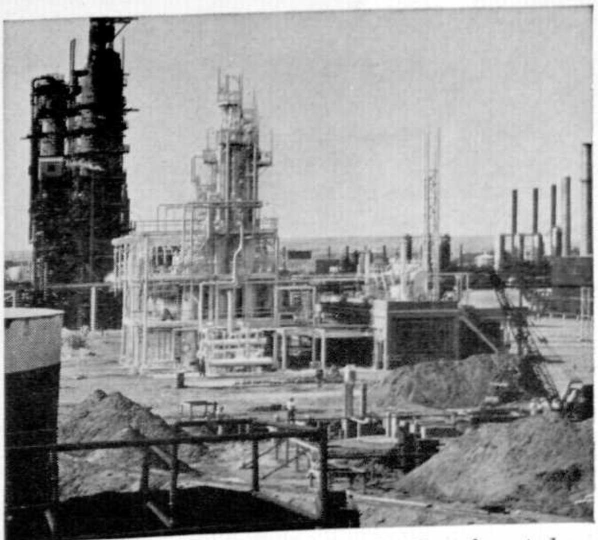
This continuing program of physical expansion and product development at Standard Oil provides many opportunities for engineers and chemists. Men with technical and scientific training have found great personal and professional satisfaction in our steady industrial advance.



Nearly a quarter of a billion dollars will be invested during 1954 and 1955 in development of new crude oil production and reserves.



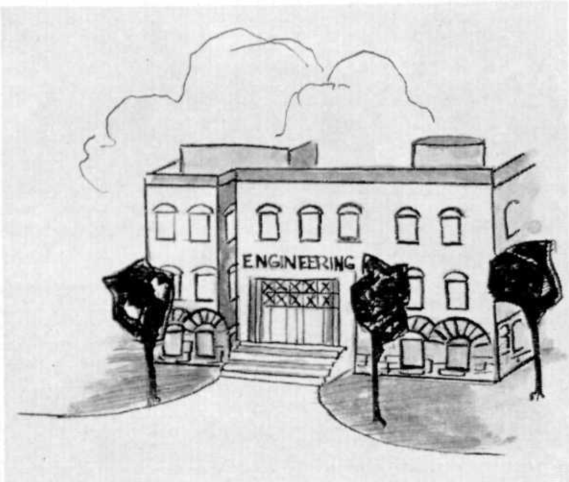
Basic research on lubrication is one of the many activities at Standard Oil's extensive Whiting laboratories.



Almost a billion and a half dollars has been invested in expansion and improvement of facilities since 1945.

Standard Oil Company
910 South Michigan Avenue,
Chicago 80, Illinois

STANDARD



ON BEHALF

OF THE . . .

SCHOOL OF ENGINEERING

AT

MICHIGAN STATE COLLEGE

the

SPARTAN ENGINEER

WISHES TO WELCOME TO THE EAST LANSING CAMPUS

Dr. John D. Ryder

NEW DEAN

OF THE SCHOOL OF ENGINEERING

Presenting:

Dr. John D. Ryder

Dr. Ryder is the new Dean of the School of Engineering at Michigan State College, his appointment becoming effective July 1, 1954. He succeeds Dr. Lorin G. Miller, who retired last summer.

Dr. Ryder comes to us from the University of Illinois, where he was head of the department of electrical engineering. One of the most significant differences between the Champaign school and ours, as pointed out by Dr. Ryder, is the huge size of the electrical engineering department at the University of Illinois – over 200 people in teaching and research – as compared to the smaller size here.

But, he said, he hopes to see that department here built up more and expanded, as he does for the rest of the School of Engineering. Included in the plans he hopes to see carried out is the erection of one, or possibly two, buildings for engineering use only.

This tall, rather mild-mannered man brings to Michigan State a wealth of experience and knowledge, from which he may draw the necessary requirements to help build up the Engineering department.

He was born 47 years ago in Columbus, Ohio, and stayed right in his home city for his scholastic career. He was graduated from Ohio State University in electrical engineering in 1928, and, as a Robinson fellow, received his MS from the same school the following year.

After his graduation, Dr. Ryder took a brief excursion to New York, where he worked in a test course at General Electric Company, specializing in his work on electron tubes suitable for heavy power use. Soon, however, he returned to his native state – this time to Cleveland – where he worked in the research department of the Bailey Meter Company. Here he was in charge of electrical and electronic research and development.

While with the Bailey Company, Dr. Ryder expanded upon and "came into his own" in the field of electronics. His work there included thyratron motor control circuits, temperature measuring devices, telemetering systems, smoke recorders, and an early form of electrical computer for process control. From this work evolved 24 patents, including two under which are being manufactured a well known recorder and a photo-electric potentiometer.

Although doing some work at Case Institute of Technology while in Cleveland, Dr. Ryder in 1941 returned full time to scholastic endeavors. He entered Iowa State College as an assistant professor, becoming a full professor and receiving his Ph.D. in 1944 For a period of 20 months, he was acting head of the department of electrical engineering there, and shortly thereafter became assistant director of the college's experiment station.

While at the Iowa school, Dr. Ryder began work on the design and development of a high-frequency network analyzer, a form of computer used now by many electrical utilities. He transferred his work to the University of Illnois in 1949, where until now he has been the head of the department of electrical engineering.

Besides this experience in the engineering industry, Dr. Ryder has to his credit membership in several professional organizations and honorary fraternities, and the publication of a number of textbooks and articles. Included in the latter are three textbooks already published, and one now in preparation; four articles on the technical phases of engineering, and four articles about the more general aspects of engineering.

Outside of the field of engineering, Dr. Ryder lists as his main interest travel, more specifically, mountains: climbing them and taking pictures of them. Recently, he and his wife took a trip to South America and returned with many colored slides of the sites – particularly mountains – that they visited.

From his predecessor as Dean: Lorin G. Miller, and from his immediate predecessor: Andrey A. Potter, as a special consultant to the School of Engineering, Dr. Ryder has a high standard to maintain. But, with his vast interest in engineering in general, in electrical engineering, and in engineering education, we feel that Dr. Ryder is eminently qualified to not only maintain, but to even better, that standard.

The new basic industry

by Harlow Nelson, M. E. '56

Chemistry is a relatively young science. It was only about 150 years ago that Lavoisier layed the groundwork when he explained the nature of substances and the role of oxygen in combustion. The early colonial settlements in America demanded common chemicals for meat-pickling, tanning, dying, and soap-making. John Winthrop, Jr., responded with the first chemical plant in 1635. The industry grew slowly during the expansion of the west and in 1850 began to assume some importance. The demands of the Civil War expanded the industry 500%. Sulfuric acid and the phases of starch and glue manufacture dominated the mushrooming industry, while dyes, drugs and fine chemicals came in from foreign sources. Nitrates were purchased from Chile. In the 1880's the organic chemical industry, based on coal tar, began to develop. Sulfuric acid and other inorganic materials remained the big volume items in the later half of the 19th century, with chemicals made by electricity appearing before 1900. The 20th century produced new frontiers thru commercial processes. In the period prior to World War I a number of the leading companies of today were established. American production of sulfuric acid and alkalies exceeded that of England, Germany, and France combined. Because of the war's demands, it became a major industry. A start was made on the domestic dye industry. The foundation stones for American independence from foreign sources of supply in the entire synthetic organic field were in place. Research teams of specialists replaced the lone investigator in most programs which experienced expansion in the '20's. The first substantial contributions to medicine by American chemistry were made at this time. The study of the complex molecules of materials such as wood, silk, rubber, and cotton led to the production of valuable products. Synthetic plastics and fibers appeared with superior qualities to natural materials. Around 1925 commercial production of petrochemicals was under way.

The important chemical growth is a phenomenon of the 20th century. Public acceptance and the desire of the chemical industry to create and improve new materials that serve needs better while reducing costs, are important factors in this growth. Here is another example of the incentive enterprise system fostering an industry that serves as a stimulus to all other industries and ultimately to prosperity. Research of the depression years produced products that helped win World War II. In the late '40's many new products, curtailed by the war emergency, began to stimulate business. Textile fibers are a case in point. Consumer profits are less over-all costs, better quality, higher standard of living, job creation, and a more dynamic economy. This World War II period is when the chemical industry, as a basic industry, evolved. Supplying all other industrial groups, it ranks in tonnage and value of output alongside the other industrial giants. Calculating its value becomes complex, for the products sold are increased in value by further foreign operations. The value of chemicals manufactured alone ranks the industry ninth. In view of the diversification and integration of chemistry with other industries, a better picture is given by viewing the chemical process industries such as rubber processing and petroleum refining. With this definition we find the industry producing 15% of the value of U.S. output of all goods and services. The industry's influence seems headed for an even more widespread scope in the future with even "mechanical" industries such as the steel industry becoming integrated. Post-war expansion continued after the multi-million dollar expansion of the war period, until the American chemical industry of today stands far above that of any other nation. Its component to America's might serves as an influential deterrent to aggression and a powerful factor in the domestic economy. Every phase of the chemical field has been characterized by this tremendous growth, with the advance led by plastics, agricultural chemicals, antibiotics and the newer synthetic fibers. The capacity in 1955 is expected to be one-third more than in 1950 due to the present national preparations.

A greater understanding is possible if one knows what the industry makes and the classifications used therein. The principle classes are: (1) basic chemicals, such as acids, salts, and tonnage organic chemicals, (2) chemical products to be used in further manufacturing, such as synthetic fibers, plastics materials, solvents, colors and pigments, and (3) finished products, including drugs, cosmetics, paints, detergents, and fertilizers. The chemicals themselves are classified as organic or inorganic. Originally the distinction was based on whether the chemical was derived from living or dead matter; that is, plant or animal tissue, or whether it was derived from matter that never lived, such as rocks and minerals. But when it was found that members of both classes could be chemically changed to the other class, the basis became the absence or presence of the carbon atom. Compounds containing carbon atoms are classified as organic chemicals. When fine chemicals are spoken of, the term refers to chemicals made for a specific use and sold in smaller quantities at a high-unit price.

(Continued on page 28)

teeth for a 1000 h.p. bite...

Undoubtedly you will recognize this application of a familiar technique for studying stresses. In this case, it was used to develop gears that are less than 5 inches in diameter yet easily transmit over 1000 horsepower.

Inherently, the design and development of aircraft engines offers unusual opportunities for applying basic engineering principles learned in school. In few other places can a technical graduate utilize his education and abilities more fully — gain recognition and advancement.

Many of our engineers who had important roles in developing the most powerful jet engine known to be in production — rated in the 10,000-pound thrust class — are still in their twenties.

To those young graduates who can see the career possibilities in the rapidly evolving field of aircraft propulsion, we can offer a real opportunity for growth and professional development.

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

East Hartford 8, Connecticut

Leisure is an essential element in an engineering education

by C. Ip, Ass't Professor of Mechanical Engineering

No person works harder than the engineers. Many a successful engineer in industry confesses that he has never worked as hard out of engineering school as he did when he was in it. It seems then, in being industrious, our engineering students are MEN OF THE YEARS (Freshmen, Sophomores, etc.). And examinations – ah, examinations! – the time when they stand alone against all elements: the designing professors, the ensnaring problems and what not, are (to misquote Sir Winston) the FINEST (or CURSED) HOURS.

To glorify our engineer as a hero does not make his job of getting an engineering education any more pleasant. Is it possible for our engineer to do less work and have just as good, or better engineering education? Now engineers are experts in talking about efficiency. Let us assume first that the answer to our question is in the affirmative, and let EFFICIENCY, E, be defined by the equation,

$$E = \frac{U}{W}$$

where, U is the degree of understanding of engineering principles, a quantity somewhat hard to measure, and W is the amount of Work put in for the noble purpose of acquiring an engineering education. (Here W is measurable by the number of hours of sleep lost, or the number of foot-pounds of muscular energy spent in pushing the slide-rule, or the number of cups of black coffee hastily gulped down at night.) Now if U, the numerator of our fraction, is given a fixed value, that is to say, if the student of engineering aims at being an engineer of a certain calibre, he will be a more efficient engineer if he cuts down on his work (i.e., W, the denominator). Continuing the process of being efficient, ultimately the engineer will be most efficient when he does no work.

Still, efficiency is not synonymous as possibility in our equation, "Is it possible to do less work?" Let us look into a historical case. Jean-Victor Poncelet (1788-1867), who was a prisoner at Saratoff, Russia, after the defeat of Napoleon's Grand Army, had only scraps of charcoal for drawing diagrams on the wall of his cell, and much time to kill. He made the interesting observation that practically all details and complicated developments of the mathematics he had been taught had evaporated, while GENERAL, FUNDAMENTAL PRINCIPLES remained as clear as ever in his memory. The same was true of physics and mechanics. He went further to give lasting contributions to projective geometry. Furthermore, Poncelet was a French military engineer of no mean skill.

Albert Einstein, on education, remarked: "Education is that which remains, if one has forgotten everything (else) he learned in school." Again he said, "The development of general ability for independent thinking and judgment should always be placed foremost, not the acquisition of special knowledge. If a person masters the fundamentals of his subject and has learned to think and work independently, he will surely find his way and besides will better be able to adapt himself to progress and changes than the person whose training principally consists in the acquiring of detailed knowledge."

Now then, from the aforesaid reasoning, it is not only possible but desirable to do less work – the writing of reports, the performance of routine experiments, the solving of detailed problems, etc., which can be grouped together as details and complicated developments of engineering – and to do more thinking, independent thinking, which is not hampered by what the textbooks say, but which must be based on logical reasoning and guided by established fundamental principles. After all, the average college engineering education consists of but roughly twenty books and a dozen engineering principles. Time spent on pondering over these books as a whole, seeking out the fundamentals from the details, and relating the examples and applications of these principles to the principles themselves will be most profitable. Leisure is the best companion to independent thinking. The time when our engineer is plotting hundreds of points in an experimental curve, or when he is boning up the assignments for the Friday quiz, is hardly the time to realize that the basic assumption in his text book might be erroneous. It is the case of trees and the forest. Leisure and the right environment help creative thinking. We thereby recommend the beautiful M.S.C. campus to be the more desirable environment than the cold Saratoff prison.

Are you telling us, while we are taking seven engineering subjects a quarter and participating in numerous essential extra-curricular activities, to sit down, smoke a pipe, and day-dream? Why, yes! We highly advocate day-dreaming; and hoping that the professors will give fewer assignments, fewer problems, and fewer quizes, is just part of it. Seriously speaking, the engineering institutions all over the country can have still further integration in their curricula; the text-book writers can further standardize their defini-

(Continued on page 32)

The successful engineering executive

by Emory Geisz, M. E. '56

Every college engineering student looks to the future for success. Of course, we all have our own conception of what constitutes success, stemming from our environmental backgrounds, etc. This discussion is directed to those engineering students who feel success arises from the following desires:

a. The stimulation of approaching new problems, making outside contacts and exchanging concepts with others.
b. The personal satisfaction of achievement; of having others in your circles recognize your success.
c. A chance to work with broad problems rather than exclusively with detailed matters — less time devoted to a fixed routine.
d. The satisfaction of providing well for your family.

If these satisfactions appeal to you, then you will accept and find enjoyment in the challenge of management.

The present day college engineering curricula does not provide the engineering students with the necessary tools to enable them to hold successfully managerial positions. This situation is most easily viewed by stating it as a simple problem of subtraction: Characteristics constituting an executive minus teachings of the school equals knowledge the student lacks.

If there is a formula for the successful engineering executive, the basic ingredients are technical knowledge plus practical experience plus top personal qualities. The *Encyclopedia Britannica* says, "Qualifications (for a successful engineer) include intellectual and moral honesty, courage, independence of thought, fairness, good sense, sound judgment, perseverance, resourcefulness, ingenuity, orderliness, application, accuracy, and endurance. He should have extreme knowledge . . . of other branches of learning." Having been endowed more or less completely with such qualifications and capacities requisite, the school should realize that the engineer is under obligation to consider the sociological, economic, and spiritual effects of engineering operations and to aid his fellowmen to adjust wisely their modes of living, their industrial, commercial and governmental procedures, and their educational processes so as to enjoy the greatest possible benefit from the progress achieved through our accumulating knowledge of the universe and ourselves as applied by engineering.

Theoretically, an engineering curriculum for a particular field or subfield should include all pertinent parts of fundamental subjects not required for entrance upon the curriculum, all professional subjects peculiar to the field or subfield, and all other pertinent parts of professional subjects peculiar to other fields. Using Michigan State College's School of Engineering as a typical example of the type of curricula being offered in today's engineering colleges; this is what the *MSC Catalog* states on the School of Engineering:

> **A knowledge of the fundamental principles of the sciences which are the basis of engineering practice are among those things which the courses of study here offered are designed to provide. The curricula of the various departments are planned: (1) to train the senses in accurate habits of observations, the mind towards logical deductions from observed facts; (2) to acquaint the student with approved methods of engineering practice, and with the use and limitation of instruments; (3) to offer opportunity for experimental work on engineering problems; and (4) to provide a true conception of the duties and privileges of the engineer as a citizen and as a member of his profession.**

Yes, this is what they indicate the courses are designed to accomplish, but they should state more explicitly that they are aiming at the ideals set forth, and maybe someday when more nearly reached, the students will be better prepared to meet the business world as well-rounded, educated gentlemen, ready to go out and take a fitting place in society. The fact of the matter is, engineering curricula is not properly designed to develop prospective industrial leaders.

Too bad we cannot blame some tangible element as a cause for insufficient curricula, but as time, being this factor, is eternal and everlasting, no punishment can be inflicted. From any curriculum of any feasible length, a great part of the ideal subjects are necessarily excluded. In fact, the whole time of the theoretical curriculum would suffice to present a small part of the matter presented above. Time is important in our lives and no practical student, especially those dedicated to management, wishes to spend the rest of his life in school. The engineering educators are striving toward the ideal curricula and although it is infinitely out of reach, year by year continual progress advances them nearer and nearer toward their goal.

One of the greatest curricula weaknesses necessary in executive development is the lack of emphasis on communication. Theoretically, the engineer should have a working knowledge of the written and spoken language of all countries which notably contribute to the development of engineering and engineering sciences. As mentioned, the time element makes this nearly impossible. But, at least if teachers kept the engineering student as continually conscious of his imperfections in speaking and writing as they do of the shortcomings of his drawings, undoubtedly at graduation he would be as good a self-critic of his English as he is of his drawings; and thus would be removed the grounds for the long lament that engineering students lack interest of good practice in speaking and writing. The courses in English of

(Continued on page 34)

SCEL not SKOL

by Capt. Edward D. Meares, U.S. Army Signal Corps

At the beginning of time for the mammals of this earth, the prehistoric man was at about the same level of existence as the animals about him. The primary concern of each was to avoid becoming a meal while attempting to convert another mammal into a meal. Since that time man has steadily risen above the level of animal, primarily because of two abilities. These two abilities in addition to that spiritual quality endowed by the Almighty are simply the ability to reason logically and the ability to communicate the results of this reasoning to other humans and from one generation to a succeeding one. Granted, animals possess these abilities, but not to the same degree as man. The opposable thumb has also played a part in man's rise but the simian has not only opposable thumbs but opposable big toes as well as highly versatile tails. Still, they remain incapable of rising above the animal level. Essentially then, these two abilities are two of the primary reasons why man, not animal, is master of the world today.

Of particular interest to the engineer of today is the communication factor. The unlimited fields to improve with the corresponding unlimited challenge to improve are the particular realm of the electrical and mechanical engineer. The fields of military communications and interspace communications offer a special challenge to these engineers because of the unique requirements of this type of communications.

Communications in the beginning of time must have consisted of crude gestures and grunts. Undoubtedly when the Neanderthal said to his son, "Run, Percival, and get the women and children off the streets, the dinosaurs are coming!" we of today would have had trouble understanding him. However, when one Bau Brummell of Cavetown Heights waved his club in the face of some Cro Magnon Casanova his meaning of "Get the meat hooks off the skirt" would be quite clear even today. Our present day efforts at thought transmittal are somewhat more refined than the grunt and gesture methods used then.

And yet, with all the refinements that the modern scientist and his skill have made, communications have not kept up with the needs of modern civilization.

In particular the communications of our modern army have not kept apace of the needs of the Army Commanders. In days of old when two armies gathered to do battle, the leaders massed their armies facing each other across an open space. The leaders waved their swords, the trumpets sounded and the opposing hordes advanced. Once the battle was joined, it was mostly every man for himself until the end. Army communications had not been developed beyond the point where the commander could do much more than point to the enemy and call "Follow me and the devil take the hindmost." Throughout the history of warfare there are examples of battles that were won or lost or uselessly fought because of the lack of adequate intercommunication. For instance, the Battle of New Orleans in the War of 1812 was fought after peace had been declared, because of inadequate means of communication.

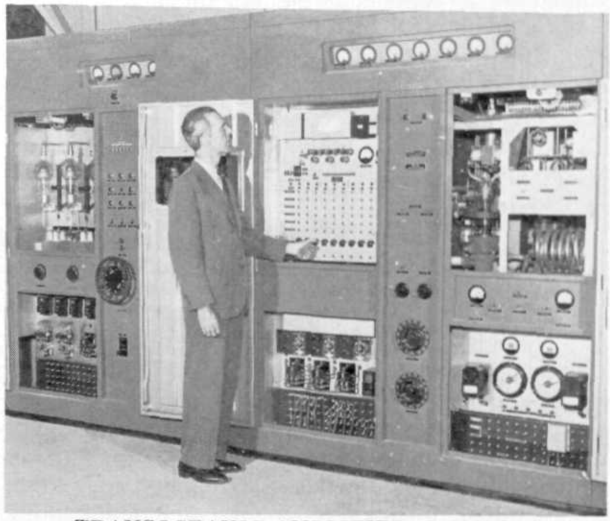
Today the U.S. Army's Signal Corps is dedicated to the task of providing communications that can keep apace of modern warfare. The Signal Corps has an unlimited field to work in, with a never-ending need for improvement. The Dick Tracy two-way radio is not so fantastic as it may seem. Such a device would be extremely useful both for Army and civilian use. With the advent of printed circuits, peanut tubes, transistors and other modern miracles of miniaturization, the perfecting of this small radio transceiver is just a matter of time. The Signal Corps is also getting into the fields of Rockets and interspace travel. The remote control devices of the NIKE and other rocket devices were developed in part by the Signal Corps. This opens up new areas for the Signal Corps scientist in the research and development of devices for remote control of rockets and communications for inter- and intra-space travel.

The Signal Corps is well-equipped to continue the research and development necessary to keep abreast of the needs of modern warfare and to expand into the field of space communications. At Fort Monmouth, N.J., the Signal Corps Engineering Laboratories (SCEL) have the very latest in laboratory facilities. SCEL's mission is research and development for improved radar, meteorological, photographic and radiac equipment. SCEL develops some equipment for the Air Force and Navy as well as the Army. To fulfill this mission, SCEL has about 4100 civilian employees in three main laboratories within a 15-mile radius of Ft. Monmouth and at field stations in New Mexico, New Hampshire, Alaska and Canada. The Military assigned about 77 officers in addition to the SCEL detachment of 17 officers and 450 enlisted personnel. These men work as Engineering Aides and furnish teams for the introduction of newly developed equipment to the troops in the field.

Briefly, the breakdown and function of SCEL's three main laboratories are as follows:

Squier Signal Laboratory on the grounds of Ft. Monmouth has six operating branches covering Photographic, Components and Materials, Power Sources, Frequency Control, Specifications and Drafting, and Service.

It performs research and development, improvement and test on the following: internal combustion engine-driven power units, primary and secondary batteries, battery chargers, dynamotors, power supplies, rectifiers and battery substitutes; materials used in electronic equipments and finishers thereof; component parts (circuit elements); equipments and techniques for the design and manufacture of frequency stabilizing devices, analyzes climatical and biological conditions on equipment developed by the Signal Corps, especially component parts, and develops methods and equipment to overcome abnormal deterioration caused thereby; conducts research and development on precision frequency control oscillators and filters; conducts qualification, developmental, and contractual testing of all components and materials developed by SCEL, and performance tests for which Squier Signal Laboratory is responsible; conducts research and development on standardized test equipment, all photographic and supplementary type equipment used by the Army Field Forces and other using forces as directed by higher authority; accomplishes the responsibilities of SCEL for the standardization program in conjunction with the Armed Services Electro-Standards Agency; prepares procurement information.



TRANSOCEANIC AMPLIFIER: In developing world-wide communciations systems, the Signal Corps uses high-powered amplifiers with its long-range radios. At the Ft. Monmouth laboratories a radio engineer adjusts experimental amplifier.

Coles Signal Laboratory, Red Bank, N.J., has five operating branches covering: Radio Communication, Wire Communication, Suppression and General Engineering, Specifications and Drafting, and Service.

It is responsible for the development, design and test for Army Field Forces and other services, of communication equipment, both tactical and fixed plant, including all communication radio such as vehicular and pack equipment, mobile and fixed plant equipment; radio relay systems, telephone and telegraph equipment, field wire, cable, communication systems; television equipment, radio interference suppression systems, and mobile installations of communication equipment; studies and reports on foreign equipments. Also maintains basic and advanced research and development on vehicular and mechanical devices and acoustical systems. Administers a program of research and special investigations for the advancement of the state of the art, and to improve technical performance of the above equipment. Prepares procurement information on those equipments for which it is responsible and acts as technical consultant in the preparation of JAN and Department of the Army specifications.

PRINTED CIRCUITS REDUCE SIZE: Signal Corps printed circuit techniques developed in the laboratories at Ft. Monmouth, have led to tremendous reductions in size and weight of military and commercial equipments. When used with transistors, a circuit for a frequency meter, as the one held by this scientist in his hand, plus small battery at right, replaces all the parts shown in conventional vacuum tube model pictured at left.

Evans Signal Laboratory at Belmar, N.J., consists of eight branches covering: Countermeasures, Radar, Nucleonics, Meteorology, Thermionics, Applied Physics, Specification and Drafting, and Service.

It performs research, design, development, test, and improvement on the following types of ground signal equipment and special electronic devices; ground radar; special equipment involving direction finding and ground-based countermeasures techniques; vacuum tubes; detection, identification and measurement devices and instruments for use in radioactivities; executes and evaluates all aspects of Signal Corps participation in atomic weapons tests. Coordinates with outside organizations developing signal equipment for which Evans Signal Laboratory is responsible to insure conformance with design and material standards; develops, standardizes, tests and performs type approval activities pertaining to vacuum tubes used by the Army and the Air Force, designs, develops, and improves items of test equipment for which it is responsible; prepares procurement information.

To tell of the equipment that has been developed by SCEL would take entirely too much space so only a few developments will be mentioned. For instance in World War II, the Secret Service called on SCEL to produce "immediately" a series of portable special duty FM radio sets that could precede and follow President Roosevelt wherever he travelled. It just so happened that SCEL, looking ahead, had developed

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Mackinaw straits pipeline crossing

by Bruce Trudgen, M. E. '54

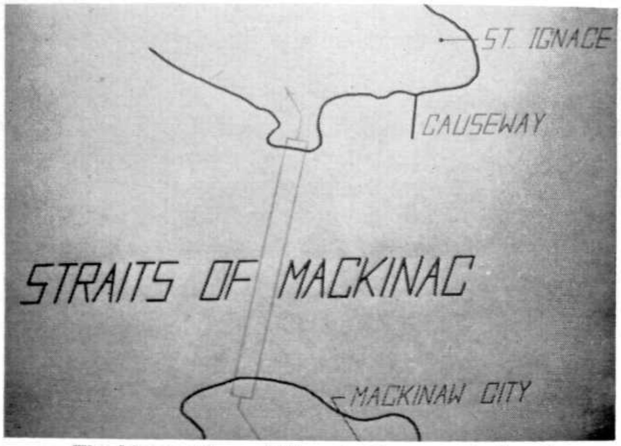
In the province of Alberta, particularly around Edmonton, there are vast oil fields which supply crude oil to the Canadian refineries at Sarnia. A thirty-inch underground pipeline to carry this flow of oil was completed during the summer of 1953. Previously, the oil was piped as far as Duluth, at the western end of Lake Superior, and then carried the remaining distance by a fleet of tankers. The short navigation season, plus the inherent expense of operating the fleet, made the continuation of such a system economically unsound. The obvious answer to the problem was to extend the pipeline.

It was realized that if the oil could be piped directly from the oil fields to the refineries, the wells could operate the year round, rather than lie idle for five months each winter, waiting for the ice to break up in Lake Superior.

Laying the line from Duluth to St. Ignace presented no particular problems, and similarly the line from Mackinaw City to Sarnia was relatively easy. The one bottleneck lay between St. Ignace and Mackinaw City; namely, the Straits of Mackinac. There were many obstacles to be overcome in stretching a pipeline across four miles of open water. The water was found to reach a maximum depth of 246 feet, with currents up to two miles per hour. Also, there was wind – lots of wind. A continuous flow of commercial shipping thru the straits imposed certain limitations on the construction procedure. This problem was solved by the use of a unique and relatively new method of launching the pipe.

The first problem confronting the contractor for the job was to determine the best method of laying the pipe. It was decided that the pipe would be welded together on the north shore, placed on a series of launching rollers, and then pulled into the water by means of a cable extending from the head of the pipe to a large pulling winch located on the south shore.

The next problem was to obtain the best pipe for the job. The result was an order for eight miles of twenty-inch steel pipe with a wall thickness of 13/16 inch and weighing 166 pounds per lineal foot. Two 20″ pipes were used, rather than one 30″ pipe, as was being done overland. There were several reasons for doing this. First, the greater flexibility of the smaller pipes allowed a smaller minimum radius of curvature, which meant that the pipes would conform themselves to the bottom more easily, and less dredging would be required. Second, if one pipe were disabled, the flow of oil could continue through the other. Third, it was possible to use a smaller pulling cable and a smaller pulling winch.



The big problem of the pipeline was to lay the pipe across the Straits of Mackinac. The feat was an experiment in that it was a bigger job than had ever been endeavored.

The north shore was chosen for the launching area because of the wide expanse of low, level ground which was available. Although the area was heavily wooded, it proved to be ideal for the use intended, because bedrock was very near the surface. This made for good foundations, which was of prime importance.

The first big job was to clear the land. Each of the two pipelines required a clearing over one-half mile deep and wide enough to handle eight strings of pipe plus several roadways.

At the north, the two pipelines were twelve hundred feet apart, while the spacing at the south shore was thirteen hundred feet.

The south shore was far from level, which meant that the pulling engine was placed quite some distance above water level.

The pipe arrived at the job site in sections 27 feet long. For each line, the pipes were welded into eight 2500 ft. strings, so that when the eight strings were welded together the result would be one piece of pipe 20,000 ft. long. The pipes were arc welded by hand, each joint having eight passes of weld. The Pittsburgh Testing Laboratory x-rayed each weld after the second pass and again after the eighth pass.

Washing the pipe was the next step in preparing it for launching. The pipe was passed thru the round section under the motor of a pipe washing machine which contained several dozen scrub brushes. As the machine moved along the pipe, the brushes rotated.

After the pipe was washed, it was coated with tar and wrapped with fiberglass cloth and tarpaper. As the wrapping machine moved along the pipe, the rolls of wrapping material rotated around the pipe.

After being wrapped, the pipe was painted white.

Next, the lower half of the pipe was covered with 1 x 3 inch pine, and the top half was covered with roofing paper, all held on by steel bands. The pine was to protect the bottom of the pipe from abrasion during the pulling operation.

With the addition of a special pulling head, the pipe was ready for launching.

An elaborate triangulation system was set up to provide a means of accurately locating the dredges and derrick scows.

Eight range lights were erected, one on each end of each line at water's edge and one on each end of each line about one-half mile back from water's edge. This solved the problem of keeping the floating equipment on line.

Next, a base line was established. One end was on the north shore, mid-way between the two pipes. The other end was on the south end of the causeway. A transit was permanently set up on the east end of the base line. Then by measuring the angle between the base line and a line from the transit to the particular piece of floating equipment in question, an accurate fix could be obtained. Communication from the boating equipment to the causeway was by radio.

In addition, four survey towers were erected. They were made of structural steel and set in about 70 feet of water. The platforms of the towers were cantilevered out over the pipelines, so that transits could be set up directly over the lines. They were used very little, simply because they wouldn't hold still. There were five things that kept them on the move — wind, wave action, currents, small boats bumping them while transferring personnel, and the men moving about on them. The story of the towers serves to illustrate again the experimental aspect of the project.

The amount of dredging to be done was determined by studying three specifications in the design. First, the pipe was to be buried 15 feet deep at water's edge, and was to remain buried 15 feet deep until

Pipe washing machine designed for the pipes used in the crossing.

it reached a depth of 65 feet below low water datum. Second, the maximum unsupported span of pipe was to be 75 feet. Third, the minimum radius of curvature of the pipe was to be 1700 feet. Simply stated, it meant that in shallow water the pipe was put in a trench and back-filled, and in deep water the pipe lay exposed on the bottom, the dredging being simply a process of cutting down the high spots. The trenches were made 15 feet wide at the bottom.

In shallow water along both the north and south shores, there was a lot of rock that had to be blasted. Offshore from the rocky areas the bottom turned to sand, and then as the water became deeper there was nothing but red clay. All the bottom in deep water was red clay.

The red clay held a trench very well. That is,

Here the pipe, with floats attached, is fed to the pulling cable, which attained a velocity of 20 feet per minute.

once a trench was dug, there was no appreciable back-filling due to currents in the water. On the other hand, the areas of sand created quite a problem. It was necessary to dig the trenches somewhat wider and deeper than was wanted, and then estimate how quickly they would refill. This provided the correct depth on the date of launching.

The dipper-dredges Mogul and Sullivan were used for rock, the hydraulic dredge Niagra was used for most of the sand, and derrick scows were used wherever the water was deeped than 40 feet. A 20-ft. Jafco utility runabout, equipped with a Raytheon recording fathometer, was used for checking the progress of the dredging. Profiles and cross-sections were taken periodically to see that the trenches were meeting specifications.

The west trench was completed about a month before the east trench. As soon as the dredging was terminated, equipment was readied for the cable-laying operation. The pulling cable was a 2 inch, 6 x 19 wire rope. It was made up into 2500 ft. sections, each section on a separate spool. The largest derrick scow available (the Cherokee) was anchored over the trench at the south shore. On the stern of the scow was mounted a two-drum winch with the first section of cable on one of the drums. The end of the pulling cable was secured at the pulling engine on shore. Four concrete anchors were put out on each side of the scow. Each anchor cable was attached to a deck winch. These were to keep the scow on line, and were continually moved north by two smaller derrick scows. From the bow of the scow were put

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Materials for high temperature service

by Joe Myers, Jr., Met. E., 54

Recent years have witnessed a remarkably rapid development of equipment to operate at high temperatures. Many examples are to be found in the fields of chemical processing, in the generation of power and in new types of engines. Recent advances in jet propulsion, turbo-superchargers, and gas turbines were possible only because new alloys were developed by research metallurgists. Jets, in particular, have spurred metallurgical research. The impetus for this research is the pressing need for materials for "hot end parts" which can defy the consuming heat of jet engines, some of which can blaze away 2,000 gallons of fuel an hour.

Rapidly becoming as familiar as pistons and cylinders of the conventional engines are hot end parts of jet engine combustion chambers, exhaust cones and afterburners.

Jet planes fly at supersonic speeds above 50,000 feet in routine flights and the turbojet is already 5 times as powerful as the largest piston propelled drive. Yet, engineers declare that the potential of the jet engine has scarecly been tapped. Compact engines with power equivalent to 30,000 horsepower are possible if temperatures and pressures can be increased. This is where the metallurgical engineer is pacing performance. New alloys with the prescribed high temperature properties must be developed to meet the challenge.

What are the temperatures encountered in the jet engine? The highest readings are found in the combustion chambers and afterburners where flame temperatures as high as 3700° F. have been recorded. Since this is 1000° hotter than the melting point of the alloys presently used in these structures, it is evident that wall temperatures are considerably lower than these figures. Actually, the metals operate between 1200° F. and 1800° F. This disparity between flame and wall temperatures is accomplished by ingenious design innovations which insure the centering of the combustion flames within structures and provide a blanket of cooling air around each component.

Why are metallurgists facing a dilemma in finding alloys to withstand operating temperatures of 2000° F. when a number of metals have melting points in excess of this figure? For instance, tungsten melts at 6200° F., molybdenum melts at 4800° F. and columbium melts at 4400° F. But melting point is not the most important consideration in determining whether a metal can withstand the rigors of jet engine use.

The four characteristics which metallurgists search for in an alloy for high temperature application are oxidation resistance, high temperature strength, corrosion resistance, and thermal expansion and conductivity. Probably the most vital of these is the capacity to resist oxidization, because structural strength is useless if the metal rapidly burns away.

The ability of a metal to resist oxidization at elevated temperatures is largely determined by the type of oxide scale it forms. Laboratory investigations show that many metals form a tough impervious scale which retards progressive oxidation, while others form a porous type of scale which continues to build up and flake away, eating into the metal. However, over prolonged periods of exposure almost every type of oxide film tends to break down due to compressive stresses which are set up. The effects of repetitive heating and cooling cycles experienced in jet engine operation cause compressive stresses in the oxide film because the underlying metals tend to contract faster than the oxide scale. Alloys having high coefficients of thermal expansion aggravagate this condition because they exhibit greater dimensional change under varying temperature.

When considering pure metals, scaling may be classified in two types, linear and parabolic. The linear type of scaling will in general occur when the oxide has a smaller specific volume than the metal. The scale is thus porous and offers little obstruction to the inward flow of oxygen to the metal surface. Scale also has a tendency to spall and fall off from the metal. Among metals which show linear rates of oxidation are calcium and lithium. Metals of the linear type have little if any application for extended service at elevated temperatures. The parabolic rate type of scaling is to be expected when the scale is adherent and the oxide has a specific volume equal to or greater than the underlying metal. Metals like chromium and iron form a dense adherent scale. This parabolic type of scaling, with increasing thickness of oxide offers increasing resistance to the inward diffusion of oxygen and outward diffusion of metal.

When alloying elements are added to a metal, its scaling behavior may become quite complex; the effects of time, temperature and amount of alloying additions on rates of scaling are not simple and behavior is not readily predictable. New phenomena such as selective oxidation and precipitation of phases from solution may occur.

The second vital quality which a metal must possess for jet engine use is good strength at high temperatures. This involves all kinds of strength exhibited by alloys, such as ultimate tensile strength, creep strength and stress rupture strength. There is a striking difference in the behavior of metals at room temperature and at those temperatures experienced in jet power plants. A good conception of this can be obtained when it is realized that structural carbon steel with a room temperature strength of 140,000 psi would have an ultimate tensile strength of only 1,000 psi after exposure to 1400° F. for 1000 hours.

The design of load bearing structures for service is generally based upon yield or tensile strength, which is determined in ordinary room temperature tests. In service at ordinary temperatures a metal behaves essentially in an elastic manner. At elevated temperatures the behavior is quite different. A structure will continue to deform with time after load application, even though the design may have been based upon tensile tests taken at elevated temperatures. This is due to the fact that tensile tests are relatively short term affairs, accomplished in a few moments. Under prolonged application of temperature and stress metals tend to deform at a slow rate. This deformation is called creep (expressed in terms of pounds per square inch required to produce an elongation of one percent in 10,000 hours at the specified temperature). For jet engine parts where precision and exact dimension are a necessity, high creep strength is of prime importance. Certain rotating structures have a creep strength which will resist a one percent elongation in 100,000 hours of service – equivalent to about 11 years.

Creep of a metal under constant load and temperature occurs in three stages. First, the metal elongates rapidly but at a decreasing rate. In the second stage, usually of a longer duration, the rate becomes constant. The third stage occurs when elongation increases rapidly until the metal fails.

At the beginning of a creep strength test, the metal will exhibit an elastic extension before it starts to flow. Also, if the test is not carried to fracture, the metal will contract a similar amount when the load is removed. From these phenomena it is apparent that metals creeping under stress at high temperatures possess both elastic and plastic properties simultaneously.

A metal will not stretch indefinitely without fracturing. Therefore, it is important to the designer of high temperature metal components to know when a metal will rupture under conditions which produce creep. Since creep tests are usually long term undertakings (some have been run for 10 years) another means has been evolved to disclose the stress rupture point of metals. Similar to the creep test, this test utilizes a greater strain than the creep test in order to speed up the elongation process. By extrapolation of creep and stress rupture data, it is possible to determine when a metal will fail under prescribed conditions. This failure occurs at a lower stress level than the ultimate tensile strength of the material.

The third characteristic which catches the eye of the high temperature metallurgists is corrosion resistance. Corrosion is the destructive alteration of a solid body by chemical or electrochemical reactions arising on the surface. Usually metals are corroded by chemical solutions in which some of the positively charged ions in solution lose electrical charges to the metal being corroded. The elevated temperatures of jet engines amplify and accelerate the factors causing corrosion, which are products of combustion and atmospheric elements. Fortunately corrosion resistance is the least important obstacle in the quest for high temperature materials, because the elements which provide alloys with good oxidation resistance also contribute to their capacity to resist corrosion. Chromium and nickel, present in many high temperature alloys, are examples of these elements.

A fourth group of characteristics are thermal expansion and conductivity properties. These must be controlled to provide the lowest induced stresses resulting from localized hot areas. Also included in this group is thermal shock resistance. Thermal shock is a very high instantaneous stress induced on a turbine or compressor blade by a rapid temperature change.

The alloys presently in use are chrome-nickel steels, chromium steels, nickel base alloys and cobalt base alloys.

The chrome-nickel steels are austenitic with an 18-8 ratio of Cr to Ni. This group of steels is most widely used for high temperature applications because of its good characteristics of oxidation and corrosion resistance and high strength at elevated temperatures. These steels have six times the electrical resistance of unadulterated steels and respond readily to welding techniques. However, since they have a high coefficient of expansion and low heat conductivity, they require special care to prevent distortion during welding. They do not need heat treatment after welding to develop maximum physical strength. They are non-magnetic and cannot be hardened by heat treatment. They may be hardened by cold working and then they become slightly magnetic. Cold working enhances their structural strength at the cost of ductility. These steels are difficult to machine unless they contain added amounts of sulphur of selenium. The addition of columbium or titanium protects against precipitation of harmful carbides at high temperatures.

The straight chromium steels containing no nickel are either martensitic or ferritic in crystalline structure depending on their hardening characteristics. Because they respond to heat treatment, they are capable of being given a wide range of mechanical properties. Corrision resistance in these steels is a function of the percent chromium contained, so for oxidation resistant applications 10-30 percent Cr steels are designated. These Cr steels exhibit inferior creep resistance compared with the Cr-Ni steels. The 25 percent Cr steels are designed for severe heat and corrosion applications and may be used at temperatures as high as 2000° F. These alloys are embrittled by welding, therefore careful welding techniques must be followed.

The elements which are most commonly added to steels for high temperature use are molybdenum, which is the most active in giving creep resistance to iron; chromium, which gives resistance to oxida-

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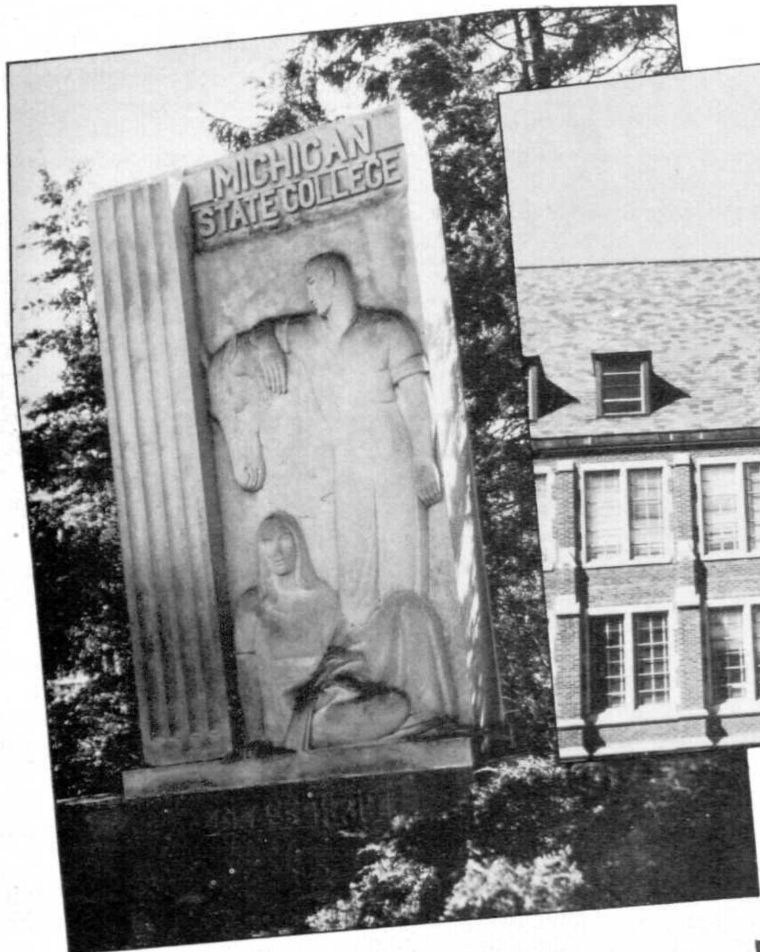
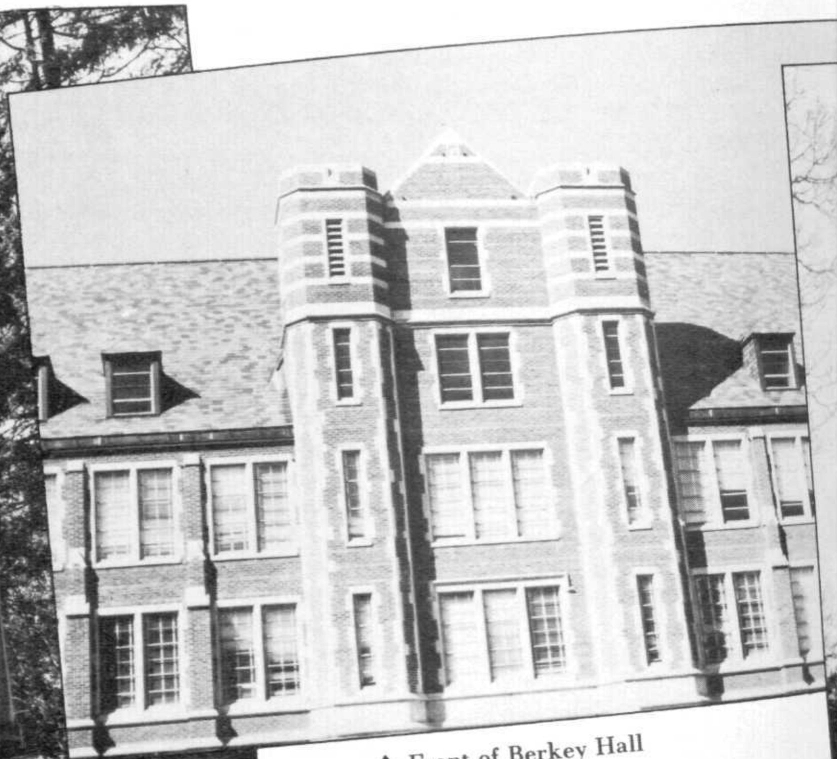
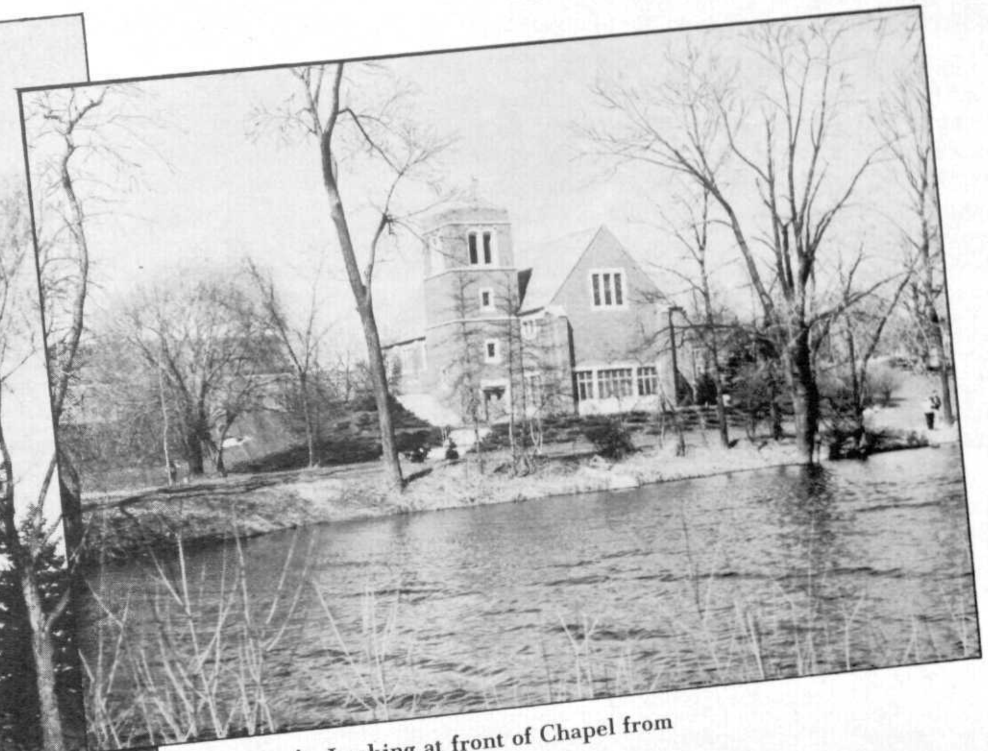


▲ Spartan Statue



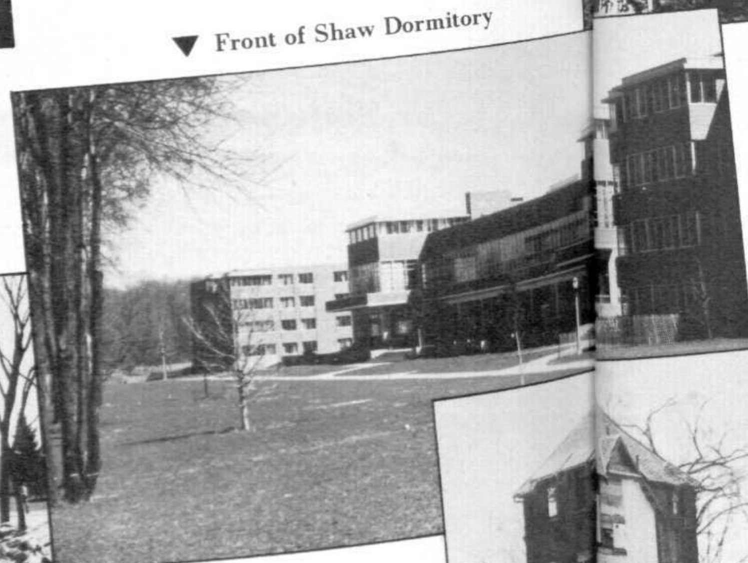
▲ Front of Berkey Hall

▲ Beaumont Tower

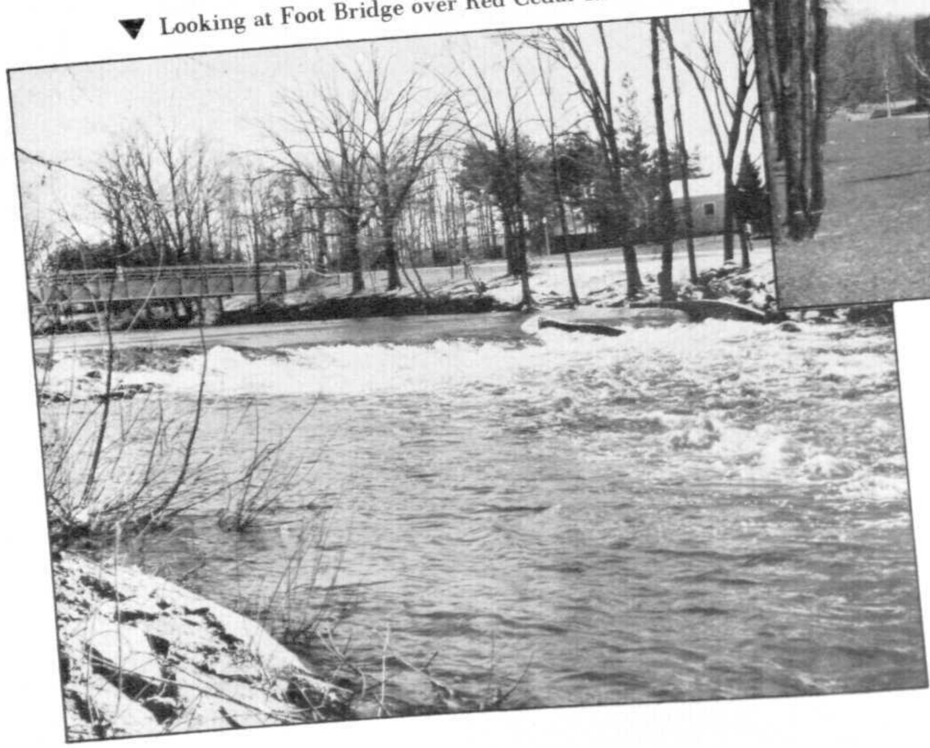


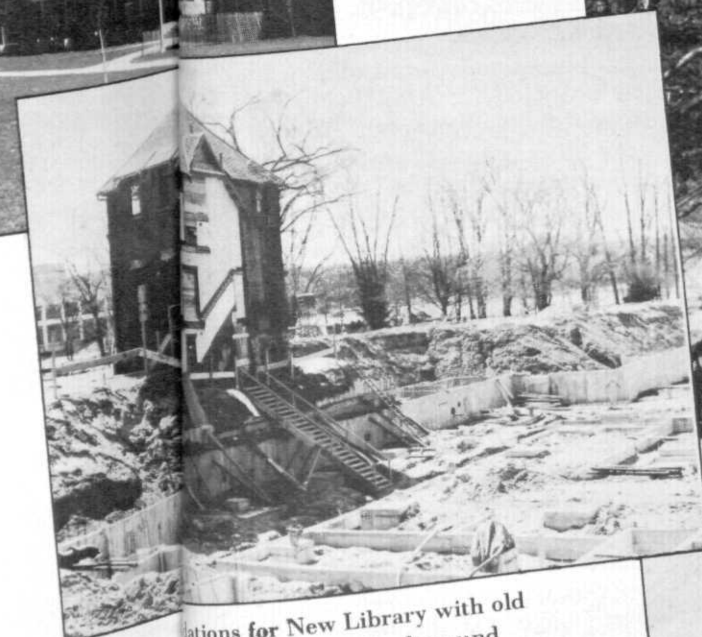
▲ Looking at front of Chapel from across Red Cedar River

▼ Front of Shaw Dormitory



▼ Looking at Foot Bridge over Red Cedar River





dations for New Library with old
nalism building in background

▼ Looking from site of Library construction, at Beaumont Tower

PHOTOS BY RAY STEINBACH

Mackinaw Pipeline

(Continued from page 21)

out two salvage anchors with their cables attached to another two-drum winch. These were to pull the scow north along the trench. When the scow moved north and approached the first salvage anchor, the second anchor was placed further out and it did the pulling while the first anchor was being moved. This procedure continued until the scow reached the north shore.

The 2500 ft. sections of cable were connected by means of swivels. At each connection there was also a float 3 ft. in diameter and 12 ft. long. The floats served to keep the cable from burying itself in the clay, as well as to scraps a trench for the pipe.

When the Cherrokee was about half way across the straits, laying the cable for the west line, a severe thundersquall struck, with winds up to 50 mph. Luckily, due to the generous size and number of anchors, the crew was able to hold the scow on line.

The pipes were extended back into a clearing ½ mile deep while being made ready for the crossing.

Two foundations were built on the south shore for the pulling engine, one on each line. Each foundation was made by drilling four holes in the ground, 20 ft. deep and four ft. in diameter. In the center of each of these holes was placed a steel beam and then the holes were filled with concrete.

The pulling engine was a 180-HP diesel engine driving a two-drum winch through a system of reduction gears. Its rated pulling capacity was 210 tons.

When the west pipe was less than half way across, one of the reduction gear shafts sheared off and resulted in a minor catastrophe. When the shaft failed and the tension of 46 tons was instantaneously released from the pulling cable, the cable partially untwisted. The immediate problem then was to determine the extent of the damage to the cable. During the next four days, the divers were busy checking the underwater portion of the cable near the south shore. As a result, a small section of cable was replaced and pulling was resumed.

Meanwhile, the original diesel driven, 210 ton pulling winch had been replaced by two smaller steam winches rated at 50 tons each. These were rigged with a form of block-and-tackle that gave them a 4 to 1 mechanical advantage, which increased their combined pulling effort to 200 tons. Actually it was less than 200 tons, due to friction losses in the tackle.

The control tower was the nerve center of the launching operation. Most of the communication in and out of the tower was by telephone. However, at each phone station there was also a radio, so that if the phones failed, the messages could be handled by radio.

In front of the control tower was a profile of the west pipe. The vertical scale was greatly exaggerated. If the profile were plotted to scale, with the distance from shore to shore equal to three feet, the maximum depth would be less than one-half inch.

The one question that the author has been asked more than any other is, "Did the pulling cable rise off the bottom at any time?" The answer is no. With the maximum depth being less than 1/80 of the distance across, it becomes obvious that if a sufficient tension were applied, the cable would break long before it would rise off the bottom.

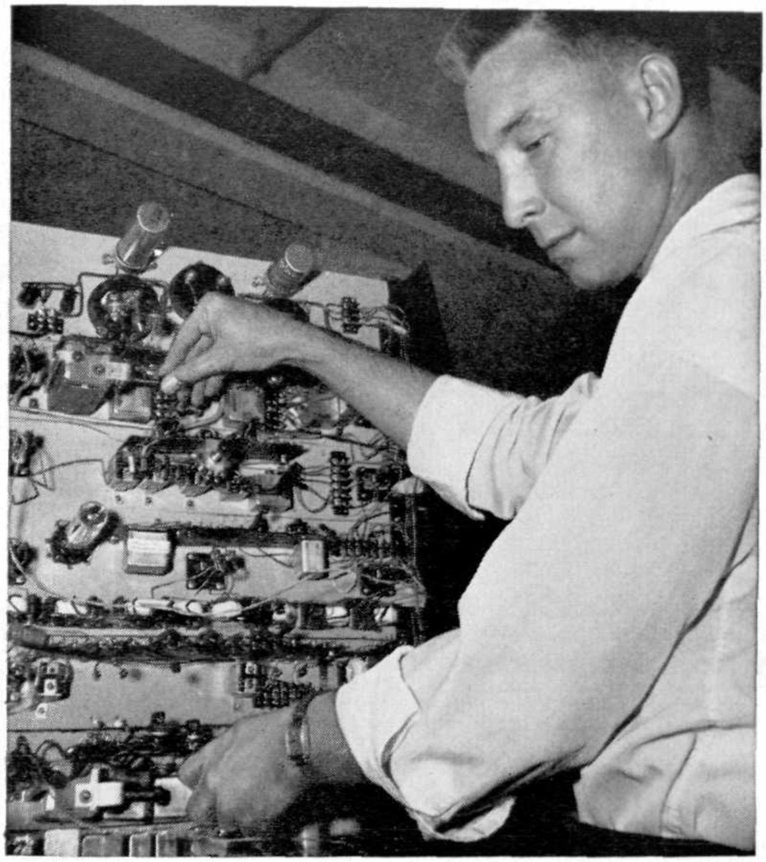
During the launching, the pipe was full of air and a float was attached every 66 ft., thus giving the pipe a negative buoyancy of six pounds per lineal foot. The floats were filled with compressed air at 100 psi, to keep them from being crushed by the water pressure.

The pipe attained a velocity of 20 ft. per minute. Its mass with the floats attached, was approximately 2000 tons. A running hold-back was used to decelerate the movement of the pipe, and stop it at exactly the right spot to weld on another section of pipe. The running hold-back was the same steam winch that was used on the deck of the Cherrokee for laying the pulling cable. A cable ran from the winch to a sheave which was attached to the tail end of the pipe, and then returned to an anchor point in front of the winch.

A standing hold-back was used to hold the pipe while another section was being welded on. It was located between water's edge and the welding sta-

(Continued on page 31)

A CAMPUS-TO-CAREER CASE HISTORY



Bob Wilson uses a "breadboard" circuit, studying the electrical properties of a carrier system

"My first assignment at Bell Labs"

Fresh out of school, Bob Wilson, '53, was put to work on a Transistor project at Bell Laboratories. He explains why he never had time to be awed.

(*Reading time:* 39 seconds)

"In some ways it was hard to believe. I had received my B.E.E. at the University of Delaware in June, 1953, and a week later I was working in the world-famous Bell Laboratories.

"But I didn't have time to be awed because they put me right to work. They gave me responsibility fast.

"My group was working on the experimental application of transistors to carrier systems. My assignment was the electrical design of a variolosser for the compressor and for the expandor to be located in the terminals.

"The supervision I received and the equipment I had were tops. I quickly discovered that I had to rely on my ingenuity as much as on the college courses I had taken. Perhaps that's one reason for the great new discoveries continually turned out by the Labs.

"Now I'm in the Communication Development Training Program, continuing my technical education and learning what all the Laboratories sections do and how their work is integrated.

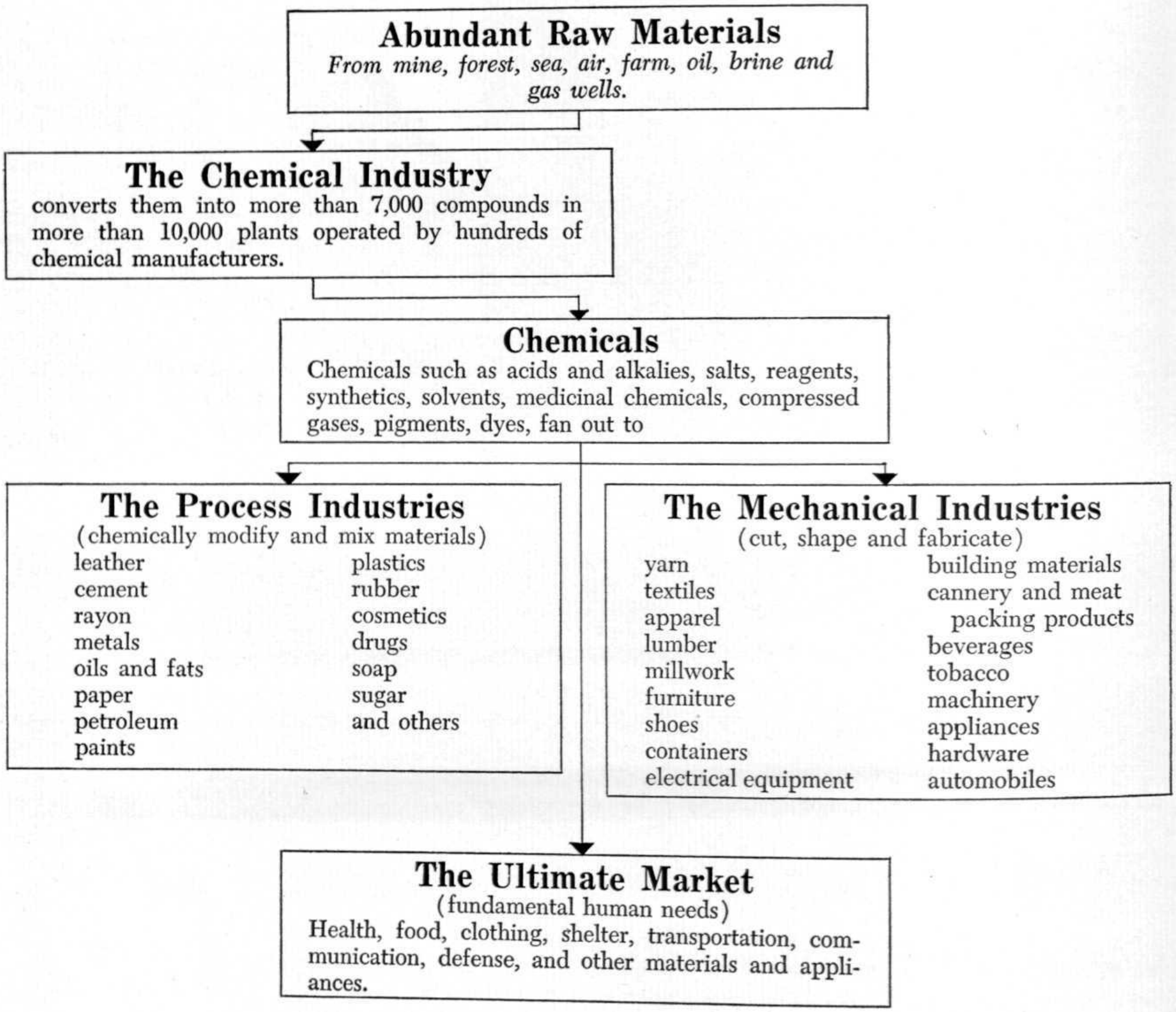
"In a year I'll be back working with the group with which I started."

. . .

Assuming responsibility fast is a common experience among the engineering, physical science, arts and social science, and business administration graduates who join the Bell System. Bob Wilson went with Bell Laboratories. There also are job opportunities with the operating telephone companies, Western Electric and Sandia Corporation.

BELL TELEPHONE SYSTEM

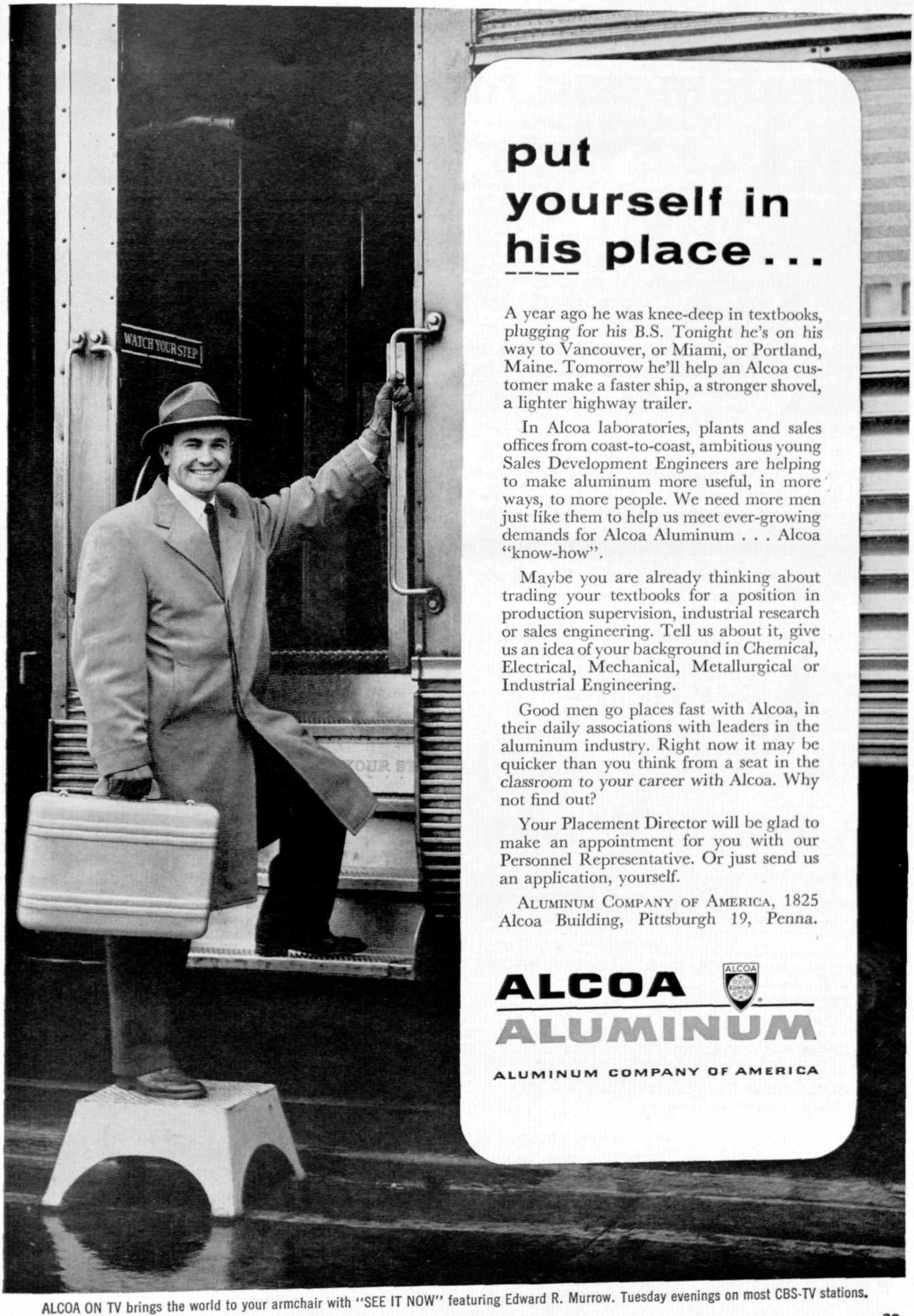
KEY POSITION OF THE CHEMICAL INDUSTRY



Heavy chemicals are the big tonnage, workhorses of industry, which are basic materials and are sold at large volumes and low-unit profit, but the demand is relatively stable. Other groupings are based on the source of the chemical, giving us wood chemicals, coal chemicals, petrochemicals, and electrochemicals. The end-use of the chemicals give us such classifications as photographic chemicals, rubber chemicals, agricultural chemicals, etc.

The accomplishments of this industry are phenomenal. It is responsible for the creation of a multitude of new products, which in turn create new jobs and industries. It was estimated that forty percent of the 1951 sales were in products unheard of in 1936. This is less surprising when one considers that research turns out ten thousand new chemicals yearly, with some companies introducing ten to thirty new products annually. The prices on these products are kept low through keen competition and extensive research. These same factors also contribute to the improvement of products in regular use. Many examples are available, but a suitable one is the fact that present engine oils stand up under high temperatures and remain free flowing at sub-zero temperatures due to chemical additives. These products also replace materials made from scarce natural materials with material made by transforming plentiful raw materials into synthetics. Many times these synthetics have desirable properties not found in the natural materials and ultimately are applied to new uses. In 1921, aluminum and plastics accounted for twenty percent of the non-ferrous metals and plastics produced. In 1949, seventy percent of the total volume was made up of aluminum, magnesium and plastics, thus conserving scarce metals. Magnesium was added to the light metals and plastics in the mid-'30's. There are cases where the raw material used to replace the scarce raw material was not only abundant but previously unused. 1,100 tons of titanium, which

(Continued on page 35)



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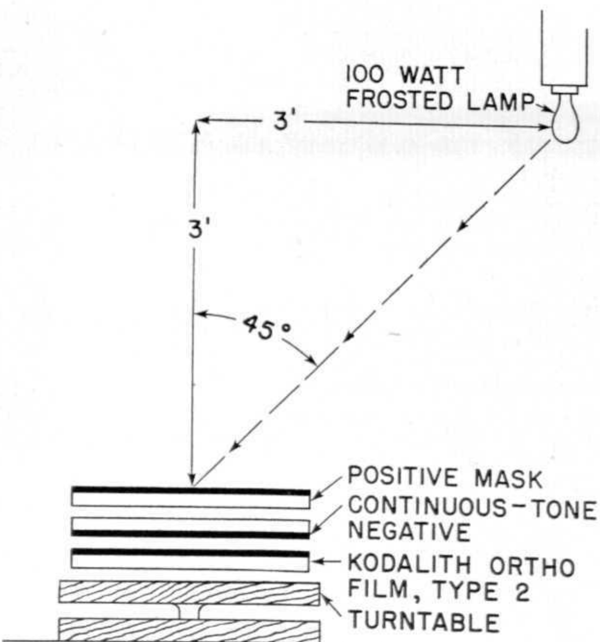
Microfilm and the engineer

by Ray Steinbach, Geology '55

Every engineer may be required at some time to make copies of his work, if only for his own records, to say nothing of the many other possible uses for such material. Thus, it would seem that it would be advisable for an engineer to be able to make reproductions of his work, such as written reports, plans, photographs, drawings, etc.

At the present time the most versatile method of reproduction of such material is photography. In most cases, photography will provide a maximum of results with a minimum expenditure of time and money.

Nearly everything imaginable can be photographed, including such things as sound and shock waves, and objects illuminated by infra-red or ultra-violet light. X-rays can be photographed, rapid motion may be stopped, and pictures can be made in places in which a person could not get, or could not survive once he got there. This would include extremely hot and cold places as well as very small or radioactive places.



Method of exposing film to produce line effects with the Kodak Tone-Line Process utilizing the turntable method of exposure.

With proper use and a little initiative, photography can be a very valuable tool for producing permanent records of anything desired.

One of the simplest methods for producing copies of material for permanent records is microfilm. This has the advantages of speed, ease of operation, and little storage space is needed to contain a vast amount of material of all types. Anything that can be put on paper can be microfilmed and many small, three-dimensional objects can be photographed directly on microfilm. This includes pictures, drawings, blueprints, and even pencil work in addition to printed matter. The material is copied on a special film known as microfile film, which is the same size as standard 35 mm film. When it is needed again, the film may be projected or prints may be made for longer periods of reference.

A photograph as reproduced by the Kodak Tone-Line Process.

The equipment needed for microfilm work is comparatively simple and even a large setup for constant use requires only a space a few feet square.

With a microfilm system set up for constant use, two operators would be necessary; one to do the filming and one to do the processing and reproduction work. If the volume of work done is not that large, one person would be sufficient to do it.

Since the printing press is an extremely common method for reproducing material, it would be well to consider how it compares with photographic reproduction. The printing press is easier to use when large quantities of material are required. However, for small amounts of material, photographic reproduction is the best and, also, it is considerably cheaper. The space required for a photographic reproduction and photo records-setup is much less than would be required for a printing press setup capable of handling the same volume and variety.

Another useful technique is converting a continuous tone image into a line image. This makes many

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Mackinaw Pipeline

(Continued from page 26)

tion. It was merely a large clamp which was put on the pipe and secured to two concrete foundations by means of cables and turnbuckles.

When welding the 2500 ft. sections of pipe together, eight passes of weld were put on, leaving a small hole at the top. Then the weld was wrapped with sensitized paper and a small piece of radioactive cobalt was lowered in through the hole. As soon as the x-ray picture was complete, the cobalt was removed and the hole welded shut. It took about three hours for each weld – that is, three hours from the time stopped moving until it started moving again.

While the pipe was being welded on the north shore, the crew at the pulling engine was busy clearing the drums for the next pull. These two jobs could be done simultaneously because of the fact that both the cable and the pipe were in 2500 ft. sections.

Two side-boom tractors were used for moving the pipes onto the rollers. Hanging from the boom of each tractor was a small cradle equipped with rollers for the pipe to rest on. Once the cradles were under the pipe, the tractors could drive right down the line, lifting and moving the pipe as they went.

The floats weren's put on the pipe until after the pipe was up on the rollers. Then, after the floats were attached, they were inspected several times and closely guarded, so that they wouldn't be tampered with.

A small scow was attached, by a cable, to the head of the pipe. Each time the pipe stopped moving to weld on another section, a diver was sent down from the scow to check the head of the pipe, providing the water wasn't too deep for diving. At the same time, other divers were sent down at other points along the pipe.

The *maximum tension on the pulling cable*, as measured at the pulling engine, was 75 tons. The minimum tension was 25 tons. The maximum occurred at the beginning of the operation, when the engine was pulling nearly four miles of cable and very little pipe. The minimum occurred in the final minutes, when the engine was pulling four miles of pipe.

A small cable was run along the top of the pipe. When the 2500 ft. sections of pipe were joined, this cable was also joined. After the pipe was all the way across, this cable was pulled from the north shore. At each float there was a mechanism attached to this cable which released the small floats. All the small floats came to the surface simultaneously, each carrying up with it one end of its rope. Then the large floats were released individually by pulling on the ropes, which caused the severing of the steel bands holding the floats to the pipe.

The next order of business was to subject the pipe to a hydrostatic test for leaks. A long four-inch pipe was welded up and shoved inside the twenty-inch pipe, until the end of the four-inch pipe was at the lowest point in the twenty-inch pipe. Water was pumped in through the small pipe, filling the large

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Leisure

(Continued from page 16)

tions and symbols; and the teachers can further eliminate the non-essentials in their assignments, and teach their own subjects as part of the whole engineering education and that the division of engineering into different branches is artificial and arbitrary.

Everybody realizes that four years is insufficient time to produce a proficient engineer. In fact, it is even insufficient time to acquire an adequate introduction to engineering. The major part of a person's education comes after graduation through self study. If during his years in college he acquires a distaste in engineering, then all is lost. Many a practicing engineer boasts that he never has had an occasion to use calculus in industrial problems. More likely, he has never liked the subject or fully understood what he was taught. He makes long detours around calculus looking for tools to solve his problems. Hence, here is another point in favor of less work and more leisure. What is to prevent leisure from degenerating into mere idleness? Only the right academic atmosphere will prevent the abuse of leisure. Membership in a community of scholars where scientific investigation is the style is the best way to cultivate a creative engineer. If over cups of coffee, enriched by pipe smoke, we are as hepped up about the chance of the engineers building a space platform as we are about the chance of winning the football championship, we are getting somewhere.

Yet the major responsibility to streamline engineering education and to find leisure rests on the individual. After all, engineering education is less a program than a state of mind, and leisure is where one finds it.

Perhaps no single factor is as detrimental to a leisurely, orderly engineering education as the holding of a part-time job. Even economy-wise the holding of a part-time job and going to engineering school at the same time often turns out to be penny wise and pound foolish in the long run. Not every chief engineer had a paper route in his youthful days, and that working through college ensures success is more myth than fact. A part-time job should be considered only as an emergency measure.

Lastly leisure can take the form of some spare-time task or occupation that makes some call on one's intelligence and gives one pleasure. As to making the choice it is everyone for himself. We quote here Izaak Walton:

"As inward love breeds outward talk,
The hounds some praise, and some the hawk:
Some, better pleased with private sport,
Use tennis, some a mistress court:
But these delights I neither wish,
Nor envy, while I freely fish."
"Of recreation there is none
So free as Fishing is alone;
All other pastimes do no less
Than mind and body both possess:
My hand alone my work can do
So I can fish and study too."

High temperature service

(Continued from page 23)

tion; nickel, which is indispensible for hardening of large pieces by heat treatment; and vanadium, which increases tensile strength at high temperatures. As was mentioned above, austenitic steels are more resistant to creep than ferritic steels. The nickel base alloys which are in use at present, contain 70-80% Ni. Inconel is one alloy which is tailored for high temperature as it has excellent oxidation and corrosion resistance at temperatures up to 2100° F. Inconel and variations, Inconel X and W, have good machining, forming and welding properties. Another alloy in use is Hastelloy C. It contains 70-80% Ni plus Cr and Mo. Hastelly C shows successful performance under high stresses and thermal shock. It can be machined, formed and welded satisfactorily. Another alloy which is used is Nimonic 95, essentially 60% Ni, 20% Cr and 20% Co. Nimonic 95, which was recently put in use, is similar to Nimonic 90 but its short time creep resistance has been increased by increasing the content of precipitation hardeners like Ti and Al. Another alloy is Nimonic clad sheet, Nimoply 75, a metal sandwich of copper between sheets of Nimonic 75. This sheet has many potential uses in the field of high temperature engineering.

The cobalt base alloys are dubbed the super alloys because of the generous amounts of hard to get materials such as W, Co, Ni, and Cr which they contain. Because these alloys are expensive, they are used only in critical applications where their exceptional properties outweigh other factors. Haynes Stellite No. 25, which has excellent strength and resistance to oxidation at high temperatures, is a good example of cobalt base alloys. This alloy has good ductility and can be worked hot and cold. It is hardly to be expected that the maximum temperature of service can be raised for metallic alloys. Minor improvements may be looked for if optimum equilibrium can be found in the Fe- Co- Ni alloy and hardening additions. One fabrication process should be mentioned which shows promise: the technique of powder metallurgy. Powder metallurgy allows us to use metals of highest melting point which can hardly be alloyed otherwise.

In order to further increase the operating temperature and efficiencies of jets and other engines, materials even more refractory mechanically and chemically than metallic alloys must be investigated. Work has been centered on ceramic products, which compared to alloys, have the advantage of not being subject to oxidation and being generally very stable chemically, even after prolonged exposure at high temperature (1800° F.). They are of low density and maintain static tensile strength at high temperatures. The disadvantage of ceramics usually cited are their fragility when cold and poor resistance to thermal shock. An example of a ceramic material is the silico-aluminate of lithium, which is resistant to thermal shock.

Materials which cannot properly be called ceramics but which have the same advantages are the metallic carbides and borides. The nitrides and silicides are also worthy of interest, but have been less studied. The titanium carbide base cermets are being considered for jet engine application. Some of the properties of cermets are high thermal conductivity, high strength, resistance to oxidation at high temperatures, good thermal shock resistance and poor impact resistance. The thermal shock resistance is attributed to low thermal expansion, high thermal conductivity and the fact that no structural transformations occur until the melting point is reached.

Ceramic products can also be used as protectors against oxidation for metals, or materials with high tensile strength at elevated temperatures but subject to oxidation. For example, coatings for parts made of unalloyed tungsten or molybdenum. Various processes have been tried. Two will be mentioned particularly. The first consists of covering the parts with borides or refractory silicides formed by direct reaction of an appropriate gas with the metal to be protected. The second method is to cover the part with an appropriate alloy which is then oxidized to a tight ceramic coating.

Borides and nitrides offer immediate possibilities but the disilicides offer the biggest future because of their good oxidation resistance and high strength. This is apparently due to the fact that silicon forms a series of oxides and dioxides with the refractory metals which resist further oxidation. Also the crystal structure aspects give these materials an inherent ability to resist further oxidation, and this structure is also a contributing factor to the strength of the material. Many of the recent developments in the high temperature field are still shrouded with secrecy, but it is known that experiments and creep rupture studies are in progress with molybdenum, Cast Stellite-21, Nimonic 90, molybdenum disilicide and borolite.

The future of gas turbines, jet engines and other high temperature equipment depends now on the development of "alloys" which are non metallic or semi metallic in nature.

Microfilm

(Continued from page 30)

things much easier to reproduce and, in some cases, makes pictures much easier to understand.

The tone to line process, in operation, combines a negative with a positive of nearly equal contrast. The positive is used as a mask for the negative to produce the line effect.

The positive and the negative are taped together in register and placed on a sheet of lithographic film. The exposure is then made by rapidly spinning the printing frame with the negative, positive and film in it, underneath a fixed light, or by rotating a movable light above a stationary frame. This lets some of the light work its way around the edges of the mask and negative, and produce a line image on the film.

The film is then processed in the same manner as any other film would be.

This process allows one to produce line pictures from a variety of subjects easily and rapidly. Figure 2 is an example of what an ordinary photograph looks like after converting from tone to line.

Successful Executive

(Continued from page 17)

immediate as well as lasting value are exposition, argumentation, and public speaking. Indeed, many engineers finding themselves handicapped in practice by lack of training in these subjects have had to acquire the training by attending evening classes.

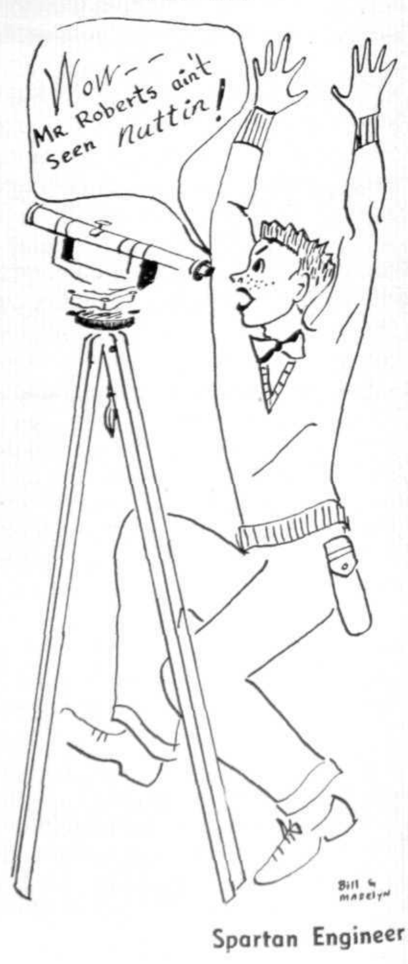
The biggest curricula weakness which each present day engineering student shooting toward an executive must remedy for himself in view of the fact that engineering schools do not provide adequate courses is leadership development. Today's courses do very little to develop and encourage this important characteristic. The future executive is going to have to develop that all important leadership knack by himself – that means extra, besides school studies. How can one accomplish this? It is not very difficult once the knack of planning time effectively is attained. Few managers are born. Fewer still inherit the title. If you are the one in ten thousand with a natural for managing things, you're lucky. Look for opportunities to be a leader. Make an effort to serve in clubs, societies, all types of activities. When a job must be done, volunteer to do it, even though others may hesitate. Make suggestions, then follow them up with action. The habit of leadership grows with practice.

Good scholarship is not intended to be, nor is it often interpreted, as an accurate gauge of probable success in the business world. It is possible and often happens that a man has developed personal qualities through contacts with others which go a long way in making him successful in the daily walk of life. While many an alumnus or employer will argue that campus activities are more important than grades, it would be far more accurate to state that they are of equal importance. They are an indicator of the physical, moral, and leadership factors for the record. Lack of an extra-curricular record can throw a student completely out of balance in the eyes of employers unless there are extenuating circumstances. The great value of extra-curricular activities is the opportunity to acquire maturity through the many responsibilities and testing of capacity and talent you encounter. Employers examine carefully your extra-curricular record to determine whether you have shown evidence of leadership ability. There is more, by the way, to campus activities than simply the fact that you were in them; it is the quality of the participation that counts.

A study by D. S. Bridgman of the American Telephone and Telegraph Company points some light on which means more to a future executive, superior scholarship or participation in campus activities. Mediocre or little achievement in campus activities was found to have little, if any, effect on success. Campus achievements in the nature of leadership and managerial work has considerable influence on professional success. However, he also showed that there is a direct relationship between scholarship record and professional success. Probably the best

(Continued on page 42)

MELVIN



New Basic Industry

(Continued from page 28)

evolved from a laboratory curiosity in 1944 to a material highly suitable for aircraft and marine parts, were used in 1952. The ultimate conclusion one draws is that chemicals have worked their way into almost all industries and have been integrated to such an extent that they are invaluable to these industries and their effects are felt directly and indirectly by all consumers.

To say that the outlook for future progress looks bright would be an understatement. Though it is the backbone of industry now, some forecasts predict a 75% increase in the next decade, which would probably be four or five times faster than the growth of other industries. A 400% increase is looked for by 1975. Chemistry is expected to attack the problem of health and also to increase food production through fertilization and protection of plants from pests and weeds. Also, it will play an increasing role in clothing and textile materials. Expansion can be seen in all directions. The industry will be justly expected to meet the challenge of serving the needs of industry and the consumer, through the use of cheap and abundant raw materials.

There are distinctive characteristics of this industry; a few of interest will now be noted. The field is extremely broad, which would be expected from the 7,000 different end-chemicals currently made. The capital investment per worker is very high, and intense, widespread competition is also characteristic. Competition is on every level: between products for similar markets, between processes, between raw materials, and the usual competition between companies. A high rate of equipment obsolescence and a rapid new product growth are also prevalent. Many raw materials are used for a multitude of various processes. Coal, petroleum, and agricultural products are the important ones. Though it buys and sells to many persons and industries, the industry itself is its own best customer. Because of its high productivity per worker, its labor force is less than comparable industries, but it still retains the status of a major employer. Moreover, the continual flow of new products add cumulatively to the employment. Because of its highly technical nature, much of its personnel is scientific trained. The industry also leads in expenditures for research, with even small companies participating. Both basic or fundamental research, and applied research are practiced. Basic research is the search for unknown facts, where applied research has a practical objective behind the investigation. As one might suspect, there are huge capital requirements in the industry, but returns to shareholders are not as attractive as one might think, due to the need for large retainment of earnings for reinvestment. Truly, it has the earmarks of the type of industry we encourage here in America, for we cater to competitive industries with high productivity obtained through the application of scientific skills.

A major portion of the industry is devoted to serving other industries, and the benefits that trickle down

(Continued on page 42)

The big brake

by Leonard Efron, C. E. '57

Man has put the wheel to work for him in various manners and devices. However, centuries elapsed between the invention of the wheels and the complementary invention of an "adequate and reliable" brake for controlling its motion.

The building of faster and heavier trains was accompanied by the invention of new brakes. By 1870, over 600 patents had been granted, in the United States and England, for various forms of brakes for railroad vehicles.

Nearly all trains used manual brake systems. Each car had to be braked individually. At the sound of the engineer's "down brakes" whistle the brakemen, carrying pick handles, ran across freight car tops or through passenger coaches. At one end of each car they turned a horizontal handwheel that tightened a chain under the car which forced the brake shoes against the wheels. If the train was going to stop short of the station, the engineer opened the throttle. If the train was going to overshoot its mark, the engineer "plugged" the engine by throwing it into reverse.

New methods were tried until one day in 1866, between Schenectady and Troy, New York, two freight trains crashed into each other on a level, straight stretch of track. Because of the accident, a Troy bound passenger train came to an unscheduled stop. One of the passengers on that train was George Westinghouse.

Talking with the brakeman from one of the trains involved in the wreck, he learned that the engineers had seen each other and had tried to stop, but there wasnt enough time. On being asked if the brakes had taken hold, the brakeman answered, "Oh, yes, the brakes worked fine. We clamped them on the moment we saw what was ahead of us. But there just wasn't enough time to stop before the crash. You know, sir, you can't stop a heavy freight train in a moment!"

Upon arriving home, George Westinghouse set to work to design a new automatic railroad brake. In the course of his work he considered buffer and chain operated brakes, and a steam pipe to cylinders under each car. He also considered the use of electricity as a power source, but gave all these schemes up as "impractical or inadequate."

In 1869, while at work in his Schenectady shop, he bought a two dollar magazine subscription to *The Living Age.* His first copy of the magazine contained an article titled, "In the Mont Cenis Tunnel." In it was described the construction of the Mont Cenis Tunnel through the Alps in Italy. A 3,000 foot pipe line had been built and through it was being pumped compressed air to power the rock drills within the tunnel. Three thousand feet being longer than any train of the day, he began studying the possibilities of using compressed air to operate railroad brakes. Finally on April 13, 1869, he received patent number 5504 for the first air brake.

The superintendent of the Panhandle division of the Pennsylvania Railroad made available a train for the purpose of testing the new air brake. The Steubenville test train, consisting of a locomotive, tender and three cars, was equipped with air brakes. The trial was to be made on the tracks between Pittsburgh, Pennsylvania and Steubenville, Ohio.

The train left the Panhandle Station in Pittsburgh, and headed across town to the bridge over the Monongahela River. Precautions were supposedly taken to keep pedestrians from using the two surface crossings between the station and the river. Running at thirty miles per hour, the train emerged from Grant's Hill Tunnel and rounded a curve. Coming out of the curve the second crossing came into view.

At that moment a huckster was driving his loaded cart over the crossing. The driver applied his whip to the horses, causing them to rear, and was thrown onto the tracks. The engineer reached for the brake handle and pulled. The brakes took hold and when the train came to a halt there was four feet of space between the locomotive cow-catcher and the huckster. For the first time in railroad history, a train traveling at thirty miles per hour had been brought to an emergency holt in less than two hundred feet. Within a few months the Westinghouse Air Brake Company was formed and the commercial production of air brakes began.

The operation of the air brake depended entirely on compressed air and a movable piston. A pump on the locomotive compressed air to seventy pounds per square inch in a tank. The tank was connected to a pipe line beneath each car and connected between cars with a hose coupling. To stop the train the engineer opened a valve that sent compressed air through the pipe line. The air pushed against the movable piston in the brake cylinder under each car. As the piston moved it caused the brake shoes to press against the wheels.

Westinghouse claimed that trains of any length could be controlled by mechanical methods alone. He did further work on pneumatic control and invented the triple valve. The triple valve provided a relay action which distributed control through all cars of the train.

(Continued on page 38)

Mackinaw Pipeline

(Continued from page 31)

pipe from the bottom up. Then the small pipe was withdrawn and both ends of the large pipe were sealed. If the water had been pumped directly into the large pipe at too high a rate, the mass of water rushing down into the gorge would have been sufficient to buckle or break the pipe.

Next, a pressure of 1200 psi. was applied and held for ten hours. The water was left in the pipe, to be forced out by the oil when the pipe went into use.

The east pipe was launched in the same fashion.

After both pipes were across, a pumping station was put on each side of the straits, and the crude oil now leaves the north shore at a pressure of 400 psi.

Now that the pipes have been laid successfully, the only real risk remaining is the chance that some ship might hook one of them with an anchor. If this should happen, the escaping oil could easily cause water-front damage which would run into millions of dollars. Fortunately, this is an extremely remote possibility because directly between the two pipes is the telephone cable, which has been there for a good many years. Thanks to the telephone cable, the area has an established reputation as being a poor place to drop anchor.

The Big Brake

(Continued from page 36)

He purchased a fifty-car train and had the locomotive and cars fitted with air brakes and triple valves, all at his own expense. The train, running on the level at twenty miles an hour, stopped in ninety-eight feet without upsetting a glass of water in the fiftieth car.

The triple valve also enabled the train to stop even if the air lines broke, because each car carried its own tank into which air was compressed while the train was in motion. It also stopped any runaway cars or both halves of a train in case it broke in two.

For the first time the railroads considered their brake systems "automatic." Westinghouse had substituted an automatic power brake, under the direct control of the engineer, for the hand brake, requiring the assistance of the train crew who acted on signal from the engineer.

Until this time both freight and passenger trains were controlled by the same type of brake systems. The function of the early systems had been to stop a train in the shortest possible distance without damage. Now the railroads began developing refinements which added comfort and convenience to passengers and economy to railway operations.

The first exclusively passenger brake was designated: Type P-Triple Valve. It has a high speed reducing valve which provided a braking force some-

(Continued on page 40)

The Big Brake

(Continued from page 38)

what proportional to the speed of the train.

With all these subsequent improvements not one of the original functions of the triple valve had been discarded. Instead, they had been extended and new functions added.

Further refinements in the air brake were made by Westinghouse when the Interborough Rapid Transit Company was compelled, by the increase of traffic, to lengthen its trains in the New York subways. The trains also had to be operated at closer intervals.

The factors of the problem were that the trains, the full length of which were just the length of the station platforms, were operated at one and a half minute intervals and their weight when loaded with passengers increased almost fifty percent.

Westinghouse's solution was a mechanism which automatically weighed the cars and adjusted the braking force so that the stopping distance was the same regardless of the load. Trip cocks were attached to the trucks of each car which engaged a wayside signal arm bringing the train to a rest if the motorman failed to act at the proper point, either because of negligence or incapacity.

Through developments such as those mentioned train lengths have increased from ten, at the time the first air brakes were installed, to over one hundred and fifty cars. In 1870 a freight train of twenty-five cars weighed 1,100 tons while today's trains of 150 cars weigh 11,000 tons and sometimes exceed 17,000 tons. The 11,000 ton train running at sixty miles an hour will have a kinetic energy forty times that of the 1,100 ton train running at thirty miles an hour. This means a forty-fold increase in the amount of work to be done in propelling and stopping the train. In passenger trains attaining a speed of 100 or even 120 miles an hour, the relative increase in kinetic energy is greater. The horsepower attained by the first air braked trains in stopping was 4,000. On present day trains 80,000 horsepower is reached. This is ten to twenty times the horsepower generated by the locomotive in starting.

Since the first application of the air brake to railway transportation all improvements in the apparatus have been designed with the same purpose in mind: to make possible longer trains, moving with heavier loads at higher speeds, and to do this with ever-increasing safety and economy. But, these changes have not ceased. It has been applied to motor vehicles, machinery and ships. In these other fields it has also undergone and brought about changes and growth.

This judgment may be supported by the fact that the Smithsonian Institute considers the invention significant enough to honor it with a permanent exhibit along with the first electric light, the first automobile, and the first airplane.

New Basic Industry

(Continued from page 35)

to the final consumer are difficult to associate with the industry, although untold benefits surround us. We can also cite chemicals in everyday life, the benefits of which we readily appreciate. One of the more obvious categories is chemicals in health. Here they serve as curative measures against nutritional deficiency, infectious diseases, the degenerative diseases. Twenty-five years ago authorities felt much was being accomplished if one major discovery resulted from 25 years of drug research. Today one is expected every six months. Mortality rates of all kinds have been cut, with a good share of the credit going to chemistry. Sanitation has been much improved through the help of chemistry, thus decreasing infectious diseases. Antibiotics are a further deterrent to these diseases. Vitamins have also proved their worth. Beriberi was a major cause of death in Bataan, where the native Filipinos ate white rice that lacked nutritional bran. In 1948 synthetic vitamins were added in one region. A decrease in deaths due to beriberi of 67.3% resulted. Hormones are also coming into use and the latest advancement promises to apply radioisotopes, by-products of the development of atomic energy, as medicine. The constructive importance of atomic energy is hoped to overshadow the destructive potential. Chemicals play an important role also in food conservation. Proper nutrients for growth are supplied by fertilizers, hostile factors are resisted, and post harvest preservation is a contribution. Many successful farmers have learned, and more learn yearly, that chemicals are his most potent helper. Calcium and sodium propionates are now used which retard bread molding for about a week.

Successful Executive

(Continued from page 34)

solution is to strike a happy medium keeping in mind that it is better to appear a man than a genius.

Get into a few of the most appealing organizations. Every college campus has numerous engineering clubs, societies, honoraries, and fraternities. Learn how to properly organize and direct men and develop your resourcefulness, self-confidence, imagination, quickness of action, and general alertness. Remember the words of Cassius, in Shakespeare's *Julius Ceasar,* who said:

> *Men at some time are masters of their fate:*
> *The fault, dear Brutus, is not in our stars,*
> *But in ourselves, that we are underlings.*

Learn how to be a leader by being a leader. In spite of the fact that the present day college engineering curricula does not provide engineering students with the necessary tools for executive development, the student can achieve a sufficient background by supplementing his curriculum with active participation in campus organizations.

Scel not Skol

(Continued from page 19)

just such a radio and by working day and night in conjunction with civilian manufacturers, the requirement was met promptly.

Military requirements differ from civilian requirements in that military equipment has to be rugged, compact, light, portable and extremely reliable, yet simple to operate. It is a challenge to creative thinking to meet these specifications. The current watchword at SCEL is "Miniaturization, Ruggedization and Reliability." An example of this "new look" in equipment is the new lightweight (22 pounds) switchboard which is about the size of a portable typewriter which replaces the old 72 pound WW II board. The weight of a WW II four channel-carrier telephone terminal has been reduced from 550 lbs. to 177 lbs. Both the weight and size of the post-WW II Walkie-Talkie have been cut exactly in half while the range increased from three to five miles. Four pounds have been knocked off the weight of the field telephone while its range was increased 30%. To a soldier nearly dropping with fatigue a few pounds makes a lot of difference, so these improvements have met with the unqualified approval of those who use the equipment. Two new developments just coming into use are really helping the process of miniaturization and ruggedization. First is the transistor, the other in typical military phraseology is "Auto-sembly System of Circuit Fabrication for Subminiature Electronic Equipment." The transistor performs the same function as vacuum tubes in radio, TV, radar and other electronic equipment. It is not perfected yet, nor has it replaced vacuum tubes yet, but it is a big step toward smaller, more rugged elements. The "Auto-Sembly System" without going into great detail is simply a printed circuit process, whereby, instead of actual wiring of an electronic circuit, the circuit is etched into the chassis, the etched lines filled with solder and the wiring part of the circuit is complete. These printed circuits and the transistor will probably be the basis for the "Dick Tracy Radio."

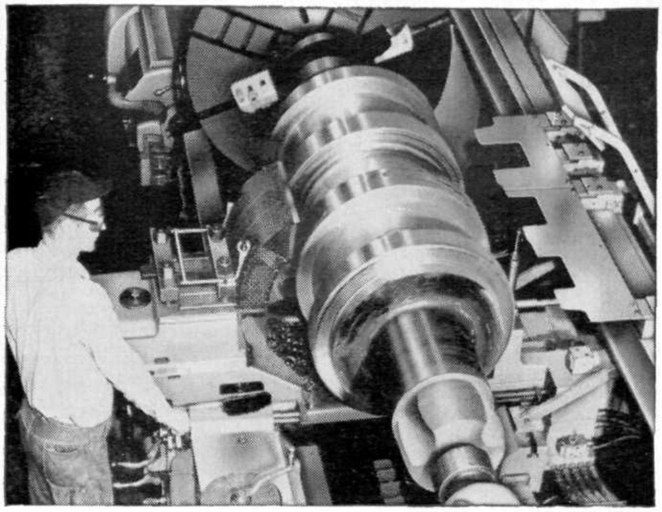
Another device developed by SCEL in cooperation with the Ordnance Corps is a robot weasel, a vehicle capable of running over rough terrain and marsh tundra, controlled by remote radio and equipped to transmit TV pictures to the controller. This device has been used in the Nevada Atom Bomb tests. From this brief description, it's not too hard to foresee robot controlled, TV equipped tanks moving against the enemy while similarly equipped planes give the commanders a running picture of the entire battle area.

One last example of the work done by SCEL engineers was "Operation Diana." In January of 1946 it was announced that the SCEL scientist had made contact with the moon using high-frequency radar beams. What actually happened was a powerful fixed beam was transmitted to the moon some 240,000 miles away and some 2½ seconds later a pip was reflected back from the moon. As a point of interest, recently the National Bureau of Standards in collaboration with Collins Radio Company staged a successful variation of this by sending a radio message from a transmitter in Cedar Rapids, Iowa, and picking it up on a bounce from the moon with a receiver in Washington, D.C. The message, incidentally, was the same one Samuel Morse flashed over his new Washington-Baltimore telegraph line in 1844: "What hath God wrought" The SCEL scientists are presently engaged in new moon experiments aimed at tracking the moon as it moves and finding out what happens to radio waves that pass through the outer periphery of the earth's atmosphere.

SCEL is interested in having newly graduated Mathematic and Physics majors as well as electrical and mechanical engineers work in the labs. There are good prospects for a career in the labs including an opportunity to get a master's degree while working there. There are openings for the above mentioned groups under the civil service plan in grads from GS-5 at $3410 pr year up to GS-12 at $7040 per year. The requirements for GS-5, the starting grade for Junior Scientist and Engineers, are either a B.S. degree from an accredited college or university, or a combination of education and experience comparable to a four year college course, or four years actual experience that would be comparable to the college course To qualify as a GS-7 at $4205, it is necessary to qualify as a GS-5 and have either a master's degree or months' professional experience in the appropriate field. Incidentally, there is a program set up whereby graduate engineers can continue their education while working at the labs. Rutgers University established a branch of its Graduate School at SCEL where those qualified engineers and scientists who can meet the requirements may be admitted to the Rutgers Graduate School in a full graduate status while working at the labs. Subjects included in this program are Advanced Electric Transients, Electric Waves and Radiation, Electrical Network Theory, Advanced Electronics, Ordinary or Partial Differential Equations, Vector or Higher Analysis, Advanced Calculus, Theory of Functions of a Complex Variable and thesis or Advanced Electrical Engineering Theory and Electrical Engineering Seminar.

All in all, there is a bright future for SCEL and an unlimited demand for their products. The SCEL Engineers both Army and Civilian have an unlimited horizon before them. With the never-ceasing demand for better and more extensive communications systems and with the immediate prospect for space travel, the SCEL scientists have their work cut out for them. They have need of bright young scientists capable of creative thinking and doing. Without doubt, one of the most important groups aboard the first manned rocket ship will be the communicators. The day is probably not too far distant when instead of conveying a message by a series of grunts and gestures, a bright young man seated before a console mounted by a TV screen will flick a switch and transmit a message which might say, "LUNA FIRST CALLING EARTH CONTROL. FIRST PHASE OPERATION MOONSTRUCK COMPLETE. SPACE SHIP LUNA FIRST HAS JUST MADE FIRST SUCCESSFUL LANDING BY MAN ON MOON. EXPLORATION PARTY NOW PREPARING TO LAND. OVER."

Another page for **YOUR BEARING NOTEBOOK**

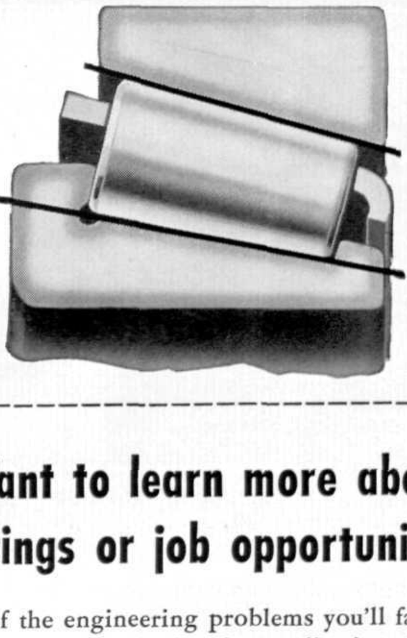


How to hold a heavily-loaded lathe spindle in accurate alignment

This big lathe machines rolls for steel mills. The roll is rotated by the lathe spindle and it must be machined to very accurate dimensions. So the lathe manufacturer, LeBlond Machine Tool Company, mounts the spindle on Timken® tapered roller bearings. Despite the great weight on the spindle, the Timken bearings hold it precisely in place—because they are made so accurately and have such high load capacity.

Why TIMKEN® bearings have high load capacity

This picture shows why Timken bearings have such high capacity—the load is carried on a *full line contact* between the rollers and races in the bearing. Note also the tapered construction. This permits the bearing to be tightened up (preloaded, we call it) to prevent chatter in rotating parts like the machine tool spindle above.

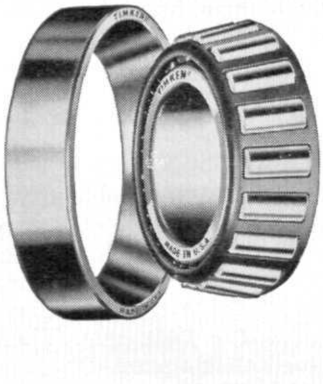


Want to learn more about bearings or job opportunities?

TIMKEN

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

TAPERED ROLLER BEARINGS



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

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

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Feature Column

Here's one that will keep you busy for a while:

A monkey is tied to one end of a rope. A weight is on the other end. If the monkey and the weight weigh the same, and if the rope weighs 2 oz. per foot of length, what is the length of the rope if the following information is known?

1. The monkey's weight equals the weight of his mother.
2. The monkey's age plus his mother's age equals 4 years.
3. The weight of the weight plus the weight of the rope equals half again as much as the difference between the weight of the weight, and the weight of the monkey added to the weight of the weight.
4. The mother's age is twice what the monkey's age was when the mother was half as old as the monkey will be when the monkey is three times as old as his mother was when the mother was three times as old as the monkey was.

What is the length of the rope?

* * * *

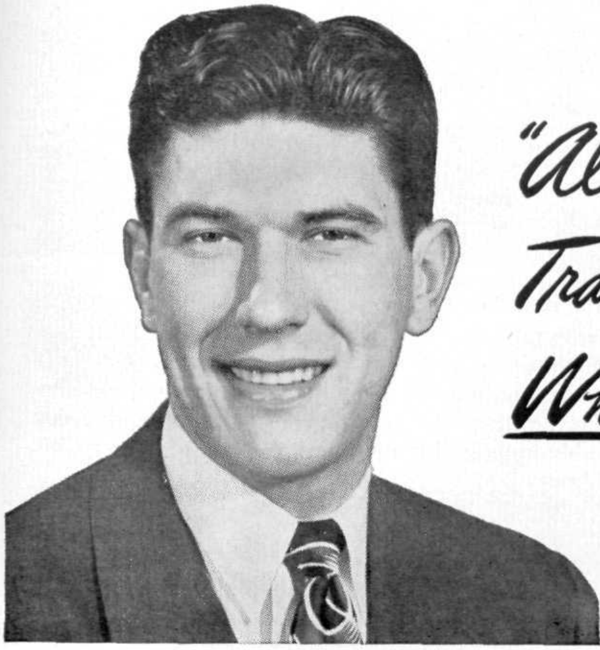
A few more pertinent quotations for engineering students:

1. There are a lot of men in this world who started at the bottom – and stayed there.
2. Even a turtle doesn't get anywhere unless he sticks his neck out.
3. The man who toots his own horn soon has everybody dodging when he approaches.
4. Failure is the only thing which can be achieved without effort.
5. Two thirds of *promotion* is *motion.*
6. The attitude toward the job is always as important as the aptitude.
7. There is no limit to what a good man can do, if he does not care who gets the credit.
8. No rule for success will work if you don't.
9. The reason a lot of people do not recognize an opportunity when they meet it is that it usually goes around wearing overalls and looking like hard work.
10. If you make your job important, it is quite likely to return the favor.

* * * *

Answers to Problems in the Last Issue

1. The rug problem:
   Cut a one-foot strip along the 9-ft. side and place it in the hole; then cut off the 1-ft. square which overlaps. Then cut another 1-ft. wide strip from the 9-ft. side and lay it along what was originally the 12-ft. side. Then fill up the corner with the 1-ft. square.
2. The fly problem:
   Each fly walks 10 inches.
3. The worm family:
   The baby worm hadn't learned to count right yet!
4. The balls in the box:
   1944 balls.



"Allis-Chalmers Graduate Training Course Was Just What I Needed,"

says LOWELL E. ACKMANN

University of Illinois—B.S., E.E.—1944
and now manager, Peoria, Ill., Branch Office

"MY EXPERIENCE with machinery in the Navy during the war convinced me I needed a training course. There was so much equipment on board that was a complete mystery to me that I became very 'training-course minded'.

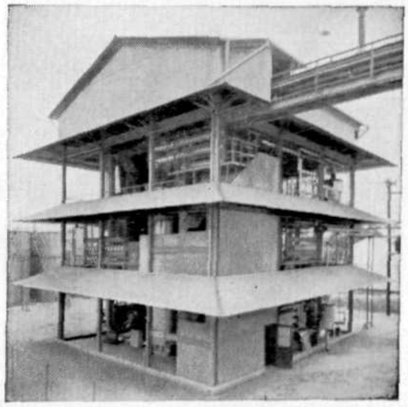
"After investigating many training courses, the one at Allis-Chalmers looked best to me then—and still does.

"In my opinion, the variety of equipment is what makes Allis-Chalmers such a good training spot.

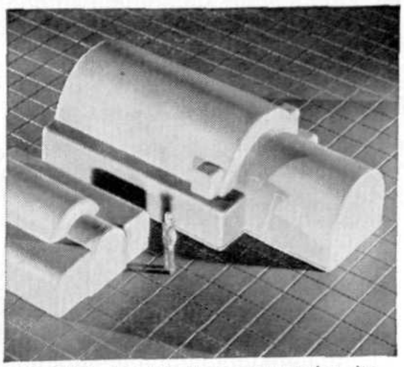
"No matter what industry you may be interested in, Allis-Chalmers makes important, specialized equipment for that industry. Electric power, steel, cement, paper, rock products, and flour milling industries—to name a few, are big users of A-C equipment.

"Before starting on the Allis-Chalmers Graduate Training Course, I thought I would like selling, preferably technical selling but, as is often the case, I didn't know for sure. This course, together with some personal guidance, helped me make up my mind. That, too, is an important advantage of the GTC program.

"But whether you want to be a salesman or designer, production engineer, or research engineer, Allis-Chalmers, with its wide variety of equipment and jobs, is an ideal place to get off to a good start—without wasting time."



PROCESSING—Allis-Chalmers built solvent extraction plant processes one hundred tons of rice bran per day at oil processing plant in Texas.



POWER—Models show comparative size of generators having the same rating with and without super-charged hydrogen cooling. Allis-Chalmers is first to supply super-charged hydrogen cooling.

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 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, Wisconsin.

ALLIS-CHALMERS A-C ALLIS-CHALMERS

C-5676

Sidetracked

They say that things are so dry in Arizona that even the trees are going to the dogs.

° ° °

A philosophizing friend remarks that a man never knows whether he likes bathing beauties until he's bathed one.

° ° °

Two bopsters, smoking reefers, were suddenly thrown into a panic by the wail of a police siren. Not knowing if their apartment was going to be raided, they threw their butts into the cuckoo clock.

Four hours passed before the cuckoo crawled out, looked around and said, "Man dig those crazy cigarettes. What time is it?"

° ° °

The day after finals, a disheveled Ch.E. walked into a psychiatrist's office, tore open a cigarette, and stuffed the tobacco up his nose.

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

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

° ° °

Student: "Have you any four volt, two watt bulbs."
Clerk: "For what?"
Student: "No, two."
Clerk: "Two what?"
Student: "That's right."

° ° °

Old maids are born, not made.

° ° °

I think that I shall never see
A girl refuse a meal that's free;
A girl with hungry eyes not fixed
Upon a drink that's being mixed;
A girl who doesn't like to wear
A lot of junk to match her hair;
But girls are loved by guys like me
'Cause I'll be damned if I'll kiss a tree.

° ° °

Soph E. E. walking out of calculus class: "I call my gal a discontinuous function because she has no limits."

° ° °

Believe it or not: Adam and Eve invented the loose-leaf system.

Girls are like newspapers: They all have forms, they always have the last word, back numbers are not in demand, they have great influence, you can't believe everything they say, they're thinner than they used to be, they get along by advertising, and every man should have his own and not try to borrow his neighbors.

° ° °

And then there was the rather forlorn engineer who, on seeing a pigeon flying overhead, exclaimed: "Go ahead, everyone else does!"

° ° °

The house guests were assembled with their hosts in the living room after dinner, chatting pleasantly, when the five-year-old daughter of the host appeared suddenly in the room, her clothes dripping with water. She could scarcely talk, so great was her emotion, and her parents rose in amazement as she entered.

"You—you," the little girl shouted, pointing to the male of the house guests. "You are the one who left the seat up."

° ° °

A freshman engineer is a young man who knows why a strapless gown is held up, but doesn't yet know how.

° ° °

Little Mary nailed the bathroom door shut and then laughed and laughed, because she knew her big brother and his college friends were having a beer party that night.

° ° °

Joke No. 495-36B.
We can't tell it here, so write in for it.

° ° °

Mistress: "You know, I suspect that my husband is having an affair with his stenographer."

Maid: "I don't believe it. You're only trying to make me jealous."

° ° °

A country couple married and arrived at the hotel about 9 P.M. The wife got undressed and set for bed while the groom sat in a chair with his hat and coat on. She asked him why he was not getting ready for bed.

He replied: "Paw said I'd be 'going to town' about 11 o'clock so there's no use getting undressed."

° ° °

The editor of this column points with pride to the clean, white spaces between the jokes.