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he Wisconsin

engineer

November, 1948

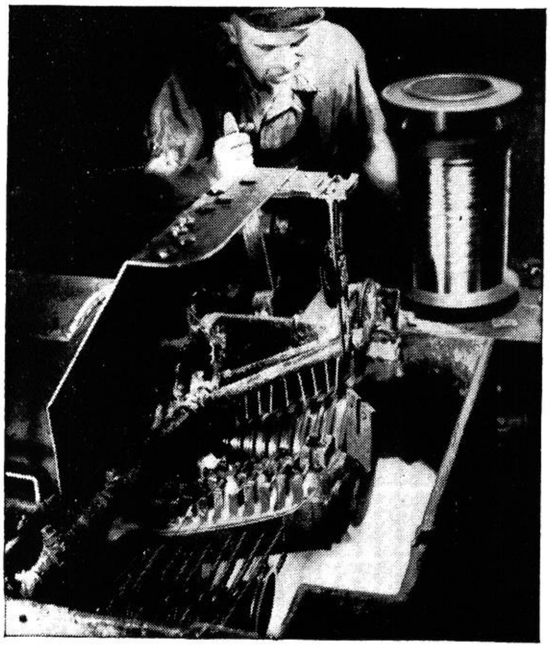
In This Issue:

15¢

SUPER TENSILE MUSIC WIRE PLATED WITH PURE GOLD...

developed by American Steel and Wire Company

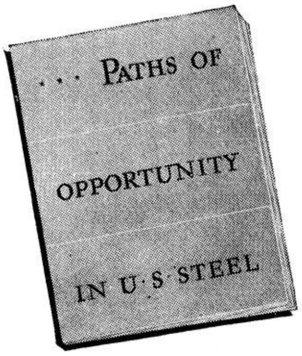
Tenor banjo and tenor guitar players have long been plagued by unsatisfactory "A" or first strings. This string, when properly tuned, is under such high strain that most wires barely reach pitch. At the request of the Mapes Piano String Company, the Metallurgical Department of the Worcester Works of the American Steel and Wire Company, a subsidiary of United States Steel, created, after months of research, a wire specifically for this purpose. This new wire is made so strong that it possesses more than twice the tensile strength, in pounds per square inch, of cross sectional area, of the steel wire which American Steel and Wire spun into cables to suspend the 8¼ mile bridge across San Francisco Bay from San Francisco to Oakland, California. This makes the new string the strongest wire of its size of any kind known today.



This high quality super tensile wire is produced by a special combination of heat treatments and exceptionally long and exacting cold working. The result is a wire of 0.010 gauge with a tensile strength of approximately 460,000 pounds per square inch. One pound of this wire extends 3749 feet, or sufficient footage to pass from nut to bridge on approximately 1500 banjos or guitars. This unusual wire is then plated with pure gold in order to prevent rust and to impart beautiful appearance.

Opportunities

This wire development is typical of the work being done in United States Steel Laboratories. But such research is only one kind of development to be found within the United States Steel industrial family. United States Steel and the steel industry are famous for development of men.



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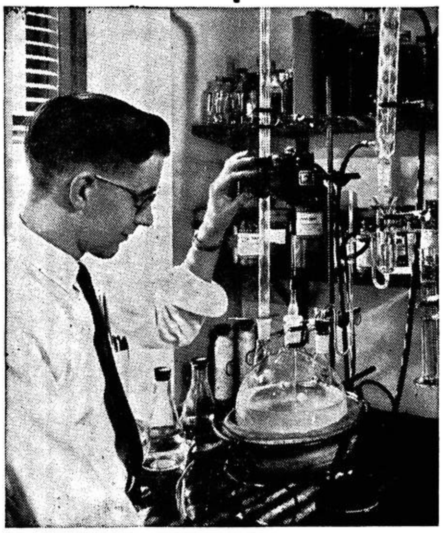
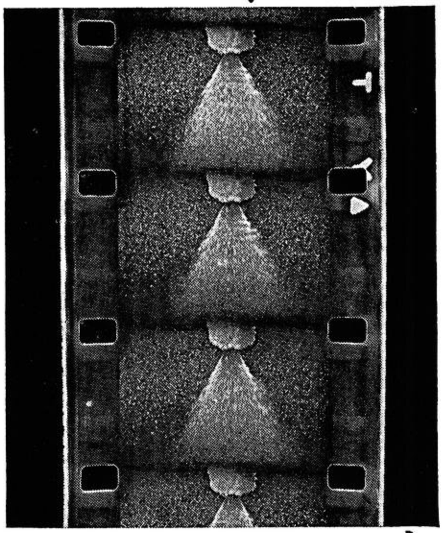
UNITED STATES STEEL

"Flow Chart" of Procter & Gamble Teamwork

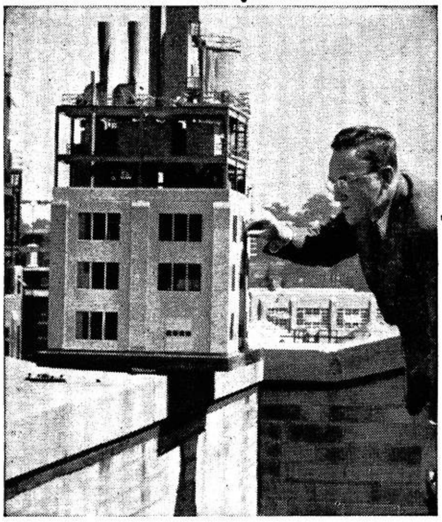
How the skills of many specialists develop a new synthetic detergent . . .



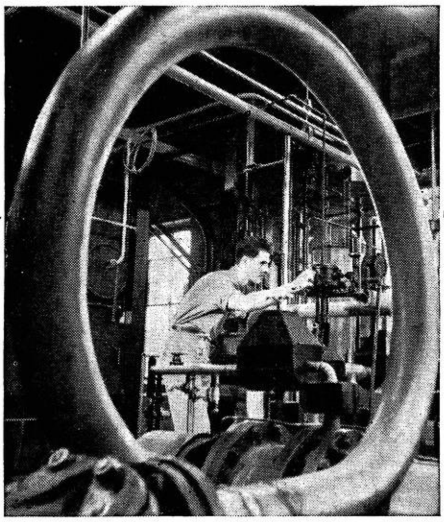
Chemists work in uncharted fields on reactions and formulae in Procter & Gamble's Research Laboratories.



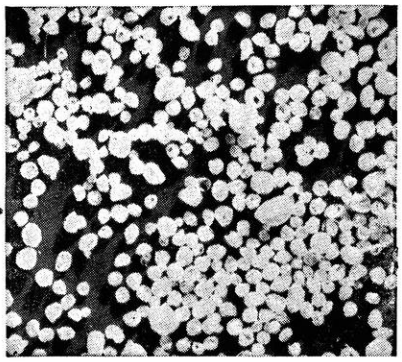
Chemical Engineers use high-speed motion picture photography to study proper nozzle design.



Mechanical Engineers study a 1/32 size model to help translate laboratory processes into reality.



Industrial Engineers face and solve interesting new problems when the finished plant goes into operation.



Result:
A new synthetic detergent

(magnified to show nature of hollow spherical particle)

This is just one example of P & G technical teamwork in action; similar developments progressing in other fields call for additional men with technical training. That's why P & G representatives periodically visit the country's top technical schools to interview students. If you would like to talk to a Procter & Gamble representative, ask your faculty adviser or placement bureau to arrange a meeting.

PROCTER & GAMBLE

CINCINNATI 1, OHIO

IF HE COLLECTED SAMPLES

as he made his rounds

For many years, ADVERTISEMENTS SUCH AS THIS ONE have appeared regularly in leading business magazines. Their primary purpose is to build acceptance for Square D Field Engineers, practically all of whom come to us from leading engineering schools such as yours.

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In This Issue . . .

COVER:

Recent engineering graduates test a huge transformer as a part of their training course. This sort of work is both interesting and informative.

—Photo courtesy of Allis-Chalmers

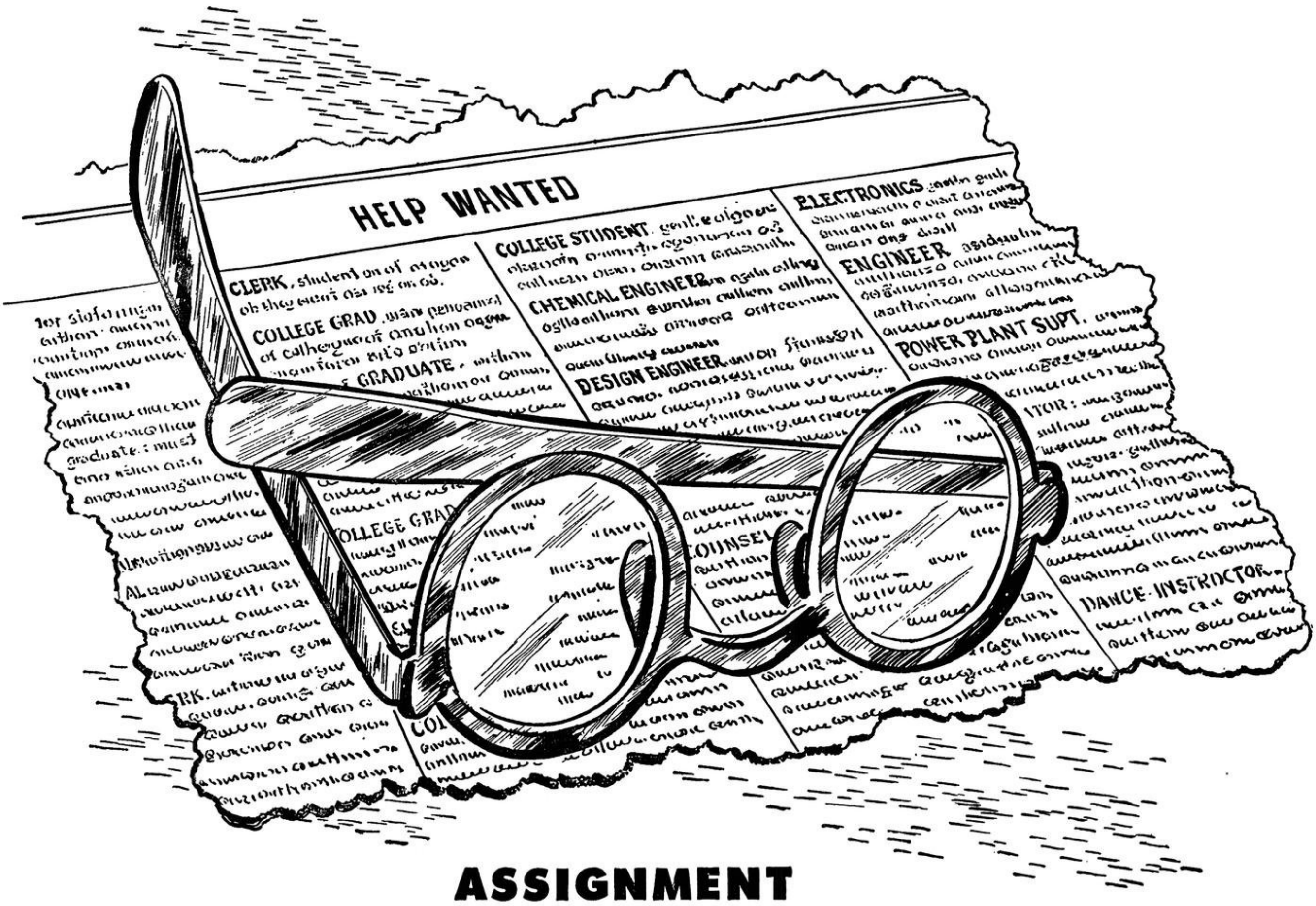
FRONTISPIECE:

Testman D. M. Demarest of the General Electric Co. flashes over a stack of insulators for substations at 600,000 volts.

—Photo courtesy of General Electric

Articles

Departments



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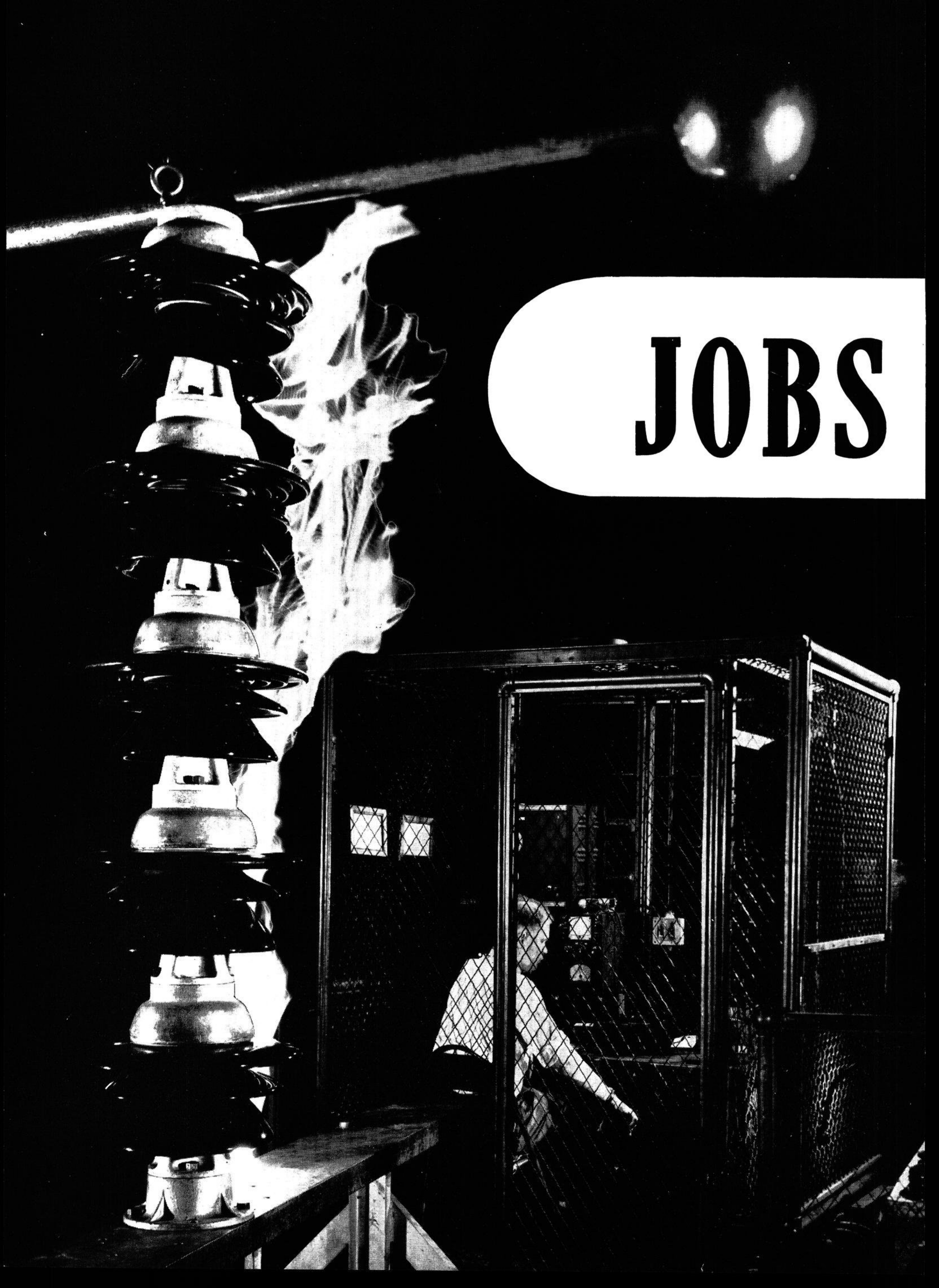


Training For New Engineers

by John Misey e'49

—Photos courtesy of General Electric

One important fact that all engineers must remember is that when they graduate they are not able to cope professionally with any one engineering problem in competition with other established engineers. The formal education which has lasted four or five years can only scratch the surface of the many engineering problems. Nearly all companies realize this situation and have set about to alleviate it. Their interests are to **secure** for each man a worthy position in the engineering profession and at the same time to provide a **trained** technical staff to promote their economic interests. To bridge the gap between the knowledge of principles and their application in industry they offer the graduate engineer on-the-job training programs.

The general objectives of such a training program are three-fold. First is to acquaint the college graduate with the company; its products, operation, and policies. Second is to show how the college training will be applied to industry, and third and most important is to help each man find the type of work for which he is best suited. This last point is of permanent benefit for both the individual and the company.

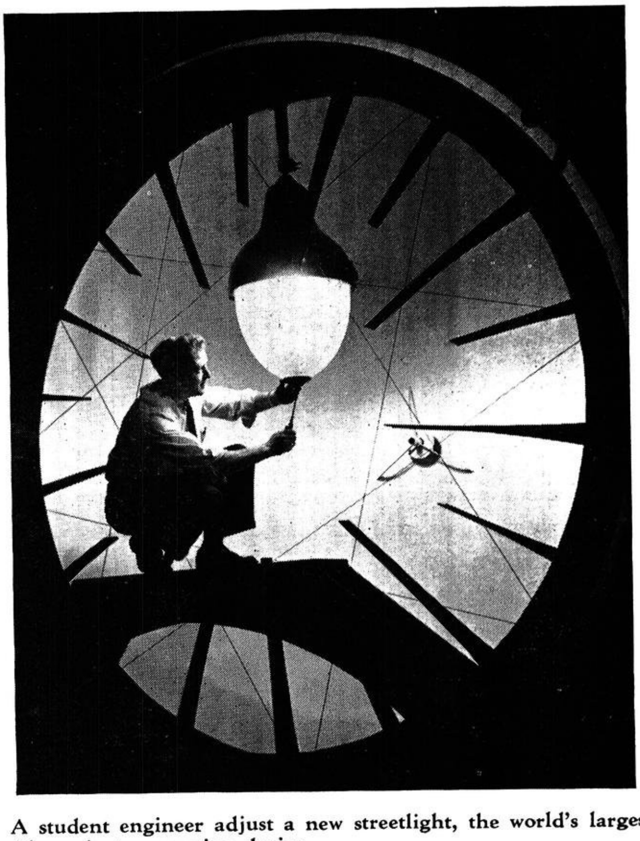
The training program is usually divided into three sections, but these may vary according to local conditions. The first is the orientation period followed by a basic training period. The last phase is devoted to advanced studies in specialized fields.

The orientation period is the first introduction to any training program. First impressions play an important part in preparing the graduate engineer for a successful career. It is the groundwork on which all successive experiences will be based. The friendliness of the employers and employees, their interest in him, and the way they introduce him to the operation of their organization go a long way toward establishing a firm basis of cooperation. It is with some awe and respect that the new engineer takes his first professional steps in the engineering world.

The orientation period begins with the necessary clerical work of installing the new man as an employee of the company. This includes the recording of information for the personnel files and introducing him to insurance plans and other benefits offered by the company. A tour of the plant is next on the agenda. The guide will point out the physical layout of the plant, show how each department is correlated to promote efficiency of operation, and trace out the many steps of production from the raw materials to the finished products. He will trace out the steps of new developments; where they are born, developed, and prepared for installation into the production line. During this time the supervisors and the workers of the production will be introduced. After the inspection tour the company may want to acquaint itself more with his latent skills and aptitudes. They will conduct tests to ascertain intelligence and aptitude, give personal interviews, and use whatever means at hand to discover any traits. Finally a general meeting is held in order to introduce the officers of the training program and to pass on other pertinent information which may have not been previously given. The orientation period has now reached an end and the training is about to commence.

The type of training program depends largely on the type of organization. It varies in every company and is determined by its size, scope of business, type of technical work, and policies. However, all these types of programs have been evolved into three general philosophies of application. The first one is represented by the smaller companies, the second by the larger companies, and the third is adopted by the large corporations.

The first group can offer only a very limited training program. They can't afford to have men specialize, consequently the training is directed towards the development of an all-around engineer as quickly as possible. To do this most advantageously, the new man is put directly on the job as an assistant to a competent engineer. With him the graduate will attend to all the technical problems that arise, and from him he will acquire all the technical



A student engineer adjust a new streetlight, the world's largest, inside a giant measuring device.

skills of application. As time progresses more and more responsibility will be transferred to him. At one point the progress achieved will be sufficient to indicate competence, and this will signal the end of the training program.

The second group represents a more formal type of training. After a brief orientation the man goes into the shop and proceed to learn the business from the bottom up. The shop can mean the local factory, the oil fields, the construction and road gangs, the laboratories, or anyplace where the actual work of the company is being done. In the shop he will be placed alongside the regular employees, performing the same work, being directed by the same foreman, and assimilating the manual skills of the job. The time spent on each job will be allocated previously or will depend on individual progress as noted by the immediate supervisors. In the meantime, if the company so wishes, occasional reports will be written on the work in the shop. There will be occasional conference meetings at which time pertinent engineering news and problems will be discussed. When all the mechanical skill has been acquired the engineer will proceed into the more technical phases. It may be in the laboratories, on the drawing boards, or in the design and development department. When all the phases of the training program have been completed, the engineer will be placed in a

A cooperative student from University of Cincinnati working on a generator test.

position depending on his aptitude exhibited during the training period.

The third group is different from the others because large corporations can afford a more extensive training program. The first phase of the training program is called the basic training period and lasts a specified period of time. During this time each man is given a number of assignments in various laboratories, engineering, and production groups. On each assignment he works under an experienced supervisor who directs and criticizes his work, and rates him on his performance. A man in such a capacity is not merely an observer but actually works on the job along with the regular employees. He is encouraged to learn as much as possible about the work in each section for frequently he gets valuable practical experience not directly related to his own assignments. The close contact with the factory gives each man an introduction to the problems of production schedules, safety measures, and employee relations. The assignments are as varied as possible so that each man will get experience in several different types of industrial work. Each man in training writes a short report on each assignment so that the program supervision can follow his progress in detail. The reports are encouraged to contain frank comments and criticisms. Occasionally desireable changes in operating procedures are made on the basis of comments in these reports. On a social level a series of meetings and luncheons are arraigned, at which time the men in training meet company executives and supervisors for impromptu discussions.

To supplement the practical training on the job and to review and extend previous technical education an extensive program of formal education is conducted by many of the larger corporations. The general courses give instructions in technical and business subjects. They discuss the basic fundamentals of engineering practice, the principal materials and special processes used in industry, and specialized engineering fields. The advanced classes for selected men offer thorough grounding on the graduate level in the fundamental theory of technology. Some of these classes are conducted by nearby universities or colleges while others are offered by the corporation with specialists as instructors in the fields under discussion. While the classes stress basic theory, outside work assigned in the classes requires the application of theory to the complicated phenomena actually encountered in industrial practice.

All training is, of course, preparatory to permanent placement. If at all possible considerable freedom is given each man in choosing his eventual location. Naturally most men are placed in sections to which they have been previously assigned or in positions which they prefer. Others who show definite aptitude along certain specialized engineering lines are transferred directly to such a position. In some cases where different aptitudes are exhibited and for which the company is not able to provide placement, the company sends them out to seek employment elsewhere with their good graces.

The success of any training program depends entirely on the individual. All the opportunities to learn and advance are given, but the final result will be a measure of what each man has accomplished. A few friendly tips will go a long way toward getting a good start. First, go into the program with an open mind. Forget all the rumors and hearsay for these are just idle speculations of discontented and biased people. Secondly, show an interest in the program. Lack of interest, laziness, lack of courtesy, non-cooperation, and carelessness are some of the traits that prevent advancement. Finally, be yourself. Don't try to pass yourself off as someone you aren't. The truth will come out eventually and only to your disadvantage.

POWER ALCOHOL . . .

Is it the answer?

by Russell Henke m'49

The past few years there has been a full blown controversy developing between two factions; one of which insists that there will be plenty of oil available in case of another national emergency such as beset the nation from 1941 to 1945, and the second, a more realistic faction which states that the oil shortage is critical, and is becoming even more critical as time passes.

That the problem is not considered lightly in government circles is evidenced by the large number of congressional committees which have been assigned to investigate and report on the situation. The latest of these committees is the "Special Sub-committee on Petroleum, Committee on Armed Services, House of Representatives"; it is this committee which is the authority for statements regarding the national petroleum situation made herein.

If another war were to come, and events of the past year don't make this an impossibility, it is almost a certainty that the United States would be forced to depend on its domestic supply of petroleum since foreign sources would be cut off by hostile forces. According to the subcommittee on petroleum, if the United States were to depend on its own oil reserves for petroleum products, the life blood of warfare, it would fall short between two and three million barrels a day of its requirements.

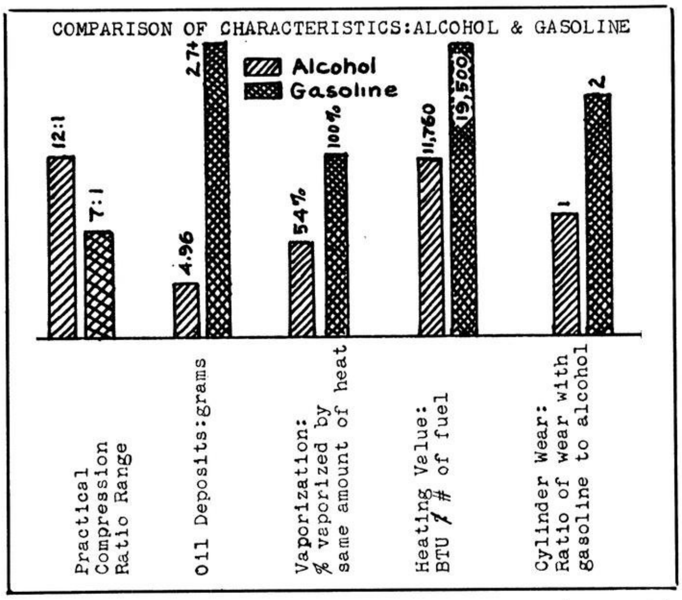
The committee thought the situation serious enough to state that, "The Nation is in a grave situation in respect to its petroleum; the national defense is in a precarious position in respect to its petroleum." The committee made it very evident that it was not bowing to modern trends to the sensational for the purpose of publicity, but that it felt so strongly on the situation that it must speak out in this manner to bring home its seriousness.

Why this sudden emphasis on the petroleum shortage? Why hasn't anything been done to offset the trend? You might well ask these questions when confronted with the problem. The nearest thing to an answer that can be given is that as far back as 1936 a group of serious thinkers in American industry and science met, at the invitation of the late Henry Ford, for what is known as the Dearbourn Conferences. These conferences were undertaken, in part, to search for a practical solution to the problem under discussion. At these conferences alcohol was presented as a possible substitute for gasoline as an automotive fuel.

The idea behind the Dearbourn conference selection was twofold; first, to alleviate the critical petroleum situation, and second, to improve the farm economy by providing another market for farm produce, namely, the raw materials from which alcohol is made. Since that time other interests have taken up the work on alcohol as a source of power.

The feasability of using alcohol as a motor fuel has been investigated to a limited extent. The National Bureau of Standards, the Bureau of Mines, and individual researchers have run tests on engines using alcohol and gasoline, to compare the performance of the two. However, since these engines were all carbureted engines the tests left an important void, namely injection. This is important because there are many problems connected with inducting the fuel to the engine in carburetion that are not found in fuel injection. It is with this in mind that Professor R. A. Rose inagurated the experiments on fuel injection-spark ignition engine performance comparison between alcohol and gasoline.

Professor Rose, in inaugrating the project, wanted to get a set of data on alcohol as compared with a standard reference fuel which could be reproduced anywhere in the country, in the hope that in this way the experiment could be of use in evaluating the characteristics of alcohol as compared with gasoline.



In selecting a fuel for automotive purposes, the considerations that must be made are: starting characteristics, anti-knock characteristics, power output and economy, vapor lock, oil contamination, and wear and corrosion. The vapor lock characteristics are important from the standpoint of delivering the fuel to the engine from the storage facilities.

The Bureau of Mines' starting tests indicated that alcohol alone starts well above 58 degrees F. Additives of naphtha and ether present in concentrations of 20%

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ON *the Campus*

WHEELS, ACHTUNG!

Here it is, engineering societies and fraternities. This is your column where you can let the rest of the campus in on what's right with your gang. Just keep firing the info, on what you're doing, at us. We'll do our best to get it all in print. Our box is in the lobby of the M.E. building or, if you're really ambitious, our office is room 352 in the same building. Submit material as soon as possible after it happens.

CENTENNIAL SMOKER

Slip sticks were laid aside and gouges hidden from sight as more then 500 engineers flocked to the Centennial Smoker presented by Polygon Board on Oct. 20.

The program provided some of the best entertainment seen on the Campus in a long time. Bob Peterson kept the show running smoothly while background and fill in music was provided by Bob Schumpert's six-piece band.

Don Root, first on the program, provided magic tricks that kept even us engineers guessing.

The Four Roses Quartet, rated one of the best on the Campus was called back for an encore after already singing two songs.

Blonde, blue-eyed, petite, Mitzi Thompson, a blues singer, drew wolf-calls, etc., from the audience which brought her back for an encore.

Caroline Kimball in a unique gay nineties dance, the next on the program, was duly appreciated although hindered slightly by the carpeted stage.

The last act, Joy and Jerry Curtis, went through some contortions not unlike those of a freshman at exam time.

As Mitzi Thompson drew the names Bob Peterson handed out the door prizes which included a fine pen and pencil set, a leather notebook cover, a lettering kit, a certificate for an engineer's handbook, and others. The last prize, booby prize, was won by an E.E. It was a well known article of feminine attire closely resembling king sized ear muffs.

About nine o'clock movies of the Yale game were shown with Coach Mansfield commentating.

Refreshments were provided at the end of the evening while the engineers visited the tables set up by their various societies.

This smoker endorsed by everyone represents our first big social event of the year. It was very ably prepared by Polygon Board with special credit to Charles Cheney for the fine program.

When is the next one?

CHI EPSILON

Chi Epsilon, civil engineering honorary fraternity, will be under the direction of the following men this fall: Sylvin Lange, president; Walter Belter, vice-president; Robert Donaldson, secretary and treasurer; and Ralph Michael, corre-

(please turn to page 26)

The Centennial Smoker sponsored by Polygon Board

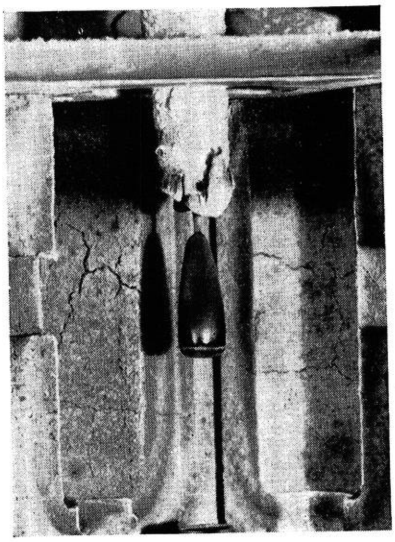
—Photos by Mitchell

Artificial Beauties

by T. J. Iltis che'50

—Photos courtesy Linde Air Products Co.

Today the formerly expensive and precious gems are available to the American people and to American industry at a much lower cost in synthetic form. The new synthetic sapphire, ruby, and spinel developed by Linde Air Products Company are for all practical purposes



This close-up view of the boule furnace shows a finished ruby boule ready for removal.

identical to the natural gems themselves, and are now being used in place of these natural jewels for all types of products ranging from beautiful jewelry to accurate and delicate technical instruments.

During the war, great progress was made in the production and fabricating techniques of synthetic gems. Previous to the war, the Unted States had obtained its jewel bearings for precision instruments from Europe. The unavailability of these important materials forced the U.S. into producing her own high quality synthetic gems which she had never done before. The Linde company, upon request by the Government, set to work immediately on an extensive research program in the development of synthetic corundum with jewel bearing qualities. It was during this research that many important developments were made in production and fabrication.

PHYSICAL AND CHEMICAL PROPERTIES

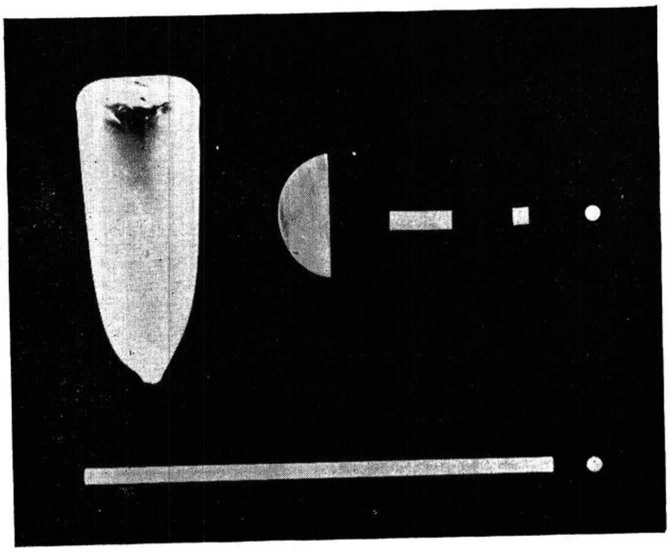
The synthetic white sapphire and ruby, as produced are single crystals of synthetic corundum having no weak spots such as might be found in multi-crystalline structures and are thus highly resistant to wear. The hardness rating on the Moh's scale is 9 as compared to 10 for the diamond and 5.5 to 7 for hardened steel. This hardness permits a high polish on the surface of the gem which is an important characteristic to the jewelry merchant and fabricator. The tensile strength of synthetic corundum is of the same order of magnitude as steel and when heated up to temperatures around 1,800 deg. C. (3,272 deg. F.) it becomes soft and plastic allowing it to be shaped.

Synthetic spinel has many of the same physical and chemical properties of corundum. It is the single cubical crystal of aluminum and magnesium oxide ($MgO\ Al_2O_3$) Spinel has a hardness of 8 on the Moh's scale, making it suitable as a gem stone. It can be produced in several colors and shades not obtainable in sapphire.

USES

Synthetic gems are now becoming more and more popular in jewelry. Stones can be produced in many shades and they will retain their high polish indefinitely. One of the more recent developments along this line is that of the star sapphire and star ruby. Although these synthetic stars will never be available in quantity, they will be available at prices well below those of the very expensive natural stars.

Many people already are using the new long wearing sapphire needles which replace the old type steel and bamboo needles. These new needles not only are long lasting, but they also are easier on the records and do



Here are shown the successive stages in reducing boule and rod corundum to the jewel bearing blank,

A fine mechanical polish is attained by holding the corundum against a metal lap impregnated with diamond dust.

not create as much surface scratch as the old type.

Synthetic sapphire is now being fabricated into strong, scratch-resistant watch crystals which are becoming increasingly popular with watch manufacturers.

Compasses, watches, chronometers, and many other precision instruments require hard, wear-resistant, low-friction bearings for the operation of their delicate parts. The development of the sapphire rod has made possible the production of these bearings in great quantities with minimum waste of time and materials.

Along with high strength, hardness, and polish, synthetic sapphire has the following excellent properties: will not rust or burr, not subject to acid corrosion, and has relatively low thermal expansion. All of these characteristics make sapphire a superior material for gage faces and faces on accurate measuring devices.

There are numerous other uses for which synthetic sapphire and spinel are outstanding including thread guides, extrusion dies, cutting and burnishing tools, injector nozzles, and knife edges.

PRODUCTION TECHNIQUES

In short, the production of synthetic corundum, as devised by Verneuil in 1902, is this: Oxygen and Hydrogen are fed into an inverted burner, along with very finely divided particles of alumina. As the alumina enters, it fuses and collects on a small pedestal beneath the nozzle of the burner, gradually building up or growing into a carrot-shaped crystal known as a boule. This boule is allowed to cool and is then split along a crystal plane before fabricating it into various products.

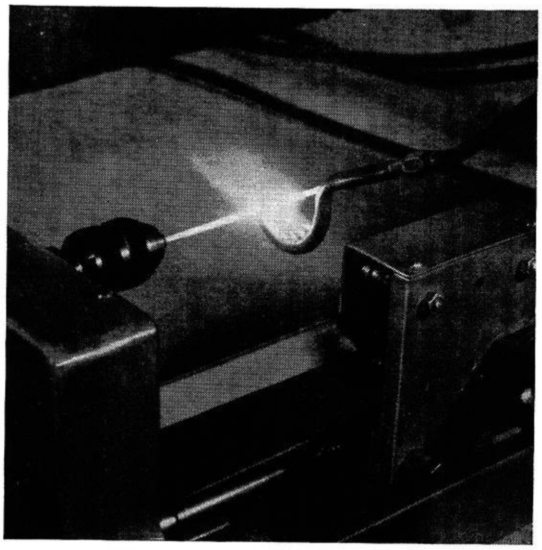
The actual production of the synthetic gem of today involves much more than has been described in the previous paragraph. While most manufacturing processes can be precisely controlled, the manufacture of synthetic sapphire is an art requiring much skill and experience.

In order to obtain water-clear corundum boules, it was found that it is necessary to provide exceptionally pure alumina, such that not even "chemically pure" grades were pure enough. The size of the alumina particles now being used is on the order of one-tenth of a micron, an unbelievingly small particle. If this particle were magnified 50,000 times, it would be no larger than the head of a pin.

The alumina powder is fed into the burner in small increments, since a good clear crystal must be grown very slowly. Close control of this rate of deposition and of the flame temperature are extremely important and they must be kept within narrow limits. These specifications are rigid to prevent such flaws as feathers, tiny bubbles, or imperfect homogeneity and crystallographic orientation which can not be detected until the final polishing.

The finished boule is ordinarily three-fourths inch in diameter and 2 or 3 inches in length. The average corundum boules are about 200 carats in size, and they have been grown as large as 1000 carats. Spinel boules have been grown experimentally as large as 1400 carats.

Research continued after the production of a successful boule had been accomplished. It was found that considerable time and materials were being spent in fabricating the sapphire boule into jewel bearings. Significant amounts of diamond and sapphire itself were being used in the slitting and cutting operations to reduce the boule to small bearings. The object of the research was to furnish material in a more useful form, and as a result, Linde produced long, slender crystals known as corundum rod. Now all that was necessary to make the bearings was to slice off the slender rod and polish the small pieces into final form. Such articles as textile thread guides, phonograph needles, and gages, in addition to jewel bearings, are fabricated from this sapphire rod.



When a rod has been flame-polished, as shown above, no surface scratches are visible even under a high-power microscope.

FABRICATING TECHNIQUES

The production of the boule is only part of the job of making beautiful gems and small bearings. The sawing and grinding of the boule into these forms is another delicate operation requiring much skill. Two new methods, flame polishing and flame shaping have been developed by Linde Air Products Company. These are ex-

(please turn to page 34)

NEWEST LAB

by Walter Mueller m'50

The old foundry lab on the second floor of the M. E. Building has become a legend. All the back-breaking work that is associated with it is now a legend too. There won't be any more lugging of molds or puddles of molten metal on the floor. It has been superseded by a spacious, well arranged and well equipped metal casting laboratory.

The old foundry lab was outmoded and the equipment was not sufficient to enable the instructors to convey a comprehensive idea of good foundry practice to the students. In some instances the equipment was impractical and in other respects, the arrangement was impractical. The cupola was much too large for efficient melting of the small amounts of metal that was needed for each class. The sand mauler and fuel were in the basement of the M. E. building and necessitated a trip to the basement every time these were needed. The sand testing equipment as well as the equipment for melting steel were in the M. & M. Building and when those phases of the course were being demonstrated it would be necessary to move the class over there, creating confusion and disinterest. The pouring facilities were awkward and the cupola was hard to control because of its large capacity. Thus the results of the pourings were not always as satisfactory as they could be.

Considering all this and the fact that such a course should entail an explanation of modern foundry techniques which was almost impossible, except on a verbal basis, it is readily seen that a new laboratory with modern equipment was needed if the course was to remain a practical one.

New Site

The new Metal Casting Laboratory answers every requirement. It is located in a building behind the M. & M. Building and occupies it entirely, including a class room and office. The arrangement was carefully planned resulting in a maximum of space for working. Definite work areas, similiar to subdivisions of a regular foundry have been alloted to each phase of foundry activity such as molding, coremaking sand conditioning, melting and pouring, sand testing, cleaning and inspection and storage. The lab has a neat appearance very unlike a foundry. The students keep the sand where it belongs and consequently the floor is as clean as any floor in school.

The cupola is the first thing one sees as one enters the lab. It is new and much better adapted to laboratory work than the old one was. It has a capacity of 2000 lbs. per hour which is the rate that metal is normally used for each section and has an automatic air control and a metering device that weighs and records the air used with compensations both for changes in barometric pressure and temperature. The cupola gases are handled in an unusual manner. The stack is equipped with a down-comer connected to an exhaust fan. A water spray cools the gases in the down-comer and then they are exhausted through the side of the building at window level. A trap separates the solid particles from the gases so that the exhaust is inoffensive. A new monorail to carry the ladle down the center from the furnace is being installed. Conveyor systems will lead to the monorail from the benches so that it will not be necessary to carry the molds or the ladles.

After the furnace, one sees the new TOCCO heat treating unit for induction heat treating. It also has a melting capacity of 300 lbs. A 100 kw, 250 lb. capacity single phase arc furnace, now in the M. & M. Building, is to be installed alongside the TOCCO unit. The pot furnace for metals with low melting points that was in the old lab has been installed near the cupola. With this melting equipment, each process of melting that is used in industry can be demonstrated.

New Equipment

The molding equipment is adjacent to the furnaces. There are two new companion mold making machines. The first is the jolt rollover draw machine that makes the drag. The match plate is mounted on the machine and the flask put in place and filled with sand and jolted. Then an arm of the machine turns the drag over and draws the pattern leaving it ready for the cope. The

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View of the molding room showing the furnaces and molding equipment.

Alumni Notes

by Al Nemetz e'50

In Memoriam

EMERITUS PROFESSOR MEAD

March 6, 1862

October 13, 1948

Upon the death of Emeritus Professor Daniel W. Mead, the College of Engineering, the University of Wisconsin, indeed the entire nation, lost one of its outstanding engineers. After graduating from Cornell University in 1884 with a degree in civil engineering he joined the U. S. Geology Survey. He later became city engineer for Rockford, Illinois, but in two years Mr. Mead resigned to became general manager of the Rockford Construction Company. Dr. Mead came to the University of Wisconsin in 1904 as a part time professor and retired in 1932 for part time consulting work. Until 1937, however, he continued giving weekly lectures, and until 1944 he gave occasional addresses to the students. In 1944 the University recognized Dr. Mead's outstanding services with the award of an LL.D. degree.

Daniel Mead was awarded many honors during his lifetime. Both the Washington award and the Octave Chanute medal were presented to him by the Western Society of Engineers, the Fuertes medal from Cornell University was awarded him, and the Norman medal from the American Society of Engineers was awarded him in 1937 for his paper entitled "Waterpower Development of the St. Lawrence River." President Coolidge appointed Dr. Mead to pass upon the Boulder Dam project, and the lake formed behind the dam, Lake Mead, was named in his honor.

Dr. Mead was a past president of the American Society of Civil Engineers, a fellow of the American Institute of Electrical Engineers, and a member of the American Water Works Association, the New England Water Works Association, the American Society of Mechanical Engineers, the Wisconsin Society of Professional Engineers, and was a national honorary member of Triangle. He was also the author of several books, among which was the first English language book on Hydrology.

The passing of Dr. Mead will be mourned by all who were associated with him. His dignity and sense of fair play will be always remembered by his friends and pupils. He was an example worthy of the emulation of all engineers.

C.E.

Ernest M. Barnes ('22) is now General Manager for the Knox Concrete Products Company, at Knoxville, Tenn.

William Z. Lidicker ('27) has been made a partner in the engineering firm of Knappen-Tippetts-Abbett Engineering Company of New York.

Arthur J. Anderson ('28) is Division Engineer for the Milwaukee Road at Spokane, Wash.

Gerald C. Ward ('29) who was a major during the African campaign, has accepted a regular commission in the Air Force. "At present", he writes, "I am what is known as Air Installations Engineer with the National Guard Bureau."

Otto W. Wehrle ('29) is now a stress analyst with the Douglas Aircraft Corporation, at Los Angeles. He married a French girl and has two teen-age daughters.

Edwin L. Saxer ('39) has been appointed Associate Professor and head of the department of Civil Engineering at the University of Toledo.

Dale J. Jennerjohn ('44) is now with the National Canners Association of Washington, D. C., as a Sanitary Engineer.

Edwin R. Shorey ('35) has been appointed General Superintendent of the North Texas division of the Shell Oil Company, Witchita Falls, Texas.

Earl E. Hunner ('07) has retired as General Manager and has been appointed Executive Consultant of the M. A. Hanna Company, Duluth, Minn.

M. & M.E.

Kurt Kuelthau ('39) is now Mining Engineer for the M. A. Hanna Company of Iron River Michigan. He was formerly associated with the Allis Chalmers Company.

Robert H. Ramsey ('31) is Acting

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The JUMO - 004

by Russell Pipkorn m'49

Much useful information was obtained during the war about German equipment through tests on such captured equipment by the Air Materiel Command. Some of this equipment, along with reports on actual tests performed and complete specifications of individual elements, has been supplied to schools for study and observation.

A Jumo 004 German jet engine is now located in the heat-power laboratory. Various sections of the shell have been cut away to show the important parts of the engine. This was the work of Robert Mitchell and Jan Urdal, who also composed a report on the engine and its components. The following information was taken from their report. Much of their technical information was gathered from reports supplied by the Air Forces.

The Jumo engine is not a single type of engine, but rather a whole family with the following common characteristics:

(a) Axial flow compressor
(b) Single stage impulse turbine with 10-12% reaction.
(c) Can-type combustion chambers with fuel injection against incoming air.
(d) Variable cross-section exhaust.
(e) High speed internal combustion starting engine.

This type of engine was first conceived in 1937 but actual work was not started until 1939. The first work was carried on with models, but the scaled down combustion chambers caused operational difficulties. The first full scale model was completed in 1940 but flight tests were not completed until 1942. By the end of the year, though, the 004B model was already completed. This was further modified and the engines which finally were put into production were the 004-B1 and the 004B2. These differed only in output and turbine blading. The B-1 developed 1870 pounds thrust and used solid blades weighing 1 pound each. The B-2 developed 1980 pounds thrust using hollow blades weighing only 0.325 pounds per blade.

Approximately 4000 of these engines were produced and used in the following planes:

(1) ME 262, intercepter.
(2) Arado AR 234, bomber and reconnaissance.
(3) Focke-Wulf TA 183, fighter.
(4) Heinkel HE 162-A, fighter.
(5) Henschel HS 132, dive bomber.

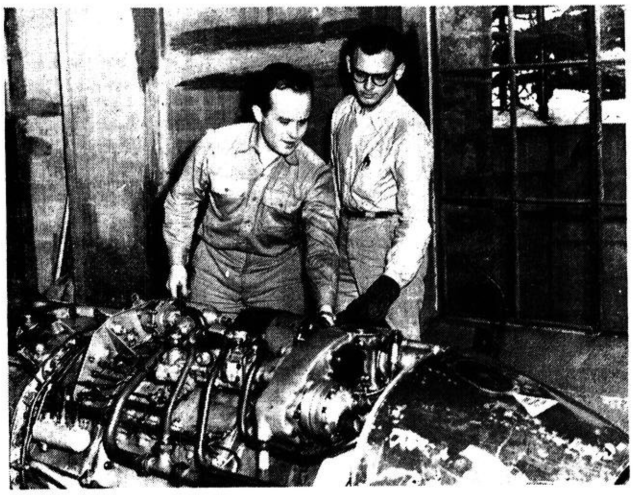
The fuel consumption was extremely high and consequently the length of flight was restricted.

The major components of the engine, all contained in the cigar-shaped structure will be touched upon in the following paragraphs giving a sketchy description of the primary design characteristics. These major items include the starter, compressor, combustion section, turbine section, and exhaust section.

UNIQUE STARTER

The Jumo is unique among aircraft engines for having an internal combustion engine for its starting unit. This engine, in turn, is started by a small electric starting motor which operates on a d.c. supply of 24 volts. The electric starter is supplemented by an automatic rewind hand starter, similar to those in use on popular American outboard motors. Both are very compact and evidence precise design.

The main starter itself is a two cylinder, two cycle, simultaneous firing, crankcase injection engine. It is spark fired, having its contact points on a cam on the main crankshaft. The limiting factor in the speed of the engine is the speed of return of the cam-follower which times ignition. The maximum speed of the unit is 10,000 rpm (crankshaft) or 2080 rpm (starter dog). The maximum operating temperature of the unit is 550°F, which dictates a maximum operating time of 1.28 to 2.33 minutes, depending upon the initial temperature.



—Photo by Wahlin

Jan Urdall and Robert Mitchell viewing the upper front portion of the Jumo engine with the casing removed. Note the numerous accessories.

The Reidel starting engine is cast almost entirely of aluminum, with cast iron sleeves inserted as cylinder walls. The unit is air cooled, having forced draft supplied by a centrifugal fan connected directly to the crankshaft.

Maximum horsepower for the Reidel engine is approximately 9 hp. This is unusual because of the small size of the unit. Its weight, complete with gas tank, is only 55 pounds. Without the bullet-shaped sheath, tank and fuel, its own weight, including its own starter, reduction gears, centrifugal clutch and starter dog assembly, is only 33 pounds.

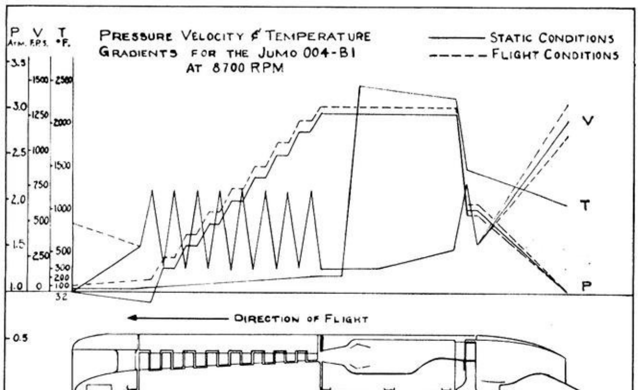
Upon starting, the engine develops a crankcase pressure which is transmitted through a bore in the crankshaft to a sliding, spring-return piston which forces the starter dog into engagement with the main shaft of the engine. As the starter side of the clutch approaches 1100 rpm (after being reduced by a 4.8:1 reduction gear) it gradually engages the starter dog assembly, which drives the main shaft. When the starter-dog rpm. reaches 2000, fuel is introduced into the main combustion chambers and is spark ignited. After the turbo-jet is self-sustaining, the Reidel engine is cut off. The reduced crankcase pressure allows the return spring to disengage the clutch.

The centrifugal clutch is worthy of mention because of its compactness and efficiency. In a rotating member geared to the crankshaft as before mentioned, there are 16 holes bored at 30° to the shaft. In these, there are 16 steel balls weighing 0.0065 pounds each. These are hurled outward by centrifugal force to increase the normal pressure between alternate bands of steel and a friction-coated steel band which rotates free. The steel-faced parts are alternately keyed to the driven inner drum and the outer drum which connects to the starter dogs. These are free to slide, but not free to turn. The clutch assembly serves as the only flywheel which the starter can boast, as well as to reduce shock on the starter reduction gear.

EIGHT STAGE COMPRESSOR

The compressor in the 004-B class engine is an eight stage, axial-flow type which develops a 3 to 1 pressure ratio. After starting, its power comes from the single stage turbine wheel, located aft. It is connected by a splined shaft.

The compressor rotor is supported upon a roller bearing in the rear, and upon three identical ball bearings which serve as both radial and thrust supports at the head. These bearings must assume a thrust of 5000 pounds when the rotor is operating at rated speed, 8700 rpm. They are mounted on a common inner race, but their outer races are separate and are adjusted to take equal amounts of thrust. After an adjustment in the shop, they are pinned together to insure a continued equality of load.



Schematic drawing of the Jumo engine showing the basic elements along with pressure, velocity, and temperatures at various points in the unit.

The rotor blading is of a light alloy (which appears to be magnesium) and is anchored in eight cast aluminum disks of mating construction. The blading is locked into these disks by means of dovetail joints with clinching toe screws. At the trailing edge of the fourth stage of stator rings, there is an annular slot through which cooling air is bled for use in the double-skinned exhaust cone.

Performance of the axial flow compressor was found to be most desireable at 7700-7800 rpm, whereas the rated speed is 8700 rpm. At the optimum point, the efficiency was found to be 78%.

Various methods might be used to improve the performance of this compressor. Primarily, a different speed setting could be effected to give a blade speed to properly balance the incoming air. The latter is varied by the exhause cone needle, however, and the position of the needle is dictated by the thrust required by the plane. It is apparent that it is simpler to vary the thrust by means of the exhaust needle than by varying the speed of the turbine rotor. The alternate method to maintaining a high efficiency is to install variable-pitch stator blades to change the angle of entry into the rotor independently of the air velocity. The NACA has experimented with variable-pitch stators, but has concluded that the increases in efficiency were not warranted by the ponderous equipment necessary to control the system.

The stator rings of the compressor are well adapted to mass production, since the majority of the blades are stamped from sheet steel. The first three stator rings are made of a light alloy and have airfoil sections, but the balance were of the sheet steel construction. Methods of attachment were varied from passing through patterned slots with brazed fixing, to spot welding the three tabs on either end of the blades when placed between the sheet metal shrouds.

The housing of the compressor was of cast aluminum, and was made in two halves. These were split apart at an angle of approximately 30° to the horizontal. The stator rings were bolted to the inner periphery of the housing.

In order to maintain its adaptibility to mass production that previous design attained, the clearances of the rotor and stator were quite large. The rotor blades averaged a clearance of 0.033″ (radially) and the stator cleared by the unusually large dimension of 0.12″.

SIX COMBUSTION BURNERS

Combustion in the Jumo is accomplished in six burners located around the periphery of the engine immediately behind the compressor section. Ignition is begun in these burners by spark plugs located in every other unit, but it is perpetuated without this ignition after it is once properly initiated. The chambers are interconnected by tubes which tend to equalize pressures and propagate the flame during the ignition period. If one burner

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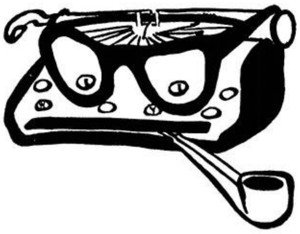


The Way We See It

HOW ABOUT IT, SENIORS?

Last spring Joe was taking a trip across the country. One day he found himself on a muddy road. It was hard to steer, and sometimes he was not so sure of where he was going. At other times, his car couldn't get a footing, and he expended much energy and didn't get very far very fast. In short, it was somewhat of a discouraging situation for Joe. So, like most humans, he began to complain about the weather, the condition of the road, all the people who had anything to do with it, and why didn't they fix it so that his journey might be easier and more fruitful. He vowed that when he got out of the mud, if indeed he ever did, he was going to "see somebody and get something done about it."

The next day the sun was shining, however, and when Joe continued on his journey, he found a broad, smooth, concrete road to drive on. Soon Joe was in good spirits as his car swiftly rolled along. It wasn't long before he had left the bad road behind. And, he never did "see about getting it fixed."

This sort of thing often happens in school, too. Many engineering students say, "Why do they give us this stuff? We'll never use it anyway when we get out!" Then the students graduate, take positions in industry, and gradually their school loses track of them. Often the graduate will find that the methods used in practical work are the same as he was taught in school. Again, he finds that perhaps some of his courses could have been modified to include more of the problems typical of his everyday work.

Now college isn't quite as bad as the muddy road, and the graduate's life isn't always like the super-highway. But the fact remains that very few graduates exert their influence on their alma mater to bring the school and courses up to the practices of industry. The experience of the alumni would be invaluable in forming the nature of the educational program that is to be provided for the new engineers.

W.M.H.

A GOOD START

On Wednesday night, October 20, the College of Engineering saw the first of what we hope will be a series of many enjoyable get-togethers for the group. It was the Centennial Smoker. We trust that the name doesn't mean so much that it will be necessary to wait one hundred years for another.

The event was very well presented, publicized, and attended. Judging from the experience of previous years, it was evident that this type of social affair is much more popular than the Engineers' Ball that was usually presented in the fall semester. It seems that the average engineer would rather sit and watch a program than move around and dance after a hard day at school. The smoker, for those of you who didn't attend, was a well rounded program of high-class entertainment, football movies, refreshments, and good fellowship. It even paid for the faculty to attend, as Professors Larson and Koehler will attest. They walked off with two of many appropriate and valuable door prizes.

The overall credit for this affair should go to Polygon Board whose planning got it under way, but the individual credit should go to Bob Peterson, the hard-to-beat master of ceremonies.

Each engineering society has two representatives on Polygon Board; so if you as individuals appreciate the work that was done on this event and would like to see more in the future, be sure and tell these fellows when you see them. People don't mind doing something for others if that effort is well received, appreciated, and acknowledged.

So even at the risk of being repetitious, I am going to say once again, well done!

R.W.H.

Science Highlights

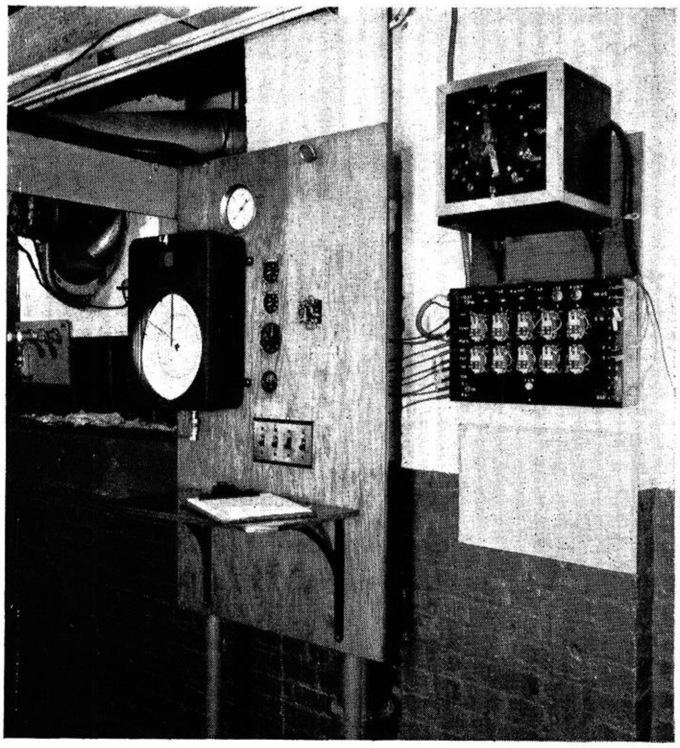
by Howard Traeder m'48

LABORATORY FOR STUDY OF CYLINDER WEAR

A new laboratory for the study of automotive engine performance has been installed at the National Bureau of Standards under the direction of A. R. Pierce. Equipped with completely automatic controls, this laboratory offers a means of closely simulating actual operating conditions in such a way that tests can be reliably duplicated. While designed primarily for investigations of cylinder wear, the new equipment may also be used in studying the effects of various types of fuels and lubricating oils on pistons, piston rings, bearings, and carburetors. A problem under investigation at the present time is the determination of the amount of sulfur that can be tolerated in gasolines without appreciably increasing wear.

Cylinder wear is an important factor limiting the useful life of automotive engines. In general, reliable data on the process can be obtained only by actual operation of a test engine under conditions of frequent starting, stopping, accelerating, and cooling, such as occur in normal driving. Road testing has not given reliable results in this work because it is impossible to control properly all conditions of operation. In connection with the Bureau's study of cylinder wear, it was therefore necessary to develop a laboratory arrangement for testing automotive engines under conditions such that any run could be exactly duplicated.

The automatic test equipment utilizes a battery of five automotive engines from three popular makes of automobiles. Each engine is complete except for fans, radiators, and mufflers, and is coupled to a "dynamometer"—an electric generator which provides a uniform load. By varying the electrical output of the dynamometer, and the amount of throttle opening, any speed or power within the range of the engine may be obtained. The extent of cylinder wear is determined by use of the McKee Wear Gage, which employs a sensitive indentation method developed at the National Bureau of Standards for investigations of the wear of walls and pistons of internal combustion engines.



—Photo courtesy Bureau of Standards
The laboratory control board for the testing of cylinder wear.

To obtain data that are valid for actual service, the engines, under the control of a master clock, are put through an operating cycle which provides conditions corresponding to cold starting, warm-up, speed-up, idling, stopping, and cooling. The half-hour cycle that is used begins with cold starting, after which the engines are first idled for 1½ minutes at 500 rpm, then accelerated for 3½ minutes at a speed equivalent to 40 miles per hour on the road and a horse-output equal to "road load." The idle and speed-up periods are then repeated three times. At the end of the fourth speed-up period the engines are stopped, and during the remaining ten minutes of the cycle they are artificially cooled to the original starting temperature in preparation for another cold start. The cycle can be repeated automatically as many times as desired.

A wear test requires many comparison runs. In order that data from successive runs may be comparable, the engine temperature, load, and speed must be accurately controlled. Bureau studies have shown that both starting and running temperatures have an important effect on cylinder wear. Proper control of load is important, since variable power output would cause the fuel consumption to vary and a corresponding temperature variation within the combustion chamber. Obviously, speed must also be controlled in wear tests in order

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S-T-A-T-I-C . . . (*continued from page 22*)

A drunk opened the doors and fell to the bottom of the elevator shaft. Staggering to his feet and brushing himself off he indignantly muttered, "I said up."

* * *

"What's that black soot", asked the first cannibal?

"That's not soot, it's holy smoke. We've got a missionary for supper."

* * *

The cleanest thing these days is a dollar bill. Not even a germ can live on a dollar.

* * *

Signs of the Future

JET AIRLINES
Lv. New York .... 1:00 a.m.
Ar. San Frans. .... 12:15 p.m. (yesterday)

* * *

Irreversible Process

One hot day last summer an M.E. student was observed throwing water up in the air and waiting for dry ice to come down.

* * *

Did you hear about the electron who was picked up drunk? The judge gave him thirty days in a dry cell.

* * *

As the dentist said when he inserted the rubber gag in the patient's mouth, "How's the wife and kids?"

* * *

"Say, there's a lovely looking lass!"

"Nice face too."

* * *

They say that there is an engineer on the campus who won't take a drink—you have to hand it to him.

* * *

Most girls think they are young colts when they are really old 45's.

* * *

Did you hear about the Scotsman who went out and bought a pair of tight shoes after he found a box of corn plasters?

* * *

Shades of St. Pat, begorrah!

The courtroom was crowded. The witness was on the stand, and the prosecuting lawyer was trying his level best to discredit said witness. Said the lawyer, "And what is your profession?"

To which Grogan replied, "I am a hod-carrier."

"What," cried the lawyer, "do you mean that you consider that as a profession?"

"Well, I'm doing better than my old man did," replied Grogan, with strong conviction.

"And what was your father's business?" asked the lawyer.

"He was a shyster lawyer, he was."

Campus . . .

(continued from page 10)

sponding secretary.

Favorable responses to the Newsletter of the past spring were numerous so the present active group is contemplating a comparitively large publication this fall. An initiation is also scheduled as usual.

IRE

"Your Chance for a Job" was the title of the address delivered by Henry G. Goehring at the first meeting of the student branch of the Institute of Radio Engineers on October 5. Mr. Goehring is job placement officer for the college of engineering.

The scheduled meeting with Dr. Lee DeForest, inventor of the radio, had to be cancelled due to business pressure. Dr. DeForest was in Madison to visit radio station WHA.

TRIANGLE

Triangle Fraternity opened its social slate for the new term with an informal house party after the Wisconsin-Illinois game (we won that one). Forty couples spent an enjoyable evening dancing to recorded music, while refreshments were served in the Triangle "Rathskeller". The social schedule looks like a success if this party was any indication of what's to come.

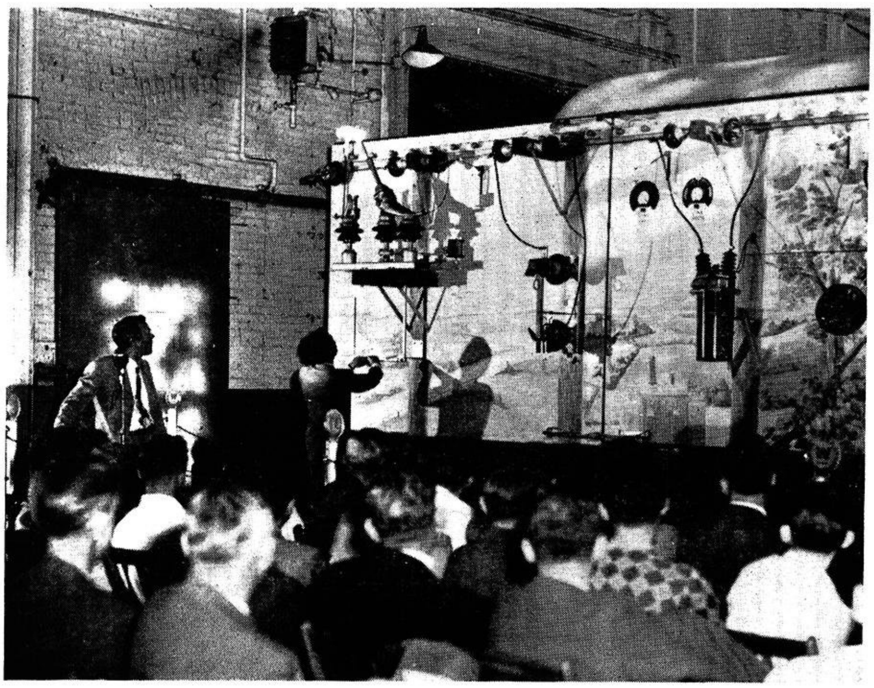
THE WINNAH!

Ernest "Bud" Elliott, ME student, recently won first prize for his model of the C. & N.W. Pioneer locomotive in a Chicago contest. The model was machined out of brass and steel to a scale of 3 1/3 mm to the foot. The model is now at the offices of the Chicago and North Western Railroad. Bud estimates that it took him somewhere between 300 and 500 hours to complete his masterpiece. Our collective hats are off to Bud.

POLYGON PLUG

Polygon board, representative board of all engineering societies, has swung into action this semester with President Arnold Arnaut, M. & Met., at the helm.

Certain decisions have already been made that affect all engineers as a whole. One of the first was to publicize the business of all Polygon Board meetings so that the engineers may become acquainted with the function of this group. In line with this policy, records of the Board meetings will be published in the Wisconsin Engineer.



One of the most educational events of the past semester was the Westinghouse demonstration that was put on in one of the Gisholt buildings. An actual layout of their distribution equipment was mounted on the side of a truck, and in this way its operation could be observed. Students and faculty members of the E.E. department along with men from Madison's industries observed the two demonstrations that were put on.

POLYGON BOARD MINUTES

Tuesday, Sept. 28

1. A vote of thanks was given to Anthony Heredia for the execution of the task of compiling and distributing pamphlets to freshman engineers as well as upperclassmen relating the functions and purposes of the Polygon Board and the student chapters of the engineering societies on the campus.

2. It will be the policy of the board to call on the societies for aid whenever personnel is needed in the undertaking of certain projects.

3. Merrill DeMerit, IRE, was appointed publicity chairman for the current semester. Charles Cheney, AIEE, was appointed program chairman to be assisted by Warren Armstrong.

4. The board approved an all-engineering smoker for the fall semester this year to replace the Engineers' Ball heretofore staged in the fall semester. It was explained that the traditional St. Pat's Dance to be held this year in Great Hall on Saturday, March 19, would be sufficient. Plans for the smoker will be discussed at the next meeting.

5. The difficulties and inconveniences resulting from the scheduling of two or more meetings of engineering organizations on the same night may soon be done away with. Immediate action is being taken by this board to install, in the office of Dean Withey, a coordinating calendar on which entries are to be made in advance of such meetings. Similar action should be taken with organization activities. Ray Wilhelms, ASME representative, is responsible for this project.

6. It has been called to the attention of the Polygon Board that adequate notification of its proceedings has not, in the past, been made to the engineering school as a whole. Consequently every effort will hereafter be made to keep the school notified. To achieve this end our publicity committee is being advised as to the appropriate outlets. The staff of the Wisconsin Engineer has been enlisted to aid toward this end. In addition Polygon representatives will report to their respective societies the business of this board.

Tuesday, Oct. 5

1. This year marks the resumption of the engineering freshman lectures. It will be the responsibility of each engineering department to conduct one lecture per semester. It was suggested that the respective engineering societies aid in these lectures and perhaps illustrate the functions of the various societies.

2. Polygon Board sponsored a telegram to the V. A. requesting a new interpretation of the by-law of the G. I. Bill providing expenses for engineering field trips. A vote of thanks was extended to Richard Ausborne, president of IRE, for the work that he had already done concerning this project.

3. Plans for the Engineering Smoker were completed.

JUMO --- 004 . . .

(continued from page 16)

should lose its flame during operation, it can be relighted by this passage to the adjacent chambers in which combustion is still taking place.

In burning low volatility fuels, mixing of the air and fuel becomes more difficult. In cognizance of this fact, there were installed in the entrance to the chambers small swirl blades which lend turbulence to the air. The fuel is injected at pressures of 100 to 400 psi. depending upon the engine load. The main fuel pump will deliver a maximum of 3000 lb.-hr. at 740 psi. at 8700 rpm, main shaft speed. The design of any combustion chamber must ultimately become a trial-and-error project.

To maintain optimum conditions at all times the overall temperatures would have to be kept at that temperature which would be safe for the most critical point. In this case, the blade roots are the most critical, for they must withstand centrifugal stresses greater than any part of the machine. As the temperature increases, the strength decreases; yet, as the temperature decreases, the work decreases and the efficiency drops. The compromise must be for an uneven temperature distribution, in order to keep the roots cool, yet keep the gas hot on the whole. This is accomplished by playing cooling air over the face of the turbine, which spreads the air centrifugally to enter the gas stream at the roots of the blades on the forward side. In the Jumo, the air stream is separated into two parts—cooling air and combustion air.

After combustion has taken place, the gases are passed out the rear of the chambers to be collected in a manifold. At the end of this manifold is the ring of nozzles for the turbine. In order to shield these from the radiation from the burning gases, and to aid in mixing the cool air with the hot air, a baffle is placed in the outlet from the chambers.

SINGLE STAGE IMPULSE TURBINE

The driving unit for the axial flow compressor is a single stage impulse turbine with 10-12% reaction. The velocity of the entering gas is such that, when running at rated speed, the exit velocity relative to the case is directly to the rear. When running at other speeds, the gases will have a swirling motion.

The temperatures across the length of the turbine blades are not constant, but vary from 1100°F at the roots to 1380°F at the center section—then back to about 1120°F at the blade tips. The average temperature across the length is 1250°F. The stress concentrations throughout their lengths will show the importance of having low root temperatures. At the roots, centrifugal stress alone becomes 25,000 psi, whereas the blade tip must withstand no centrifugal force.

The material for blading these turbine wheels is a 10%

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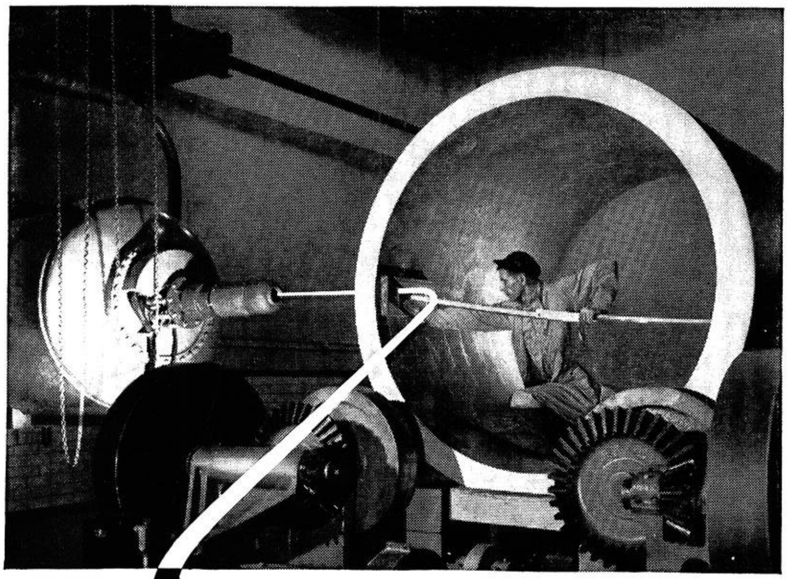

Food—ours to have and to hold

QUICK-FROZEN or in cans, dried or powdered, processed or in bulk, foods can now be kept fresh and flavorful from harvest to harvest . . . or longer.

For this we can thank research . . . and *better materials.*

There's nitrogen, for example, that protects the flavor and nutritional values of packaged foods. It is also used to protect delicate foods . . . butter and vegetable oils . . . keeping them sweet and free from undesirable odors.

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FREE: *You are invited to send for the new illustrated booklet, "Products and Processes," which shows how science and industry use UCC's Alloys, Chemicals, Carbons, Gases and Plastics.*

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Alumni . . .

(continued from page 14)

Editor of the "Engineering and Mining Journal", New York, N. Y. He has been affiliated with the publication for some time.

Harold N. Propp ('38) has been recently appointed Western Representative of the Nordberg Manufacturing Company, La. He transferred from Milwaukee.

Daniel V. Dodge ('48), Warren K. Finn ('48), and Orville H. Dahlberg ('48) are now employed by the Oliver Iron Mining Company of Hibbing, Minn.

Donald Colbo ('48) and George J. Anderson ('48) have been employed as trainees by the Shell Oil Company of Houston, Texas.

Lemoyne S. Olson ('48) is now affiliated with the Inland Steel Company of Ishpeming, Mich. He is employed as a Mining Engineer.

Curtis R. Bently ('48) has been employed by the Denver Gardener Company as a Sales Engineer.

Robert G. Schmidt ('48) has been employed as a Geologist by the U. S. Geological Survey.

Anthony J. Hausladen ('48) is now in the Special Research Department of the Carter Oil Company, Tulsa, Okla.

Robert Ramage ('43) and Leonard Wortman are now operating a Specialty Foundry in Sheboygan, Wis.

M.E.

John A. Metcalfe ('48) has joined the Camera Works division of the Eastman Kodak Company, Rochester, New York.

Following graduation from high school, he entered the Air Force in 1943, and served until 1946. He then completed his studies at the University of Wisconsin, receiving the B.S. degree in mechanical engineering this spring.

Richard L. Wilson ('48) is now working as a student engineer for Wright Aeronautical Corporation in Fanwood, N. J. Last June he received his B.S. degree.

This is where to dig for oil

No one has ever brought in a gusher in Whiting, Indiana—

—yet some of the greatest discoveries in petroleum history have been made in Whiting, and more will be made there. For at Whiting is Standard Oil's research laboratory, now housed in new buildings like the one above.

Standard Oil researchers, engineers, and other technical men have worked for years on the problems of getting more and better products from crude oil. Results to date are equivalent to the discovery in the laboratory of extra *billions* of barrels of petroleum.

Now Standard's men of science are looking beyond crude oil, as well as deeply into it. Already they know how to make liquid fuels and other products from natural gas and from coal, by variations of the hydrocarbon-synthesis process. The future will bring additional progress on possible replacements for petroleum and particularly on more effective methods of using our present supply.

A good share of that progress will be made in the Whiting laboratory. Standard Oil men of the present and future will continue to dig for oil in their own effective way.

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POWER ALCOHOL . . .

(continued from page 9)

decreased the starting temperatures to 32 degrees F. and 0 degrees F. respectively. Although these additives reduce the octane rating somewhat, they seem to be the solution to the starting problem.

One of the chief advantages of alcohol as a fuel for internal combustion engines is its high antiknock characteristics. Most gasolines available for automotive purposes today are of moderate octane rating, in the range of 68 to 72 perhaps, and these octane numbers have limited compression ratios to the present day highs of around 7:1. With alcohol the compression ratio can be run up to around 10 or 12:1, with resultant increase in power output and efficiency for a given amount of fuel. It is interesting to note that in a test made by the Bureau of Mines, an engine with a compression ratio of 5.11:1 gave from 2 to 5% more power output than gasoline, and this was done in an engine designed for gasoline.

In the preceding paragraph it was stated that the alcohol fuel gave slightly greater power than gasoline. This was obtained at a greater fuel rate than that obtained with gasoline. The explanation for this increased consumption lies, mainly, in the lower heating value of alcohol as compared to gasoline. Alcohol has a heating value of 11,760 BTU per pound while gasoline has 19,500 BTU per pound heating value. This indicates that in order to get the same power output from a similar engine, more alcohol must be burned. However, it has been determined (Lichty, Internal Combustion Engines) that the heating value of correct air-fuel ratios of both gasoline and alcohol is practically the same which seems to indicate that the matter of fuel consumption for alcohol is more one of design than an inherent characteristic of the fuel itself.

Other characteristics worthy of survey listed in a preceding paragraph were, vapor lock tendencies, oil contamination, and wear and corrosion tendencies of the fuel. From tests made by the National Bureau of Standards it was found that the vapor pressure of alcohol is materially lower than that for gasoline at the same temperature, which would seem to indicate that less trouble would be encountered from vapor lock with an alcohol fuel than with gasoline.

In comparing an engine run on alcohol with one run on gasoline, it was found that the measureable cylinder wear was twice as much for gasoline as it was for alcohol.

Bureau of Mines tests showed that with alcohol there was no detectable contamination of the oil in the engine, while with gasoline the dilution was several percent. These same tests showed that the average oil free deposits for 40 runs were 27.56 grams for gasoline and only 4.96 grams for alcohol. What this means in engine cleanliness and oil life need hardly be stated.

One of the primary characteristics of alcohol not before considered, is its high latent heat of vaporization. From the National Bureau of Standards tests it was shown that it takes from 3.5 to 5 times as much heat to vaporize alcohol than it does to vaporize an equal amount of gasoline. Or putting it in another way, for an amount of heat sufficient to vaporize a quantity of gasoline 100%, this same amount of heat will vaporize only 54% of an equal quantity of alcohol, and the final temperature after evaporation will be 46 degrees F lower than that for gasoline. This ability of alcohol to absorb heat is graphically illustrated by citing one of the tests run by the Bureau of Standards. The engine under test was a standard type automobile engine and the test was a road test. In 90 degree air temperatures the intake manifold on the car was covered with frost due to the cooling effect of evaporating the alcohol.

Of what use is this high latent heat of alcohol and of what detriment? Well, in the first place it is known that a gas is more dense at lower temperatures than at high, and that the greater the weight of charge in the cylinder, the more power is developed. With the low temperatures involved in the induction of alcohol to the engine, a greater volume and, therefore, greater weight of gases may be inducted with consequent increase in output. The big handicap in this respect is, that with this large amount of heat necessary to vaporize the alcohol where is it going to come from? It's all right to say that there is generally an excess of heat around an engine, but will there be enough if it is constantly used up in such large quantities? The off shoot of this whole discussion is that if enough heat is not available all of the alcohol will not be vaporized with resultant waste and increase in an already high fuel rate. What these effects would be in an engine designed specifically for alcohol is not known since no such engine has been built, but it might call for some arrangement whereby the induction system would be heated. This again would result in decreased volumetric efficiency, so again the final solution would be a matter of compromise to get the greatest advantage with the least disadvantage.

From the general picture of alcohol which has just been given, it can be seen that it has definite possibilities as a fuel. In comparison to gasoline it has better antiknock characteristics and can therefore be used at higher compression ratios; it gives only about one-fifth as much oil contamination as gasoline and shows only about one-half as much cylinder wear; alcohol has less tendency to form vapor lock; and, because of its high latent heat of vaporization, it gives increased volumetric efficiency.

On the other hand, because of its lower heating value, in present day engines alcohol has a considerably higher fuel rate than gasoline, and it is hard to start without additives at moderately low temperatures. The long list of advantages checked off against the few disadvantages, however, does seem to indicate that alcohol will play an ever increasing part in the solution of future fuel problems in the United States.

Artificial Beauties . . .

(continued from page 12)

clusive processes and users who wish to take advantage of the processes may apply to Linde to be licensed to do so.

Sawing of the boule is usually done with metal blades which are charged with diamond dust. The accompanying photograph illustrates the various steps in the reduction of the boule to rough "blanks". It also illustrates the saving in intermediate sawings brought about by the development of the corundum rod.

Grinding of synthetic is done by the conventional techniques using diamond as an abrasive. In the accompanying photograph, the operator is grinding a piece of corundum on a diamond-charged copper lap. Successively finer diamond dusts are used as the product is brought to its desired shape. Mechanical polishing is accomplished by holding the corundum on a metal lap impregnated with diamond dust.

Drilling operations are done with a hardmetal wire which has been charged with diamond dust.

It is necessary to grind and polish many products mechanically, but still there are many which can be flame-shaped and flame-polished. This process was a direct outgrowth of the corundum rod. The rod is of such form that it is easily worked with and bent at high temperatures.

Flame-polishing has become important in the polishing of the sapphire rods. As the rod rotates, the flame travels back and forth, producing a surface on which no surface scratches are visible even under a high-powered microscope. Interesting shapes such as the tear-drop can be fashioned by the flame-shaping process.

Synthetic gems are available in several sizes, shapes and colors. With continued research and development they will be available in all sizes, shapes and colors to replace the natural gems in many capacities at a much lower cost.

Science . . .

(continued from page 18)

that each engine may run approximately the same number of revolutions and thus have the same amount of piston travel.

To permit simultaneous cyclical operation of the five test engines, a central panel for automatic timing and control has been installed. The timing device is basically an electric clock which makes contacts at five-minute intervals, opening and closing circuits to the relay panel at the proper time. The relay panel, in turn, opens, closes, or holds the circuits that operate the throttle, the cooling system, the starter, and the stopping mechanism. Five indicating lights on the panel show what part of the cycle is in progress, thus permitting a ready check on the compliance of the engines with the controls. From this central panel any cycle of operations may be arranged.

In addition, each engine has an individual control panel which contains a recording vacuum gage, an oil-pressure gage, temperature indicators for water and oil, tachometers to show the speed of the engines, and switches for each type of operation. Any engine may thus be cut out of the test cycle and controlled manually during adjustment or repair. This arrangement also permits an engine to be stopped for observation without interfering with the others in the cycle.

Electric solenoids are used to assure simultaneous operation of throttles and corresponding valves for all engines. Each engine is equipped with an automatic choke to insure starting after the cooling period, and also with a device which automatically engages the starter at the beginning of the cycle, or whenever the engine may stop while running. Intake manifold pressures of each engine are recorded over a 24-hour period by a recording gage. Since the manifold vacuum at a given speed is a function of throttle opening, the operation of the engine is thus charted during the cycle.

NEW SAFETY BASE FOR MOVIE FILM

A new type of safety base for professional movie film was recently disclosed publicly by the Kodak Company at a convention of the Society of Motion Picture Engineers. If large scale tests in the field continue to prove satisfactory, the new base promises to eventually replace the standard 35 mm. cellulose nitrate professional film.

The safety base film used in 8 and 16 mm. amateur film burns very slowly, but the nitrate film used professionally has always presented serious hazards. The 35 mm. film has different requirements than the amateur films, and heretofore a suitable safety base for the professional film has been lacking. Development of this present high acetyl acetate formula is the result of extensive research since the company first changed to cellulose acetate propionate base in 1937.

NEW WELDING ELECTRODES

A new type of manual arc welding electrode will be displayed for the first time at the National Metal Exposition in Philadelphia, October 25-29, by North American Philips Company. The new electrode is designed to improve weld quality while lowering welding costs.

Certain definite advantages are offered by these electrodes, which are available in lime ferritic, iron oxide, and organic types with a special type of coating. Lower costs per foot of weld joint are achieved with high deposition rates and efficiencies. Weld metal of the highest mechanical properties is deposited at from 25% to 100% faster rates than with standard type electrodes. Training time for apprentices is reduced, operator fatigue is lowered, higher production rates are possible, and the electrodes may be used in all positions except vertical up. High deposition efficiency is obtained because of the low spatter losses and special coating of the new type Norelco contact welding electrodes.

R.W.H.

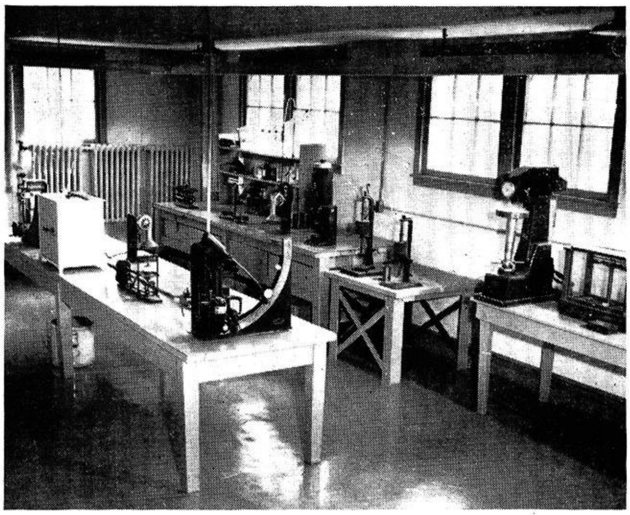
NEWEST . . .

(continued from page 13)

cope is made on the jolt squeeze pin lift machine. The match plate is fixed to the machine and the flask is put on, filled with sand and then jolted and squeezed. Then four pins lift the cope and draw the pattern so that it is ready to be put on the drag. Both machines are operated by compressed air and little work is left for the operator. The jolt machine that was in the old foundry is in this group too. The molding benches are those from the old foundry. The molding tools are in tool boxes so that they can be kept together. There is one tool box for every two tables. Metal patterns will be used instead of wooden ones. These patterns will be painted in the color scheme recommended for good foundry practice. The color scheme is being developed throughout the laboratory.

Sand Test Equipment

The second room contains the cleaning apparatus, the core making equipment, the sand and the sand testing equipment. The tumbling barrel and the sand blast cabinet are the ones from the old foundry. A new Wheelabrator Table has been installed. This machine has a table which revolves. On this table the castings are placed and an elevator that carries patented malleable iron heat treated grit from a bin to a wheel that throws the grit at a high velocity against the casting. A new core blower and



View of the sand testing equipment where the permeability and strength of sand is tested.

a new mauler add to the core making equipment. The mauler is unique because of a plexiglas window that allows the students to see the action of the mauler as it is working. It is portable, being mounted on rubber tires from which it derives the name "Maulbarrow". A new screenerator also mounted on rubber tires screens the sands and heaps it. Ferrous and non-ferrous sand is being used now where before ferrous sand only was used. Synthetic sands are also on hand and are mixed for instructional purposes.

New Hines Pop-off Flasks complete the list of equipment. These flasks spread open, releasing the mold and making it much easier to remove the mold than the ones that were being used. Complete metallurgical laboratory facilities are readily available in the M. & M. Building. Equipment for physical testing, chemical analysis and metallographic examination may be used for demonstration. A 120 kv radiographic, a x-ray diffraction and a spectrographic machine are included in this equipment.

The laboratory is for the course, M & M 33, which M. E.'s are required to take. Students in other engineering schools may choose it as an elective if it satisfies their program. It also serves metallurgical students in a course stressing the technical and metallurgical phenomena of cast metal. It provides research facilities for the faculty and students who are encouraged by the recently reactivated University of Wisconsin Engineering Expriment Station.

The planning and the work that has gone in the development of the laboratory has been under the direction of Prof. G. J. Barker, chairman of the Department of Mining and Metallurgy, Prof. P. C. Rosenthal and Assist. Prof. R. Hienie of the same department. Dean M. O. Whitey of the Engineering College has provided the administrative encouragement.

WATCH FOR

- Transistor
- Opposed piston engine
- The future of the electric power industry
- Printed circuits
- Teflon
- Controlled conditions plant
- Graduate study
- Ultrafax
- Sulfur mining
- Flame gear cutting

These will be the subjects of articles in future issues of the

WISCONSIN ENGINEER

JUMO-004 . . .

(continued from page 28)

chromium—30% nickel steel. The original blades were solid without cooling, but later blades were of hollow construction with cooling air passing through from their roots (in the wheel) to their tips. At the tips, this air enters the stream of hot gases to maintain a relatively cool surface on the inside of the casing.

The wheel disk is made of a hardened chrome steel with 2.8% chromium. It is cooled by a quantity of air introduced near the hub to be spread outward by centrifugal force, and that gas behind, to the outer edge of the wheel. At this point, the air enters the gas stream to cool the roots of the blades.

The stators are cooled by air passing through from one end and exiting through slots on the trailing edges. The material is chrome-manganese steel, having 18% manganese and 9% chromium. The total throat area is 84 square inches. The gas acceleration through these nozzles was from 345 fps to 815 fps, when operating at 8700 rpm. The overall efficiency of this turbine was 69.7% at 7000 rpm and 72.4% at 8700 rpm.

—*Photo by Strasse*

German fighter plane using two Jumo-004 engines, one mounted below each wing. This type of mounting on most planes made possible adding the unit without design changes.

EXHAUST CONVERSION

In contrast with more conventional engines, the exhaust section is that which supplies the greater portion of the work; that is, the conversion of heat energy to mechanical energy is accomplished here.

The position of the jet nozzle is of great importance, since it determines both the back-pressure on the turbine and the velocity of leaving gases. As the back-pressure on the turbine increases, its constant-speed governor causes more fuel to be injected into the combustion chambers to retain the desired pressure-drop across the turbine.

It can be shown that for any given rotor speed, a great number of thrust values can be obtained. This is due to the variable area of the nozzle. Since the thrust is dependent upon the change in velocity of a mass of air and fuel, diminishing the cross-sectional area of the nozzle will increase the thrust by increasing the exit velocity. This is very convenient for landing and idling conditions, since the engine must be kept operating with very little thrust. By increasing the area, the engine rpm can be maintained high with little thrust.

Consequently, the position of the exhaust needle is of great significance. The manner in which its position is controlled is therefore of equal importance. The needle itself is mounted within a sleeve for support, and it is given longitudinal movement by a rack—which is driven by a servo-motor through miter-gears and a pinion. This servo-motor is powered by an oil pump which is driven directly from the rotor through a gear train.

Cooling in the exhaust section is accomplished by passing air between its double-skinned construction; in addition to this, however, an envelope of cool air is caused to flow over the inside surfaces of the skin and over the outside of the sleeve supporting the needle. Air is forced through the struts supporting the sleeve to be circulated through the needle and eventually discharges between the sleeve and the needle to cool the outer surfaces of the latter.

The extreme end of the engine is cooled by air which is scooped up from the outside by a "lip" to be forced through the double-skinned converging section. This, then, is discharged on the periphery of the exhaust.

GOOD ENGINE UNDER THE CIRCUMSTANCES

Before comparing the Jumo with other, and more contemporary, jet engines, one should remember that this engine was made under the pressure of war-time shortages and with an eye to high production at minimum labor requirements. The design, as adapted to these conditions, speaks well for the engineers who conceived it. There were, however, certain shortcomings which seemed to stem from occasional laxness in design.

The combustion chambers of the Jumo, though they could boast a life of only 25 hours under normal conditions, were so inaccessible that a major overhaul of the engine was necessary to replace them. The starting engine was entirely adequate for its primary purpose of starting on the ground, but the difficulty of restarting at altitudes made it inferior to a similar installation electrically driven.

Had alloys permitting higher temperatures been available, the output of the unit could have been much greater for the same size. Less cooling air would have been bled off from the compressor, which would have decreased the engine losses.

The unit offered a very low frontal area, and the weight was low. The engine was very easily dismounted for servicing, having "plug in" connections grouped together on one connection plate. These connections included the fuel lines, electrical and instrument connections. The engine mounts themselves are few and simple. The engine was adapted to existing airplanes, and the underwing type mounts made the installation of the engine possible without major revisions of the original designs.

Because photography lasts . . .

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CAREERS AT GENERAL ELECTRIC

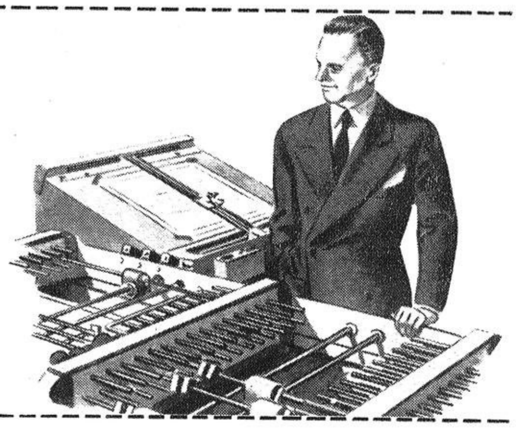
General Electric is not one business, but an organization of many businesses, offering opportunities in virtually all the professions. Here three G-E men brief the career-possibilities which the company offers to the technical graduate, the mechanical engineer, and the chemical engineer.

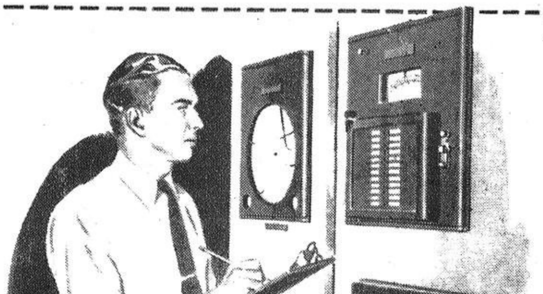
TECHNICAL SPECIALISTS: MEET YOUR HOST

M. M. Boring (Colorado), manager of the Technical Personnel Division: It's my job to contact young men with technical training who are interested in careers with General Electric, and to start them on their way up through our training programs. Opportunities for them were never greater. This year we have hired more electrical, mechanical, and chemical engineers, and more chemists, metallurgists and physicists, than ever before.

MECHANICAL ENGINEER

H. P. Kuehni, of the General Engineering and Consulting Laboratory: Much of my work has to do with such hurry-up calculating machines as the differential analyzer, the AC network analyzer, and the electronic digital computer. For the engineer with a bent toward mathematics, these machines are opening up exciting possibilities in many problems whose mathematical complexities, or sheer length, have heretofore discouraged investigation.





CHEMICAL ENGINEER

Gil Bahn (Columbia), graduate of the G-E Advanced Scientific Program: Graduation from this program poses an interesting problem to the chemical engineer. Which of the company's diverse fields of endeavor offers the greatest challenge and opportunity? My own choice was in plastics, particularly the complex processes used in manufacturing synthetic phenol. I'm convinced it's one of the most fascinating tasks a young chemical engineer could tackle.

For further information about a BUSINESS CAREER with General Electric, write Business Training Course, Schenectady, N. Y.—a career in TECHNICAL FIELDS, write Technical Personnel Division, Schenectady, N. Y.

GENERAL ELECTRIC