Spartan ENGINEER

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4th Annual Engineering Exposition Speaker
Topic "The Challenge of Engineering's Second Hundred Years"

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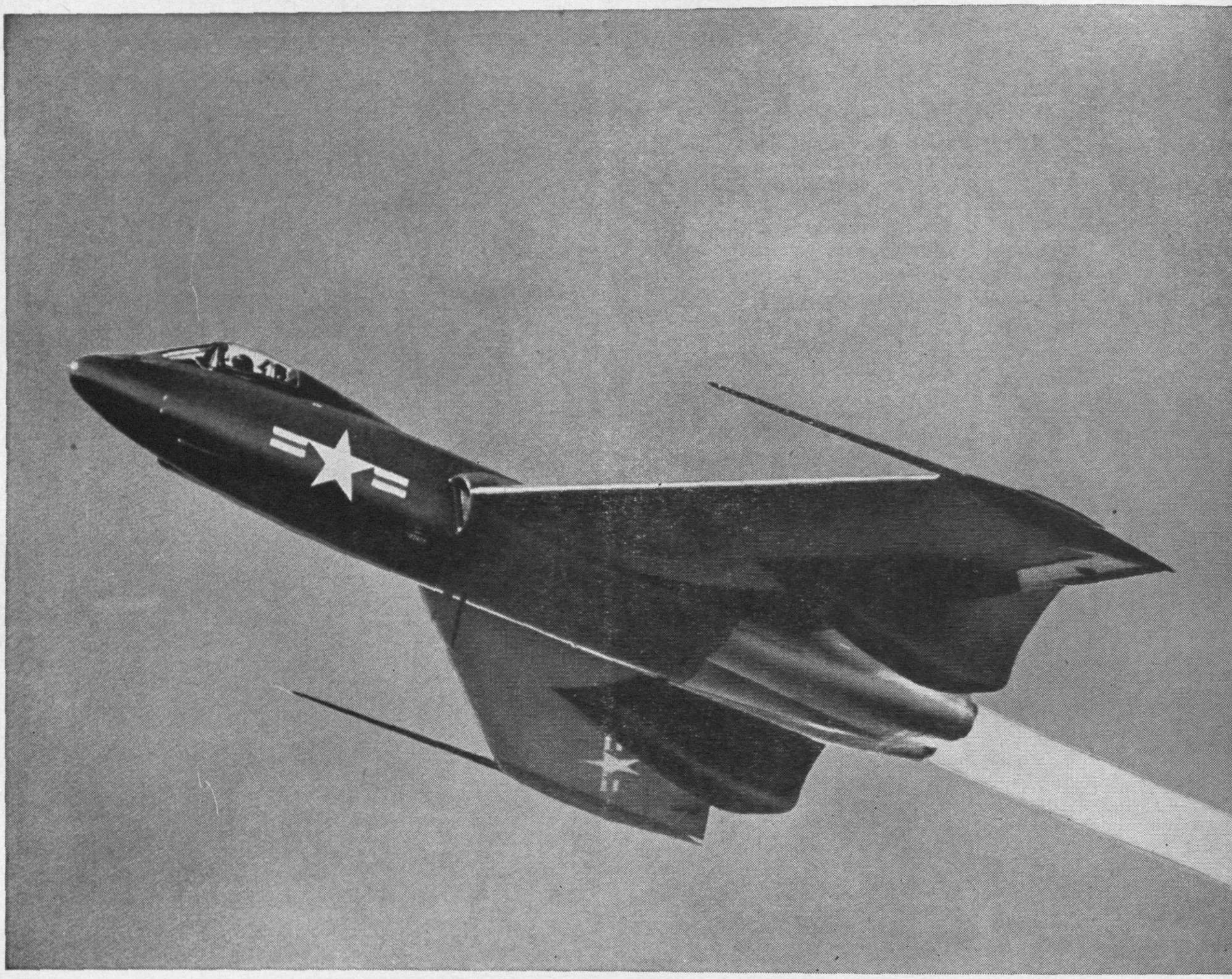

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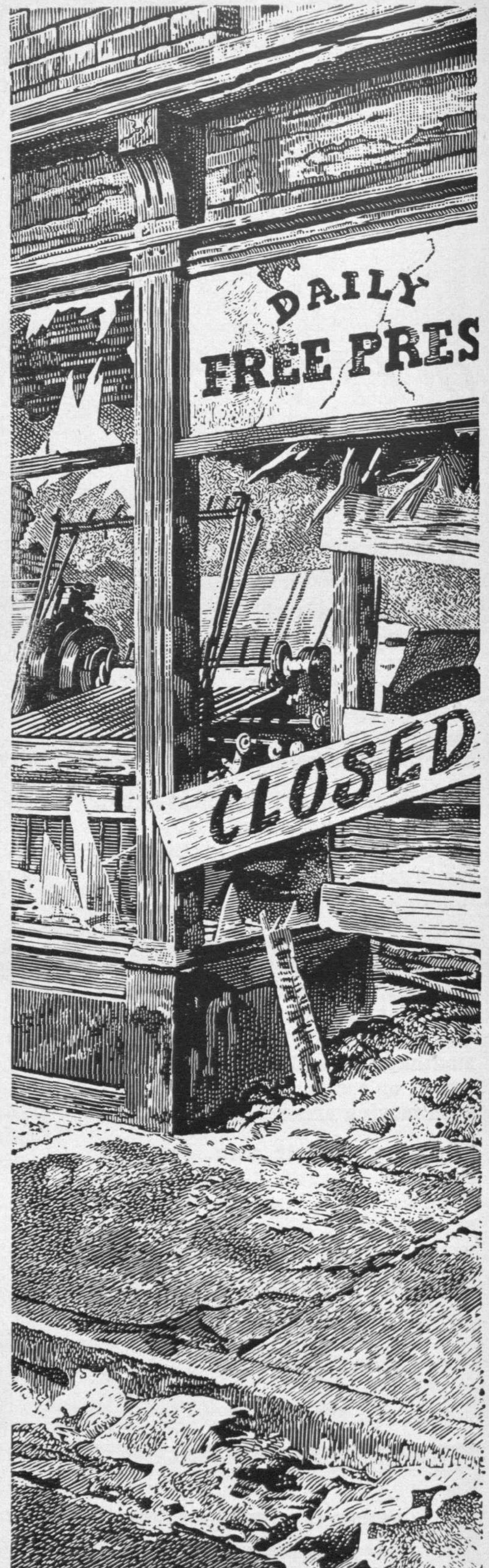

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Spartan ENGINEER

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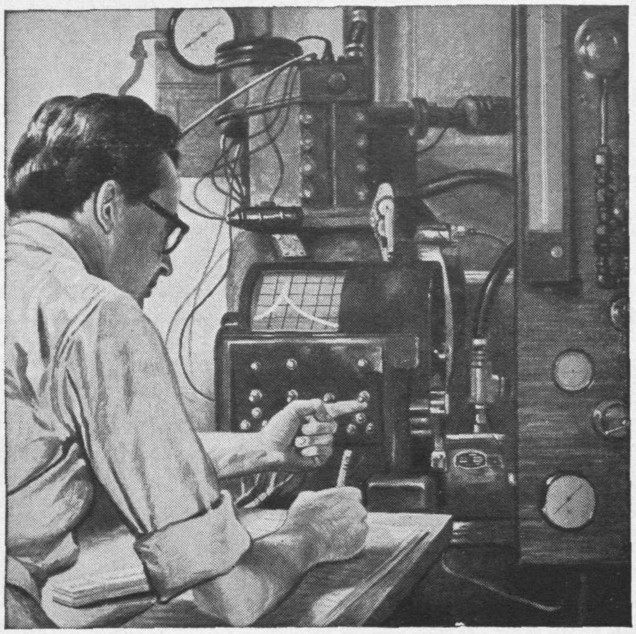

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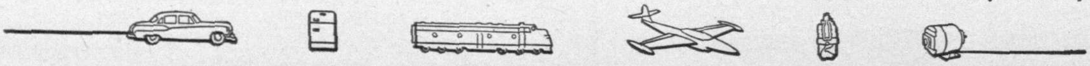


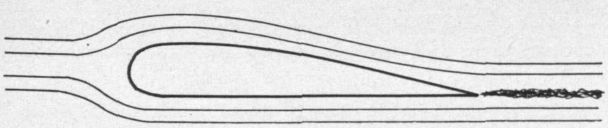
THE SONIC BARRIER

By LEE JEDYNAK
Electrical Engineer '54

Early in World War II Ralph Virden, of Lockheed Aircraft Corporation, nosed his P-38 into a terminal velocity test dive. The plane's airspeed increased steadily until, without warning, it went out of control in a series of violent vibrations. With his life at stake, Virden tried every trick he knew to regain control of the plane, but his efforts were useless. With snapping finality, the tail assembly was torn away by rampant air currents, and he knew that further struggle could not save him. Virden's death was among the first caused by the sonic barrier. At that time all that was known about the barrier was that it was composed of violent and unpredictable currents of air moving at, or near, the speed of sound over the surfaces of an aircraft.

Research in sonic and supersonic air flow dates back to the early 19th century, when Professor Ernst Mach studied the relationship of air speed to sound speed and its effects upon air flow and density. From Professor Mach's work with artillery shells, at the University of Vienna, until shortly before the second world war, there was little progress made in the study of high velocity air flow. However, the last decade of military demands for high speed aircraft has resulted in rapid progress in the study of the behavior of air at high velocities.

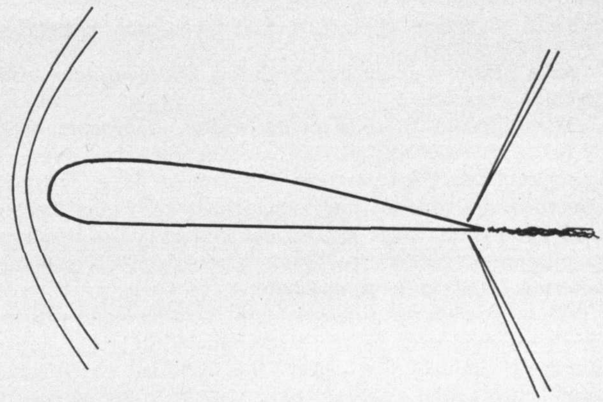
The wing of a slow flying aircraft, by slightly compressing the air at its leading edge, generates pressure waves. These pressure waves are sound waves which travel out in concentric spheres or shells at the speed of sound and prepare the air for easy passage of the wing. Figure 1 shows a conventional airfoil at subsonic speed. Notice the smooth flow of air with only slight turbulence at the trailing edge.



(Fig. 1)

As the plane approaches the speed of sound the pressure waves in front of the wing become closer together. When the plane reaches and exceeds the speed of sound the waves can no longer outrun the plane, and pile up in one continuous standing wave at the leading edge of the wing. This standing wave is known as a **shock wave** and is a region of compressed air. At speeds greater than sound speed the shock waves cannot keep pace with the plane and therefore trail outward and back at a Mach angle (from the studies of Professor Ernst Mach). The size of the Mach angle is a function of the ratio of the plane's speed to the speed of sound in the air immediately surrounding the plane. The numerical value of the speed ratio is called the Mach number. A Mach 0.8 simply means that the plane is moving at a velocity 8/10 that of sound. A Mach 1.2 means that the plane is traveling 12/10 the speed of sound.

Figure 2 shows a conventional airfoil moving at supersonic speed. The shock wave at the leading edge of the wing is the one caused by the pressure waves generated by the wing. The shock wave shown at the trailing edge is known as an **expansion wave.** It is formed as the air from below the wing meets the air from above the wing and both are deflected. These shock waves are the type that exist when an aircraft is flying faster than sound. Their major effects are changed flight characteristics and increased drag, otherwise, they are not as dangerous as the shock waves generated at speeds just below the speed of sound.



(Fig. 2)

The conventional design of aircraft wings is such that shock waves will be formed at less than sonic speed. As a plane travels slightly slower than the speed of sound the air accelerating over the greatly curved leading edge of the wing becomes supersonic with less than atmospheric pressure. On the longer, flatter descent to the trailing edge the air again becomes subsonic with atmospheric pressure. Since a pressure difference can travel only at the speed of sound, and the air upstream is supersonic, the higher pressure at the trailing edge cannot propagate itself to the leading edge. This results in a difference of air pressure over the wing. A more complete analysis of conditions over the wing is as follows; "the upstream edge of the wing has an air pressure, density, temperature, and velocity different from that of the downstream edge. The resultant transition which occurs; a change in pressure, density, temperature, and velocity of the air; occurs in a distance of 0.0012 inches. It is obvious that from this fact that the transition must be violent in nature. This region of transition is a shock wave.

Moreover, there is usually a rapid alternation between formation of these shock waves and smooth aerodynamic flow. This rapid alternation is basically responsible for the extreme air turbulence and the violent actions of an aircraft flying in the sonic barrier. Ralph Virden became a victim of this when the violently disturbed air tore the tail assemlby from his plane. Figure 3 shows a conventional airfoil at 630 miles per hour. Notice the marked air turbulence due to the vertical shock wave near the center of the wing.

(Continued on Page 36)

PLASTER TOOLING - AN AGE OLD ART

By PHIL SANFORD
Civil Engineer '54

One of industry's oldest processes—plaster tooling—has survived until recently with very little change. Today, thanks to a few rather radical improvements, the art of plaster tooling is becoming more prominent than ever before.

Most plaster tooling in the United States is done with gypsum cements.

The "life" of these cements begins as gypsum rock, or calcium sulphate dihydrate. The rock is mined or quarried, and then sent to mills where it is crushed, screened, pulverized, and dehydrated by being heated and agitated in large cylindrical kettles. The result of this process is Plaster of Paris, a powdery-white hemihydrate of the calcium sulphate.

When mixed with water, this hemihydrate returns to its original rock state. Although there is no change apparent immediately after the mixing, the plaster soon enters the "period of plasticity," in which it stiffens slightly. Shortly, it "sets" to a solid mass. As the set progresses, the mass begins to heat and expand, continuing until the final "set." The linear expansion can be regulated from as little as .0005 up to .02 inches per inch.

In addition to a regulation of the amount of expansion, different types of cements take different lengths of time to reach a required expansion. With these different types of cements available, a few specialized tools, and a keen knowledge of how and particularly when to work, a pattern maker may bring his work to the exact expansion required. In some cases, tolerances of as little as 1/28 of an inch have been met.

The pattern maker's toughest and most important job is making proper use of the period of plasticity. During this period, the cement can be shaped by a template, or formed by hand. The former process is called screening, and is possible because of a slow, or "controlled" flow of the plaster. Usually, however, the work will be done best by hand; this somewhat resembles a game of patsy or perhaps the making of mud pies.

Different areas of the pattern will require different stages of plasticity: as the plastic period progresses, the cement gains in strength, and can be built up to the proper contours. It is the correct handling of this progressive plasticity that enables the pattern maker to reach perfection in his work.

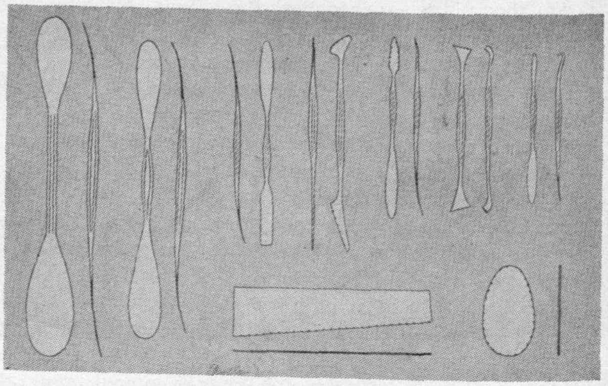
Another important bit of work to be done during the period of plasticity is reinforcement. In some cases the reinforcement is for strengthening purposes alone; in other cases, bulky and awkward patterns must be hauled around and placed together. The reinforcement supplies the means of handling.

Reinforcement can be accomplished by using hemp, sisal, wire mesh, expanded metal, burlap, or muslin, or by a combination of any of these. Probably the best reinforcers are hemp and sisal, which is a type of white hemp, a little stronger than the ordinary kind. Because the hemp used is a very loose type, it can not only be shortened, but can also be lengthened or made thicker. Thus, with the hemp thoroughly soaked in a liquid plaster, the worker can make anything from thick pads, of folded hemp, to long twiny pieces that secure any handles the pattern might have.

The order of operation of plaster tooling is similar in most cases, although the work itself may differ greatly for each type of operation. Before beginning the tooling, the plaster workers will often make a template. The template is usually a piece of metal or pressboard cut to the exact shape required. This will serve not only for screening the cement to shape, but will also serve as a check on the final pattern.

Once the necessary templates are made, the worker can proceed with the actual plaster work. First, of course, is the mixture of the powdery-white sulphate with water. The operation itself consists of strewing the cement into the water, allowing it to soak, and then mixing it with the water, either by hand or with a propeller blade attached to a motor of up to ¾ horsepower. Simple as the operation may seem, the worker has to strew the cement evenly to prevent lumps, has to allow a proper soaking time, usualy two minutes, and has to time the actual mixing operation correctly. Even before all this, the worker must be sure to get the proper consistency of water and cement, according to his needs.

After the mixing, the tooling work begins. Using the proper tools and his knowledge of tooling, the plaster worker can apply himself to making anything from a simple straight mold to a piece of work that has to be rod-turned as its final step. Many rod-turned pieces rival similar wooden pieces, rounded on a lathe, for both accuracy and beauty.



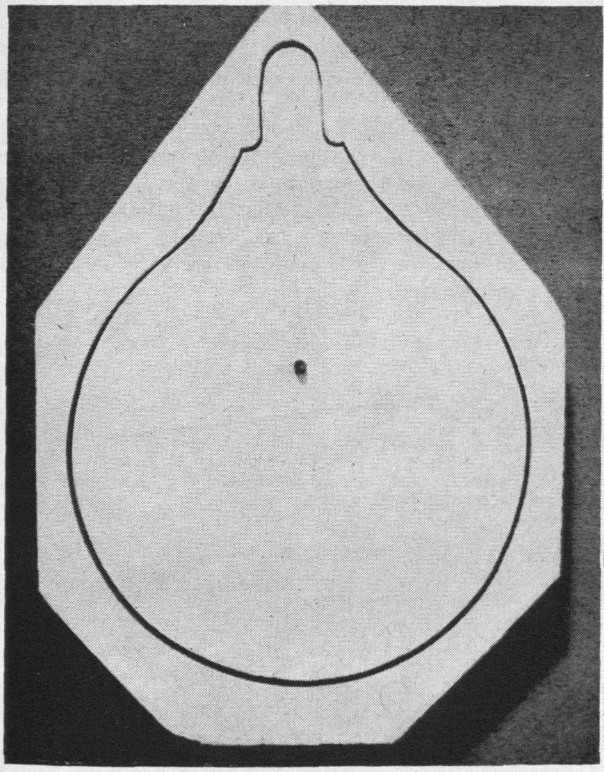
Some of the plasterer's tools include spatulas, scrapers, cutting and filing equipment, carving tools. (U. S. Gypsum Co.)

If the pattern to be made is simple, the process used is usually also simple. Nevertheless, care must be taken to insure the greatest dimensional accuracy.

As in every case, the worker must utilize the period of plasticity to its greatest extent. Using his tools, which range all the way from a spoon—or his hand—for dishing out the liquid plaster, to a very fine special file, the tooler can work all through the plastic period until the beginning of the setting process. During the set he knows, if he has done his work properly, that the cast will reach the desired expansion.

The type of work that can be done depends largely upon the type of cement used. Produced by United States Gypsum under the trademark Hydrocal, there are six kinds of general-use cements.

For a low expansion and high dimensional accuracy, Hydrocal A-11, Hydrocal B-11, or a pattern shop cement can be used. Pattern shop Hydrocal has the most gradual set and longest plasticity, while A-11 sets rapidly with a short plasticity. With a more gradual set than A-11, B-11 is the most suitable cement for template-formed, or built-up molds.



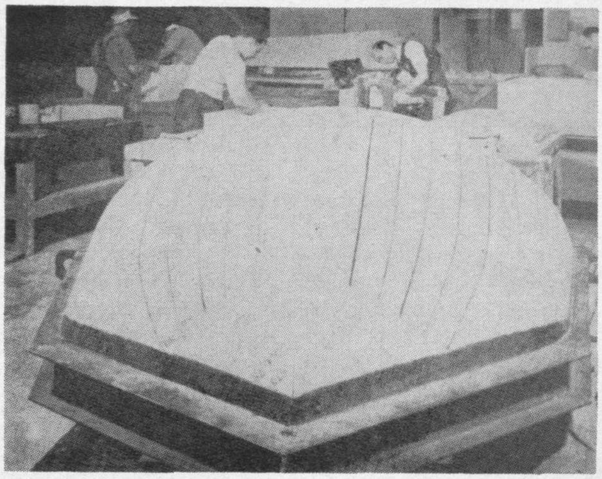
An original pattern and the expanded mold, made of high expansion cement. The neck shows that expansion is proportional. (U. S. Gypsum Co.)

For patterns that require a high surface hardness and tensile strength, Hydrostone is used. It is the toughest of all gypsum cements. Industrial White Hydrocal has the longest set of any of the general cements. Because of a high early strength, it is easily accessible to carving.

If a pattern is to go on past the first casting stage, a very high expansion cement can be utilized. It is this cement that represents what is probably the most radical improvement ever made in the plaster field.

As the name, High Expansion Hydrocal, implies, it has the highest setting expansion of any known gypsum cement. The expansion is uniform in all directions, is proportional to the breadth of the expanding section, and can be controlled by regulating the amount of water in the mixture.

It is these characteristics that make it especially suitable for a great variety of uses. For example, it can be used to expand the pattern described earlier.



One of the many applications of gypsum cements. This is a master prototype model made by wiping the cement into a series of nested templates. (Douglas Aircraft Co.)

The first step in the expansion process is to apply several coats of thinned shellac to the pattern to be expanded. The shellac, and a parting compound applied after the shellac has dried, help ease separation of the original pattern and expansion cast after the process is over. The parting compound is usually of stearic acid-kerosene, or similar substance.

Next comes the mixing, and this process will control the final expansion that can be expected. Here is where the expansion can be made to be as high as .02 inches per inch.

Meanwhile, a four-sided box must be made; one that will fit around the pattern to hold in the plaster that is poured over the pattern. When made of a special "plasterboard," the box will easily pull away from the expansion cast.

The mixing operation must move quickly, for expansion begins quickly. After mixing, the plaster is poured into the box, over the pattern. The excess should be leveled off, resulting in what is known to some in the trade as "Mount Hyrocal."

Following the initial expansion and hardening, the box is removed, and complete expansion allowed. Once expansion is complete, this cast can be used to get the expanded pattern. By working in just the opposite direction—using one of the five low expansion cements, cast in or over the expansion cast—the final result will be a pattern with the same shape as the original one, but with enlarged dimensions.

There are other means of accomplishing the same result, but; making a new pattern is time consuming and costly; building the pattern up with wood, sheet wax, or paper gives rise to inaccuracies; filling in gaps left by the original pattern cut into sections will not give the proper contour to the finished pattern.

Using the high expansion cement, however, a larger cast can be made quickly and accurately. This fact makes plaster tooling adaptable to many new fields. The jobbing-foundry industry, the new plastics industries, several others—all present new opportunities for the oldest of plastics.

Thus, with these different types of cement, and the plaster-man's increasing knowledge of them and their tooling, plaster is an old industry that keeps moving forward.

NUCLEAR POWER ENGINEERING CAREER WITH A FUTURE

By JOHN LOERCH

Chemical Engineer '53

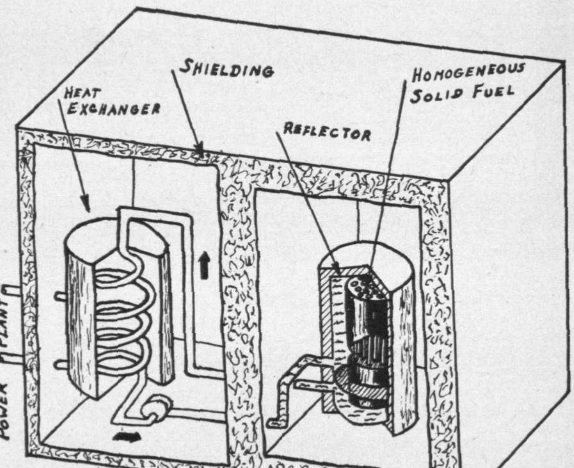
The BOMB! Alpha particles! Gamma rays! Radioactivity, half-lives, nuclear fission, Einstein's mass-energy equation; yes, and Geiger counters, U 235, transmutation, synchrotrons and atomic power!

Since 1945 these phrases and many more like them have been drilled and pounded, worked and re-worked into our thoughts. At first they stood for terror, and death. Now that the first shock has dissipated we find we can turn our thoughts to the brighter side: that of a thriving healthy civilization based on peace and a new source of power: that of the atom. Here and now indeed is the world's Armageddon!

Much of the basic research and theory has already been accomplished toward the development of fission as a source of controllable energy, thanks to the development of nuclear reactors by the Atomic Energy Commission during the last World War. It is true that these piles were set up for the sole purpose of obtaining materials suitable for use in the atomic bomb, and that all by product energy was wasted in the government's haste to get the piles in operation, yet it is also true that these reactor piles were designed to handle many of the problems inherent in all nuclear reaction plants. These problems include some workable construction materials, control of radiation, standards of safety, methods of quickly and effectively damping the chain reaction, critical masses, disposal of radioactive wastes, and means of cooling the pile.

To date ten known permanent units utilizing chain reactions have been set up in the United States. Examples of these are the Argonne National Laboratories and the Oak Ridge plants. None of the ten, unfortunately, develops useful power. For this reason it must be realized that we are just beginning the process of finding methods of using atomic power once the pile is in operation. Ten thermal power plants exist, including both heterogeneous and homogeneous types of fuel utilization, and yet no effective means of utilizing their energy is known.

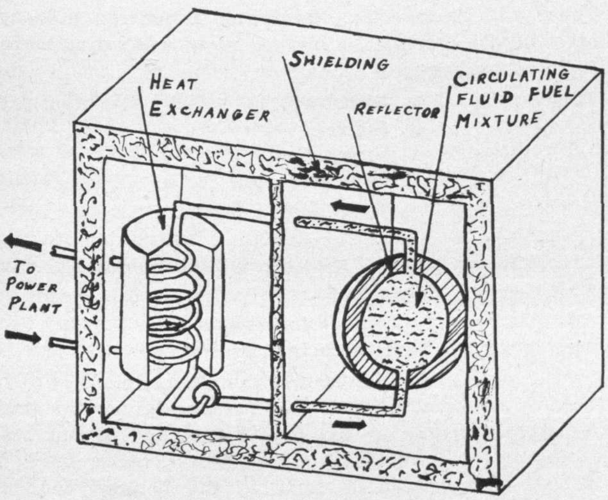
For the present, it appears all nuclear power units must depend on the following steps of operation: (a) maintenance of a controllable chain reaction, (b) the inherent conversion of the energy produced to relatively high entropy heat energy (discussed later), (c) removal of this heat energy by raising the temperature of a fluid, and (d) the conversion of this energy to mechanical energy by conventional means. Basically, therefore, a nuclear power reactor is simply a new type of heat source. As we shall see, it is inherently capable of delivering its energy at a very high temperature level, but for practical reasons is limited to moderate temperatures, such as are encountered in other engines. One reason for this is that construction materials are unable to withstand the temperatures that would be desirable. Also, the problem of cooling the reactants and diluant, a reaction-promoting filler, is not any easy one to solve. In other words, three problems now confront any efforts at setting up a reactor to be used for power supply purposes. These deal with: (a) construction, (b) heat transfer and cooling within the pile, and (c) utilization of the heat energy developed. Several small piles are in the process of being built as propulsive units for military purposes, and presumably solutions for the more basic questions have been found, but national security prevents their being released to the public. For the purposes of this discussion I shall assume that questions whose answers are covered by security regulations remain unanswered.



(Fig. 1)

Construction problems depend primarily on the ability of the enclosing materials to withstand exceedingly high temperatures, and secondarily the effects of concentrated radiation on their structures. The atom bomb itself points out that inherently there is no practical limit to the temperatures obtainable through fission. Elementary thermodynamics makes it possible to show that the fission particles fly apart with velocities corresponding to temperatures of many billions of degrees Kelvin. The only drawback is that even the most refractory materials known (such as W, graphite, BeO, Al_2O_3, MgO, US_2, UO_2 and ThO_2) melt or decompose at temperatures of only a few thousand degrees. This is a case where limits must be placed on the release of intra-atomic energy in order that inter-atomic forces may contain it. Thus it is that the atomic properties of structural materials, by their very nature, impose very stringent limits on the useful applications of nuclear energy. Since it must be realized that this reactor is not isolated, it follows that the highly available energy of the fission process almost immediately undergoes a large increase in entropy upon being distributed as thermal agitation to the surrounding atoms. In this process a large proportion of the thermodynamic advantage (that of obtaining energy from extremely low-entropy sources) of the nuclear reactor is lost permanently.

This serves to point out two possible lines of approach for obtaining more energy, faster, from the unit. The most obvious line of inquiry that might be followed would lead toward the improvement of inter-atomic/intra-atomic energy ratios of the structural materials used in the pile. Perhaps some means of energizing these materials could be worked out so as to increase the atomic and molecular attraction present in the material, and hence increase its melting and decomposition points. Another possibility would be to foster a more intimate contact between the heat source and the coolant, since this would remove a larger quantity of heat in the same length of time by increasing the area of heat transfer. This would necessitate a larger reactor, but it is certain that considerations other than economic will be predominant in the next several years.



(Fig. 2)

An important consideration to be taken into account is the selection of a coolant for the pile proper, and an efficient method of transferring the heat from the pile to the coolant. These considerations will depend entirely on the type of reactor being used. At the present time two types are in existence. The first to be considered is the homogeneous pile. This design employs U235 or other actively fissionable material which is distributed completely and evenly throughout the body of the reactor unit. The simplest known way of doing this is to put the reactive material in solution (liquid or solid) in the presence of an effective moderator and in the concentrations determined to be necessary for maintenance of a chain reaction. One problem that appears is that all of the homogeneous units to be considered, with the possible exception of those containing D_2O (heavy water), must use a concentrated nuclear fuel; i.e., enriched uranium (greater than 1 percent U 235 or its equivalent in U233 or Pu 239). The solid homogeneous mixture is simple in construction and easy to produce in the oxide form, but a serious objection to this type is the difficulty in removing just a part of the active portion in order to refuel. Removing all would necessitate a complete shutdown of the plant, which, for many cases, is impossible. Furthermore, reprocessing the active section requires handling a large mass of 'hot' materials (the fuel plus the diluant) in order to replace a relatively small percentage of burned-out fuel. Since the completeness of recovery of the U or Pu is an important economic consideration, the presence of a large amount of diluant changed often for refueling would increase costs greatly by decreasing the recovery of the active substances.

In this homogeneous solid unit (see Fig. 1) the heat is developed throughout the active section. This heat must flow by conduction through the mixture to the coolant, and thermal stresses are bound to develop. This necessitates using a material as diluant having a large thermal conductivity, a low thermal expansion, a large modulus of elasticity, and a continued maintenance of these properties under the attack of intense radiation. If these conditions are not met the solid mixture may rupture badly under the large temperature gradients that must be expected.

The liquid homogeneous system (see Fig. 2) is the answer to the above problem, as well as several others inherent in the solid type unit. The fluid fuel mixture would itself be circulated through the heat exchanger, where its energy would probably be transferred to water and steam. This unit also eases the refueling and defueling problem, since it could be handled simply by pouring the solutions through properly constructed entrance ports, without necessitating a complete plant shutdown. The major disadvantages of the homogeneous reactor are: (a) the somewhat larger amounts of fuel required, since neutrons are lost when the fluid is circulated to the exchanger, (b) the difficulties of servicing auxiliary components due to induced and deposited radioactivity of a high level, and (c) the greater amounts of shielding required.

With the previous discussion, and an understanding that heterogeneous reactors are those whose active components are lumped together, either in bars or "slugs," and separated by the moderator used and spaces for the coolant, a general idea of the principles of construction of this type can perhaps best be given by a sketch of one possible workable design, as shown in Fig. 3. Several other possible methods might be the use of liquid diluent surrounding tubes of a liquid fuel (either of which could be circulated as coolant), or the fuel could be in a fusible state contained in vertical tubes in a solid diluent, while a liquid or gaseous coolant circulates through horizontal tubes. Liquid metals might be used to advantage as a coolant in any of these liquid-cooled reactors, since their heat transfer coefficients are particularly high. This problem of heat transfer and utilization of heat energy is a rather standard one in engineering, and as such has no place in this discussion, however the problem can be treated in a normal manner, the only deviations being possibly radioactivity and relatively high temperatures.

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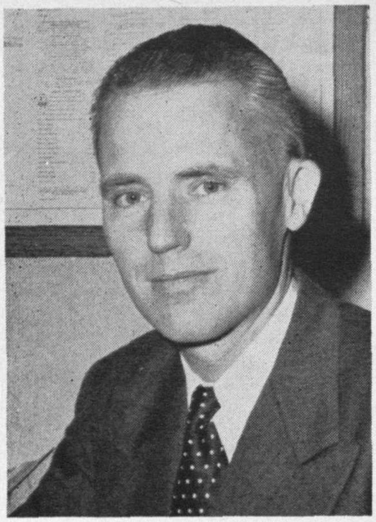

THE NEW CIVIL ENGINEERING DEPARTMENT

By JOHN R. SNELL
Head, Civil Engineering Dept.

EDITOR'S NOTE: This is the first of a series of articles on the conditions and improvements which are in effect or in planning for the various departments in the School of Engineering.

To chart a fixed future course for the Civil Engineering Department is impossible after only one term on the campus, yet even at this time certain comments and observations may be appropriate. Under the democratic process the program which actually develops as we move along depends only in a limited way on the thoughts of the department head, but rather on the thoughts, the ability and the drive of the whole Civil Engineering staff. Another important factor which we are counting on is the complete backing of the administration in improving our program. The success of our program also depends to a large degree on the ability of our staff to inspire the students to higher attainment in scholastic standing.

NEW CURRICULUM

Much interest has been expressed in the new civil engineering curriculum. This curriculum has been revised several times in the past four months. The curricula of all of the Big 10 colleges plus certain outstanding eastern schools has been studied in detail and compared with our present and proposed curriculum. Results of the professional engineers examination in the state of Michigan have been studied in detail. A number of the larger employers of our engineering graduates have been questioned concerning the strong and weak points of our engineers. Armed with all these data we have altered our new curriculum to meet the needs indicated in so far as was possible. Here are a few points of interest concerning our new curriculum.

1. All Civil Engineers will be required to take 224 credits instead of the 215 required under the present curriculum. Of these 212 will be taken during the twelve regular terms. The twelve additional credits will be added as a nine weeks summer school between the freshman and sophomore year. During this period, all of the required surveying and the new curriculum will be taught. With the initiation of a summer school by the Civil Engineering Department the Mechanical Engineers have also added a summer school. Others may follow suit.

2. Physics is being reduced from a twelve to a nine credit course by dropping the laboratory. It is hoped that a new physics course will evolve, which will fit more closely and efficiently into our engineering curriculum.

3. Addition of these extra credits makes it possible to strengthen our curriculum in the following fields.

a. Applied mechanics
b. Structures
c. Hydraulics
d. Water Supply

4. A new course in Engineering Geology has been made a required subject.

5. The new curriculum includes twelve credits of technical electives for military students and thirty credits of technical electives for non-military students. These will be selected and taken under the guidance of a faculty advisor in one or more of the following fields of preference.

a. Structures
b. Soils
c. Hydraulics
d. Transportation
e. Surveying
f. Construction

A wide variety of subjects will be available from which seniors may choose.

6. The sanitary engineering option has likewise been heightened and broadened in its scope.

7. It will be of interest that the Basic College will be experimenting with Civil Engineers by giving its basic humanities course in the Senior year. This not only facilitates the scheduling of technical series such as structures, soils and so forth in the Senior year, but takes account of the many scores of suggestions which have been offered by Civil Engineering seniors and graduates. This will be a separate higher level course.

8. More senior and graduate courses have been added to the field of soils, structures, foundations, highways, airports, railroad engineering and construction. All and all, we believe we have a far superior curriculum. This will be the framework within which we will operate in the years ahead.

SUMMER SURVEYING

A report to the administration is under preparation concerning the teaching of surveying at a summer camp. Although consideration is being given to several sites, the foresters camp at Dunbar appears very attractive. There is no question, but what the efficiency in teaching surveying will increase at least 100 percent by including

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METALLURGICAL ENGINEERING

Metallurgy is one of the oldest branches of engineering and historically it has been of such outstanding importance that the great eras of history have been named in accordance with metallurgical development. Thus we have the Bronze Age, the Iron Age, and now the Age of Alloys. Like all such ancient activities of man, metallurgy developed as an art—sometimes a black art. Many of its time-honored traditions and methods still cling to it. Some of them are still very useful; others are merely obstructions to progress.

The new branches of engineering, such as electrical engineering, which have been established since science became the guiding factor of civilization are exact sciences in a sense unknown to metallurgy. Here, in brief, lies the future development of metallurgy—that it becomes less and less an art and more and more a science. The science of metallurgy has improved remarkably in the past fifty years and it is at present undergoing very rapid development.

Modern metallurgy includes not only the science and art of extracting metals from their ores, refining them, and preparing them for use, but also the science of the metallic state, of the structure and properties of metals, and of their chemical and physical nature and behaviour. Metallurgy is an art in that it involves the skill and ability to produce and employ metals together with the scientific application of the knowledge of individuals and of organizations in the adaptation of metals to the uses of man. In short, metallurgy is engineering. This dual nature of metallurgy requires that its students be trained in both science and engineering, a requirement which is not at all unusual in modern engineering education.

The term "Metallurgical Engineering," if used in its broadest sense, means exactly the same thing as "metallurgy," however the latter term is frequently used as the broader form to include metallurgical engineering and the science of metals. The metallurgical engineer at Michigan State College directs his studies largely to the field of physical metallurgy, because of the large amount of metal processing which is done in such typical industries as automobile and refrigerator manufacturing. Proper emphasis is placed on foundry metallurgy, because Michigan is one of the large centers of foundry industry in the United States. Everything used and produced requires metal casting, directly or indirectly. Manufacturers spend more than three billion dollars annually for casting of all sizes, shapes, and of some six hundred alloys. These manufacturers need engineers who are familiar with the economics of casting use and casting design. Modern foundry practice demands close cooperation between designers, pattern makers, and foundrymen. The foundry industry needs young men with this training. The foundry is a basic industry, and it offers a place in which to apply engineering techniques and in which the opportunity to advance is great. There is a shortage of technically trained men in the foundry industry, while the number of complex technical problems is inordinately large.

Until recently the metals and alloys originating back to primitive times were sufficient for all needs. Such things as printing, the steam engine, the electric generator, and equipment of war all found acceptable metals at hand, and even the airplane grew apace with the skill of the design engineer and never was limited by the lack of metallurgical advances.

In late years, however, the metallurgist has been faced with a host of new challenges. Engineering design is now frequently limited by the metals at hand. Metals and alloys have frequently become the critical limitation determining the complete realization of engineering design. Dr. Cyril Smith, Director of the Institute for the Study of Metals, has said: "The design of gas turbines, rockets, and nuclear power are all crucially dependent on the development of better materials. Throughout most of history, the important figures in metallurgy have been those who, through improved chemical processes or handling methods, have cheapened and expanded production. In the future, the important figures will be those who permit the development of better and better properties."

The development of nuclear energy has put the spotlight on uranium, plutonium, beryllium, zirconium, and titanium. The new jet engines and supersonic aircraft have accelerated the development of molybdenum, vanadium, and complex alloys of iron, nickel, cobalt, chromium, and columbium in the search for metals to operate at high stress for long periods at red heats.

These relatively rare metals are all developing into industries of their own, with titanium the most dramatic in its possibilities because of its unprecedented strength-weight ratio. Several years ago titanium was available to only a few research workers in pound lots, whereas in 1952 the production of this metal will most likely exceed the five thousand ton mark.

In the future, we may expect almost unbelievable application of ultra-sonic energy and the use of electron beams in steel production, metallurgy, and the fabrication of metals. Ultrasonics may well exert a profound influence in extractive metallurgy for the separation of larger and larger quantities of metals from the poorer grades of ore that of necessity must be exploited. The effects of ultrasonics on crystal growth or crystal alignment in metals is an entirely new science so far just barely touched.

The next several years may witness the development of another great step forward in steelmaking. For centuries metallurgists have dreamed of continuously pouring molten metal into a water-cooled mold from which it will constantly emerge as a solidified, cast section of appropriate shape, to be automatically cut into lengths suitable for further processing. Such a process is in the pilot plant stage in steelmaking and appears to be well on the way to realization.

The relentless battles between technology and cost, which have given America a multitude of low-cost, man-produced articles, are destined to continue as invigorating contests for metallurgists with imagination and ingenuity.

The designer's dream of today and his triumphant product of tomorrow must be bridged by materials and plenty of thought, work, and capital. The metallurgist

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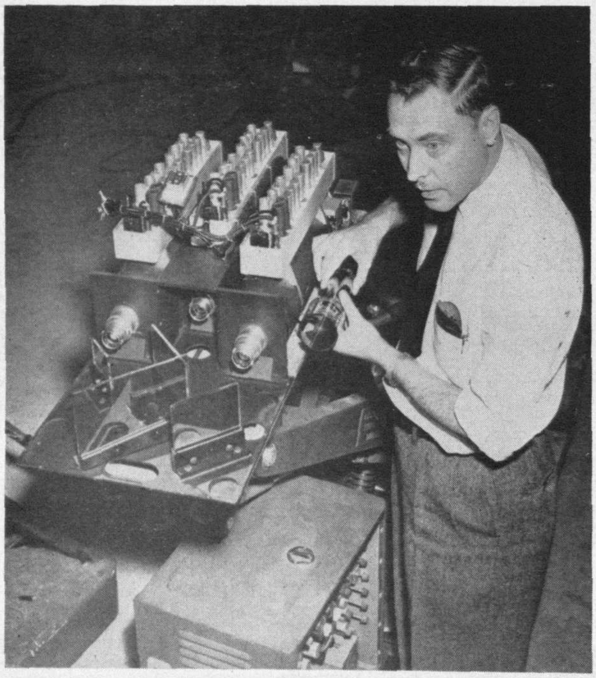
COLOR TELEVISION
The Rainbow in Your Home

By TOM CLARK
Chemical Engineer 54

The rainbow will soon be brought to your television screen. Electronics has developed for you another miracle of modern science, color television. For the past few years you have heard about color television, but very few of you have seen it in your homes. In this article you will learn what color television is and what has happened to it.



A view of the color camera showing the color separation setup. Each tube takes a one color image.

All color television systems are based on the principle that with a suitable set of three basic colors all other colors can be reproduced. The same principle is utilized in color photography, color printing, and can even be used in painting. The basic colors giving the widest range of mixed colors are in the red, blue, and green regions of the spectrum and are called the primary colors. RCA has developed an all-electronic, compatible system which makes use of a tri-color television tube. In the RCA tri-color tube, three different phosphors are used; giving red, blue, and green light when struck by a stream of electrons. These three phosphors are deposited on a flat glass plate in the form of tiny dots next to each other in such a manner that they form equilateral triangles with a different color at each apex. Three separate electron guns are mounted in the neck of the tube, one shooting a stream of electrons at the red dots only, the second at the blue and the third at the green dots. When one of these guns is turned off the brightness adjustment of the other two will determine the color on the screen. For example, if the green gun is shut off and the brightness of the red and blue varied, different shades of purple will appear. When looking at the screen very closely it may be possible to distinguish between individual red and blue dots, but from the proper viewing distance various shades of lavender, purple and cerise red will be seen. Similarly, cutting off the red gun will produce shades of bluish green and greenish blue. Mixtures of red and green will give the yellow and orange shades. When all three electron guns are operating the resultant colors will be more like pastel shades and the predominant color will be the one having the greatest brightness. To get white or gray a balance must be struck between all three primary colors, but the amounts of brightness from each electron gun will not be equal.

CBS has developed the field sequential system for color television. In this system the colors are switched after the transmission of each field. A rotating color wheel placed in front of the camera tube causes the scene being televised to be passed through a different additive primary color filter during the scanning of each field. Thus, one field contains information on only the red elements of the picture, the next field only the blue and the next field green. Field interlacing is used and six fields are required to produce a complete color picture. At the standard black and white field frequency of 60 per second, a six-field picture would be produced only each 1/10th second—not fast enough to avoid "flicker" on scenes which are predominately one color. Therefore, field sequential transmission of color required 144 fields per second. This gives 24 complete pictures per second, which is safely above the flicker rate. At the receiving end, the field sequential system employs a process which is the reverse of that used for transmission. The picture tube is viewed through a rotating color wheel of red, blue and green, which is synchronized with the one at the transmitter in both speed (1440 rpm) and color phase. The Federal Communications Commission has announced its approval of the CBS system of color television.

The choice of the CBS system came as a distinct surprise to many radio-men, especially in view of the fact that it is not compatible with the present black and white system. Much of the argument during the FCC color hearings centered about two words: compatibility

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TITANIUM - The Atomic Age Metal

By ROBERT RHODES

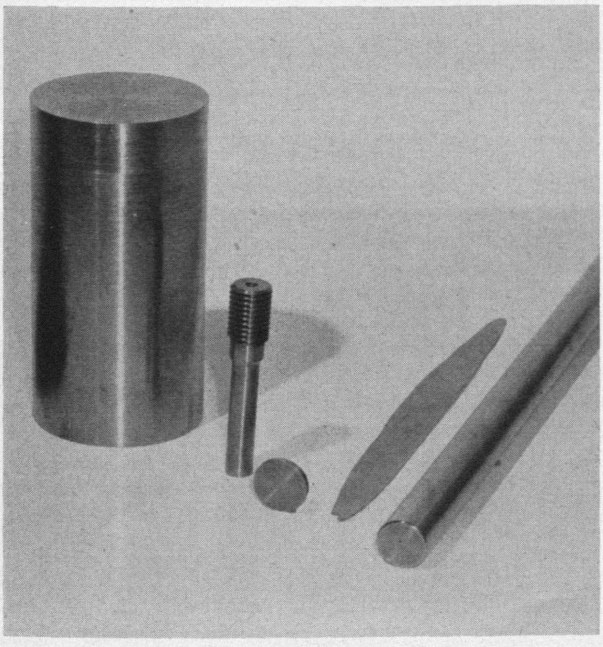
Metallurgical Engineer '53

If titanium can live up to the properties attributed to it, and if economical commercial production can be obtained, then it could very well be science's answer to the present structural metal crisis.

Vast strides have been made in recent years in the fast growing metallurgical field. The development of titanium metal is only one of the results, but could very well be the most important. In light of the present day metal situation, the development of titanium into a full scale commercial product is not only justifiable, but is highly desirable.

Titanium has a relatively low specific gravity, good resistance to corrosion, and high tensile properties; all desirable characteristics for a good structural material.

The modulus of elasticity, density, and strength of titanium metal at intermediate temperatures fill in the gap between aluminum alloys and stainless steel. Where titanium is substituted directly section for section in place of stainless steel, a forty per cent saving in weight will result.



Several pieces of tooled titanium are shown above. Titanium may be used for high speed engine parts because of its high melting point (3150° F.)

The extremely high melting point of titanium should develop into an advantage when used in high temperature mechanical devices. The low coefficient of thermal expansion reduces thermal stresses to a minimum. This makes close tolerances practical for devices operating over a considerable temperature range. Titanium also has relatively low thermal and electrical conductivity.

Material presented by C. I. Bradford of Remington Arms Company shows that titanium in the annealed state has relatively high tensile and yield strengths in combination with good elongation. It also shows a substantial increase in tensile properties with only moderate amounts of cold work. Twenty per cent cold work raises the yield strength from 75,000 psi. to about 100,000 psi. On the other hand small amounts of cold work reduce the ductility considerably.

Titanium has a usable strength up through 800° F., comparing very favorably with the best aluminum alloys which are not used to any extent over 400° F. Young's modulus also holds up well through 800° F. This is important in applications involving elastic stability at high temperature. The sub-zero strength and modulus are also high.

The popular belief that titanium is a recently discovered element is not true. Metallurgists have known about it since 1789, and possibly earlier. In its infancy, however, it was looked upon as an undesirable element. Rich iron ore deposits in New York and other areas lay idle for years because the ore was "contaminated" by titanium. Today the "impurity" that once caused these immense iron ore deposits to remain idle is the main reason they are being worked.

Titanium metal has the advantage of a large ore supply. It is the fourth most plentiful metal of structural utility in the earth's crust, and the seventh most common metal. More of it exists than all of the lead, zinc, tin, antimony, nickel, copper, gold, and silver combined. Of course the mere presence of the element does not imply that it can be extracted for use, since it is only where it occurs in concentrated form that separation can be accomplished profitably. However, rutile and ilmenite, the principal ores from which titanium can be extracted, occur in huge concentrated quantities in both the United States and Canada.

The chief headaches in the development of this metal are its high tendencies to react with all other elements when molten, and the extremely high melting point of 3150° F. The slightest uncontrolled reaction with any

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New Developments

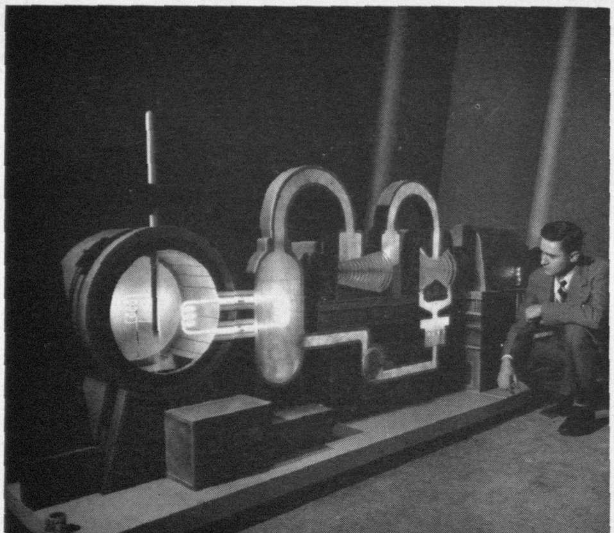
Edited by RALPH POWELL

Electrical Engineer '55

"ENERGY IN ACTION"

Lead assumes the properties of spring steel and rings like a bell when struck, a miniature steam engine runs with ice as the only fuel, and an atomic power plant is shown in mock up in the latest Westinghouse science show —"Energy in Action."

Designed to show the progression of science towards the atomic age and the ever increasing utilization of energy by the world today, the eight act, ninety minute production is given predominately to demonstrations by two Westinghouse science reporters. A two-hour version of the show includes a color movie, "Energy is Our Business."



Model atomic power plant as it appears in the Westinghouse "Energy in Action" show.

In a demonstration of the effect of ultra-coldness on lead, liquid nitrogen at a temperature of minus 321° F. is employed. When the normally soft lead is immersed in the liquid nitrogen, it assumes the properties of a steel spring and resounds with a bell-like tone when struck.

GERMANIUM PRODUCTION

One of the world's few setups for producing single-crystal germanium is on public view in New York at the Institute of Radio Engineers exhibit at Grand Central Palace.

Refinement of this rare element, which is of prime necessity in making transistors for the radio, television and electronic industries, proceeds with professional efficiency through the use of a small electric furnace, set up by engineers of the Radio Corporation of America.

The germanium furnace, part of a display showing research into electronically active solids, transforms the germanium into the desired single-crystal form.

A quantity of the processed germanium about the size of a pinhead is sufficient to make a transistor, a tiny new device having the capabilities of certain electron tubes and holding promise of opening many new fields of electronic development.

To obtain the type of germanium crystals needed for transistors, RCA engineers "draw"—instead of cast—a thin, pencil ingot from a crucible of molten germanium. This action takes place inside of a quartz tube.

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NEW TIRE SIZE MARKINGS

A new method of marking passenger car tire sizes on the treads is now being used by The B. F. Goodrich Company, Akron, Ohio.

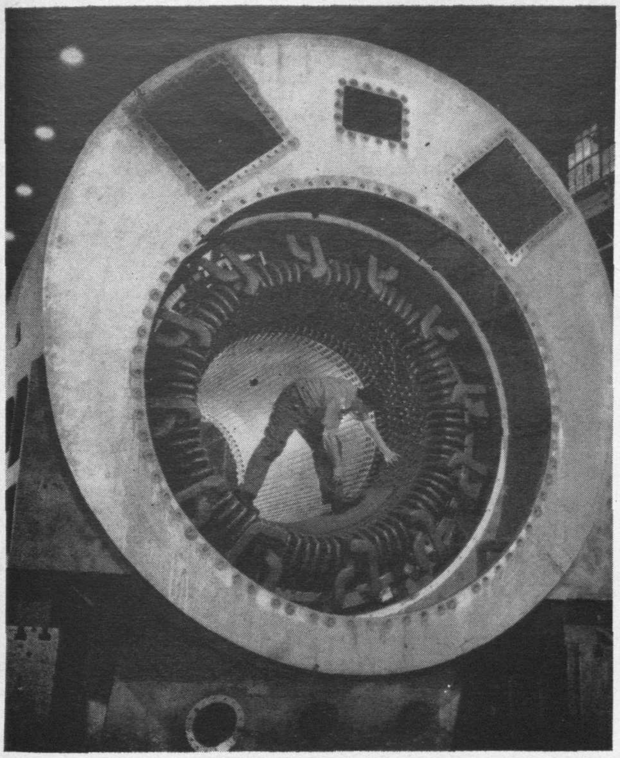
Treads are embossed in three places with six different stampings so that regardless of how the tires are stacked the sizes can be read right side up.

The adoption of the method eliminates the use of labels and the danger of their being defaced or lost from the casings, makes easier the reading of stacked tires in dealer and factory warehouses, and reduces danger of errors in identifying tires for shipment.

★ ★ ★

THERMALASTIC INSULATION

One of the first turbine generators to be insulated with Thermalastic insulation is this 100,000-kw unit constructed at the East Pittsburgh plant of the Westinghouse Electric Corporation. Capable of assuming its original dimensions upon cooling, Thermalastic insulation does not tend to separate as a result of heating



Inspecting one of the first turbine generators to be insulated with Thermalastic.

and cooling cycles during operation. This eliminates likelihood of internal short circuits, and means an increase in insulation life. Coils of this generator have been wrapped with a mica-bonded tape and impregnated with a water-thin plastic that solidifies. Application of a protective coating completes the insulating process.

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HEAT RESISTANT ADHESIVES DOING WORK OF RIVETS

Heat resistant adhesives, widely used in brakes and automatic transmissions, are doing the job of rivets and weathering some of the roughest tests automobile parts can undergo.

These adhesives also are being used successfully to join or stick together both metal and non-metal parts that require good strength and performance at high temperatures.

The adhesives have given good service in their present applications, as is indicated by the performance of millions of brake shoes and transmission parts in the automotive industry.

Because continued improvement is essential to any product, further development is under way with so-called phenolic-elastomer adhesives. Indications are that improvements in these bonding agents can be accomplished with adhesive materials in use today.

In laboratory tests on a brake dynamometer with 500 pounds per square inch air line pressure for the braking action the adhesive bond between the brake lining and brake shoe withstood temperatures, caused by friction, as high as 1021 degrees Fahrenheit without failure of the bond.

NEW LACQUER THINNER FORMULAS

New formulas for lacquer thinners, described as the most significant developments of their kind in 25 years, are improving automotive finish quality.

The new concept of lacquer thinner, now applied in GM automotive divisions, has improved both technique and results of applying lacquer to car bodies.

So-called thinners or reducers in the paint industry are used to make lacquer fluid. A thinner is a medium for putting into solution the nitrocellulose and resins that make lacquer. Also, it lowers the lacquer's viscosity to the point where it can be sprayed through a gun onto the car boy.

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A-C NETWORK CALCULATOR

The a-c network calculator at the East Pittsburgh plant of Westinghouse Electric Corporation has been in almost constant use during 1951 by utility customers. Engineers from the Duquesne Light Company work with Westinghouse engineers in making a complex system study that would require literally man-years of hand calculation. Electrical representation of a utility system on the calculator makes it possible to impose any conditions desired and study the effects throughout the system. Westinghouse has built 19 such calculators, and has two on order.

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"THE CUTTING WIND"

A "cutting wind," produced by a knife blade moving faster than the speed of sound, is being used to cut thin slices of almost everything from asbestos to zinc by a scientist of the General Electric Research Laboratory in Schenectady, N. Y.

Although a knife blade is used, its primary purpose is to produce a small pocket of compressed air immediately preceding the knife. Dr. E. F. Fullam, the scientist, believes air does the actual cutting, rather than the knife itself.

The blade is mounted in the whirling wheel of a laboratory device called a high-speed microtome.

As the wheel whirls at 65,000 revolutions per minute, the knife blade is propelled at a calculated top speed of 1,200 feet per second, or at the supersonic speed of more than 818 miles per hour. Speed of sound is about 750 miles per hour.

The blade's supersonic speed is believed to produce a small pocket of compressed air which tears materials on a submicroscopic scale. This action leaves a smooth surface on the face of the cut, through which the knife easily passes.

Dr. Fullam, Research Laboratory microscopist and designer of the instrument, uses his "sharp air" technique for cutting asbestos, cork, bone, mica-insulation, metals, wood, plastics and many other items.

The instrument was primarily designed by Dr. Fullam, and tailor-made to his specifications by an instrument manufacturer, for cutting extremely thin cross-section specimens of materials for study under an electron microscope. Because of the blade's tremendous speed, the microtome has cut what is believed to be one of the thinnest slices ever made, a metal shaving less than two-millionths of an inch thick, or about 1,000 times thinner than a human hair.

Submicroscopic sections produced by the microtome are invisible to the naked eye. In fact, the sections are so small that they can be studied in detail only under an electron microscope. This type of microscope magnifies the original size about 25,000 times; and larger magnifications can be obtained by photographing the specimen at a pre-determined magnification and then enlarging the picture. By way of comparison, Dr. Fullam says that a human hair enlarged 25,000 times would be larger than a giant redwood tree.

In attempting to obtain ultra-thin sections, the G-E scientist experimented many years with cutting instruments. Evidence that air can apparently cut was first noted by Dr. Fullam in early experiments with his present instrument, when he found that blades were not dulled by cutting.

"Since perhaps it is the air that does the cutting, sharpness of the knife should not be too important, except to produce a very small area of compression," he said.

He believes, in theory that cuts could be made with a crowbar, if the bar could be moved with sufficient speed and accuracy.

In cutting, the microtome blade moves through objects in the same fashion as a knife through butter. The instrument's knife has a slicing effect, instead of the chipping action of a saw.

Material to be cut enters the knife's path from the side, by means of a small pencil-shaped device. Dr. Fullam likens the method to that of baloney being fed into a meat slicer at a delicatessen.

No cutting noise is heard during operation, since according to theory, air, rather than the blade, is doing the cutting. Only the motor's shrill humming can be heard.

The laboratory instrument has a cutting blade mounted in a three-and-three-eighth inch diameter wheel. Powered by a "souped-up" one-third horsepower electric motor, the wheel can be rotated up to 65,000 revolutions per minute. This terrific rotational velocity is necessary to produce the pocket of compressed air, the scientist said.

Razor blades were formerly used as cutting edges in most laboratory experiments, "not because of their sharpness, but because a razor's fine edge is more suitable for building up a thin area of compression," he said.

Dr. Fullam now uses blades especially designed for the instrument. In order to obtain a thinner area of compression, however, he manually sharpens blades to a keener edge.

Thinner blades result in smaller cuts, according to the G.E. microsopist. He said he has sometimes used a very thin wire for a cutting edge.

Centrifugal force, produced as the wheel rotates at supersonic speeds, adds considerable stiffness to a wire. In fact, Dr. Fullam believes that at these speeds, wire so thin as to be barely visible to the naked eye, will become as stiff as a one-sixteenth-inch-diameter steel bar.

Design of the laboratory instrument has limited him to small-sized samples of materials for sectioning. A specimen about the thickness of a lead pencil is the maximum size the microtome will cut.

Among few materials which the instrument cannot successfully cut are rubber and vitallium, the latter being one of the hardest of metals.

Rubber could be cut if it were first frozen with liquid nitrogen, or vulcanized to a more brittle state. The hard metal could be cut if more air could be obtained through greater rotational velocity of the wheel.

According to the G-E scientist, about a dozen high-speed microtomes of his design are in use throughout the country.

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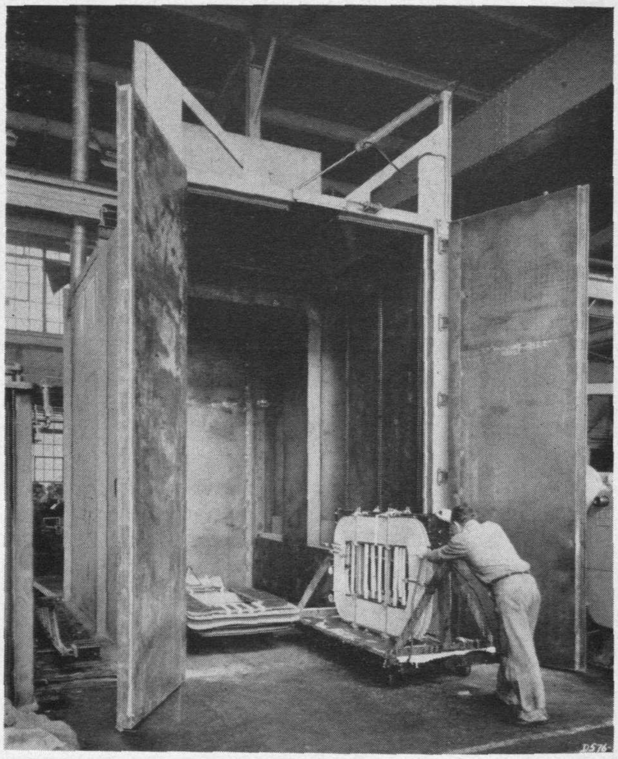
THE PAUL BUNYAN OVEN



A workman's view of the opened Paul Bunyan oven.

Recently completed and now in operation is this huge varnish insulation curing oven at the Westinghouse Electric Corporation's manufacturing and repair plant in Buffalo, N. Y. Largest of its kind in western New York, it is 8 feet wide by 13 feet high and 15 feet long. The oven is heated by either gas or electricity, and equipped with automatic controls to maintain constant temperature throughout. An air-changing system keeps the heat in continuous motion and results in effective evaporation and removal of varnish solvents.

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PRECISION MEASUREMENTS

Elimination of variables in precise measurement techniques is always a problem and is doubly so in the big new addition to the Engineering Hall at Carnegie Institute of Technology in Pittsburgh. Herein is located the research laboratories of the American Petroleum Institute (API), a service organization for the entire industry. In addition, many graduate and undergraduate chemical and chemical engineering labs are involved in delicate measuring projects. Westinghouse Sturtevant fans, air-conditioners, and heating units play an indispensable role in the maintenance of required

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CHEMICAL ENGINEERS
The Mass Producers of Chemical Research

Chemical Engineers help new products up the steep path from the laboratory to the market place. The Chemical Engineer makes a career of putting to practical use the discoveries of the laboratory research chemist. They guide new products from the test tube through the semi-works and pilot plant stages to full-scale production.

The field of chemical engineering is very broad. Perhaps one of the most important and interesting phases of the Chemical Engineer's work is in bringing new scientific discoveries to the point of practical usefulness, in applying these discoveries to the service of man, and in planning, designing, and building a plant to use the new processes and manufacture the new products. The Chemical Engineer's stock and trade is fundamental scientific and engineering knowledge. He is versatile and able to go in more than one direction. An engineer should possess a share of the banker's hardheadedness in financial matters, combined with the creative imagination that can translate what happens on a laboratory bench into a factory process. This process must be able to compete economically with others in industry.

Chemical engineering recognizes a resemblance in purpose, principle, and method in widely diverse fields, such as petroleum refining, ore dressing, or ceramics, and emphasizes the broad fundamental principles and methods common to all processes and materials regardless of the special field in which they are practiced. The Chemical Engineer must have basic training in the principles of business, finance, and economics.

The Chemical Engineer is well-trained in the sciences of chemistry, physics, and mathematics, because he is concerned with the application and direction of chemical processes. The chemist is primarily concerned with laboratory work which may be routine in nature or of a research character. A Chemical Engineer, however, is concerned with industrial equipment and large-scale plant operations. The Chemical Engineer should be technically trained, reliable, resourceful, honest, systematic, intelligent, and a creator and seeker after truth, for he is a member of a profession that is very definite and exacting in its requirements.

Chemical Engineers are employed in almost every industry and activity from teaching and research to petroleum production and refining, in the processing of food, chemical raw materials of all kinds, plastics, ceramics, paper, rubber, fertilizers, and in the field of atomic energy. There is an increasing tendency for chemical engineers to eventually be selected for executive and administrative positions.

As our way of living becomes more complex and more dependent upon technological developments, the field of opportunity for the adequately trained Chemical Engineer expands proportionately. This tendency will undoubtedly continue for there is no turning back in the field of technology—each new problem and discovery leads on to others.

The task of the Chemical Engineer is to advance new materials and new processes from the research laboratory stage of test tubes and flasks, through the semi-work and pilot plant stages, ultimately to industrial production. Such an effort requires the Chemical Engineer to make calculations and decisions involving raw materials, product yields, equipment design and construction, plant location and arrangement, flow of materials, labor and power cost, and rate of equipment depreciation.

With the increasing size of equipment necessary to transfer from the scale of laboratory breakers to tank car lots, the Chemical Engineer must inevitably encounter unforeseen problems of equipment corrosion, materials handling, temperature control, and automatic regulation. Such difficulties are solved by close cooperation with the research chemist, and with the plant electrical and mechanical engineers, who have the detailed and specialized knowledge necessary for the efficient solution of the problem. The final process is established and standardized as the result of such closely coordinated efforts and knowledge.

Supervision and direction of production are also within the province of Chemical Engineers. They are responsible for the lives of others, as well as for large property values. They must be reliable and trustworthy in their professional service for they have the same relation to society as the architect, lawyer, or surgeon.

All chemical industries are related because of a similarity of many basic operations and procedures. Although the final product of two industries may differ widely in properties and uses, yet the apparatus, equipment, and methods used may be very similar. The number of such basic unit operations is not large, and not every type of industry uses all of them.

Although the Chemical Engineer has due regard for the chemical nature of the substance he is using, he is more often devoting his attention to factors such as handling of materials, application of heat, corrosion of materials used for piping and construction of equipment, mechanical mixing and grinding, heat exchange systems, or filtration rates and capacities.

A few typical chemical engineering unit operations are listed below:

1. Distillation and Absorption
   a. Fractionating columns
   b. Absorbing towers
2. Evaporation
   a. Vacuum evaporators
3. Drying
   a. Rotary dryers
   b. Vacuum dryers
4. Filtration
   a. Filter presses
   b. Rotary filters
5. Crushing and Grinding
   a. Jaw crushers
   b. Gyratory crushers
   c. Ball mills

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IRRIGATION PROJECTS IN MEXICO

By FELIPE JAUREGUI
Mexican Ministry of Hydraulic Resources

Among the extensive current construction activities of the Ministry of Hydraulic Resources of Mexico, the Papaloapan Project merits special attention because it includes a greater variety of hydraulic features than any previous undertaking, and because it is bound to constitute one of Mexico's main sources of agricultural and industrial wealth.

The large dams on which work has been started to back up the waters of the Tonto, Santo Domingo and Papaloapan rivers will fulfill three general and principal purposes: the irrigation of a vast and fertile zone, the production of electrical power representing about one half of the total required by the country for its industrial development, and the control of overflows that for many years have caused havoc all along the lower lands of the Papaloapan basin. As the completion of the dams will not be effected, a general project for the rectification of the Papaloapan river course was elaborated with the approval of one of the best technical engineers on the matter, Mr. G. H. Matthes, and it consists in the execution of seven cuts on the sharpest bends of the river and a relief canal near the city of Tlacotalpan. Two of the most urgent cuts, the Cosamaloapan Nos. 1 and 2, have already been finished. Massive levees that besides their protective character will also furnish ample and efficient highway service are under way and it is believed that upon the completion of this work the flood threat will have disappeared.

Another important characteristic of the Papaloapan Project is the drainage and disiccation of marshes which is being successfully carried out, and this, together with an intensive use of D.D.T. in towns and villages has greatly contributed to improve sanitary conditions and almost eradicated the endemic malaria. Public-utility undertakings have also followed this phase of the initial activities in connection thereof and cities as important as Alvarado, Tlacotalpan, Cosamaloapan and Acayucan are being provided with sewerage and drinking water distribution systems.

The Papaloapan basin, with an area of 17,582 square miles and nearly one million inhabitants, is a highly unhealthful region where malaria, intestinal diseases and other ailments of hydric origin are prevalent; but the active sanitary campaign launched and carried out by the Papaloapan Commission with the cooperation of the best hyginist corps of the Republic through the Medical Sanitary Board has given the most satisfactory results.

In a brief, condensed report on the Papaloapan Project written by Engineer Adolfo Orive Alba, Minister of Hydraulic Resources, and which covers the subjects of sanitary engineering, floods control, rectification of the river course, roads and highways, navigation, airports, electrical power production, irrigation and drainage, social work, education, urban improvements and agricultural and industrial development, he has emphasized the fact that the most important of the existing resources in the Papaloapan basin is, evidently, the human element, without which all the other resources would be useless. He therefore considers that it is fundamental to have a thorough and scientific appreciation of not only figures that can give a quantitative form of knowledge about the inhabitants of the basin, but of what is still more important, their qualification, their social structure, their grade of education, their actions and disposition, in order to know how to induce them to develop their own resources.

Following Mr. Orive Alba's historical outline of hydraulic works in Mexico, we learn that long before the arrival of the Spaniards, the Aztecs had admitted the necessity of building irrigation projects and he cites as two of the most interesting examples the dike built by the Aztec Emperor Netzahualcoyotl to separate the salty from the fresh water of the ancient lake formed around the lower part of the Valley of Mexico in order to utilize the fresh water for cultivation, and the inverse form of irrigation practiced by the Aztecs in what is now the Xochimilco lake in the suburbs of Mexico City, where instead of conducting the water to the soil, the soil was hauled into the water to form the then existing floating islands that finally were anchored by root-growth.

During the Spanish domination, several hydraulic projects were undertaken, especially on the high plateau, some of which show daring and important characteristics as the one completed in 1548 by Friar Diego de Chavez in Guanajuato to divert the water from the Lerma river into a natural depression of the land, closing the reservoir thus formed with the Taramatacheo levee to impound a volume of 300,000 acre-feet.

It has been estimated that up to 1910, when the people of Mexico overthrew the Diaz regime, only an area of 1,750,000 acres of land was under irrigation, and it was not until 1926, the year that marked the dawn of a new era in hydraulic construction in Mexico, that the Government decided to launch a great irrigation program. To this effect, an irrigation law was passed by Congress and the National Irrigation Commission was created, both somewhat similar to the Reclamation Act and the Bureau of Reclamation of the United States.

The investments made through the new organization from 1926 to 1946 amounted to 900 million pesos and 2 million acres were put under irrigation, which is an area larger than that watered during the whole history of Mexico up to 1910.

On Dec. 1, 1946, the National Irrigation Commission was transformed into the Ministry of Hydraulic Resources in charge of Eng. Adolfo Orive Alba, and since the Papaloapan Project has been properly termed President Aleman's project because the present executive has included the necessary works for the complete and methodical development of the Papaloapan river basin as one of the outstanding features of his constructive program, the Papaloapan Commission was created as an independent department, with Mr. Adolfo Orive Alba as Chairman, to take care of all the work involved in the execution of this great hydraulic enterprise.

It is not therefore a venture to state that when the Papaloapan Project is completed, Mexico will be going forward at a seven-league-boot pace in her efforts for self-sufficiency by putting to beneficial service her potential natural resources.

MICA BASE PAINT

ONE ANSWER TO EXPOSURE

Courtesy — Westinghouse Electric Corporation

The life of the finish on distribution transformers has been more than doubled by a three-coat paint system which has been given the name, "Coastal Finish." Each coat functions cooperatively with the others to withstand the oxygen, acids, salts, and alkalis found in seacoast and industrial atmospheres. This three-coat system is applied in the same manner as standard finishes and in production it is baked on for speed. A modification of this finish air dries which means that it can be used to patch a transformer in the field should the surfaces be damaged.

Distribution transformers operate under especially severe conditions that affect the finish applied to the outside of the tank and associated hardware. The surfaces of fully loaded transformers exposed to direct sunlight often reach temperatures of 200 degrees F and sometimes higher. During the winter months these surfaces may be exposed to temperatures as low as -50 degrees F. With an operating range of 250 degrees F the paint must be sufficiently flexible so as not to flake off due to differential expansion and contraction between paint and metal.

Elevated temperatures and oxygen of the atmosphere also cause the paint films to age and become brittle. This accelerates the tendency to flake or craze during the winter months. It is important, therefore, not only to select a finishing material from the standpoint of initial flexibility but for heat resistance as well.

Moisture in liquid or vapor form is perhaps the greatest enemy to the finish on distribution transformers in ratings commonly hung on poles. It readily attacks any exposed steel surface forming rust and gradually penetrates paint films corroding the metal underneath. Rust formation and hydrogen generated at the metal surface cause the paint to blister and lift. Once the film is broken, corrosion is accelerated and pits develop. If they are not given attention they may eventually completely penetrate the tank wall. This may drain the insulating oil from the tank and cause the transformer to fail. If it were not for moisture, the finishing of pole type transformer would present no serious problem except in rare cases. Oxygen, salts, acids, and alkalis present in the seacoast and industrial atmospheres usually are destructive as they deteriorate the film and pave the way for moisture to do its damage. Also, the effects of certain impurities accelerate corrosion by moisture once it gets to the metal.

THREE COAT COASTAL SYSTEM

The individual coats of the new three-coat system act cooperatively to resist moisture penetration and also the elements that promote it. Proper preparation of the metal surface is necessary before the finish is applied. Good adhesion is generally obtained by removing all rust, scale, grease or other extraneous material. Ideal surfaces are obtained by treatment with phosphate solutions to form iron phosphate at the surface. The phosphate film retards corrosion by the passivating effect and offers a tightly adhering porous surface for the base coat of paint to penetrate and grip mechanically.

The prime or first coat applied to the prepared surface is composed of a vehicle giving good adhesion with desired flexibility and chemical resistance to salts, acids, and alkalis. The pigments used are primarily zinc chromate and iron oxide. Zinc chromate is perhaps one of the best corrosion inhibiting pigments due to the availability of the chromate iron in the presence of moisture. However, if used as a single pigment, it usually produces a film that is somewhat brittle. When combined with iron oxide, the brittleness of the film is reduced and the vat or storage life of the paint is increased. Surprising as it may seem when this combination is tested as a priming coat alone in comparison with other primers containing, for example, lead chromate or red lead, it may at times appear to be inferior. The superiority stands out when the tests are repeated after the finish coats have been applied.

The second or intermediate coat is without doubt the key to the successful performance of Coastal Finish. The vehicle is composed of modified phenolic and alkyd resins. These are chosen for resistance to heat, oxygen, salts, acids and alkalis in concentrations generally encountered in the atmosphere. The resin is of the thermoset type. By proper selection of solvent and adjustment of setting time of the resin, it is possible to remove the solvent completely during the initial part of the drying cycle before the resin has set to the hard state. This permits the resin to flow after solvent elimination and prevents pinholes through which oxygen and moisture could enter.

The pigment is composed of selected mica flakes which overlap each other in the film and produce a "shingle roof" effect to further ward off moisture and oxygen. The mica also increases heat stability of the intermediate coat as much as ten times at elevated temperatures.

The use of mica in paint is not new but the way in which it is used in this paint has not been utilized in the past. The relatively large mica flakes plus their tendency to settle presented problems of application but these have been overcome.

The third and final coat is composed of resins and pigments to withstand the elements and to provide good appearance when new and after weathering has taken place. It can be tinted to give any desired color. When chalking takes place, a slightly darker shade develops which does not detract from the appearance of the transformer.

The final coat has several functions:

1) It adds to appearance.

2) It enhances the resistance of the other two coats to oxygen, moisture, etc.

3) It screens out the ultraviolet light of the sun's rays.

A series of panels were made to demonstrate the resistance of the combination of primer and mica-filled second coat to salt spray and weathering. These panels were phosphatized, given a coat of primer and then two coats of the intermediate or second coat of the system. They were tested simultaneously with panels painted with the standard three coat finish.

After 2000 hours exposure to the salt spray the mica finish showed no change whereas the standard finish was approximately 50 per cent deteriorated. At 3000 hours the standard finish was completely gone. It required a total of 10,000 hours continuous exposure to salt spray before small blisters began to appear on the mica finish. When the blisters were broken, there was evidence of trapped gas, possibly hydrogen, and a thin film of rust.

Other mica-finished panels were exposed for 18 months on Florida and California seacoasts. Weathering took place at the surface exposing some of the mica flakes. However, there was no sign of corrosion. The exposed mica flakes appear to be largely parallel to the film surface and definitely indicate a shingled effect which may partly account for resistance to salt spray and added heat stability of the vehicle.

It appears also that the mica addition improves the coverage on sharp or burred edges, thus reducing the tendency to corrode at these points.

Methods of Application

The metal surface is first alkali cleaned and rinsed, followed by phosphatizing and a dip in dilute chromic acid. This results in a very clean surface light gray in color and of sufficient porosity for good paint penetration with maximum adhesion. To prevent any contamination of the prepared surface the transformer tanks are given the first or priming coat within a matter of hours by flow coating. Viscosity and gravity are controlled. The flow-coating process is used for priming to fill any crevices left between tank wall and projection welded parts. It also assures complete and uniform coverage of all parts. The tank then is conveyed by monorail through an infrared dryer. A surface temperature of approximately 340 degrees F is reached by the time the tank leaves the oven.

After cooling, the second coat is sprayed on. A dark green dye is incorporated into the otherwise clear mica-base paint or enamel to assist the operator in determining coverage and to allow for easy and quick inspection. The dye fades out leaving a dark-brown color on subsequent infrared baking which is done in the same type oven and at the same temperatures as for the first coat. The film dries to make a hard, tough, abrasion-resisting coating.

Not until the transformer is completely assembled and tested is the third and final dark-gray coat applied. The transformer is then conveyed through a steam convection oven operating at 160 degrees F where the final coat is dried tack-free. Hardening of the film takes place in storage and shipment.

LABORATORY AND FIELD TESTS

Salt Spray Resistance Test

This test is made in standard salt spray equipment using a 20 per cent solution of sodium chloride at 90 degrees F with 15 pounds pressure on the spray head. As an example, the finish was completely gone from the cover and from many areas on the tank wall of the transformer with a standard finish. By comparison, the Coastal Finished transformer showed no signs of deterioration and no signs of corrosion.

After 2000 hours under the salt spray, a large area of paint was gone in the case of the standard finish and corrosion was quite apparent, whereas with the mica-base finish there is no indication of corrosion.

One rather interesting result was the severe action of the salt spray on galvanized parts. This was indicated by the white deposits on the hardware. As a result it was considered desirable to test the mica-base finish on hanger irons for distribution transformers where standards are now for galvanizing.

The test samples include: galvanized; cadmium plated; galvanized and Bonderized; cadmium plated and Bonderized; galvanized plus mica-base finish; cadmium plated plus mica-base finish; galvanized and Bonderized plus mica-base finish; and cadmium plated and Bonderized plus mica-base finish. After 2000 hours exposure to the salt spray it was found that the zinc had been completely consumed on the galvanized hanger irons with iron rust spots showing through the white deposits of zinc salts. The cadmium-plated irons showed fairly good resistance to salt spray but small areas were attacked. The iron was not corroded. The galvanized and Bonderized and the cadmium-plated and Bonderized iron showed up extremely well. The galvanized and painted and cadmium-plated and painted irons showed extremely good resistance to salt spray with practically no indications of attack. Of all the combinations tested, the cadmium-plated and Bonderized plus mica-base finish irons showed absolutely no signs of attack after 2000 hours.

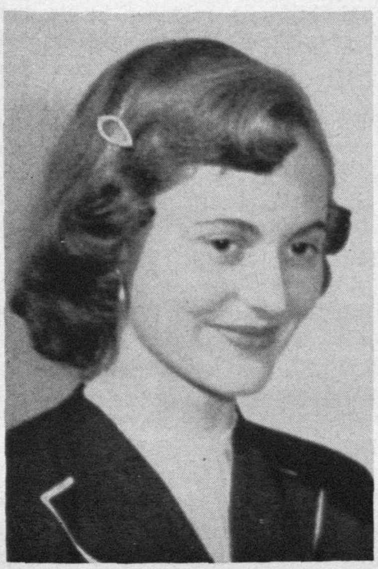
For these tests, ordinary production hanger irons were used. It is realized that the salt spray is a grossly accelerated test and that galvanized or cadmium-plated parts stand up well in marine and most industrial atmospheres. However, it is felt that the Bonderizing plus mica-base finish greatly enhances the protection already given by the electropositive metal.

Weather-O-Meter Tests

It is generally considered that one week's exposure to Weather-O-Meter conditions is about equivalent to outdoor exposure for a period of one year under average conditions. In the Weather-O-Meter test, the panels are attached to a cylinder and rotated continuously. They are exposed to periodic cycles of one hour in fog and three hours under ultra-violet light. Neither finish showed severe deterioration after 12 weeks exposure. It was noted that the final coats on both the standard and mica-base finish showed some dulling and evidence of light chalking. Tests are being continued to obtain the ultimate life of the two finishes under this condition.

(Continued on Page 48)

"Miss Engineer" 1952



"Miss Engineer" for 1952 is Mary Lee Backhurst, Port Huron sophomore. Members of her court are Marilyn Thompson, Battle Creek junior (left) and Cora Peterson, Detroit freshman (right).

MENTAL GYMNASTICS

Edited by L. B. MILLER

Here are some more brainteasers such as were published in the last issue.

The engineer, brakeman and fireman on a train are Gray, Green, and White, but not respectively. There are three passengers on the train named Mr. Gray, Mr. Green and Mr. White. These facts are known:

1. The brakeman's nearest neighbor, one of the passengers, earns exactly three times as much yearly as the brakeman.
2. The passenger whose name is the same as the brakeman's lives in Chicago.
3. White beat the fireman at billiards.
4. Mr. Green lives in Detroit.
5. Mr. Gray earns exactly $4000 per year.
6. The brakeman lives halfway between Chicago and Detroit.

What are the names of the engineer, brakeman and fireman, respectively?

A couple has two children. The husband is four years older than his wife, and one child is four years older than the other. The combined ages of the couple is now nine times the combined age of the children. Four years from now it will be five times. How old is each person now.

Three families each have one son and one daughter. Each child has a savings account which was started with one dollar the first year. The deposit each succeeding year has been two dollars more than the last deposit. Now each boy has $45 more on deposit than his sister. The names of the boys are Vern, John, and Robert; the girls are Betty, Jane and Mary. Vern is 17 years older than Mary, and John is seven years older than Betty. Find all the ages and determine the brother of each girl.

Here's another crossword division for you to work on.

```
             H E H A
      I C H | F C D I I I E
              G C I
              H D C I
              H I F H
                B H I
                G C I
                F H C E
                F H C E
```

ANSWERS TO THE LAST ISSUE'S PROBLEMS

The Captain is 28, and the ship is 21.

The train had to be travelling 60 mph. to meet the tramp at the end of the bridge.

The string has to be lengthened an amount equal to pi times the increase in diameter for any sphere, so the increase would be 2 pi feet or 6.28 feet.

For the long division, 0, 1, 2, ... 9; are J, F, D, A, C, K, G, E, H, B.

The snow began falling at 11:30, one half hour before the snowplow started.

The bad penny can be limited to one of eight in the first weighing (four on each side of the balance). These are divided into three groups for the next weighing: three remain in their original positions, three are moved to the opposite side of the scale, and two are removed and replaced by good pennies (the four which weren't weighed in the first weighing). By observing which side of the scale goes down and which goes up the bad penny can be limited to one of the groups. The penny can then be found in the third weighing (it is known by this time whether the penny is light or heavy).

ALUMNI NEWS

Walter Mischley, C.E. '46, former city manager of Manistee, Michigan, has accepted a position as Chief of Municipal and Commercial Facility branch of the Atomic Energy Commission.

Telesphore Bourbonnais, E.E. '43, has left the Idaho Power Company, where he was located for five years, and is now with du Pont at their Savannah River Project Hydrogen Bomb plant. He called at the College en route to his new location.

Major Donald Appling, Ch.E. '37, was returned from six years in Honolulu, and will now be stationed at 1705 Air Trans. Group, McCord, A.F.B., Tacoma, Washington.

Lt. j.g. Howard I. Bacon, C.E. '48, has been assigned as staff officer and instructor at the U. S. Naval School, Civil Engineering Corps Officers, Naval Construction Battalion Center, Port Hueneme, California.

Ens. Jerome Chmielewski, M.E. '52, is located at Port Hueneme, California. He called recently at the College and stated that his brother Walter was located at the Navy post in Chicago.

Richard Clemmer, M.E. '48, lives at 270 Independence Drive, Boston, Massachusetts. He is an industrial sales engineer for the Timken Roller Bearing Company.

Sidney Hay, M.E. '48, is consumer salesman for the Standard Oil Company, and lives at 4406 Ingham St., Lansing, Michigan.

Rudolph Jacobs, E.E. '48, is radio design engineer for the Westinghouse Electric Company and is doing work on color television. He is married and has one daughter and lives at R.F.D. 1, Selinsgrove, Pennsylvania.

James Oberlin, M.E. '48, is chief engineer with National Korectaire Company of Chicago. He lives at 720 Chestnut St., Deerfield, Illinois.

Hajime H. Ota, A.E. '48, is doing research on poultry respiration calorimeter for the U. S. Dept. of Agriculture. He is living at 3223 Northampton Ave. N. W., Washington 16, D.C.

Richard C. Austin, M.E. '47, is engineering assistant for the Detroit Edison Company. He lives at 1119 Mayburn, Detroit, Michigan. They now have a baby boy, Ronald, to play with Nancy, who is five years old.

George Bodfish, M.E. '47, is sales engineer for Ingersoll Rand Co., and lives at 1701 N. Illinois, Indianapolis, Indiana.

Robert Delderfield, M.E. '47, is engineer in Product Design, Test & Development for Chrysler Corporation. He lives at 2638 Robina, Berkley, Michigan, and has three children.

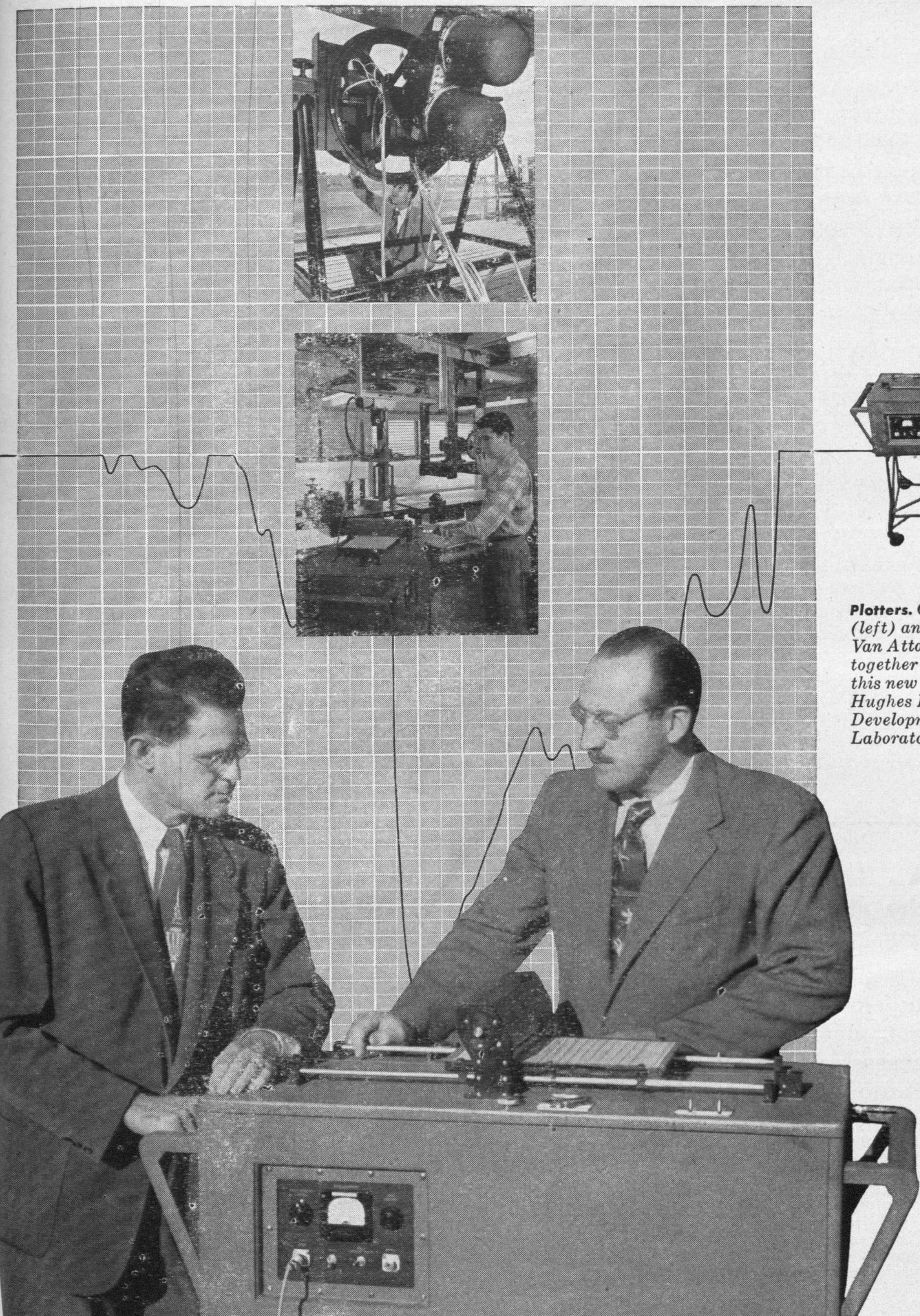
David W. Eddy, M.E. '47, is spark plug engineer for the A. C. Spark Plug Company and lives at 1410 Gainey Ave., Flint, Michigan. They have a baby girl.

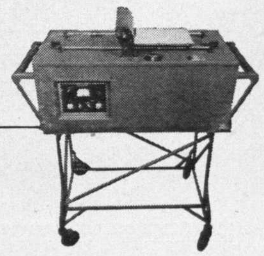
Floyd Lamb, E.E. '47, is associate engineer for the Detroit Edison Company and lives at 22904 California St., St. Clair Shores, Michigan.

Charles W. Means, Ch.E. '47, is senior development engineer for the Upjohn Company, and lives at 1528 Kingston Ave., Kalamazoo, Michigan.

Frank M. Pelton, E.E. '47, is electronic research engineer for the Cornell Aeronautical Laboratories, and lives at 133 Shimerville Road, Clarence, New York. Frank received his M.S. in 1948 and his Ph.E. from M.S.C. in 1950.

Harold Rockwell, M.E. '47, is Oldsmobile dealer in Grand Rapids, Michigan. He lives at 2524 Albert Drive S.E. He reports that Jeffra Jill arrived on April 27, 1951.





Plotters. *O. A. Tyson (left) and Dr. L. C. Van Atta worked together in developing this new machine at Hughes Research and Development Laboratories.*

CHEMICAL ENGINEERS

(Continued from Page 19)

6. Flow of Fluids
   a. Friction losses
   b. Valves and piping
   c. Centrifugal pumps
7. Instrumentation
   a. Flow meters
   b. Heat controllers
8. Crystallization
   a. Batch crystallizers
   b. Continuous crystallizers
9. Flow of Heat
   a. Conduction
   b. Radiation
   c. Film effect
10. Size Separation
   a. Screens
   b. Cyclone separators
   c. Classifiers

Representative unit operation such as those listed above are integrated into an orderly sequence to constitute a particular process. In preparing to translate the laboratory process to the industrial scale, a Chemical Engineer must set up and conduct critical experiments that will define the outlines of a safe and economical operating process and indicate the equipment needed for manufacture. Because of his training in chemistry, engineering, and economics, he is most often the logical man to coordinate the work of the many others who play an important part in process development. A Chemical Engineer might easily be called a "Process Engineer."

The distinguishing feature of chemical engineering education is the approach via the method of studying certain fundamental or basic "Unit Operations" that are common to all industries whether they are petroleum refining, food processing, by-product coke plant, or plastic material manufacture. The professional courses in chemical engineering are based, not upon a study of a series of seemingly unrelated industrial processes, but rather upon a relatively few fundamental techniques and operations that form the basis of all industrial processes. For example, the same basic knowledge of the unit operation of filtration can be applied equally well to the separation of yeast cake, the purification of city water supplies, or the recovery of magnesium from ocean water.

Chemical engineering is one of the youngest branches of the engineering profession and it has undergone extensive development and expansion in the past thirty years. Chemical engineering is presently in a very healthy state for development in growth at an even greater rate in the future. Chemical engineering is distinguished from the pure sciences by a philosophy, attitude, and a viewpoint in obtaining and applying technical information to the development, design, and operation of processes and process equipment. This philosophy is very important to the Chemical Engineer. The Chemical Engineer is concerned with bringing the "idea" of a process into a commercial reality. It is apparent that this is a particularly good training ground for future executives of a company. Further, in a large organization or a small one, engineering work yields well in the sense of important accomplishment. It is work of this type that has made possible the material advances in our civilization that provide better living and a fuller life for all.

The staff of the Spartan Engineer hopes that all those who attended the "1952 Engineering Exposition" found their visit here both enjoyable and educational.

Many members of the School of Engineering, both student and faculty, put many long hours of hard work into making this year's exposition a success. The only measure of their success or failure, however, is the public's opinion of the exposition.

Any comments that you, the public, would like to make would be greatly appreciated.

Please send your comments to:

THE SPARTAN ENGINEER
P. O. Box 468
EAST LANSING,
MICHIGAN

Thank you very much.

The Editor

CLUB AND SOCIETY NEWS

S. A. E.

On the 14th day of January, an invitation was extended by the Ford Motor Company for a group of engineers from MSC to go to Dearborn on the 17th. Even on such short notice a large section of the student chapter was able to make the trip.

At the plant, tours were conducted through such various sections as the body and structure laboratories, truck garages, dynamometer labs., and assembly. Lunch was served at the Dearborn Inn, followed by more tours. The group finished the trip at the showroom where the new 1952 models were on display.

On January 28 a group of members made a trip to Saginaw for the mid-Michigan section meeting of the S. A. E. Saginaw Steering Gear Company held an open house in two of their plants, in which the group saw the manufacturing of all kinds of steering gears. In the evening a reception and dinner meeting was held. After some short business Mr. C. W. Lincoln, chief engineer of the company, spoke on the subject, "Power Steering for Passenger Cars."

The first regularly scheduled meeting of the winter term, on February 5, featured a talk by Mr. Frank Hershey, chief of styling, for the Packard Motor Company. He brought with him Mr. Richard Teauge who illustrated the talk with free hand sketches. Mr. Hershey showed how styling has developed since the days of the curved dash Oldsmobile to the present low silhouette type of body with adequate seating space and driver visibility.

★ ★ ★

TAU BETA PI

The MSC chapter held its regular election of officers for the 1952-1953 school year on March 6, 1952. The following men were elected to the respective offices:

President—Elvin E. Tuttle, Hanover, Mich., Junior, M.E.

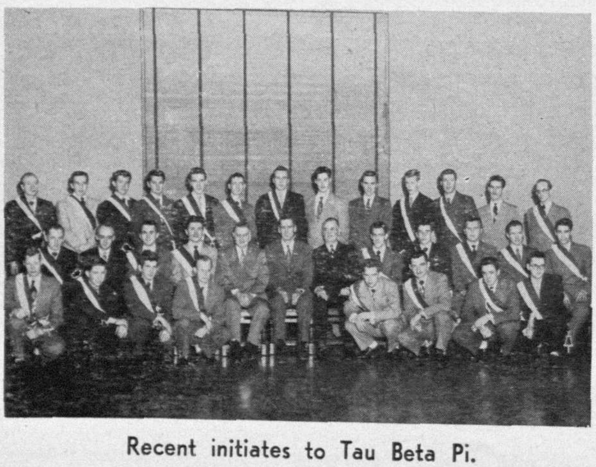
Vice President—Harry M. Schiefer, Frankenmuth, Mich., Junior, Ch.E.

Corresponding Secretary—John Allwood, Grand Rapids, Mich., Senior, M.E.

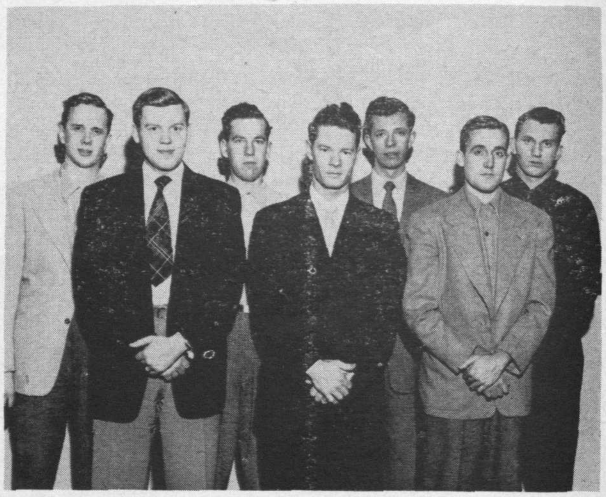
Recording Secretary—John Lenosky, East Jordan, Mich., Junior, M.E.

Cataloger—Floyd Backus, Lansing, Mich., Junior, C.E.

Eng. Council Representative—Philip Wright, Youngstown, N. Y., Junior, M.E.



Recent initiates to Tau Beta Pi.



Initiates to Eta Kappa Nu.

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A. I. Ch. E.

A field trip was the highlight of the month for the members of A. I. Ch. E. in February. The trip was made via college bus to Kalamazoo. A tour through the new plant of the Upjohn Company took the largest part of the morning. The tour was a guided one, but was on the informal side as members stopped longest at the points of greater interest and by-passed those of lesser interest. The only disappointment encountered was that the research department was in a state of redevelopment and was, therefore, closed to the group.

After eating dinner as guests of the Upjohn Company, the group journeyed across town to the Kalamazoo Vegetable Parchment Company. Here the tour through the plant enabled the group to witness the manufacture of paper from the raw pulp stage right through to the finished product, which in this case consisted of such items as, wax paper, manifold, shelfpaper, and various package wrappers. The tour ended with a trip through the research laboratories.

After the success of this trip members are looking forward to more in the future.

The last regular meeting of the A. I. Ch. E. was held in March. The program consisted of the monthly business meeting and an entertaining and educational feature.

The feature was a movie which was entitled, "The Building of a Tire," courtesy of the Firestone Tire and Rubber Co. This movie depicted the manufacturing processes involved in the production of a rubber tire from the raw material to the finished product. The means of presentation was very effective as the film was in the form of an animated cartoon.

★ ★ ★

PI TAU SIGMA

The members of Pi Tau Sigma plan to have their formal initiation in the third week of April. The initiation will start on April 22, and will be climaxed by the initiation banquet which is tentatively scheduled for May 3.

The chapter has been active in constructive work which includes the building and installation of a bulletin board in the reading room of Olds Hall, and is at present engaged in the project of putting blackboards in the same reading place.

(Continued from Page 15)

other active substance is sufficient to embrittle it to the point where it is useless.

All oxide refractories are reduced by contact with the molten metal which is then contaminated by both the oxygen and the metallic element.

Work carried out at Battelle Memorial Institute has resulted in an arc-melting furnace suitable for handling titanium and its alloys. This furnace incorporates the following features:

(1) A water-cooled copper crucible

(2) A water-cooled tungsten electrode

(3) A fairly tight melting chamber and alloy addition apparatus whereby outgassing operations can be carried out

(4) A protective atmosphere consisting of 99.92 per cent argon which effectively prevents contamination of the melt

(5) A device for continuous or semicontinuous addition of the melting charge for the production of small ingots.

This furnace is also suitable for the production of large ingots, and it is believed that a method of producing continuous ingots could be developed with relatively little additional work.

The J. B. Sutton's Pigments Department and E. I. duPont de Nemours Company have developed a method for induction melting of titanium metal in graphite. They have facilities constructed that are capable of melting and casting one-hundred pound ingots.

The Metallurgical Division of the U. S. Bureau of Mines deserve a great deal of credit for the work they have carried out in developing methods for producing and fabricating titanium. Most of the titanium reduction today is based on the chemical method developed by W. J. Kroll of the Bureau of Mines. Essentially the Kroll process for production of titanium consists of reducing titanic chloride by reaction with magnesium. This is done in a closed iron chamber with a protective atmosphere of helium.

Inspecting a 300 pound Titanium sponge.

Another big step towards solving the problem of producing titanium was made early in 1950. The National Lead Company and the Allegheny Ludlum Steel Corporation, two of the largest producers of titanium, linked their respective facilities into one integrated pattern by creating a sales and development organization, Titanium Metals Corporation of America.

The extent of titanium's structural uses will probably depend, to a considerable degree, on the properties of its alloys. While most of these are still in the testing stage, it is still possible to foresee a goodly number of probable applications.

The aircraft industry will possibly be the largest single user, largely because of the metal's high strength-weight ratio. It should prove ideal for propellers, landing gear, and many parts in jet engines.

Its excellent resistance to salt water corrosion gives it a future in marine installations. It should be ideal for salt water piping systems, pumps and rotors, high-speed propellers, and water-lubricated bearings and shafts. It may eventually be used for entire ship hulls if the price can be reduced enough.

Titanium could find a high tonnage use in transportation. The advantages of light weight, strength, and corrosion resistance could be profitably combined.

W. Lee Williams, U. S. Naval Engineering Experimental Station, emphasized the following facts:

> "In competition with stainless steel, light weight can be an outstanding advantage; in competition with the light metals, corrosion resistance stands out; against structural steels, corrosion resistance, lightness, and possibly ease of surface hardening may be controlling factors. Thus titanium appears to be most important because it possesses some of nearly all desirable properties, thus making these properties available in a non-critical material."

Thanks to around the clock work in the development of titanium and its alloys, the world may soon have all of this useful metal it wants and which it so badly needs.

★ ★ ★

It was Christmas Eve in East Lansing, and in the newspaper office the stern-faced State News editor had called a reporter before him and assigned him to cover Lansing's slums for human interest stories. "Find out," he instructed the reporter, "what those poor devils down there are getting to eat. Then get over to the tenement district and see what the really poor are having for their Christmas dinner, if anything. Then go over to the Municipal Lodging Houses and talk to the unfortunates standing in line for their annual handout. And, oh yes, on your way back—bring me a hot dog."

★ ★ ★

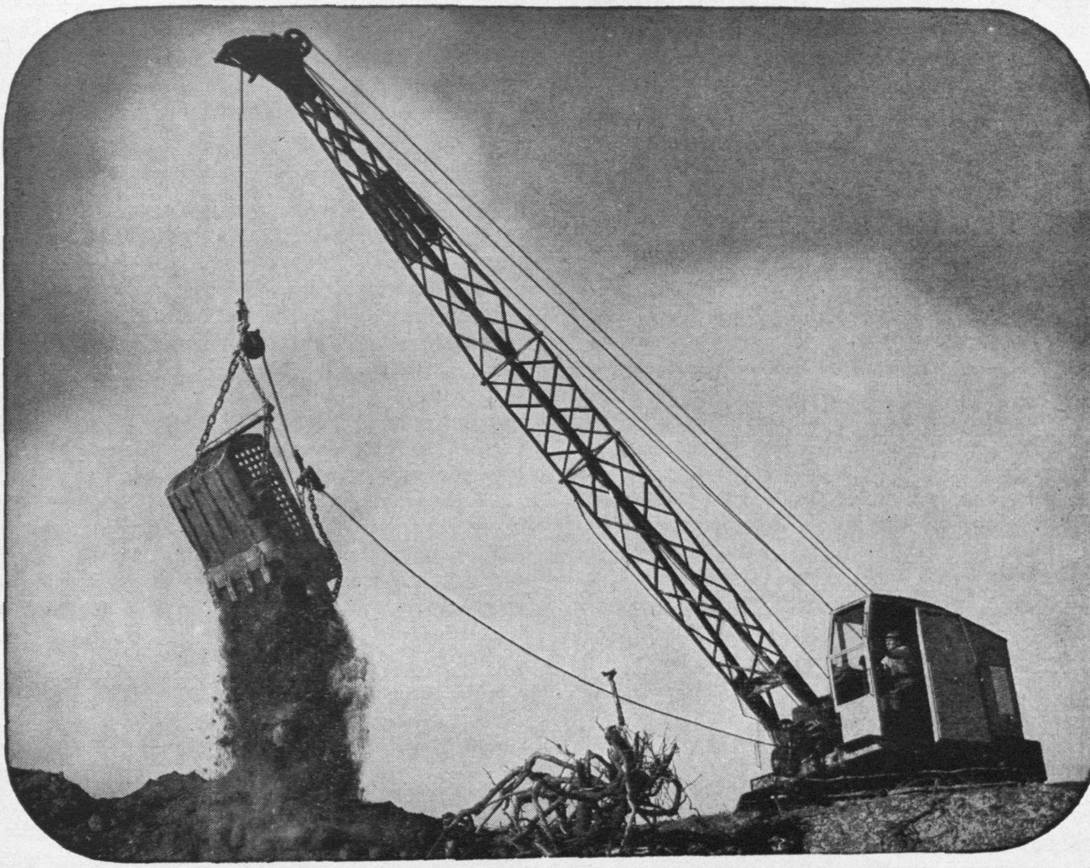
Both of the blacksmiths stuttered. One had finished heating a piece of pig iron and placed it on the anvil for the other to hammer.

"Hi-h-h-h-hit it," he stuttered to his helper.

"W-wh-wh-wh-where?" asked the other.

"Aw g-g-g-gosh, n-n-n-n-now we'll ha-have to heat it again."

WIRE ROPE



This is the most economical rope we've ever made for construction equipment

ROEBLING is the best known name in wire rope. That's partly because we were the first wire rope maker in America. But more than that, we've always led in developing better wire and better rope for every purpose.

Today's Roebling Preformed "Blue Center" Steel Wire Rope *is* the best choice for efficiency and long life on excavating and construction equipment. This rope has extra resistance to crushing and abrasion . . . stands up under rough going. It saves time and cuts costs.

There's a Roebling wire rope of the right specification for top service on any job. And Roebling Field Men are always showing users new economies through proper operation and maintenance. John A. Roebling's Sons Co., Trenton 2, N. J.

ROEBLING

ATLANTA, 934 AVON AVE • BOSTON, 51 SLEEPER ST • CHICAGO, 5525 W. ROOSEVELT RD • CINCINNATI, 3253 FREDONIA AVE • CLEVELAND, 701 ST. CLAIR AVE, N. E. • DENVER, 4801 JACKSON ST • DETROIT, 915 FISHER BLDG • HOUSTON, 6216 NAVIGATION BLVD • LOS ANGELES, 5340 E. HARBOR ST • NEW YORK, 19 RECTOR ST • ODESSA, TEXAS, 1920 E. 2ND ST • PHILADELPHIA, 230 VINE ST • SAN FRANCISCO, 1740 17TH ST • SEATTLE, 900 1ST AVE S. • TULSA, 321 N. CHEYENNE ST • EXPORT SALES OFFICE, TRENTON 2, N. J.

CIVIL ENGINEERING

(Continued from Page 12)

it in nine weeks surveying camp. A camp has the further advantage of placing the men in operating conditions. It will give them an esprit de corps such as is now enjoyed by the men in the Forestry Department. Friendships built while roughing it at camp go deep and last a lifetime. It is further believed that a camp will attract many persons desiring to take up only surveying. Engineers completing this course will have a real mastery of the subject and have a worthwhile advantage over the present engineers in an increased earning power for the two remaining summer work periods.

IMPROVEMENT OF STAFF

Although we have a very excellent teaching staff at present, it is felt that there is always room for improvement. To make this improvement possible, each staff member will be encouraged to select and concentrate in one or two limited fields, thus becoming more proficient in his field. In this way he may undertake more creative thinking and research. The areas to be selected are the six fields of preference described previously. Consideration is also being given by our civil engineering staff to self-improvement of teaching methods and techniques. This may include inter-visitation as well as criticism of classes in progress by the staff members themselves. It may also include special seminars, instruction or possibly practice teaching. Student evaluation of teachers might well be rejuvenated. Encouragement of a larger amount of research should also reflect on the quality teaching.

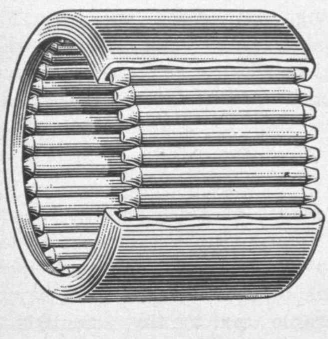
SCHOLASTIC STANDING

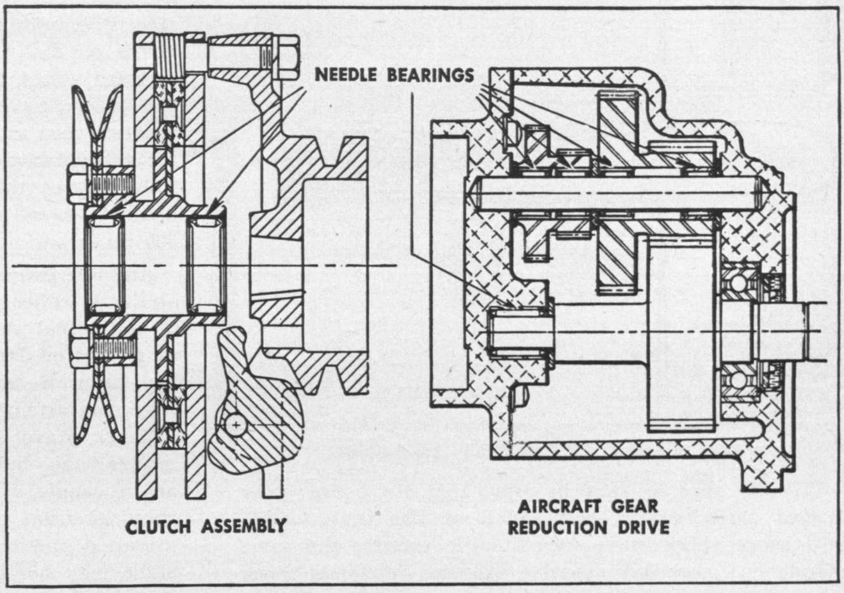
Michigan State Engineers need to place higher emphasis on scholastic standing. My rather limited contact here indicates that the students are not lacking in mental ability, but that the necessary incentive, drive, and inspiration have not been instilled into them to the point where they are willing to make the effort required for such attainment. Too few students realize what an important investment high grades can be. Few understand fully that study and work habits performed during the four college years may largely control the future success or failure of their career when they are thrust into competition with men from other schools.

MORAL AND SPIRITUAL VALUES

The moral fiber of many engineers and the men in the construction field is in serious need of strengthening. Kick backs and corrupt practices have become common practice and too frequently the young engineer becomes, directly or indirectly, a tool in the hands of scheming politicians who have become engrossed in the game of pillaging the public's purse. Only when men are fortified with real understanding of moral and spiritual principles are they able to effectively meet a crisis such as that presently encountered by their profession. It is a major part of our task to see that each engineering graduate leaving Michigan State College will have adequately prepared himself to meet temptations and difficulties which lay ahead of him. May it ever be said that when a great crisis arose men from Michigan State were already at hand ready to step forward and give sound leadership.

The Torrington Needle Bearing needs little space—saves time in assembly





Typical installations of Torrington Needle Bearings are characterized by simplicity of design. Needle Bearings are made for shafts as small as 5/32" up to those as large as 7¼".

The Torrington Needle Bearing is a completely self-contained unit consisting of a full complement of small diameter rollers and a single retaining shell. This unit design and construction greatly simplify handling and speed assembly, and help reduce the size and weight of related parts.

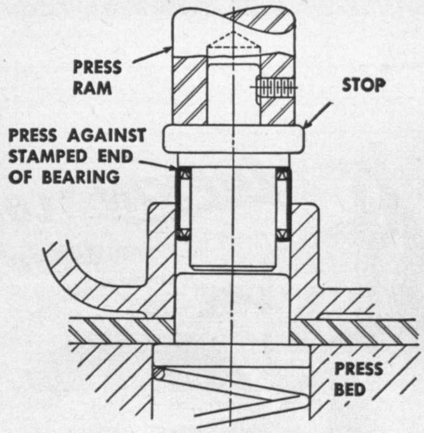
High Load Capacity in Small Space

Because the many rollers distribute loads over a large contact surface, a Needle Bearing has a very high load capacity in relation to its size. In fact, the Torrington Needle Bearing has a higher rated radial load capacity than any other type of anti-friction bearing of comparable outside diameter. This not only permits the use of a smaller, lighter bearing for a given load, but also allows reductions in the size and weight of housings and other related components. The Needle Bearing's large inside diameter permits larger shafts to be used in cramped quarters, an important factor in many designs.

Installation Simplified

The installation of Torrington Needle Bearings is fast and easy. The housing bore is simply machined to proper diameter. The bearing is then pressed into this housing. An arbor press is normally used for this operation. No spacers or retainers are needed to keep the bearing in place. An accurately made shaft is required, of course, as it serves as the inner race in most cases and must be hardened and ground to correct size. For applications where an unhardened shaft is desired or necessary, inner races can be furnished for all Needle Bearings.

These advantages make Torrington Needle Bearings ideal for applications where space or weight is at a premium, or where mass production methods necessitate the use of a bearing that is as easy as possible to handle and install.



The use of proper tools for installing Needle Bearings speeds up assembly. The arbor press tools above are ideal.

Other features of Torrington Needle Bearings will be covered in other advertisements in this series. For additional information regarding Needle Bearings, please contact our engineering department.

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

TORRINGTON *NEEDLE* BEARINGS

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

THE SONIC BARRIER

(Continued from Page 7)

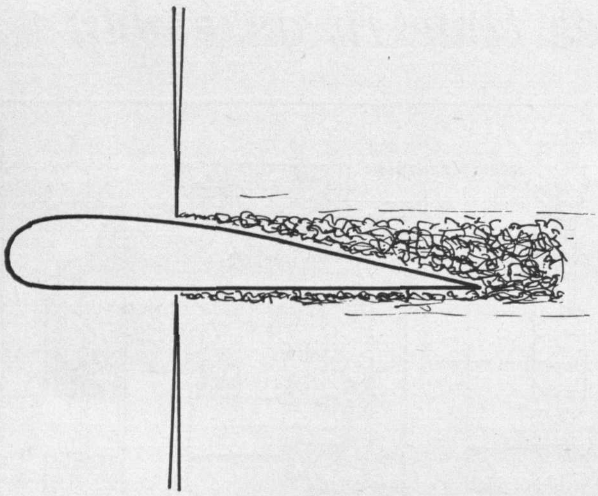


Fig. 3

It must also be kept in mind that there are other curved areas, called **local areas**, on the craft, which will cause shock wave formation in exactly the same manner as described above. Anyone of these shock waves, whether due to the wing or to a local area, can easily destroy the aircraft. To emphasize the danger from this type of shock wave it has been stated that, "If an aircraft could be designed so that all of its surfaces reached the speed of sound at the same time, the **transonic range** (sonic barrier) would be no more dangerous than the subsonic range."

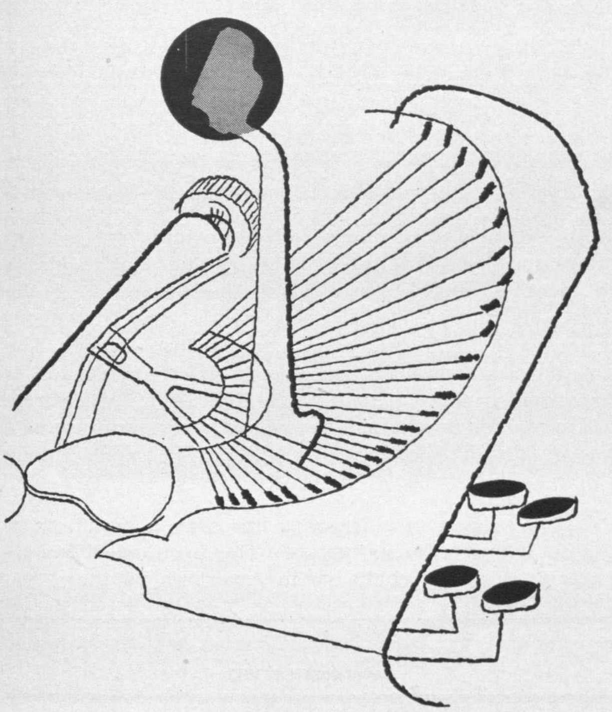
The greatest present difficulty in designing supersonic aircraft is the requirement that the aircraft have good flight characteristics in all three speed zones, the subsonic, sonic, and supersonic. The National Advisory Committee on Aeronautics has performed experiments on many wing types: swept back wings, swept forward wings, thin wings, etc. None have been found that are efficient in all three speed zones. The standard practice used at present to reduce sonic barrier hazards for an operational aircraft is to refine the plane's lines. This assures that there will be a minimum of local areas to cause shock wave formation at speeds near 600 miles per hour.

An interesting property of shock waves is their ability to reflect light. This permits photos to be taken of the actual shock wave. On film the wave appears as a light or dark streak or area. Needless to say, this has been of immeasurable aid to the scientists and engineers attempting to overcome the sonic barrier.

Shock wave formation is a sudden process **not** a gradual one, but for the alert, experienced pilot there are a couple of indications that shock waves may be about to form on his plane. A slight, but noticeable, vibration and buffeting of his plane will occur, or the plane may become slightly nose heavy. But whatever the warning, it is time to slow down a little. The plane which can withstand the sonic barrier is no longer a dream, but it is still an experiment.

What's Happening at CRUCIBLE

about special shape type steel



5. The flash trimmed off after the swadging operation.

6. The finished type ready for hardening, plating and soldering to the type bar.

The production of Crucible steel for this job is the result of engineering and practical know-how combined with a special method of manufacture to assure a homogeneous microstructure for maximum forming properties, excellent surface characteristics for good die life, and close accuracy control for all dimensions of the shape.

The production of type steel requires the use of small precision rolling mills equipped with shaped rolls and operated by skilled workmen. During preliminary and final inspection, shadowgraph equipment is constantly used to check for size accuracy.

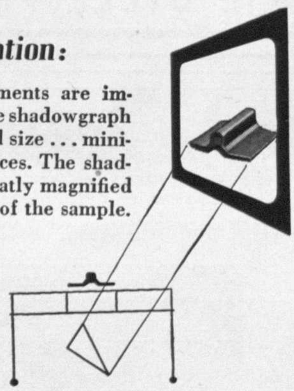
As a result of its outstanding quality, Crucible's special shape type steel is constantly in demand and used by leading typewriter manufacturers.

Crucible special purpose steel for type character application

The development of cold rolled special shape type steel is one of Crucible's important contributions to the business machine industry. A major part of the type characters used for the manufacture of typewriters are made from this special shape.

Shadowgraph Operation:

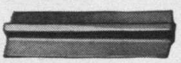
Since micrometer measurements are impractical due to the shape, the shadowgraph is used to measure shape and size . . . minimum and maximum tolerances. The shadowgraph is a projection, greatly magnified . . . on a calibrated screen . . . of the sample.



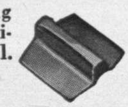
Schematic of shadowgraph

Here's the step-by-step process:

1. Cold rolled special shape produced by Crucible.



2. The type slug cut from the special shape material.



3. The wings of the type slug are bent down and taper formed toward the edges.

4. The type characters are cold swadged on the solid edge of the bent type slug.

If you have a requirement for special steels—check with Crucible. Feel free to draw on the experience of our metallurgists and engineers. Crucible Steel Company of America, General Sales and Operating Offices, Oliver Building, Pittsburgh, Pa.

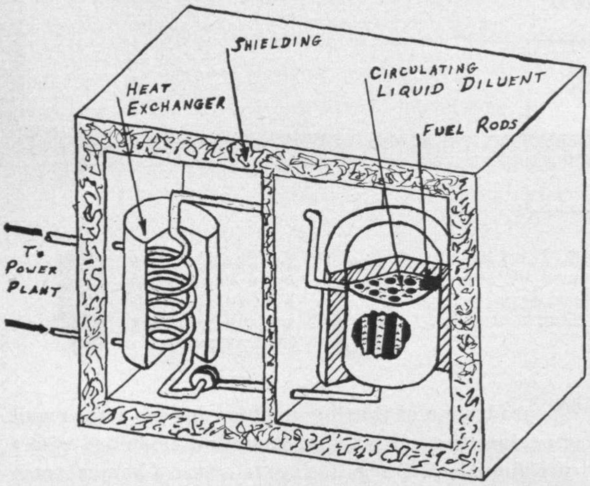
CRUCIBLE first name in special purpose steels

52 *years of* Fine *steelmaking*

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

NUCLEAR POWER

(Continued from Page 11)



(Fig. 3)

The preceding notes give some promise of useful applications of nuclear power in the not too distant future. What is needed most are men willing to work and work hard toward a solution of some of the problems just outlined. The field is new, and the possibility of development of new ideas is exceedingly great. The field is almost entirely one of non-standard engineering practices, and both money and fame await those pioneers willing to develop it into a workable source of energy for a power-hungry world.

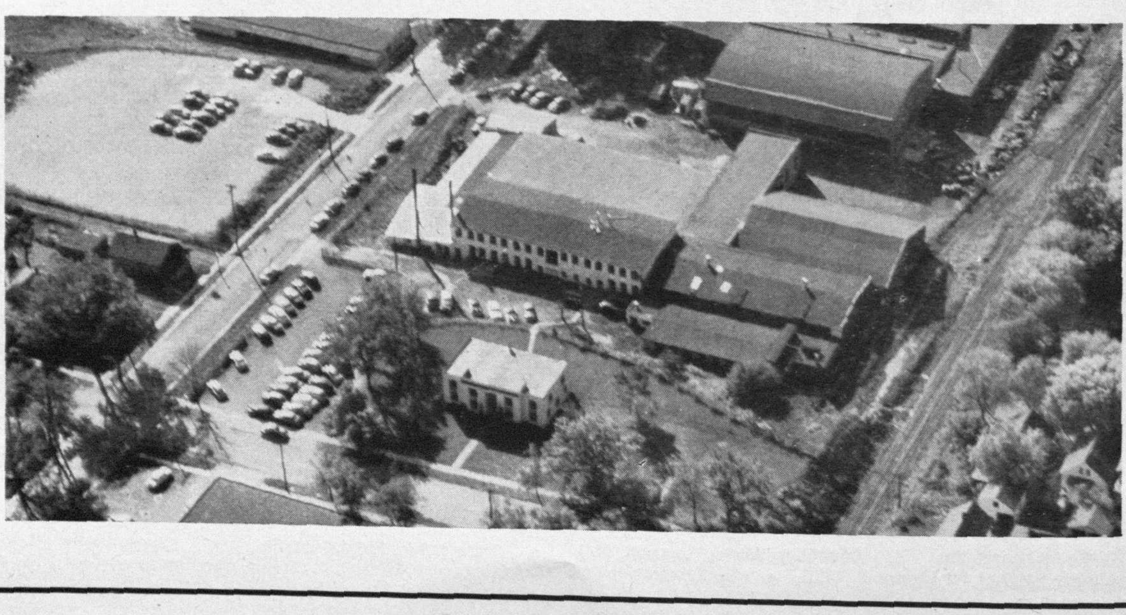
METALLURGICAL ENGINEERING

(Continued from Page 13)

and metallurgical engineer must usually provide the materials, for these dreams require properties that can be found only in metallic materials. We know that new machines and new materials are being developed today and that when they are perfected will require unique combinations of properties for metals and alloys. This is where the metallurgist and the metallurgical engineer pick up a physicist's discovery and put it to human use.

Metallurgy is one of the branches of science, engineering, and technology. It is a very important branch because our modern civilization cannot exist without metals and alloys; without metallurgy there would be no railroads, automobiles, skyscrapers, or airplanes. Opportunities are unlimited in the field of metallurgy, and the future will reveal developments in the metallurgy of high-temperature alloys for jet motors, and in new alloys for diesel engines, television, and atomic plants to mention only a few. More than seventy of the ninety-six natural elements are metals, but only about one-half of them are in commercial use today. The metallurgical engineer has extraordinary opportunities for research, development, and application of entirely new alloys, or for the more economic design and use of a known alloy. The metallurgical industries are among the basic industries of civilization.

No other class of substances has such a broad range of useful properties as metals. The frontiers of metallurgy offer a real challenge to America's youth.



AT JOINT Technical Meetings of Standard Oil Company and its subsidiaries, many opportunities are presented for an easy exchange of ideas. From formal meetings, where technical papers are read, to small discussion groups and conversations between individuals, a healthy and stimulating air prevails throughout the five-day meeting.

How Exchanging Ideas Advances Petroleum Progress

WHEN MORE than 150 scientists meet for five days and exchange views on their work during the past year, the American consumer is likely to benefit, through improvement of products for his use. Conversation between scientists can often accomplish a more complete and satisfactory coordination than mere exchange of written reports.

From May 5 through May 9 this year, the Standard Oil Company (Indiana) and affiliated companies held their tenth annual Joint Technical Meeting at French Lick, Indiana. The key scientists and engineers from the parent company and all its subsidiaries attended. More than eighty technical papers were presented.

In addition to the research men, the manufacturing, production, sales, chemical products, and patent departments of the companies were represented. This helped give a broad view of company problems.

The Standard Oil Joint Technical Meetings are outstanding in their field. The company has been a pioneer in bringing together scientists and engineers from all the branches of its activities.

This is another example of leadership in engineering and research, and well illustrates the progressive atmosphere men with technical training may find in a career at Standard Oil.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

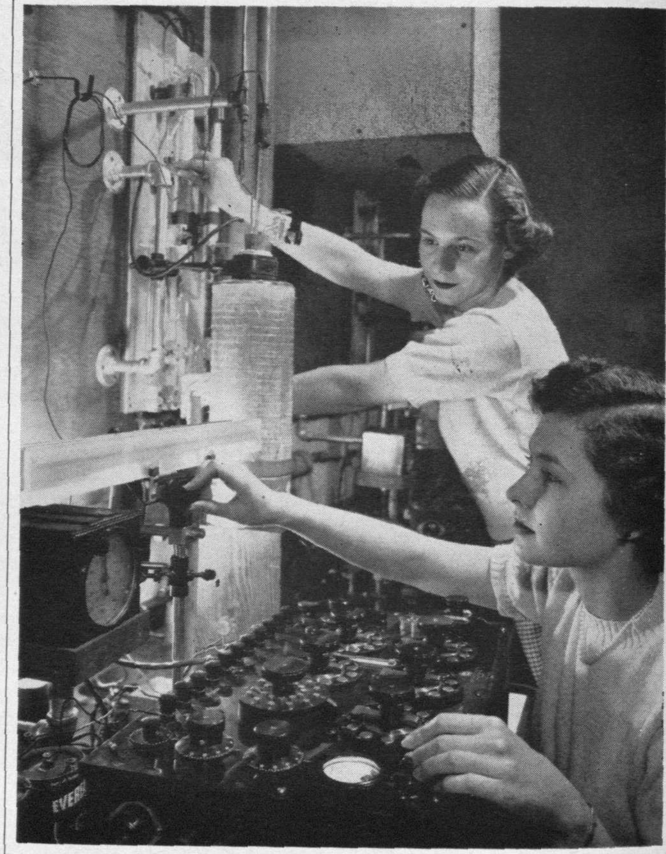
STANDARD

NEW DEVELOPMENTS

(Continued from Page 18)

atmospheric conditions and removal of undesirable fumes in the labs.

In one section of the API, two researchers, below, check the purity of a hydrocarbon by measuring its freezing point. By use of the platinum resistance thermometer and an extremely accurate resistance bridge, they will be able to obtain an accuracy within 0.002° C in freezing point comparisons.



Determining the purity of a hydrocarbon by measuring its freezing point.

For additional information write to:

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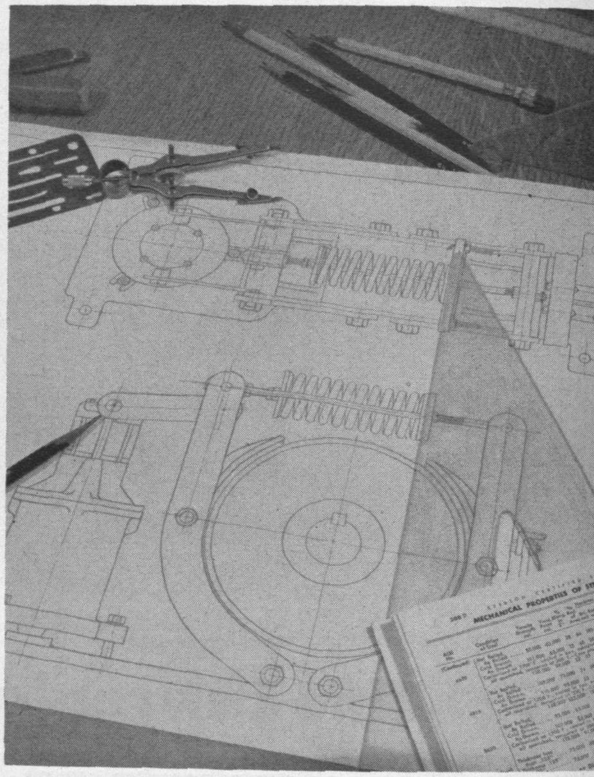
JETS-O-GRAM

The School of Engineering extends to members of JETS a hearty welcome. You will find both the students and the faculty ready to answer your questions or to direct you about the campus. There will be exhibits and activities to keep you busy. You can trade project and activity ideas with other members. Seniors (and juniors) may make progress on their college plans. We hope you will feel your time well spent.



JETS CLUBS

The present shortage of engineers was foreseen several years ago. The only source of future engineers is in the high schools. These two facts were brought together by Dean Lorin G. Miller of the School of Engineering to form the organization known as JETS Clubs.

Now we are making progress in the JETS program. The eagerness and interest with which you, the members of JETS, enter into its activities indicate the need for such a program.

Much emphasis has been placed upon the shortage of engineers, but one must not lose sight of the values of JETS beyond increasing the number of engineers; it can also improve the quality. In many cases members of JETS Clubs today will have a better idea of the engineering profession when they start their college career. They, too, will be better prepared by their choice of high school subjects.

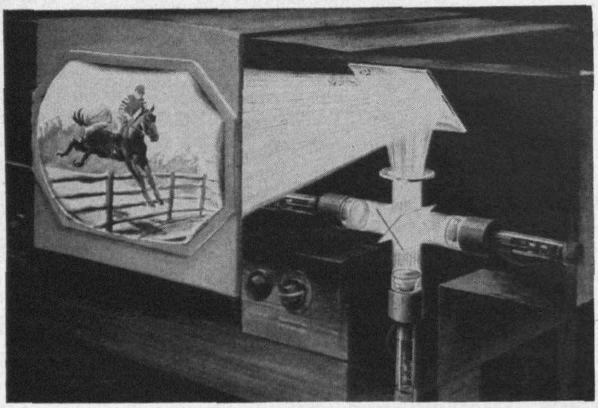
ENGINEERING FOR A STRONGER AMERICA

The theme of the Fourth Annual Engineering Exposition presents a goal toward which we all may strive. In its attainment we achieve satisfaction in our work and opportunity for our future.

COLOR TV

(Continued from Page 14)

and adaptability. A color system is said to be compatible with the present black and white system if the



color broadcast could be received and viewed on a black and white set without any circuit changes. Of course, the picture seen would be black and white, but it would contain all the detail of the color picture. The RCA system falls within this category.

An adaptable color system is one whose programs could be viewed on black and white sets only after certain changes were made in the existing sets. The CBS system falls into this class. Because CBS' line frequently (29,160 lines per second) and field frequency (144 fields per second) differ from the line and field frequencies employed in current black and white receivers, CBS programs could not be received on the sets now in use without a change in circuitry.

Now, what does the adoption of the CBS system mean to you? Present sets coming off the production line are designed to operate at a horizontal line frequency of 15,750 cycles per second and a field frequency of 60 cycles per second. Since these values differ appreciably from those found in the CBS system, certain changes would have to be made in your set before you could view CBS color programs even in black and white.

Your next question, of course, is: "How much would such a change cost?" The exact answer to this question cannot be given at this time because no such conversions have been made to date. The cost for conversion of your present set to receive CBS color telecasts may be as little as $25 retail. In order to receive color programs in color a motor and a color wheel would also have to be added. If the picture tube on your set is less than 12½ inches in diameter, you can purchase a color wheel for about $100. If your picture tube is larger, your set cannot be readily converted to receive CBS color program in color since the color wheel would then become too large and unsightly.

With the RCA system on the other hand, there would be no initial cost of converting your present sets to receive color programs in black and white. In order to receive RCA color television you will have to buy a new set which would include the tri-color picture tube.

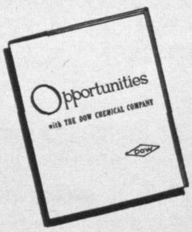
(Continued on Page 48)

NEW research expansion AT DOW

Research is the cornerstone of rapid growth in the chemical industry. The continuance of this growth at Dow is assured by expanded research facilities requiring the talents of many scientific people in widely varying fields of endeavor.

At the home plant in Midland, Michigan, Dow is building another completely new laboratory to augment the current work in organic chemistry. Increased facilities for Dow's progressive work in spectrographic analysis is planned to keep pace with important advances in this field.

In Dow's Freeport, Texas Division, even greater research expansion is taking place. Here a huge research center consisting of eight buildings is under construction. This center, which will include a modern technical library, will have a total floor space of 57,000 square feet.



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

THE DOW CHEMICAL COMPANY

Midland, Michigan

DOW
CHEMICALS
INDISPENSABLE TO INDUSTRY AND AGRICULTURE

MICA PAINT

(Continued from Page 22)

Outdoor Exposure Tests

Panels of the standard three-coat finish and the three-coat mica-base finish were prepared and exposed on both Florida and California Coasts. At the end of eighteen months none of the mica-base panels had shown signs of corrosion. The standard panels showed edge corrosion and rust creepage to the extent of about one-sixteenth inch in from the edge. Some chalking had taken place on both panels. This was particularly true for the panels exposed on the Florida Coast. It is interesting to note that the panels exposed on the California Coast at San Francisco still have most of the original gloss.

Summary

This three-coat, mica-base, paint system of the baking type was developed specifically for pole-type distribution transformers. The goal was to develop a finish that would better withstand the widely diverse atmospheric conditions under which these transformers must operate. The results of laboratory and field tests show that the Coastal Finish is superior to the finish previously used on distribution transformers; that, as a result, the service life of the finish will be more than doubled. Many industrial-type paint systems have been tested but the mica-base system described shows superiority over all examined to date. The tests reported are only a short summary of the many tests that have been made on this system.

COLOR TV

(Continued from Page 46)

At present, a three judge Federal Court has issued a temporary order preventing CBS color telecasts, and has under consideration an RCA petition for a permanent injunction. A surplus of black and white sets in storehouses is causing the color manufacturers to be hesitant about offering color TV to the public immediately; sets that sold for $375 in 1947 are available for $140 today. RCA color broadcast are limited to experimental telecast during hours when regular program schedules are not in operation, but they offer good reception to all viewers over Channel 4, New York. Introduction of color television generally, it is believed, may be postponed because of the war emergency.

Now, you may be wondering whether to trade in your old set for a new one or wait for the advent of color television. When buying a television set today, it involves some risk of early obsolescence. Buying a set two or three years from now will probably involve the same risk. Television is a rapidly evolving industry. Fortunately, most of the anticipated changes would not impair the usefulness of present sets; they would only make you wish you had a newer set. For instance, you'll need another receiver or a converter to pick up ultra-high-frequency (UHF) stations—expected to be in operation soon—as well as regular channels. The UHF can accommodate 70 new TV channels, providing for perhaps more than 2,000 UHF television stations.

I am Industry–1952

Ushered into a new world,
I had a bustling, brawling, bruising youth.
I was a potential giant awakening in a world of giants.
People were hurt when I first stirred in life;
Then I grew and learned;
Then I matured and knew that
Though I work with water and metal and chemicals and fire,
I am more than these things.
I am the people's work!
I am the people's dream!
I am the people!

With maturity, I have grown, too, in social responsibility
To the people,
To America!
And even to those beyond our shores.
My efforts are not in selfish interest;
Rather, all my brain and brawn strives for the good of the many.
I am the American way!

Now, I have sworn that these things shall be:
I shall deliver ever-better products to those who use my fruits!
I shall offer equal opportunity to those who work at my side
Whatever their race!
Whatever their creed!
Whatever their color!
Whatever their national origin!
I shall forever do my part to keep America great!

And why?
Because only in this way can I remain a healthy force in our free world.
For when I am healthy, America prospers
And tyrants tremble before my might.

I am America's life-blood!
I am America's strength!
I am the bulwark of
the World's freedom!

SIDE TRACKED

Fie upon thee, little man
With thy slide rule in thy hand;
Seated at your work all day
While your roommates drink and play;
Throw away your cams and charts
Now's the time to switch to arts.

★ ★ ★

A woman surprised her husband in a bar, sampled his drink, made a wry face and demanded, "How can you drink such horrible stuff?"

"See!" exclaimed the husband with injured dignity. "And all the time you thought I was having fun."

★ ★ ★

While out of town, a stingy husband sent his wife, as a token of his affection, a check for a million kisses. His wife, a little annoyed that the gift wasn't a real check, sent back a postcard which read:

"Dear Jim: Thanks for the birthday check. The milkman cashed it for me this morning."

★ ★ ★

"Has your boy friend's English improved any?"

"Well, he still ends every sentence with a proposition."

★ ★ ★

Just as the bus was about to pull away from the curb, a feminine voice was heard pleading, "Just a minute, please. Wait till I get my clothes on." Every eye in the crowded bus swivelled expectantly. What they saw, however, was merely an attractive young lady struggling onto the bus with a large bundle of laundry.

★ ★ ★

An engineer making a week's stay in a small town bought some limburger cheese to eat in his room. When he got ready to leave, he still had part of it left. Not wanting to pack it or leave it lying open in his room, he went to the window-sill, carefully removed a plant from the pot, buried the cheese, and replaced the plant.

A few days later he got a telegram from the hotel: "OK, we give up. Where in heck did you hide it?"

★ ★ ★

Little boy watching milkman's horse: "Mister, I'll bet you don't get home with your wagon."

Milkman: "Why?"

Little boy: "Cause your horse just lost all his gasoline."

A tree is a solid thing that stands in one place for fifty years and then suddenly jumps in front of a woman driver.

★ ★ ★

Then there was the fellow who had a hobby of collecting stones and putting them in his bathroom.

He had rocks in his head.

★ ★ ★

"Do you have any physical defects?" the army doctor said.

"Yes, sir!" the draftee answered promptly. "No guts."

★ ★ ★

I sure got a shock last night. I went to see my girl friend, and her old man met me at the door and right away asked my intentions."

"I guess that was pretty embarrassing."

"Yeah, but that's not the worst of it. My girl friend called from upstairs and said, "That's not the one, Dad."

★ ★ ★

"Where did I come from, Mother?" inquired a six-year-old, just home from his first day at school.

"This is it," thought his mother. She had been reading and rehearsing herself for this very moment. So she told him at length, with natural manner and tactful language the story of birth and life. Then, drawing a relieved breath, she smiled and said, "Does that answer your question, dear?"

The little boy, looking a little perplexed, replied, "I guess so, Mom. I was just wondering. The boy who sits in front of me at school came from New Jersey."

★ ★ ★

A business firm kept sending a bill to one of its customers without receiving a payment. Finally, however, they did receive the following letter:

"Dear Sirs: Every month I put all my bills together, pick five at random and pay those. If you send any more reminders, you won't even get a place in the shuffle next month."

★ ★ ★

"Pull over, Bud," commanded the traffic officer. "You haven't any tail-light."

The motorist got out for a look, and his eyes almost popped out.

"Well a tail-light missing isn't quite that bad," said the officer.

"But," hoarsely whispered the motorist, "what's become of my trailer?"

★ ★ ★

The prominent educator's ego slipped a few notches when he found out that his own child thought the degrees M.D., D.D., and LL.D. meant Mairzy Doats, Dozy Doats and Little Lambsy Divey.

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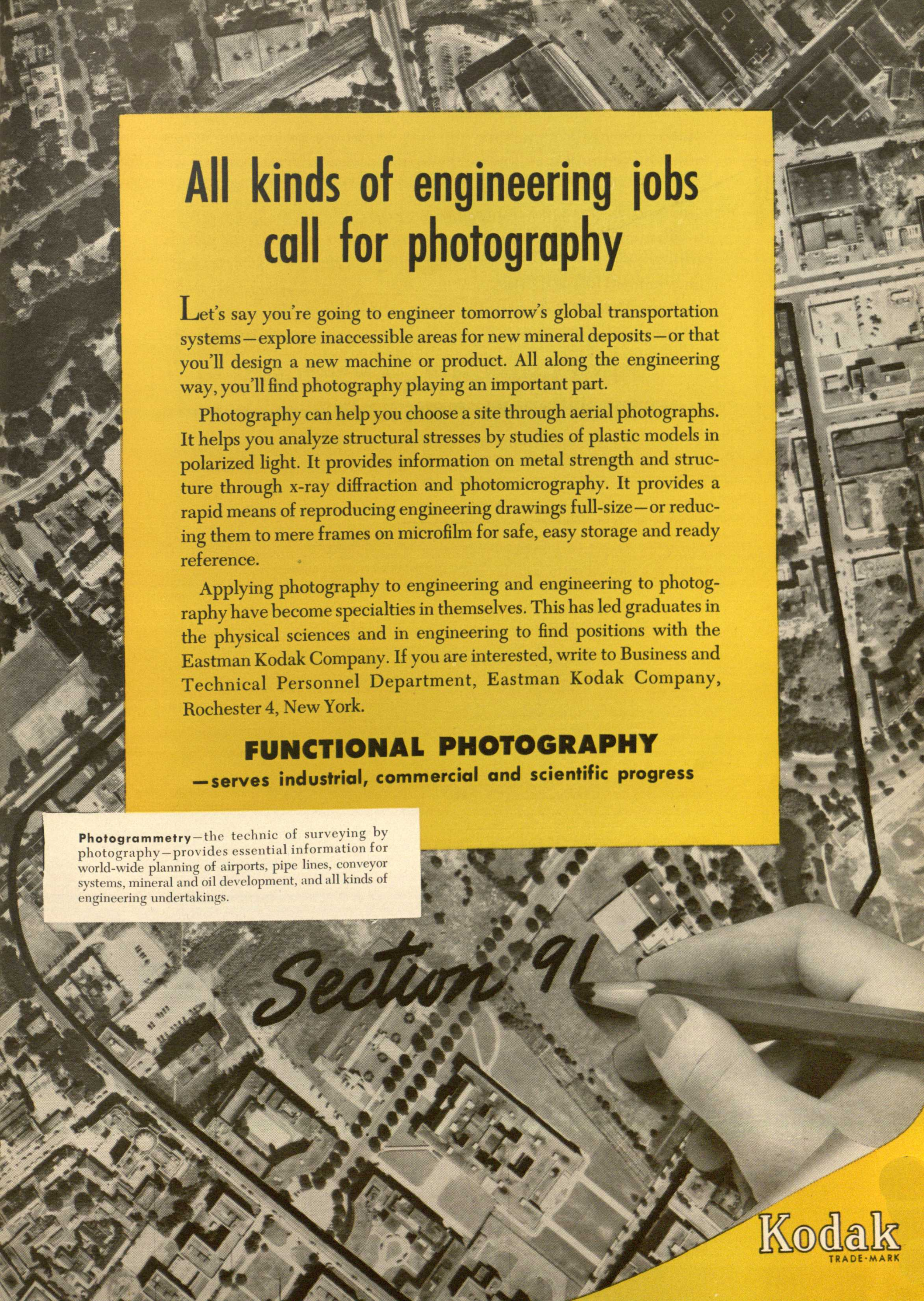

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