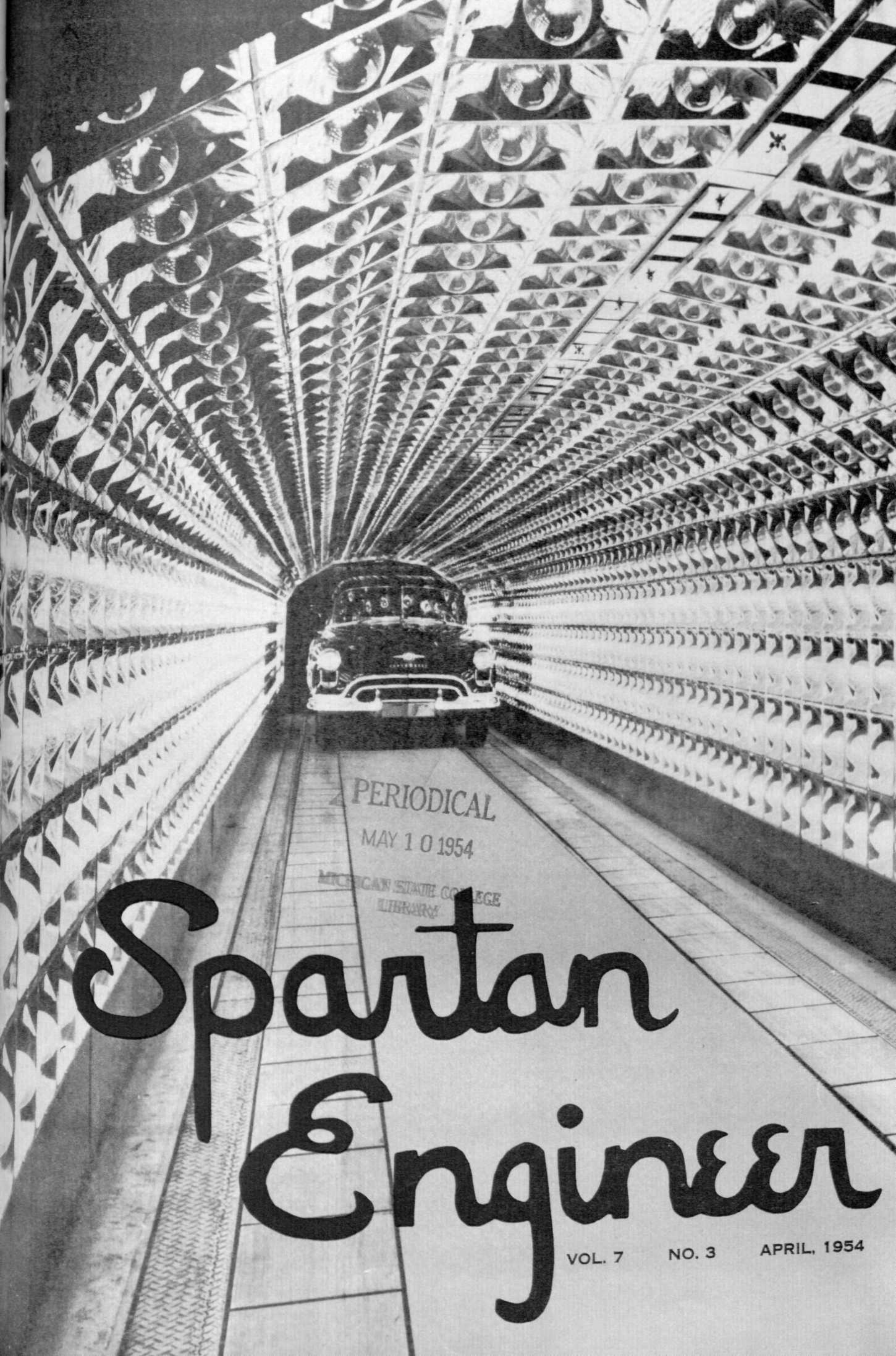
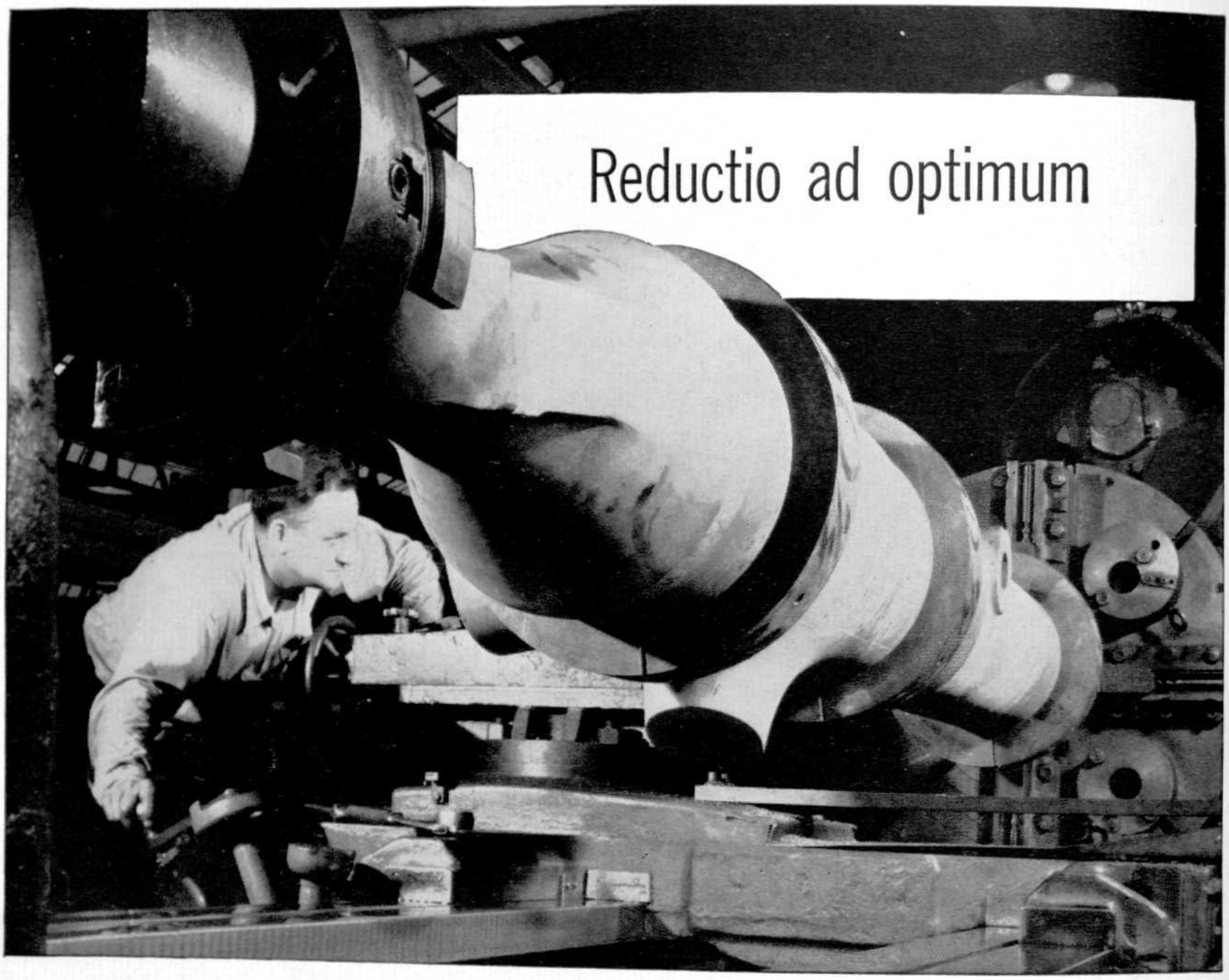
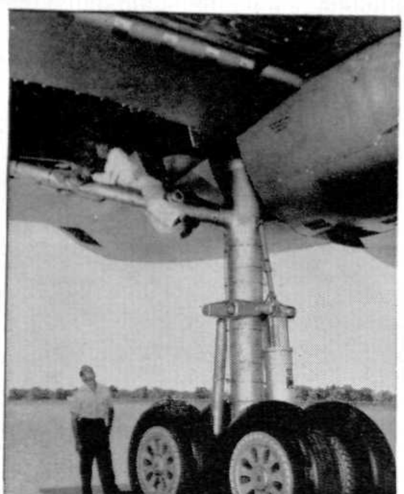


Spartan Engineer

VOL. 7 NO. 3 APRIL, 1954

Reductio ad optimum





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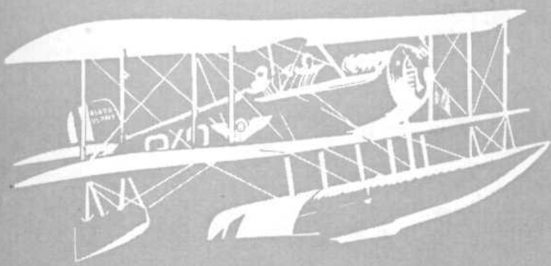

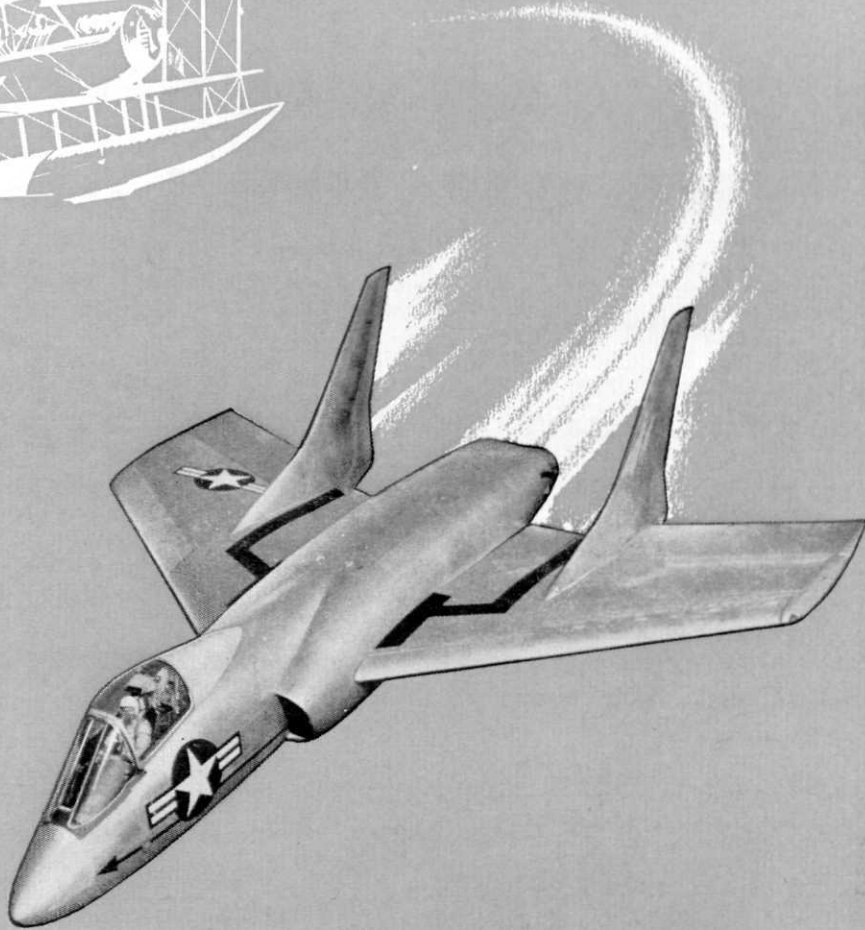

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ARTICLES

FEATURES

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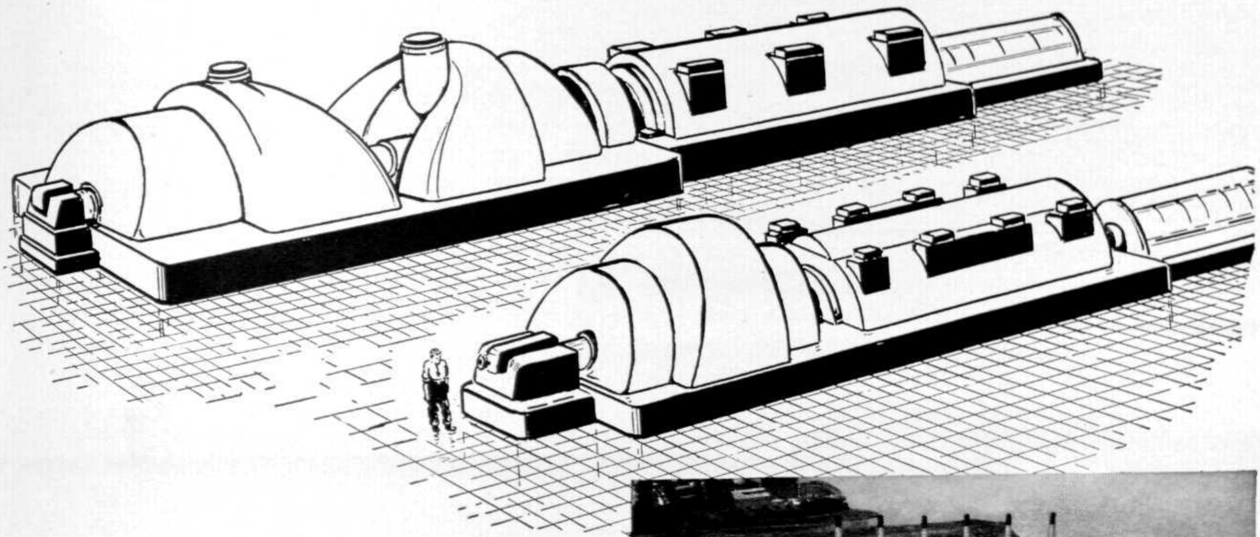
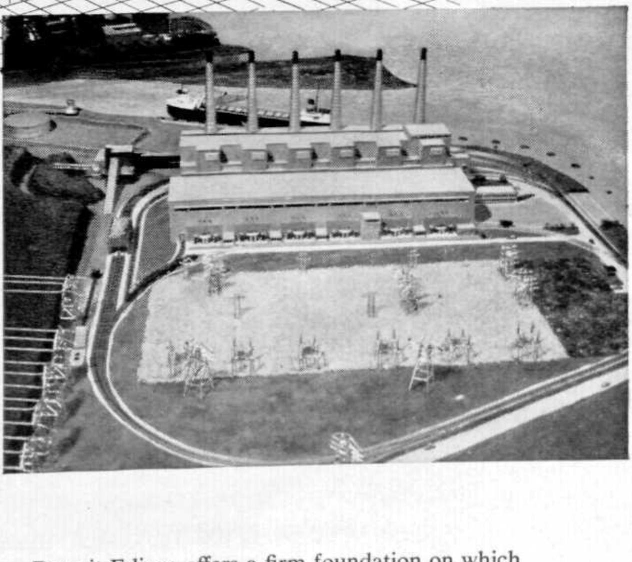
World's Largest Steam Turbine Generators for Detroit Edison



Mammoth generators of the cross compound type (2000 pounds pressure at 1050 F initial temperature and 1000 F reheat) being built by General Electric Company and Westinghouse Electric Corporation for Detroit Edison.



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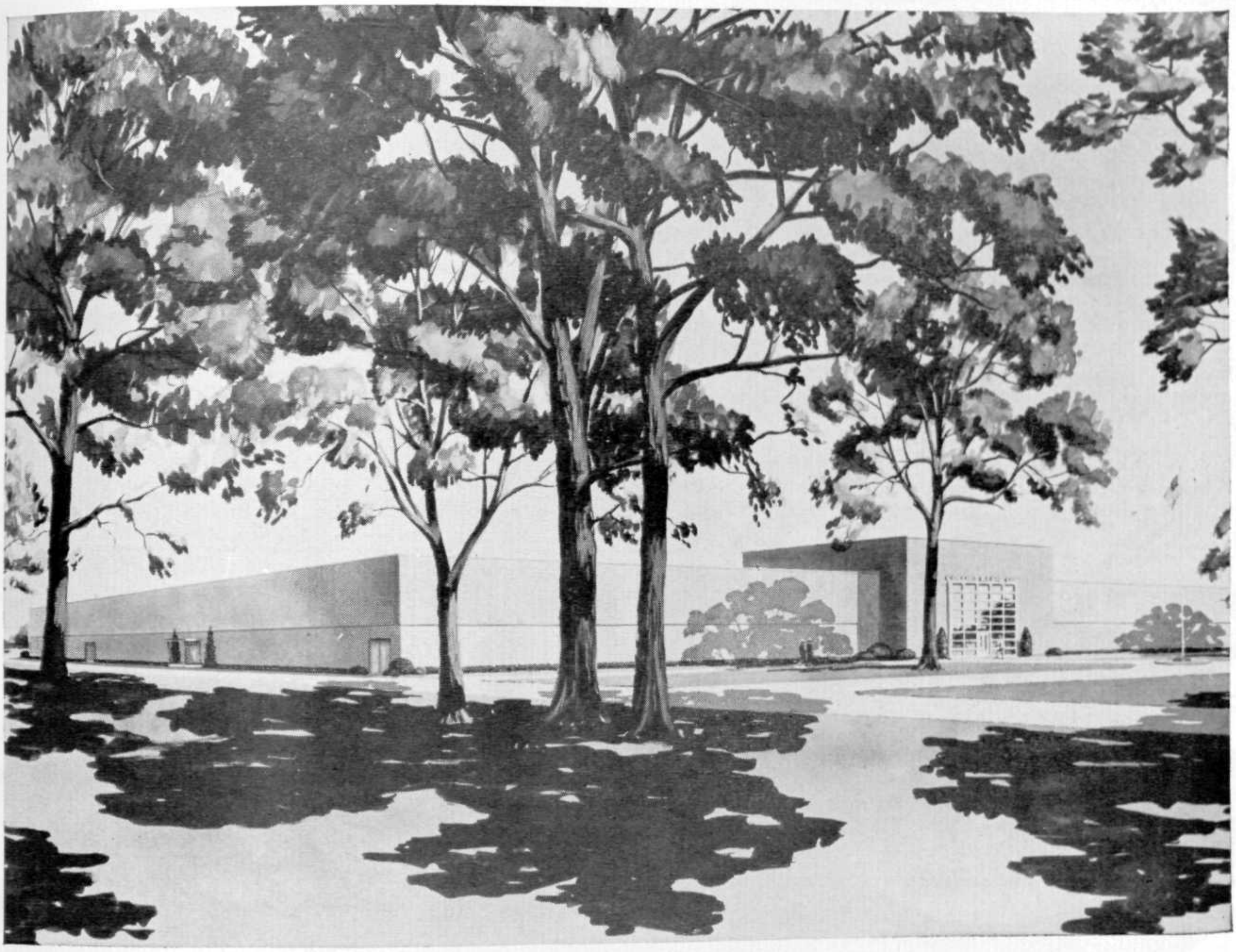
Editorially Speaking

In the previous two issues of the Spartan Engineer this school year, we have told you a little bit about Michigan State College's annual Engineering Exposition and its sponsoring body, the MSC Engineering Council. In this issue, however, we would like to offer a special salute to the members of that sponsoring body, for this year their work has been twice as hard and twice as great as ever before. For, this year, the Exposition has jumped from a two-day affair to one of three days duration, in preparation for a four-day Exposition in 1955. This will be in connection with the celebration of Michigan State College's centennial year.

Page 58 of this issue carries a complete list of the membership of the Engineering Council and the duties each member performs for the Exposition. But more than just this listing of names, we wish to thank the members of the Engineering Council for their work. Therefore, we have decided to dedicate this issue of our magazine to the matters with which the Exposition and the Council are concerned—the engineering profession in action.

We've tried to touch upon all phases of engineering, being by no means comprehensive. We've neglected several of the branches of engineering, but believe that we have given a representative cross-section of the opportunities awaiting the engineering graduate entering his chosen profession, and the studies awaiting many of the high school graduates who wish to make engineering their career.

This, then, is our salute to you—the members of the Michigan State Engineering Council.



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If you are graduating in Mechanical, Industrial or Electrical Engineering, be sure to contact the Engineering Placement Office. They are arranging interview-appointments on campus with Collins representatives for Thursday, March 11. Make it a point to talk with them about Collins.

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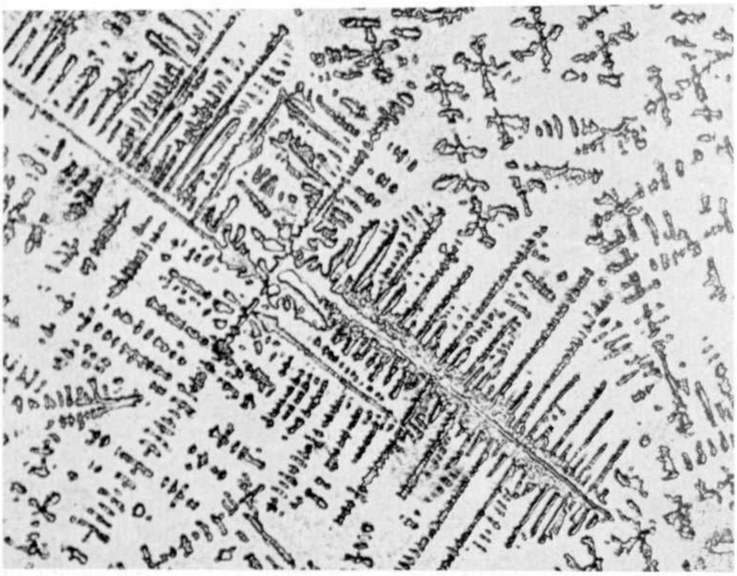


Fig. 1 — Dendritic pattern found in as-cast bronze alloy of copper and tin. Magnified 50 diameters.

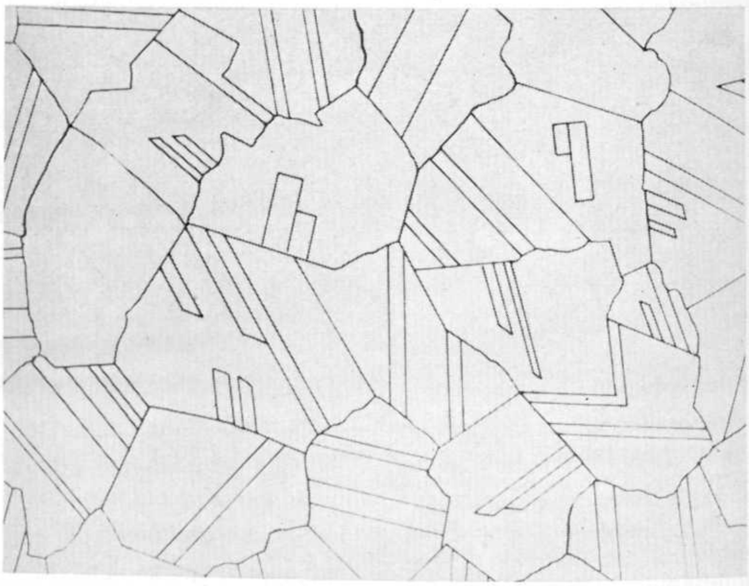


Fig. 2 — Sketch of typical sharp, angular grains characteristic of several pure metals and their alloys in wrought form.

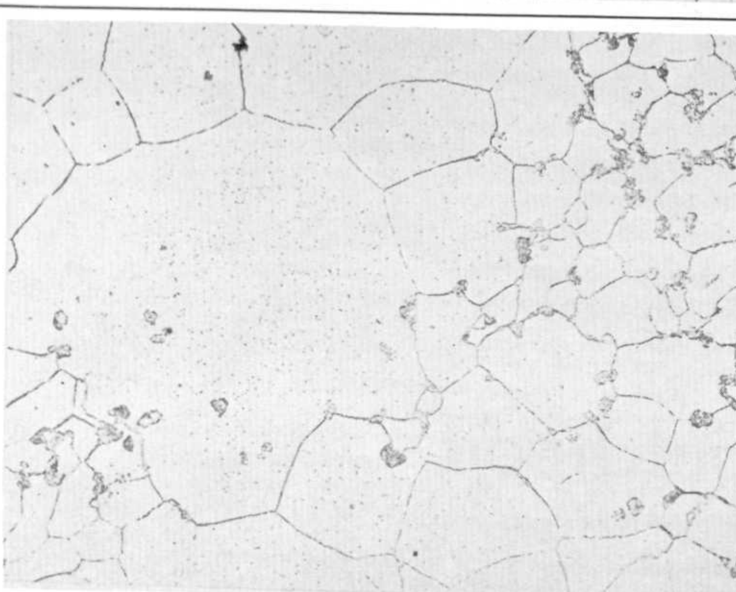


Fig. 3 — Rounded grain shapes found in pure iron plate or bar.

Metallurgical engineering

by D. D. McGrady, Associate Professor of Metallurgical Engineering

Have you been "dusted" with meteorites lately? Probably so, because an estimated 146,000,000 small meteorites fall on the earth each year. Man has always been fascinated by The Metal from Heaven and it is quite likely that prehistoric man found a piece of meteorite and noticed that it was unlike the stones he was using for tools and weapons. Our cave man could not chip or break the iron-nickel alloy of his meteorite fragment, but could pound and form it into a shape he needed.

Considerable evidence exists that metal was used in Egypt at least as early at 4,000 B.C. and in India by 2,000 B.C. Thus man and metals have been closely allied through the ages. Today every phase of our present life is dependent upon metals. Transportation, communication, and agriculture require a wide range of alloy analysis and properties. Steel, bronze, copper, and aluminum are every-day terms.

"Metallurgy is one of the oldest branches of engineering and historically has been of such outstanding importance that the great eras of history have been named in accordance with metallurgical developments. 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 still very useful, others merely obstructions to progress and improvement.

"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 markedly in the past 50 years and it is at present undergoing very rapid development.

A publication of the American Society for Metals described "metallurgy" as follows: "The science of metals which concerns the constitution, structure and properties of metals and alloys. A young science, metallurgy is also an old art. A part of this art concerns the application of the science of metals and of other branches of science to the extracting of metals from their ores, refining them for use, producing and preparing alloys, and using metals and alloys safely and economically. This part of the art embraces metallurgical engineering. The terms 'metallurgy' and 'metallurgical engineering' are often used interchangeably as are also the terms 'metallurgist' and 'metallurgical engineer'."

An Outline of Metallurgy

Webster's definition of metallurgy . . . "the science and art of extracting metals from their ores, refining them, and preparing them for use . . ." seems acceptable in a very broad sense. Chipman states that modern metallurgy includes the science of the metallic state, of the structure and properties of metals and their chemical and physical nature and behavior. Metallurgy is an art in that it involves the skill and ability to produce and employ metals, 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.

What then is the scope of Metallurgical Engineering? Broadly speaking, the metallurgist is responsible for the processing of ore into crude metal and for the refining, alloying, and shaping of this metal until it becomes a useful and needed product – perhaps an automobile fender or wing of a jet plane. The metallurgist deals with materials. In fact, progress in the application of nuclear energy and jet motors will coincide with the progress of the metallurgical engineers of the future.

The outline in Table 1 sets forth the main features of the entire field of metallurgy not as a course of study, but rather as a field of human endeavor.

Course of Study

"The curricula in metallurgy differ widely from one school to another; metallurgical engineers and the occupations and interests of metallurgists differ just as much. There is no established course of study for Metallurgical Engineering. Many acceptable solutions are possible based upon such controlling factors as local conditions, availablity of staff, equipment, and student needs.

Spielman sets forth the following specifications for the newly graduated metallurgical engineer.

1. **He must be able to speak and write the English language correctly and with reasonable fluency.**
2. **He must be thoroughly grounded in the basic sciences and the fundamentals of metallurgy and engineering.**
3. **He must be inculcated with the engineering approach to a problem and the engineering method of solving it.**
4. **He must have a knowledge of the field of human engineering.**
5. **He must have a knowledge of the functioning and the problems of the society of which he is a part and he must be willing and able to assume more than the average share of the responsibilities of citizenship.**

6. He must have imagination, initiative, ingenuity, and integrity.
7. He should enter industry with some understanding of the economic structure of American business.
8. He must be willing to work for his place in the profession, learning as he does so.

TABLE I

An Outline of Metallurgy

A. Metallurgical Engineering
  1. Mineral Dressing
    a. Crusihng and grinding of ores
    b. Separation of minerals
    c. Flotation
  2. Process Metallurgy
    a. Roasting and sintering
    b. Reduction and smelting
    c. Fuels and combustion
    d. Heat and fluid flow
    e. Electrometallurgy
    f. Melting, refining and alloying
    g. Casting and solidification
  3. Metal Processing
    a. Hot and cold forming
    b. Foundry practice
    c. Joining
    d. Surface treatment
    e. Powder metallurgy
    f. Heat treatment
  4. Application Metallurgy
    a. Selection and specification
    b. Alloy design
    c. Quality control
    d. Service behavior

B. Metallurgical Science
  1. Chemical Metallurgy
    a. Crystal chemistry and mineralogy
    b. Thermodynamics of systems and processes
    c. Reaction kinetics
    d. Surface chemistry
    e. Corrosion and electro-chemistry
  2. Physical Metallurgy
    a. Metallography
      1. Structure of alloys
      2. Equilibria in metallic systems
      3. Recrystallization and grain growth
      4. Reaction in the solid state
    b. The Physics of Metals
      1. Atomic and electronic structure
      2. Diffusion
      3. Electrical and magnetic properties
      4. Theory of the solid state
    c. Mechanical Metallurgy
      1. Elastic behavior
      2. Plastic flow and fracture

The above specifications are general over the nation with no differentiation by geographical location and no differentiation by fields or branches of the industry."

A fairly typical course of study for metallurgical engineers might be outlined as follows:

I. Basic Sciences.
  a. Chemistry—General chemistry, qualitative analysis, quantitative analysis, physical chemistry.
  b. Physics—General physics, modern or advanced physics.
  c. Mathematics—Calculus, differential equations, statistics.

II. Basic Engineering Subjejcts.
  a. Mechanics—Graphics, statistics, dynamics.
  b. Strength of materials.
  c. Electrical engineering—Alternating and direct current, electrical machinery, electronics.
  d. Chemical thermodynamics.

III. Humanistic-Social Group.
  a. English—Composition, technical and business writing.
  b. History.
  c. Economics.
  d. Political Science.
  e. Sociology.
  f. Psychology.
  g. Public speaking.

IV. Metallurgical Subjects.
  A. Extractive Metallurgy
    1. Mineral dressing
      a. Unit operations—crushing and grinding, separaton of materials, classification, filtration.
    2. Process Metallurgy
      a. Unit processes — metallurgical calculations, flow of heat, flow of fluids, combustion, heat and material balances, refrectories and furnaces, instrumentation.
  B. Adaptive Metallurgy
    1. Physical metallurgy
      a. Metallography—thermal analysis, dilatometry, hardness testing, use of microscope and metallograph.
      b. X-ray and radiographic analysis.
      c. Metal processing—fatigue, corrosion, machinability, extrusion, rolling, forging, stamping.
      d. Heat treatment and engineering applications of metals and alloys.

The metallurgical engineer at Michigan State College directs his studies largely to the field of physical metallurgy because of the extensive foundry and metal processing industry in the state of Michigan.

During the past two decades, metallurgy has become more and more a science, and less an art. The training of the metallurgical engineer is in physics and chemistry and in the creative science of engineering. Metallurgical education involves in part a study of the methods and equipment commonly used for obtaining metals from complex ores and raw materials. Such studies involve the application of engineering science blended with practical experience. The student of metallurgy studies the basic operation of crushing and grinding, size separation, filtration, flow of fluids, and heat transfer, and then applies these basic concepts to his particular problems of roasting, smelting, refining, quenching, or heat treating.

The various processes of extractive metallurgy are identified as Pyrometallurgy, Hydrometallurgy, and Electrometallurgy. The final result of this series of processing operation on the ore is a crude metal suitable for additional refining and alloying.

Another major portion of metallurgical education centers around the study of alloy systems of metals.

The student of metallurgy studies not only the casting and solidification of alloys from the molten state, but also the subsequent procedures of mechanical rolling and forging, and of welding, heat treatment, and fabrication into a finished product. Metallurgical engineers who are primarily concerned with refined metals and with the heat treatment and properties of alloys, are identified as physical metallurgists. The tools of the physical metallurgist are such things as: microscopes, x-rays, hardness testers, tensile strength machines, and impact testers.

The microscope, for example, will reveal much information about the internal structure, composition, and grain size of metals. Fig. 1 shows a typical pattern found in a cast bronze alloy of copper and tin. In contrast Fig. 2 illustrates the typical sharp, angular grain shapes and formation in pure copper that has been wrought and drawn into wire and then heat treated to soften it. Thus it is evident that metals can be identified and their condition and properties recognized by proper use of the microscope. Fig. 3, which shows rounded grains of various sizes in essentially pure iron, reveals that even pure metals may have quite different grain outlines.

Certain fundamental concepts, common to all alloy systems, are studied by the student of physical metallurgy, and he then applies his knowledge to the understanding of various commercial alloy systems of aluminum, copper, magnesium, zinc, tin, and iron.

Employment Opportunities

Alumni records show a wide diversity in the fields of work in which metallurgical graduates are engaged. A large majority of the graduates go into industry. Some 10% may elect to take up specialized study and research leading to advanced degrees.

A classification of the *types* of employment available is given below:

I. Research and Development work
II. Production and Quality control
III. General
- **a. Selling and servicing**
- **b. Teaching**
- **c. Writing and editing**
- **d. Consulting**

Metallurgical personnel are employed by all industries that produce or process metals and alloys. This includes fabricators of metal as well as service industries which supply transportation, communication, and power. A total of over 35,000 industrial organizations in the United States produce, consume, or fabricate metals and alloys.

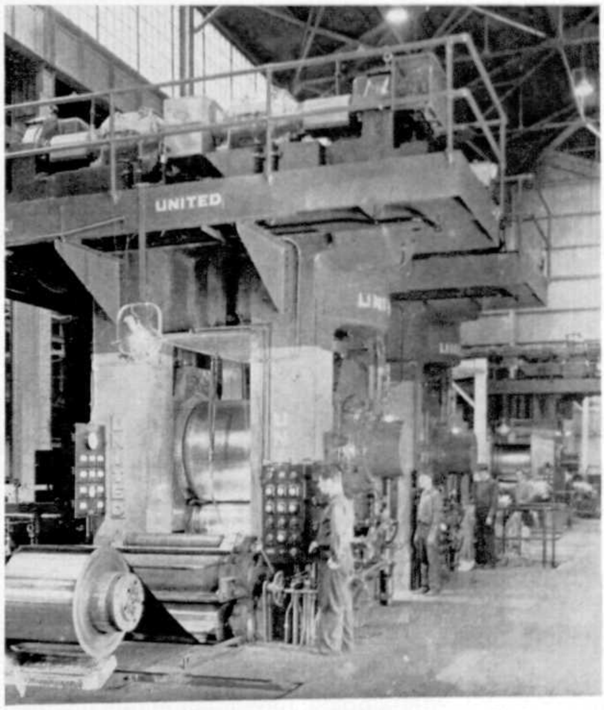
Occupational Analysis

A survey of persons actively engaged in metallurgical pursuits reveals that nearly one-half of them are employed by companies that have only one or two plants with fewer than 5,000 people on the payroll. Larger companies, with three to ten or more plants and 5,000 to 15,000 or more on payroll, employ slightly over one-half of the metallurgists.

Three-quarters or more of all metallurgists are employed by companies that produce basic metals, or that do commercial processing, or that are manufacturers of assembled parts.

A study of the categories of work in which metallurgists are engaged shows a very predominate emphasis upon (a) Metal Production (winning, refining, and shaping of metals) and (b) Metal Consumption (purchasing, fabricating, and consuming of metals).

More than three-fourths of the metallurgists were concerned with Technical Production problems or with Technical Research or Development. Management, Supervision, and Technical sales account for about ten percent.



High speed continuous strip mill producing steel sheet at a 'mile-a-minute' rate.

For the purposes of development and research the metallurgical industry has customarily expended nearly 1% of the gross sales income. This amount is equivalent to more than 50 million dollars used for the advancement of the industry.

The metallurgical engineering graduate finds opportunities presented by this vast industry at every stage of research, development, engineering, production, and sales.

Summary

The entire field of metallurgy is conveniently divided into two broad classes (1) extractive metallurgy, which deals with the extraction of metals from their ores; and (2) physical metallurgy, which deals with microstructures, strength, hardness, forming, and application of metals.

Special emphasis of metallurgical engineering is to apply the basic principles of engineering to processes and operations in which metals and alloys are the materials undergoing treatment. To this end the student in metallurgical engineering, after securing a sound foundation of basic scientific knowledge in his first two years of college, concentrates his efforts during the junior and senior years upon basic alloy

(Continued on page 44)

One engineer's concept of relativity

by William C. Bartley, E. E. '55

A note from the author:

Knowing that I have delved into Einstein's theories of relativity for several years, some of my friends have asked me to write this article on my interpretation of general relativity and gravitation. I have attempted to present the ideas in terms which will be familiar to most engineers. I hope this article will stimulate others to investigate the subject, for it leads to a very interesting avocation.

I believe that relativity should be of interest to the engineer, for he is continually confronted with field problems. Although an understanding of general relativity is not necessary for solving ordinary gravitational force problems, it does carry the engineer's concept one step beyond the $F = km_1m_2/r^2$ equation.

To what is gravitational force due? Galileo, Kepler, Newton, Faraday, Maxwell, Lorentz, Michelson, and others pondered this problem. But the laws resulting from their theories were based on excessively hypothetical reasoning. Then came Einstein with an approach to the problem which revolutionized scientific thinking. He made science his life work with this as an objective:

"The grand aim of all science is to cover the greatest number of empirical facts by logical deduction from the smallest number of hypotheses or axioms."

Galileo believed that all "flying" bodies were subject to two fields of force: (1) inertial force and (2) gravitational force. Newton took these principles, and applying "cut and try" mathematical deduction, formulated the laws of *Inertia (First Law)* and *Universal Gravitation.*

However, there was a mystery in connection with these Galilean and Newtonian conceptions. In the Galilean dual force theory the magnitude of "pull" on a body in an inertial field is proportional to the "inertial mass" of the body and the "pull" in a gravitational field is proportional to the "gravitational mass" of the body. Every body (piece of matter) was assumed, therefore, to possess two kinds of mass corresponding to the two types of field. But, the most refined physical experiments invariably proved the strictest proportionality between these two kinds of masses; so, that by choosing units suitably, it is possible to represent both the inertial and gravitational masses of a certain body by the same number.

This equality seemed a miraculous coincidence for there appeared to be no connection between the two types of field. The "inertial field" can be explained mechanistically using Newton's First Law. For example, the explanation for the inertial force which "pulls" an auto passenger toward the front of the car when the brakes are applied can be made by an observer outside the car, who will argue that a mechanical force (road friction to brake wheels) was applied to the car, interrupting its forward motion, but the passenger continued in "uniform motion" tending to leave the car behind. However, this sort of reasoning did not seem to apply to gravitational force in any way.

One of the steps taken by Einstein in dealing with gravitational phenomena was to make an assumption which did away with the "dual mass" mystery. To explain – if a person is standing in an elevator and it starts downward suddenly, for a moment he will feel very light. If the elevator cables break and the elevator car accelerated at a rate g equal to that caused by gravitation, then the passenger will have no weight at all (in relation to the elevator). In trying to explain this phenomenon, the classical scientists would have said that the gravitational field seems to vanish because it is "compensated" by the inertial field of the accelerating car. On the other hand, Einstein assumes that if the gravitational field *seems* to vanish, then it does vanish.

Continuing with this same reasoning, if the elevator car accelerates upward at the gravitational rate, g, the person inside will weigh twice his normal weight and, therefore, the gravitational field has been doubled. Now, if this elevator were carried out into space, far away from the earth and other large pieces of matter, and were allowed to travel at uniform velocity, there would be no fields of gravitation or inertia present. But if it were forced to accelerate in space at the rate g, then an inertial field would exist causing the passenger to have weight.

This "car" or room (of relatively small mass) could be accelerated in space in different ways (transitional and rotational) to produce an inertial field. One way would be to accelerate it along a Euclidian straight line (if such a line can be determined in space). If the acceleration were g along this "straight" path, then a field would exist in the room similar to the earth's field. However, it would *not* be identical, the configuration of its surfaces varying from that of the gravitational field. It follows then, that if an inertial field is going to be made to approach the configuration of a gravitational field, the inertial field will have to be produced by accelerating along some locus other than a "straight" line.

Human sences unreliable

In the study of sensory continua or continuous manifolds it is demonstrated that the human senses *cannot* be relied upon to analyze physical characteristics. For instance, it is possible to produce several audio tones, one after the other, which, although having slightly different frequencies of oscillation, will sound identical. If tone X be slightly higher than tone Y and tone Y slightly higher than tone Z, it may seem that X=Y and Y=Z when the tones are sounded in the order X-Y-Z or Z-Y-X. But if X be sounded followed by Z, the continum may be broken by the omission of tone Y so that the ear can perceive that X=Z. Thus, the inadequacy of the senses is shown here by the inconsistency of their mathematics (X=Y, Y=Z, X=Z).

Realizing the manifestations of the sensory continua, it is possible to recognize the possibility of deviation in geometry from that described by Euclid. The question arises, "Is one capable of recognizing, and thereby defining, a straight line?" Several criteria for straightness may be suggested: (a) a line is straight when it can be turned over and superposed with itself; (b) an object is straight if no "bumps" are apparent when looking from one extremity; (c) the shortest distance between two points is a straight line (the Special Theory of Relativity limits this). But in every case it is apparent that intuitive recognition of straightness will always be based on physical criteria dealing with the behavior of light and material bodies. From this viewpoint several non-Euclidian geometries arose, including those developed by the mathematicians Lobatchewski and Riemann.

Roughly, Einstein's reasoning in the development of the gravitational equations (General Theory of Relativity, 1916) might go something like this: Everything in the universe is moving (all matter having relative velocities less than the speed of light, c). Some things, like electrons and planets, appear to be traveling in curved paths while energy often appears to be traveling in a "straight" line (in relativity, light and time make possible changes in the coordinates of the observer such that a straight line will appear curved and vice versa). If the hypothesis be taken that everything in space behaves by non-Euclidian geometry, then things which were assumed to be straight in the Galilean system are actually curved. Thus, a concept of curved space time is developed.

It is conceivable that in curved space time all matter accelerates along complicated non-Euclidian loci. The problem is to represent mathematically a locus and find a form of acceleration which will give an "inertial" field which is identical (same configuration) to the field measured around matter called "gravitation." Einstein's General Theory of Relativity uses tensor analysis a shorthand representation of vector calulus) to approach this problem. The tensor used is symmetrical and of the second degree (nine components).

In the appendix of the December 1949 edition of *The Meaning of Relativity*, Einstein published his "General Theory of Gravitation," often referred to as the "Unified Field Theory." Although it covers relatively few pages, it is of great importance for it presents the mathematics of the old General Relativity Theory in a new form of mathematics which may be compared with the mathematics of electric and magnetic fields developed by James Maxwell (Maxwell's equations are formed by an assymetrical tensor of the second degree). The objective of "General Gravitation" is to interrelate all electric, magnetic, and gravitational fields.

Thus, Einstein has suggested the answer to the problem – To what is gravitation due? – by conceiving the hypothesis that gravitation is a form of "inertial" force generated by accelerating bodies (matter) resulting from the curvature of space. From the mechanics of his curved space equations he has been able to draw many conclusions, using mathematics alone. Among other things, he predicted: (a) The light from a star will be bent 1.75° as it passes through the field of the sun; (b) atoms will vibrate *slower* in a strong gravitational field than in a weak field; (c) the planet Mercury will travel around the sun in a prescession perihelion. These conclusions and many others have been verified by accurate measurements.

A young man's business —reinforced plastics

by Paul E. Sanford, Chief Engineer, Molded Fiberglass Co., Ashtabula, Ohio

A young man's business – that's reinforced plastics. A young man's business because the business itself is not yet ten years old. A young men's business because today's problems are new, tough, and nerve-wracking, and it takes hard work and ingenuity to lick them. A young man's business because it looks to the future and its hope. A young man's business because it needs the optimism and faith that abound in young men.

Reinforced plastics is still a small business, amounting to only one percent of the total plastics industry. In fact, the largest processors number their employees only in the hundreds. But it is doubling itself every two years, and it doesn't take long at that rate to become big business – really big, and profitable. The men who stick out the early years will some day be

The Chevrolet Corvette—first mass-produced American sports car—features a body molded of fiberglass reinforced plastic. The Corvette, the Kaiser Darrin, and other sports cars are the most recent and most dramatic use of this material, and point toward new horizons in the automobile industry.

"in the chips," but for everyone who hits the top, many will fall short. "The road to riches is strewn with rocks" was never truer than in reinforced plastics.

Recently a new, highly publicized application has captured public imagination and dramatized the future of reinforced plastics. The Chevrolet Corvette and the Kaiser Darrin, first American mass-produced sports cars, have all-plastic bodies. To a sports-car-crazy American public this is an ideal marriage – the newness of the sports car, and the newness of its plastic body. But the sports car is only the most recent use of reinforced plastics. Boats from rowboats to yachts, have been a famous product. Refrigeration and the electrical industry have utilized the insulating properties for years. Millions of sportsmen use fiberglass fishing rods. Chairs, awnings, paneling, window fans, and lamp shades have given the material household appeal. And the military has long been the biggest single customer; in fact, the use of reinforced plastics for aircraft radar housings is what started the industry during World War II. And what a dramatic life this ten-year-old has seen since then.

What problems it has seen. Sometimes it seems as though the industry has been one continuous problem. Before all else, what are these reinforced plastics to be made of? First requirement is a reinforcing material, and the usual selection is fiberglass. The strands of glass fibers have high strength, excellent insulating ability, and workability. Most important, they will bond with certain resins while these resins are curing, to give the cured solid a "backbone" and much greater strength. In fact, it compares pound for pound with the strength of steel, aluminum, and other metals.

The resin is another variable, with even tougher requirements. It must flow through the fiberglass strands as a liquid at room temperatures, permeating the strands without displacing them. Yet as a cured solid it must bond with the glass, for it is the bonding of strands by resin that provides strength. And its curing should be at low temperature, even as low as room temperature. Polyester resins are usually chosen, though phenolics, epoxies, and others are being developed. Polyesters are so commonly used, however, that their production is taken as the gauge of the reinforced plastics industry. Another advantage is that they easily mix with thinners, fillers, coloring agents, and several catalysts.

Materials mean nothing until they are molded, and this is problem number two. Here more choices exist, for two leading processes are available, and each has its place and value. The first jobs ever made with fiberglass reinforced plastics were radomes for military aircraft. Because these housings for radar units were large and cumbersome, bag molding was devised. Woven cloth or mat of fiberglass is laid by hand over a model of the shape to be molded. As additional layers of mat or cloth are laid on, they are impregnated with polyester resin. The operator is the most important element, for it is entirely a manual task.

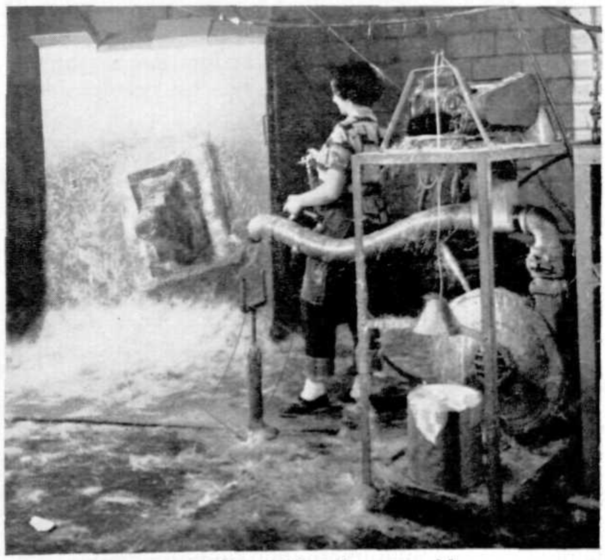
Once the fiberglass and resin are built up to a desired thickness, they are covered by an airtight enclosing overlay, usually a rubber bag. Either compressed air may be applied to the bag, or the basic mold and layup may be evacuated. In either case, at least six pounds per square inch pressure is desired to cure the resin and wet the glass strands. Heat may be applied by lamps or by an oven, but many bag-molded parts must be cured at low temperatures. Obviously a layup is a slow, manual job, and curing is also slow – in fact, a full day is taken for many bag-molded parts. Smaller parts may be "speeded up" to a one-hour cycle, but still the process is limited to small quantities, or to pieces so large they can be molded no other way. For example, boat hulls and gasoline tanks can be molded in one piece, but only after a long, arduous layup job.

If reinforced plastics are to hit their stride as "big production," it must be with matched-metal die molding. Dies, corresponding to steel-forming dies, may be heated and transmit pressure, both of which speed curing and give a better surface. A cycle is reduced from terms of hours to minutes. Of course, a greater investment is involved in dies, presses, and a heating system than with bag-molding; therefore, larger quantities must be produced to be economically sound. But for the popular concept of American mass-production, matched-metal dies hold the future of reinforced plastics. This was recognized when it was decided that eventually all the Corvette body parts will be made in matched-metal dies, despite the size of some of the pieces involved.

Polyester resin is poured over the preform. When the dies are closed, pressure forces the resin throughout the preform, bonding the fiberglass in a cured plastic solid.

Among the advantages of metal dies are the heating made possible by steam, hot water, or electric resistance strips; pressure applied by hydraulic presses; and the use of cut-off edges. The last are closely matched shearing edges at the parting line of the mold. Not only do they shear the glass layup, giving a clean edge on the piece, but they trap the resin and prevent its loss and waste and keep it under pressure while curing. A clean, smooth-surfaced piece is cured in minutes, rather than in hours. Still another feature of matched-metal dies is that, for deep-draw pieces, instead of undergoing a long, tedious hand-layup process on the die itself, "preforms" may be made. Chopped strands of fiberglass are blown and drawn onto a screen having the shape of the molded product. Bonded loosely together by a resin spray, the glass fibers make up a preform – actually a preshaped form, made entirely apart from the dies. It may then be molded with resin in the same manner as mat and cloth, without tying up a die and press with a manual operation. Indeed, the future of the industry lies in matched-metal die molding.

And the future had better hold some improvements in finishing reinforced plastics, too – yet another problem for a young industry. A surface free of air pockets, pinholes, resin cracks, exposed fibers, and blisters is a seldom-attained goal. Almost every piece requires sanding to some degree; and in bag-molding, finishing is as big a job as is molding. Painting presents many problems, still unbeaten. Surface imperfections are actually highlighted rather than covered by paint. Bonding to plastic surfaces has been poor, especially when silicones are used as molding parting agents. And the more complex the molding jobs taken on, the more complicated are the finishing problems involved.



Chopped strands of fiberglass are blown on a shaped screen to make a preform. This is the first step in producing a loudspeaker horn of reinforced plastics.

All right, a young man will ask, these are some of the problems – and like any new industry, there are plenty of them. But what good is the material when the problems are licked? What is the end result? It's not an easy question to answer. John Q. Public likes to make the snap judgment that "plastics are cheaper than metals," and therefore will soon replace metals because of the cost advantage. Nothing could be more wrong. Reinforced plastic items, as molded and sold to the user, run from three to ten times the

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The position of the tool engineer in business

by John L. Harding, Chief Tool Designer,
Waltham Watch Co., Waltham, Mass.

It is entirely possible that a very large number of persons are unaware of the extremely important role played by tool engineering in modern manufacturing. No mechanical or electrical device (automobile, food mixer, kiddie kar, television set, or any of the host of things we use and take for granted every day) could be manufactured at a price we are able to afford, without well-engineered machining processes, and tooling capable of turning out large quantities of duplicate parts in as short a time as possible.

In 1798, Eli Whitney decided to establish a gun factory, and in so doing, he made all his own gages and tools for producing duplicate gun parts. This is believed to be the recognized successful beginning of interchangeable manufacture. Previously each gun and other device was hand-fitted from hand made parts. Consequently no two were quite alike and parts were far from interchangeable.

It is obvious at once that to produce in today's vast quantities by such methods would be impossible. The very limited possible supply of the things we consider commonplace would be far beyond the financial reach of all but a few.

Modern methods of manufacture call for rapid duplication of close tolerance parts. This is accomplished through the medium of tool engineering, which is comprised of careful Processing, Tool Design, and precision built tooling. Large plants have separate processing and tool design departments that work closely together, while in smaller plants the two are frequently combined under Tool Design. In either case the design and/or process engineers have a great and very interesting responsibility. They must be very resourceful as they are constantly faced with the problem of turning out good parts at minimum cost. Therefore they must have fingertip knowledge of the capacities and capabilities of the available production machines and equipment in their plant.

Each different part to be manufactured is studied very thoroughly and decisions are made as to what operations will be performed and their sequence. Quantity is a great factor in reaching these decisions as a part that is to be made in extremely large quantities may require the use of a special purpose machine, designed only for this part. The same part made in relatively small amounts will not pay for such a machine and must be produced at a slower rate by different methods using simple tools and standard machines. This procedure is known as processing and sheets are written showing exactly what is to be done to the part at each operation.

These process sheets are then turned over to Tool Design, where each operation is carefully studied and tools are designed to perform them in such a manner as to conform to dimensions, ease of operation, and at minimum cost. The tool designer must know not only the capacities and capabilities of the production machines for which he is designing tools, but toolmaking methods, practices, and short-cuts in order to embody in his design accuracy where it is needed and not call for accuracy where it is unnecessary. Tool room accuracy and time are expensive, and should not be used indiscriminately. The designer will resort to the use of standard tool parts wherever feasible, and not use fancy and expensive-to-make components simply because they are ingenious.

It has been said that every new tool design is a new invention, and this is not without some truth. While the tool possibly incorporates several individual tried and true methods of holding or location, it is the simplicity of their arrangement and ease of fabrication that makes for better tooling and better production.

Thus, in today's industry we do not require a great army of master craftsmen to tediously make and fit each production part. Rather, the craftsmanship goes into the designing and making of tools which can be made to turn out enormous quantities of duplicate precision parts in the hands of semi-skilled and non-skilled labor.

Since the more we produce, the more we earn, and the more we earn the better we live; tool engineering is a great field in which to advance manufacturing and lower consumer costs.

Your time on the drafting board

by Bruce L. Harding, M. E. - Design, 1954

Many of us, when we enter industry as junior engineers, will find ourselves at the drawing board with a pencil in one hand and a drafting machine in the other. This is the stage of their career which many engineers dread, and strive by whatever means possible to avoid. Let's look into this probable phase of our future, and see what lies ahead.

Draftsmen usually start by detailing; that is, drawing and dimensioning the separate parts of a machine. This is the part of the draftsman's work which is so often considered dull and uninteresting; but look a little closer. In order to draw the part and give it proper tolerances, the draftsman must understand the operations of the machine so that he may apply running fits, sliding fits, press fits, etc., and he learns the proper use of each of these through his drafting experience. Furthermore, to dimension the part in a logical way, making it easier for the workman to follow, he must be familiar with the processes which will be involved in its production. This knowledge he may gain to a limited degree by sitting at his board and asking questions, but better by watching such processes in operation if the opportunity presents itself. By observing the machinery or other equipment he is drawing, the detailer can learn a lot by seeing what the designers have done and by asking why they did what they did, if he is in a shop where the draftsmen and designers are together. In his idle moments, a draftsman can study the equipment catalogs which abound in every drafting room, and will thus broaden his knowledge and prepare himself for things to come, the first of which is making minor layout changes.

The layout is the birthplace of the product, for it is the original design of the overall machine, and is often very complex, showing all of the components

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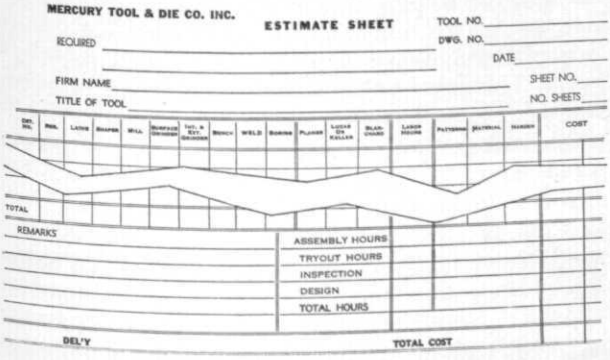
Fundamentals of cost estimation

by Vic Marshick, Head, Estimating Department, Mercury Tool and Die Co., Inc.

The success of any tool and die business, large or small, is based on the accuracy of estimating the cost of each tool, die or special machine, this cost being requested by the buyer before an order is placed. Due to the keen competition confronting companies in this line of work, an accurate cost must be estimated if there is to be a profit.



An estimator must be able to read blue prints thoroughly and know the analysis of different kinds of metal, their heat treatments, and the cost of the metal specified for each detail, these costs varying as to shape, size and analysis. A metallurgy course proves to be a great asset to an estimator.

The estimator must know the setup, the method required to machine each detail, and on which machine it may be best processed. To estimate the time required to make each detail depends primarily on practical knowledge entailing how each operation is to be performed, such as setup time, the actual machining time, and hand operations if any. Also, time and material required to make up special tooling to help expedite the operation on each detail, are necessary considerations. This machining and fabricating knowledge is best obtained by a person's actual participation in machining similar details or by time study of others performing similar operations. Time study courses also prove to be very beneficial.

For the purpose of efficiency and organization in evaluations, all information is usually entered on a simple estimating form sheet with a column for each kind of machine required to the work, such as the lathe, mill, shaper, etc.; also columns for material, patterns, heat treat, etc., as shown.

Nickel—a history

by Joe Myers, Met. E., '54

Although used in natural alloys even in ancient times, nickel was unknown as an element until 1751. Probably the first use of nickel by man was in fashioning implements and later swords from nickel-bearing meteorites. Meteorites were perhaps the first metal known to man. The fallen star sought out with fear overborne by curiosity, was found to be a better stone than the earth-given. The invincible blades of the great warriors of old in China, Persia and northern Europe were Heaven sent, a fable which sounds significant of meteoric iron.

Man found another natural alloy of nickel known first to the Chinese as paktong or "white copper." This rough reddish-white metal was sent from southern China to Canton, where zinc ores were added and the whole smelted to form a malleable alloy used for ornamental purposes, candlesticks, and the like. By 1760 the unwrought metal was imported into England for domestic manufacture. While English craftsmen were attempting to rival Chinese workmanship, new mines which showed great promise of copper and silver were opened near Schneeburg in Saxony; where from time immemorial copper and silver mines had existed. After innumerable trials, instead of a useful metal, all that could be obtained from this new ore was a brittle, worthless metal; named by the superstitious miners kupfer-nickel (Old Nick's copper).

In 1751, a Swedish scientist, Cronstedt, after five years work with an arsenical-silicate ore from Helsingland, succeeded in extracting a new element, which he named nickel.

The advent of electroplating by Prime & Co. of England in 1854, made an important change in the uses of nickel. The effect was two fold, one in introducing silver-plated ware with a German silver (copper-nickel) base; for competition with Sheffield plate, and the other was nickel plating itself.

In 1859, a Belgian commission on currency reform recommended a 75-25 copper-nickel alloy for coinage purposes. This was adopted in 1861. The United States did likewise in 1865, Germany in 1873 and Switzerland in 1879.

In 1865, Joseph Wharton made a contribution to metallurgy by the production of malleable pure nickel. In 1873, he sent to the Vienna Exposition, samples of nickel forgings and at the Exhibition in Philadelphia, he displayed some remarkable wrought nickel objects. About that time, Fleitmann patented the method of obtaining malleability by adding small amounts of magnesium to the melt. Nickel so treated could be rolled into sheets and drawn into wire. Fleitmann also succeeded in rolling sheet nickel upon iron and also sheet steel. This development led to the manufacture of nickel culinary ware.

First sources of nickel

The first sources of nickel in Europe were the arsenical and silicate ores of the mines in Saxony. Mines were active also in Cornwall, England; Sweden and the Russian Ural Mountains. Norway controlled the nickel market from 1870 until 1887, the advent of New Caledonia as a producer. In the U. S., mines were worked in Connecticut, Pennsylvania and Missouri, but the most important mine was at Lancaster Gap, Penn. The New Caledonian deposits, discovered by a geological survey in 1865, were opened in 1875 and by 1887 had brought all nickel mining to a standstill except that in Norway. The occurrence of nickel ore in Canada was reported as early as 1848, but it was not until 1883 when the Canadian Pacific Railway in its track laying operations dug into a vein of the Sudbury district, that deposits were laid open. The size of this deposit was found to be an oval of length thirty-three miles and breadth fifteen miles, with the ore bearing norite outcrops of igneous origin, an irregular oval band varying from one-half to four miles in width. Mining operations were started in 1886. In 1903, Canada surpassed New Caledonian production and by 1910 produced 75% of the world total. Since then their production has increased to about 95% of the world total. Recently, large deposits of lateritic nickel ore have been discovered in Cuba.

The Norwegian nickel ore is a pyrrotite-chalcopyrite similar to the Sudbury ore, while the New Caledonian ores are a hydrated Ni-Mg-SiO, which contain no copper or sulfur. Nickel is found as pendalite $(Ni, Fe)_{11}S_{10}$ associated with the pyrrhotite, $Fe_8 S_9$ in the Sudbury ores. Other nickel bearing Canadian ores are millerite NiS niccolite, NiAs, and Gersdorffite, NiAsS.

The present treatment of New Caledonian ores is based on the production of a matte by adding suitable fluxes and a sulfur bearing material of some kind. The usual source of sulfur is gypsum. The ore, fluxes and gypsum are briquetted and smelted with coke, producing a matte with 30-45% nickel. The matte is then besemerized in small convertors, with flux being added to slag off the iron oxide. This product contains approximately 80% nickel and 20% sulfur. It is next ground, then roasted to remove the sulfur; giving NiO which is reduced with carbon to give nickel of about 99.25% purity.

Canadian ore

The Canadian ore, concentrated by flotation to 6% Ni & Cu, and 26% sulfur, is roasted to about 16% sulfur. These calcines are then charged into a reverberatory furnace with proper fluxes; producing a matte which is 17% Ni & Cu, 27% S and 51% Fe. The matte is then blown down in Pierce-Smith convertors, using a siliceous flux until practically all the iron is removed and the convertor is full of high grade matte, containing 75% Ni & Cu, 20% S. This matte is cast into slabs, broken into small pieces and sent on to the "top and bottom" process. The "top and bottom" process depends on the fact that in a molten system of sodium sulfide, nickel sulfide and copper sulfide two liquid layers separate out, the upper layer consisting of sodium sulfide and copper sulfide, the lower, primarily nickel sulfide. The Bessemer matte is melted in cupolas, and poured into pots, where stratification of the sulfides takes place. There results "first tops" containing about 40% Cu and "first bottoms" with 65% Ni. The "first bottoms" are smelted with sodium sulfate. This yields "second bottoms" of 72% Ni. The "second bottoms" are ground leached and treated with hot H_2SO_4 to dissolve the iron. This washed sulfide is roasted to remove sulfur, chloridized to form $CuCl_2$ leached to remove $CuCl_2$. This gives "green oxide" of about 77% Ni. This oxide is mixed with soda ash and roasted, then leached to remove NaS giving "black oxide" (77.5% Ni, 0.25% Fe and 0.005-8% S). Another treatment for "second bottoms" is used to produce electrolytic nickel. The sulfide is leached, de-sulfurized on a sintering machine, reduced to metal in a reverberatory furnace and cast into anodes of 95% Ni. The Ni is deposited from these anodes by electrolysis on a "starting" cathode to give nickel plates of 99.95% purity.

Other processes used for nickel recovery are the Mond, which is based on the fact that Ni and CO form a carbonyl which can later be decomposed into Ni metal and CO, the Hybinette process and the Freeport Sulfur process for Cuban lateritic ores.

Nickel products are marketed in various forms: nickel pellets from the carbonyl process, electrolytic cathode sheet, blocks or shot from remelting electrolytic sheet, malleable nickel which is deoxidized remelted electrolytic sheet, nickel rondelles from New Caledonian reduction nickel salts, nickel oxide and nickel powder.

In 1889, when Samuel Ritchie's Canadian mines were in full production, he found that the market was heavily over-stocked. German-silver, electroplating and coinage were practically the only uses for nickel. Of all possible future uses, the NiFe alloys; first produced by an Englishman, John Gamgee, caught Mr. Ritchie's imagination as the most promising. This same year, the Frenchman, Marbeau, presented his famous paper "Alloys of Nickel and Steel." In the discussion of the paper J. F. Hall of Sheffield reported independent work confirming the results published by Marbeau and another investigator, Riley. Mr. Ritchie brought these papers and reports to the attention of the Secretary of the Navy of the U. S. As a result of this and further investigation the U. S. Navy made an order for the purchase of Ni to be used in making nickel steel armor plate for its ships.

The next thirty years witnessed an increased growth in the use of nickel steel in bridge building, automobiles, and navy ordnance. At the end of the first World War, the nickel industry was again faced with the problem of creating new markets. It was at this time that the nickel producing companies established departments of Development and Research. The nickel industry since then has developed nickel chromium and nickel-chromium-iron alloys for use as electrical, heat and corrosion-resistant alloys, magnetic nickel-iron alloys and nickel cast iron. The growth of the automotive industry brought about an increase in the consumption of nickel in many forms. Nickel has profited indirectly, too, by the engineering material research done by the automobile companies.

Other nickel products

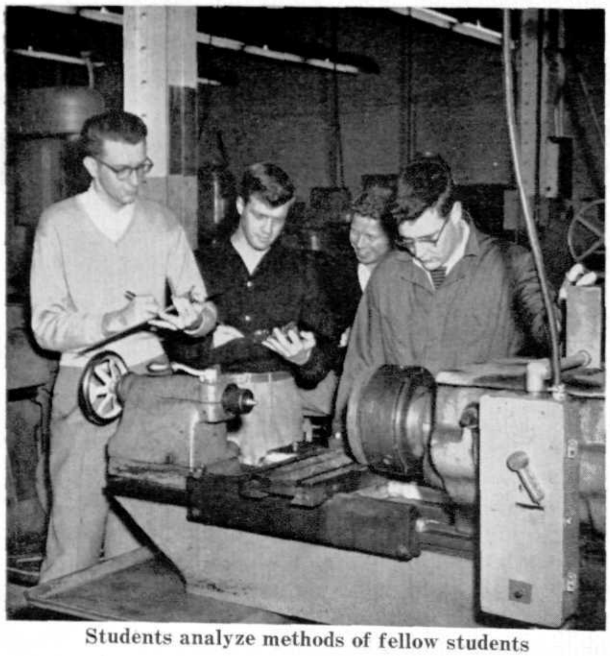
Other nickel products and uses which have been developed are: nickel steels which are strong, tough and resistant to low temperature shock loading; heat and corrosion resistant steels such as "stainless" electrical resistant alloys for electric furnaces, heating appliances and thermocouples; special alloys such as "Invar" which exhibits no expansion under ordinary temperature changes, used for watch springs and surveyors' tapes; "Permalloy," a magnetic alloy used in telephone installations and current transformers; non-magnetic alloys for use in electrical machinery. Other products include high strength non-magnetic nickel cast irons; nickel silvers for table ware, lighting and plumbing fixtures, building and marine hardware; "monel" metal, a natural malleable nickel-copper alloy which is a product of the Creighton ore of the Canadian mines.

In the years to come as scientific research spurs industry on to new accomplishments the search will be intensified for metals having properties capable of increased or special performance. Tougher, stronger, abrasion, corrosion and high and low temperature resistant alloys will be needed. Nickel is sure to play an important part in the metals industry of the future.

Is there a better way?

by Harlow Nelson, M. E. '54
and
P. J. Thorson, Assistant Professor of Mechanical Engineering

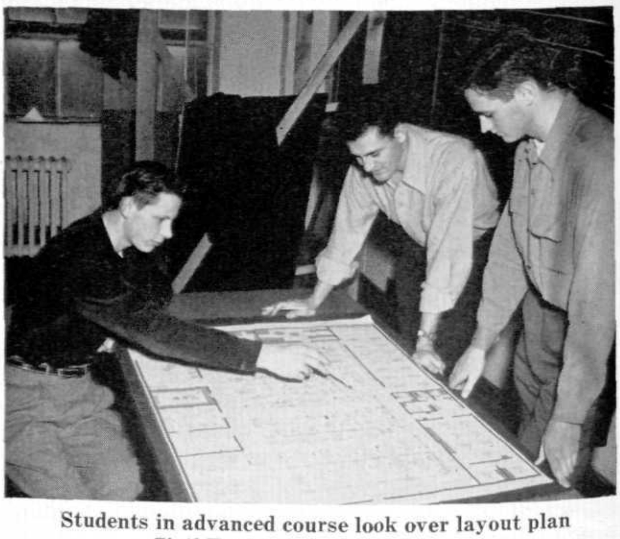
If one could define the objective in the broad scope of time and motion study field in a few words, it would probably be something in the order of finding a better way. Motion and time study is a phase of industrial engineering that deals with systematic determination of better work methods and the time appraisal of work involving human activity. The methods improvement sought may be as simple as a change in the hand movements used by the operator of a machine or a relayout of the work place, but may range to changes as complex as new equipment and to changes in the design of the product to facilitate manufacturing operations. The increase in productivity through better methods or work simplifications always being the objective in mind. The methods engineer, therefore, will work with several different groups within the organization. He will find himself in day-to-day contact with line supervisors, with the product design engineer, with the tool and die designers, and others.



Students analyze methods of fellow students

Those involved in the time study phase work directly with the first line supervisor and with the operator. They make an analysis of an operation, recording data on time study record charts, which are later corrected with allowances and the normalizing of the speed rate corresponding to the rate of the average worker. This calculated timing is used in such things as incentive plans, labor cost, estimates, efficiency and plant synchronization. The methods engineer also uses a chart to record the motion or process being studied, and this chart is the tool which he uses to eliminate, combine, change the sequence of, or simplify certain steps in a process.

In recent years there has been a large demand for the services of trained methods engineers, for when an industrial enterprise ceases to progress in the reduction of costs, it does not stand still but loses ground in comparison with its own capacity as well as with its competition. The recent demand comes not only from the large manufacturers employing a substantial number of production methods engineers, but also from the smaller companies which have need for this type of service. However, the scope of this work is not confined to manufacturing establishments. Methods engineers have helped to devise better methods to be used in cafeteria installations, warehouses, offices, and even in hospital operations such as surgery. In the story, "Cheaper by the Dozen," two of the twelve children of Frank and Lillian Gilbreth write on the work of their parents. The Gilbreths were the originators of motion study. As many have learned from this book, motion study can be applied to most anything, including household activities.



Students in advanced course look over layout plan
Civil Engineering—wind tunnel

The mechanical engineering department of Michigan State College offers two courses dealing in this special area of methods improvement and work measurement, in addition to several other courses closely related to this. One course is entitled, "Beginning Time and Motion Study." The aim of this course is to familiarize the engineer with the basic tools and techniques that the methods engineer uses as well

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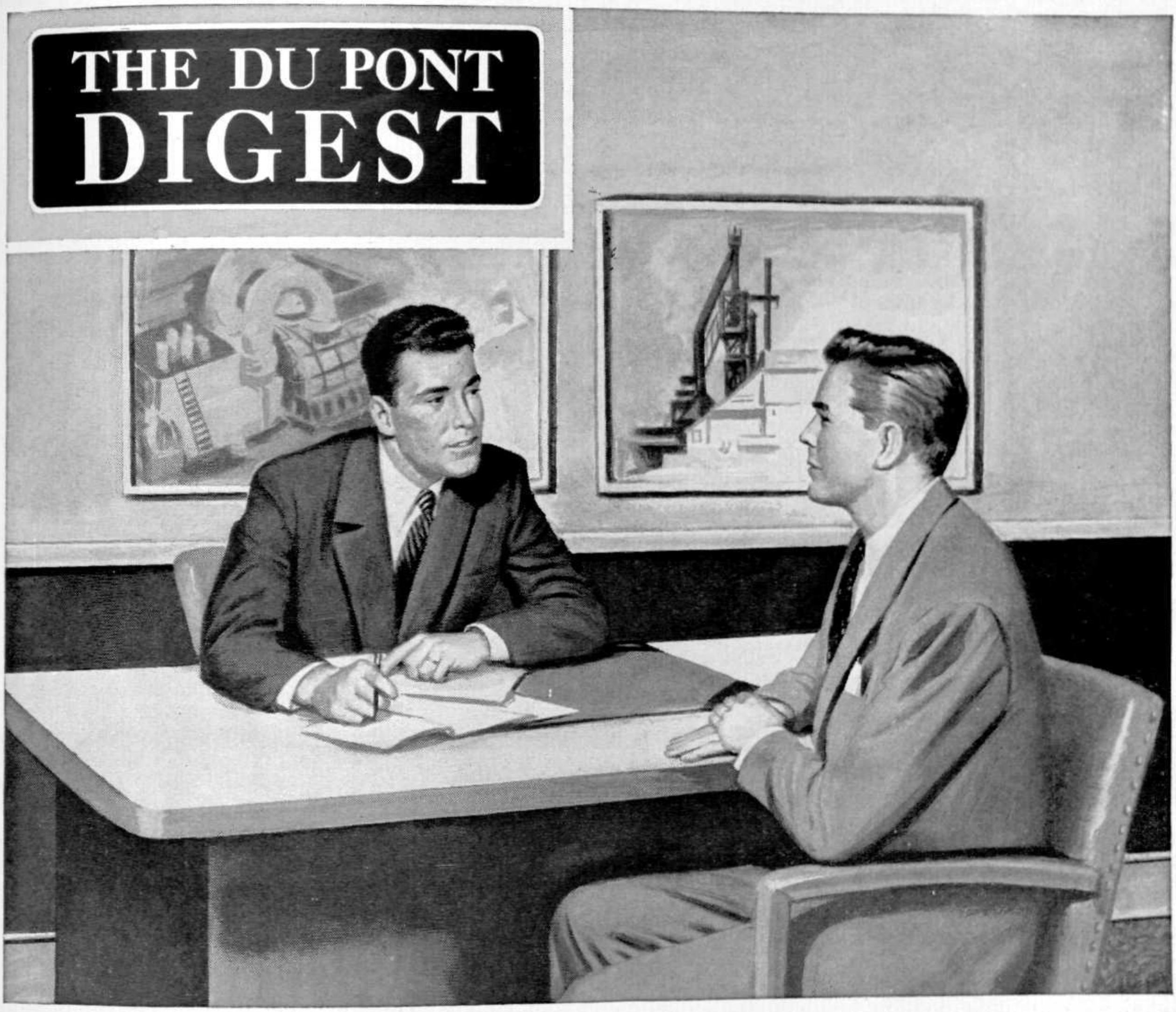

What do YOU look for in an employer?

Undoubtedly, you'll want most of the following characteristics:

1. Job satisfaction—the chance to do work you really enjoy.
2. Recognition—the assurance that good work will be noticed, appreciated, and properly rewarded.
3. Opportunities for advancement—a growing company can provide them.
4. Security—the knowledge that a company is both stable and progressive.
5. Pride—a feeling that your company is respected by the public and produces goods which contribute to a better way of life.
6. Good companionship—a factor which contributes greatly to happiness on the job.
7. Good pay—not in salary alone, but also in terms of vacation plans, pensions, and other benefits.
8. Safe working conditions.

How can you obtain this kind of information in advance?

One of the best ways is to discuss the matter with an acquaintance already working for the company you are considering. You will also find it helpful to consult your college placement officer, your professors and company representatives visiting your campus.

The selection of an employer is one of the most important decisions you'll make. It justifies considerable thought and effort.

SOON AVAILABLE for student ASME chapters and other college groups, a 16-mm. sound color movie—"Mechanical Engineering at Du Pont." For further information, send post card to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington, Delaware.

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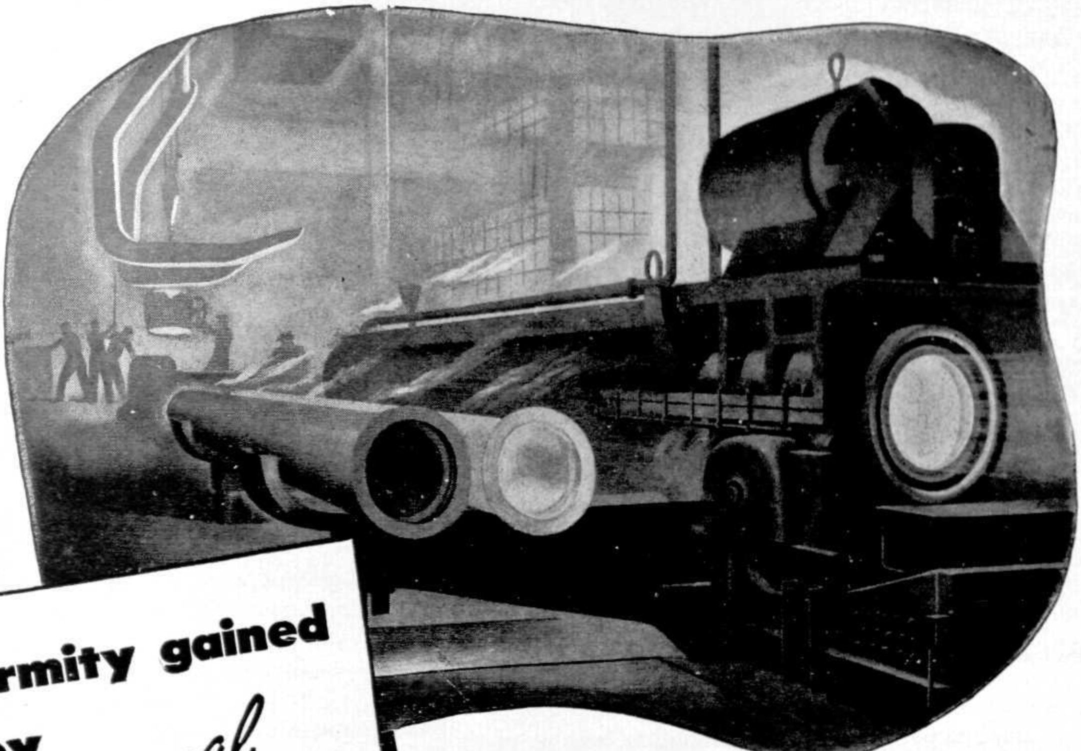
BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

Watch "Cavalcade of America" on Television



Uniformity gained by *"Centrifugal Casting"*

The great majority of cast iron pressure pipe produced today is cast centrifugally, in metal or sand-lined molds.

When this mechanized process was introduced 27 years ago, its potentialities for improved production controls were evident. For human fallibility was largely replaced by machine accuracy based on scientific principles.

The improved production controls made possible by the centrifugal casting process have long since been realized. Hundreds of millions of feet of centrifugally-cast-iron pressure pipe are now in service. All of this pipe is more uniform in metal structure, in wall thickness, and in concentricity, than pipe not centrifugally cast.

Better production control means better pipe; it results in greater uniformity of quality.

Production controls in cast iron pipe foundries start almost literally from the ground up with inspection, analysis and testing of raw materials; continue with constant control of cupola operation by metal analysis; and end with rigid tests of the finished product.

By metallurgical controls and tests of materials, our members are able to produce cast iron pipe with exact knowledge of the physical characteristics of the iron before it is poured into the mold of a centrifugal casting machine.

Cast iron pipe is the standard material for water and gas mains and is widely used in sewage works construction.

Send for booklet, "Facts About Cast Iron Pipe." Address Dept. C., Cast Iron Pipe Research Association, T. F. Wolfe, Engineer, 122 So. Michigan Avenue, Chicago, 3, Illinois.

Section of 114-year-old cast iron gas main still in service in Baltimore, Md.

CAST IRON PIPE **SERVES FOR CENTURIES**

New developments

Gas Turbine Auto

The first gas turbine automobile ever to be built and tested in the United States was announced recently.

The car is purely an experimental vehicle, not intended for highway use. It has been test run at the proving grounds.

Constructed as an experiment to study future possibilities of the gas turbine for commercial uses, the XP-21 has undergone preliminary tests since last October.

"The XP-21 is not the car of tomorrow," it was explained. "Actually, it is a laboratory on wheels built only for the proving ground and test track, not for public highways."

"Possibly, this is a development along a road we may not wish to go, so far as passenger automobiles are concerned. We built the Firebird to help us explore commercial possibilities of the gas turbine and add to our knowledge of thermodynamics," a spokesman said.

Has "Aircraft Motif"

"The tremendous power and speed potentials of gas turbines are well known by engineers. However, we are not trying to develop either overwhelming horsepower or tremendous speeds in this test car. Rather, we are trying to determine whether the turbine can be harnessed to give efficient and economical performance in the low and normal automotive driving ranges," the spokesman explained.

An aircraft motif is evident in the car's "needle" nose, delta wings swept back along the rear half of the body, a vertical tail fin and a plastic bubble over the driver's cockpit.

"Moreover," he explained, "underlying the unique styling is a series of special wind tunnel tests developed at California Institute of Technology."

He explained that on a vehicle of this type, completely streamlined, a tail fin or some flat vertical surface behind the car's center of gravity is necessary to give the body directional stability or hold it on course when it is in motion.

"This becomes particularly important with an aerodynamic shape such as the Firebird's contours. To examine this idea thoroughly, we called on California Institute of Technology to give a scale model of the car a wind tunnel test."

The gas turbine car's mechanical anatomy, the reverse of conventional automobiles, includes a 35-gallon glass fiber-plastic fuel tank in the nose ahead of the driver.

Behind the driver is an integrated power "package" with an engine consisting of two mechanically independent parts.

The two parts of the engine are called the gasifier section and power section. The gasifier section provides a source of compressed hot gas, and energy from this gas is delivered by the power section to the car's rear wheels.

The Whirlfire gasifier section closely resembles a complete small jet engine. The exhaust gas, instead of firing through a tailcone to propel the car, is funneled through a power turbine that is directly connected with the car's rear wheels through a transmission.

Backbone of the gasifier section is a so-called compressor rotor and a gasifier turbine wheel, both attached to the same shaft. Air enters the compressor where its pressure is raised to more than 3½ times atmospheric pressure, before it enters the engine's two combustion chambers.

Kerosene is burned in these chambers, raising the gas temperature to approximately 1500 degrees Fahrenheit.

The hot gas goes through the gasifier turbine which drives the compressor. The blast of hot gas from the gasifier turbine is funneled toward the second turbine, the power section turbine, which is connected with the car's rear wheels via a two-speed transmission.

The Firebird's power comes from the power turbine, rather than the thrust of exhaust gas through a tailcone, such as the high velocity thrust that propels a turbo-jet aircraft. This is the major difference between an automotive and an aircraft turbine.

The Whirlfire engine develops 370 horsepower when the gasifier turbine is spinning at 26,000 r.p.m., and the power turbine is revolving at 13,000 r.p.m.

Total weight of the engine unit, including gasifier and power sections, is only 775 pounds. Overall weight of the entire car is 2500 pounds.

This gives the Whirlfire power plant and drive a weight-to-power ratio of approximately two pounds per horsepower. This ratio is about one-third of a conventional piston engine and drive.

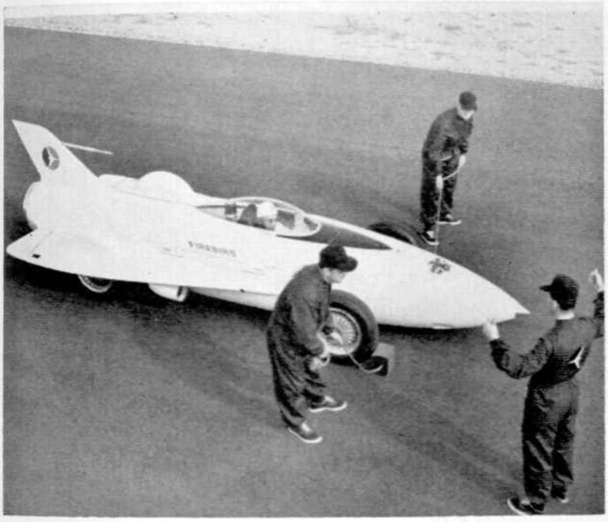
The wings have a functional purpose with their brake flaps on the trailing edges. They are electrically controlled from the steering wheel with aircraft type actuators.

The Firebird's main braking system differs from conventional design with brake drums outside rather than inside the wheels. Location and design of the brakes facilitate rapid cooling.

The car's exhaust outlet resembles the tailcone of a jet aircraft. It is much larger than the exhaust pipe of a conventional engine, a necessity with gas turbines because of the comparatively large air volume they swallow, digest and expel.

At the wheel was Mauri Rose, an engineer and former three-time Indianapolis Speedway champion. In his trial runs, Mr. Rose concentrated on testing the car's handling characteristics and controls which required specialized driving know-how.

Two-way radio shortwave communication between engineers and the driver was set up to check every phase of the Firebird's performance. To record the performance were 16 dials, meters and other indicators on the car's instrument panel.



The Firebird

Sphere for Atomic Sub Completed

The Atomic Energy Commission has announced the completion of the large steel sphere at the Knolls Atomic Power Laboratory's West Milton, New York, site, where they will test-operate a prototype atomic power plant for submarines.

Closing of the last openings – at top and bottom – marked the end of ten months' work. A total of 682 steel plates were joined together to make the structure which, together with its supporting columns, weighs 3850 tons. Two welds skirting its "equator" are each 706 feet in length. The sphere, 225 feet in diameter, rises higher than an 18-story building above one-time farm land at nearby West Milton.

The builders of the sphere said that the largest previously-built structures of its kind are five fuel storage tanks in Connecticut – each 76 and ½ feet in diameter.

Purpose of the housing is to provide insurance against the escape of radioactive material in the remote chance that numerous safety devices fail simultaneously. Scientists say there is no chance of a bomb-type explosion.

The atomic reactor will be installed in a land-based submarine hull section. Water will surround part of this hull inside the sphere to simulate actual sea-going conditions.

Background on Reactor:

The reactor to be tested will be the first to use neutrons in what scientists call the "intermediate" energy range. Consequently it has been named SIR for submarine intermediate reactor. Most of those previously built employ lower-energy for "thermal" neutrons.

SIR will derive its energy from the fissioning or splitting of uranium atoms. Liquid sodium metal will be heated to high temperature by energy released from these splitting atoms and in turn will be used to convert water to steam. The steam will drive turbines to run the vessel's propeller shafts.

Atomic submarines will be able to cruise at high speed for months without the frequent refueling necessary with oil-fueled vessels.

In addition the atomic powered submarine will be able to remain submerged for periods limited only by the endurance of the crew. Atomic engines, unlike combustion engines, require no oxygen to operate and a supply of oxygen for the crew can be carried aboard.

After SIR has been tested, a second and similar reactor will be built by the Knolls Atomic Power Laboratory for installation in the sea-going submarine, "Sea Wolf," which is now under construction.

Quiet Motor

One of the oldest and most annoying headaches in industry – machinery noise – will be greatly alleviated as the result of a new electric motor design.

Engineers, after five years of extensive research into the causes of noise in electric motors, have developed what they call a "sonant" motor.

Special electronic tests prove the success of this latest concept of engineering: The new 10-horsepower motor was shown to have about the same over-all noise level as the old 2-horsepower motor.

By isolating the three main causes of motor noise – bearing rattle, magnetic hum, and windage (the rush of air through the motor) – the scientists were able to decrease the noise and, perhaps more important, make the sound frequency more pleasing to the human ear.

Since electric motors are the most widely used form of machinery in the modern world, attacking the noise problem at this level is a major technical advance for all industry, the engineers explained.

Method Developed for Finding Accurate Temperature of Flame

Two scientists have called upon a discovery nearly a century old to improve performance of space ships of tomorrow.

They needed an improved method for measuring temperatures over the entire cross-section of a rocket motor flame to determine the motor's efficiency.

They knew that almost any thermometer introduced into the flame would quickly disintegrate. Thermometers relying on probes placed in the flame were not sufficiently accurate.

So the pair harked back to methods based on the 1859 discovery of G. R. Kirchoff, a German physicist. Kirchoff found that a flame containing sodium vapor

(Continued on page 40)

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

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

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

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

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

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

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

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

3.6

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

WORTHINGTON

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The 1953 summer surveying camp

by Leo V. Nothstine, Associate Professor of Civil Engineering

Fig. 1. Party 11 pauses with their field assistant.

To be a good engineer, one must anticipate troubles and difficulties and have them eliminated before they occur. Although this doctrine is not original with me, I found myself anticipating almost every conceivable difficulty when preparing for our summer surveying camp operation at the Dunbar, Michigan, Forest Station.

It was well understood that at camp the professor would have no escape, let's say, as he does on the campus. He would be in constant contact with the students through all classes and meals and most recreation periods. He would be part of all camp programs, academic, recreational, and accidental. This was much different than at East Lansing where there is a different professor or dean for each program and activity. Actually, the chief concern was one of maintaining morale at a high level, in order to have an efficient and effective academic program.

The chow was the most important factor in maintaining morale. We were extremely fortunate in this respect. The camp cook was Mr. John Russell, regular at camp, and regular cook at the A. G. R. house in East Lansing. It was soon recognized by one and all that, no matter what happened at camp, we knew that we wanted to take good care of the cook.

The Dunbar Forest Station is administered by Dr. P. A. Herbert, Director of the Michigan Conservation Division. The resident director is Mr. Maurice Day, who has charge of the station, operating the wood utilization projects, experimental plots, and the seedling plantations, along with maintaining the summer camp facility for the Foresters and now the Civil Engineers. Professor Henry Stochs was in charge of administering the summer camp operation, while I was in charge of the Civil Engineering students and their academic program.

Our civil engineering staff included professors G. Blomquist and B. J. Shell, instructor L. Davis and assistants Steve Galezewski and Ethan Axtmann. We had 47 young men to instruct. Right now, I want to say that this fine group was a pleasure to be with. We had a rugged schedule – usually two one-hour lectures and two one-hour supervised study periods in the forenoons, and a full afternoon of field practice on practical problems. After supper it was light until about 9 P.M. for softball, volleyball, horseshoes, target range, fishing, swimming, or a scenic drive down to Cozy Corners on the bank of the St. Mary's River. Field astronomy was practiced after dark until 11 P.M. the last three weeks. Assigned problems and drawings also usurped some of this period so it took diligence and ambition to keep up the grades and participate. The academic week was climaxed each Saturday at 10 A.M. by one-and-one-half hour examination. Nothing was scheduled from that time until 8 A.M. on Monday.

Many things shall remain in our memories that stand out among recollections of the summer, like some I mention here. Steve Galezewski has two ribs cracked during "football a-la-Dunbar"; the little buck, Herbie, wandered into camp for softball and football. Mrs. Day had to chase him with a fly swatter to get him out of her lettuce. We nearly went broke, shooting pictures of him in kodachrome. It took several meals before I was convinced that I couldn't keep up with the cook. I believe that if records were kept, student Bob Gustafson would have won the prize for weight gained in camp.

One night a siren kept us awake. It was a danger signal at the "Rock Cut," the downstream channel for the lake freighters when it was foggy. Doug Bruce had his speed boat at camp, one which we used for many trips over to Sand Island, an observation point for locating soundings. Phil Stout lost his glasses when a lead line knocked them into the water. I expect to catch a fish up there next summer that has learned to wear them. Ethan Axtmann and Steve Galezewski threw a raw egg (in competition) about 150 feet without breaking it – of course, they broke it on the next throw. It took quite a few eggs that day. Bob Stone, a forester, chopped a 14" log through in 28 seconds, less than half the time anyone else could do the same in competition. Dr. Feurig and family were in camp when he learned he was to be team physician. How happy he was, as we all were, and what a year was starting!

I certainly hope that succeeding years at camp will see the high morale and industry that we enjoyed in the camp of 1953.

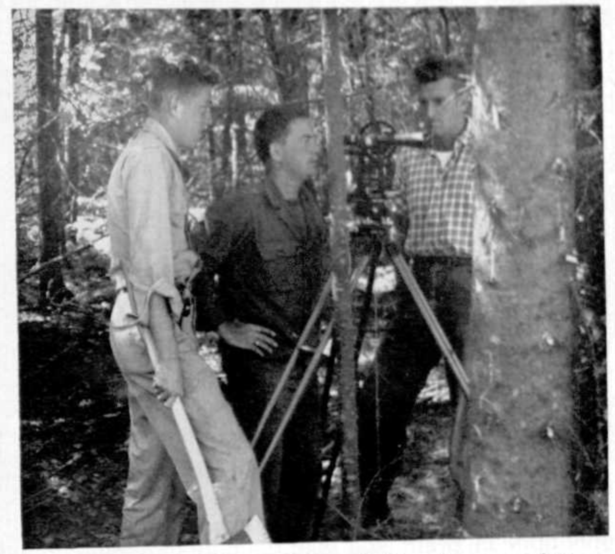


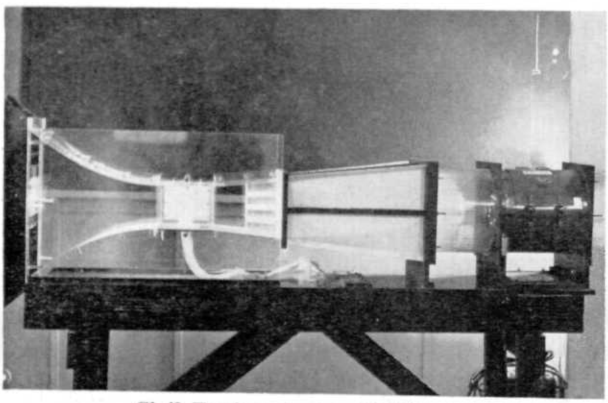
Fig. 2. Rusty Voorheis and Don Ryan ponder over a point set on a curve in the woods with their field assistant Steve Galesewski.

Fig. 3. Prof. Nothstine photographs the C.E. camp personnel.

Engineering research at michigan state college

by James A. Gusack, Graduate Assistant of Applied Mechanics

Did you realize that materials used in engineering today have only about one-thousandth of the strength predicted by the physicists? Calculation of the known forces which bind the atomic crystals together prove to be enormously optimistic when the materials are practically tested. This problem is only one of many in engineering which, if solved, would initiate a revolution in the design of machines. Research is now being carried on by industry, government, and universities in all fields to help maintain our technical superiority in peace and war.



Civil Engineering — wind tunnel

The Nature of Scientific Research

Scientific research may be divided into three broad categories: (1) pure research, (2) background research, and (3) applied research and development.

Pure research is investigation without specific practical ends. Men engaged in this field try to find general knowledge and understanding of nature and its laws. Although the pure research scientist may not be at all interested in the practical applications of his work, his initial efforts are necessary for the development of new industries. Many of the most important discoveries have resulted from experiments undertaken with quite different purposes in mind.

Background research is the compilation of essential data, after the theory has been formulated by the pure research scientist. Examples of this work are the collection of meteorological data, determining physical and chemical constants, and tables of stress concentration factors in materials. The background research may be thought to bear the same relationship to pure research as the detail draftsman has to the layout man. The service performed by this group is important to the practical engineer, as well as its supplying information for advances in pure science.

Applied research and development work usually has a definite objective. The development of radar during World War II was undertaken with a very definite purpose in mind: the winning of the war. The results of this research usually have a practical or commercial value and these investigations are often sponsored by private organizations only in the hope of ultimate recovery of the funds used. Most engineering projects are of this nature.

Engineering Research at Michigan State College

The department of Applied Mechanics under Dr. C. O. Harris is currently working on several research problems. A pilot wind tunnel has been built in Building A-4 on the South Campus. This tunnel has a throat section of six by nine-and-one-half inches and is powered by a one-half horsepower motor. Preliminary tests have shown an excellent velocity distribution. A second wind tunnel with a throat section of twenty-four by twelve inches and powered by a one horsepower motor is now being assembled. At its completion, many aerodynamic problems such as "singing" suspension cables will be investigated.

A student in the department, Zigurds Levensteins, is working on the problem of balancing field laundry units for the office of the Quartermaster General.

The department of Civil Engineering under Dr. John R. Snell has begun several major research projects. A new method of garbage disposal by composting is being investigated at the site of the College and East Lansing sewage treatment plant. This fast process will produce a product usable for fertilizer having a high percentage of nitrogen and selling at an economical cost.

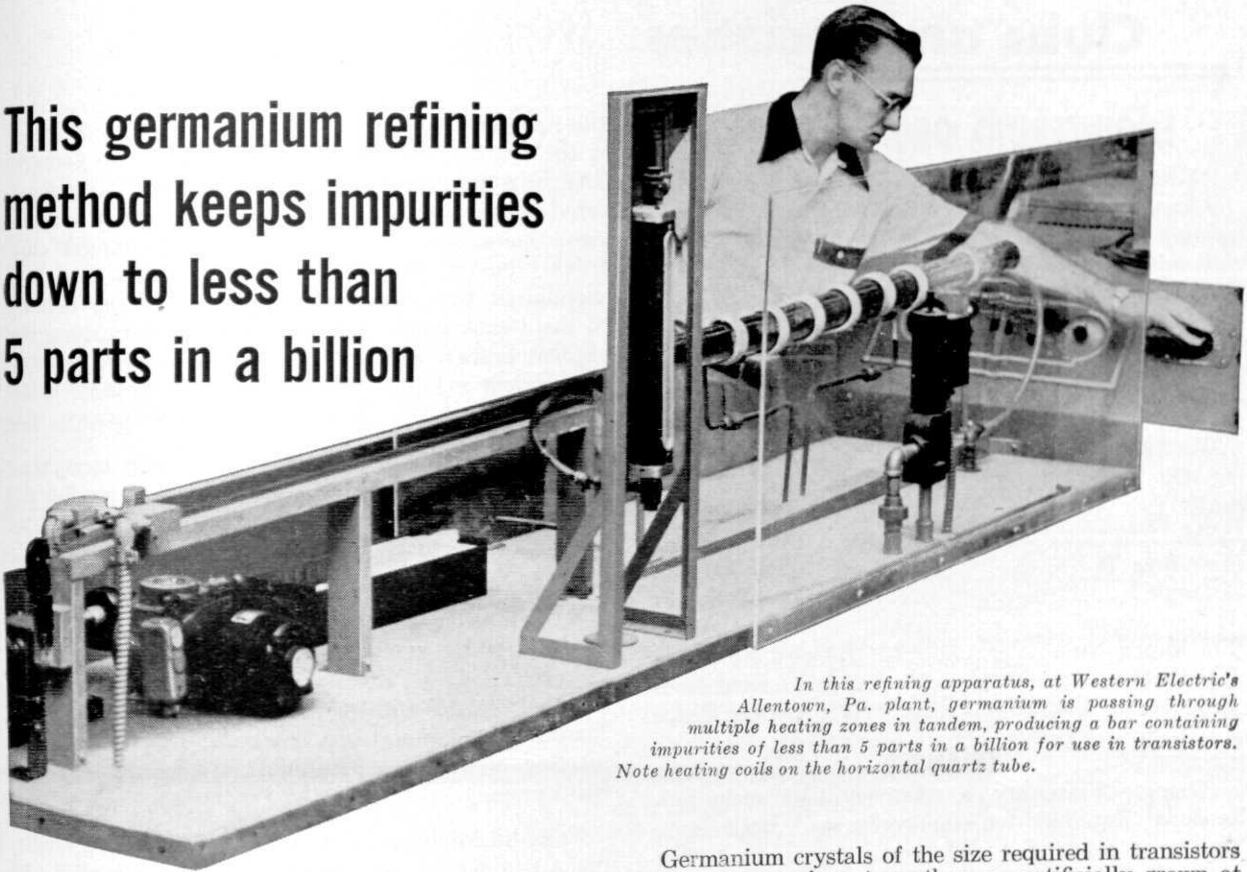
The effect of calcium chloride on soil stabilization is being investigated. A laboratory has been set up in Olds Hall with the necessary testing machines. The effect of various concentrations of this salt is important in building highway beds and building foundations.

The Electrical Engineering department has undertaken work for the United States Government. Secret projects are now being worked upon by Messrs. Robert Jeffries and Edward Vidro. Mr. James Cockrell is maintaining experiments on transistors while completing the requirements for his Doctor's Degree.

The Mechanical Engineering department has several projects running in the automotive field under Mr. Lewis Otto. Engine performance tests varying engine compression ratio, air-fuel mixture, and ignition tim-

(Continued on page 46)

This germanium refining method keeps impurities down to less than 5 parts in a billion



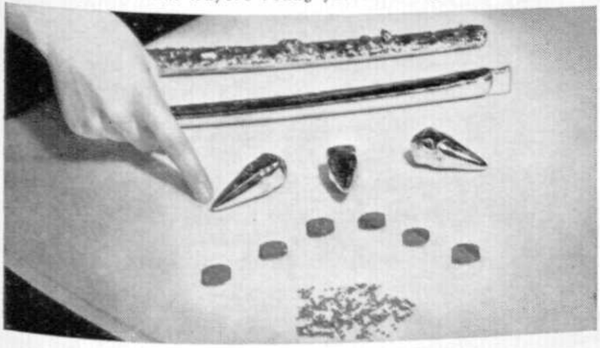
In this refining apparatus, at Western Electric's Allentown, Pa. plant, germanium is passing through multiple heating zones in tandem, producing a bar containing impurities of less than 5 parts in a billion for use in transistors. Note heating coils on the horizontal quartz tube.

A new method of metal refining, currently in use at the Western Electric plant at Allentown, results in the production of germanium that is better than 99.9999995% pure – the highest degree of purity ever attained in a manufactured product.

The need for germanium of such exceptional purity came about when research by Bell Telephone Laboratories in the field of semi-conductors led to the development of transistors, which are manufactured by Western Electric.

The transistor is a tiny crystal device which can amplify and oscillate. It reduces space requirements and power consumption to a minimum.

Various forms which germanium takes before being used in transistors are shown in this photo. Bar at top is an ingot of germanium after reduction from germanium dioxide. Next is shown the germanium ingot after the zone refining process used by Western Electric. Below the ingots are shown 3 germanium crystals grown by machine, 6 slices cut from these crystals, and several hundred germanium wafers ready for assembly into transistors.



Germanium crystals of the size required in transistors do not occur in nature; they are artificially grown at Western Electric. At this stage in transistor manufacture, other elements are introduced in microscopic quantities to aid in controlling the flow of electrons through the germanium. But before these elements can be introduced, it is necessary to start with germanium of exceptional purity, so that the impurities will not interfere with the elements that are deliberately added.

So Bell Telephone Laboratories devised an entirely new method of purification, known as zone refining, which was developed to a high-production stage by Western Electric engineers.

In zone refining a bar of germanium is passed through a heat zone so that a molten section traverses the length of the bar carrying the impurities with it and leaving behind a solidified section of higher purity. By the use of multiple heating zones in tandem, a number of molten sections traverse the bar. Each reduces the impurity content thus producing a bar which contains impurities in the amount of less than five parts per billion.

Because of the importance of the transistor in electronics, the zone refining process – like so many other Western Electric developments – has been made available to companies licensed by Western Electric to manufacture transistors.

This is one more example of creative engineering by Western Electric men. Engineers of all skills – mechanical, electrical, chemical, industrial, metallurgical, and civil – are needed to help us show the way in fundamental manufacturing techniques.

Western Electric

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Clubs and societies

ENGINEERING ORGANIZATIONS

(Editor's Note: To accommodate the many requests for knowledge on who to contact for information pertaining to the various engineering organizations, the following list of organizations and their presidents has been compiled.)

ASAE	Rolland Wheaton
ASCE	Rocco Sylvestri
AFS	Bruce Harding
AIChE	Bob Somerville
AIEE-IRE	Gene Lazarus
ASME	Erik Brogren
SAE	John Kuly
ASM	Dick Lambert
Tau Beta Pi	Leo Jedynak
Triangle	Daniel Robins
Pi Tau Sigma	Bruce Harding
Eta Kappa Nu	Howard Newcomb
Chi Epsilon	Fred Neils
Engineering Council	George Pence

TRIANGLE

Triangle Fraternity, a relatively new social-professional fraternity for engineering and architecture majors, is enjoying a well earned success in its first year of operation on the Michigan State campus. Membership includes 27 actives along with a sizeable group undergoing the pledge program.

Perhaps the biggest step forward was the purchase early winter term of a house which is located on a spacious lot at 1214 E. Grand River (next to the Delta Sigma Phi house). The back yard of the Triangle property is located right off the Red Cedar River.

Presently, Triangle's main project is a general house "fix-up" program. With the constant work by the pledges and actives the house will be occupied Spring term. According to president Daniel Robins, living capacity is in the neighborhood of 25 members.

Also, Winter term, Triangle was admitted representation in the Engineering Council. There was some discussion as to whether they are entitled to three representatives, the same number as the engineering socities, or are only entitled one member like the engineering honoraries. The Council decided in favor of a three-member representation.

Greatly assisting Triangle in their promotion and organization is national vice-president William Brown, of Flint, Michigan. Faculty advisers are Charles Harris, head of the department of applied mechanics; James Apple, professor of mechanical engineering; and Matthew Huber, assistant professor of civil engineering.

SAE

The Michigan State student branch of the Society of Automotive Engineers is one of the most active organizations that a student may join. Membership this year has risen over 76%. With 106 members, it is the fourth largest student branch in the country. SAE helps prepare engineering students who are interested in such fields as: development; design; production; operation and maintenance of passenger cars, trucks, busses, and aircraft; fuels; lubricants, and metallurgy by performing such services as mailing to them each month the *SAE Journal*, furnishing the student branch with qualified speakers, and inviting the student members to all local and national meetings.

Since this term began, there have been more than a dozen members from MSC who have attended the Annual Meeting in Detroit and also the Mid-Michigan Meeting in Owosso. In this manner students are able to hear numerous engineering authorities, as well as meet with practicing engineers in many fields.

Meetings on campus Winter term have included talks by Mr. E. M. Estes of Oldsmobile and Mr. H. C. Kirtland of GM's Allison Division. An engineer from Piasecki Helicopter Corp. spoke at the early March meeting on the development and manufacturing of helicopters.

The Mid-Michigan Section of SAE is again sponsoring a student paper contest. The award is $75. All regularly enrolled undergraduate SAE student members at MSC are eligible to enter this local contest. Society advisor Dr. L. L. Otto has complete information on the contest rules.

Student Branch Chairman Juhn P. Kuly says, "All engineering students are cordially invited to join with us and the more than 18,000 senior members of our professional society in technical thought and discussion at our periodic meetings. We members feel that the benefits of our association with SAE – the monthly issues of the *SAE Journal*, attendance at local and national meetings, reduced prices on a great number of technical publications, and participation in student branch activities is an important investment for our future."

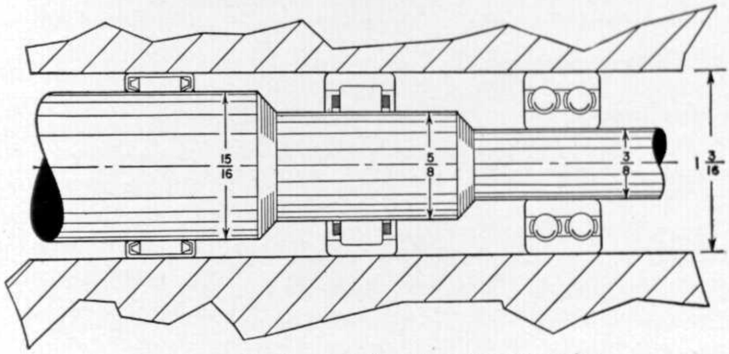
ENGINEERING COUNCIL

Primary activity of the Council is concerned with the 1954 Engineering Exposition entitled "Engineering for Better Living." General chairman of the Exposition is Council vice-president Joe Myers, senior from Owosso, Michigan. The 1954 edition is planned to be twice as large as in 1953; it will act as a stepping stone to an extra-large showing expected in 1955 for Michigan State's centennial celebration.

To encourage student exhibits, an item that has been lacking in previous Expositions, the Engineering Council is offering a $50 savings bond for the best student exhibit and a $25 savings bond for the second best exhibit. Also offered is a plaque for the society with the best participation.

The Torrington Needle Bearing
is designed for high radial loads

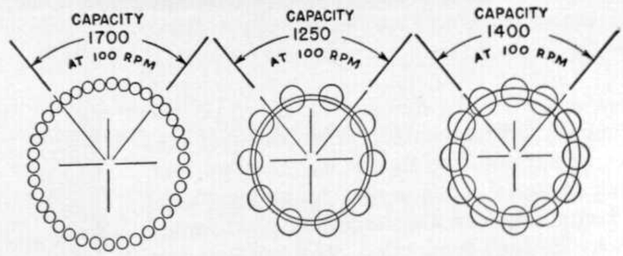
The many lineal inches of contact provided by the larger number of small diameter rollers give the Torrington Needle Bearing an unusually high load rating. In fact, a Needle Bearing has greater radial capacity in relation to its outside diameter than any other type of anti-friction bearing.



1. *Illustrates the fact that for a given housing bore size, a larger and, therefore, stiffer shaft can be used with Needle Bearings than with a roller or ball bearing.*

Precision Manufacture and Unique Design

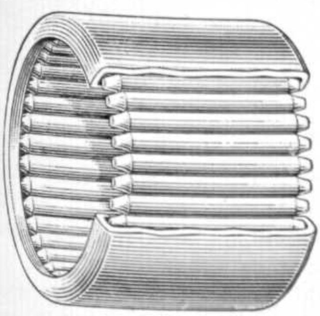
The exceptional load capacity of the Needle Bearing is the result of proper selection of steels, precision workmanship to close tolerances, and the application of modern anti-friction principles.



2. *Shows the greater number of lines of contact in the load zone of a Needle Bearing compared with a ball or roller bearing.*

The one-piece shell, which serves as the outer raceway and retains the rollers, is accurately drawn from carefully selected strip steel. After forming, it is carburized and hardened. There is no further grinding or other operation that might destroy the wear-resistant raceway surfaces. The full complement of thru-hardened, precision-ground rollers is retained by the turned-in lips of the one-piece shell.

The small cross section of the Needle Bearing allows a large shaft which permits a rigid design with minimum shaft deflection, a factor of utmost importance to good bearing design.



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TORRINGTON *NEEDLE* BEARINGS

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Reinforced plastics

(Continued from page 19)

cost of the same weight of metals. Cost advantage? – none here, as far as simple weight comparisons go. No, the great promise of the material lies in its engineering advantages, in its design features which make it superior to metals in spite of its higher per-pound cost. The engineer is king in the use of reinforced plastics, especially the young engineer with imagination, ingenuity, and foresight.

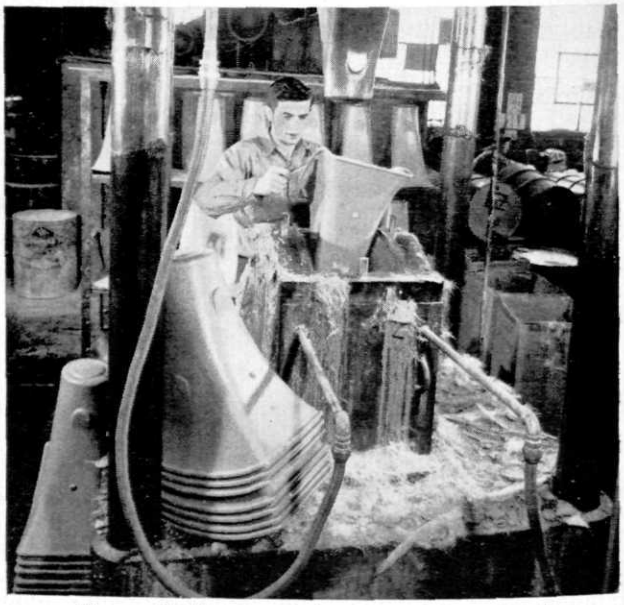
For example, plastic bodies are perfect for sports cars – the Corvette, the Darrin, and others to follow. Corrosion resistance is complete – rusting is unknown to fiberglass plastics. The high strength-to-weight ratio permits a reduction in weight, with a corresponding jump in speed. High impact strength makes a higher speed safer, for the body will absorb more energy and show less damage than sheet steel. And once fractured (not "dented"), a plastic fender is easily patched with a repair kit of glass, resin, and catalyst, and a heat lamp. As far as direct material cost goes, reinforced plastic parts are about three times as expensive as steel parts; but, so long as quantities are low, another factor enters. That is, die costs for the molding are much lower than for steel fabrication because of looser die tolerances and because fewer dies are required. Die costs for an all-steel sports car, with its anticipated market of only a few thousand, would be intolerable; but for reinforced plastics they are much more reasonable. When demand goes above fifteen thousand, the shoe is on the other foot. Then direct material costs begin to outweigh die cost as a factor. Still another automotive advantage is that, even in high-production steel cars, certain featured body parts can be changed frequently by making them of plastic. Die cost being less, it is easier to suit the whims of public fancy.

Military aviation was the first big customer of reinforced plastics. Radomes housed the aircraft radar units, permitting passage of radar beams, while still giving the necessary strength, impact resistance, low weight, and aerodynamic shape. Other aircraft parts are now fiberglass-made: cowlings, airfoils, wing tips, fuel tanks, tail sections, etc. And the aviation and automobile industries are not alone among transportation lines in their interest in fiberglass plastics. Any medium desires highest possible strength for lowest weight. It means bigger pay loads on railroads and truck lines. And it explains why bathtubs and shower stalls and corrugated panels of plastic have become popular in house trailers. Most recent use is the molding of fuel tanks for transporting gas and oil by truck – a bag-molding operation.

Now for a contradiction – the exception that proves the rule. Though the direct material cost is much higher in reinforced plastic than in metal, design changes can often reverse the advantage. In fact, molded plastics can often do jobs metals cannot hope to match. For example, a machine housing or engine cover may be molded in one press operation, while cast or sheet metal would require a long series of operations to achieve the same end. Here the cost break is in labor, tooling, and overhead. One or two plastic moldings can often replace a dozen metal parts requiring assembly. But notice – the cost advantage is strictly due to design characteristics, not actual raw material cost.

And what else can reinforced plastics show? They show excellent insulating qualities. Their use in refrigerators, coolers, electric motors, and electric tools is a result. They show beautiful effects when made translucent and colored. Awnings, lamp shades, window fans, chairs, tables, and wall panels apply these qualities. They show less noise under vibration, which explains their use in computing machines. Their impact resistance is famous in bullet-proof vests used in Korea. They can be given flame resistance with certain resins; thus, their employment in fuel tanks and pressure vessels. The automobile industry employs them for short-run steel-forming dies. Indeed, some automotive engineers foresee a greater future for plastic dies than for plastic bodies themselves. And daily more uses are being devised by alert, ingenious engineers.

Sounds great, doesn't it? But ask any molder, and he will reply that his greatest problem is successfully making the jobs he has now, besides finding new customers. The glass and resin suppliers are primarily



The molded horn as it is removed from the dies after a three-minute cure. This deep, narrow part is an excellent example of molding in matched-metal dies, and one of the most difficult parts made by the process.

worried that their materials are not good enough to do the job molders demand. The one great problem of the industry now is with material – getting it to do what it should; producing enough to keep up with demand; predicting what it will do, with very little data to draw from. There is no other industry in the nation that knows less about its own material than fiberglass – reinforced plastics.

Opportunity for young men? Scads of it! And problems? – even more so. Any young man entering reinforced plastics business can expect long hours,

(Continued on page 43)

Brig. General David Sarnoff, Chairman of the Board, Radio Corporation of America

Sees No. 1 wish come true!

Television Tape Recording by RCA Opens New Era of Electronic Photography

In 1956, RCA's General Sarnoff will celebrate his 50th year in the field of radio. Looking ahead to that occasion, three years ago, he asked his family of scientists and researchers for three gifts to mark that anniversary: (1) A television tape recorder, (2) An electronic air conditioner, (3) A true amplifier of light.

Gift No. 1—the video tape recorder—has already been successfully demonstrated, two years ahead of time! Both color and black-and-white TV pictures were instantly recorded without any photographic development or processing.

You can imagine the future importance of this development to television broadcasting, to motion pictures, education, industry and national defense. And you can see its entertainment value to you, in your own home. There the tape equipment could be used for home movies, and—by connecting it to your television set—you could make personal recordings of your favorite TV programs.

Expressing his gratitude for this "gift," Gen. Sarnoff said it was only a matter of time, perhaps two years, before the finishing touches would bring this recording system to commercial reality. He described it as the first major step into an era of "electronic photography."

Such achievements as this, stemming from continuous pioneering in research and engineering, make "RCA" an emblem of quality, dependability and progress.

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New Developments

(Continued from page 29)

gives off the same amount of sodium radiation it absorbs from a tungsten lamp when both are at the same temperature.

The established method of measurement, based on Kirchoff's law, is to pass a light beam from a calibrated comparison lamp through the flame to which sodium vapor has been added, then into a spectroscope. There the sodium radiation can be seen against the background radiation of the comparison lamp.

If the lamp is hotter than the flame, the sodium radiation appears dark against the background of the spectrum. If the flame is hotter, the sodium radiation is bright against the background.

When the two have the same temperature, the sodium radiation merges with the background. This point of merging determines the flame temperature. But in flames that have varying temperatures throughout, the method does not give the correct reading for a broad cross section.

With this method in mind, the two scientists worked out extensive improvements that have enabled them to accurately gauge complicated temperature structures in a single flame.

To magnify the flame spectrum they substituted an interferometer for the conventional simple prism spectroscope.

The scientists found that by using a sodium vapor lamp as a means of comparison and the interferometer to magnify the spectrum of the sodium radiation, they could find more detailed information than by the older method.

In effect, the method enables the scientists to peer through various zones of a flame into more distant ones and determine their temperatures accurately.

In addition, it enables them to survey the temperature structure in a large section of the flame in one observation. By older methods a flame could be examined only one point at a time.

The gauge has helped rocket and jet technicians to determine accurately how efficient are various flames. Indirectly, the device also shows how much energy is converted into thrust for rockets, jets, ram jets and similar propulsion mechanisms.

Heating from Atomic Reactors

It has been disclosed that large quantities of waste heat developed in atomic reactors at the Hanford plutonium-producing plant at Richland, Washington, shortly will be used for the first time in this country for heating buildings.

This practical industrial use of the excess heat will be achieved by indirectly using water carrying away reactor heat to warm the air drawn into certain Hanford plant structures now under construction.

Enough heat to take care of the needs of a thousand average-sized homes will be extracted from the reactor-cooling water and transferred to the air going through plant air conditioners.

The initial investment for the heat recovery system is estimated at about $614,000, and an annual operating cost, excluding repairs, at about $2,200. The estimated fuel saving of $59,000 a year would pay off in 7.5 years the $444,000 of the initial cost of the heat recovery system that would be additional to the cost of a conventional steam system.

As explained by the designing engineers, here is how the system will work.

Water from the Columbia River is pumped through the great Hanford reactors where plutonium is made by the transmission of uranium. The water absorbs immense quantities of heat generated by the process; on its trip through the reactor, dissolved mineral matter in the water becomes slightly radio-active.

Because of this factor, the water from the reactor will be run through a heat exchanger to warm up the water in a secondary piped circuit that will relay the heat to an air conditioning system in the building, while the radio-active water is carried away. This activity quickly dies away by natural decay, but the concentration of large volumes would create a radio-activity hazard to the plant areas before being harmlessly dissipated in the main stream of the Columbia.

To prevent the movement of contaminated dust particles from the reactor to working areas, a constant flow of air is maintained across the reactors to the outside.

Consequently, no air is reheated and recirculated in the building. Instead, a large volume of air per minute is pumped from the outside, cleaned, heated and poured into the building.

To pipe the water direct from the reactor through coils in the floor or walls to warm the building by radiant heat would be impractical because of this large volume of fresh air constantly moving in.

The heating system itself is simple in both concept and in execution. It consists of three major elements connected by an appropriate system of piping. First, the primary exchanger, which transfers heat from the effluent stream to an intermediate fluid – second, the secondary exchangers, which transfer heat from this intermediate fluid to the air – and third, a by-pass exchanger, which is arranged to provide adequate heating when the reactor process is shut down.

This heat recovery system will answer the question of scores of engineers throughout the nation who have hoped for some economic use of this large energy source. Since September 1944, the huge reactor process plants at Hanford have been pouring vast quantities of waste heat into the Columbia. This heat, a necessary by-product of the nuclear reactions involved in converting uranium to fissionable plutonium, has been of great interest to engineers, who have looked forward to its industrial application.

Jet Trainer

A two-seat trainer version of the Korea-famed Air Force F-86 Sabre Jet capable of exceeding the speed of sound in a dive is undergoing flight evaluation after a successful first flight.

The swift prototype is the nation's first trans-sonic trainer, and is designed for advanced pilot training in high speed flight, gunnery and dive bombing.

In building the trainer, engineers added a tandem cockpit, dual controls and a duplicate instrument panel to the original installations of the Air Force F-86F fighter-bomber.

A proven airframe was used for conversion to a high speed trainer to reduce costs of development and production and to provide a ready store of spare parts and trained maintenance personnel.

The trainer has retained most of the performance characteristics of the original F-86F. It is rated in the 650 miles per hour class, has a maximum service ceiling of 45,000 feet and a combat radius of over 600 statute miles.

In converting the F-86F to the trainer, engineers returned to the slatted leading edge of earlier Sabre models. The moveable edge reduces stalls at low speeds and allows the trainer to make slower landings.

Added to the instruments normally carried by the F-86F are an inter-communications system, an omni directional range receiver, instrument landing system and a directional finder.

New F-86 Sabre Jet

Safety features of the trainer include separate ejection controls for both the hinged canopy and the seats, and a seat belt that automatically opens after ejection. The ejection controls may be operated from either seat armrest.

Provision has been made for the installation of two .50 caliber machine guns for gunnery practice. Retained were the battle tested APG-30 radar set and the A-4 gunsight.

For extended flight, the trainer is fitted with dual stores stations which allow the plane to carry the normal two 200-gallon droppable fuel tanks and an additional pair of 120-gallon tanks or two practice bombs.

The F-86F Sabre Jet fighter-bomber entered the Korean War during the late months of the conflict. It was credited with boosting the ratio of "kills" over the Russian-built MiG-15 to an astonishing 14 to 1 at the end of hostilities. The F-86F also performed long range fighter-bomber strikes and was used as a dive bomber in support of frontline troops.

Research improves an age old product

American industry, as we know it, has come to flower in the twentieth century. Automobiles, airplanes, washing machines, electronics and atomic fission are notable examples. All have grown of age in the last fifty years.

However, there is one industry, vitally essential and of important size, which has been blooming for centuries. It has served mankind, not only for the past fifty years, but for the past five thousand years – the vitrified clay pipe industry.

Fig. 1. Greek plumbers 2500 years ago really knew their business. This clay pipe line was recently uncovered during excavations of the City of Agora, near the famous Acropolis in Greece.

Clay is a stiff, plastic earth, composed mainly of aluminous silicate, formed through the ages by erosion and decomposition of rocks. It is found, in some form or other, practically everywhere. And it is as indispensable to modern living today as it was to the ancient Greeks many centuries ago.

No one knows exactly when sewer pipe made from clay was first manufactured and used. Recently, Homer Thompson, Professor of Archaeology of the American School of Classical Studies at Athens, Greece, uncovered a clay pipe line which was installed in the early Fifth Century, B.C., in ancient Athens. The clay pipe line was discovered during excavations of the ruins of Agora, a public square about 25 acres in size, just below the famous Acropolis. This may have been the world's first shopping center. (Fig. 1.)

Greek plumbers 2500 years ago did an excellent job of designing the pipe. A modified bell and spigot was used, which is similar to the house connection pipe used today. Engineers, who examined the pipe after it was excavated, said it was in good enough shape to be put back into use.

Clay pipe manufacturers proudly boast of the antiquity of their product, but at the same time they are proud of their rightful place in the parade of modern production techniques and developments. They point to such innovations as continuous tunnel kilns, electrically-controlled grinding and mixing machines, automatic forming and trimming, palletizing and fork-truck handling. With a raw material older than civilization itself, the clay pipe industry is progressive indeed. Today, the annual volume output of the industry is approximately 2,000,000 tons. In the past five years the industry's capacity has expanded by more than 50 per cent to meet demand from municipalities, industries and other users of clay pipe.

Vitrified clay pipe was first made by machine in this country in 1854. No one knows how much has since been made and used. It is estimated that in the last four decades over one billion feet of clay pipe have been used in this country alone.

Raw clay must have certain qualities to be ideal for pipe making. It should be coarse-grained and uniform, and free from an excess of organic material and free metals. It should have a long firing range, meaning that heat can be applied to the pipe for a long time period to soften the clay grains to a fusing point, without actually melting the grains. When deposits of clay with these qualifications are obtained, pipe manufacturers then employ modern mining and earth moving machinery to get the raw material to the plants for processing into clay pipe.

At a typical clay pipe plant the clay is pulverized and mixed with water to form a uniform doughy mass. This is pressed through a die and shaped into pipe under tremendous pressures. Both steam and hydraulic pressures are used. The pipe is formed under a vacuum which draws all air from the clay as the pressure is applied. Elimination of air bubbles results in greater strength, truer dimensions, decreased absorption, and elimination of flaking.

(Continued on page 48)

Reinforced plastics

(Continued from page 38)

hard work, dirt, sweat, and the fiberglass itch. He can expect frustration and fury when things simply will not work out right. But if he sticks it out, he can expect a tremendous future, limited only by himself and his abilities. He can expect a reward unmatched by other industries, both in cash and in satisfaction. And he can expect to be fascinated by a business that has more hope, more optimism, more aggressiveness, more spunk, more daring, and more ingenuity than any other today. Yes, it's a young man's business.

Drafting board

(Continued from page 21)

in position, and usually bearing evidence of much erasing. With the basic principles and configuration determined, minor changes may be necessary, as is usually the case after trial operation of a new machine. Thus, the junior engineer may find himself strengthening a part here, lightening another there, and so forth, exercising his initiative and imagination.

The next step in the design engineer's progress is to become a designer, where the entire unit upon which he is working is his own creation. Here college training comes to bat, with the good drafting experience to swing it, and with this combination good design is expressed on paper in a way that is easy to understand, especially to the detailer. It is easy to see, at this point, that training in the drafting room has made the designer aware of the problems facing the detailer who looks at a scramble of lines called a layout, and it is hoped that the designer will try to avoid such confusion.

Now let's look back over the whole scene and see what it has done for us. First of all, coming fresh out of college we were relatively unfamiliar with many of the processes and practices used in manufacturing, for our college administrators knew we would pick these things up as we started working in industry. So we learned about tolerances, processes, and design, and became familiar with drafting standards.

The intent of this article is to show that no matter how dull detailing may seem, a lot can be learned through it. The detailer should try to perfect his style so that he can produce the best possible drawing in a reasonable length of time, for his drawings will be seen in the shop and in the front office long before, and many times more, than he will, and it will be from the quality of his work that he will be judged in these places. This is an opportunity for a young engineer to make a start towards a good reputation. So when some college professors and some engineers warn you to avoid drafting if possible, remember that drafting can be interesting and beneficial if you make the most of its advantages, and also remember that it is probably the best way to spread your name about the plant—to advertise and sell yourself according to the quality of your work.

Metallurgical Engineering

(Continued from page 15)

systems, x-rays, atomic structure, crystal structure, pyrometry, heat treatment, metallography, and similar topics related to the metallurgical profession.

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 of new alloys for diesel engines, television, and atomic power plants, to mention only a few.

Future metallurgical engineers will be interested in food processing, better sanitation, with textile machinery, oil well drilling, television, and farm equipment and machinery. The world awaits the availability of new and harder metals, of metals that have greater corrosion resistance, and of metals that can be used at very high temperatures or in sub-zero weather.

The student in metallurgical engineering today may see his future in the production of stronger bridges, faster aircraft, better diesel motors, safer ships, or lighter and more powerful electric motors.

Metallurgy and its related engineering activities are in the front lines of progress at all times. The metallurgical engineer of today has an expanding area of opportunities before him. New applications for the metals presently in use, and the production and development of commercial use for some 40 known but unused metals, offers an unlimited creative opportunity for the present and future generations of metallurgical engineers. Little used previously, the metal titanium has come into commercial production and use during the past five years. Within the past year the metal Zirconium has been produced in quantity amounts for use in nuclear reactors designed as a part of the atomic energy program. The current demand for these two newcomers to the field of industrial metals far exceeds present output.

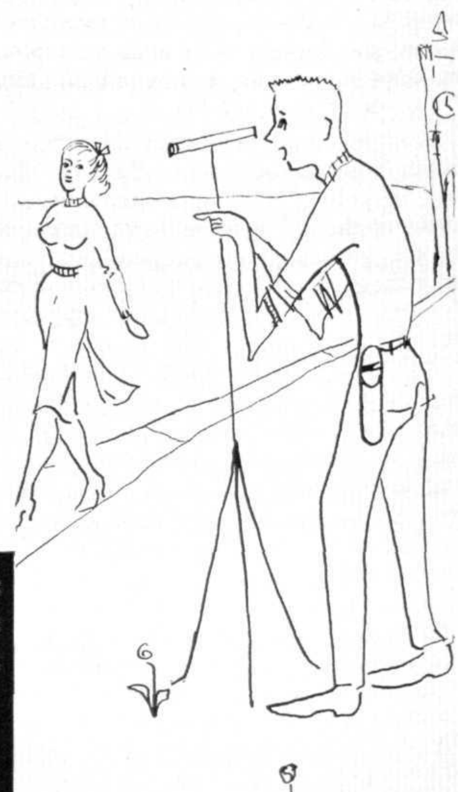
The metallurgical engineer has extraordinary opportunities for research, development, and application of entirely new alloys, or for the more economic design and of a known alloy. The metallurgical industries are among the basic industries of civilization.

Out of some 98 natural elements, more than 70 are metals; and yet less than one-half of these 70 metals are in commercial use today. Metallurgy has no more than scratched the surface of its possibilities.

* * * *

A young man whose father had been hanged was filling out a college application. After the usual hereditary questions there was one asking the cause of death of his parents. He thought for a while and finally put down this answer: "Mother died of pneumonia. Father was taking part in a public ceremony when the platform gave way."

MELVIN



by Madelyn

Better way?

(Continued from page 24)

as with a number of the attitudes and principles that he applies to effective work methods. Also treated in this beginning course is the procedure by which time standards are set. An advanced motion and time study course is also offered. The purpose of this course is to give the student further practice in the application of the tools and techniques which he learned in the beginning course. This practice is accomplished through the setting up of laboratory exercises and by a term project in methods improvement. The term project is usually undertaken at some local manufacturing plant.

The student, after first thoroughly analyzing a production problem, works up a solution; presents the solution to the management, and then installs an improved method. The problem of installation of the new method familiarizes the student with many of the human relations problems involved, as well as with the technical problems.

Michigan State College has a well-equipped laboratory to carry on the course work in motion and time study. The mechanical engineering department has recently purchased photographic equipment, including a special camera for the taking of motion pictures of industrial operations. The camera is equipped with a constant speed motor drive capable of taking pictures at speeds ranging from 50 frames per minute to 1000 frames per minute. Other recent acquirements are a number of woodworking and metal-working machine tools. These tools are used primarily in making up jigs, fixtures, and workplaces for projects in the advanced motion and time study course.

Man has sought to improve his methods since he struggled with his first task, but it wasn't until the nineteenth century, with its scientific-management movements, that it was made a separate study with men specializing in the field. And they had a hard time convincing management of their worth, but it is apparent now that this field is well grounded and has much to offer to society. It is human nature to resist change, but it also is an American characteristic to junk old ways in view of better ones when they are discovered.

Engineering research

(Continued from page 34)

ing are now being performed. Experiments on the flow velocity of water in the water jacket of an engine, and the power demands of fans are being studied experimentally. Intake manifold design and the development of a connecting rod for the tentative three horsepower engine to be made in the MSC engineering laboratories are examples of the analytical development work carried on in this department.

The above mentioned projects are a few of the research problems being investigated at Michigan State College. The various departments will be happy to furnish you with additional information about the projects.

* * * *

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Research improves product

(Continued from page 42)

The "green" or unburned pipe is dried in temperature-controlled rooms through which hot air is blown for four to seven days. This must be done to "set" the pipe before it can be "burned" and vitrified at high temperatures.

From the drying rooms, the pipe goes to big oven-like kilns, where it is "burned" to a temperature higher than the melting point of iron, 2,000 F. This burning is known as vitrification, and fuses the clay grains into a hard, impervious pipe which resists the penetration of any foreign substances.

Two main types of kilns are used by clay pipe producers – the "beehive" kiln and the "tunnel" kiln.

The beehive kiln is so called because of its remarkable resemblance to a beehive. It is a round-roofed structure 30 to 40 feet in diameter, and 16 feet from floor level to the roof peak.

Tunnel kilns look just like the name implies. The pipe, after it comes from the drying room, is piled on cars about 12 feet long. These cars move through the kiln on tracks.

Heat in tunnel kilns is maintained at a constant temperature and may be supplied by oil, gas, or coal. Heat is applied direct with flame from the burners playing on the pipe itself. Slow heating and cooling of the pipe is accomplished by moving the pipe load from the tunnel entrance, through a central fire zone, and on out to the tunnel exit.

After the clay pipe is vitrified, and before it is stored or shipped, each length is expertly and carefully inspected.

Research activities for the clay pipe industry are conducted in their own laboratory in Los Angeles under the direction of Dr. Harvey House, nationally famous research chemist. In the years that Dr. House has been supervising this industry's research, he has assembled facilities and equipment without duplicates anywhere, and all specifically designed to study vitrified clay pipe and kindred products. Much of this equipment Dr. House designed himself to meet testing requirements.

For sewage and drainage work, certain piping has inherent advantageous characteristics. Research determines what these are. For example, in non-pressure installations such as building sewers, vitrified clay pipe is permanent, it is resistant to chemical action of all products of sewage decomposition. It is also resistant to alkaline or acid ground water and to disintegration by chemicals and spent waste.

To substantiate findings of the Los Angeles research laboratory, tests were made at various universities on sections of vitrified clay pipe immersed in sulfuric acid. In Chicago, where additional testing was forwarded, acetic, hydrochloric and nitric acids were used and in none of these tests was the vitrified clay pipe affected.

Because of these outstanding characteristics, engineers are teaching an old product new tricks. For example, the new Health Sciences Building at the University of Washington, which has been called by

Fig. 2. Pulverized and mixed with water into a uniform, doughy mass, clay is die-pressed into pipe shape under tremendous pressure with either steam or hydraulic press.

medical authorities the finest of its kind in the world, contains a unique system of vitrified clay pipe for venting chemical fumes from the medical and dental laboratories. In various phases of their study and research, students and researchers find it necessary to cook hydrochloric and nitric acids and other substances which emit powerful fumes. This is especially true of their work with radioactive isotopes. Hoods catch the fumes in the laboratories and direct them into clay pipe ducts. Acid proof fans pull fumes up to the roof and disperse them harmlessly into the upper air. Vitrified clay pipe was chosen for the ducts because it is completely immune to the disintegrating action of acids and other chemicals.

Many home builders are now using this new and revolutionary system of duct heating for basementless homes. Vitrified clay pipe is used as ducts to distribute warm air.

This heating method economically combines the favorable factors of radiant heat with forced warm air perimeter heating. Clay pipe is the ideal duct material. It is inexpensive and easy to install and never wears out.

(Continued on page 56)

Re-refined oil

Change your oil? Change your oil? CHANGE YOUR OIL? Every one or two thousand miles you change the oil in your car. Under adverse conditions you may change it more often. Or perhaps you conveniently forget and don't change it quite so often. In any case there are thousands upon thousands of quarts of oil – dirty, grimy, diluted, weakened oil – removed from cars, trucks, buses, trains, airplanes, and machinery, every day of the week. What happens to all this oil? Surely it must have some value.

Much of this oil may be discarded – wasted – but sometimes it is salvaged in some manner. It may be reclaimed. That is, impurities such as solid carbon, gasoline, road dust, and water are removed by filtration and low heat treatment But more and more, the oil is being re-refined. In re-refining all impurities, including oxidation products, dissolved in the oil, are removed by a refining process similar in many respects to that given virgin oil.

A used oil properly treated is as good as or better than new oil. According to W. S. Boynton of the Wright Aeronautical Corporation, "Re-refined oil may be used over and over again and is usually preferred to new oil. It has more body, the volume consumed is not so great as with new oil, and it has better lasting and holding qualities." Re-refining of used oil is based on the fact that oil does not wear out or break down to any great extent. Dr. Winslow Herschel, associate physicist, Bureau of Standards, states, "Oils do not wear out mechanically; they do not wear out in the sense of wear in a rope, in which the length of fiber has been shortened and which cannot again be made as useful as when new." When used in an engine, oil becomes adulterated with suspended solid impurities and dissolved liquid impurities. The removal of these impurities by correct re-refining methods renders the oil fit for use again."

Re-refining of oil is becoming big business. As early as World War I it was tested and proved, and now re-refining of crankcase drainings is a practice accepted by thousands of commercial oil users. In a recent year almost eighty million gallons of high grade lube oil were re-refined and put back into use. Most of the oil re-refining is done as "custom jobs" for industries, airlines, railroads, trucking concerns, bus and cab companies, public utility companies, and the like. The oil is collected, treated separately, and returned to the company. About seventy-five per cent of the re-refiners' business is done with commercial users. Collecting used oil for re-refining and sale at filling stations is a highly localized, difficult, and rather high cost method of operation.

It has proved profitable for certain major oil users to do their own re-refining. Some of the major airlines like American Airlines and Pan American Airways operate their own re-refineries. Others, like Eastern Airlines, send their oil to a commercial re-refiner, since commercial refiners are able to restore oil to any required specifications. A major customer of the commercial oil re-refiners is the United States Air Force, which in a recent year sent out 2,700,000 gallons of used oil for reprocessing. This operation reportedly saved the taxpayers $600,000, and today the Air Force gets top grade oil for approximately 20 cents a gallon. During the recent war, re-refining returned 1,000,000 gallons of crankcase drainage a month to top grade aircraft engine oil specifications.

Re-refined, or "further refined" oil, as it may more properly be called, is actually "triple-refined." It is originally refined from the crude; it is further "refined" in the crankcase of the car, where the remaining sulfur is oxidized and the weaker hydrocarbon molecules are broken down; and it receives its third refining in the re-refining process, where these impurities are removed along with other accumulations. For the refiner of crude oil to carry his refining process to the extent to which it is carried in the crankcase of a car would be economically unfeasible.

The re-refining of used oil generally follows the pattern of either the steam distillation process or the newer, lower temperature, vacuum distillation process, both of which are used by the petroleum industry to refine crude oil. The steps in both processes are essentially the same, except for the temperature and pressure at which distillation and fractionation occur. Basically the steps may be broken down as shown below: removal of water and solid particles by dehydration and settling; sulfuric acid treatment to precipitate gums, grease, and other matter; alkaline treatment to neutralize acid compounds; water wash to remove soaps formed in neutralization; mixing with special clays such as Fuller's Earth to bleach the oil and absorb certain impurities; distillation to drive off light ends, moisture, and other volatiles; filtering to remove clay and other solids; and blending to desired specifications and the use of additives.

In the re-refining process 75 to 90 per cent of the drainings to be processed are usually recaptured as good oil. The oil may be re-refined many times. Some oil in Greyhound buses has been lubricating pistons

(Continued on page 52)

Re-refined oil

(Continued from page 50)

for 200,000 miles. The process, while removing the impurities, usually removes all traces of additives put in by the refiner of the crude oil. In most cases only fifty per cent of the original amount of additives has to be added to the re-refined oil to produce an oil of the same quality.

Aside from the prevalent misconception that oil wears out, re-refiners have other false ideas to overcome. The confusion existing between reclaimed and re-refined oil and the tendency to identfy the two as one has hurt the re-refiners' business. Reclaiming methods are incomplete and inadequate, and are often based solely on the removal of visible solids. Various methods of filtration, such as through earths, sands, sawdust, papers, rags, fibers, porous blocks, and the use of centrifuges have been tried to obtain this removal. Since many of the harmful impurities found in used oils such as moisture, diluents, tars, and resins can not be properly extracted by filtration, reclaimed oils have not been able to live up to the impossible claims made for them, resulting in prejudice against re-refined oil. With proper re-refining these adulterants and diluents are eliminated, giving the used oil the body, viscosity, viscosity index, and other properties of new oil. The viscosity index is a measure of the degree of change of viscosity with temperature changes, a high index indicating a small amount of variance. A good quality light or medium weight oil will have a viscosity index of 90 or above.

Another problem faced by the re-refiner, which is of more concern to the average motorist than to the commercial user, is a disbelief by the buying public in the re-refiner's ability to produce an oil of consistent quality. With the commercial user he does not face this problem, since the oil he receives from them is usually of a standard quality to begin with, has generally been used in a similar manner each time, and is most likely removed after a definite period of service. The re-refiner then treats each batch separately as it arrives. Furthermore, the commercial user sets specifications and usually has a means of periodically testing the re-refined oil to see that these specifications are met.

However, the re-refined oil that the motorist buys at the local filling station has had varied backgrounds. It was picked up from a garage pit where all types of oil were dumped, where the best and the poorest grades have been intimately mixed. It is hard to believe that out of this hodge-podge the re-refiner can produce an oil day after day with consistent quality. Yet that is exactly what he does.

Although crude oil may be either an asphalt base or a paraffin base oil, many oils are a mixture of the two and the main difference between brands and the various grades of new oil is the degree to which refining has been carried out and the amount of additives used. The refining process that takes place in the crankcase of the car tends to equalize the differences in the degree of original refining, and the re-refining process removes all the additives. This means that the re-refiner can depend upon a fairly consistent product and can count on making up any differences by the amount of additives that he uses. Also, the re-refiner has found that he can depend upon collecting from the filling stations a mixture of oils having a fairly constant content. Thus he is able to standardize his process to some degree.

The above facts still give the motorist no assurance that he can depend upon consistent quality from the same re-refiner, since the re-refiner is able to produce oils of all grades. But so is the refiner of crude oil. Yet we have come to rely upon his ability and integrity, and we choose our oil by brand and grade without any doubts. Being relatively new in the field, the re-refiner has not yet been able to build up a reputation. Realizing this, the Association of Petroleum Re-Refiners, with headquarters in Washington, D. C., has prepared a list of specifications, which must be met by the re-refiner before he can carry the seal of approval of the Association on his product. Because of the exacting specifications thus met, a re-refined oil carrying the seal of the Association of Petroleum Re-Refiners is probably more consistent in quality than new oil from a certain refinery. The Association is also willing to answer questions in regard to individual re-refiners.

Outside of its advantages to the immediate consumer, re-refined oil serves us in other ways. Refining of oil is a means of conserving one of our most important natural resources — crude oil. Estimates on savings by using re-refined oil have shown that aircraft and engine manufacturers save about 60-70 per cent of their total oil requirements while airlines save less than 20 per cent. The reason for this is that because of frequent drainings after their numerous tests, manufacturers discard more oil than they burn.

Crankcase drainings are all too often dumped into city sewers, left to be collected by city sanitation facilities, or poured into rivers and streams. The U. S. Fish and Wildlife Service and numerous state and local authorities have found that dumping of used oils causes serious river and stream pollution with resulting injury to fish and other wildlife, and hazards to and interference with navigation. Before re-refiners located in the Washington, D.C., area collected most of the city's oil waste, it cost the city tens of thousands of dollars annually to collect and dispose of these used oils. Now the taxpayers need no longer finance this operation.

It is not hard to see why re-refined oil is becoming more and more accepted by the average consumer. An estimate of the saving to the U. S. public already afforded by the collection of used oils by re-refiners amounts to approximately $5,000,000 per year. With all these accomplishments to its credit, re-refined oil is fast making a name for itself in the petroleum industry.

° ° ° °

America is the only country where they lock up the jury at recess and let the prisoners go home.

The chemical engineering profession

by Tom Clark, Ch. E. '54

It has been said that Hitler might have been considered the "Saviour of the American Republic." The world crisis which he precipitated aroused a great number of complacent men and women who were unable to fight on the battlefronts, and inspired them to rise to the defense of the principles of our republic here at home. Certainly this was true of the men in the chemical engineering profession.

The facts show that during World Wars I and II great advancements were made in the field of science. During the Second World War, the Bureau of Foreign and Domestic Commerce was gathering data on the amount of business that may exist in various fields of industry after the war. They predicted that there would be a great demand for such things as plastics, products of electronic research, and prefabricated houses, all of which require the work of chemical engineers. As a result, writers of sensational stories greatly exaggerated the idea of *immediate* postwar possibilities in these fields.

This is the story of the chemical engineers that made these predictions a near reality.

A professional chemical engineer must have at least a bachelor's degree. A master's degree is preferred and in some cases a Ph.D. is useful or required. But there is more than this to the education of a good chemical engineer. In the future, if he is to be a success, he must have as a foundation a good liberal education, especially in humanistic and cultural subjects. In addition to this, the chemical engineer must have a broad engineering background. He must know about equipment design, plant design, process control, plant operation, industrial economics, business management, plant administration, sales engineering and public relations, labor relations, corporation law, and finance. The chemical engineer of the future must know more about his own profession and other fields than the average engineer of the past.

Here is how the chemical engineer puts the training to work: When a new product, first developed in the laboratory and then made in the pilot plant, is considered worthy of exploitation for the market,

(Continued on page 56)

A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from A. C. Montieth, Vice-President
in Charge of Engineering and Research,
Westinghouse Electric Corporation,
Queen's University, Kingston, Ontario, 1923

The second most important decision in your life

Now, as you near graduation, you are about to make a decision—second in importance only to choosing your life's partner.

I'm talking, of course, about that all-important first job. Which company will it be? I wouldn't presume to answer that question for you. But I would like to emphasize the importance of this decision.

You have a lot at stake. The direction your career takes will most certainly be influenced by the company with which you cast your lot. May I offer a few personal suggestions.

Choose a company not for its bigness or smallness, but for how it will treat you as an individual. Choose it not only for its engineering activities alone, but also for how it is set up to help its engineers develop themselves professionally. Choose your company with an eye on the opportunities ahead—and an eye on the future of the company itself. Above all, select a company that has a definite program to help you determine the work for which you are best fitted.

Only you can make this vital decision. Whatever it may be—good luck!

G-10275

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

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

Research improves products

(Continued from page 48)

Another outstanding clay pipe installation was made by the village of Monsanto, Illinois. Though a village, Monsanto is no sleepy country settlement. It contains some of America's heaviest industries – and hence it puts unusual demands on its sewers. Most recent project at Monsanto is a twin industrial sewer which will serve several companies in the area. In specifying pipe, the engineers realized that the line would be carrying weak acids and other chemical wastes. Hence, they chose vitrified clay pipe, which is proof against chemical attack.

There was a complicating factor, however. Clay pipe is made no larger than 36 inches in diameter, and the volume of wastes to be carried here required more capacity than this. Yet rather than consider other pipe materials which are available in larger sizes, the engineers preferred to use multiple clay pipe lines.

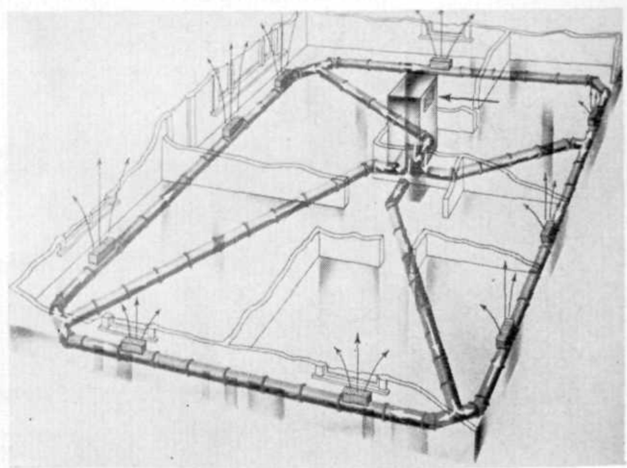


Fig. 3. Many home builders are now using this new and revolutionary system of duct heating for basementless homes. Vitrified clay pipe is used as ducts to distribute warm air.

Engineers who safeguard the public and who advance our nation's productive capacity play safe by specifying clay pipe. Modern sanitary systems constructed of clay pipe play an every-day role as guardians of the health of the people.

The vtirified clay pipe industry is alert to its responsibilities. It must anticipate the needs of a growing nation.

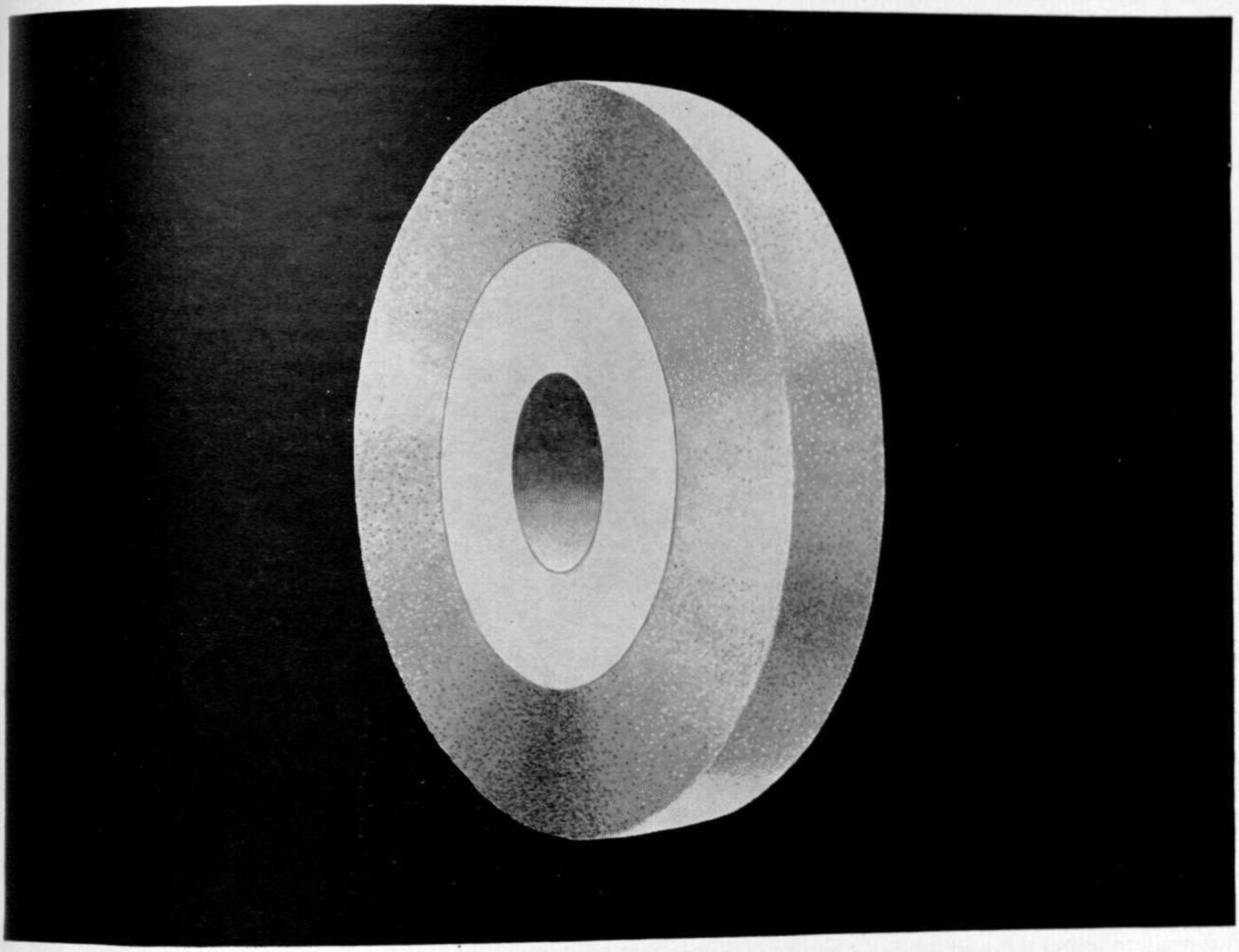
Research is meeting this challenge and will continue to do so.

Chemical engineering

(Continued from page 54)

the design and construction of suitable equipment for full plant-scale production becomes the problem of the chemical engineer. When processes are developed from the test tube stage to the production scale, there are many new factors to be considered. For instance, the chemical features of a reaction in a 40,000 gallon steel tank are different from those of the same reaction carried out in a 500 ml. Erlenmeyer flask. While the chemist deals primarily with the fundamental chemistry of the new product, the chemi-

(Continued on page 60)



The engineering council

Name	Organization	Council Position	Exposition Job
George Pence	ASME	President	
Joe Myers	ASM	V-President	General Chairman
Don Jagger	ASAE	Secretary	*Routing, Couns., Guid.
Dana Squire	AICHE	Treasurer	Financial Chairman
Tom Clark	Phi Lambda Tau	Pub. Rela. Officer	*Publicity
George Fox	SAE	Sgt. at Arms	†Exhibits
Jack Crane	ASAE		*Student Exhibits
Ed Champagne	ASAE		Industrial Exhibits
Joe Sciacca	ASCE		Special Shows
Gordon Mellencamp	ASCE		†Industrial Exhibits
William Tambo	ASCE		*Publicity
Clayton Callihan	AICHE		†Special Shows
Jerry Linton	AFS		†Convocation
Rennie Swope	AFS		*Exhibits
Ed Lahnala	ASME		Signs
Richard Herrick	ASME		*Student Exhibits
Gregg Trilevsky	ASM		*Auto Show
John Mieras	SAE		*Auto Show
Ray Steinbach	Spart. Engr.		†Programs
Harlow Nelson	Spart. Engr.		Industrial Exhibits
Emory Geisz	Spart. Engr.		Publicity
Gene Parker	Radio Club		*Communications
Jim Jennings	Radio Club		*Communications
Lee Mah	Eta Kappa Nu		†Printing
Delbert Elliott	Tau Beta Pi		Lighting
Dick Sedlack	Pi Tau Sigma		*Routing, Couns., Guid.

†Chairman
*Co-Chairman

Advisors to the Engineering Council

James Anderson .... Mechanical Engineering
Ralph Rotty .... Mechanical Engineering
Matthew Huber .... Civil Engineering

Here is a list of the entire membership of the Michigan State Engineering Council. Beside each name is the Council position, if any, occupied by each member; his job in connection with the Engineering Exposition, and whom he represents on the Council.

Authorized membership of the Council is 38 representatives. Currently, however, the membership totals only 26. Chi Epsilon and AIEE-IRE do not have representatives on the Council, and Triangle Fraternity is in the process of electing three representatives.

Job Description

Exhibits Chairman – Coordinates the procurement, placing and dismantling of all exhibits and shows.

Ind. Exhibits Chairman – Responsible for procurement, placing and return of all industrial exhibits, together with maintenance of Ind. Exhibits files.

Stud. Exhibits Chairman – Responsible for stimulation of student exhibits, placing, manning and dismantling, through the Engineering Societies. Also responsible for awarding prizes.

Auto Show Chairman – Responsible for procurement, placing and safety of automobiles exhibited.

Programs Chairman – Responsible for assembling ma-

(Continued on page 60)

★

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SPARTAN
ENGINEER

★

Apply Third Floor,
Union Building.
Especially
FRESHMEN
and
SOPHOMORES

★

Chemical engineering

(Continued from page 56)

cal engineer is chiefly concerned with the handling of materials, the flow of heat and such unit operations as distillation, filtration, and evaporation. He must also be concerned with improving production methods, reducing costs, and developing new uses for products.

The need for engineers with this type of training has arisen in almost every industry. A large number of chemical engineers are employed by the manufacturers of equipment, scientific apparatus and control devices, both for development work and for sales and service. Many industries not primarily chemical employ chemical engineers to control the quality of the things they purchase and sell, and to introduce chemical rather than mechanical operations wherever desirable. There has also been an increased trend toward the employment of chemical engineers in what may broadly be called non-technical work. The opportunities for today's chemical engineers are unlimited.

The men in the chemical engineering profession get a great deal of pleasure in knowing that they are applying chemistry in a way that satisfies some of the wants of humanity and that they are a necessary part of our present day civilization.

Engineeeing Council

(Continued from page 58)

Identified around the table clockwise: Don Jagger, Joe Myers, (standing) George Pence, Professor Anderson, Jack Crane.

terial and layout of program material received from all other chairmen. Also responsible for distribution.

Routing, Registration, Counseling and Guiding Chairman – Responsible for obtaining exhibit rooms, arranging route of show, maintaining record of visitors, procurement of exhibit and personnel from MSC Counseling Clinic and guides for any special groups.

Financial Chairman – Responsible for securing funds, requisitioning purchases and maintaining books.

Printing Chairman – Responsible for all printing, including programs.

Signs, Lights, Communication and Manpower – Responsible for all lab, exhibit and routine signs, all outside lighting, efficient communication system, and procurement of manpower needed other than for guiding and student exhibits.

Convocation – Responsible for speaker, publicity, dinner, invitations, and arrangements for speech.

Publicity – Responsible for advance publicity and arrangement of tours for high school groups.

Feature section

edited by Bruce Harding, M. E. '54

Here are a few more brain teasers to keep you busy in your idle hours.

1. A rug is 9 ft. x 12 ft. and has a 1 ft. x 8 ft. hole in its center (with the 8 ft. dimension parallel to the 12 ft. dimension). How should the rug be cut so that with only three cuts, the pieces can be put together to form a rug 10 ft. x 10 ft.? (No folding is needed.)

   –from the "Bent"

2. There is a fly on each corner of a 10-inch square napkin. Each fly faces the fly next to him in a clockwise direction, and each starts walking at a certain instant, always walking directly toward the fly he was originally facing. When they meet at the center, how far has each walked?

   –adapted from the "Bent"

3. Here's our favorite: Three worms – a mother worm, a father worm, and a baby worm – were out for an afternoon stroll when they came to a big puddle. The puddle was too big to bother going around, so they swam across it. Upon crawling out at the other side, the baby worm said, "Now there are five of us!" How come?

4. If you have an excess of spare time, you might solve this problem:
   What is the maximum number of 1-inch diameter balls which can be put in a box which is a 1-foot cube?

The answers to these Brain Teasers will be in the next issue of the *Spartan Engineer.*

° ° °

Here are a few thoughts which we, as engineering students, might well keep in mind, both now and after graduation.

"Learning without thought is labor lost; thought without learning is time wasted." – *Confucious.*

"Resolution is omnipotent. – Determine to be something in the world, and you will be something. – Aim at excellence, and excellence will be attained. – This is the great secret of effort and eminence. – 'I cannot do it,' never accomplished anything; 'I will try' has wrought wonders." – *J. Hawes.*

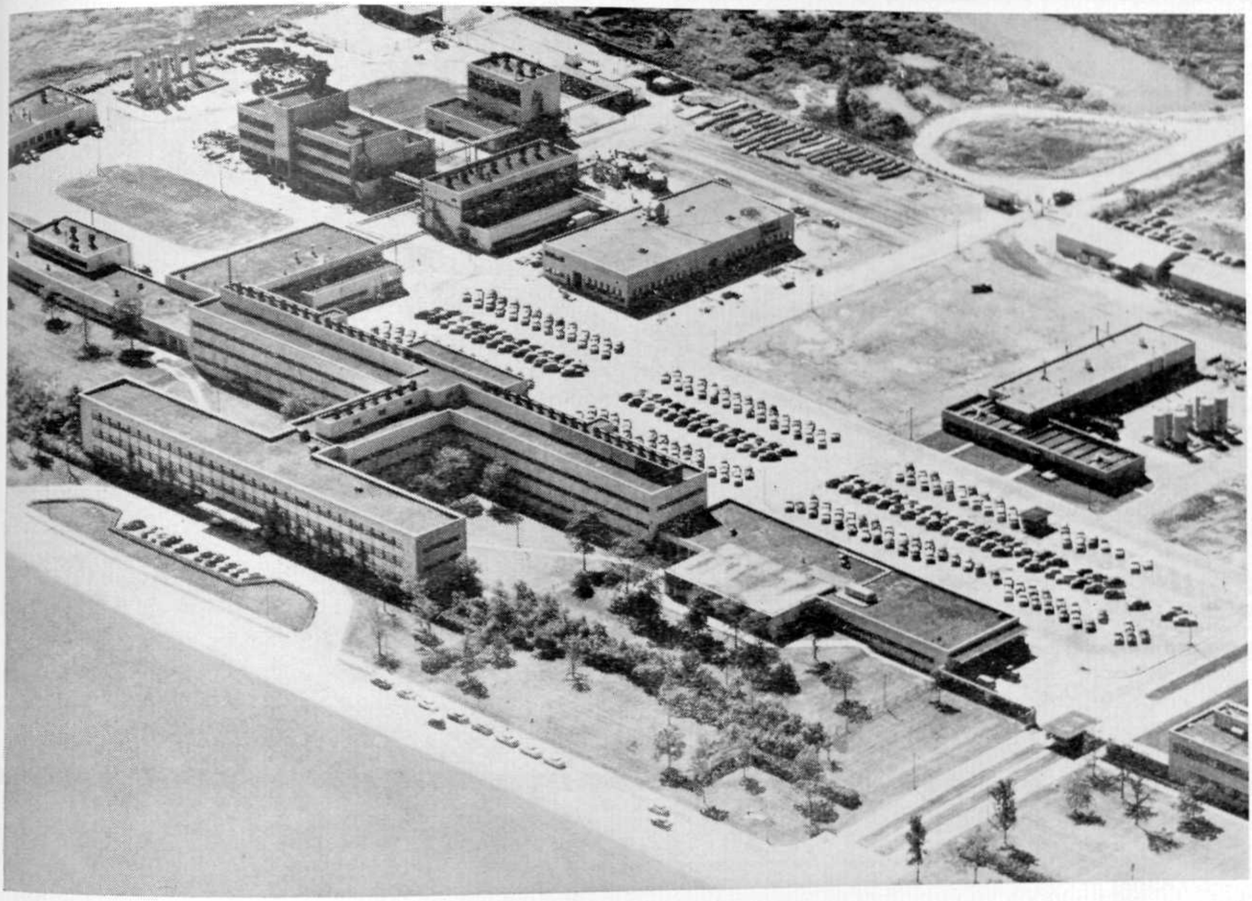
–both of the above from *"Dictionary of Thought"*

Or apply this to your campus organizations:

"An organization is like a transmission – the idlers help it only to go in reverse."

° ° ° °

Pedestrian: A man who has two cars, a wife, and a son.



MOST OF THE RESEARCH WORK that led to the development of Ultraforming—a more efficient and economical refining process—took place in the Whiting research laboratories of Standard Oil, above. Extensive studies in seventeen research-scale units demonstrated the merits of cyclic regeneration.

Standard Oil scientists develop **Ultraforming--** the latest in catalytic reforming

After several years of research, Standard Oil scientists have developed a new and important refining process—Ultraforming.

The process is a better way of improving the low-octane straight-run gasoline found in crude oil. To make such gasoline suitable for present day cars, refiners must change it into an entirely different material, which gives good anti-knock performance. The change is known as reforming.

Ultraforming is the last word in catalytic reforming. It gives greater yields of higher octane gasoline than were previously possible and gets good results even with poor feed stocks. In addition, it raises the yield of hydrogen, an increasingly valuable by-product of catalytic reforming.

Ultraforming units do not have to be shut down when the catalyst begins to lose activity through use. By a new technique, an improved platinum catalyst is regenerated to maintain peak performance.

The advantages of Ultraforming over previous methods are so great that Standard Oil and its subsidiary companies are building units at four refineries. They will start operating this year. The new process, of course, is available to the petroleum industry through licensing arrangements.

At Standard Oil, young engineers and chemists work with the stimulating knowledge that they are participating in important and lasting contributions to the oil industry and to their country.

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910 South Michigan Avenue, Chicago 80, Illinois

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Why Don't

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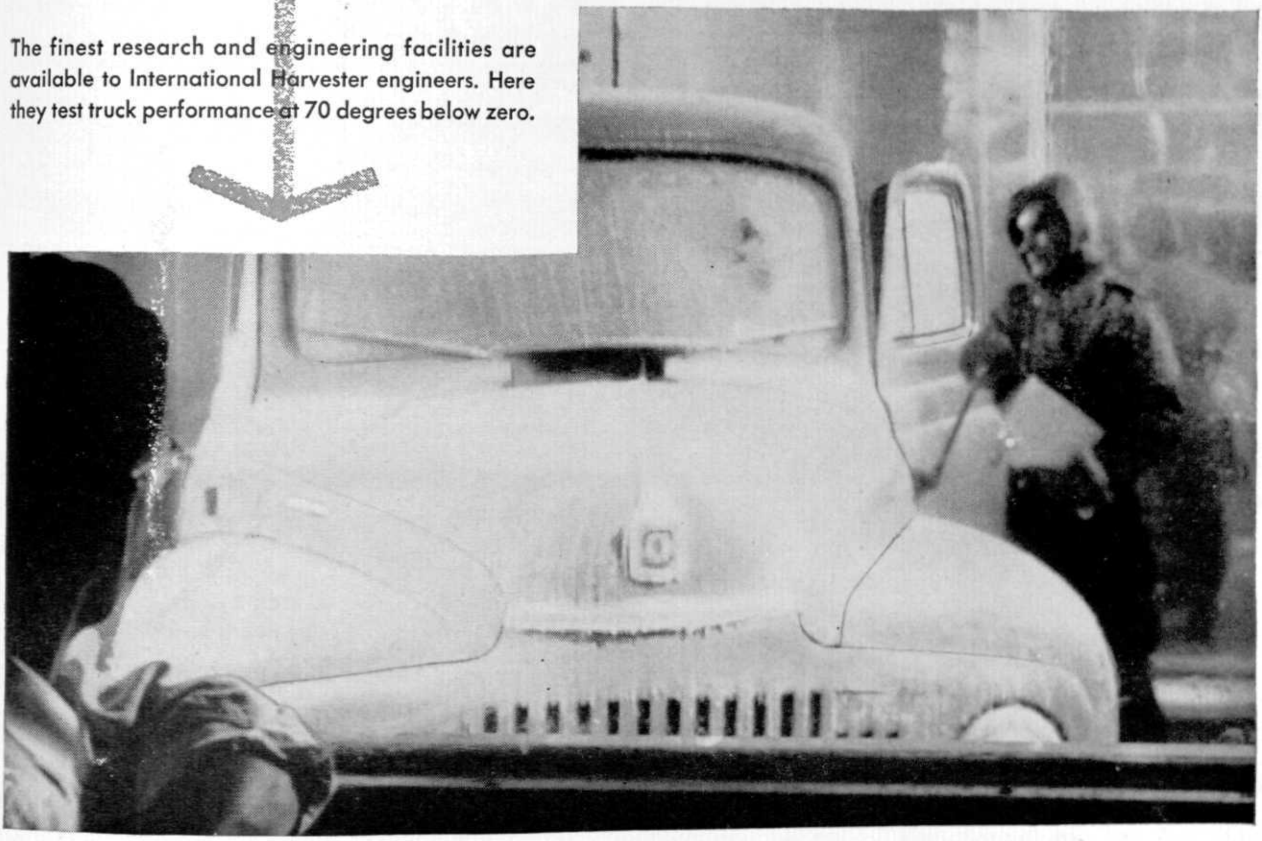
May 6, 7, 8

Index To Advertisers

*Inside front cover
**Inside back cover
***Back cover

Good climate for **engineering** jobs!

The finest research and engineering facilities are available to International Harvester engineers. Here they test truck performance at 70 degrees below zero.



▪ The American transportation system is the most highly developed in the world. And International trucks are part of this picture.

At Fort Wayne, Indiana, International Harvester maintains the biggest truck research, development and testing laboratory in the world. The opportunity such an operation provides for young engineers is obvious.

Throughout the entire International Harvester operation, engineers are needed. Electrical, mechanical, industrial, metallurgical, agricultural, design, research, and testing engineers find that Harvester offers unusual opportunity.

If you are interested in a career in the engineering field, we suggest you write to F. D. MacDonald, Education and Personnel Department, International Harvester Company, 180 N. Michigan Avenue, Chicago 1, Illinois.

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Sidetracked

I. S. Problem, Test No. 3:

A cross-eyed woodpecker with a cork leg and synthetic rubber bill required ½ hour to peck ¼ of the distance through a cypress log 53 years old Shingles cost 79 cents per hundred and weigh 8 pounds apiece. The log being pecked upon is 34 feet long and weighs 46 pounds per foot. Assuming that the coefficient of friction between the woodpecker's bill and the cypress log is 0.097 and that there is negligible resistance to diffusion, how many units of vitamin B_1 will the woodpecker require in pecking out enough shingles for a $7,500.00 barn with detachable chicken house? The woodpecker has an efficiency of 97 per cent, and gets time and a half for overtime.

° ° ° °

Then there's the tale of the Australian Bushman who invented a new type of boomerang. He went crazy trying to throw the old one away.

° ° ° °

"Calling all cars – Calling all cars – Be on the lookout for a one-legged hunchback!"

Back from car 26 came this question: "Any distinguishing marks?"

° ° ° °

I love the *Engineer*,
  I think it's swell.
And every month
  I run pell mell
To get my copy
  And read each line.
The stories and features
  I think are fine.
I laugh at the jokes,
  I read all the ads;
I note all the news
  And take up all the fads.
When I praise it
  I scorn those who laugh.
I'm really most loyal–
  I'm on the staff.

° ° ° °

A young engineer took his girl to the open air opera one beautiful warm evening. During the first act he found it necessary to excuse himself. He asked the usher where the men's room might be.

"Turn left and walk down to the big oak tree, and there it is."

The young engineer did as he was told and in due time returned to his seat.

"Is the second act over yet?" he asked the girl.

"You ought to know," she replied, "you were in it."

The judge, quizzing the defendant, asked, "You mean to say that you threw your wife out of the second story window through forgetfulness?"

"Yes, sir," was the quick reply of the defendant. "We used to live on the ground floor and I plumb forgot we moved."

° ° ° °

Salesman: "I have here the one and only sure cure for dandruff."

Housewife: "Really, how does it work?"

Salesman: "Oh, it's awfully simple – it's a mixture of alcohol and sand."

Housewife: "But how does it cure dandruff?"

Salesman: "Well, you just rub the mixture on your hair; then the bugs get drunk and kill each other throwing rocks."

° ° ° °

Two drunks wandered onto a railroad trestle one dark night.

First drunk: "Boy! Thish is a long flight of stairs."

Second drunk: "I don't mind that so much, but I'm having a helluva time getting used to thish low hand rail."

° ° ° °

A small boy was seated on the curb with a pint of whiskey in his hand reading a racing form and smoking a big cigar.

An old lady passed and asked, "Little boy, why aren't you in school?"

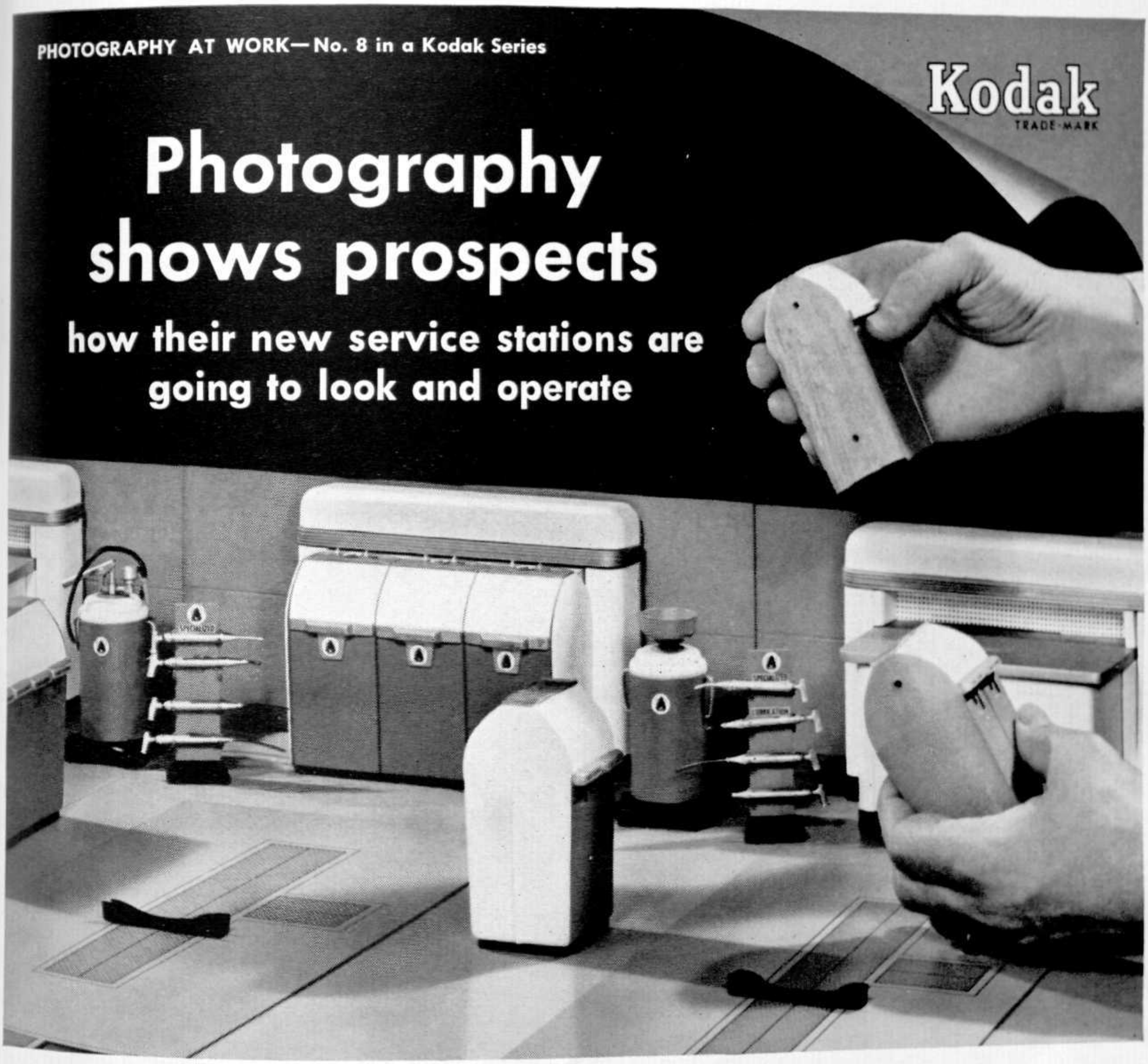
The child replied: "Gee's lady, I ain't but four."

° ° ° °

Then there was the Scotsman who wrote the editor saying that if any more Scotch jokes were printed in his columns, he'd quit borrowing the magazine.

° ° ° °

My parents taught me not to smoke;
  I don't.
Nor listen to a dirty joke;
  I don't.
They make it clear I must not wink
At pretty girls, nor even think
About intoxicating drink;
  I don't.
To sew "wild oats" is very wrong;
  I don't.
Wild youths chase women, wine and song;
  I don't.
I don't kiss girls, not a single one,
I don't even know how it's done,
You'd think that I wouldn't have much fun;
  I don't.



Alemite sets up scale models of their service station equipment on the customer's own floor plan—photographs them—and portrays the new custom-built station ready for action

SALESMEN don't just pull lube racks, grease pumps and other service station equipment out of a sample case. They're far too big—far too bulky. Besides, final location and arrangement count heavily in how well they are going to work out.

The Alemite Division of Stewart-Warner solves the problem with photography. Prospects see new service station equipment virtually right in their own premises.

It works this way. The salesman sends in a rough sketch of the space available, with windows and columns marked. Experts fit exact replicas of racks, lifts, and other equipment to the plan, then put the camera to work. The customer pictures his new station—modern, efficient, handsome—and the sale is well on its way. It's an idea for any company with bulky products to sell. Photography is a great salesman for any business, large or small. And it's very much more. It works in all kinds of ways to save time, cut costs, reduce error and improve production.

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

Eastman Kodak Company, Rochester 4, N.Y.