Spartan Engineer

★ A Bright Future

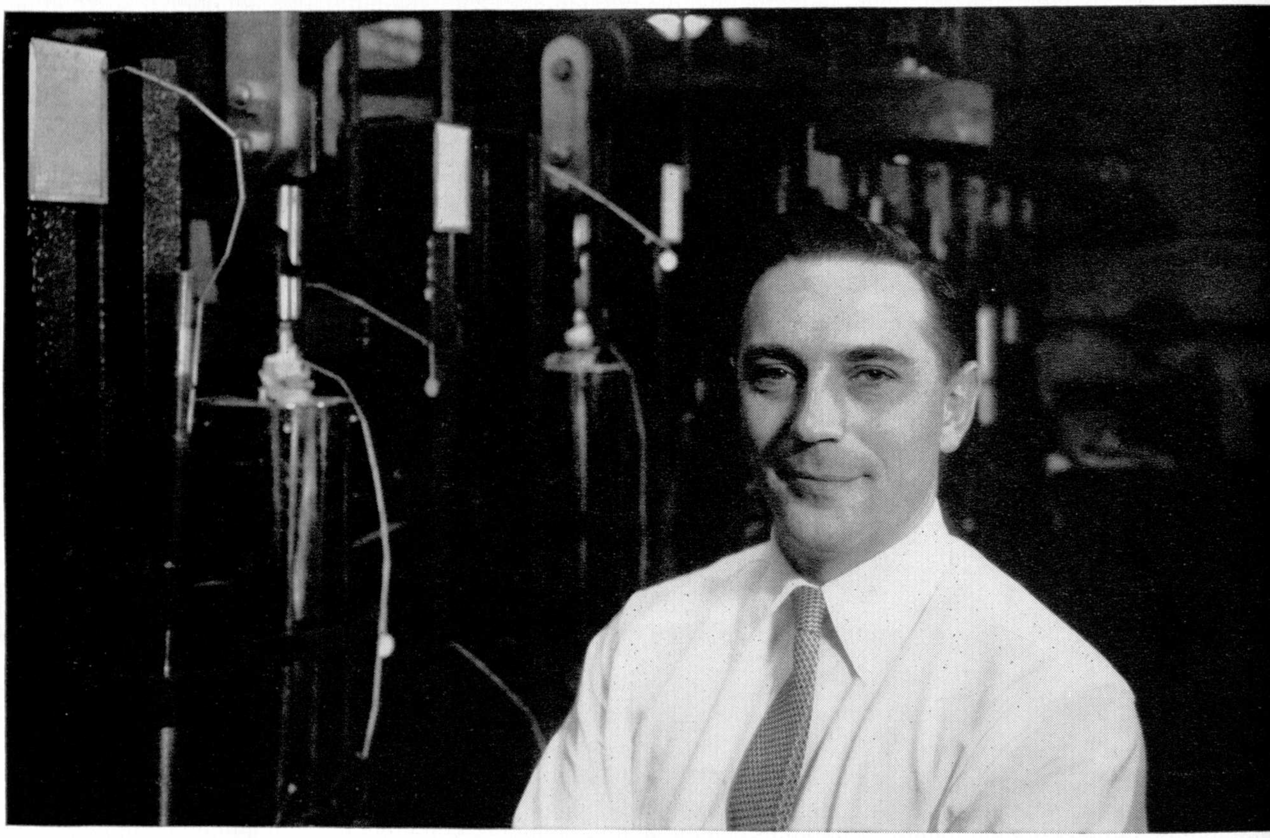
★ Chemical Engineering
. . . Pathway to Progress

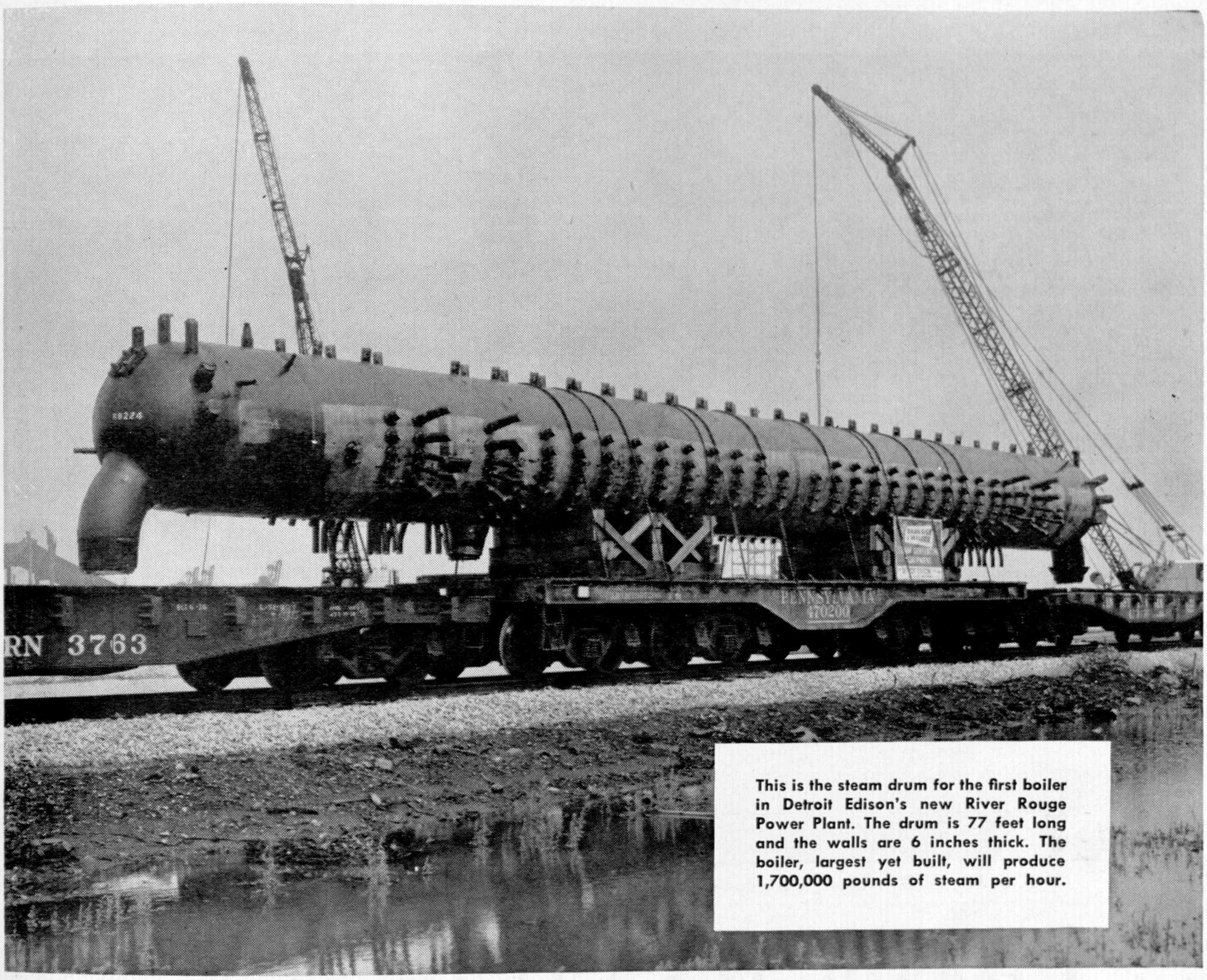
★ The Engineering Society

★ New Developments

★ Topology

VOLUME 8 NUMBER 2 JANUARY, 1955 PRICE 25c





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Editorial

A BROAD EDUCATION

Are you a bookworm? Do you spend all your spare time studying? This may be a good way to increase your academic education, but are you learning anything, or are you just becoming a parrot?

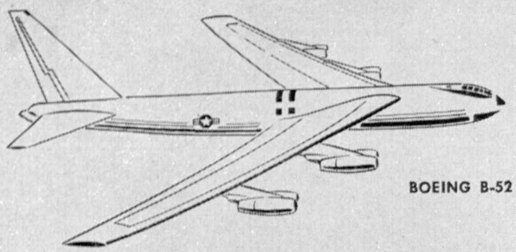
College is basically designed to provide one with knowledge; but, that is not all that can be gained. College offers a person an excellent opportunity to learn to work and live with other people. It also offers one the chance to engage in almost any type of activity imaginable, on a non-academic basis. This is possible because of the many clubs and societies which are active on campus. There is at least one student organization connected with every branch of engineering. These clubs make it much easier to get to know the other students in your branch of engineering; also, this is a good way to get to know your instructors in something other than a teaching role.

For those who desire to learn about something other than engineering, there is everything from the Acrobat Club to the Zoology Club. All of these clubs provide the opportunity for a person to meet different people and engage in a large variety of activities.

What, you may ask, is the sense of spending time on outside activities? The answer to that is simply this: the more the variety of experiences you have had, the better your chances for success in your chosen field. This has been proven many times when someone comes up with a new idea in his line of work. Frequently, the idea has originated somewhere not at all connected with the final use.

The variety of clubs on campus should provide at least one which would be interesting to each person; so, why not investigate the possibilities? It may not show any immediate gain for you, but even the chance to think about something different for a while may do much more good than one would have thought possible before trying it.

jrs



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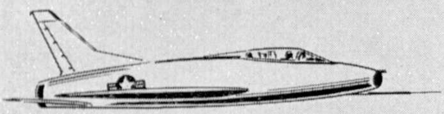

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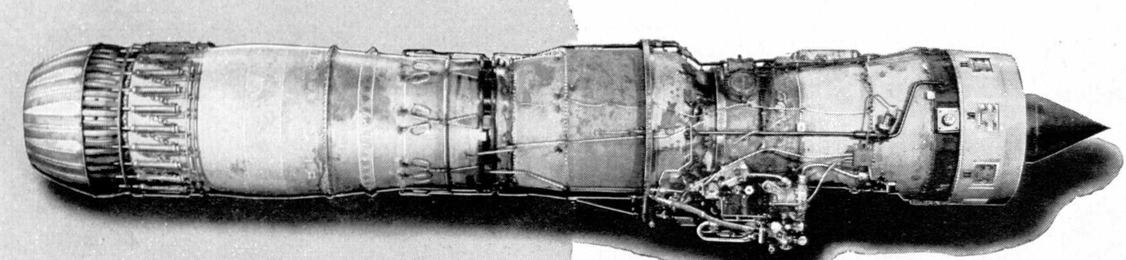

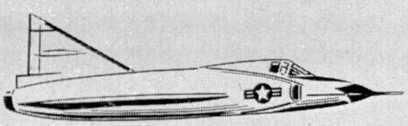

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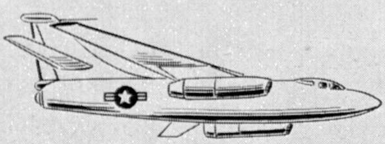

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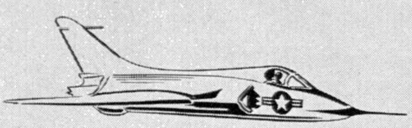

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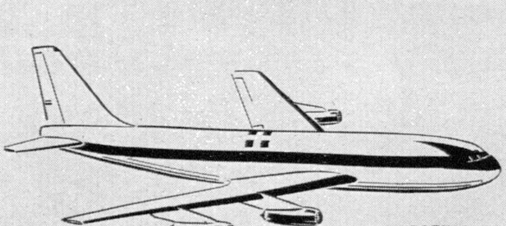

BOEING 707

A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from Donald C. Burnham, Vice-President
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Westinghouse Electric Corporation
Purdue University, 1936

To the young engineer with a creative mind

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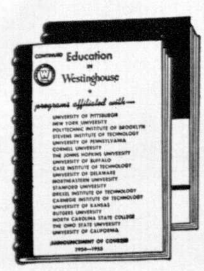

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Topology . . .

A LITTLE-KNOWN AND IMPORTARANCH OF MATHEMATICS

by John G. Hocking

A short article on topology poses a difficult problem. Although it is a quite recent development, topology is so extensive and enters into the body of mathematics in so many places that there is no brief definition of the subject. The author of an article such as this is placed in a delicate position, for he must try to inform the general reader and must not offend his fellow topologists too much. This time, however, I will not consider my fellow topologists at all, and they are hereby warned to read no further!

Several goals are in order in an article of this nature. First, a brief history of the subject should be included. Then, a general description or definition is desirable but this should not be so technical as to vitiate its purpose. And finally, a few interesting examples are a must. We shall see how well these goals are attained.

As far as history is concerned, I will be very brief. The word "topology" seems to have been coined in 1847, but the real beginnings of the study came with the work of Cantor, Poincare and others near the turn of the present century. Thus topology is only about sixty years old. Furthermore, the greatest advances have been made within the past thirty years. It is not surprising then that this basic study has only recently been added to our curriculum, and that it is still not well known even among mathematicians. You see, as is true for many other subjects, mathematics is much too extensive for one man to know; our life-span is simply too short. For a history of topology see the paper by Wilder. [6]*

Philosophers have defined mathematics as the study of number and form. This is almost equivalent to stating that mathematics is a combination of algebra and topology. In algebra, while we deal with an infinite collection of objects (numbers), we operate on them a few at a time by means of the rational operations of addition, multiplication, etc. On the other hand, in geometry we handle entire infinite collections (sets of points) at once. Insofar as it includes the abstract parts of geometry, this is precisely what topology does, too. The advantage of its abstract generality is an extremely wide application of topology but we shall see later just how this application is limited.

In order to visualize the chief tool of the topologist, his most important process, let us recall the calculus. The new fundamental idea found in the calculus is the introduction of the limiting process into mathematics. In a sense, then, Newton founded topology because the concept of a limit is the essence of topology. We see examples of limits everywhere in the calculus, of course, but in reality all of these examples deal with the basic notion of a sequence of real numbers converging to some real number. That is, we are only concerned with real numbers and their structure, their limit-point structure and their algebraic structure. A little reflection will show that the calculus consists of just these two basic types of operations, the rational operations of algebra and the limiting processes which have become a part of topology.

The algebraic properties of the real numbers have been abstracted and generalized to an enormous extent. And usefully, too! Nobody objects, for instance, to discarding the property of real numbers expressed by the identity $ab = ba$. We do it all the time when we discuss vector algebra. Similarly, we can discard *all* of the algebraic properties and retain only the limiting processes, (i.e.) only the structure which permits the limiting processes, if it is useful to do so. It has been found not just useful but vitally important to do so, and the resulting study is topology. To quote one of the greatest of living mathematicians, Solomon Lefschetz says [4] "algebra and topology form the poles of the mathematical world." So much for the position of topology in the study of mathematics.

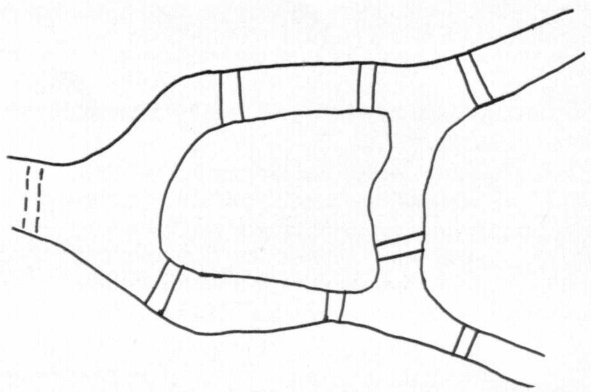


Figure 1

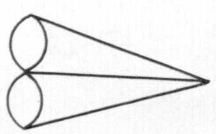


Figure 2

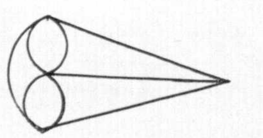
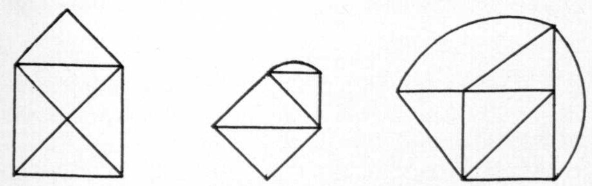


Figure 3

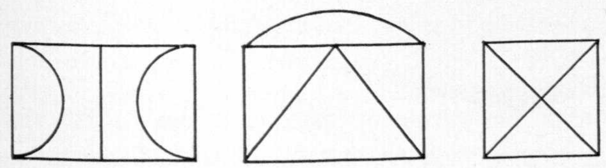
———

*Numbers in square bracket refer to articles listed in the references.

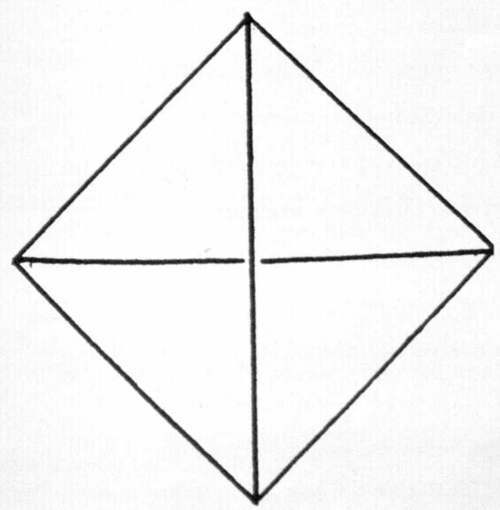
Let us next look at perhaps the first topological problem ever solved, the famous puzzle of the seven bridges of Koenigsberg. The city of Koenigsberg (in what once was Germany) is built at the confluence of two streams and centers on an island. Long ago there were seven bridges as indicated in the sketch map in Figure 1. (Now there are eight bridges, I understand, the eighth being dotted in.) Someone once posed the following problem: Start anywhere in the city and walk over each bridge just once!



can do



cannot do
Figure 4



The edges of a tetrahedron
Figure 5

This simple puzzle amused and frustrated people for years until the famous mathematician Leonhardt Euler heard about it. He noticed that the puzzle of the seven bridges is exactly equivalent to that of trying to draw Figure 2 without lifting the pencil from the paper (which would correspond to flying) and without re-tracing a line (which corresponds to re-crossing a bridge).

This makes it much easier to experiment (The actual walk would be quite long.) since we can now sit at a desk and draw pictures. Well, Euler "solved" the puzzle by showing that it was impossible to solve! (With the eight bridges now present, it is possible as we will see.) Euler's success with this problem led him to study other such configurations and whether they can be drawn with an "Euler line," (i.e.) without re-tracing or lifting the pencil. He was able to derive a general rule about all such puzzles. To describe his rule, we will call the point where the two or more arcs meet by the name "vertex." Now in a figure composed of arcs and vertices, such as Figure 2, count the number of arcs emanating from each vertex. If that number is even, call the vertex even; if that number is odd, call the vertex odd. Count the number of odd vertices. (It can be shown that there will always be an even number of odd vertices.) The criterion for the existence of an Euler line is simply this:

> *The given figure can be drawn with an Euler line if and only if there are no more than two odd vertices. Furthermore, if there are two odd vertices, the Euler line must start at one of them and will then automatically end at the other.*

The proof of this rule is a tricky little application of logic, and I will not deprive the reader of the pleasure of working it out for himself. Notice now that Figure 2 corresponding to the seven bridge problem has four odd vertices and so is not traceable by an Euler line. On the other hand, the figure corresponding to the eight bridges now present in Koenigsberg would look like Figure 3, which has just two odd vertices, hence is traceable. Try it. In Figure 4, there are several more examples to try.

All of these configurations are examples of the generic term "linear graph." These pictured above are planar but some linear graphs are three-dimensional. For instance, Figure 5 shows a linear graph which must be drawn in three dimensions. (Why?)

(Continued on page 22)

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Chemical Engineering
. . . Pathway to Progress

by Denton D. McGrady, Met. Engineering Dept.

The story of the history and philosophy of chemical engineering education parallels the story of industrial progress in the development of equipment and processes for the large-scale production of synthetic rubber, plastics material, paint, dyes, new fabrics, fertilizers, and gasoline, to mention only a few.

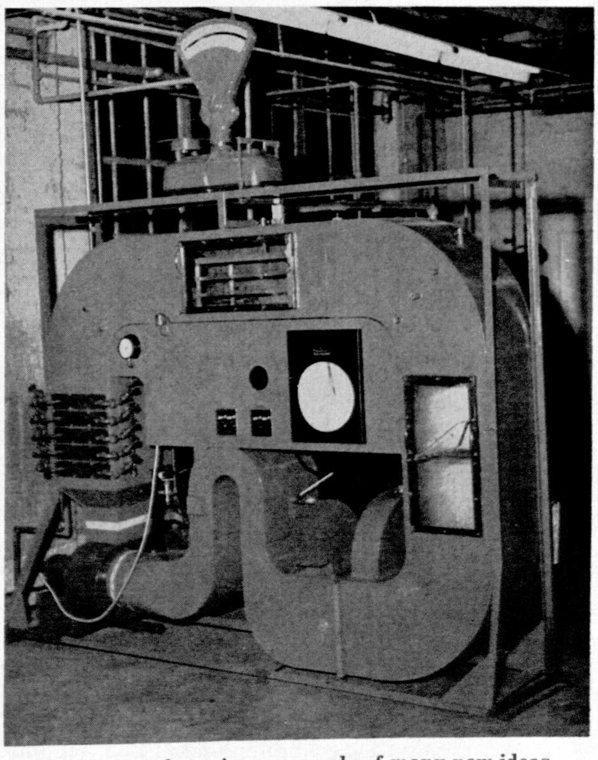
Dr. Donald G. Keyes, formerly head of the chemical engineering division of the University of Illinois and now representative for an industrial research and engineering organization, has stated that changes in the philosophy of chemical engineering education in the United States can be traced through four main periods of growth: (1) from 1885-1915; (2) between 1915 and 1925, when quantitative principles were stated; (3) from about 1925 to 1941, a span of years in which chemical engineering education made its most remarkable growth; (4) from 1945 to the present time.

HISTORY OF CHEMICAL ENGINEERING INSTRUCTION

The first curriculum in chemical engineering in this country was organized and established by the Massachusetts Institute of Technology in 1888. A few years later, in 1894, the University of Illinois created a separate department of applied chemistry, and Tulane University changed the name of its chemistry department to chemistry and chemical engineering. In 1898, the University of Michigan established a curriculum in chemical engineering. After 1900, several other colleges followed these examples. At this point of development, however, the courses in chemical engineering were largely descriptive. Although some interest was shown in equipment for chemical engineering, there was no approach from a quantitative design point of view.

During these early days of chemical engineering, comparable activities were starting in Europe. As early as 1887, lectures were given on chemical engineering at the Manchester Technical School in England. The first handbook of chemical engineering, published in England by George E. Davis in 1901, was largely descriptive in nature, although the desirability of a quantitative treatment of the subject was clearly indicated. E. Sorrel of France in 1893 published a book on distillation in which the quantitative approach was emphasized. In Germany, E. Hausbrand published a similar book the same year and followed it in 1895 with another book developing a quantitative treatment for chemical engineering.

During the early days of American industry, the chemical experts employed in the chemical industry were called industrial chemists, rather than chemical engineers. The training of these persons was in chemistry, and only a very few were in the engineering field. The design of equipment for the chemical industry was of interest largely to the graduate of the mechanical engineering curriculum. At that time the chief industrial problem was to find methods of adjusting a chemical reaction so that it would operate satisfactorily in equipment already designed and built by mechanical engineers.



This new dryer is an example of many new ideas developed by research in Chemical Engineering.

The industrial chemist, although he had an excellent knowledge of chemistry, had little or no training in the solution of large-scale problems of the chemical industry. He satisfied the educational world, but was found lacking in the industrial world. Fifty years ago the course of study in chemical engineering included both engineering and chemistry, with emphasis on the latter. At that time there was little recog-

(Continued on page 27)

The Engineering Society

by Jerry Linton, M.E. '56
President, Engineering Council

The Engineering Societies here at Michigan State are open for membership to all MSC engineers and provide many opportunities for the student engineer to broaden his education. Besides being of an educational and social nature, the society gives the student many chances to make numerous industrial contacts and to meet and work with other students having similar interests.

To further the education of the engineer, the various societies schedule lectures by prominent men in their field, which gives the student a perspective at applying the technical knowledge obtained in college. Field trips that are taken each year are of great value in supplementing college education and are probably most attractive to prospective members of an engineering society. They consist of conducted tours of industries and a look at new methods and processes in action. Never to be forgotten in the educational phase of the society is the technical magazine, which almost every society subscribes to. It is a necessity that engineers read many technical magazines in some part of the engineering profession, for it is in these magazines that new developments are first described in detail for other members in a particular phase of the profession.

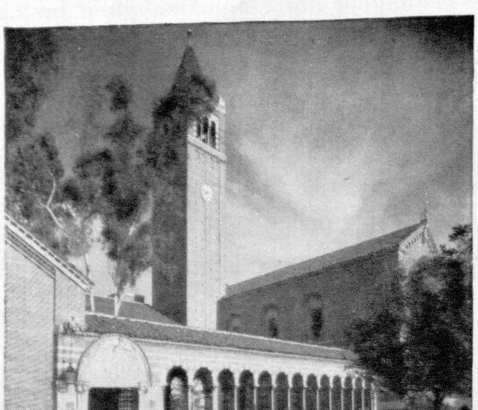
In the many functions and activities of the society the student is given several opportunities to make contacts with men from industry. The Engineering Exposition which is held on campus each spring is useful in providing industrial contacts as well as many other fine benefits for the students.

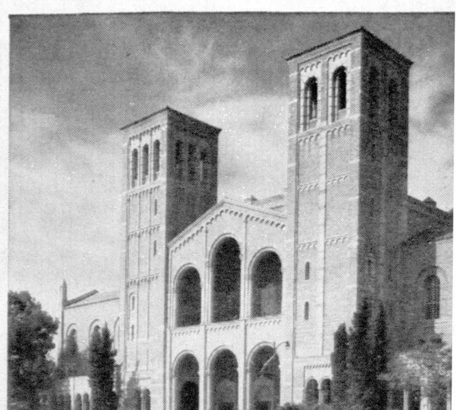
During the Exposition, each society is called upon to display and publicize new developments in their particular line of interest. Also, industry is well represented at the Exposition with interesting and informative exhibits.

Usually they have representatives who try to answer any questions pertaining to their firm or product. This is where the student engineer can make valuable industrial contacts that may lead to summer jobs, as well as jobs after graduation, and sometimes directly or indirectly help in deciding your future.

In meeting and working with other students having similar interests, the engineer can establish lifelong friendships. This can be educational in many respects, because when men get together and compare their experiences, a lot can be learned. Last but not least in the long list of advantages of engineering societies, the experience in working and getting along with all types of personalities is of great value to the student. Most engineers will have some form of a supervisory position in industry, and the things learned while working with a society in college can develop many leadership qualities.

If an engineering student at Michigan State College feels that he is wasting his leisure time and would like to become a better engineer, this author, on behalf of all the societies in the School of Engineering, extends an invitation to you, the engineers of MSC, to join a society of your choice.





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A Bright Future

Edited by Emory R. Geisz, Jrn. '56

Until 75 years ago there were only open-flame light sources – the torch, the candle, the oil lamp, the gas mantle. All of them played important parts in the cultural and social advance of man through the centuries.

It was not until 1879, when science produced electric light, that light was created without flame. Edison's invention of the first practical incandescent lamp, just three-quarters of a century ago, marked the beginning of the age of electric light, the beginning of convenience, safety, dependability, and comfort in lighting.

Let's take a look at the remarkable progress achieved in electric lighting.

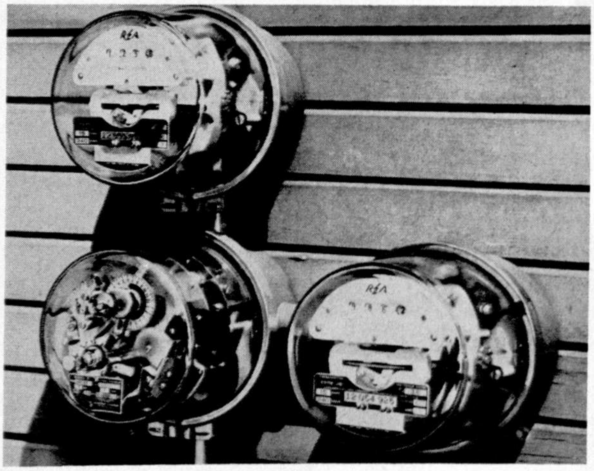
THE INCANDESCENT LAMP

The possibility of an illuminant using electricity had been demonstrated with crude, short-lived 'lamps' in laboratories before Edison's birth. But to Edison goes the credit for inventing the first commercially practical incandescent lamp. He made over 1200 experiments on lamps at his research laboratory in Menlo Park, N.J., beginning in 1877. After two years of work, he devised a lamp containing a carbonized cotton-thread filament in a glass bulb, and a relatively high vacuum.

The first lamp burned for 40 hours, during which Edison and his co-workers carried on what later was to be known as the 'death watch.' Certain they were on the trail of succes, they increased the voltage and deliberately burned it out. The lamp was of 110-watt size and had an efficiency of 1.4 lumens per watt of electricity consumed. Seventy-five years later saw the development of an electric lamp (fluorescent) of the same wattage with a rated life of 7500 hours (187 times as long) and a light output of 6800 lumens (44 times as efficient).

The incandescent lamp bulbs we use today in principle are like that which Edison invented in 1879. The greatest advances made in the 'art' of incandescent lighting since then are: substitution of tungsten in 1906 for Edison's carbon filament, and the introduction of the gas-filled bulb in 1913. Other developments which have helped provide low-cost, efficient, long-life, versatile bulbs we enjoy today include: double coiling of the filament wire, reducing the blackening of the bulb, improving the diffusion of the light, removing the tip from the bulb, varying sizes from one-fifth watt to 75,000 watts, construction of lamps with internal reflectors, modern volume production methods, and others.

Today, thousands of sizes and types of incandescent lamps are marketed, many tailor-made for specific lighting jobs. In 1954, an estimated one and one-half billion incandescent lamps were the industry's total production in the United States. These include both large and miniature sizes. About 50 per cent of all incandescent lamps are purchased for residential use. Of the others, 15 per cent goes into commercial uses, 15 per cent into industrial applications, and the remaining 20 per cent goes into institutions, transportation facilities, and the like.



ELECTRIC METERS . . .
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Fundamentally, an incandescent lamp is a simple thing – just a wire sealed in a glass bulb, with a few supplementary parts. The power required to force electric current through the filament wire heats it to incandescence, and light is produced. However, to design and produce millions of efficient, uniform, precise electrical devices which are today's light bulbs, requires the most detailed knowledge and application of metallurgical, chemical, electrical, and mechanical sciences.

A coiled-coil filament for a 60-watt household lamp starts as a tungsten wire 0.0019 inch in diameter and 21 inches long. After the first coiling the length is reduced to 3.4 inches. The coil, now comprising about 1200 turns, is again coiled, leaving the finished filament only five-eighths of an inch long. Double coiling of the wire causes a higher concentration of heat, and increases the efficiency of the lamp by about 10 per cent. The mandrel on which some fila-

(Continued on page 36)

★

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NEW DEVELOPMENTS

Solar-Powered Transmitter

A solar-powered experimental radio transmitter, the size of a package of cigarettes, was announced by General Electric.

The transmitter is self-contained. It uses transistors instead of electron tubes, and selenium solar energy converters instead of batteries. When light rays strike the selenium, sufficient electrical energy is delivered to the transistors to operate the transmitter. The transistors are used in the transmitter's oscillator circuit because they operate on comparatively small amounts of power and require much less space than tubes.

The transmitter currently has a short range, about 100 feet, which could be improved, by increasing the number of selenium solar energy converters or using silicon or germanium instead of selenium. A home or car radio is used to receive messages broadcast by the transmitter.

Developments in the light sensitive elements over the next decade may make practical small personal radio transmitters and receivers powered by solar energy.

Radar "Eyes" Guide Guns

A remote controlled tail turret system, capable of knocking down enemy interceptors in the night or fog, will protect the Air Force's Boeing B-47E Stratojet bomber.

The turret gives the six-jet bomber a heavyweight punch to the rear and, guided by its radar "eyes," it can track and shoot down unseen targets. It is especially adapted for high speed jet airplane operation. The gun-firing system has been designed so that radar and the "Electric Brain" will do most of the work.

Engineers explained how the gun-firing system works:

In danger areas, the radar is switched to "search." With this done, the radar maintains a watch to the rear. When the radar picks up an attacking plane, a "pip" shows up on the radar screen.

Once the target is centered in the crosshairs, it is tracked automatically. This tracking action supplies the computer with the information it needs, and when the attacking plane gets into range the gun is fired. The system consists essentially of a tail turret mounting two guns, a computer ("electric brain"), control equipment and search-track radar.

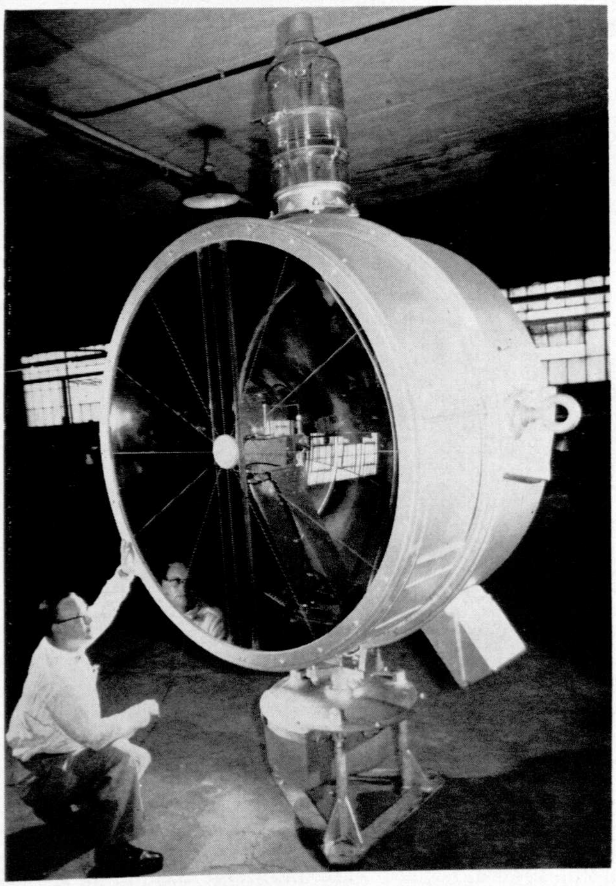
Fisher Body Craftsman's Guild records reveal that 131 university scholarships, with a total value of $420,000 have been awarded youthful automobile model builders since the Guild's inception in 1930. In addition to the scholarships, more than half a million dollars has been awarded to state and regional winners.

Searchlight — 2500 Watt Lamp

One of the world's largest and brightest searchlights, capable of throwing its beam approximately 120 miles, has been shipped to Dallas, Texas, by the Westinghouse Electric Corporation's lighting division plant at Cleveland, Ohio.

The huge light, containing a 2500-watt short-arc mercury-vapor discharge lamp, will develop 275,000,000 candlepower. It has a reflector five feet in diameter, stands more than 11 feet high, and weighs 1200 pounds.

The unit will be installed as an attention-drawing beacon atop the new 150-foot-high ornamental tower of the Republic National Bank Building in Dallas. When in place, the searchlight will be 598 feet above the street level. It was ordered by the Federal Sign Co. of Texas.



This huge searchlight has a reflector five feet in diameter, and is capable of developing 275,000,000 candlepower.

Originally a carbon arc light used as an antiaircraft searchlight during World War II, the light was modified by the addition of a mercury lamp and a rotating base constructed of aircraft steel and alumnium capable of withstanding 100-mile-an-hour gales. A small, one-sixth horsepower motor will drive the light as it revolves at a rate of 12 revolutions per minute from dusk to dawn.

(Continued on page 19)

(Continued from page 17)

Power Pack for Drill Rigs

The oil industry's first "standard package" electric-power drilling rig was announced recently at the American Petroleum Institute's annual convention.

Introduced after two years of development, the diesel-electric plant is designed as an integral package furnishing all power requirements for offshore or land drilling.

The new "standard package" power plant is priced to sell at about the cost of a conventional power rig while the relatively few diesel-electric power plants now used for oil drilling have been custom designed, and have been comparatively high in price.

Major oil and drilling companies have expressed keen interest in the new power plant and are particularly attracted by the fact that it can easily replace a steam rig at a competitive cost.

The package plant consists of eight skid mounted components with the power generated by two disesl-generator sets, each consisting of a diesel engine, two main generators and an auxiliary generator for extra power needs. Two motors, mounted on one skid, drive the drawworks, which raises and lowers the drilling bit and drill pipe. Two pump motors circulate the drilling mud. A main control cabinet mounted in front of the two diesel-generator sets distributes the power as required. A driller's control cabinet and control stand complete the package.

The flexibility of the package permits the driller to run the drawworks, pumps, rotary table or other drilling apparatus singly or in combination. The standard package is so designed that a third diesel generator set for extra power, or other modifications, can be made through simple additions to the control panel. No matter what modifications are made, the control system is so simple that a driller can operate the rig with push-button ease.

Aircraft Periscope

"Down periscope" is usually associated with submarines but to the crew of the *flying laboratory* it means that the flight engineer wants to see how the engine being tested is operating in flight. The flying laboratory is a four-jet North American B-45 bomber which is used for flight testing new model turbojet engines.

In order to observe the test engine in operation, which is extended from the bomb bay in a specially-designed nacelle, the engine operator must use a periscope, as the engine is located below and behind his observation post located in the nose of the plane. This position is normally occupied by a navigator-bombardier.

On each flight this engine undergoes a variety of tests which the engine operator must observe.

As a first step during normal testing, the flying lab may climb with the engine at full throttle. Such a test phase shows whether or not the engine will hold its designed power up to altitude. A second test phase may be to decelerate and then immediately accelerate with the engine's afterburner cut in, both being done at altitude to see if the engine will perform within design specifications.

Deceleration and acceleration tests are then carried on at different altitudes and as a final phase the plane may descend with engine idling in order to check engine idle speeds. The engine operator observes visual performance through the periscope.

A visual check, however, does not complete his test function, as the engine operator, surrounded by test equipment including a direct-writing oscillograph, a tape recorder and a vibration meter, must obtain other specific engine performance data. Probably the most valuable instrument in recording this data is the direct-writing oscillograph. This device has six pens which plot six graphs simultaneously, thereby providing such engine performance characteristics as speed, engine temperature, fuel flow and air pressure.

A tape recorder is employed to document unusual happenings that take place during the test flight which the operator would normally not have time to record. Another valuable test equipment item, the vibration meter, safeguards engine operation by indicating excess engine vibration.

Additional data which might be useful for future research purposes is recorded in the compartment aft of the bomb bay through the use of a series of cameras called photo-panels. These photo-panels can take motion pictures of over 100 instruments and can be operated by remote control during flight.

Voodoo Fighter

The F-101A Voodoo is believed to be the world's most powerful fighter airplane. The Voodoo was developed by the U. S. Air Force in conjunction with McDonnell Aircraft Corporation.

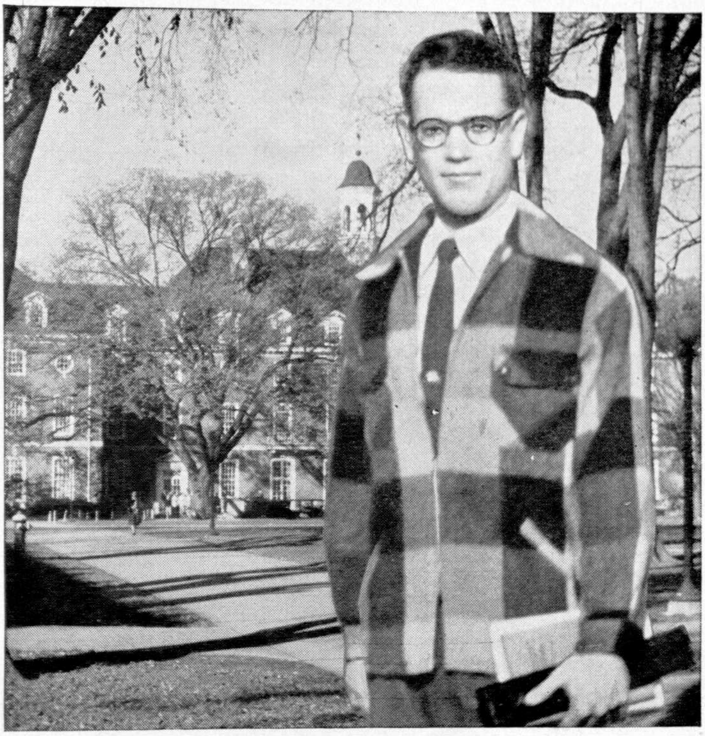
Designed to meet Air Force requirements for a long-range fighter, the F-101A will be assigned to the Strategic Air Command. It is in the supersonic class and it is also capable of carrying atomic weapons. It is also capable of inflight refueling.

Aircraft dimensions of the F-101A are 39.7 foot wing span, 67.4 foot length and 18 foot height. Both wings and stabilizer are swept back 35 degrees. The wing skin consists of heavy, tapered, pre-formed sections. The Voodoo employs a tricycle landing gear and retractable speed brakes housed in the aft fuselage section.

The aircraft is equipped with a parabrake – a parachute stored in the tail section compartment which may be released by the pilot to reduce the landing roll. Two Pratt and Whitney J-57 turbojet engines which power the Voodoo develop a total of approximately 20,000 pounds of thrust. Most of the unusually large fuel load carried by the F-101A is contained in the fuselage with additional provisions made for carrying extra fuel externally.

Bill Zartman wants to know:

What effect would an advanced degree have on my opportunities for advancement at Du Pont?



William N. Zartman is studying for a B.S. in Chemical Engineering at the University of Illinois. Last summer he worked in the Technical Laboratory at Du Pont's Chambers Works to gain industrial experience. He has not yet selected a permanent employer, however; and right now he's asking the kind of questions which will help him select the right job and plan a successful career.

Dr. Sheldon Isakoff received his Ph.D. degree in Chemical Engineering from Columbia University in 1952, doing his graduate research work on the problem of heat transfer in liquid metals. Since graduation he's been engaged in fundamental research work at the Du Pont Experimental Station, Wilmington, Delaware. Dr. Isakoff is now a Research Project Engineer in the Engineering Research Laboratory.

Sheldon Isakoff answers:

An advanced degree would undoubtedly have a *favorable* effect in technical work, Bill, but let me enlarge on that just a little. In my own field—chemical engineering—a doctorate is considered to be evidence of demonstrated ability in carrying out original research. An advanced technical degree is therefore helpful in obtaining work in research and development, where that skill is definitely important. You might say it gives a man a head start in proving his ability in those areas.

It's less important in some other areas, though. For example, in production or sales work a manifest ability for handling human relationships is just as important for advancement as technical competence. If an engineer is sold on production work or sales, a graduate degree in marketing or business administration might be more helpful to him than advanced technical training—in getting started.

But I've noticed this at Du Pont. Once a man lands a job in his chosen field and actually begins to work, his subsequent advancement depends more on demonstrated ability than on college degrees. That's true throughout the entire company—in scientific work, administration, or what not.

So an advanced degree is not a royal road to anything at Du Pont, Bill. But when coupled with proved abilities, an advanced technical degree is unquestionably helpful to a man in research and development work. It often gives him a chance to demonstrate his abilities more rapidly.

Are you interested in research work?

About 2000 Du Pont scientists are currently engaged in research, aided by some 3500 other employees. Laboratory facilities of the highest quality are available at the Du Pont Experimental Station near Wilmington, and elsewhere throughout the country. Full information about research work at Du Pont is given in "The Story of Research." Write for your copy of this free 28-page booklet 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

Topology

(Continued from page 9)

The one-dimensional figures shown so far are very elementary and might mislead the reader into thinking that the subject of linear graphs is trivial. This is emphatically not true! But before mentioning a difficult problem, let me point out that an electric circuit is a sort of linear graph and that both Kirchoff and Maxwell developed and applied some graph theory to electric circuits. For instance, electrical engineers are frequently interested in the number of independent simple closed loops in a circuit. The formula for this is very simple. If there are "k" arcs and "q" vertices in a linear graph, then the number K of simple closed loops (also called the *connectivity* of the linear graph) is given by the equation $K = k - q + 1$. Try it!

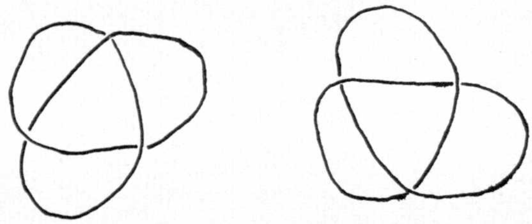
To give an extremely difficult problem, let us consider a knot. For our purposes a knot is formed by cutting a circle, tying a knot and then joining the cut ends together again. As a linear graph (just insert two vertices anywhere on the knot) such a figure is very simple. For example, the connectivity K mentioned above is equal to one. But many complicated problems arise with regard to knots. One such is this: Under what circumstances may one knot be deformed by twisting, etc., into another? Or, as the topologist puts it, when are two knots equivalent? The two knots in Figure 6 are *not* equivalent and when two such similar objects fail to be equivalent, just think of the difficulty involved in analyzing a really complicated knot such as a knitted sweater!

I mention knot theory to show that even the one-dimensional configurations can offer some difficult topological problems. As we might expect, the degree of difficulty increases tremendously with higher dimensions. Boldly, however, we plunge into higher dimensions and take a look at some two-dimensional surfaces. Some of these are quite impossible to even visualize. We noticed that there were one-dimensional figures which simply had to be drawn in three dimensions. Similarly, there are two-dimensional figures which may only be constructed in *five* dimensional space (whatever that is). In general, it can be shown that there exist n - dimensional figures which take $2n + 1$— dimensional space (and that none require $2n + 2$ dimensions) for construction.

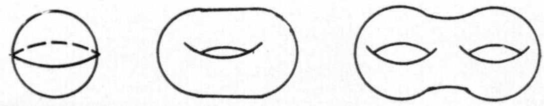
We will limit ourselves to simple surfaces, primarily those which are closed, (i.e.) which have no boundary edges.

There are two distinct types of closed surfaces, the orientable and the non-orientable surfaces. Here "orientable" means that you can tell one side of the surface from the other. Mathematically speaking, orientable means that you can decide upon a positive direction of the normal vector to the surface. The only closed orientable surfaces are easily classified by the number of holes through them. See Figure 7. If we cut out some holes in these surfaces, we can obtain a wide variety of surfaces. Let me point out however, that the sphere can be deformed into a cube, a tetrahedron or a lumpy twisted surface (without holes) and still be a sphere to the topologist. That is, to me, each row of figures in Figure 7 represent the same thing.

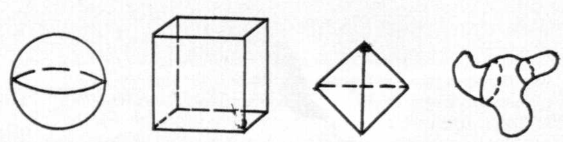
The non-orientable closed surfaces are also completely classified but the process is more difficult. Such a surface can only be constructed in four dimensions so we cannot really visualize them very well. Two simple examples may help to see the difficulties. The simplest non-orientable surface is the Moebius strip, a surface which is constructed by giving a strip of paper a half twist and gluing the ends together. The result is a non-closed surface which looks like Figure 9.



Right-hand and left-hand trefoil knots
Figure 6



Sphere Genus 0 **Torus Genus 1** **Genus 2**
Figure 7



four spheres

three torii
Figure 8

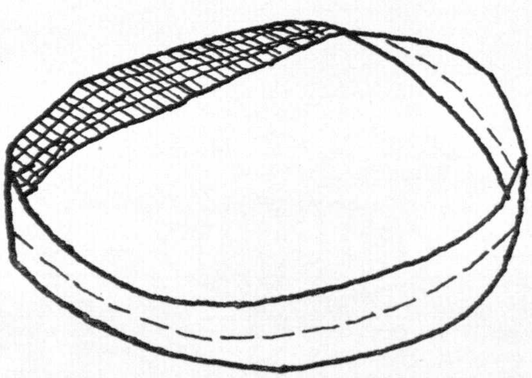


Figure 9

It is easily seen that the Moebius strip has but one edge and one side! For instance, try coloring the thing or, more simply, trace out the center line and watch it duplicate itself! Peculiar things happen when you cut this strip longitudinally. What do you think will happen if you cut it along its center line? Along a line one-third of the width in from the edge? The thing is fun to play with and provides a severe test for your space visualization.

Another non-orientable surface is the Klein bottle, which is constructed in theory by joining two Moebius strips along their edges. This construction is impossible in three dimensional space, unfortunately, but we can build a surface like it by cutting a hole (which makes the resulting surface non-closed). See Figure 10. It would be amusing to build a pitcher in this form. By examining Figure 11, you can see that the pitcher would not pour in the standard way but would pour if tilted backwards. If someone tries it, please build one for me, too!

Before leaving two-dimensional surfaces, I want to mention a very famous problem. Cartographers noticed that in coloring their maps they never required more than four colors in order to distinguish between countries. That is, using only four different colors, any map can be colored so that contiguous countries are in different colors. This led to the question of *proving* this seeming fact, the widely-known four color problem. It can be stated as: Show that any decomposition of a sphere into "countries" can be colored with no more than four colors in such a way that no pair of contiguous countries receive the same color. (By "contiguous" here, we mean that countries meet along a line. If they meet only in one point, no confusion would result in their having the same color.) Although a great amount of work has been done on this simple-sounding problem, it has not been completely solved. It is known that no more than five colors are ever required [2], and that only four are required in many special cases, but the general problem seems to be destined to stump us for quite a time yet. I do not recommend this one as a problem for the novice!

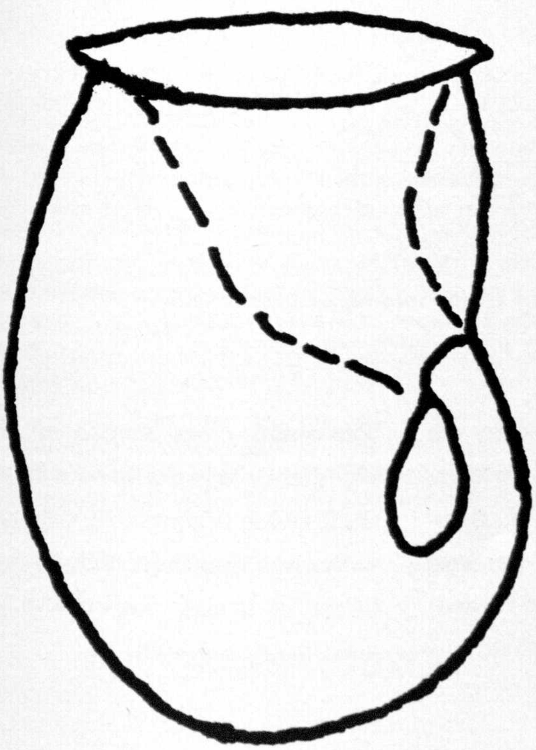
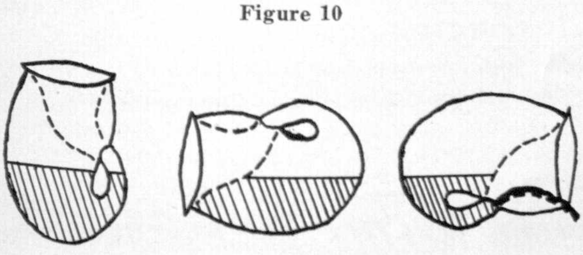


Figure 10



no pour **pour**

Figure 11

Another class of results deserve mention here, the so-called fixed-point theorems. The basic fixed-point theorem is due to the Dutch mathematician, L. E. J. Brouwer. In technical language, this theorem states that for any continuous transformation of an n - dimensional cube (n being an integer) into itself, there is at least one point which is not moved by the transformation. This can be described intuitively as follows:

Suppose we have a cube of foam rubber fitted into a cubical box. Pick out the rubber cube, squeeze it, bend it, fold it (but never tear it!) and put it back into the box. The theorem says that at least one point is back exactly where it started. An elegant proof of this may be found in [2]. This result is typical of topology. It states that something remains unchanged by the most radical twisting, bending, stretching and folding.

To see how the Brouwer fixed-point theorem and related results can be applied, let me quote several true statements which follow from these. First, at any moment there must be at least one spot on earth where the wind is not blowing. The mathematical theorem is: A continuous tangent vector field on a sphere must contain at least one zero vector. Another application is this: Combing a fur-covered billiard ball must leave a cow-lick. (Don't ask me why one would want to comb a fur-covered billiard ball or even where to obtain such a ball!) A related result yields the following: At any instant there is at least one pair of antipodal (diametrically opposite) points on the surface of the earth where the temperature and barometric pressure are exactly the same, another useless bit of meteorological information, I fear.

An engineer might, however, be interested in the application of fixed-point theory to the question of the existence of solutions to a particular problem. Let me digress a moment to show why this is important. In any application of mathematics certain simplifying assumptions must be made before the physical problem can be formulated in solvable mathematical form. For example, if the problem is the determination of the current function in a proposed circuit, we will

(Continued on page 32)

CLUBS AND SOCIETIES

ASME

The Student Branch of ASME is open for membership to any undergraduate or graduate student registered in a regular course of study leading to a degree in engineering.

For forty-six years the basic aim of the Student Branch of ASME has been to acquaint the student with the practical side of engineering before he graduates. Every activity of the MSC Chapter is planned with that in mind.

The program for the coming year includes at least one technical meeting per month with professional and student speakers, student papers and films. Also on the schedule are field trips, joint meetings with other student engineering societies and with the Senior Branch of ASME and social events. Participation in Engineering School and college activities and the Annual Regional Student Conference of ASME rounds out the list of ways that membership in Student ASME will benefit the engineering student.

ASCE

A.S.C.E. is open to all civil engineers, sophomores and up. Freshmen can be visiting members only. They try to hold 5 or 6 meetings a term, usually on Tuesday evenings in the Union Building. The meetings consist of general business, different speakers, and sometimes movies.

A.S.C.E. chapter sponsors have a joint banquet with the professional A.S.C.E. This banquet is held fall term.

This school year they are the host chapter for the North Central Conference which is comprised of 13 universities and colleges from Ohio and Michigan. This conference is to be held March 30, 31, and April 1, 1955.

ENGINEERING COUNCIL

During recent meetings of the Engineering Council, plans for the 1955 Engineering Exposition have been discussed. The Exposition is to be held Thursday, Friday and Saturday, May 12-14, and being in coordination with MSC's Centennial Anniversary, promises to be the largest exposition to date.

Tentative plans have also been made to hold the all-college "Holiday Ball" on the last night of the Exposition, Saturday, May 14. At the dance, the Queen of the School of Engineering, chosen from nominations by the women's housing units, will be crowned and reign over all future activities of the engineering school.

Officers of the Engineering Council, left to right: Gordon Mellencamp, treasurer; Earl Terpstra, secretary; Jerry Linton, president; Richard Herrick, vice-president.

ASAE

The Michigan State College branch of A.S.A.E. holds bi-monthly meetings during the school term. Speakers from the college and industry are frequently included in the program. Movies are sometimes shown and refreshments served occasionally. The length of the meetings are held at a minimum, as the students have several other obligations. The standing committees meet as necessary between meetings. It is the policy of the Club to send the minutes of the previous meeting to all Agricultural Enginering students to stimulate interest in the Club.

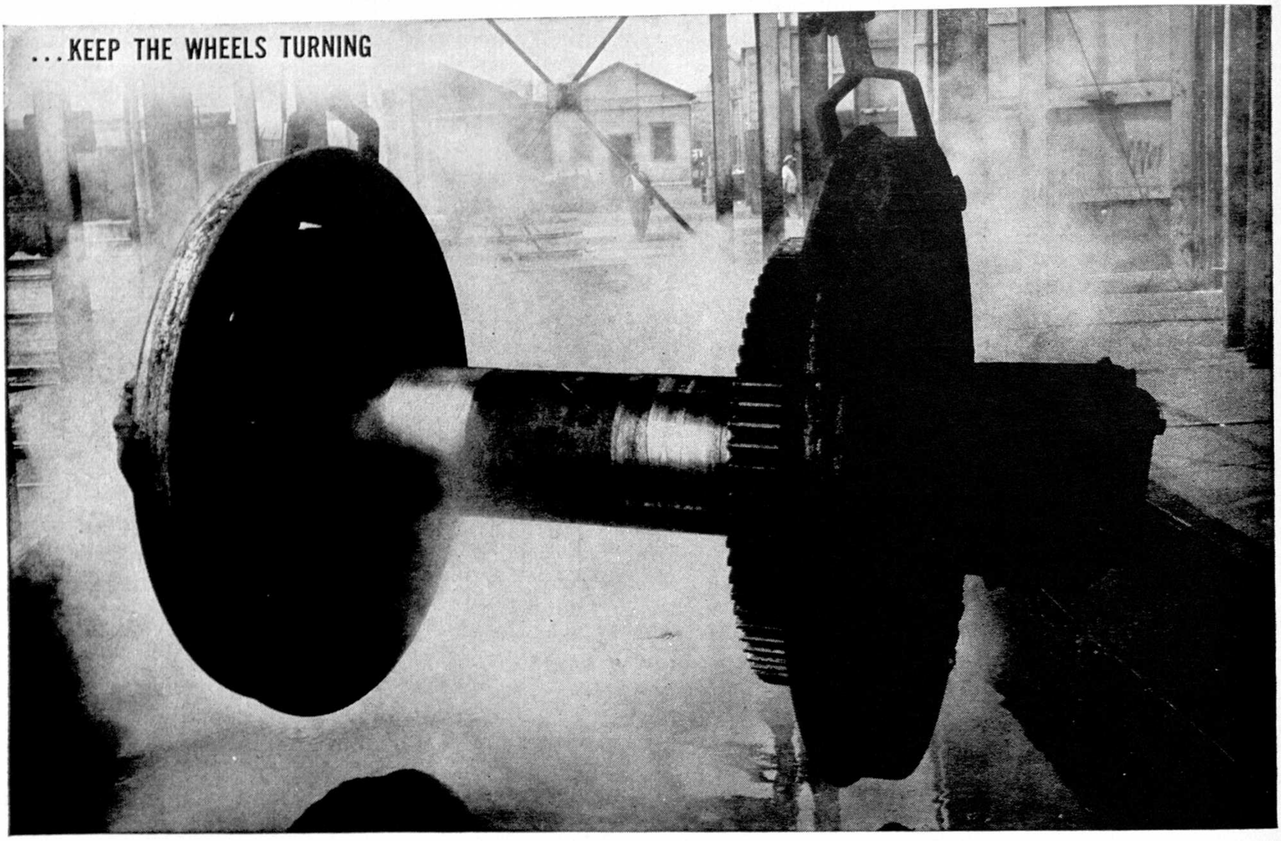
Specific Activities

On October 16, 1954, four of the student club members went to St. Johns, Michigan, to judge a 4-H and F.F.A. Tractor Driving Contest. At this time the students also gave a tractor safety demonstration, using several small model tractors. This demonstration has been taken over by the members as a club project and has since been presented to several high school and adult groups.

Farmers' Week is sponsored annually by the School of Agriculture. The A.S.A.E. furnished guides for those wishing to visit the Agricultural Engineering Building. The men having exhibits in the building used our Club Room as a lounge and lunchroom.

Every year the Engineering Council, composed of three members from each engineering society, presents the Engineering Exposition. Our Club sponsored a television show over the college TV station, announcing events and exhibits of the Exposition. Club members contacted several companies and arranged for industrial exhibits for the Exposition. The students set up exhibits such as model farms, tillage methods, live irrigation demonstrations, heat control circuit for milkhouses, etc. The Club also operated a trolley service which furnished spectators transportation between the various buildings where exhibits were being held.

The Agricultural Engineers proposed a micro-midget auto race between the engineering societies. Students designed, constructed, and finally raced their micro-midgets as one of the main attractions of the opening day program at the Exposition.



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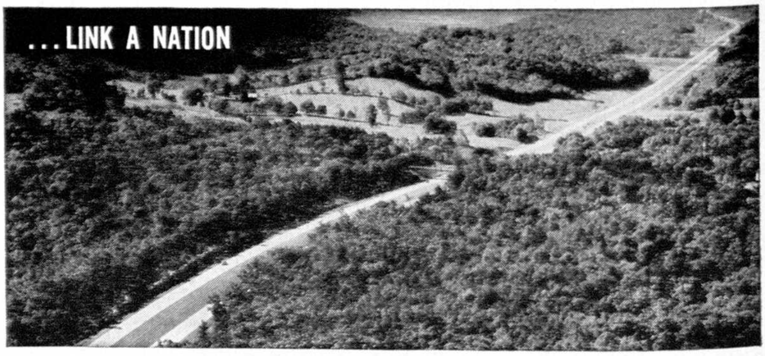
VERSATILE RAW MATERIAL—The linters left on cotton seed are made into chemical cotton (bleached cotton linters) by Hercules' Virginia Cellulose Department. In high-grade paper, chemical cotton replaces rags, eliminates costly rag sorting. And chemical cotton is the best source of cellulose, key to products ranging from lacquers to plastics.



IMPOSSIBLE WITHOUT EXPLOSIVES—Modern highway construction, such as the $555-million, 427-mile New York State Thruway, would be impossible without explosives. Whether it means cutting through a mountain, spanning a gorge, or even moving a river—the modern highway can go straight and level, thanks to the controlled energy supplied by Hercules® explosives.

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Chemical Engineering

(Continued from page 11)

nition that chemical engineering was not a mixture of the two fields, but a distinct branch of engineering. In fact, this attitude undoubtedly did much to hinder the growth of chemical engineering education in the early 1900's.

Moreover, it should be remembered that in these early days before World War I, there was little or no synthetic organic chemical industry in the United States. Rather, it was in Germany that major strides were being made in the creation and development of new organic compounds. The industrial work in the United States during that period was largely confined to heavy chemicals using large-scale production and well-known and established chemical processes. New processes, and often new equipment of the larger type, were usually developed in Europe and brought to the United States where experienced engineers might make improvements.

Thus it was that very gradually there evolved a group of "practical" engineers who had obtained their training through experience. These men developed their own knowledge and methods because the quantitative principles of chemical engineering were not then taught in the colleges. The knowledge acquired by these practical engineers was valuable, but because it was considered to be unpatentable, it was kept secret for the most part. This philosophy also retarded and hindered the advancement of chemical engineering education during that period.

In Germany, during this period previous to World War I, a similar attitude prevailed in that the industrial chemists, who had done a most excellent job in applying their knowledge to the small-scale synthetsis of costly organic compounds, rose in the industry. There was a tendency to belittle the engineering features of these relatively small units and to place major emphasis on developing new processes and products.

Following World War I, the requirements of American production methods necessitated a reversal of this attitude, because for economic reasons it was desirable to use continuous processes in large units with low labor costs. Thus it was the American chemical engineer who came forward with new and novel ideas in procedures and materials that made possible and practical the large-scale syntheses which ultimately reduced the cost of the final products for universal use.

MODERN CHEMICAL ENGINEERING EDUCATION IN THE UNITED STATES

The development of modern chemical engineering education starts with the year 1915. The American Institute of Chemical Engineers was organized in 1908, but it was not until a report by Arthur D. Little and William H. Walker in 1915, that the concept of the basic unit operation of chemical engineering was clearly described. In 1922, the American Institute of Chemical Engineers developed its first official definition of chemical engineering, as follows:

Chemical Engineering, as distinguished from the aggregate number of subjects comprised in courses of that name, is not a composite of chemistry and mechanical and civil engineering, but itself a branch of engineering, the basis of which is those unit operations which in their proper sequence and coordination constitute a chemical process as conducted on the industrial scale.

During the year 1916, Warren K. Lewis of the Massachusetts Institute of Technology gave four lectures or papers on unit operations at the annual meeting of the American Chemical Society. By 1923, there had appeared the first great treatise on the principles of chemical engineering authored by three members of the M.I.T. faculty, William H. Walker, W. K. Lewis, and W. H. McAdams. This was the start of a series of text and reference books based on the unit operations of chemical engineering.

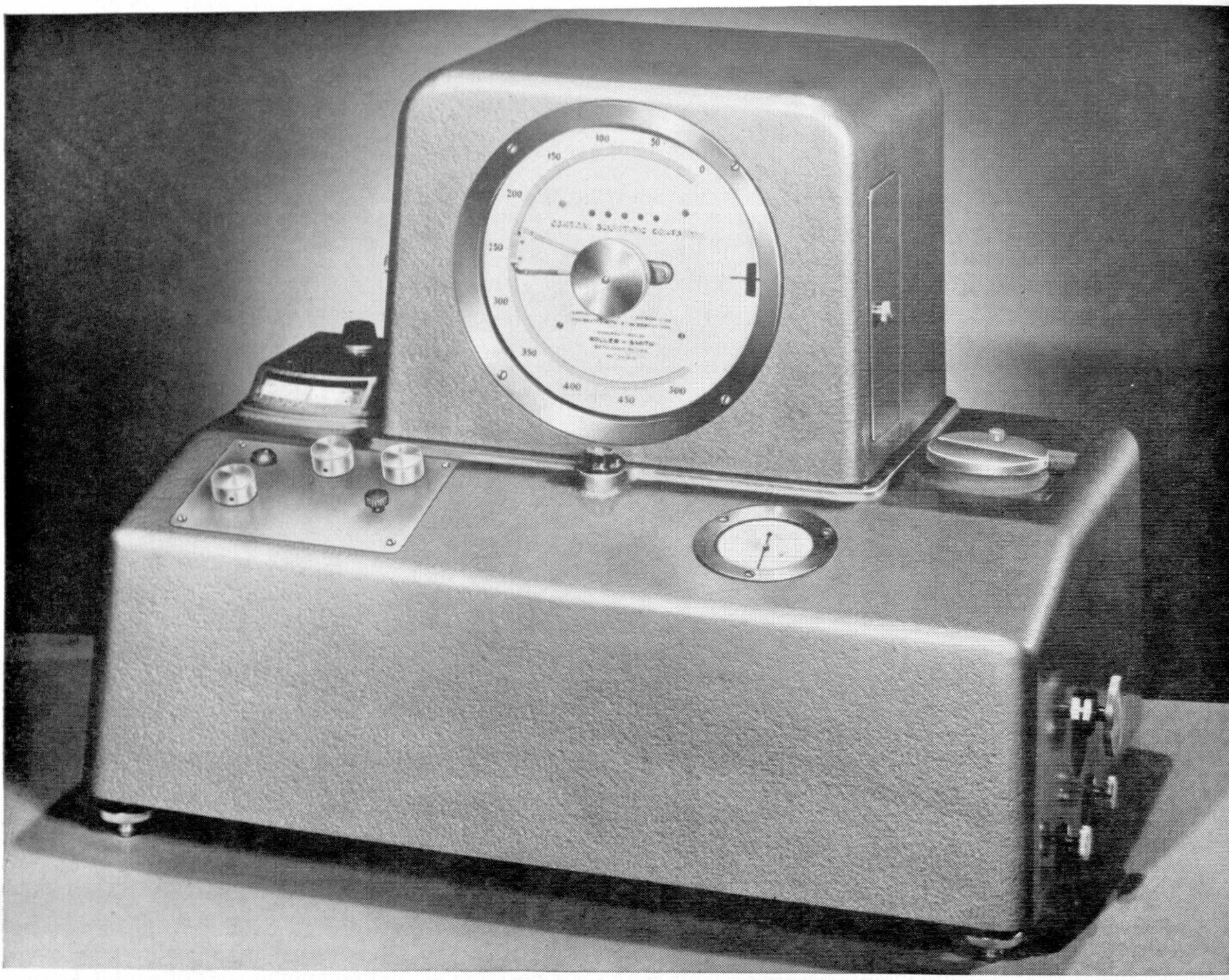
By 1925, because of intense interest in this field, the American Institute of Chemical Engineers had established an accrediting committee to study chemical engineering education and establish requirements. Fourteen schools were accredited in 1925 and the number has increased to some seventy-nine schools at the end of 1954.

In 1931, W. L. Badger and W. L. McCabe, of the University of Michigan, published their book, *Elements of Chemical Engineering.* Basic chemical engineering became an important subject for study and experimentation in large industrial research laboratories. This development created much additional interest in the curriculum, and more and more young men trained in unit operations were added to the university staffs to handle the increased teaching and research loads. This development greatly improved the teaching of chemical engineering from a quantitative standpoint. Industrial progress soon reflected the value of this training as pilot plant design became more scientific.

The present day definition of chemical engineering as embodied in the constitution of the American Institute of Chemical Engineers, states:

Chemical Engineering is the application of the principles of physical sciences together with the principles of economics and human relations to fields that pertain directly to processes and process equipment in which matter is treated to effect a change in state, energy content, or composition.

Chemical engineering often involves a study of the control of physical processes and chemical reactions on a large scale so that a high yield is secured at reasonable cost. Although it is evident that basic knowledge of chemistry and physics together with mathematics and general application of science to the chemical industry is the chief goal of a four-year curriculum, it should also be recognized that chemical engineering is closely associated with industrial economics. Indeed, chemical engineering is vitally concerned with material, energy, and economic balances.



THE PERCENTAGE of hydrogen in liquid hydrocarbons can be determined by making two simultaneous measurements on the sample to give (1) density and (2) the absorption rate for beta rays. The weight percentage of hydrogen in the sample is computed from these measurements and a calibration curve. The new instrument shown here, a Standard Oil development, measures the beta ray absorption rate.

BETA RAY

used to speed hydrogen measurement

The problem: How to measure the percentage of hydrogen in organic compounds in a short time.

The established process was combustion. It took about four hours, and so discouraged the use of hydrogen determinations. But such analyses are increasingly important. Processes in the petroleum and chemical industries often involve hydrogenation or dehydrogenation. In addition, the percentage of hydrogen is an index to the performance of critical fuels such as those used in jet planes.

A rapid method for measuring hydrogen content would therefore be a great help in both research work and plant control. Standard Oil's Engineering Research Department, specialists in solving technical problems, took on this challenging assignment.

A new machine—a beta ray hydrogen analyzer—was invented and constructed. It gives results in five minutes, and is twice as accurate as the old combustion method. It is so easy to operate that a laboratory technician can use it.

Problems such as this are met continually in Standard Oil laboratories. They offer an opportunity for young men with training in chemistry and engineering to test their knowledge, skill and ingenuity.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

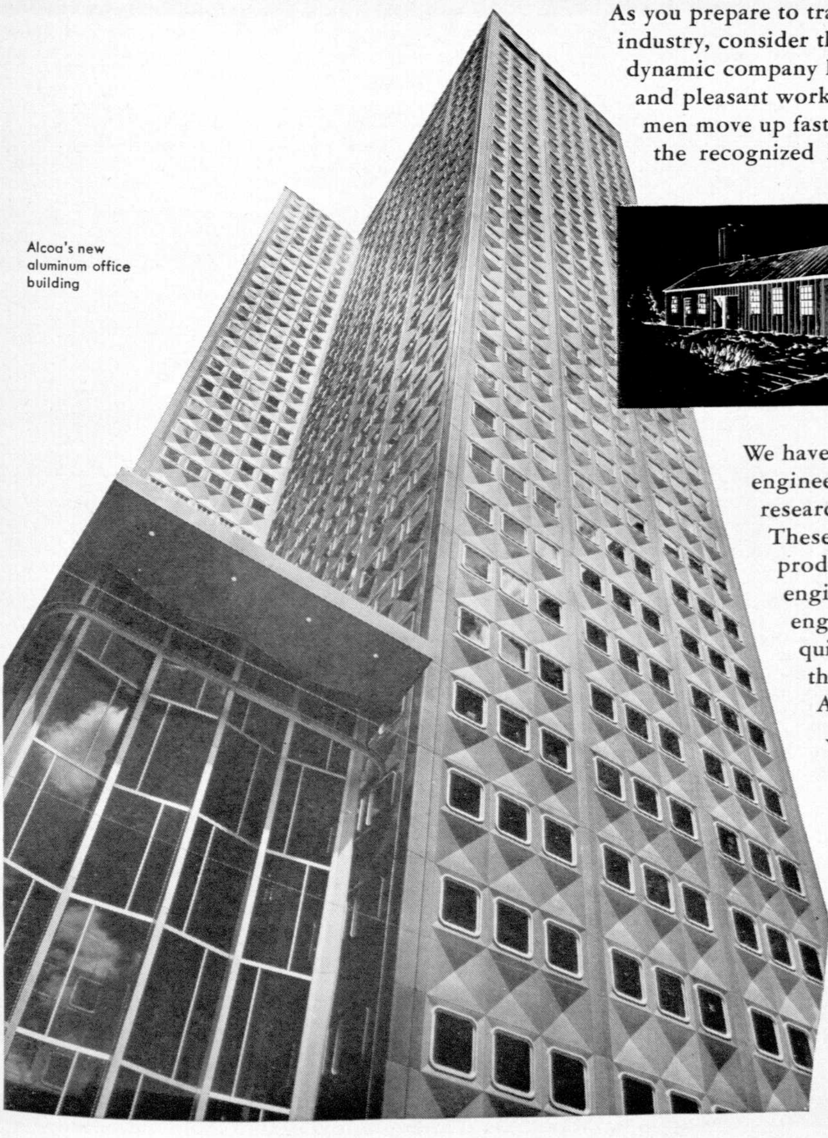
STANDARD

THE ALUMINUM INDUSTRY WAS BORN ON SMALLMAN STREET

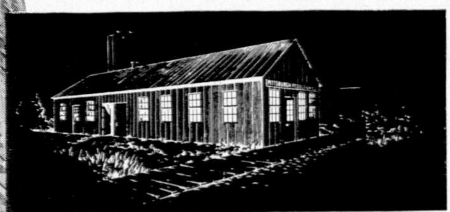
▼ In 1888, the aluminum industry consisted of one company—located in an unimpressive little building on the east side of Pittsburgh. It was called The Pittsburgh Reduction Company. The men of this company had real engineering abilities and viewed the work to be done with an imagineering eye. But they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

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

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



Alcoa's new aluminum office building

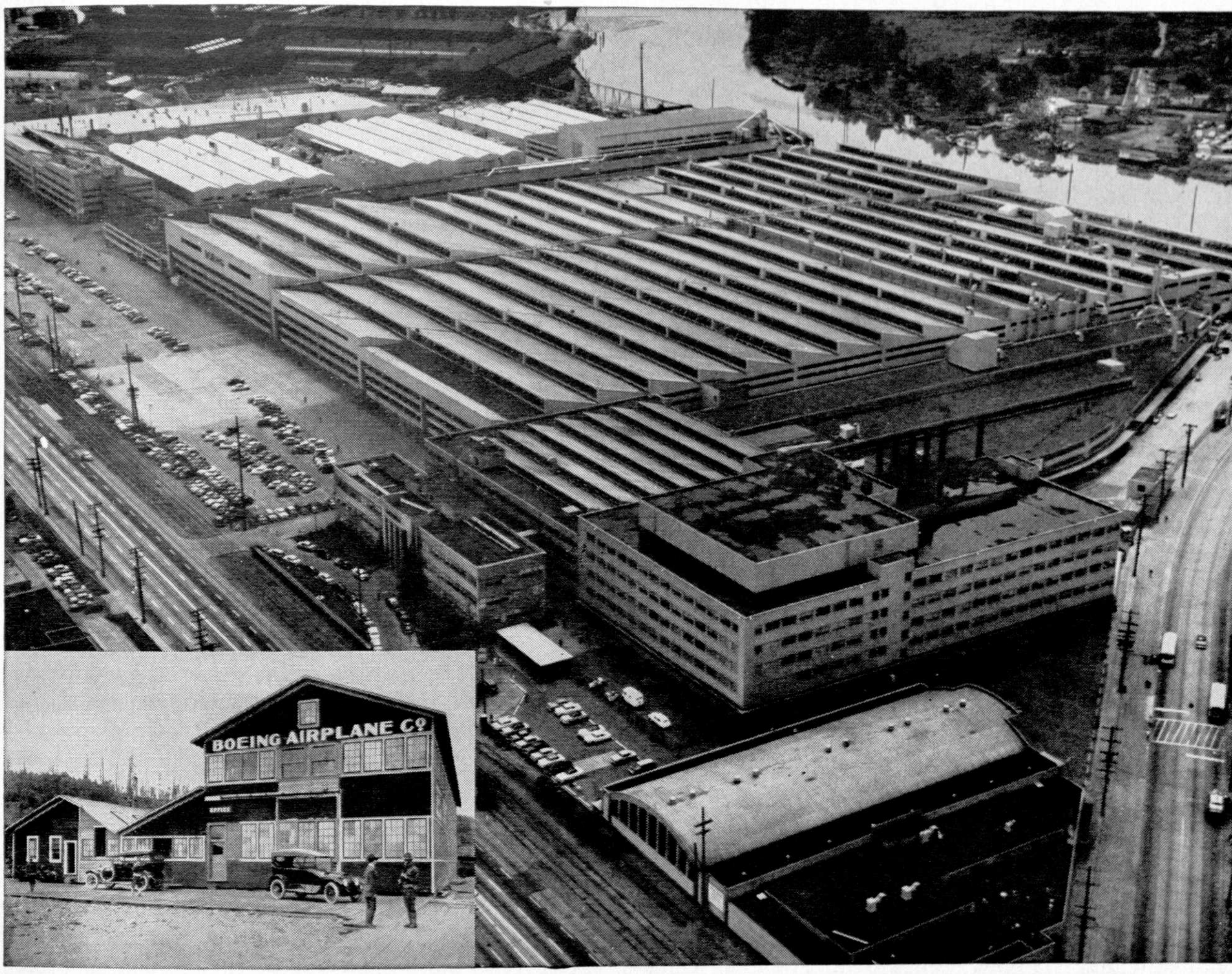


We have fine positions for college graduate engineers—in our plants, sales offices and research laboratories from coast to coast. These are positions of responsibility in production supervision, plant and design engineering, industrial research or sales engineering. Right now it may be quicker than you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

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

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

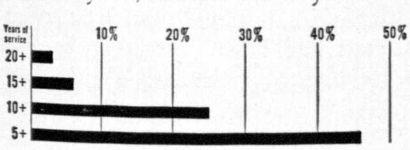


1916—The first Boeing plant, Seattle

1954—Boeing's Seattle plant as it appears today. New Engineering Building is shown in foreground.

Is career stability important to you?

Then the chart below will be of interest. It shows that 46% of Boeing's engineers have been with this company for five or more years; 25% have been here 10 or more years, and 6% for 15 years.



One reason for this stability is that Boeing has grown steadily for 38 years, providing plenty of room for advancement. Another reason is the highly interesting type of work at Boeing, such as designing and building America's first jet transport and the revolutionary B-47 and B-52 jet bombers, as well as work on pilotless aircraft, supersonic flight and research in nuclear-powered aircraft.

Still another reason is this: Boeing always has put dominant emphasis on engineering development. Pioneering in this field has meant that Boeing constantly has increased its engineering staff in relation to total employees. Fifteen years ago, one out of 16 employees was in engineering. Five years ago the proportion of engineers had been raised to one in ten and today it has climbed to one in seven.

Boeing has rewarding openings for engineers of EVERY category—electrical, civil, mechanical, aeronautical and related fields, as well as for applied physicists and mathematicians with advanced degrees.

Careers at Boeing afford a wide variety of experience in research, design and production, as well as work with new materials and techniques, and contacts with a cross section of industry through Boeing's vast subcontracting program.

Boeing promotes from within and holds regular merit reviews to assure individual recognition. Engineers are encouraged to take graduate studies while working and are reimbursed for all tuition expense.

For further Boeing career information consult your PLACEMENT OFFICE, or write

JOHN C. SANDERS, Staff Engineer—Personnel
Boeing Airplane Company, Seattle 14, Wash.

BOEING

SEATTLE, WASHINGTON   WICHITA, KANSAS

Topology

(Continued from page 23)

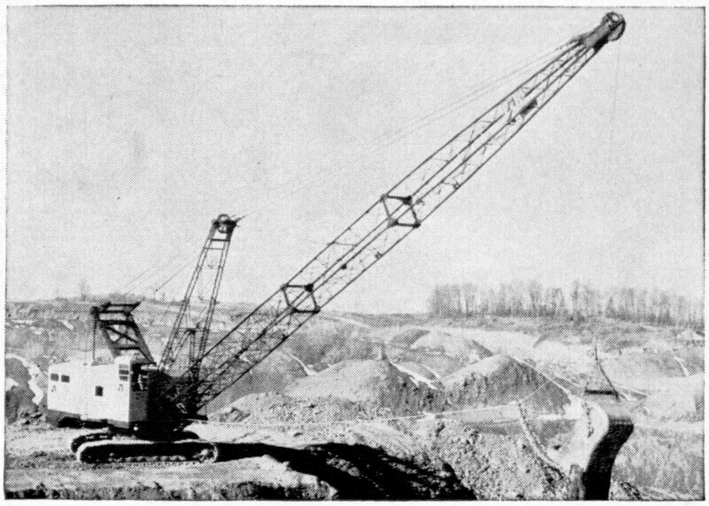
usually assume that the function is continuous. But we know full well that the current is quantized into electrons. Is our assumption of continuity justified? Sure, if it gives the correct solution! We cannot know that it does, until we have solved the problem. Of course, the problem of the current function does have a solution. We *could* build the proposed circuit, push the required current through it and – cautiously stepping back – simply read the meters. A mathematical solution is easier and cheaper, however; or is it? Suppose that the mathematical formulation leads to a formidable non-linear differential equation. Because we may have made unrealistic simplifying assumptions, the equation may have very little relation to the physical problem. In fact, our assumptions could have been so drastic that the equation has no solution at all! Hundreds of man-hours could be spent on asymptotic expansions, etc., and thousands of dollars of electronic computer time could be wasted.

The fact is that we can often determine in advance whether such an equation has a solution, and this is done by means of a fixed-point theorem. Briefly, under the proper conditions, one may think of the differential equation itself as a continuous transformation in a space of functions. Under the proper boundary conditions, this "transformation" will be of a generalized cube into itself and hence, will leave a "point" fixed, (i.e.), a function satisfying the equation. Needless to say, this gives no means of *finding* the solution but it is nice to know that there is a solution to be found! In this roundabout way fixed-point theory has a decided practical value but, like most of topology, the application is to mathematics and not directly to the physical problem.

REFERENCES. (A few words should be said about these works. The book by Courant and Robbins is a fine popularization of mathematics. I recommend it highly. The two articles by Bailey and Tucker and by Lefschetz are also popularizations. Wilder's paper is a survey, quite technical, but well worth reading. The books by Lefschetz and by Seifert and Threlfall are textbooks and are listed for the serious inquirer.

1. Bailey and Tucker, "Topology," Scientific American, January, 1950.
2. Courant and Robbins, "What Is Mathematics," Oxford University Press, New York, 1941.
3. Lefschetz, "Introduction to Topology," Princeton University Press, Princeton, N. J., 1949.
4. Lefschetz, "The Structure of Mathematics," The American Scientist, January, 1950.
5. Seifert and Threlfall, "Lehrbuch der Topologie," Chelsea Publishing Co., New York, 1947.
6. Wilder, "The Sphere in Topology," American Mathematical Society Semicentennial Publication, New York, 1938, vol. 2, pp 136-184.

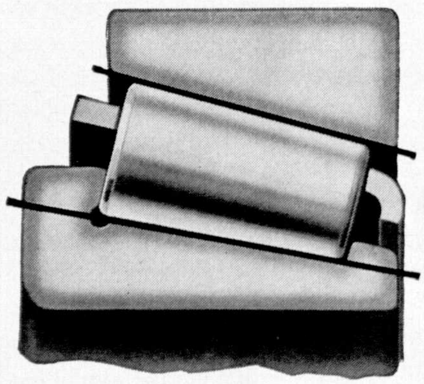
Another page for **YOUR BEARING NOTEBOOK**



How to beat shock loads in a big dragline

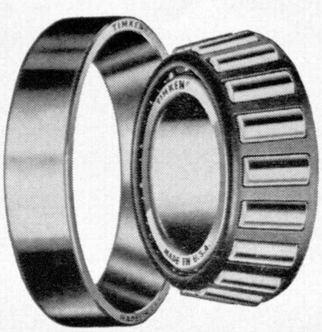
Imagine the shock loads put on this big dragline's intermediate swing shaft when the cab, the boom and an 8-yard load of dirt being swung through the air are suddenly stopped and the direction reversed! Engineers solved this problem by specifying Timken® tapered roller bearings. Timken bearings not only take radial and thrust loads in any combination, they also assure long, trouble-free operation.

Why TIMKEN® bearings have high load capacity



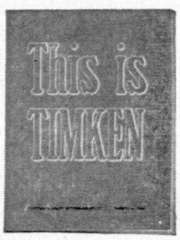
This cross section of a Timken tapered roller bearing illustrates one reason why Timken bearings do such a good job under heavy load conditions. Notice that there is full line contact between the rollers and races. It's this full line contact that distributes the load over a wider area, gives Timken bearings their extra load-carrying capacity.

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



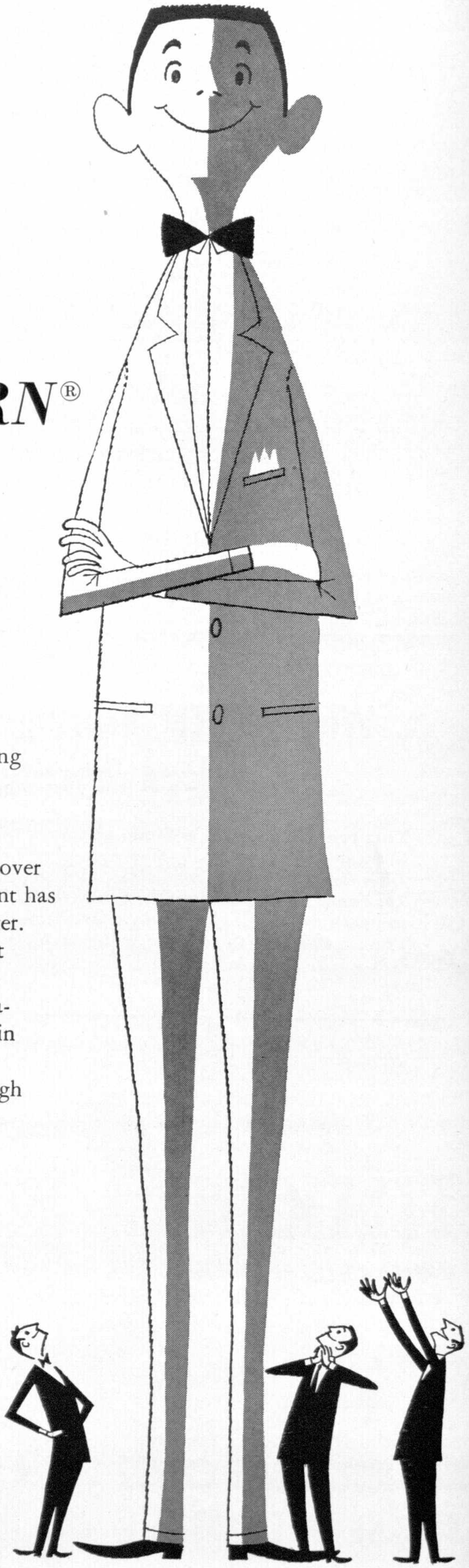
Want to learn more about bearings or job opportunities?

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



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

Choose a career with COLUMBIA-SOUTHERN® and grow with us!



To a young man about to embark on a career, two factors should be paramount in his selection of a company: the company's rate of growth both present and potential, and the attitude of its management.

The attitude of Columbia-Southern's management is extremely progressive. It believes in constant progress, steady research, high quality, streamlined production and in improving present markets and creating new ones.

Columbia-Southern is one of the fastest growing chemical operations in the fast growing chemical industry. In the past dozen years Columbia-Southern's annual sales have increased over four times . . . employment has doubled . . . capital investment has more than doubled . . . the research budget is five times greater.

Columbia-Southern is alive. It is expanding and growing. It wants trained men to move ahead with it. And in addition to finding ever-present challenges and opportunities at Columbia-Southern, capable men who prove themselves can participate in Columbia-Southern's continuing growth.

For further information, write now, Dept. P at our Pittsburgh address or any of the plants.

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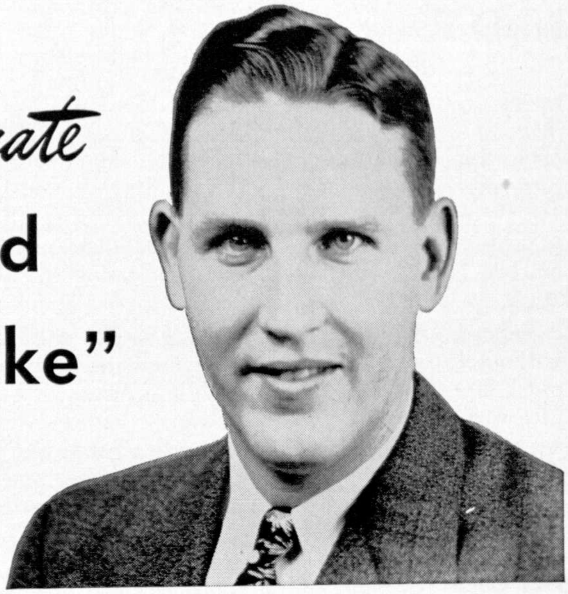
"Allis-Chalmers Graduate Training Course Helped Me Find the Work I Like"



says HUGH C. SELLS,
Syracuse University, BS—1942
and now Manager, Knoxville District Office

"I guess I was like many graduating engineers. I didn't really know what I wanted to do. When the Allis-Chalmers representative visited the campus, and described their Graduate Training Course, it sounded like the type of postgraduate training I really needed.

"What appealed to me then—and still does—is the broadness of the program. Here is a company filling a unique spot in industry. It makes important, specialized equipment for almost any industry you can name."

Wide Choice of Activity

"It's like a big department store for industry. But that isn't all! In addition, it offers a wide choice of activity within each of these many product groups . . . whether it be sales, design, research or production.

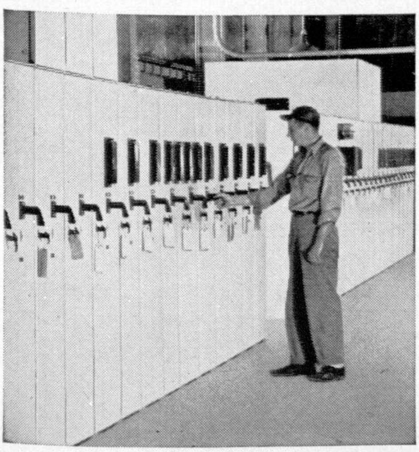
"After getting the broad look at industry the program offers, my interest began centering on Service and Erection of large equipment. This led me into many departments of the company, and I learned about everything from steam turbines to sifters for flour mills."

Valuable Background

"The transition from service to sales was natural. The background of service and erection work proved very valuable.

"So you see, whether you think you know what you want to do or not, the Allis-Chalmers Graduate Training Course is so flexible, so broad in its scope, you have a real chance to find yourself. Best of all, you don't have to waste time doing it."

ELECTRONICS—Modern way to dry sand cores is with Allis-Chalmers *Foundromatic* Sand Core dryer. Revolutionary new process dries cores in minutes instead of hours.



POWER—Neat, compact and safe switchgear installation is big improvement over open framework and knife switches in older installations.

Facts You Should Know About the Allis-Chalmers Graduate Training Course

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

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

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

4. He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic, turbo-generators, circuit breakers, unit substations, transformers, motors, control pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

Foundromatic is an Allis-Chalmers trademark.

C-5677

Bright Future

(Continued from page 15)

ments are coiled must be accurate to 1/10,000 of an inch, or life may be affected by as much as 20 per cent. Spacing between coils must be minutely accurate, not only to avoid short circuiting, but also to avoid concentration of heat at one point, thus affecting life. A single drop of moisture distributed in 500,000 lamps will cause early blackening in all of them.

Incandescent lamps can be made to last a lifetime without burning out, or they can be made to burn out in a very few hours. When a lamp filament burns at a low temperature, light output is low and life is very long. Such lamps produce radiation largely composed of infrared energy, which can be used for heating applications. When a filament burns at high temperature, light output is very high and life is very short. Such lamps are useful in the photographic field.

Most household lamps are designed to burn in the range of 750 to 1000 hours. Lamps designed to burn for a longer period, even if they were sold at the same price as present lamps, would waste so much electricity that they would be a poor investment for the customer. They would give out very little for the wattage consumed. The answer to how long a light bulb should last is this: Long enough to give the best lighting value for the combined cost of bulbs and current.

THE FLUORESCENT LAMP

The fluorescent lamp, in effect, is a low-pressure mercury lamp with a phosphor on the inside of the tube. Synthetic phosphors were developed to utilize the ultraviolet energy which the low-pressure mercury arc discharge produces in relatively large quantities. The phosphor converts the invisible ultra-violet energy into visible light, the color of which depends upon the composition of the phosphor.

First commercial use of these lamps was made at the New York and San Francisco World's Fairs, in 1938 and 1939, principally in a variety of colors. World War II gave great impetus to the growth of fluorescent lighting, the lamps being used in high numbers to illuminate war plants and offices. In 1954 production was about 85 million lamps in the United States. Although this figure is only one-eleventh of the incandescent lamp production, fluorescent lamps now produce more light in this country than do incandescent sources. This is due to their superiority in the form of greater efficiency and longer life.

About 40 per cent of fluorescent lamps are employed in commercial installations, 30 per cent in industrial, 15 per cent in residential, and 15 per cent in public buildings, schools, hospitals, transportation facilities, and others.

To illustrate why fluorescent lamps have been welcomed as light sources, note the following: the 40-watt fluorescent lamp produces 2550 lumens for 7500 hours, while the 40-watt incandescent lamp produces 465 lumens for 1000 hours. Thus, the fluorescent source produces over 40 times as much light over its life span than the incandescent of the same wattage.

ELECTRIC DISCHARGE LAMPS

In 1860 Professor John Thomas Way discovered that if an electric circuit were opened between two jets of mercury, a brilliant greenish arc was produced. The next 40 years brought many types of arc lamps, largely experimental ones. At the turn of the century Peter Cooper-Hewitt began his experiments in this field, ultimately producing a tubular mercury arc lamp about four feet long with a mercury pool cathode and a solid iron anode. The mercury-vapor lamps, as they were called, were used widely in industrial lighting and photographic studios. A 'high-pressure' mercury lamp, forerunner of today's mercury lamps, was developed in 1934 by the Cooper-Hewitt organization.

Electric discharge lamps are quite different from filament lamps, both in appearance and operation. Instead of being a hot wire in a bottle, they are more like an 'electric storm' in a bottle. In these lamps visible light and other radiant energy known as ultraviolet are given off as a result of the passage of electric current through a gas. The most commonly used gas is mercury vapor. Because of the unfavorable color of light from these mercury lamps, they are often used in combination with incandescent lamps.

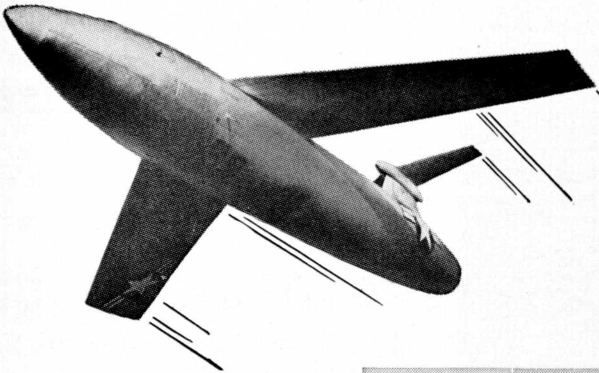
THE FUTURE

'Electroluminescence' is a relatively new method of producing light by the direct conversion of electric energy within a semiconduction solid. It is a fundamentally attractive method of creating light, because it is not inherently limited in efficiency. Both incandescent and fluorescent lamps are limited in ultimate efficiency by the indirect means used to convert the electric energy into light.

An electroluminescent light source consists of a layer of crystals of silicon carbide or zinc sulphide sandwiched between a transparent sheet of glass and a metal plate. When alternating current is passed through, the phosphor glows. Phosphor colors range from orange to blue, and include white. General-purpose lighting by electroluminescent devices will not be feasible until the present attainable efficiency is improved.

This is the age of electric lighting, and on every side we find the trend toward more and more light sources, higher and higher light levels, and better control of light so that it meets our more exacting standards of comfort, safety, convenience, and ease of accomplishing our varied seeing tasks. Indeed—'A Bright Future.'

An oil filter will remove a pound or more of dirt and sludge from the oil in a car during 5,000 miles of driving.

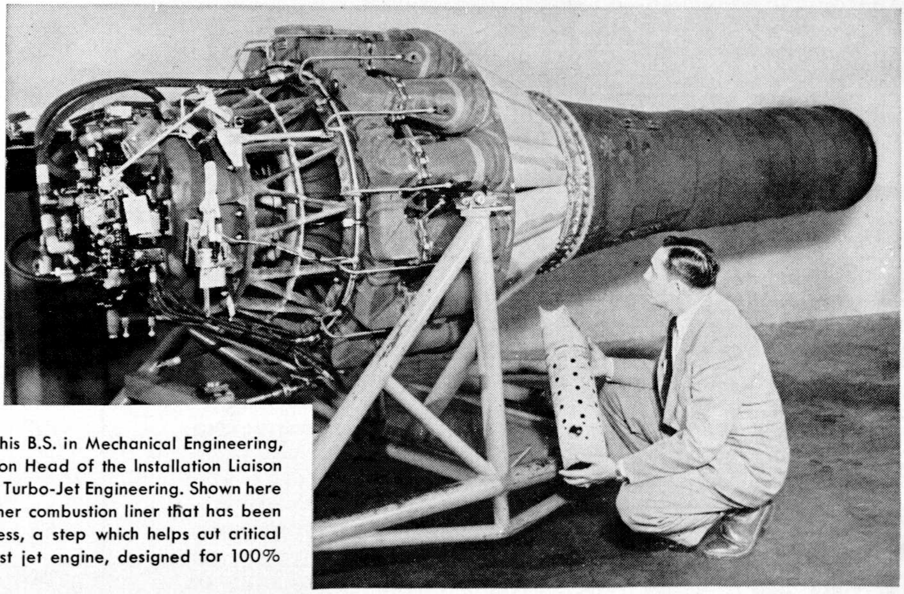


ALLISON

Engineers Pioneer

MISSILE

Power Plant Development



W. S. "Gus" Broffitt, who received his B.S. in Mechanical Engineering, U. of Kentucky in 1938, is now Section Head of the Installation Liaison and Engineering group of the Allison Turbo-Jet Engineering. Shown here by a J33-A-37, he is holding an inner combustion liner that has been through the aluminum dipping process, a step which helps cut critical materials in this high speed, low cost jet engine, designed for 100% reliability.

● The Allison jet powered USAF B-61 Martin Matador is the country's first operational ground-to-ground pilotless bomber. And, it's the first such missile to be sent overseas for duty.

The B-61 engine—an Allison J33-A-37—is based on the proven Allison centrifugal flow engine. This engine has accumulated more than 2½ million hours of flight in such aircraft as the Lockheed F-80 Shooting Star, the T-33 Trainer, F-94 Night Fighter, and in the Grumman F9F Panthers and the Cougars!

In 1950, Allison undertook the project of engineering and developing a 5-hour, low-cost, expendable jet engine for the Glenn L. Martin Co. which was under contract with the Air Force. The missile assignment made it necessary for Allison to design a J33 model—incorporating reduced material, manufacturing and testing costs—and still maintain a 100% reliability.

The concentrated efforts of Allison engineers resulted in an 85% reduction of critical materials in missile engines in comparison with the similar centrifugal flow engines built for piloted aircraft.

An aluminum dipping process, developed by Allison engineers—in cooperation with General Motors Research—helped materially in reduction of critical materials. This process was used on inner combustion liners and permits using a low alloy steel in place of highly critical material. The aluminum dipping process affords corrosion protection, and still enables the liners to withstand high combustion temperatures. First to use aluminum dipping equipment on large parts, Allison now uses the process on turbine engines scheduled for piloted aircraft.

The missile power plant project is another example of the variety of problems handled by Allison engineering. Because Allison is continually doing pioneer work in advanced engineering developments, we need more technically trained men, especially young graduate engineers. Want to know more about your engineering future at Allison? Write now for information:

R. G. Greenwood, Engineering College Contact
ALLISON DIVISION, General Motors Corporation
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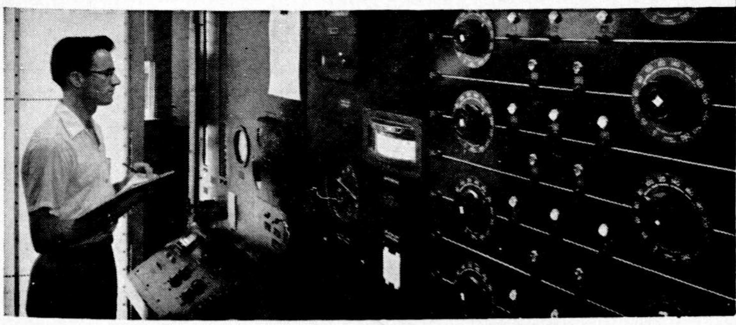
Index To Advertisers

Carl Vrooman, icing tunnel group head, studies hot-air cyclic de-icing test on wing section of C-130 transport. The tunnel has a temperature range of −40° F. to +150° F. and maximum air speed of more than 270 mph.

New icing tunnel speeds thermodynamics research at Lockheed

Designed to meet a constantly increasing volume of thermodynamics work, Lockheed's new icing research tunnel now provides year 'round testing in meteorological environments normally found only in flight. It is the first icing research tunnel in private industry.

Lockheed thermodynamics scientists were formerly limited to testing time available at installations such as Mt. Washington. Now they are able to study in greater detail problems such as: thermal anti-icing; cyclic de-icing; various methods of ice removal; distribution of ice; rate of temperature changes in aircraft components; thermodynamic correlation between laboratory and flight testing; and development and calibration of special instrumentation.



C. H. Fish, design engineer assigned to the tunnel, measures impingement limits of ice on C-130 wing section. The tunnel has refrigeration capacity of 100 tons, provides icing conditions of 0 to 4 grams per cubic meter, droplet sizes from 5 to 1000 microns.

Thermodynamicist Ed Dean monitors main control panel in picture at left. Temperature, air speed, water flow rate, air pressure and other variables can be regulated independently.

B. L. Messinger, department head, analyzes test results with Thermodynamics Engineer E. F. Versaw, right, and Thermodynamicist Tom Sedgwick, left. The report was in their hands *only two days* after it was decided to conduct the test.

Career Opportunities at Lockheed

Increasing research and development work on nuclear energy, turbo-prop and jet transports, radar search planes, supersonic aircraft and a number of classified projects offers engineers outstanding opportunity for creative work.

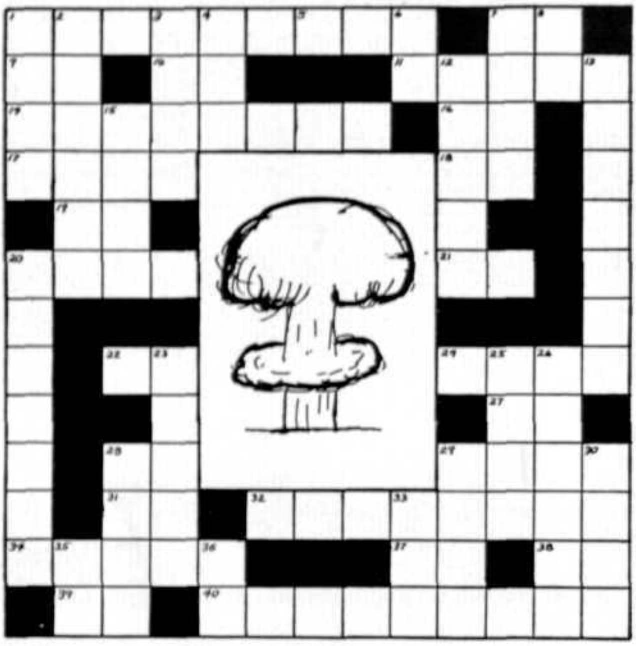
This is true not only for men in thermodynamics but for Aerodynamicists and Aerodynamics Engineers, Structures Research Engineers, Airborne Antenna Designers, Flight Test Analysis Engineers, Physicists in fields of optics and acoustics, Mathematicians, and almost every other type of engineer.

You are invited to write for the brochure, "Your Future is Now" which describes life and work at Lockheed. Address E. W. Des Lauriers.

LOCKHEED AIRCRAFT CORPORATION

BURBANK **CALIFORNIA**

Crossword for Engineers



ACROSS

1. pertaining to the use of machine (pl.)
7. chemical element (erbium)
9. an article
10. an article
11. district outside city limits
14. acting to an experiment
16. Sodium
17. trudge, as through a marsh
18. state of being
19. proceed
20. unit of force
21. strontium
22. atop
24. nerveless organ of the human body
27. abbreviation for natural log
28. abbreviation for New Testament
29. foundation
31. abbreviation for aeronautical engineer
32. elements having the same atomic number
34. sword
37. means of transportation
38. engineer's expression for tough luck
39. abbreviation for tensile strength
40. to attract

DOWN

1. a center for buying and selling
2. unit of force
3. chop (slang)
4. tiny insect
5. personal pronoun
6. strontium
7. measure of time (pl.)
8. radium
12. parts or portions
13. type of varnish applied to surfaces to make them shine
15. period of time
20. a machine used in converting mechanical into electrical energy
23. process used in bluing iron and steel
25. to lap
26. insert (pl.)
28. grabs
29. large screw
30. to be
33. golf term
35. big
36. printer's measure

ANSWER TO NOVEMBER PUZZLE