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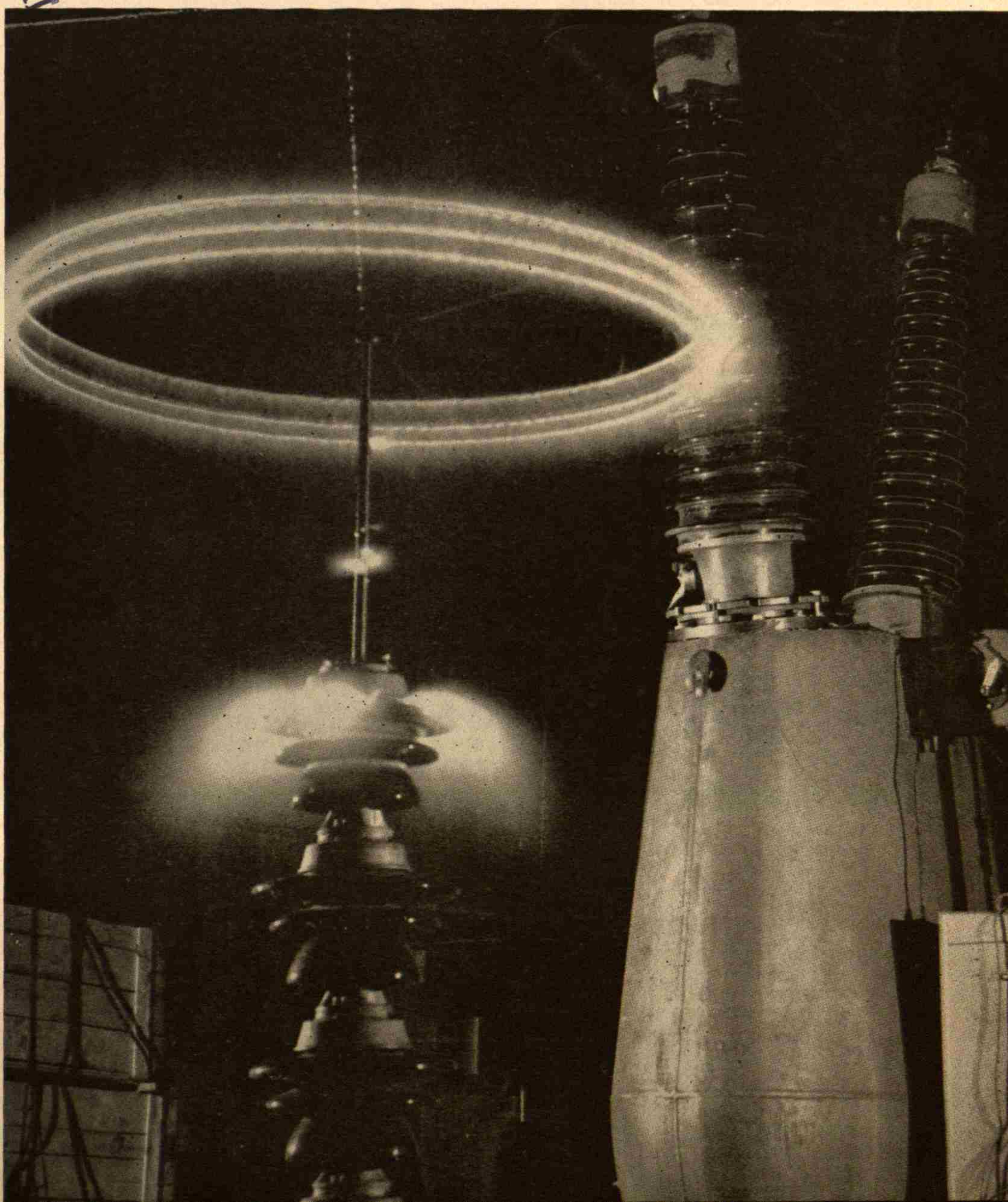

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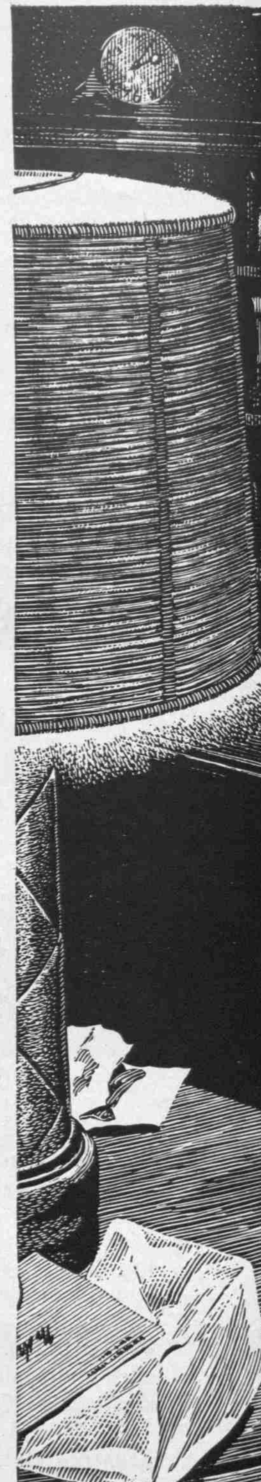

Spartan

ENGINEER

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Million-volt corona motor

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Heat Pump

Heat from the Earth

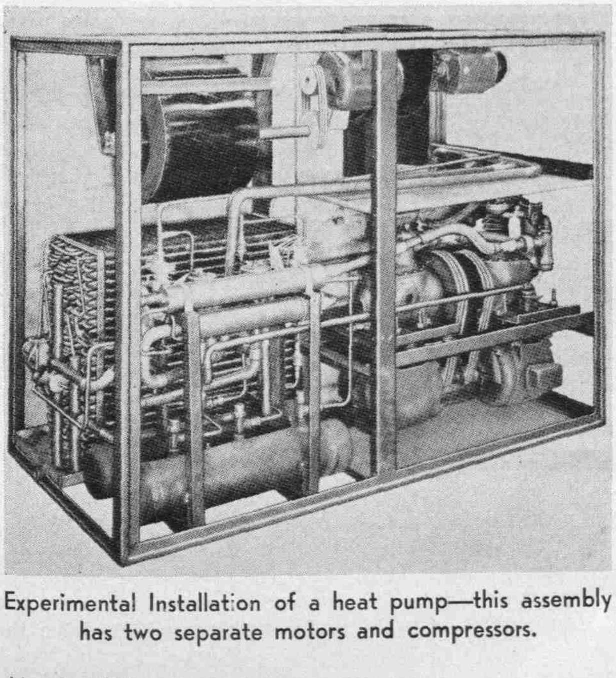
By WILLIAM CLARK
Freshman M.E.

The heat pump is not a new discovery, but an old one that suddenly has become of interest to industry. The principle of the heat pump, along with the refrigerator, was discovered a hundred years ago by a Lord Kelvin. It was not developed as rapidly as the refrigerator because of its initial cost, lack of a practical heat source and operating cost, which could not compete with a fire in its proper furnace. It has not been until recently that men throughout the world have developed it to the point where it has an entirely new aspect as a means of heating.

The heat pump could be compared with a large refrigerator running backwards. The refrigerator extracts heat at a low temperature from the desired space, raises the temperature by mechanical means and then discharges it at a higher temperature into the room where it isn't noticed. The heat pump picks up heat at a low temperature, raises the temperature by mechanical means, and then discharges the heat at a higher temperature in the desired area.

The heat pump goes hand in hand with radiant heating. Both are inherently associated with low (compared with fire) temperature heat. The heat pump is associated with low temperature heat because of the pressures involved with the refrigerant gas and radiant heating because of the temperature on interior surfaces.

The problem of finding a source of heat is one of the major factors in the use of a heat pump for heating a building. It has not been until recently that the extraction of heat from a low temperature source has been considered practical.



Experimental Installation of a heat pump—this assembly has two separate motors and compressors.

Outside air may thus be used as a source of heat. Air is taken into the heat exchange part of the system, heat is removed by the evaporating refrigerant gas, and then discharged at a lower temperature. The lower the temperature of the entering air, the more power will be required for the same amount of heat. When heating a building this fact will become more apparent since as it becomes colder outside, more heat will be required, but heat is harder to obtain so the power input will increase at an accelerating rate. Consequently, it can be seen that air as a heat source is only desirable where the winter is mild. Southern and western parts of the United States are best suited to the heat pump using air as the source of heat.

When cooling in the summer is required, the above process is just reversed. Incoming air has the heat from the house added to it and it is then discharged at a higher temperature. This type of system is called "air to air" when air is used as the heat-carrying medium within the building. If a hot water system or radiant heating is used, it is called an "air to water" system.

The earth below the frost line may be used as a source of heat, for temperature of the soil below the frost line does not vary twenty degrees the year round, and corresponds very closely with well water. Pipes are laid in the ground below the frost line and water is circulated through these pipes, or a tube is used and the refrigerant gas passes directly through it, absorbing heat in the winter and dispersing it in the summer. The amount of piping required depends on the quantity of heat needed, the moisture content, and composition of the soil. The greater the moisture content, the less pipe required. This type of system would be called an "earth to air" or "earth to water," depending on the internal heating circuit.

The third source of heat for a heat pump is water; either underground, well, lake, or stream. This source may be the most practical for metropolitan areas. Well or underground water maintains a nearly constant temperature throughout the year so it can be used successfully in northern climates.

There are a number of means in which water can be utilized as a heat source. The pumping of water from a well would appear to be an ideal source except for the

(Continued on Page 32)

AIRCRAFT NUCLEAR PROPULSION

Transportation For 2000 Plus

By DR. M. C. LEVERETT
ANP Project, General Electric Company
Oak Ridge, Tennessee

INTRODUCTION

A discussion of propulsion of aircraft by nuclear power is unfortunately considerably restricted by security. My task in making this talk is, therefore, not an easy one, and if I omit to say exactly how some of the interesting problems which I shall tell you about may be solved, it will be understood that this is unwise at present. There is, of course, the chance that in following this line I shall be credited with knowing the answers to many more problems than actually have been solved, and I hope that should you later discover that we who are working in this field have made more or less progress than you assume from my present remarks that you will not feel that I have intentionally misled you.

In spite of the restrictions placed upon our discussion we can discuss in fairly free fashion the principles underlying nuclear powered flight, some possible methods of achieving it, and some problems which are involved. Before starting this discussion, however, we should pause a moment to answer the question, "Why do we want to fly an aircraft on nuclear power?"

Many years ago Breguet set down the formula which bears his name and which states that the range of an aircraft is proportional to its lift-to-drag ratio, to the efficiency with which its propulsive system works and inversely proportional to the weight of fuel consumed per unit of work delivered to the propulsive system. Any decrease in the specific fuel consumption obviously leads to increased range. Because of the ingenuity of the designers of aircraft and engines the Breguet formula is scarcely of more than academic interest in these days. Devices such as accomplishing most of a flight slowly and using high speed only at critical times, refueling in flight, and discarding not only the fuel tanks but also the lifting surfaces which support them as soon as they are empty, all have been seriously proposed or practiced and operate greatly to increase the range of modern aircraft. However, it is no depreciation of our heavy bombers, which are the best in the world, to say that even more range would be desirable, particularly if it can be coupled with high speed. This is the point at which the nuclear propelled airplane comes into the picture. One pound of uranium-235 will liberate heat on undergoing fission equivalent to the energy liberated by burning 1,700,000 pounds of gasoline. It is at once evident that if a means can be found for converting the energy of nuclear fission into thrust that aircraft can fly for very long times on very small amounts of fuel. Indeed, fuel consumption would be measured not in thousands of pounds per hour, but in pounds per day. Because of the enormous amounts of energy available from a small amount of fuel, highly efficient utilization of this energy would no longer be crucially important. Thus, specific fuel consumption could be allowed to worsen somewhat if this were desirable in order to make some other feature of the power plant easier or better.

PRINCIPLES AND SUGGESTED METHODS

One of the basic principles of nuclear energy is that the energy of fission is manifested as heat. That is, a nuclear reactor is primarily a source of heat which must be converted into thrust or into mechanical work in more or less conventional ways. Hence, in any nuclear power plant whether it is for an aircraft, a naval vessel or for the generation of electricity on the ground there will be a reactor and heat machinery. In the aircraft the heat machinery is the propulsion system. Secondarily, and somewhat unpleasantly, the reactor is a source of radioactivity; hence, there will also be a shield of some type or other.

Propulsion Machinery

There is scarcely a single type of aircraft propulsion machinery which has not been proposed for incorporation in a nuclear power plant for aircraft. One obvious proposal is that propellers be used, driven by turbines which are in turn run by expanding through them vapor such as steam, heated in the reactor or air heated in the reactor. Another fairly obvious proposal is that the reactor should directly or indirectly take the place of the combustion chambers of a conventional turbo-jet engine. The reactor might also take the place of the combustion apparatus in a ram-jet propulsion system. It has also been proposed that a compressor-jet type of propulsion system be used, with the compressor driven by vapor or hot air from the reactor and the heat supplied to the air by a heat exchanger through which the reactor coolant passes. In all cases, except that of the ram-jet and other direct air cycles, it is required that heat be transported in a coolant from the reactor to the propulsion machinery. For example, if a propeller type propulsion system is chosen, the hot fluid from the reactor must be piped to the turbines which drive the propellers; these in turn must be mounted on the wings. Thus each propeller must be provided with its own reactor, or hot fluids must be piped around the airplane from a central reactor heat source. Any reactor coolant will undoubtedly become somewhat radioactive in passing through the reactor, and this alternative hence is not attractive. On the otherhand providing each propeller with its own reactor is not easy either, for two reasons. First, the weight of a reactor, with its shield, is very large; more than one reactor and shield therefore is highly undesirable from a weight standpoint. Second, two reactors per airplane would require more than twice the fuel investment of one reactor and a low fuel investment per airplane is desirable, rather than a high one.

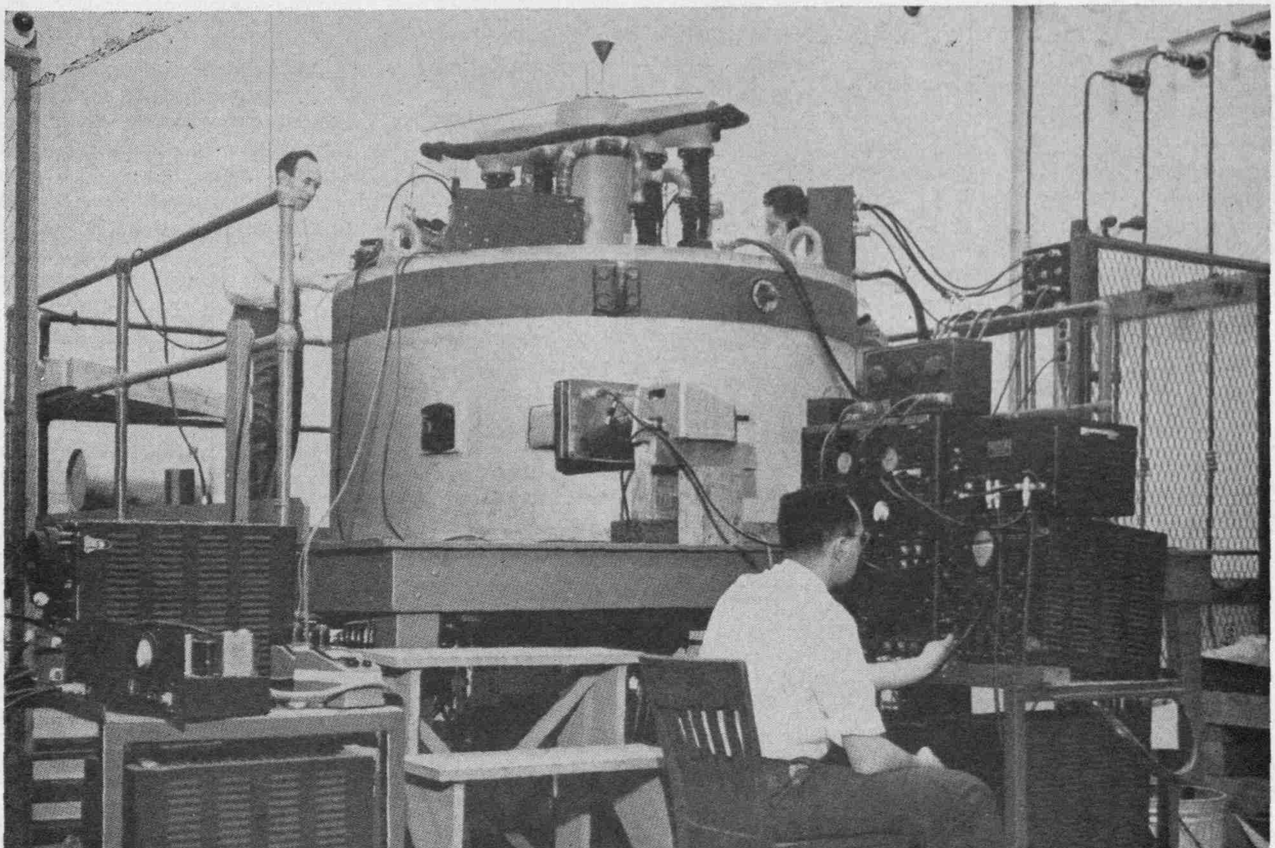
Reactor

The design of the reactor will be greatly influenced by the coolant chosen. However, the basic principle upon which the reactor operates is the same regardless of the coolant. This principle is as follows: The reactor may be thought of as a more or less cylindrical body throughout which a fissionable material such as uranium-235 or plutonium-239 is distributed. The reactor also contains passages for the flow of the coolant through it necessary for the removal of the heat and also usually contains a material which is called a **moderator.** The reaction starts with the capture of a neutron by a nucleus of, say uranium-235. Since neutrons are present in small concentration in the atmosphere everywhere, this serves to start the reaction. Immediately after capture of the neutron the U-235 nucleus disintegrates with the liberation of two to three neutrons and 2 atomic nuclei (fission fragments) both smaller than the original nucleus. Most of the energy of fission is carried off by the fission fragments; this energy is imported to the material into which they are cast and appears as heat. Gamma rays and beta rays also are given off in the fission process.

The two to three neutrons given off are ejected into the body of the reactor and may undergo one of three different fates. 1) They may escape from the reactor entirely and be captured outside it by some parasitic nucleus in the structure of the shield or its surroundings. 2) They may be captured by some of the non-fissionable materials in the reactor itself. 3) They may be captured in another U-235 nucleus, following which additional neutrons will be given off. If we can design the reactor so that as many as about 40 per cent of the neutrons given off in fission are captured in other fissionable nuclei in such a way as to cause fission there, the reaction will continue indefinitely until the fissionable nuclei are used up.

The basic problem of reactor design is to reduce to acceptably low values the first two methods of loss of neutrons mentioned above; that is, leakage from and parasitic capture in the reactor. Leakage may be counteracted to some extent by surrounding the reactor with a neutron reflecting material which scatters but does not capture the neutrons. For example, graphite and beryllium oxide are known to be good reflectors. Excessive capture of neutrons in non-fissioning nuclei in the reactor may be avoided by eliminating from the reactor atomic species which have a strong tendency to capture neutrons or, in the language of the nuclear

(Continued on Page 28)



The 300-million volt, non-ferromagnetic synchrotron.

THINKING at the SPEED OF LIGHT

By LEE MAH

Sophomore E.E.

An enemy bomber was flying toward the target. Then, suddenly, an electronically guided rocket appeared and BOOM! a bull's eye.

This happened on the plotting board of the Navy's electronic calculator, the "Typhoon," built by RCA Laboratories. This machine demonstrates theoretically how guided missiles will react in flight. While formerly thousands of hours were consumed in complicated computations and months were taken in building full-size test models with no guarantee of satisfactory performance, the desired design characteristics of any proposed guided missile may now be dialed into the electronic computer and designers can actually see in drawing and in three dimensional models how the rocket will function.

This is only one of the many uses in which the recently developed "mechanical brains" are employed. They can be used to determine production schedules and wages and to make out gas bills or insurance payment notices. The statistics of the 1950 census were computed by one of these machines.

An electronic calculator can do the calculations that would take a staff of mathematicians years to do in a few minutes. For instance, one of these machines can multiply 9,876,543,210,123,456 and 1,234,567,890,987,654 in one one-hundredth of a second. The electronic calculator is not only fast, but it is economical. It can do the work of hundreds of men for the wages of about a dozen.

Although these calculators are usually huge and contain many and complicated parts, their principle of operation is relatively simple. In general, the machines contain (1) a quantity of registers where information (numbers and instructions) can be stored; (2) channels along which information can be sent; (3) mechanisms that can carry out arithmetical and logical operations; (4) a control which guides the machines to perform a sequence of operations; (5) input and output devices whereby information can go into the machine and come out of it; (6) motors or electricity which provide the energy to operate them. The key devices of any electronic computer are the relays and electron tubes. Together they form the central nervous system of a "mechanical brain."

Most of the electronic calculators that have been produced to date can be classified into two types. One type of machine receives and answers with signals that are physically measurable quantities such as lengths, voltages, or angles of rotation of shafts. These are called analogue computers. The other type performs operations with numbers and are called digital computers. One type of digital computer may operate on eight principal digits, under the octal system, while another forms numbers by the combination of the two digits, 1 and 0, in the binary system. The latter type of machine obeys only two commands, yes and no. Yes is produced by the occurrence of an electrical signal and no when there is no signal.

Since one type of machine operates on physical quantities and another type operates on digits, information obtained from an analogue computer cannot be fed into a digital computer because one does not understand the language of the other. The translation of a problem from the digital language by humans to the analogue language is a very lengthy procees—much more difficult than translating Greek into Chinese. For this reason, a mechanical translator was invented. The

Benson Lehner Corp. of Los Angeles came out with the analogue-digital converter. The key of the converter is called a decade. Each decade unit has ten possible positions. An analogue value is fed into a decade unit as a rotation of a shaft. The shaft is turned to the corresponding position of the digital value. One, two or three decade units may be coupled together to increase the limit of translation.

The first digital computer was developed by Professor Howard Aiken of Harvard University and built by IBM in 1944. Since its completion, the IBM Automatic Sequence-Controlled Calculator (Mark I) has solved numerous technical problems for the United States Navy. The Mark I cost $250,000 to complete. It stands 8 feet high and is 50 feet long. The mechanical drive for this machine is a four horse-power motor, and the total assembly weighs five tons, containing 760,000 parts. Operations are controlled by orders fed into the machine on coded 24-hole punched tape, consisting of three columns of eight holes each.

Operating twenty hours a day for the Navy Bureau of Ordnance, the Mark I calculated range tables for guns, and studied trajectories of guided missiles and rockets. The machine has the ability to solve every problem in two different ways, to prevent error. The answer is printed if the two results check. Lights flash if they fail to check. The time required by this calculator for adding and subtracting is 0.3 seconds. Multiplication takes 4 seconds and division requires 11 seconds.

Since 1948 the Mark I has been replaced by two bigger brothers successively, the Mark II and Mark III. Mark III, the biggest and most complex, weighs ten tons, is thirty feet long and fifteen feet wide. It contains 100 miles of wires, 4500 vacuum tubes, 3000 relays, 400,000 soldered connections, 2500 magnetic recorder-phonographs, 1 sequencing drum and 8 storage drums that can store 64,000 digits. It can multiply two 16 digit numbers in 0.01 seconds and add in 0.004 seconds. Information is fed into and given out of the machine on magnetic tapes.

Another series of digital electronic calculators were begun in 1942 by the construction of the Electronic Numerical Integrater and Calculator (Eniac) at the Moore School of Electrical Engineering at the University of Pennsylvania under the auspices of the U. S. Army's Ordnance Department. Dr. John W. Mauchly, a physicist, and J. Presper Eckert, Jr., an electronic engineer, were the co-inventors. The Eniac weighs 30 tons and contains 18,800 electron tubes. The language of the Eniac is ten decimal digits numbering from 0 to 9 with a sign that may be plus or minus.

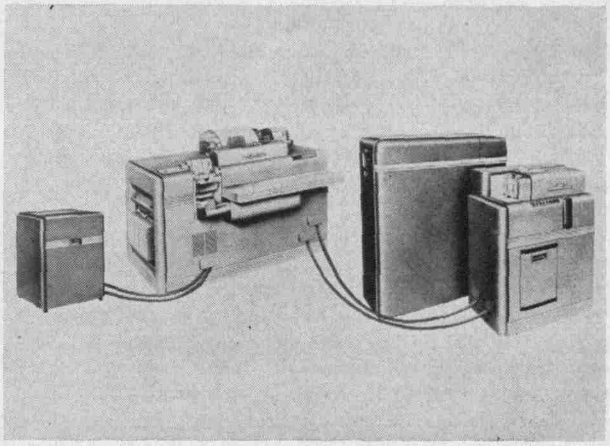
The main part of Eniac consists of 42 panels which are placed along the sides of a square U. Each of these panels is 9 feet high, 2 feet wide, and 1 foot thick. It operates by counting electrical pulses produced at the rate of 100,000 per second. Although Eniac shows amazing speed in doing calculations, it contains no moving parts. Eniac has been computing trajectory for the U. S. Army in the Ballistic Research Laboratories at the Aberdeen Proving Ground.

An offspring of Eniac is Binac, which uses the binary system of digits. Binac is smaller than Eniac, being 5 feet high, 4 feet long and 1 foot wide. It contains 1400 vacuum tubes and 2 new mercury storage tubes which can store 15,000 binary digits. Binac can find the square root of any eight or nine digit number in 1/60 second. It is three times faster than Eniac.

Another machine, the Universal Automatic Computer (Univac) was turned out by the Eckert-Mauchly Computer Corp. The Univac, 7½ feet wide, 14½ feet long and 8 feet high, is capable of solving simultaneously hundreds of equations containing hundreds of unknowns. Information is fed into Univac by means of magnetic tape. More than one million characters may be recorded in binary form on one reel of magnetic tape 1200 feet long, 6 inches wide and less than 0.002 inch thick. Univac was designed to compile statistics as well as handling mathematics. It was used in computing the 1950 census.

The other family of electronic calculators, the analogue computers, began with the invention of the Differential Analyzer at MIT by Dr. Vannevar Bush in 1942. The fundamental physical quantity utilized in this machine is the amount of turning made by a shaft. The main purpose of the Differential Analyzer, as well as other analogue calculators, is solving problems in the form of differential equations.

Another analogue computer is the Reeves Electronic Analogue Computer (Reac) which in appearance looks like any conventional type telephone switch board. It consists of a computer unit, a servomechanism unit, a recording unit, and an associated power supply. In the automotive field Reac solves problems involving internal combustion engine performance, ignition and carburetor development, and improvements in a car's riding ability. In engineering it solves problems of bridge vibrations and stress analyses.



The IBM Card-Programmed Electronic Calculator

An analogue computer was developed at the California Institute of Technology to aid plane designers in designing aircraft structures. The fundamental principle of this machine is that there are analogies between components in mechanical systems and electric circuits. For example, a mass inertia (mechanical) is analogous to an inductance (electrical). The mass tends to maintain a constant velocity because of its inertia; the self-inductance of a coil tends to oppose any change in the current. By comparing equations for the inertia force and the self-induced voltage, analogies between force and voltage and velocity and current can be shown in addition to the one between mass and self-inductance.

The possibilities of these electronic machines are enormous. One of the problems that they might be expected to solve is the application of what mankind knows. The libraries are full of books, most of which we can never hope to read in one lifetime; the technical journals are full of scientific information which we can hardly absorb to too great an extent. In other words, there is a big gap between man's knowledge and the employment of that knowledge when needed. The electronic machines, however, can catalogue these informations and hand them to us with the pressing of a button.

By HAROLD P. SKAMSER

Engineering Placement Director

WHY AN ENGINEERING SHORTAGE?

Your Future Looks Good

Even though the number of men in the engineering profession has grown from twenty or thirty thousand in 1890 to approximately 400,000 at present, we are still short approximately 60,000 engineers this year. The September 1951 issue of "Fortune" magazine has an article entitled, "A Helluva Shortage of Engineers." In fact, they say that through 1952 and 1953, the shortage will be more critical to the nation than the shortages of steel, or chrome, or molybdenum or nickel or tungsten, or a dozen other materials that are only the base materials of engineering.

The supply of engineers is being decreased at the source; many prospective engineers are being siphoned off from our supply, and the demand is increasing continually. These are the reasons why the supply is getting so short. The misleading propaganda of 1948-1950 from the U. S. Bureau of Labor Statistics, which predicted a terrific over-supply of engineers in the post-war years, scared out many young men. This word was picked up by many popular national magazines. High school counselors (who are now quite common) took up the cry and warned students against becoming "dime a dozen" engineers. Secondly, many high school seniors rushed into service, rather than college, in hopes that they could get their service period over with and go on with normal life. The freshman classes in engineering schools all over the country have been extremely small for the last several years. The small group of depression babies is just now reaching college age, so, for several more years, the number of young men is below par. Emphasis on mathematics and science and the percentage of high school students taking those courses, which are so necessary for an engineering career, has been growing smaller in recent years.

Among the many other reasons why we are faced with at least ten years of shortage of engineers are:

1. When the veteran-loaded graduating classes approached 50,000, conscientious engineering educators scoured the small industries and found many willing to try an engineer for the first time. This has turned out so well that more small companies than ever before are now employing the engineers. This has greatly increased the market for young engineers.

2. There is a recent trend toward employing young engineers in semi-technical and non-technical jobs, where they have recently become rather successful.

3. A recent survey of several hundred of our largest corporations showed that about 40 percent of their executives had been scientists and engineers, thus creating a demand for more young engineers to fill in at the bottom of the ladder.

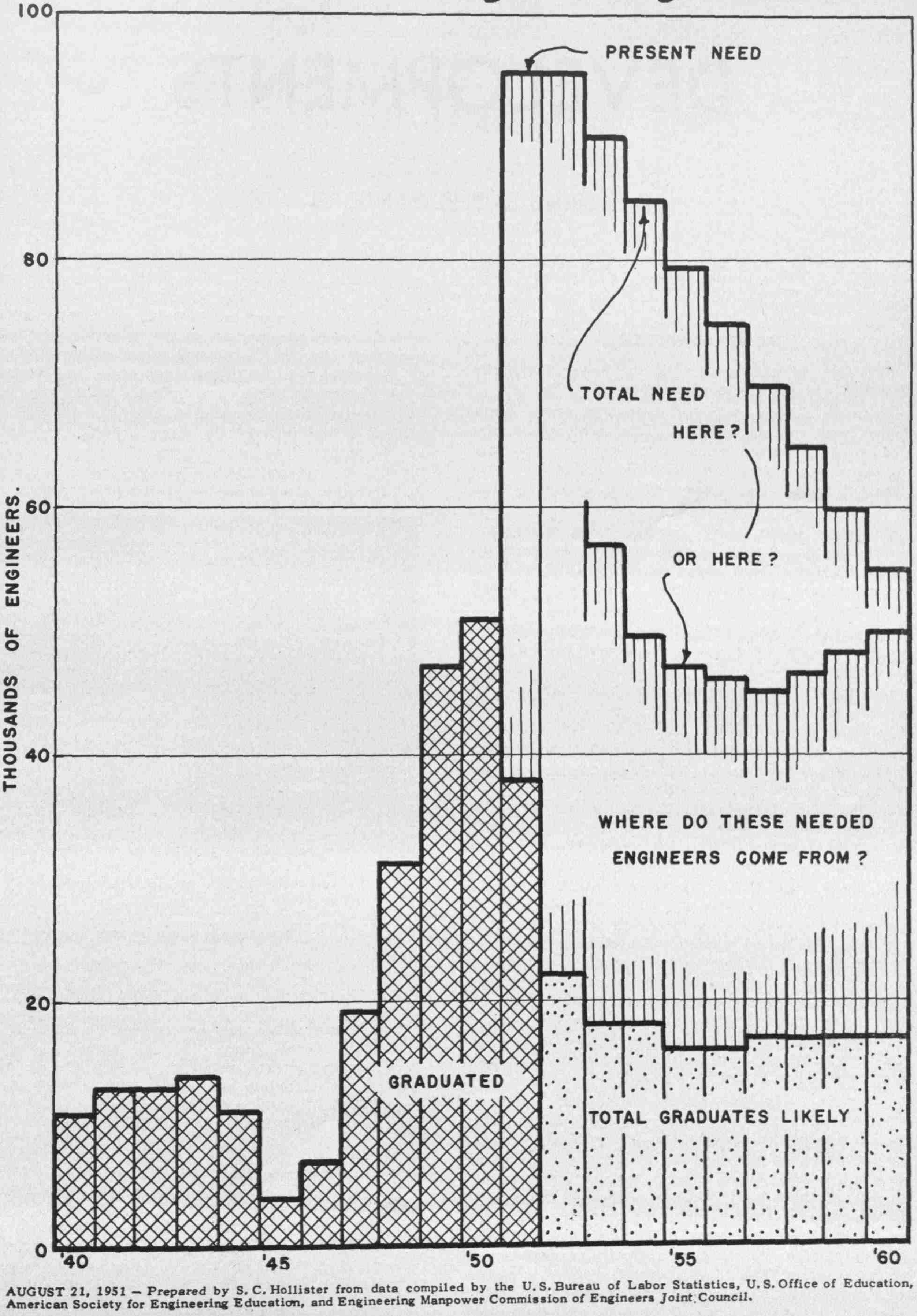
4. The military defense program will probably take from 30 to 50 percent or more of our graduating engineers in the next few years.

5. Merely to keep our technical staff stable, U. S. industry needs a minimum of 30,000 new engineers each year. The production of engineering graduates is tapering off from 25,000 in 1952 to a possible low of 12,000 in 1954, and don't forget that the military will take many of them.

In the face of all these conditions, the need for engineers has been increasing, first, steadily, and now, very rapidly. Our country has become increasingly technical. While industrial and governmental research and development has increased nearly 500 percent since 1941, the number of U. S. scientists and engineers has barely doubled. The aircraft industry says that it now takes three times as many engineers to produce a comparable military airplane as it did in 1940. Television, atomic energy, deep-freezers, the magic eye, and other electronic controls, require thousands more. The frenzy in the demand for engineers began shortly after the Korean outbreak. It was the straw which broke the camel's back in demand and supply of engineers. It resulted in a great deal of private and governmental development and plant expansion, which is already being limited, not by dollars, but by lack of technically trained men.

The shortage, far from easing, is growing worse. Even if educators should succeed in enrolling a terrifically large number of students in engineering schools next fall, it would be nearly five years before we could begin to offset our shortage. By that time, we fear it will take another five years to get back up to normal balance between supply and demand. Many of the larger companies, with every alert recruiting and personnel staffs, have been scouring the country, during early fall and winter, trying to grab everything in sight. Perhaps they are stock-piling talent, but somebody is going to be left holding an empty bag.

The Critical Shortage of Engineers



AUGUST 21, 1951 – *Prepared by* S. C. Hollister from data compiled by the U. S. Bureau of Labor Statistics, U. S. Office of Education, American Society for Engineering Education, and Engineering Manpower Commission of Engineers Joint Council.

NEW DEVELOPMENTS

Edited by PHIL SANFORD

POWER CURVE TIRE

A product of ten year's work, the Power Curve rice field tire will not bog down in mud or sandy soil.

Featured on the new high-flotation tire are an open-center tread and slanted nose cleats. The open center tread permits flexibility needed for effective self-cleaning action, while the forward-slanted nose of each cleat bites into the soil and compresses mud or sand to allow a firmer footing.

This cleat action resists bogging down, allowing a maximum drawbarpull. As the cleats release from the earth, the slanted nose helps clean the tread because the angled surface provides no niches to which mud and straw may cling.

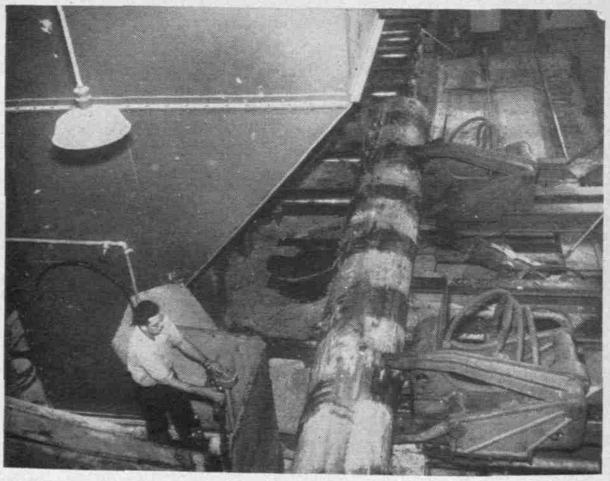
Each cleat is extra high at the shoulder to allow a deeper bite, and each cleat is kept rigid by the brace of its curve.

★ ★ ★

LUMBER SAWING

One of industry's most spectacular operations is the sawing of logs into lumber. The log, perhaps a douglas fir in the Pacific Northwest, may be up to 8 feet in diameter, 30 feet long, and 20 tons in weight. It is placed on a log carriage, which shuttles back and forth before the continuously running bandsaw, under the sawyer's control. The sawyer's job is one requiring great skill, for it is one of judging each log and making rapid decisions as to what sizes and shapes of stock to make out of the log, to insure the total value of the product of log being the largest possible. He follows his decisions by signalling his carriage-borne assistant or assistants in a sign language peculiar to his trade, and by appropriately manipulating the carriage drive control. Anything that can be done to reduce the physical effort involved in these manipulations will reduce the sawyer's fatigue and enable him to do a better job, resulting in a more profitable use of his raw material.

Two amplifying devices were paired last year to do this. They are the Rotorol and magnetic amplifier. Together, they permit control of the powerful output of the adjustable voltage DC log carriage drive from a small, very low effort, sawyer's master switch. This combination gives the sawyer "finger-tip control" of carriage movements. Any speed from maximum to zero and to maximum in the reverse direction is obtained by the movement of the master switch handle through a travel of only 11 inches and a force never exceeding the weight of a man's hand. The switch itself incorporates a slight modification of the series of metal leaves with silver contacts, such as are used in the Silverstat regulator. Successive closures of contacts are made by applying an increasing pressure to the outer leaf. The resulting small changes in current are built up by the combined amplification of the magnetic amplifier and Rotorol, and applied to the field of the drive generator where it acts to control drive speed. By means of a feedback in the system, accelerating rates are automatically limited to safe values and running speeds are held constant.



Overall view of sawing operation

STEEL CABLE SPLICING

A new method of splicing steel cable conveyor belting places all cables under equal tension during vulcanization.

This insures each cable of carrying its share of the load in the finished splice. The new method also allows only the straightest possible splice, resulting in belts which have maximum ease of operation. Tests on the belts have shown that the splice is as strong as anywhere else on the belt.

To make the splice, cable ends are cut in a staggered pattern, and small, lightly-crimped, tubular connectors are placed over the butted ends. The partially-made splice is then stressed to even the lengths of the cables, and the connectors are given a final crimping to lock them to the cable. Rubber and fabric removed for the splice is then rebuilt around the cables and the splice is cured under tension with a conventional vulcanizer.

(Continued on Page 36)

WORKERS are PEOPLE

By WILLIAM E. CRONKRITE

Industry spends millions of dollars every year in perfecting engineering techniques—more efficient machines, production methods, plant layouts, controls, etc. Millions more are lost due to strikes and labor disputes. But with all their machines, methods, labor contracts, etc., they are of little value if they cannot get men to put them into a functioning unit. It seems then, that men are an important part in the complete production process. If these engineering and management techniques are to function with utmost efficiency, the problem of profitable labor management relations must be considered an important part of an engineer's program.

It is ironic that the most technically, mechanically and industrially advanced people would have waited until such a relatively recent date to begin studying the most important source of productivity—the human will to work. Even more ironic is the fact that it should be such a hard thing for many top management men to understand, even today.

At a recent conference for Industrial Engineers at M.S.C., several problems of represented firms dealt with the acceptance, or rather nonacceptance by their workers of new machines and methods. In all the discussion pertaining to these problems, very little thought was given to the basic rules of human understanding. "Tell them why and that it is necessary," was the stem of most solutions offered by these firms, or "they'd accept it at our plant or else." Those are not solutions to any problem. With proper labor-management relations there would be no problem in the first place.

Some plants reply, "We do have good labor management relations. We have a meeting with labor representatives every other week." Yes, but meetings of this sort are too formal. In a typical meeting of this kind, the men are friendly, in good humor, and to all appearances the meeting seems to run smoothly, but, in reality, an atmosphere of tension reigns. The cause of this tension is that neither side trusts the other. The meetings are, underneath, a series of demands and counter demands. The men in management are too far away from the workers, and the workers too far away from the problems of management, with no one in between that both can trust.

Meetings of this kind are important, but something must be done to rid them of the tension. In the past, both sides have been burdened with deep emotional attitudes that are difficult to shake, and so today, bargaining is at arm's length between mutually suspicious parties. Each party feels like the fellow arriving at the "pearly gates" after a fatal accident, still maintaining he had the right of way. The blame cannot be placed on either side, nor can management wait for someone else to change. Management must outline a program for better labor management relations to bring about greater productivity and begin carrying out this program now. Management must take the first step!

What does the worker want? He wants security and the right to work continuously at reasonable wages. He wants to be treated as a human being rather than a number. He wants to feel that he is contributing something to the overall process, rather than being an animated part of some machine. When management recognizes its employees as individuals first and workers second, it will find that it has better workers.

Incentive plans, profit sharing systems, merit raises and high wages haven't been very successful in increasing production because they have been abused in the past. The unions were first organized to give a voice to some of these resentments, desires and problems. The power of this force increased as the membership in the unions rose from three million members in 1932 to over fifteen million members by 1948. Approximately one third of the workers in manufacturing and two thirds in non manufacturing work are covered by some union. Higher wages have not played the most important part of union bargaining. Some of the industries that have had the most strikes, have had the highest wage standards. Management cannot reach the workers on any intimate basis until they have built an honest, straightforward attitude toward the worker as a person.

This sounds like a campaign just for the worker's benefit. It is not. It is a campaign to make management realize the dollar and cents value to them in adopting such a program. There have been workers that actually would take a chance on letting a mistake go by them rather than report it to their boss. Other workers have said that they would probably pour soft drinks down the drain if they were furnished free to them. So, actually here is a tangible, almost untouched asset to any company, large or small.

There are a number of fine examples throughout the country of management bringing about higher productivity through the human element of personal regard for their employees. The president of one such organization best expressed the attitude of their policy when he said, "I remember how I wanted to be treated when I was at the bench, and I try to treat the people in our business that same way." He realizes how quickly some people in management forget just such things as treating others as you would like to have been treated. This plant has a loudspeaker system that reaches every one of its eight hundred "associates," as all employees are called. Through this system the officers of the company keep in touch with all workers, keeping them informed of all business activity that will in any way affect them, for here, all those whose efforts go into the manufacturing process share in the profit. Has this policy paid off? They can boast of one of the highest production rates

(Continued on Page 34)

WITH OUR ENGINEERING ALUMNI

By AGNES McCANN

Engineering Enrollment Officer

If a history of the achievements of our Engineering Alumni is ever written, we may be sure that Chapter One of each biography will tell of his early life and college activities. It is this thought that prompts me to reminisce a bit as I write about them for the Spartan Engineer.

First, I think I shall tell you something about Donald John Clark, whose home was at Algonac, Michigan, and who entered Engineering in the Fall of 1940. His training was interrupted during the spring term of 1943 by the war, and he spent the next three years as a Radio Technician in the Navy. Don returned to college in the winter of 1946 to complete his work and immediately entered into student activities by helping to reorganize and re-establish student organizations and professional societies such as A.S.M.E., of which he was Vice-President. His services in helping to orientate the large freshman class of the fall of 1946 will long be remembered by those of us who worked with him that year. Don accepted a position with the Standard Oil Company when he graduated in 1947, and was assigned to the Port Huron, Michigan, area. The company later sent him to the Standard Oil College at Gary, Indiana, and he was rated one of the ten highest in a class of 300 men. He has recently been promoted from Service Representative to Industrial Sales Promoter for the Saginaw area. On January 14, the Port Huron Junior Chamber of Commerce named him "Young Man of 1951" for that city, in recognition of his outstanding services in many different kinds of civic work. His wife, the former Betty Baker, Bus. Administration major at M.S.C., and their young son, Donald John II, will soon join him to make their home in Saginaw. (I hope Don never finds out that Betty sent us the clipping from the Port Huron Times Herald.)

Miss Ethel V. Lyon, Ch.E. 1933, of Charlotte, Michigan, has the distinction of being the first girl to receive a B.S. degree in engineering at Michigan State College. While in college she served as part time secretary to Prof. Reed, Head of the Department of Chemical Engineering, and was active and interested in all college activities. We who knew her in college will always remember her as a very amiable and energetic young lady. Since graduation she has proven that there is a place for young women in the engineering field. Her first position was with the Grand Rapids branch of the Consumers Power Company where she served as Illumination and Home Lighting Advisor. I believe it was about 1941 when Ethel accepted a position as Chemist for the Hercules Powder Company at Kalamazoo, Michigan. At the close of the war she became Chief of Library for the National Advisory Commission for Aeronautics with headquarters in Cleveland. Her duties are in connection with the Lewis Flight Propulsion Laboratory, and are in the field of aeronautics, power plants, turbojet, rockets, etc. Perhaps same day she will drop in and tell us of her experiences.

Howard Berkel, B.S. in C.E. in 1931 and M.S. in C.E.

in 1933, came to the college from Muskegon Junior College and entered with junior rating. He immediately became active in the A.S.C.E., and it was not long before he was well known on the campus. After receiving his B.S., he remained for his M.S., and was appointed Graduate Assistant in Civil Engineering. Upon completion of his work, he went with the Coast and Geodetic Survey in Muskegon County, but left that position in 1935 to accept a teaching position in Civil Engineering at Iowa State College. In 1942 he was commissioned in the Army Air Forces and was Director of School Facilities at the Army Air Forces Training Center at Orlando, Florida. After the war he went with Hall and McChesney Inc., of Syracuse, N. Y. as Vice-President. Last September he joined the Carrier Corporation at Syracuse as Assistant to the Vice President, where he is in charge of organization, planning and development of that company.

You may be interested to know that Keith Hunt, Ch.E. 1947, is no longer with the H. R. Trerice Co., and that he is now located at Wheaton, Illinois. He is Business Manager for the Inter-Varsity Christian Fellowship Association, with headquarters in downtown Chicago. This organization, which is interdenominational, has for its objective the presentation of Bible Truths to students of college age. The first chapter was started at Oxford, England, in 1870 and was brought to Canada in 1939. There are now more than 300 chapters in the United States, and one at both the University of Michigan and Michigan State College. The group publishes the magazine "His." When Keith was in college he was active in the Spartan Christian Fellowship, A.I.Ch.E., and Tau Beta Pi. He also worked part-time as student assistant in the Classification Room 109 O.H., so many of us know him very well and we wish Keith, his wife the former Gladys Schremer, M.S.C. '48, and their son Mark, the best of everything in their new endeavor.

Early in January we received a long New Year's letter from Ed and Laura Humenny. Ed finished Chem. Engr. with the class of 1947. When he first entered college he was in Applied Science and then changed to Engineering in his sophomore year. He, like the others in R.O.T.C., was called into service and was in the European area for several months. He was a German prisoner of war, and when the Americans liberated his camp, a former classmate, Charles Fiske, was in the group. After getting his B.S. and Ch.E. here, he went to Harvard and earned a M.S. in Business Administration. Ed, his wife, the former Laura Austen of Memphis, Tennessee, and their two sons, Edward age about 4, and Bradford age 10 months, moved into their new home at 508 Princeton Circle, East Fullerton, California, recently. His place of business is in Los Angeles where he is Business Manager for the Synthetic Rubber Company.

Many of the class of 1942 will remember Jorma Sarto, better known as "Ole." He finished from M.E. and was selected for the Graduate School at Chrysler, receiving his Master's Degree from that Institute in 1944. At the present time he is in charge of the Research Section of the Fuel Systems Laboratory at Chrysler Central Engineering in Highland Park. His work consists of research and development on both reciprocating and gas turbine engine fuel systems and automatic controls. He has also done considerable work on domestic heating (Chrysler Airtemp), fuel systems, controls, combustion and automotive carburetion. Besides all of these duties, he has found time to prepare for and pass the State Engineers' Registration examination, and is active in the community in which he lives. Some of his many activities are Editor of the Westacres Weekly, a community paper; member of the Union Lake School P. T. A.; Elder, Orchard Lake Community Church, and also a member of the choir; Secretary of West Lakes Lions Club, and many others. He had a good background for community living because at State he was Vice President of Tau Beta Pi, a member of Phi Kappa Phi, Green Helmet, Intramural Basketball, Treasurer of Student Club, member of Engineering Council, Glee Club, and won first place in the regional contest for the A.S.M.E. He married Frances Hamilton, M.S.C. '44, and they have two little girls, Mary Frances and Andrea Jo, and live at 7560 Honeysuckle, Walled Lake, R. 1, Michigan.

The Detroit Edison Company has just announced that Mr. Henry E. Macomber, M.E. 1917, has been appointed Chief Engineer of Power Plants. Mr. Macomber went with the Detroit Edison Company as an Assistant Engineer when he graduated. In 1946 he was made Mechanical Engineer of Power Plants for the Production Department, and for the past three years he has been Assistant Chief Engineer of Power Plants. In his new duties he will be in charge of the Production Department and will be responsible for the operation of the company's power plants. In 1950 Mr. Macomber spent three months in England as a member of the Economic Cooperation Administration, (ECA) where he made a study of England's power plants and made recommendations to assist England to overcome her severe electric power handicap. While in college Mr. Macomber was interested in civic activities and was a member of the Eunomian, now Sigma Nu fraternity, Beta Sigma, Tau Beta Pi and the Cap Night Committee.

Lee W. Sparling, E.E. 1927, has recently been promoted to Assistant Superintendent of St. Clair Power Plant for the Detroit Edison Company. Upon graduation Lee went with the Michigan Electric Power Company, Port Huron Division, and was operating engineer when it was taken over by Detroit Edison. In his new position he will be in charge of the St. Clair Power Plant, responsible to the superintendent. When in college Lee was a member of the A.I.E.E. and of the AeTheon Fraternity.

John R. Hamann, M.E. 1937, is the third M.S.C. alumnus to receive an outstanding promotion by the Detroit Edison Company. He has just been made Assistant Superintendent of Conners Creek Power Plant. His duties previous to his promotion were that of Technical Engineer. Jack will continue, we understand, with his plant personnel work and will be in charge of the plant in the absence of the superintendent. He went with the Detroit Edison when he graduated as mechanical engineer and except for a leave of absence during the war, he has been continuously in their service. In 1940 we had the pleasure of renewing acquaintance with him when he was stationed as an Army officer with our R.O.T.C. Unit. I'll try to tell you a few things Jack did while he was on campus as a student. He was a member of Theta Kappa Nu, President of the Inter-Fraternity Council, Member of Tau Beta Pi; Excalibur; President of Blue Key; Scabbard and Blade; Freshman swimming, A.S.M.E. and was listed in Who's Who in American Colleges.

When Robert Kitchen asked me to write this column, he said "just a short article" about some of our alumni. The hint is hard to take because there are so many pleasant memories associated with the boys who have graduated that it would be fun to write on and on. Perhaps sometime later the pleasure will again be mine and until then—best wishes to all of our graduates.

For Nofer Trunions

Ed. Note: Our business manager had a little trouble deciding what this was all about, so if one of our readers would take the trouble to explain it to him, we would be very grateful as the editorial staff is over burdened.

Work has been proceeding in order to bring to perfection the crudely conceived idea of a machine that would not only supply inverse reactive power for use in unilateral phase detractors, but would also be capable of automatically synchronizing cardinal grammeters. Such a machine is a turbo-encabulator.

The original machine had a base plate of prefabulated amulite, surmounted by a malleable logarithmic casing in such a way that the two spurving bearings were in a direct line with the pentametric fan. The main winding was of normal lotus-o-delta type placed in the panendermic semi-boloid slots in the stator, every seventh conductor being connected by a non reversible tremie pipe to the differential girdelspring on the top end of the grammeters.

Forty one manestically spaced grouting brushes were arranged to feed in into the rotor slipstream a mixture of high S value phenylhydrobenzamine and 5 percent reminative tetryliodohexamine. Both of these liquids have specific pericosities given by $P = 2.5\ CN^{6.7}$ where N is the diathetical evolute of retrograde temperature phase disposition and C is Cholmondeley's annual grillage coefficient. Initially N was measured with the aid of a metapolar refractive pilfrometer, but up to the present date nothing has been found to equal the transcendental hopper dakascope.

Undoubtedly the turbo-encabulator has now reached a very high level of technical development. It has been successfully used in operating nofer trunions. In addition whenever a barescent skor motion is required it mav be employed in conjunction with a drawn reciprocating dingle arm to reduce sinusoidal depleneration.

Phi Kappa Tau
Rensselaer Polytech

SPARTAN ENGINEER FINANCIAL REPORT
1950-1951

Published for the information of the Publications Board

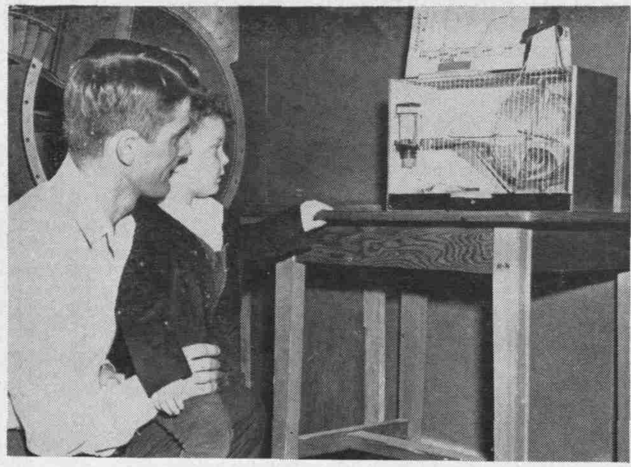
INCOME

Subscription (to editor's father)	$ 1.00
Advertising	27.65
Sales	3.25½
Editor's hobby (printing $5 bills)	7,945.00
Feature editor's hobby (basement refinery)	8,327.75
Offerings collected by business manager while posing as deacon at church	749.01
Business manager's trip to bank (2 a.m.)	3,052.00
Sale of typewriter to Spartan	200.00
Sale of old lab reports	1,378.22
Sale of old exams	3,198.36
Office rental (to undertaking firm)	13.13
Sale of Tau Beta Pi key	1.10
Deposit refund on empty bottles	12,487.82
Commission on engraving	248.00
Sale of filing cabinets	54.40
Total income	$ 38,163.19½

EXPENDITURES

New filing cabinets	$ 850.00
Printing costs	7,336.27
Bribes for articles	10,755.51
Salaries	35,247.43
Engraving	912.24
Conference trip expenses	800.04
Bad debts	1,021.58
Bum checks	530.98
Telephone	
Business	.50
Social	914.75
Straight jacket for editor	38.50
Straight jacket for assistant editor (those women)	1.272.95
30 two-way wrist radios for final exams	1.457.12
Cadillac for business manager	7,500.29
Cadillac upkeep and operation	18,748.62
Embezzlement by staff	23,269.60
Tickets for J-Hop	75.00
Law suit by Purdue Engineer for "borrowing cuts"	2,000.00
Circulation to friends and relatives	24,366.25
Giants to win World Series	750.00
Fur coat for cute blonde on 3rd floor West Landon	1.437.84
Binoculars for late evening work	385.78
Diapers for Moose	300.00
UNCLE MILTIE to win	4,539.80
Christmas presents for staff	225.09
"Coke"	18.168.22
Chasers	4,755.47
Chaser to chase the last chaser	1.80
Cigarettes	759.27
Cigars	1.024.14
Staff banquet	632.85
Illegal parking tickets	218.72
Dues for Engineering Council	5.00
Parties	4,500.00
Haircuts for the editor	24.50
Unaccounted for and miscellaneous	20.000.00
Miscellaneous and unaccounted for	5,000.00
Total expenditures	$199,766.11
Deficit	$161,602.91½

IN VIEW OF OUR FINANCIAL REPORT THE SPARTAN ENGINEER INVITES YOU TO MAKE APPLICATION FOR STAFF POSITIONS ON THE THIRD FLOOR OF THE UNION


A future engineer looking-on at the 1951 Exposition


"Miss Engineer of 1952?" Can you top this?

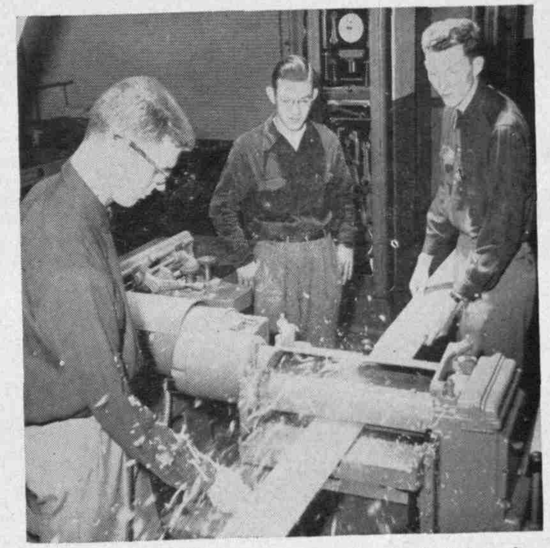

The industrial layout display by ASME

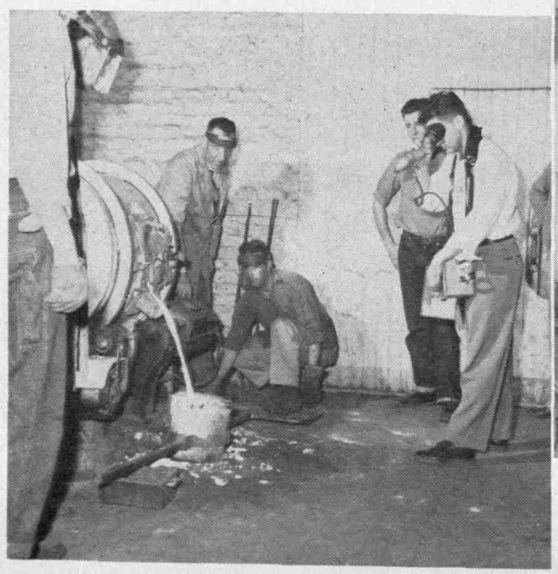

The cut-away jet engine at last year's Exposition

GETTING READY FOR MAY 9 and 10, 1952

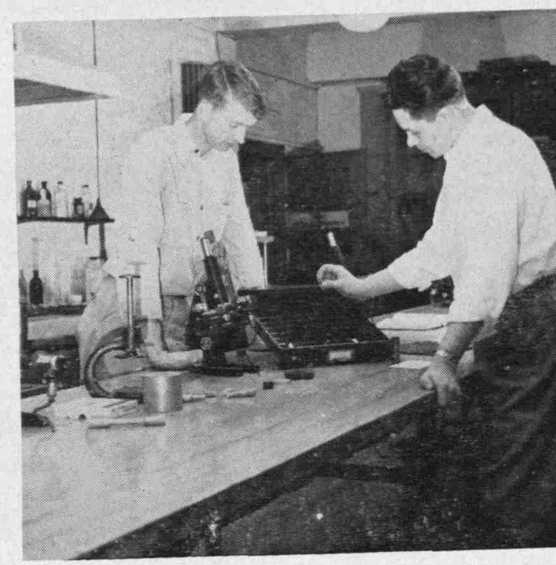
Pictures by CARL ROMI[illegible] and DOT MARKLE

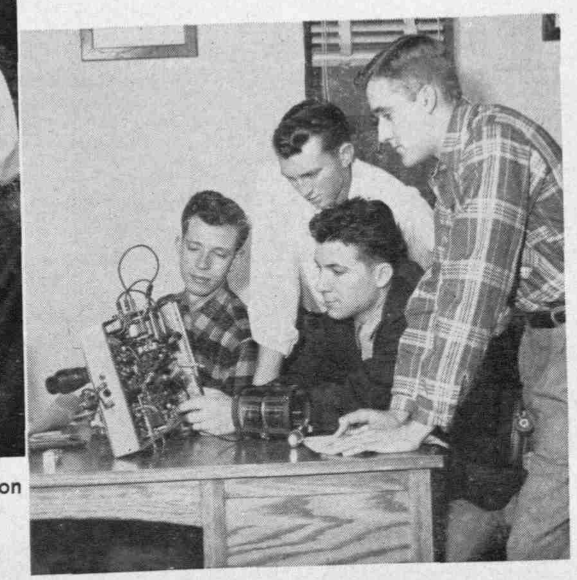

Ag. Engineers working on the "Jolly Trolley"


Phi Lambda Tau working on a giant slide rule


Pouring at the foundry—demonstrated by AFS


Breaking a concrete test specimen in the C.E. Lab.


ASM working on display for this year's Exposition


Eta Kappa Nu hard at work?

MENTAL GYMNASTICS

Edited by L. B. MILLER

The "Engineer" has something new. This page is to give you something to think about during your spare hours in the grill or wherever you spend them.

Here is one that is simple as far as algebra is concerned, but which requires a little logic.

This one is fairly easy to get you off to a good start.

A captain is twice as old as his ship was when the captain was as old as the ship is. The sum of their ages now is 49. How old is the captain now?

★ ★ ★

A tramp was three fifths of the distance across a railroad trestle when he saw a train coming at him. He could run ahead the remaining two fifths of the distance or backward at a speed of 12 m.p.h. and reach either end of the bridge at the same instant the train got there. How fast was the train going?

★ ★ ★

This one we ran into several years ago in some mathematics course. If the earth is a sphere 25,000 miles in circumference, and a string were stretched around that circumference, how much longer would the string have to be in order to raise it to a uniform height of one foot above the earth?

★ ★ ★

All you have to do here is find what number each letter stands for. Each different letter stands for a different number.

```
          C E G
      -----------
H D E | A B C D E F
        A A J H
        -------
          G A C E
          K E H B
          -------
            K K H F
            C B G D
            -------
              G F B
```

★ ★ ★

For those who are considering bookmaking after they finish their engineering course, here is one with a few odds involved. We have three cards which are placed in a hat. One card is red on both sides, one is white on both sides and the third is red on one side and white on one side. If you draw out one card and lay it on the table and you see a red face, what are the odds that the reverse face is red?

★ ★ ★

Snow began to fall at a steady rate. A snow plow started out at noon and went one mile at the end of the first hour. By the end of the second hour it had traveled a mile and a half from its starting point. What time did the snow begin to fall?

★ ★ ★

If you found these fairly easy this one should make you think a little, even if you've solved it before. One of twelve pennies is counterfeit and it must be found with the use of a balance. Not knowing whether the penny is heavy or light, find it in three weighings on the balance.

★ ★ ★

Tourist Guide: "We are passing the largest brewery in the United States."

Engineer: "Why?"

JETS-O-GRAM

By RALPH PAUL

Instructor
Engineering Drawing Department

JUNIOR ENGINEERING FOR SCHOOLS is a program to help high school students evaluate their interest and ability in engineering. A weekly newsletter entitled JETS-O-Gram is being sent to JETS Clubs carrying news, projects, and information of interest to members. The editors of the Spartan Engineer are cooperating in the program by alloting space for a JETS-O-Gram column. The column will replace the regular issue of JETS-O-Gram for the week in which the Spartan Engineer appears.

Members of the School of Engineering are making trips to high schools to assist in starting new clubs. Recent trips have been made by Professor Flory, Mechanical Engineering Department, to Rochester; Professor Baccus, Head of Electrical Engineering, to East Grand Rapids; Professor Renwick, Mechanical Engineering, to Belding and Greenville; and Professor A. J. Smith, Head of Metallurgical Engineering, to Niles, Michigan.

Student engineers at Michigan State are also encouraging the JETS program by suggesting their home town high schools as sponsors of new JETS Clubs.

RELATIVE VELOCITIES

"What's the big hurry?"

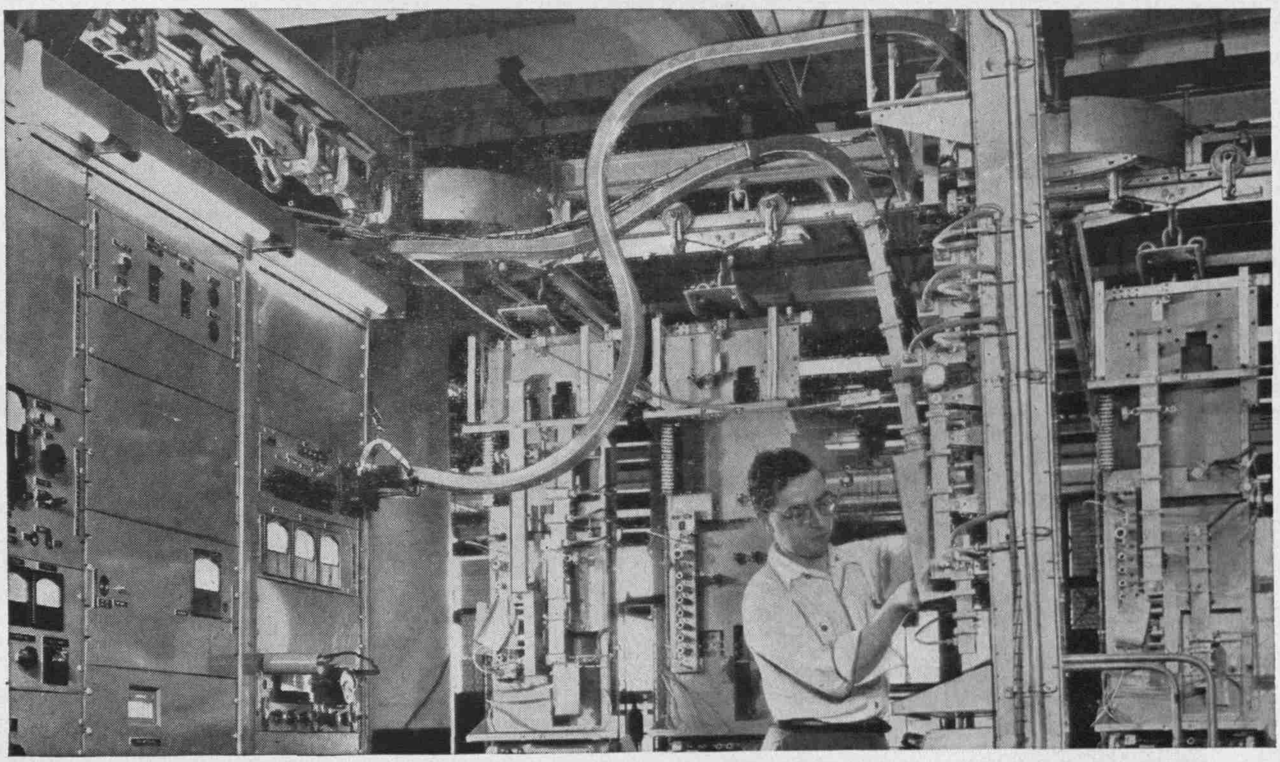
"My tail light is out, officer, and I was afraid that unless I drove 90 miles an hour someone might smash into the rear of my car."

ENGINEERING EXPOSITION

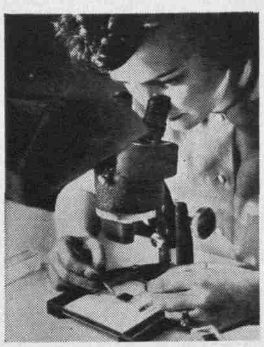
Each week brings us closer to the Engineering Exposition. Have you marked the date on your calendar? Remember! It is May 9 and 10.

There will be many varied and interesting exhibits. A big event for JETS members is the projects' contest. How are those projects coming, Engineers?

Where engineering and pioneering go together!



The transmitter-receiver bay unit being worked on by a Western Electric tester, is part of the complex equipment installed in the Bell System's coast-to-coast microwave relay towers. Special testing equipment is at the left.



Operator inspects a grid blank. The grid controls the flow of power through the tiny electron tube which is the heart of radio relay. Western Electric engineers designed machines to wind wire .0003 inch in diameter on the grid at 1000 turns per inch—spaced exactly .0007 inch apart.

COMPLETION last Fall of the Bell Telephone System's coast-to-coast radio relay route climaxed a production feat that involved doing many things never done before.

The engineers at Western Electric—manufacturing unit of the Bell System—were treading on uncharted ground when they tackled the challenging job of making the highly complex equipment.

This radio relay equipment—which transmits telephone and television signals at a carrier frequency of four thousand megacycles per second—called for many components never made before and for which no machinery, no tools, no assembly processes were known. Some components required almost unbelievably tiny parts—and fantastically small tolerances.

Manufacturing facilities and techniques had to be developed to assemble and wire the complicated equipment which receives signals having less than 1/10 millionth of the power of an ordinary flashlight bulb—at frequencies ten times as high as those used in television sets—amplifies these signals 10 millionfold and transmits them to the next tower some 30 miles away.

Finally, Western's engineers were responsible for installing the equipment in 107 towers across the nation.

In all phases of this job, engineers of varied skills worked closely together as a team which just wouldn't be stopped merely because "it hadn't been done before." That's typical of work at Western Electric—where engineering and pioneering go together.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

BELL SYSTEM

When You Find the Work You Like
STAY WITH IT!

GORDON W. CLOTHIER

by GORDON W. CLOTHIER, *Manager, Transformer Section, Electrical Department*
ALLIS-CHALMERS MANUFACTURING COMPANY (*Graduate Training Course 1938*)

THAT'S a good plan, but there's just one little catch in it; sometimes it takes a good while to *find* the work that's right for you. If you're worried about that, perhaps my own experience will point out a practical shortcut.

I got my E. E. at the University of Washington in 1935, and went on with graduate work and teaching for another year. Then—into the practical business world. That's when I found the shortcut. I enrolled in the Allis-Chalmers Graduate Training Course in 1936, and very soon I got interested in the big transformers. I've been with them ever since, and they've given me a lot in accomplishment and satisfaction.

Back to Stay

Of course, during two years in the Graduate Training Course I got around a good deal in the big West Allis works. Had some time in the shops, got acquainted with the work of many departments, tried my hand at design, test, sales application work. But I came right back to transformers and have always been a lot more satisfied because I'd seen a broad range of other types of products and work at Allis-Chalmers.

In 1941 I became engineer in charge of transformer sales, and in 1947 was made manager of the transformer section.

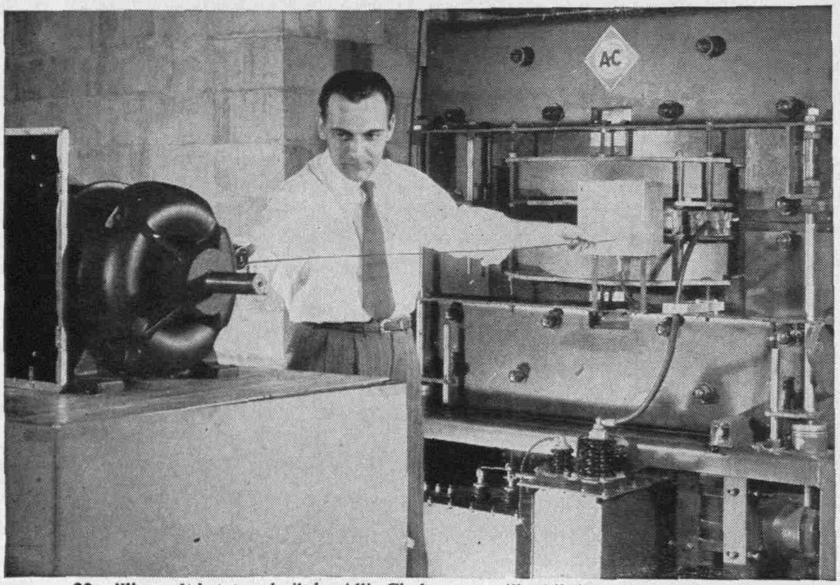
This field offers both challenges and rewards. It needs and seeks men of superior intelligence, imagination and creative ability—men who will strike out into new paths of study and development.

If you think a transformer is an inert mass of iron and copper windings in a tank of oil—look closer. There are advanced problems in magnetostriction that if solved, will eliminate transformer hum and revolutionize the business. It's the same with problems in metallurgy, insulation, measurement and control of electric field shapes and the effects of time on materials. Perhaps some young engineer, even during his Graduate Training Course days here, may make important contributions. The opportunity is waiting.

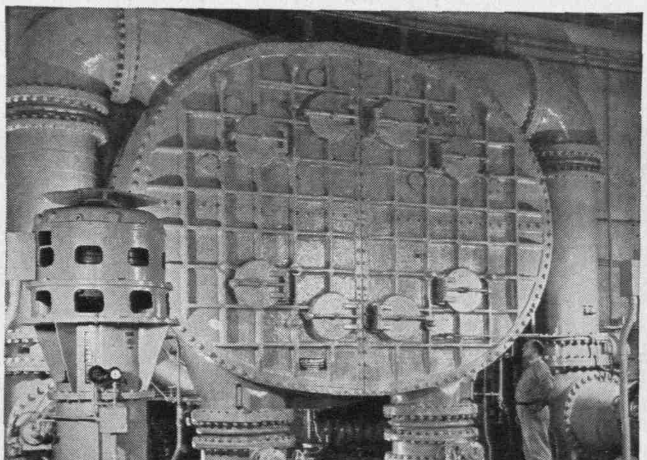
What Do You Want to Do?

It's the same in other departments at Allis-Chalmers. Ore processing methods and machinery—electronic equipment—public works—steam turbine and generator design—hydraulics—manufacturing—research—sales—they all hold opportunities. Here you'll have a chance, as a Graduate Training Course engineer, to look over the widest range of industrial fields covered by any manufacturing firm in the country. You can help plan your own course, get advanced degrees. It's a shortcut to finding the work of your choice.

Write for information and literature, or call on the Allis-Chalmers district office in your locality.



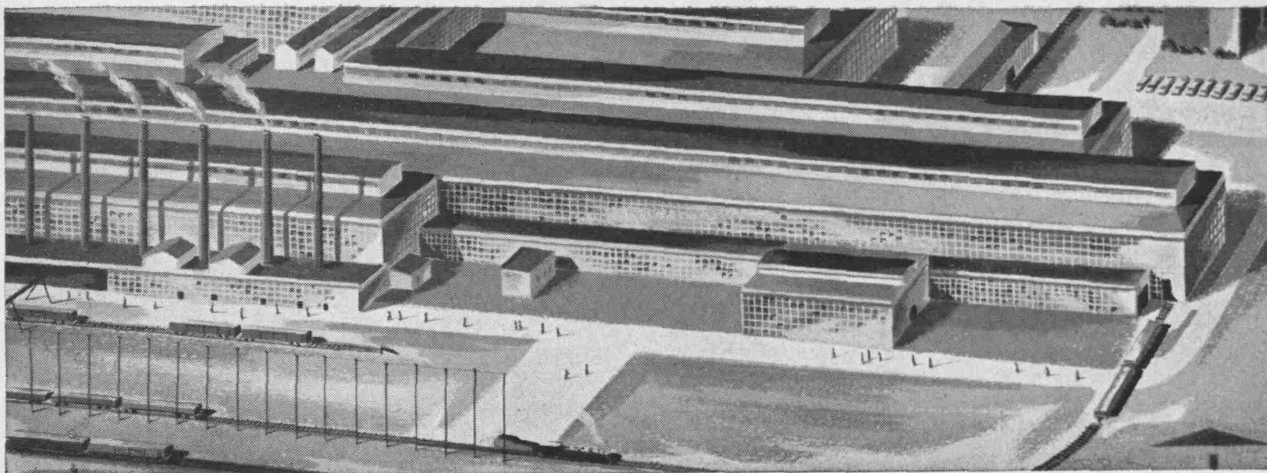
22-million-volt betatron built by Allis-Chalmers can "look" through 20 inches of steel to detect flaws. Here a technician is setting up motor specimen for radiography.



Two-pass 45,000 sq. ft. surface condenser and two 42" x 30" vertical mixed flow pumps. Allis-Chalmers oval design saved space in this big new power plant.

ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin



MAGNESIUM MILESTONE

at Dow's new Madison Plant

A significant development in magnesium is taking place at Dow's newly acquired magnesium plant at Madison, Illinois. Dow, long a pioneer in the production and fabrication of magnesium, is installing the *first and only continuous magnesium rolling mill in existence today.*

Other mills for magnesium are hand operations in which 140 lb. slabs are broken down and magnesium rolled a sheet at a time, a maximum of 48 inches wide. Dow's new mill will process 2,000 lb. slabs on 84 inch coils, marking a tremendous advancement in production methods and resulting production capacity.

The Madison plant, which has 1,400,000 feet of floor space and 110 acres of land within its boundaries, will house not only this magnesium mill but also facilities for extrusion and alloy operations. It is but one of the many new developments that indicate the continual growth and expansion taking place at The Dow Chemical Company.

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

THE DOW CHEMICAL COMPANY
Midland, Michigan

DOW
CHEMICALS
INDISPENSABLE TO INDUSTRY AND AGRICULTURE

AIRCRAFT NUCLEAR PROPULSION

(Continued from Page 9)

physicist, have a high neutron capture cross section. Unfortunately, it is not always easy to do this because some of the materials which are most suitable for use as reactor structure, and without which the reactor will not support itself, have rather high capture cross sections. These are thus poisons for the nuclear chain reaction although essential for the mechanical stability of the reactor. Obviously, we may increase the fraction of the neutrons which are absorbed in U-235 nuclei by increasing the proportion of U-235 present in the reactor. Unfortunately, this increases the amount of fissionable material invested in the reactor and since fisssionable material is extremely precious it is desirable to keep its investment to a low value. We usually, therefore, resort to the device of introducing into the reactor a **moderator.** A **moderator** is an element of low atomic weight and low capture cross section for neutrons. Because of its low atomic weight a neutron striking it loses a relatively large fraction of its energy in each such collision. Because of its low capture cross section, it does not capture many of the neutrons which strike it. After the neutrons are thus slowed down or moderated, their capture by the fissionable material in the reactor becomes much more probable since the cross section for capture of low energy neutrons is higher than that for high energy neutrons. Typical moderators are graphite, ordinary water, heavy water, beryllium and beryllium oxide.

The control of the chain reaction is in principle exceedingly simple. One of the most direct means of control is to arrange an absorbing rod so that it can be inserted into the reactor or withdrawn from it. If the rod is withdrawn from the reactor, it will absorb a smaller number of neutrons than before. If, in its original position, the rod was absorbing that number of neutrons which made the reactor just critical, (that is, neither rising nor falling in power) then withdrawal of the rods will create a slight excess of neutrons in the reactor and the power will begin to increase. Other methods of control have been proposed also. For example, in a reactor which has a reflector, removal of part of the reflector will allow the leakage of more neutrons than before. This will decrease the reactivity and constitutes a method of control. Also, removal of part of the moderator or of some of the fuel itself from the reactor will decrease the reactivity, and these expedients may also be used as control mechanisms.

It is evident that the control of the reactor is an important matter; not so much because of the very remote possibility that the reactor might turn itself into a low grade atomic bomb, but because if the power of the reactor fluctuates without a corresponding fluctuation in the heat removal capacity of the heat transfer system, the reactor inevitably will heat up. Over-heating, if sufficiently severe, can cause accelerated corrosion, warping or even melting of parts of the reactor. Evidently, too, it is important that the reactor not be operated without a flow of coolant through it since this certainly will result in serious damage if not destruction of the reactor.

Shield

A substantial portion of the energy of a reactor appears as kinetic energy of the neutrons and as ionizing radiation, such as gamma rays and beta rays. The neutrons and gamma rays, if allowed to escape with complete freedom from the reactor, would make it necessary for human beings to stay at a distance of more than a mile from a high powered reactor while in operation. Moreover, since the fission products themselves are radioactive and continue to emit gamma rays even after the chain reaction has been stopped, it would not be possible to approach the reactor very much closer than this even after it had been shut down. It is clear that a **shield** must be provided.

The basic requirements of the shield are dictated by the two basic types of radiation which it is desired to stop. The neutrons are slowed down most effectively by light atoms such as hydrogen, and moreover are more easily captured after being slowed down. For this reason an effective shield will contain light atoms such as hydrogen, which also is a good slow neutron absorber. Gamma rays, on the otherhand, are degraded in energy and stopped best by heavy elements such as lead. Hence, the shield normally will contain heavy elements also. It is clear that a mixture of light and heavy elements arranged in the most strategic fashion will be desired. For a reactor which is to be mobile it is important that the shield weight and dimensions be kept small.

Not only must the shield prevent escape of radiation from the reactor to the desired degree but also it must be capable of admitting and emitting the coolant which carries the heat away from the reactor. This means that ducts must pierce the shield and we are then confronted with the problem of leakage of radiation through these ducts. Generally speaking, gamma rays and neutrons travel in straight lines. However, under certain conditions they can be scattered or reflected around corners or curves. This confronts us with another difficult but interesting problem in the shield.

SOME PROBLEMS OF NUCLEAR POWERED AIRCRAFT

Shield Weight

The shield will be the heaviest single object aboard the aircraft. Early published estimates of shield weight placed the minimum shield at 50 to 100 tons, without any provisions for removal of heat. From this it is evident that a large aircraft will be required to carry a weight of this magnitude even though the aircraft need carry little or no chemical fuel. To a first approximation one may balance off the weight of the shield against the weight of the fuel load which would be carried in the large modern aircraft. However, every effort must be made to keep down the weight of the shield and the reactor. One obvious way to do this is to make the reactor small so that the shielded volume is kept small. This in turn restricts the amount of cross sectional free flow area through which coolant may pass through the reactor and increases the pressure drop. Moreover, as the reactor diameter decreases it usually is found that more fissionable material is required. This is undesirable. There is therefore a balance to be struck between the benefit of small shield weights resulting from decreased reactor size on the one hand, and the disadvantages resulting therefrom in smaller free flow area for coolant flow and larger fissionable material investment required.

(Continued on Page 30)

Security

A FAMILY had failed to make a living on a worn-out New England farm. Did they demand government subsidies, checks for crops they didn't raise, high prices for crops to be burned?

They would have scorned such things—scorned and feared, for they knew from days under a foreign despot that where government *money* goes, government *control* goes, too.

No, this family put everything they owned in that wagon, and *walked* beside it 2,000 miles, westward. They didn't know what was ahead, but they were determined to keep on going until they found a place of freedom where they could keep their self-respect.

They were English, Scotch, Dutch, Italian, French—people from many places—all, now, Americans. They knew that the only happiness is from self-respect, and the only way to self-respect is to earn your own way, not whine for something for nothing.

Their sons and grandsons started grocery stores, became mechanics, saved their money and started factories. American machines bought by American thrift made the factories grow.

And that's America. Made by people willing to walk 2,000 miles beside a wagon—to find opportunity. If such people are gone, if all we've got left are soft weaklings who want to be taken care of, then in truth American manliness is dead, that 2,000 mile walk was wasted, and there is nothing left of America but a hollow shell.

WARNER
&
SWASEY
Cleveland
Machine Tools
Textile
Machinery

YOU CAN MACHINE IT BETTER, FASTER, FOR LESS WITH WARNER & SWASEY TURRET LATHES, AUTOMATICS AND TAPPING MACHINES

AIRCRAFT NUCLEAR PROPULSION

(Concluded from Page 28)

Balance and Structure

The existence of a large concentrated weight such as the shield and the reactor at one point in an aircraft, makes it necessary to redesign the structure of the aircraft to accommodate this weight. Although large aircraft are designed for very large gross weights this weight is usually distributed over the wing and throughout the fuselage. Concentrating the weight in the fuselage greatly increases wing bending moments and necessitates structural redesign in many cases.

Large Landing Weight

The very fact that only a small amount of the fuel is consumed in flight means that the gross weight of a nuclear aircraft will be approximately the same on landing as on take-off. First, the landing gear must be made strong enough to take the higher gross landing weight. Second, the landing speed is increased and there may be a change in landing attitude which possibly could require changes in the landing gear, or in tall clearance angle requirements.

Heat Transfer

The essence of a nuclear power plant is the transfer of heat from the reactor to the propulsion machinery. The requirements for small size and high power density placed upon the aircraft reactor push the heat transfer designer to the limit of his knowledge. He must avoid hot spots in the flow system, he must have good flow distribution and he must know exactly how the power is distributed in the reactor so that he can supply the right amount of coolant to each part of it. If a surface be deprived of its coolant it will at once rise in temperature until it melts or disintegrates. The reactor is like a heat exchanger to which heat is constantly supplied whether it is taken away or not; only by maintaining the flow of coolant can trouble be avoided.

Fissionable Material Investment

The desirability of keeping the quantity of fissionable material in the reactor small, has been mentioned previously. It is obvious that this is desirable. However, the chain reaction will go in the reactor only so long as there is present a certain minimum quantity of fissionable material called the critical mass. As soon as the reaction has consumed so much fissionable material that the mass drops very slightly below the **critical mass,** the chain reaction dies and cannot be started again without adding more fissionable material. Moreover, the products of fission remain in the fuel elements and eventually must be removed. This makes it necessary to remove the remaining fuel from the reactor, purify it and prepare it for reuse. Thus, the uranium investment is not simply the amount of uranium carried aboard the aircraft but also that which is on the ground in various stages of preparation for use.

Radiation Damage

Some liquids or gases which might be proposed as reactor coolants are decomposed by radiation, and are hence not usable. Organic compounds are particularly susceptible, and even outside the zone of most intense radiation in the reactor ordinary lubricants turn tarry or even solidify. Lubricated machinery hence may not be used in such locations. Electrical insulation, on prolonged exposure to radiation, breaks down and disintegrates or loses its effectiveness.

There is here a large field of investigation, particularly in the physics of solids, where much work must be done in order to elucidate the effects of radiation damage, as this phenomenon is called, on the materials which might be used in an aircraft reactor, or in radiation exposed locations in the shield.

Escape of Radioactivity

It is evidently necessary to confine substantially all the radioactivity of the reactor within it. This imposes on the designer of the reactor another restriction. It is occasionally suggested that a nuclear aircraft will create a hazard to population in its vicinity. Inasmuch as the aircraft itself will carry a crew which must be protected adequately, persons at a distance will not be affected in any way.

Materials

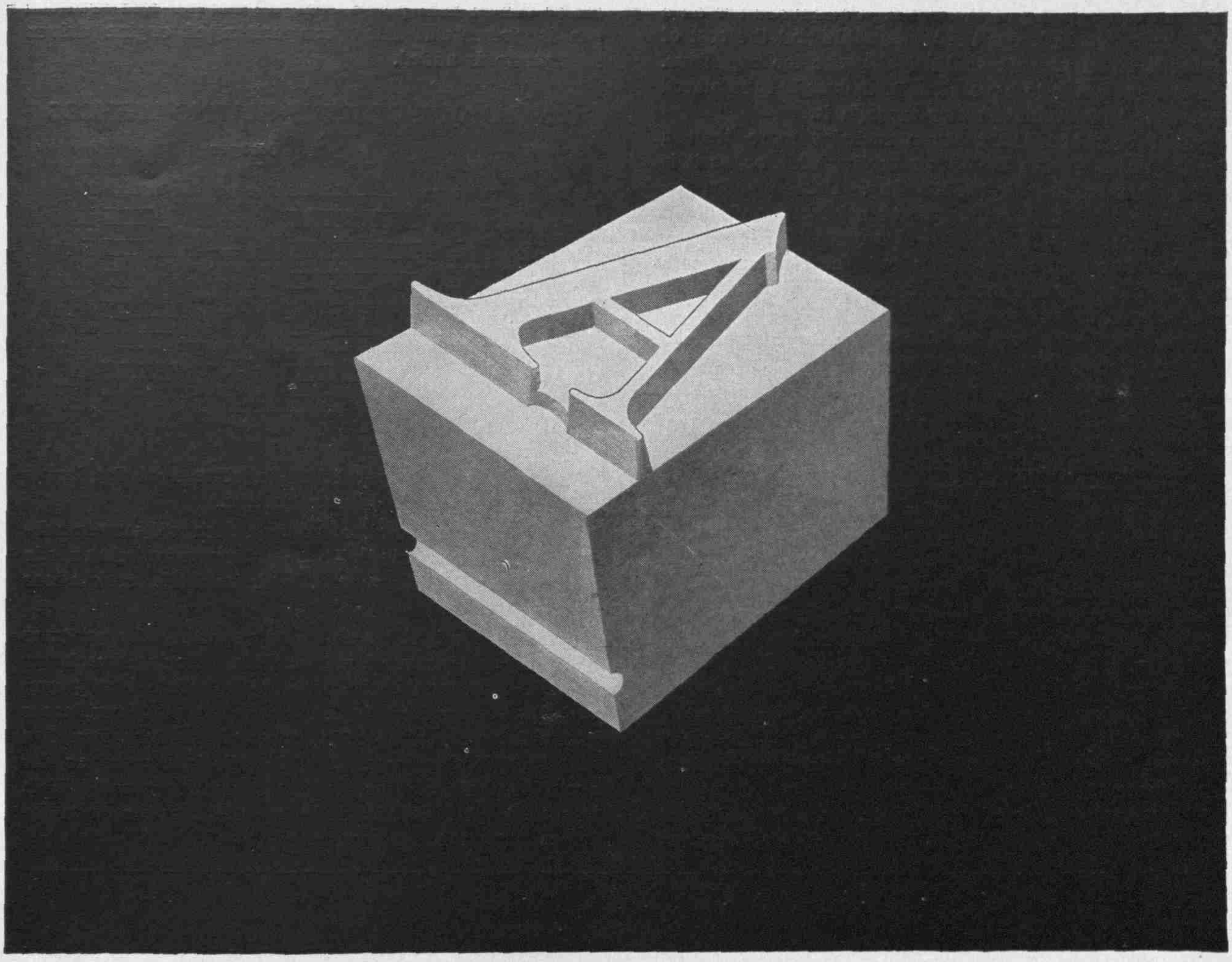
One of the most important problems in reactor technology today is the finding and development of materials adequate for use in reactors which are proposed for production of power in one form or another. The combined effects of high temperature, corrosion by various coolants, radiation damage, thermal stresses, and mechanical stresses can be extremely serious in some cases. The aircraft reactor presents these problems to an unusual and critical degree. For example, a difference of 100° F in permissible maximum reactor temperature can easily produce a 15 per cent difference in thrust output of the power plant. High temperature materials are therefore a prime necessity. A corrosion resistant coating on the reactor heat transfer surfaces a few thousandths inches thick may double the critical mass. A brazing alloy containing a few per cent boron (a strong neutron absorber) may put so much boron into the reactor that it cannot be made to go critical, and this particular alloy may therefore be entirely un-usable. The finding of materials adequate to withstand these conditions is a challenge worthy of the best metallurgist, ceramist or chemist.

OUTLOOK

In many respects the propulsion of aircraft is an ideal use for nuclear energy. Here to a higher extent than in any other application the advantages of a highly concentrated source of heat can be used to good result. Although the goal of producing a nuclear powered aircraft is an admittedly ambitious one, it is only very high performance, and premium uses of energy which can justify the consumption of as rare a resource as uranium-235 or plutonium-239. Moreover, it is inescapable that a development of this type has great military significance.

In recent months the government has announced that the nuclear aircraft program is entering a new phase. In this new phase the Aircraft Gas Turbine Department of the General Electric Company has been given the responsibility for the propulsion system and the Consolidated Vultee Aircraft Corporation is to supply an airframe.

My belief is that our efforts to fly an aircraft on nuclear power will be successful. The difficulty of the task and the value of the result combine to form a challenge which is in my opinion unmatched.



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problem of disposing of the water. Continuous use on a large scale would lower the water table and the cost of piping it down another well might prove too expensive. Another system is to have a continuous or U-tube placed in a well and circulate water through it.

Initial cost of a heat pump includes more than a heating unit. It also includes a cooling unit, or, as it is called, year-around air-conditioning. Consequently, the equipment and installation cost of a heat pump should not be compared with the cost of a conventional heating system. The heat pump cost should be compared with the cost of a conventional heating system plus that of a conventional cooling system.

Some elements now necessary for a conventional heating system are not needed with a heat pump. A chimney is an example of the former and the lack of one may cut house construction cost from $300 to $500. A coal bin or storage tank are other examples but a heat storage tank which may be used with a heat pump would occupy approximately the same space as a coal bin.

The heat pump should become more practical from the point of cost when it leaves the experimental stage and moves into the acceptance or production stage. There are some concerns producing the heat pump on a limited scale and others still experimenting with it.

The cost of proposed systems and systems now in production is still quite high ranging from $1,000 to $2,250. Such costs may or may not include installation. If installation cost is not included, it must be computed and added when comparing different systems since it is a major item.

The heat pump compares favorably with different methods of heating. In the following table a comparison of the cost of heating for electrical resistance method, motor driven heat pump, coal, oil, natural and artificial gas is presented. Also, comparison of engine driven heat pump is added.

COMPARATIVE COSTS OF HEATING METHODS

Method of Heating	Cost per Unit	Cost per Million Btu
Electrical resistance	1½c per kw-hr	$4.41
Electrical resistance	2c per kw-hr	5.87
Heat pump cp = 4	1½ per kw-hr	1.10
Heat pump cp = 4	2c per kw-hr	1.47
Heat pump cp = 5	1½c per kw-hr	0.88
Heat pump cp = 5	2c per kw-hr	1.17
Heat pump cp = 6	1½c per kw-hr	0.735
Heat pump cp = 6	2c per kw-hr	0.98
Heat pump engine driven cp = 1.5	14c per gal	0.467
Coal, 12,000 Btu/lb	$10 per ton	0.69
Coal, 12,000 Btu/lb	$15 per ton	1.04
Oil, 140,000 Btu/lb	8c per gal	0.952
Oil, 140,000 Btu/lb	10c per gal	1.19
Natural gas, 900 Btu/cu ft	40c per 1000 cu ft	0.741
Artificial gas, 550 Btu/cu ft	70c per 1000 cu ft	2.12

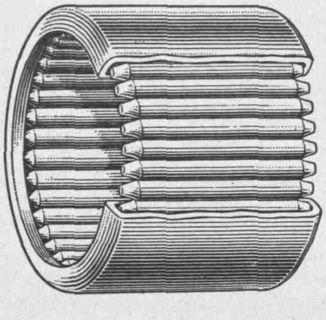
Fuel burning efficiencies taken as 0.60

The average cost per KWH in sixteen of the larger cities throughout the country is 1.7c.

Conclusions are hard to draw on such a dynamic subject as the heat pump, with new discoveries being made every day. But if progress is to be made, conclusions must be drawn.

Conclusion might be aided by reporting the progress of recent experimental installations. During the latter part of 1948, and early part of 1949, five heat pump units were installed in newly constructed residences under the sponsorship of branches of the American Gas and Electric Company. The installations were as far north as Ohio and as far South as Tennessee. With increased scarcities in fuels a bright future can be forecast for the heat pump.

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. This is illustrated in the table below, which compares the dimensions of three

	O. D.	I. D.	Axial Length
Torrington Needle Bearing No. B-1616	1¼″	1″	1″
Ball Bearing No. 405	3.15″	.98″	.83″
Bronze Bushing 3 sq. in area of bearing surface	1⅞″	1½″	2″

Dimensions for three types of bearings, all having the same rated radial load capacity.

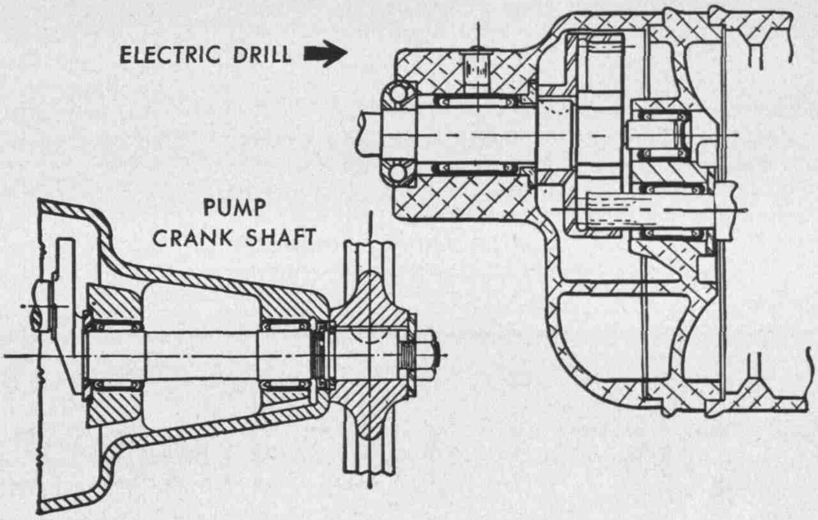
bearings with identically rated radial load capacities.

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.

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.

As the shaft is intended to serve as the inner race in most applications, it is hardened and ground to correct size. If an unhardened shaft is desirable, inner races can be furnished with the proper hardness.



High radial load capacity is vital in many bearing applications.

Plus Features For Modern Design

The unit design and compact size of the Torrington Needle Bearing provide other, related advantages which are being utilized in more and more applications.

The outer shell is easily seated by press fit into a straight bore housing, machined to the proper dimensions. No complex housing structures are needed—no spacers, retainers or snap rings required. And the compact size and light weight of the bearing itself also help make the end product lighter and less bulky.

Wherever high radial load capacity is vital, but space and weight are at a premium, Torrington Needle Bearings provide an ideal solution.

Future advertisements in this series will discuss other specific advantages of Needle Bearings. If you would like further information on these or any other type of anti-friction bearings, our engineering department will be glad to be of assistance.

THE TORRINGTON COMPANY

Torrington, Conn. • South Bend 21, Ind.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON NEEDLE BEARINGS

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

WORKERS ARE PEOPLE

(Concluded from Page 15)

per worker, per square foot of floor space in the country.

Another fine example of this same kind of reasoning is found at the Electric Products Co. Their employees will get a letter the day after a large order has been received. It might read something like this.

". . . we have received an order for $200,000 in steel plating equipment. It has taken six years of sales effort to get this order. It means subcontracting $30,000 worth of motors. Tooling, materials, and overhead account for . . . etc." This "no secret" policy has paid off for them, too, in higher moral and higher output per man with no strike or major labor dispute for more than sixteen years.

One branch of the Chase Candy Company was confronted with a serious problem. They were so far under production schedules that they were contemplating shutting down. They tried something unheard of. They presented the problem to the employees, frankly and sincerely, asking for help. The employees outlined bottlenecks, reported time wasting steps, and offered remedies to cut down on candy losses. They found enough suggestions that could be adopted by the company that not only did the plant keep open, but they were able to improve their working conditions and wages to well above the average of the other plants. Cooperation again paid off to both sides.

There are many more working examples of good labor management relations. Vacations with double pay means so much more than a cold bonus, even though it doesn't amount to as much as a bonus would. A friendly smile, a compliment to a department for good work, recognition when recognition is due, are all simple aids in achieving good labor management relations. No plant is too large for such a program.

Regardless of size, every large group is made up of smaller groups. Intelligent managers are now recognizing the importance of these groups, the largest of which are the informal or organized groups such as the departments. Next are the family groups, composed of about thirty men, and smallest of these groups are the natural teams of about seven members. Here is the place to begin. By attempting to get the smallest group working together with good relations, the problems with the larger groups will begin to disappear.

Surely, there must be something to this human element idea. Workers are people. They respond to fair and just treatment. They must understand what they are doing and what is going on around them. They must feel like members of the working "community" and have a chance to participate in the government of their "community." In the whole field of industrial relations, there is no substitute for man-to-man relations.

Someplace in every company there is a place to begin, not on an extreme "do it all at once plan," but on a gradual plan that can gain the confidence of everyone concerned. Our greatest future need is to increase our productivity, our rate of output per man hour, and to share the benefits fairly with all of the people who make these benefits possible. Unions and management must bury their grievances and unite in one common venture. This powerful ingredient, the human element, must not be overlooked in industry. It must be realized that workers are people.

You can buy a man's time. You can buy a certain number of skilled operations. But, you cannot buy enthusiasm, initiative, or loyalty. You cannot buy the human will to work. These things must be earned.

Will we ever run out of gas?

RUNNING OUT of the crude oil that powers and lubricates our civilization is not an immediate danger. Scientific methods of exploration, drilling, and recovery keep pushing farther and farther into the future the day when petroleum must be supplemented by other raw materials. When that day comes, however, there is no danger that the American economy will slow down.

Standard Oil already knows how to make high-quality gasoline from coal or oil shale. The supply of these raw materials is far greater than the reserves of petroleum. It is important that the research and development work in the entire field of synthetic fuels continue so as to lower the cost and raise quality still higher.

Work with synthetic fuels is only one example of how Standard Oil plans ahead to serve its customers. By working to keep this company in the forefront of one of America's most competitive industries, our researchers and engineers are helping to keep America itself ahead and to make life better for every American.

Standard Oil Company STANDARD

NEW DEVELOPMENTS

(Continued on Page 14)

WATER STOP FOR CONCRETE

In building large structures, the pouring of concrete is limited by the difficulty in mixing great quantities, eight-hour days, and the necessity for dissipating the hydration heat of concrete. This means dividing pours into blocks. Because of an inherent shrinkage factor in concrete, an open crack forms between the blocks, creating water leakage.

To eliminate this leakage, various designs of water stops or joint seals of rubber or sheet metal have been used in the past. However, rubber seals harden and become brittle to oxidation. When using rubber or copper sheet metal, an edge of the material protrudes into newly formed concrete, and is easily knocked out of place during pouring. This necessitates shoveling away the concrete to straighten the piece, resulting in excess material and labor costs.

Now a water stop has been built that will both be easy to install and not have the disadvantages of conventional water stops. Made of vinyl plastic, the new water stop offers superior aging characteristics, extreme resistance to the chemical action of concrete, and resistance to temperature changes that occur when concrete is poured and sets up.

The plastic joint seal consists of a central rib backed by U-shaped grooves. The finished seal, in manufacture, is rolled into 100-foot strips that are cut to the desired lengths by a saw or knife at the construction location.

A final advantage to the new seal is in the fact that rubber seals must be joined by vulcanizing, copper by brazing. Joining of the plastic strips can be done, however, simply by applying heat to the loose ends with an electrically-heated knife or gasoline torch.

★ ★ ★

NEW NAVY SEARCHLIGHT

After nine years of development, a new searchlight for Navy vessels has evolved that has an output twice that of any previous model, yet requires only one-and-a-half times as much current input.

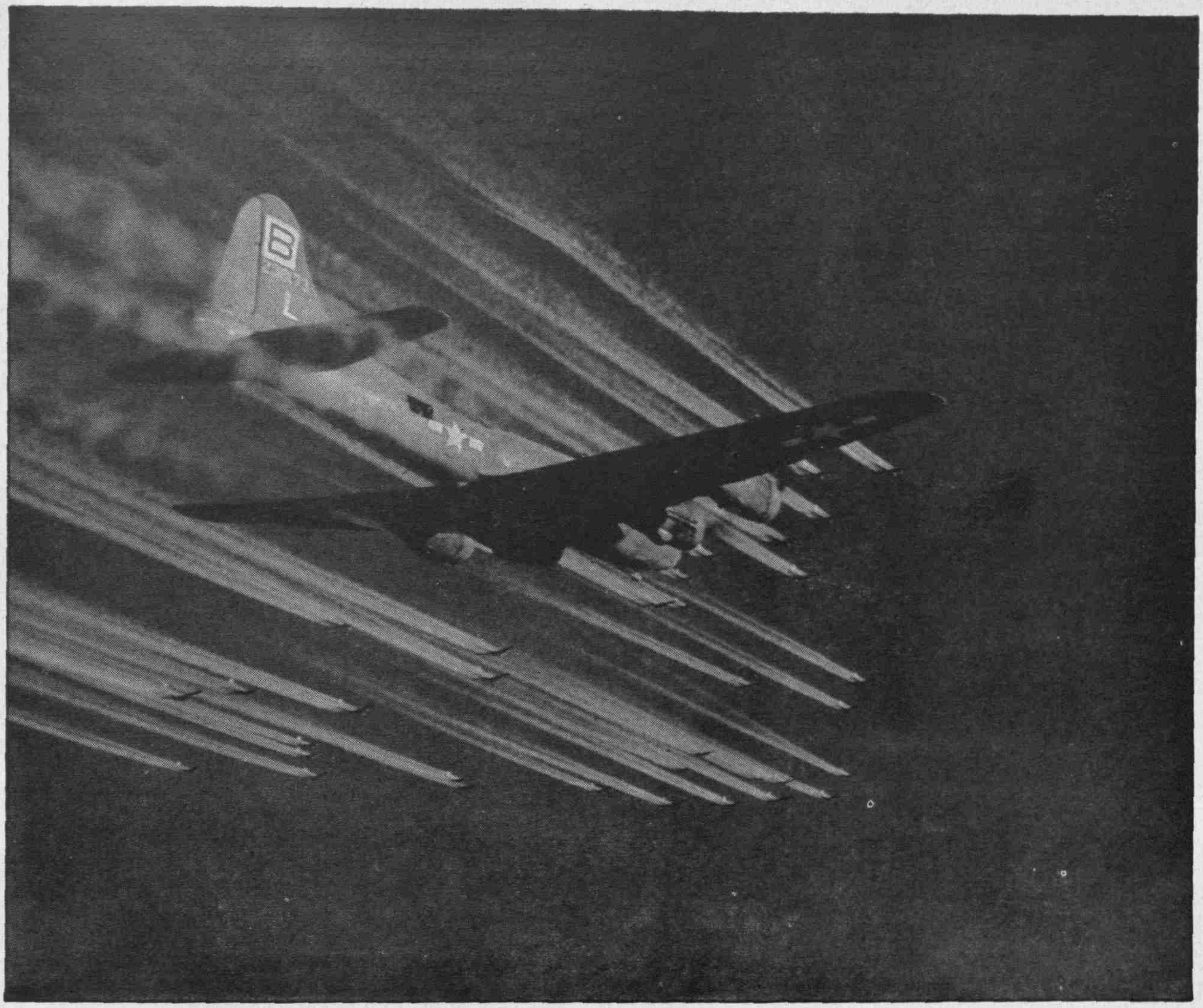
The new searchlight has a beam candlepower of 50 million, compared to the 26 million candlepower of the previously used 24 inch carbon-arc light. The new light requires a current of 105 amperes, an increase of only 35 over the 24-inch light.

Part of the gain in output comes from improved carbons. The new light also has an arc structure in which carbons burn at almost a 90 degree angle instead of the usual 16 or 23 degrees. This enables the structure to "keep out of its own light:" the area of the mirror obscured by the arc of mechanism has been cut from over 20 per cent to less than 5 per cent.

A new control maintains a much more stable arc over a wide current range. While previous controls have been based on currents, or on voltage, the new light takes both current and voltage into account. It responds to arc drop variations of 0.1 volt or a current change of as small as 0.1 ampere. Previous models responded only to a 5 volt or 2 ampere change—and not both.

Finally, while the predecessors to the new model required two minutes to reach a stable condition, it takes the new light only two seconds to do so.

(Continued on Page 38)



NEW DEVELOPMENTS

(Continued from Page 36)

HELICAL INSERTS

Because helical-wire thread inserts substantially increase the loading strengths of threads in light-metals, and thereby lessen stripping possibilities, a New York Company has specified them as original manufacturing components to solve a problem of stripped threads in its automatic stapling machines.

Four rubber suction cup legs screwed into the bases of these lightweight castings permit the machines to cling firmly to any flat surface and allow easy relocation of the machines when this is desirable. On the prototype model, the four 6/32 mounting threads in the casting stripped when the machine was rocked to break the vacuum.

To prevent the stripping of these threads on production models, 8/32 stainless steel Heli-Coil thread inserts are now installed in these holes.

Threads in the insert-lined holes can safely withstand 20 to 30 per cent higher loads than unprotected tapped holes because of better load distribution. The spring-like coils of these inserts automatically adjust themselves to both the receiving threads in the castings and the threads on mating parts.

Instead of the conventional 50 to 60 per cent thread flank engagement between threaded members and receiving threads, helical-wire thread inserts provide flank engagements of about 80 per cent.

In addition to the resultant higher loading strength, the physical properties of the 18-8 steel used in the manufacture of these thread inserts are such that wear from repeated assembly and disassembly is practically negligible. Also, all possibility of corrosion, galling, and seizure is eliminated.

★ ★ ★

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 the death of his parents. He thought awhile and finally put down this answer: "Mother died of pneumonia. Father was taking part in a public ceremony when the platform gave way."

★ ★ ★

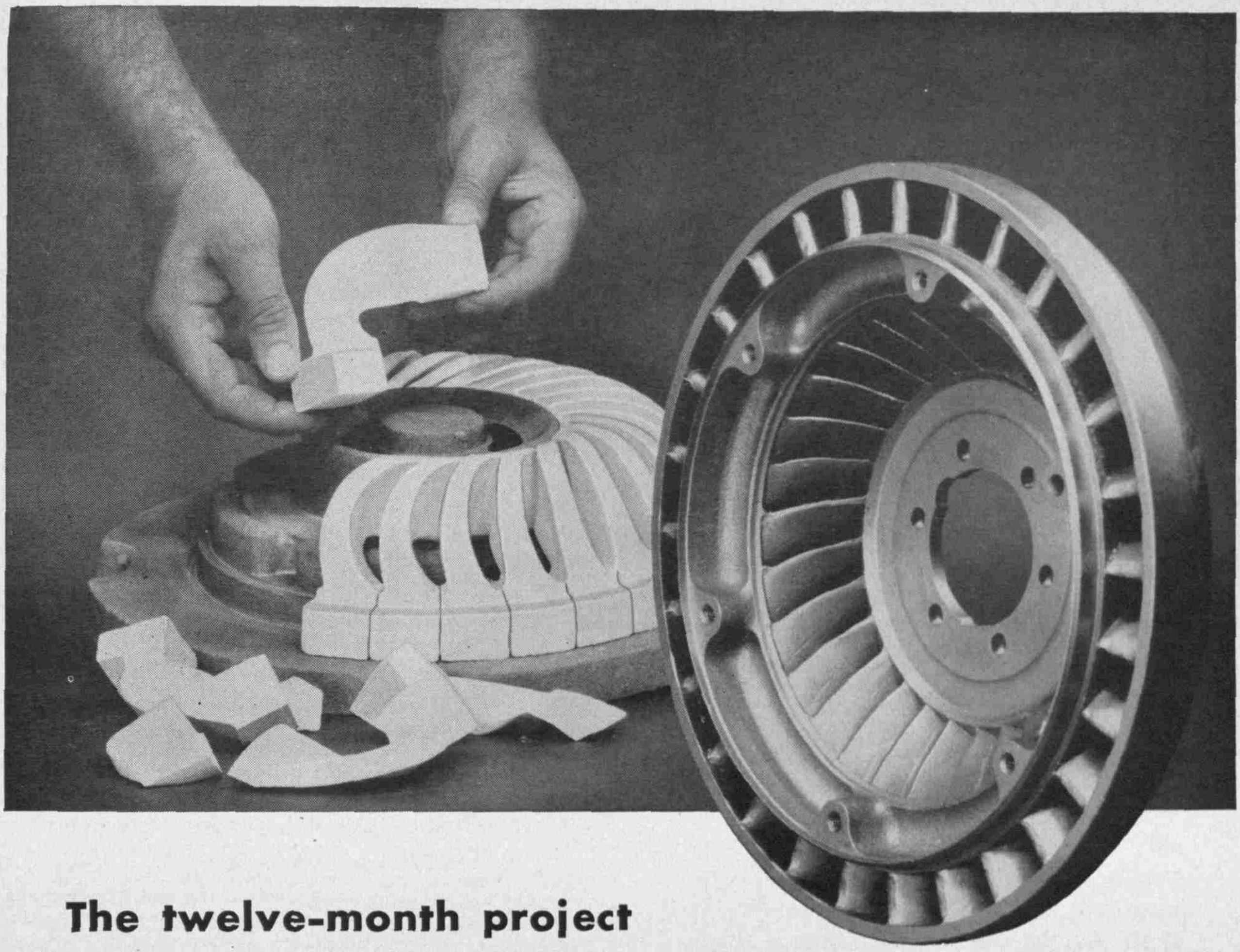
Sober: "What's your nationality?"
Drunk: "I'm half Scotch-(hic)-and half soda."

★ ★ ★

The minister's daughter returned at three o'clock from a dance. Her father greeted her sternly. "Good morning, child of the devil." Respectfully and demurely, she replied: "Good morning, father."

★ ★ ★

There are two kinds of dances: the formal kind and the kind where you wear your own clothes.



SIDETRACKED

Electrician: "What's the matter, sonny? Why all the bandages on your hand? Cut yourself?

Boy: Nope, I picked up a little bee and one end of it wasn't insulated.

★ ★ ★

An old Army story tells of a close-mouthed Major that made the Sphinx look like a chatterbox. One day, when a sergeant appeared before him for disciplinary action, the office personnel listened at the door, expecting to hear a good bit more than the Major's usual one-word sentences. They were disappointed.

"Come in, sergeant. At ease. Attention, private. Dismissed.

★ ★ ★

A woman appeared in a psychiatrist's reception room one day and caused a bit of commotion by the companion she brought along, a 6-foot ostrich.

When her turn came to enter the specialist's office, he stared and inquired. "Sit down, madam, and tell me what is wrong with you."

"Oh, it's not me, Doctor," she replied. "It's my husband. He thinks he's an ostrich.

★ ★ ★

Overheard before final exam: "I'm giving the same exam as last year but I'm changing all the answers.

★ ★ ★

Saleswoman: "Why, this slide rule will do half your work for you."

Eager Engineer: "Fine, I'll take two of them."

★ ★ ★

Visitor addressing an employee of the Oak Ridge plant, "What do you make here at Oak Ridge?"

Employee: "Horses heads."

Visitor: "What do you do with them?"

Employee: "Send them to Washington for final assembly."

★ ★ ★

Two men were flying East in a passenger plane, making the first air trips of their lives. The plane touched down at St. Louis, and a little red truck sped out to its side, to refuel it. The plane landed again at Cleveland, and again a little red truck dashed up to it. The third stop was Albany, and the same thing happened.

The first of the two men looked at his watch and turned to his companion.

"This plane," he said, "makes wonderful time."

"Yep," said the other, "and that little red truck ain't doin' bad either."

★ ★ ★

A man boarded a pullman and gave the porter $5 to wake him up when the train reached Podunk at 4 a.m. "Now, porter, I'm a very heavy sleeper, so you may have to drag me out of the berth, put my clothes on me, and carry me out to the platform. And no matter how much I resist, don't pay any attention."

Next morning the man awoke to find himself in New York. Boiling mad, he sought out the porter and roundly cussed him out.

The porter shook his head in admiration. "Boss, you sho' has got a temper, but it ain't nothin' compared to the gent'man's that I put off the train this mornin' at Podunk.

★ ★ ★

She: "Don't you wish you were a barefoot boy again?"

He: "Not me, lady, I work on a turkey farm."

Brightly painted sign on a crosscountry truck: "This truck stops for all crossroads, railroad crossings, blondes, brunettes, and will back up 20 feet for a redhead."

★ ★ ★

"Oh the stuff that we could print, if we could print the stuff."

★ ★ ★

"How did you happen to get so beat up?"

"You know that beautiful girl on the first floor whose husband is overseas? He isn't."

★ ★ ★

She was only an optician's daughter but two glasses and what a spectacle she made.

★ ★ ★

The M.E. instructor held the chisel against the rusted bolt. He looked at the M.E. student and said, "When I nod my head you hit it."

They're burying him at noon today.

★ ★ ★

"I'm shot" cried the little pot of lead as it dropped into the pail of cool water.

★ ★ ★

Prof.—What is the white line in the middle of the road for?

C.E.—I guess its for bicycles.

★ ★ ★

"I represent the Mountain Wool Company, ma'am. Would you be interested in some coarse yarns?"

"Gash, yes. Tell me a few."

Woman on crowded bus: "I wish that good looking man would give me his seat."

Five engineers got up.

★ ★ ★

You ought to laugh at these jokes, your grandfather did.

★ ★ ★

A married man returned home one night at a late hour and, finding difficulty with his equilibrium, made considerable noise in the hallway. Suddenly there was a sound of crashing glass which awakened his wife.

"John," she called, "what's the matter?"

From downstairs came a low mumble, "I'll teach those goldfish to snap at me."

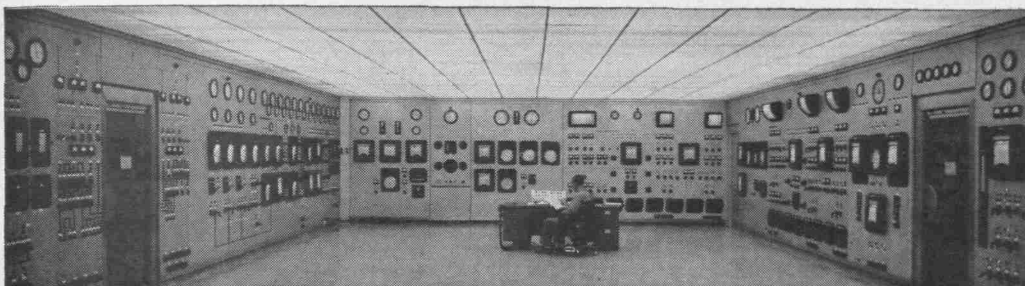
★ ★ ★

A little boy had been climbing the tree in his back yard. For the second time, he came in with his trousers torn.

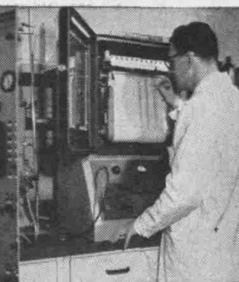
"Go upstairs and mend them yourself." ordered his mother.

Some time later she went up to see how he was progressing. The trousers were there, but no sign of the child. Puzzled, she came downstairs and noticed that the cellar door, usually closed, was open. She went over to the door and cried angrily, "Are you running around down there without any pants on?"

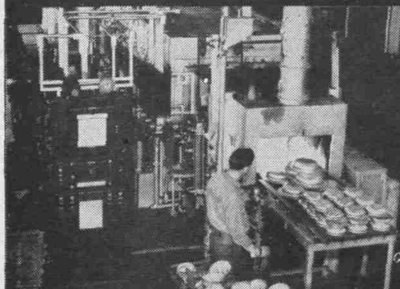
"No ma'am," came the reply, "I am reading the electric meter."



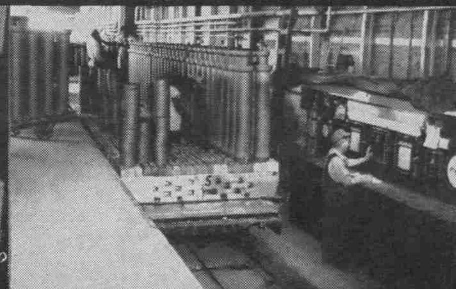
L&N instruments "From Coal Pile to Bus Bar" in central station's control room.



Electro-chemograph

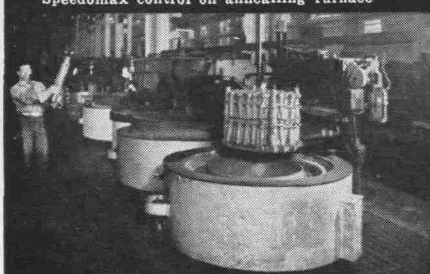


Speedomax control on annealling furnace



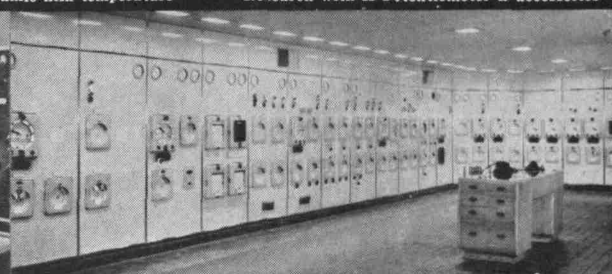
Speedomax control of ceramic kiln temperature

Research with K Potentiometer & accessories



Homocarb furnaces in auto plant

Aircraft testing



Speedomax controllers & recorders in petroleum refinery

LOOKING FOR OPPORTUNITY? LOOK AT L&N!

Because instruments are basic both to industrial and to scientific work, the instrument field ranks high in opportunity. As long as men make pig iron or pills, guns or butter, clothing or kilowatts or gasoline, industry will use more and more instruments on the production line. As long as scientists "unscrew the inscrutable" they will need instruments for laboratories, defense projects, and industrial research.

As a result, L&N job opportunities are quite varied. The openings in sales engineering utilize technical training in the examination of processes, and in selection and application of correct instruments in industrial plants. Other openings are in research and still others in engineering development of L&N products. Also beckoning are production, advertising, inspection and other operations.

We make automatic, balance-type electrical instruments for controlling, measuring and indicating temperature, chemical concentration, combustion, frequency & load, flow and other conditions. We make heat-treating process equipment complete. We make laboratory-type instruments in forms for scientists from freshman to Ph.D.-plus.

Our chosen portion of the automatic control and instrument field is in high-precision, high-dependability equipment. Commercially, we are one of the leaders; we have grown in every decade of our history, and continue to grow. And we are innovators; we pioneered many basic developments . . . are pioneering others, and will continue to do so.

Personnel-wise, the Company's policies are modern and progressive. We have long had group insurance, hospitalization, pensions and financial assistance for post-college education. Compensation includes profit-sharing as well as salary. L&N will continue to offer present opportunity and a substantial future.

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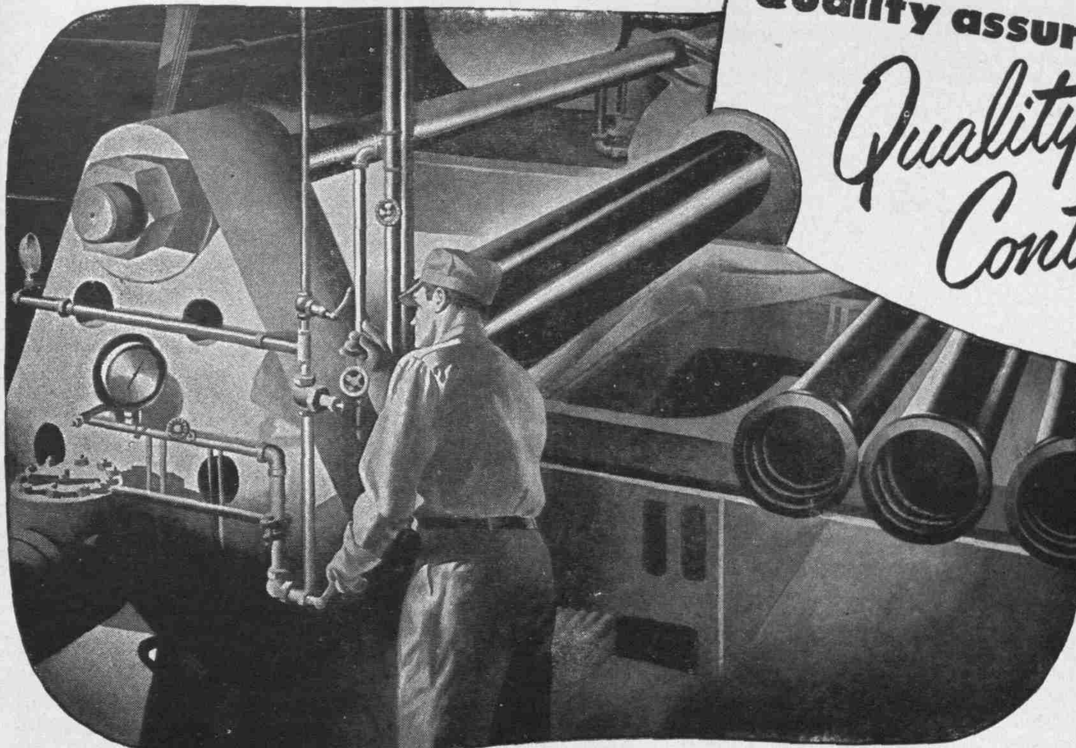

THE HYDROSTATIC TEST

Nobody can buy a length of cast iron pipe unless it has passed the Hydrostatic Test at the foundry. Every full length of cast iron pipe is subjected to this test under water pressures considerably higher than rated working pressures. It must pass the test or go to the scrap pile.

The Hydrostatic Test is the final one of a series of routine tests made by pipe manufacturers to assure that the quality of the pipe meets or exceeds the requirements of standard specifications for cast iron pressure pipe.

Few engineers realize the extent of the inspections, analyses and tests involved in the quality-control of cast iron pipe. Production controls start almost literally from the ground up with the inspection, analysis and checking of raw materials—continue with constant control of cupola operation and analysis of the melt—and end with inspections and a series of acceptance and routine tests of the finished product.

Members of the Cast Iron Pipe Research Association have established and attained scientific standards resulting in a superior product. These standards, as well as the physical and metallurgical controls by which they are maintained, provide assurance that cast iron pipe installed today will live up to or exceed service records such as that of the 130-year-old pipe shown.

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 Ave., Chicago 3, Illinois.

Section of 130-year-old cast iron water main still in service in Philadelphia, Pa.

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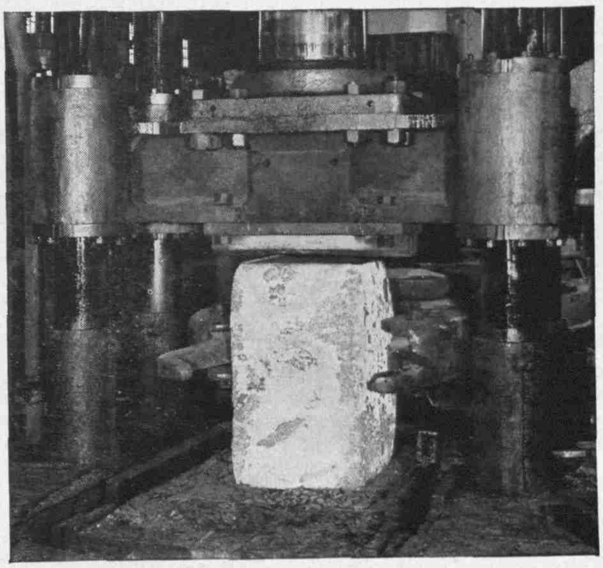
What's Happening at CRUCIBLE

about tool steel forgings

Whether 1½ pounds or 7 tons . . . forgings get the same sensitive handling

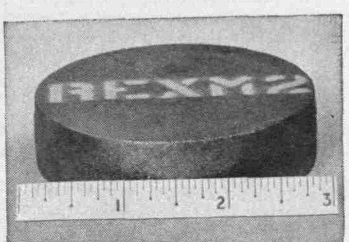
Crucible's reputation as the specialty steel leader is built on a devotion to the smallest detail . . . regardless of the size of the order.

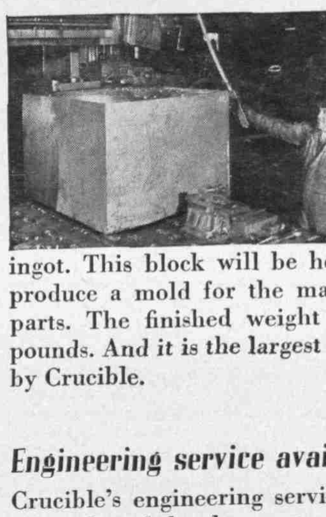
These forgings are good examples of Crucible specialists at work:



Rex M-2 High Speed Steel Disc Forging (1½ pounds)

Pancake forgings such as these are used extensively by small tool makers. Extreme care is taken in the preparation of the slug stock. The upsetting insures proper flow lines. Milling cutters, gear shavers and similar cutting tools that require maximum toughness, coupled with the best cutting ability, are made from these forgings.





CSM-2 Plastic Mold Forging (14,000 pounds)

This CSM-2 plastic mold steel forging was made from a 25,000-pound ingot. This block will be heat-treated and worked to produce a mold for the manufacture of large plastic parts. The finished weight of the forging is 14,000 pounds. And it is the largest mold forging yet produced by Crucible.

Engineering service available

Crucible's engineering service is geared to meet your research and development problems. If you use special forgings, or any special purpose steel, check with Crucible. Crucible Steel Company of America, General Sales and Operating Offices, Oliver Building, Pittsburgh, Pa.

CRUCIBLE first name in special purpose steels

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A Scotchman and an Irishman were on board a ship bound for Scotland.

Scotchman (catching sight of his fatherland): "Hurrah for Scotland!"

Irishman (riled): "Hurrah, hell."

Scotchman: "That's right, every man for his own country."

★ ★ ★

Once a dog walked by a tree
Said the tree to the dog
"Won't you have one on me?"
"No," said the dog
As quiet as a mouse,
"I've just got through having
one on the house."

★ ★ ★

Chem. E's Note:

Always measure out cyanide solutions in graduates, never in a pipette. If you use a pipette, there won't be any graduate.

★ ★ ★

Englishman No. 1: "Sorry to hear you buried your wife, old man."

Englishman No. 2: "Had to, dead you know."

★ ★ ★

Teacher: "In what battle did General Wolfe cry, "I die happy?"

Johnny: "His last one."

M.E.: "How did you puncture that tire?"

E.E.: "Ran over a milk bottle."

M.E.: "Didn't you see it?"

E.E.: "Naw, the kid had it under his coat."

★ ★ ★

Dutch: "Hey, rabbit, what are you doing in my ice box?"

Live Rabbit: "Ain't this a Westinghouse?"

Dutch: "Yes."

Rabbit: "Well, I'm westing."

★ ★ ★

R. K. S.: "What is a gram?"

Stupe: "One of those little brass things that looks like a collar button."

★ ★ ★

Prof.: "Wise men hesitate, fools are certain."

Engineer: "Are you sure?"

Prof.: "I'm certain."

★ ★ ★

"You don't know your own capacity, Sam."

"What proof have you of that, Joe?"

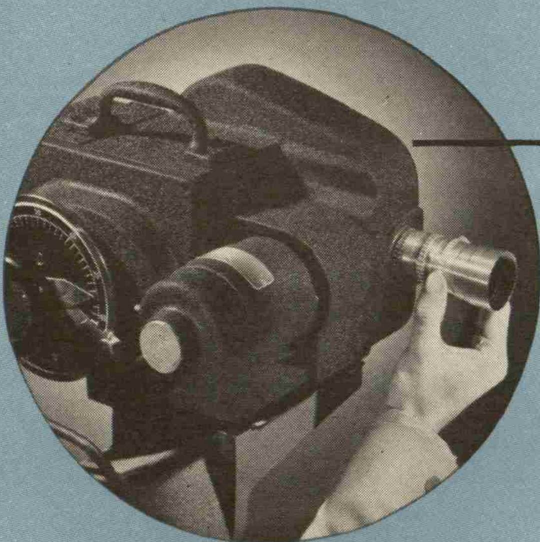
"You walk up to the bar optimistically and walk away misty optically."

★ ★ ★

"I can't marry him, Mother, he's an atheist and doesn't believe there is a hell."

"Marry him, my dear, and between the two of us we'll convince him."

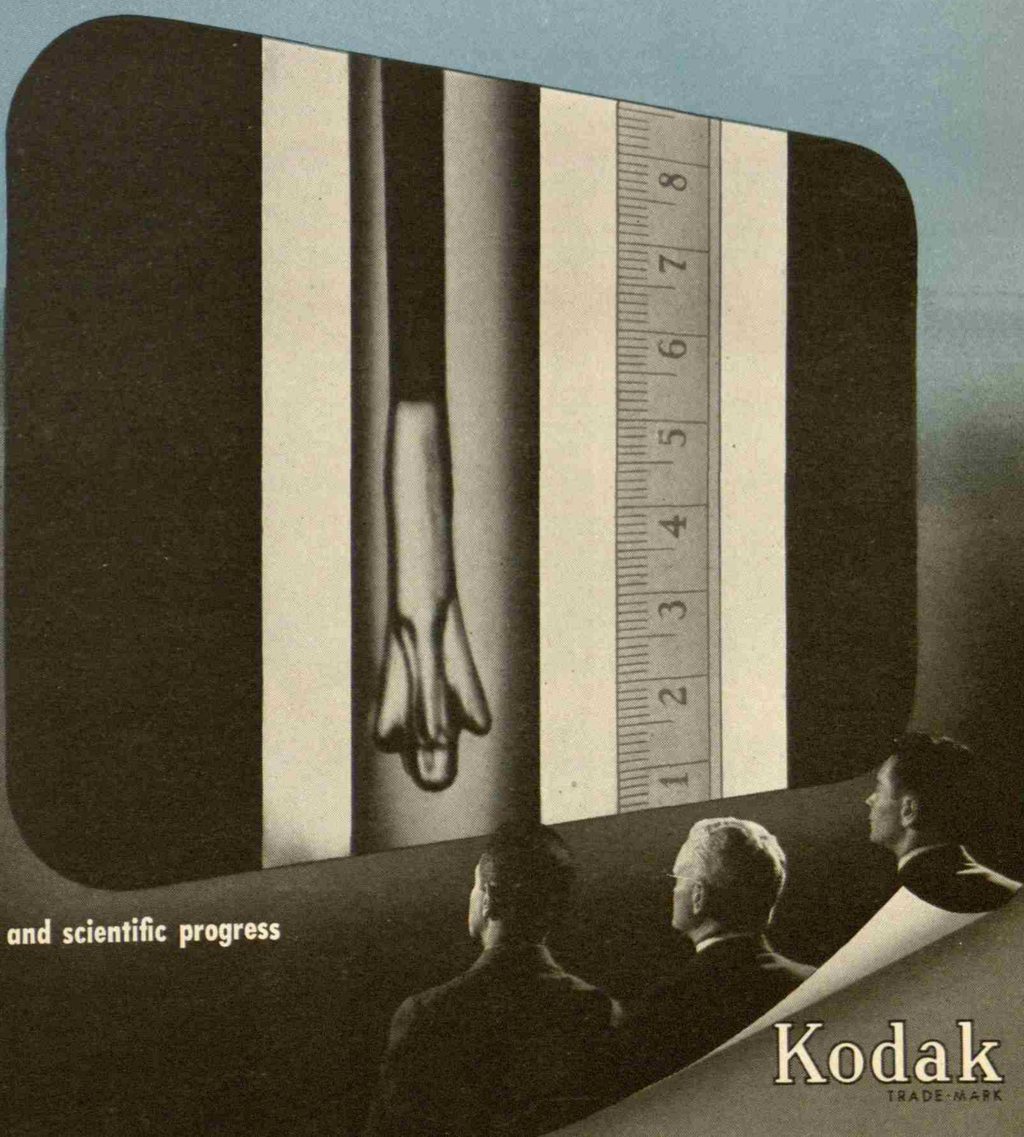
Engineering has a precision tool in photography



WHATEVER YOUR BRANCH of engineering, you'll find photography an increasingly valuable aid. With it you can picture lightning-fast operations—or extremely slow processes—at speeds suitable for study. You can capture fleeting instrument traces, study internal stresses in machine parts, examine metal structure and do countless other things.

The application of photography to engineering problems has become a specialty in itself. This has led graduates in the physical sciences and in engineering to find positions with the Eastman Kodak Company. If you are interested, write to Business and Technical Personnel Department, Eastman Kodak Company, Rochester 4, N. Y.

Here high speed motion-picture photography shows a cavity in a column of water produced when a 5-mm rod was shot through it at 12.2 meters per second. By taking the pictures at 3200 per second and projecting them at the standard 16 per second, time is "magnified" 200 times.



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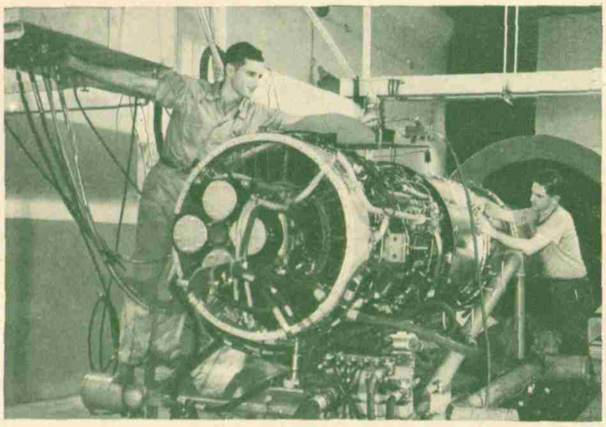

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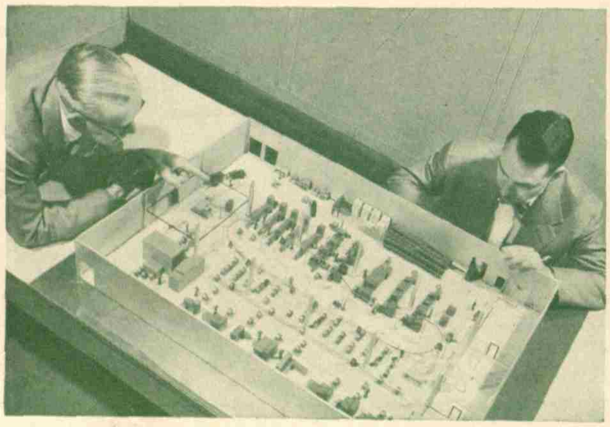
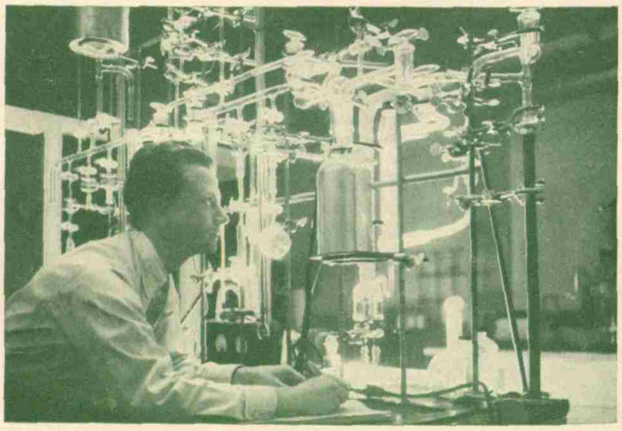


3. MANUFACTURING TRAINING PROGRAM—for developing manufacturing leaders. Open to graduates with a technical education or a general education with technical emphasis.



4. CHEMICAL AND METALLURGICAL PROGRAM—offers rotating assignments and studies for chemists and for chemical and metallurgical engineers.

5. PHYSICS PROGRAM—the gateway by which physics majors begin G-E careers. Program graduates have gone into such fields as research, development, manufacturing, design, marketing.

If you are interested in entering one of these five basic General Electric programs after graduation, talk with your placement officer and the G-E representative when he visits your campus. Meanwhile, send for further information:

- **On Test, Chemical and Metallurgical, and Physics Programs, write to Technical Personnel Services Dept., Schenectady, N. Y.**
- **On Business Training, write to Business Training Course, Schenectady, N. Y.**
- **On Manufacturing, write to Manufacturing Personnel Development Services Department, Schenectady, N. Y.**

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