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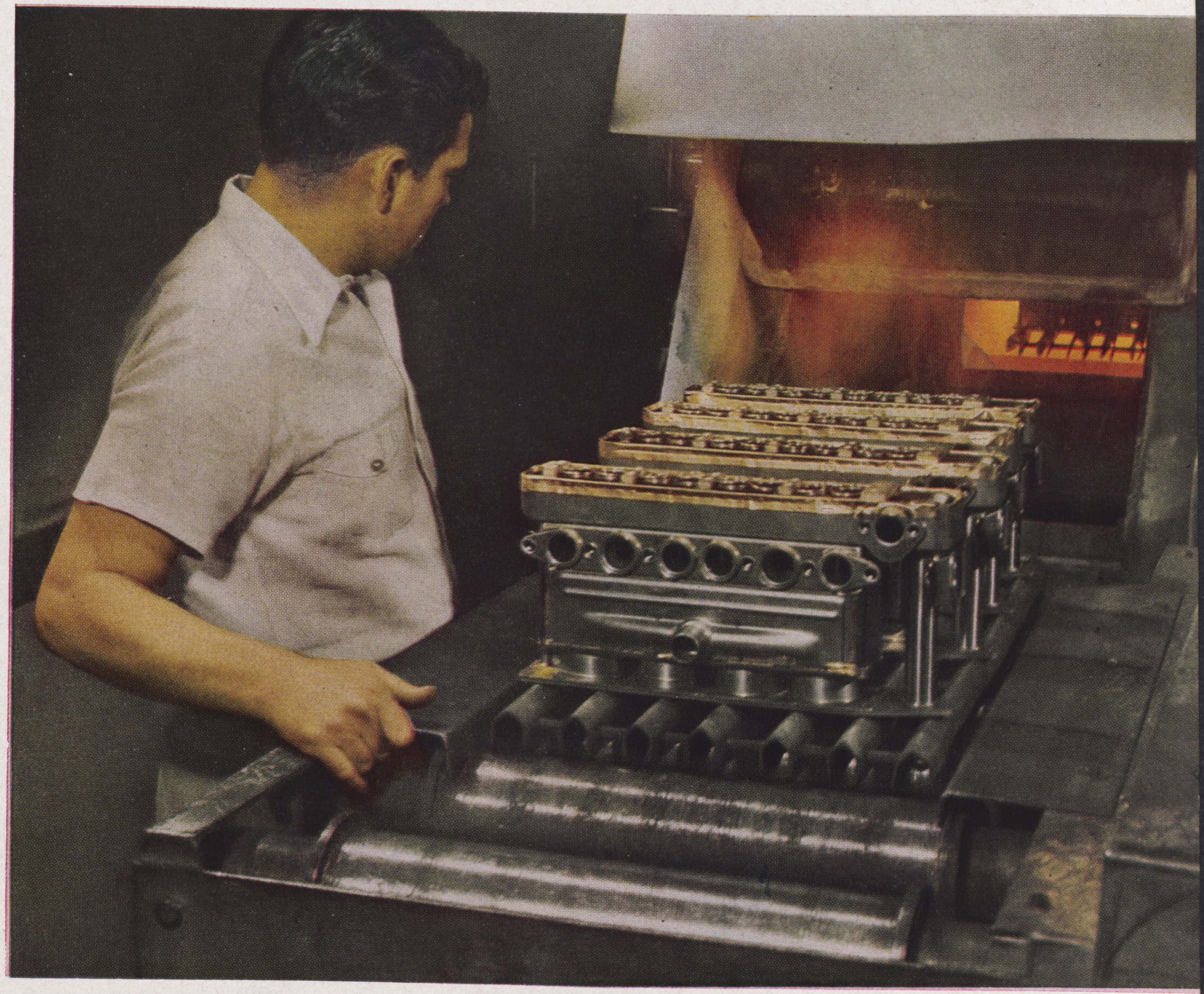
The Rose Technic

MEMBER ENGINEERING COLLEGE MAGAZINES ASSOCIATED

MAY 1948



Electric Furnace Brazing

The Gas Turbine

Modern Sewage Disposal

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RADIO CORPORATION of AMERICA

THE ROSE TECHNIC

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IN THIS ISSUE

FEATURES

COVER PICTURE—Cylinders for Crosley engines are shown entering the 2200° F. Lindberg hydrogen furnace for copper brazing. Cylinders are painted with copper-powder solution, the water jacket slipped into place, and then brazed in the operation shown. The plates for the picture were obtained through the courtesy of American Machinist, published by McGraw-Hill.

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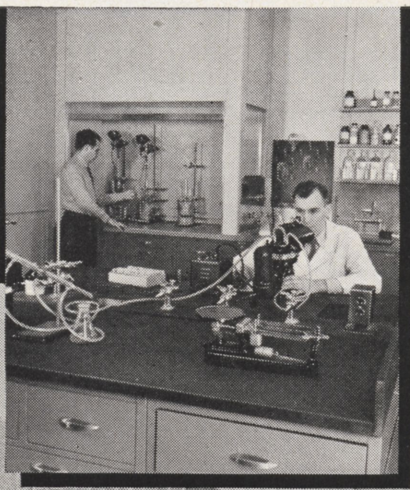
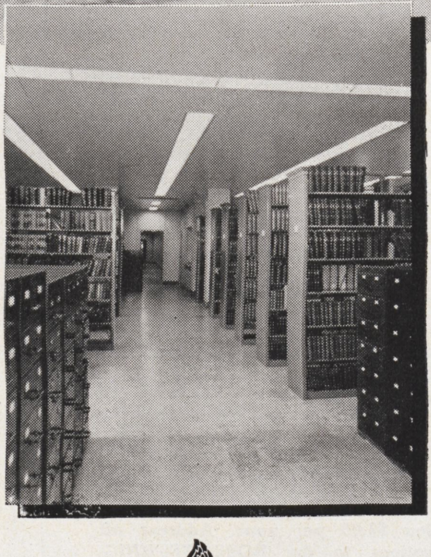


A new doorway to Petroleum Progress



No illustrations can do more than suggest the wealth of facilities at Standard Oil's new research laboratory at Whiting, Indiana. Here, in one of the largest projects of its kind in the world, there are provided the many types of equipment needed and desired for up-to-the minute petroleum research.

The caliber of the men who work here is high. For many years, Standard Oil has looked for and has found researchers and engineers of high professional competence. Further, the company has created for these men an intellectual climate which stimulates them to do their finest work.

And there is nothing new about the idea that motivates Standard Oil research. It is simply that our responsibility to the public and to ourselves makes it imperative to keep moving steadily forward. Standard Oil has always been a leader in the field of industrial research; the new Whiting laboratory is proof of our intention to remain in the front rank.

STANDARD

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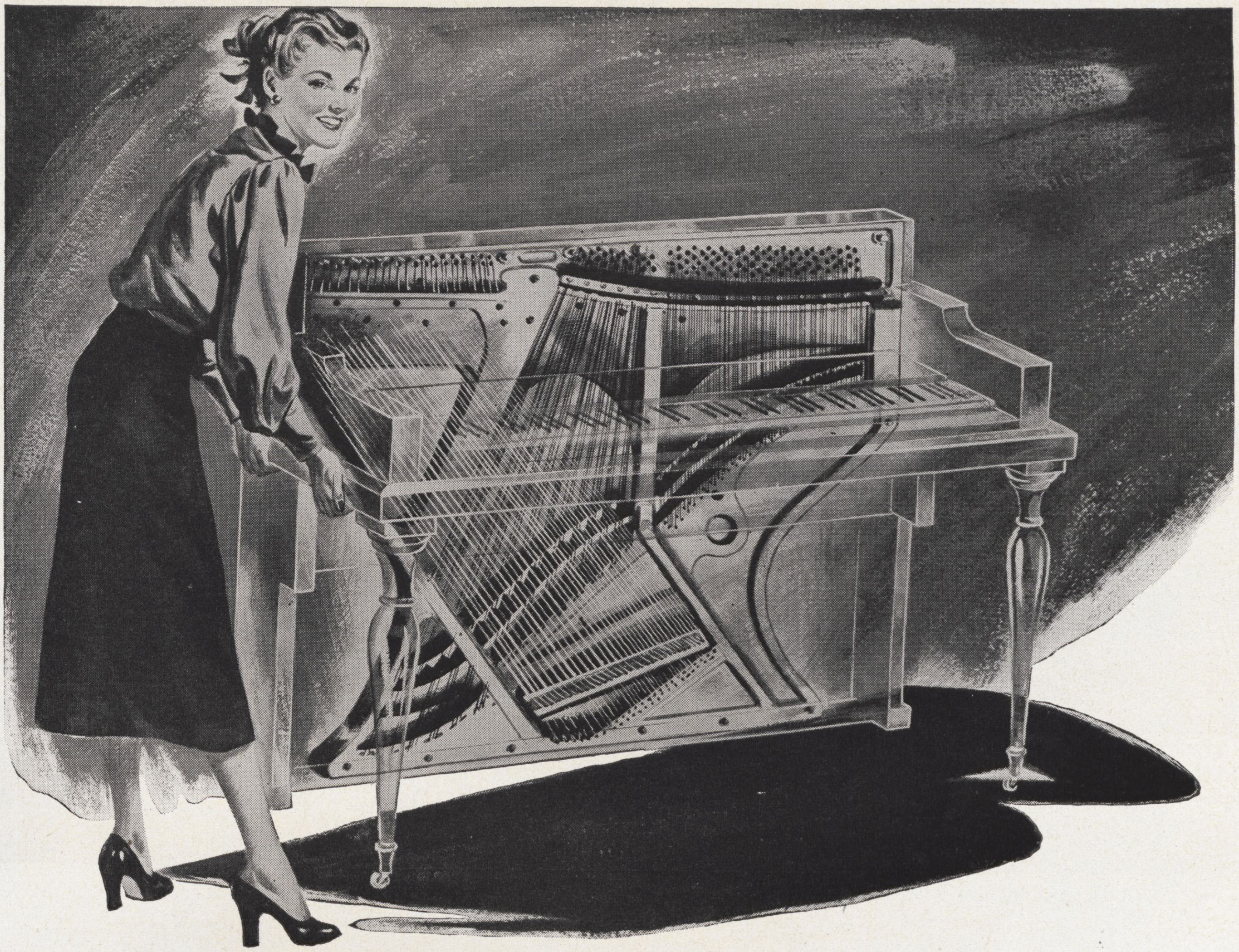


The Piano Business Gets a LIFT... when Alcoa Aluminum Castings Replace Heavy Metal

Even a well-trained husband who'll rearrange the living room every Spring balks at piano-moving. You can see the main reason above. It's the big metal plate that holds the strings—and it has always tipped the scales at around 125 pounds.

No wonder it gave the piano business a *lift* when a progressive piano builder replaced the heavy iron plate with one weighing 45 pounds—made of Alcoa Aluminum. As perfected, this big casting from our foundries is strong to resist the 18-ton pull of the taut strings. It is stabilized to provide tonal quality and stay in tune. And its cost today is competitive with the old-fashioned cast-iron plate.

With other advantages, in other industries Alcoa Castings are effecting similar changes. In one plant, their corrosion resistance means no painting, simple finishing. In another, they are liked for their superior machinability. In still another, they are preferred for the ease with which they swing through production, where iron castings had to be hauled by truck or hoisted on heavy cranes.

The change from heavy metal castings to Alcoa Aluminum Castings is a revolutionary switch in product engineering. Old, old habits are being questioned as engineers re-evaluate metals—with a sharper eye than ever before focused on Alcoa Aluminum. ALUMINUM COMPANY OF AMERICA, Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN ALUMINUM

ALCOA ALUMINUM 1888 1948 60 YEARS OF SERVICE

Just 60 years ago six young men started a tiny business in a little shed in Pittsburgh. They began to make aluminum by a new process. That was the beginning of what is now Alcoa. Alcoa's aim, then and now, was to make aluminum cheaper and more useful. How successfully that has been done is shown by the fact that America today has the greatest aluminum industry in the world, employing around 1,000,000 people in the manufacture of aluminum in its many shapes and forms or in making many useful products in which aluminum plays an essential part.

Rose Polytechnic Institute offers accredited courses leading to the degree of B.S. in chemical, civil, electrical and mechanical engineering. The next class will be admitted in January, 1949. For information address the Registrar.

ROSE POLYTECHNIC INSTITUTE

TERRE HAUTE, IND.

A House Divided

For forward looking men, these are decisive years in the world's history. For too many of us, however, the urgency of our situation seems eclipsed by our anxious efforts toward a return to normalcy after the recent world upheaval.

We, as forward looking embryo engineers, must boldly recognize this urgency occassioned by the increasing complexity of our changing world, and the accompanying revisions which the situation dictates in the structure of our present world society. We, especially, can appreciate that recent technological advances make untenable any longer a house internationally divided against itself.

The concept of a World Federation is an idea which must be evangelized by that group of thinking men who are perhaps best fitted to stem a tide born of their own handiwork, the men trained in the technical sciences. It is appropriate that this group, practiced as it is in the logical, analytical solution of its own problems, should seize for itself a high place in the administration of such a government as an International Congress of the nations of the world.

The world-wide demobilization of political and diplomatic machinery, which such a plan implies, certainly presupposes some cataclysmic revisions of moral values. Heretofore such a purpose might well have been considered to offer insurmountable difficulties to achievement, but today the "impossible" *must* be done. War must be made *unthinkable*. Men *must* reconcile themselves to the passing of the time when indifference toward the common good of the world's peoples might conceivably be tolerated, if they intend that their instinct to preserve themselves be of any avail.

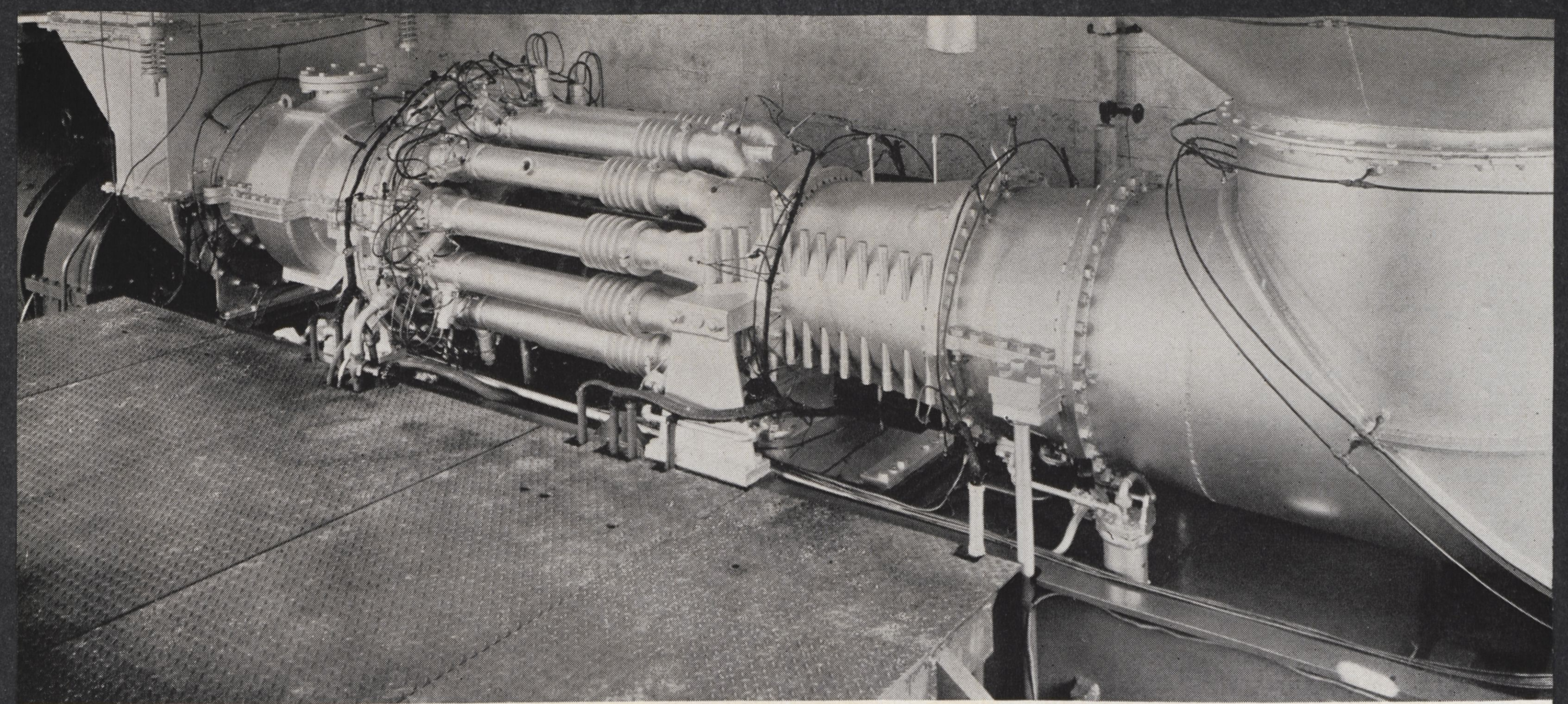
This entails for many a complete re-indexing of evaluations. But it must be done. It should be apparent that, unless we immediately cultivate a "collectivism" in our treatment of human affairs which is, at roots, and by any standard of reason, a collective problem, then we can never hope to condition ourselves to meet the crucial problems which are certain to present themselves in the immediate future. For, while war may be waged and won in the engineering laboratory, or on the battlefields, it must have its germ and sustenance in *minds* which are uncommon in purpose and principle. A common purpose is essential to survival in this age of limitless energy potential.

Such an agreement finds notable expression in one outstanding group of men today—the scientists of the world — for which national ideologies lose their significance in a common endeavor, their uncompromising search after true values.

Thus it is that we, in our position as students of applied natural science, must bear a great responsibility in furthering a World Community. We, as engineering students, a group which champions the practicality of the analytical approach to the solution of our problems, whether in the engineering laboratory or in the field of international relations, must lead this movement to oust political and diplomatic intrigue from the driver's seat.

Values must be redefined, in the mind of each world citizen, and *collectively* as a federation of world peoples, if the growth of the modern social, economic, and technological colossus is not to be destroyed in its own heat of formation.

W. ORBAUGH



—Cut Courtesy of Westinghouse Electric Corp.

The Gas Turbine

by Norman J. Pera, sr., m.e.

Author's Note: The author wishes to thank Allis Chalmers Manufacturing Co. and Westinghouse Electric Corporation for material furnished.

The combustion gas turbine is, at the present time, receiving considerable publicity both in the United States and abroad. This has erroneously led many to believe that it is an invention of the present era. In reality however, John Barber was granted an English patent in 1791 on a combination of elements which the open-cycle gas turbine power plants contain.

In the last ten years, since the first practical gas turbine developed a usable net output, it has firmly established itself in aviation, and will, in the very near future, find a place as a railroad and marine unit, and as a stationary power plant.

Even though the gas turbine is the simplest of all power generating plants, many obstacles had to be overcome before it could be efficiently adapted to practical use. Suitable materials to withstand high temperatures, necessary to produce good cycle efficiencies and efficient axial-flow compressors, were the two biggest obstacles hindering its development. The urgent necessity of war brought about the availability of these alloys and highly efficient compressors much more quickly than would be possible during normal times.

The above photograph shows an experimental 2000-hp gas turbine which is particularly adaptable to locomotive use because of its narrow in-line arrangement. The elements, from left to right are two d-c generators, gear, axial-flow compressor, multi-element combustors, gas turbine, and exhaust. It is 26 feet long, 6 feet high, and 3½ feet wide and weighs 38,000 pounds.

The gas turbine is being successfully used at the present time in jet propulsion. In a year or so, test runs of locomotives are contemplated, with the gas turbine as the prime mover. In addition to this, there is a likelihood that it can be adapted to use atomic energy. In general, the gas turbine has fewer parts, weighs less, requires less auxiliary apparatus and costs less to build than other prime movers.

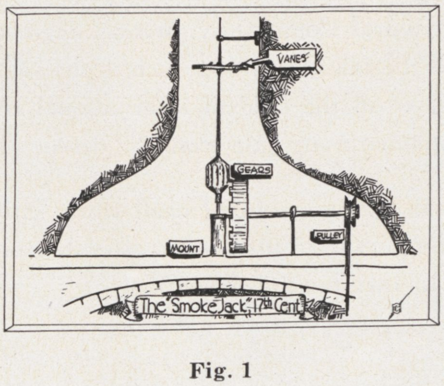


Fig. 1

Its History

The gas turbine and its development have occupied the attention of engineers since before the time of Christ. In 130 B. C., Hero of Alexandria devised an appartus which could be included in the category of the gas turbine. This machine was used to induce motion in symbolic figures on an altar. Air was heated in a vertical tube which in turn induced air in several radially displaced tubes, and, due to an impulse effect, rotation was created.

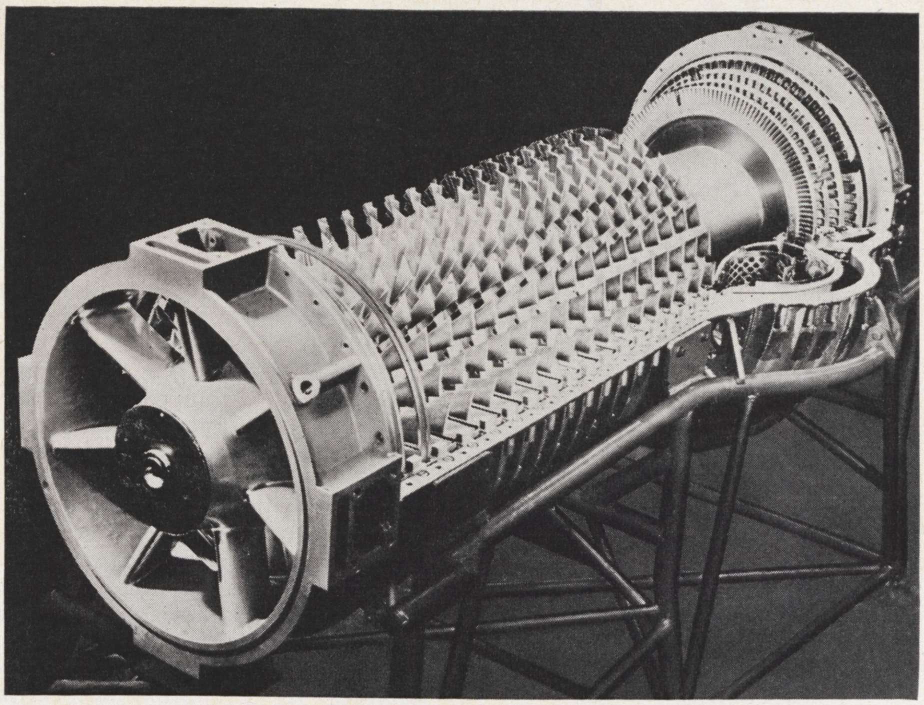
A mechanism known as a "smoke-jack" (see Fig. 1) was used to turn the meat being roasted over a fire. The mechanism was set up in a chimney and was caused to rotate by ascending currents of hot gases from the fire. The rotary motion was transmitted to the bar holding the meat through the use of gearing and belting.

In 1791 John Barber took out an English patent on a gas turbine which contained all the essential features of a present day unit. The patent included compressors for both air and gas, a combustion chamber, and the discharge of the products of combustion upon the buckets of a turbine wheel. To prevent and/or reduce excessive temperatures, he went so far as to inject water into the combustion chambers. Many other theories and papers were presented to societies

for the next hundred years, but no important practical work was done until 1872. In that year, Dr. F. Stolze of Charlottenburg, near Berlin, obtained a patent from the Prussian Government for a "fire-turbine." There is a striking similarity between the Stolze turbine and the modern turbine. It had an axial-flow compressor coupled to a reaction turbine, but was unsuccessful due to the inadequate compressor.

From this point on, many great men experimented and built gas turbines, the forerunners of the present day unit. Sir Charles Parsons, Armengaud & Lemale of the Societe des Turbo-Moteurs in Paris, DeLaval, and Dr. Hans Holzwarth are but a few of those who deserve much credit for advancements in the gas turbine art. Their greatest limitations were low efficiency, complex construction, inadequate alloys and inefficient compressors.

Many of the obstacles have been eliminated, but it must be remembered that the modern gas turbine is still in its infancy and will, undoubtedly, become one of the most important of all prime movers.



The top half of this Northrup-Hendy Turbodyne has been removed to show the construction details of the compressor (nearest the camera), combustion chamber, ond the turbine.

How It Works

The simplest form of a gas turbine plant consists essentially of a compressor, combustion chamber and a turbine. These are supplemented with fuel equipment, a generator, lubrication system, control apparatus and a means for starting. From this, it can be seen that simplicity is a distinguishing feature. Furthermore, water is not required in its operation, and air being its working medium gives it an advantage of being independent of geographical location.

The compressor inducts atmospheric air and raises its pressure. In the combustion chamber, the fuel burns in the compressed air, raising the temperature of the air and increasing its heat energy. The hot air and gases of combustion form the working fluid for the turbine. The gases are then expanded through the turbine. Part of the energy imparted to the turbine blades and shaft is used to drive the compressor; the rest is useful output. For starting purposes, a motor is provided to bring the unit to approximately 25% of normal running speed, beyond which the turbine is capable of driving the compressor unassisted. The name "gas-turbine" is due to the fact that the working fluid is a gas, there being no connection with the fuel burned which may be liquid, gaseous, or possibly solid.

At the present time two distinct types of gas turbines are in use. The simplest and most widely used is the open cycle. It has only two moving parts, the rotors of the turbine and the compressor. Although the efficiency of the open cycle is relatively low, it is higher than that of a non-condensing steam plant. The other type is the closed cycle gas turbine, which differs from the open cycle in that the air is recirculated. Heat is added by transfer in a heater, rather than by direct combustion. Its major drawback is the necessity for more heat transfer than is required by the open cycle.

With today's machines and materials, the simplest gas turbine, consisting of a compressor, combustion chamber and a turbine, has attained an efficiency of 18-20%. Higher efficiencies can be reached through five basic paths. (1) Improving the machine efficiency of compressors and turbines raises the overall plant performance. However, high mechanical efficiency has been reached, and the prospects for the future are limited. (2) Raising the throttle temperature is the largest potential efficiency increase. This necessitates improved materials and design which will allow raising the gas temperature without overheating stressed metal parts. (3) Regeneration recovers heat from the exhaust to raise the temperature of the intake air, thereby reducing the amount of fuel needed to heat the incoming air. (4) Intercooling cools the air at an intermediate point or points during compression and cuts the amount of compressor work needed, thereby allowing the use of smaller compressors. (5) Reheating is the dividing of the turbine expan-

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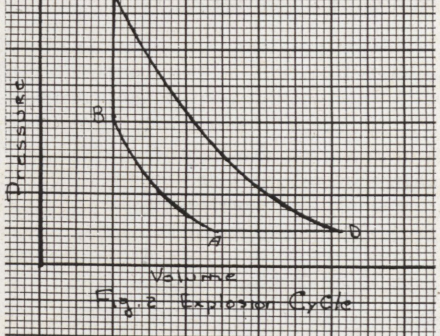

P.V. diagrams of the turbine cycle.

Modern Sewage Disposal

by Sidney Zeid, jr., c.e.

Most of us remember that one of the legendary labors of Hercules was to cleanse the Augean stables. An immense number of oxen and goats had been kept in the stables for many years, and no attempt had been made to remove the filth that had accumulated. This labor seemed an impossibility, but Hercules was undaunted, and set about the task by diverting the course of an adjacent river, the waters of which carried away the filth and flushed the stables clean.

Although we have borrowed this illustration from mythology to introduce our subject, the problem of sanitation in our present-day cities is even greater. Hundreds of years have passed since the classical writers wrote about Hercules, yet the device described is still used in essence in modern times. Sewage disposal is still effected by watercarriage, and in all probability will continue to be so for many years to come.

To a certain extent the disposal of sewage is the reverse of water supply. In the latter, every precaution is taken to ensure that the water is guarded from pollution from the source of supply to the point of distribution. With sewage, on the other hand, it is imperative that the waste-carrying water shall be prevented from causing pollution.

Before starting the discussion of sewage disposal, it is important that we know something of the composition of sewage. Sewage is more than 99.9% water, the balance being solid matter in solution or suspension. The source of much of the dissolved matter is the mineral solids of the water supply. The suspended matter is made up of feces, paper, grit, etc., and is largely organic in nature. Dissolved solids, on the other hand, have a somewhat smaller proportion of organic matter. The solid, organic components of the sewage, although small in amount, are the most troublesome since their decomposition transforms the relatively inoffensive fresh sewage into a black, evil-smelling liquid that will cause stream pollution and disease.

The raw sewage flows from the home through a sewer lateral into what is called a trunk line sewer, from which it is received by an intercepting sewer that conducts it to the out fall sewer. The out fall sewer conveys all the sewage to its ultimate destination, which may be several miles from the town where the sewage originated. It may discharge far out to sea, or well away from the shores of the estuary of a river. It may lead to irrigable land far away from the town, or it may conduct the sewage to settling tanks for clarification before it goes into a river. Possibly, it goes to a sewage farm or to sewage treatment plant, where it is purified before being discharged. Whatever its destination may be, the sewage is conducted to some location where it can cause no harm or inconvenience to the community.

One of the methods of sewage disposal mentioned above is clarification. In the clarification process of sewage, the sewage is first passed through screens to separate out coarse rubbish, and is then treated with lime-water and a solution of ferrous sulfate. These chemicals effect the precipitation of the solids that could not otherwise be separated out —certainly, ordinary sedimentation could not take place, for the majority of the solids in suspension tend to rise to the surface.

After treatment with the chemicals the sewage is led into long masonry sedimentation tanks through which it passes slowly. By means of baffle walls and scum boards it is forced to follow a devious course during which the precipitated solids settle to the bottom of the tank. When a sufficient quantity of sludge has settled on the bottom of the tank, the liquid is drawn off by means of a hinged pipe controlled by a float. This maintains the orifice a little below the surface, thereby preventing the scum from flowing out with the clear effluent. As this effluent contains much organic matter in solution, its admission into a non-tidal river of moderate size is only permissible when there is no question of the water in the vicinity being used for any domestic purpose whatsoever. This method of sewage disposal, therefore, is not adequately suited for cities located inland near small rivers, lakes, etc., but is employed mostly in coastal cities where purification of the sewage is not essential.

The sludge is drawn off through a pipe at the inlet end of the tank. This sludge may be disposed of by ploughing it into the land or burying it in trenches. In some instances it is conveyed out to sea in specially constructed ships and deposited at a distance from the coast.

Another method of sewage disposal employed by many cities is that of disposal by dilution. This may be defined as the discharge of sewage into a body of water under such conditions that no nuisances or dangers arise. The term should not be applied to the indiscriminate discharge of sewage

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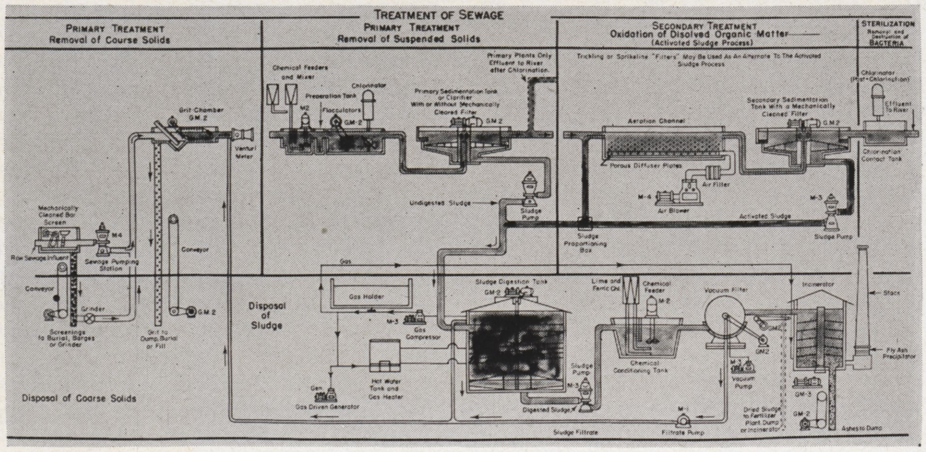

Flow diagram of Sewage Treatment Process.

Electric Furnace Brazing

by Mark Orelup, jr., e.e.

Mass production techniques demand low cost, rapidly made fastenings which will meet the physical demands required of them. Riveted, pinned, and friction joints have proved unsatisfactory in many applications so that continuous search for substitutes has been carried on and greatly intensified during the war years. One of the successful replacements found was electric furnace brazing. This method of brazing has found wide acceptance because it offers all of the advantages of brazing and eliminates all of the disadvantages of hand methods. Its application in production makes possible the breakdown of parts of intricate shapes, which may require many man-hours of machining, into easily made screw machine parts and stampings which are fastened together by brazing, permitting great savings in both time and expense.

Even though the art of brazing is almost as old as our knowledge of metal forming, it is only recently that capillary attraction has been recognized as the phenomenon underlying successful brazing. Capillarity, as we know, is based upon the attraction of the molecules in the liquid for one another. Molecules below the surface are attracted from all sides, but the surface molecules are attracted from only the sides and the bottom. They are therefore drawn towards the center of the liquid mass. Interior molecules, forced to approach the surface by the movement of the surface molecules towards the center, tend to be drawn back for the same reason. Equilibrium is reached when the smallest surface area is attained. When the surface of a liquid is extended, molecules must be brought from the interior against inward attractive forces. Work must be done against these forces for each molecule brought to the surface; therefore, an assumed force can be considered to be acting in all directions parallel to the surface. This action is familiar to us all as surface tension. Liquids like water and molten metals adhere to, or "wet," the sides of their containers. Thus in a capillary tube they tend to creep up the inner-wall surface. The surface tension, however, attempts to maintain the smallest surface area and draws the surface, and volume, of water to the level of the advancing liquid on the walls. This action continues until the force pulling the water up is equaled by the force of gravity on the mass of water. Thus, in brazing, all that is necessary is that heat be applied until the brazing metal becomes liquid; capillarity will do the rest. This powerful force draws the liquid metal between the narrowly spaced surface, where it is allowed to freeze and form a joint that is clean, strong, and gas tight.

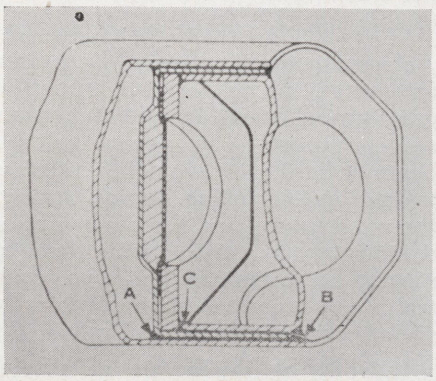

Diagram shows extent of capillary flow. Filler is placed at A where it melts, puddles and is drawn to B and then to C. The entire seam is a continuous joint.

Figure 1 shows the relationship between joint strength and joint thickness. The curve has a definite peak of slightly over 30,000 psi at a joint thickness of 0.0015 inches. The shape of this curve graphically sets forth the great need for careful design of brazed joints if maximum strength is to be expected. The curve shown here was obtained using a silver alloy as the filler. Other metals used as fillers will, of course, have different maximum points, but the shape of the curve will be similar. Care in design at this point plus thorough cleaning before brazing insures positive capillary action so that the molten filler will penetrate over the entire joint.

No matter how much care is used in the design of a brazed joint it will be wasted if the pieces to be brazed do not keep their relative positions

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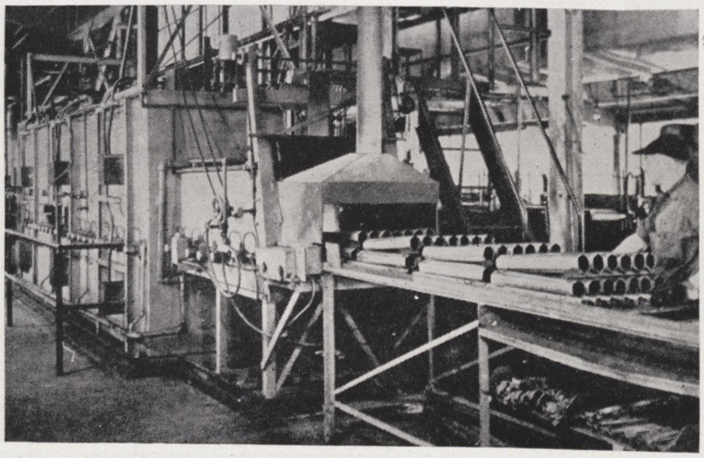
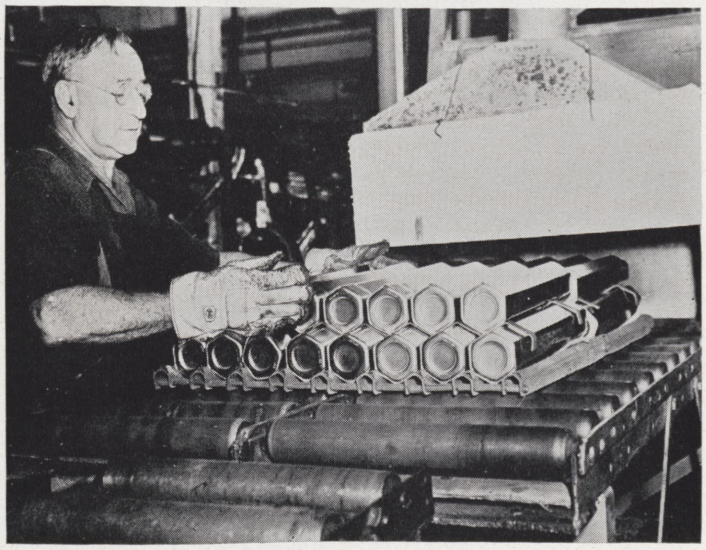




Above—Continuous roller hearth furnace in operation.

Right—Picture shows method of loading containers for trip through furnace.

Research And Development

by Dale Carey, soph.
and J. R. Brentlinger, soph.

New Synthetic Rubber Better Than Natural Product

Synthetic rubber, produced at much lower temperatures than used in most Buna S production, is better than the natural product. The new low-temperature process may bring about sweeping changes in the American rubber industry's production methods.

The process has been tested and modified in several industrial laboratories and has been tried out on a pilot plant stage. Exhaustive tire tests have proved that the new product is superior to any synthetic rubber previously produced and considerably better than natural rubber.

Under usual methods of production of Buna S, the rubber formation in the mixture used takes place at a temperature of 122° F., and the process requires from twelve to fourteen hours. In the new process it is possible to make rubber within a reasonably short time at temperatures in the vicinity of the freezing point of water. In this process an organic peroxide is used instead of the inorganic salts usually employed.

The key to the superiority of the new rubber lies in the fact that its molecules are more uniform than those in other rubbers. This uniformity results from effecting the process of polymerization at the lower temperatures.

Light Waves Measure Supersonic Air Temperature and Pressure

Light waves are now being used to measure the pressure and temperature of air moving at supersonic speeds through glass-walled wing tunnels.

In these tunnels, tiny models of airplanes, wing sections or missiles are suspended and air forced through at high speeds simulating conditions encountered in flight. Light is passed through the tunnel from one side to the other, and also over the outside of the tunnel.

An instrument called a Mach interferometer, a new development in wind tunnel optics, is used to measure air conditions. The device splits a beam of light into two coherent wave trains, one of which passes through the wind tunnel and the other around it through a control chamber by means of mirrors. The two wave trains are recorded photographically, giving measurable optical effect.

In showing the action of a wing model on the air movement within a supersonic tunnel, what is called the "schlieren effect" has been used for several years. The "schlieren effect" has been likened to the glimmering above a pavement heated by strong sunlight due to air density changes.

The air movement, if traveling fast enough, builds up what are known as shock waves which seem to grasp the plane and hold it back. The shock waves can be photographed by schlieren photography. These are made by sending parallel rays of light crosswise through the tunnel above and below the model, and then into a camera.

The air in the shock wave is of a different density from that in other portions of the air flow and therefore refracts the light passing through it. When the light encounters the sensitized plate in the camera the refracted rays, no longer parallel to the others, make a record which is either a light or a dark spot.

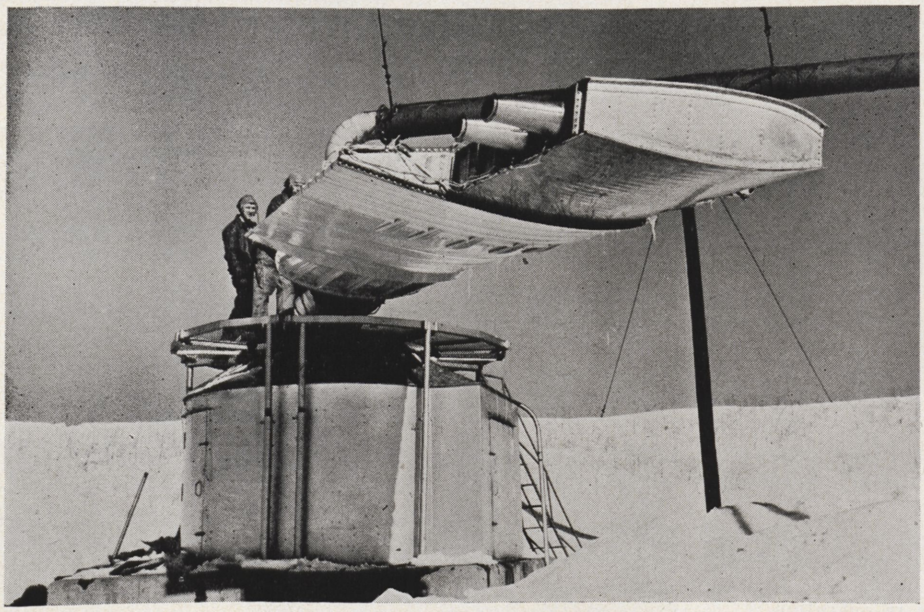
New Type Dry Cell Battery

Tiny cells have been developed that interlock to form a miniature dry cell battery, eliminating the need for wire connections and the necessary soldering. When the cells are stacked together they interlock automatically.

The new interlocking cell, to be known as the Olin cell, is one of the principal advances in the manufacture of the modern dry cell battery. The tiny cells are made of plastics and are rectangular in shape. When stacked, they make a battery which occupies much less space than those of the usual cylindrical shape.

Each individual battery cell, regardless of size or shape, produces approximately one and one-half volts of electricity. Because of this, it has been possible to reduce the size of some of the new cells to almost wafer-thin dimensions without reducing voltage. They range in size from about half the area of a postage stamp to about one and one-half inches square, and from three-sixteenths

(*Continued on page 14*)



—Cut Courtesy of General Electric
Test set up for development of jet power plant for helicopters.

Engineering Reviews

Chemical Process Control with Radio Activity

Condensed from an article by Allan P. Schreiber in *Chemical Engineering*, January, 1948.

Reviewed by Herbert B. Sliger, sr, ch.e..

Radioisotopes are now available to industry. So far they have been used mainly in basic research, but some work and much thought has been given to developing industrial uses. Two applications seem to be most promising: as tracers in chemical reactions and as sources of radiation in instruments that measure scattering of gamma rays.

However, as government regulations say that radioisotopes must be used in publishable research only, private industry has been and will be slow in devoting research time and money to the uses of radioisotopes. This is due to the fact that the Chemical Industry is a highly competitive one and process secrets are many. Potential health hazards are also a deterrent to use.

There are literally thousands of possible uses of radioisotopes in industry. For example, the rayon industry could use radioactivity and tracer techniques. In the production of viscose from cellulose, carbon disulphide is used and later in the process must be removed. If tracer quantities of radioactive sulfur were added with the carbon disulfide a continuous check of sulfur removal could be made by placing a Geiger-Mueller counter close to the solution as it emerges from the desulfurizing bath.

Radioactivity can be used to measure the specific gravity of solutions. The amount of scattering of gamma rays by a unit volume of solution depends upon the density and composition of the fluid. By means of a source of gamma rays placed outside the container and a shielded Geiger-Muller counter calibrated correctly the specific gravity may be continuously recorded. In cases of mixing to obtain a solution of a specified density automatic controls could be set up and run by the Geiger-Muller counter.

In tracing reactions radioactive isotopes are indispensable.

Undoubtedly radioactivity will very shortly be called upon to solve many problems which have seriously troubled industry for some time and for which no satisfactory solution has been found in other methods. These will be the first and probably more spectacular applications. After that, imagination, economics and ingenuity will determine the future course of radioactivity in industry.

The Capacitor as an Automatic Voltage Regulator

From *Series Capacitors on Distribution Circuits* by R. F. Marbury and J. B. Owens, February *Electrical Engineering*.

Reviewed by Philip R. Vance, sr. e.e.

Lamp flicker caused by rapid fluctuations of load current can sometimes be corrected by connecting a series capacitor in the circuit. Voltage regulators cannot prevent sudden fluctuations because the voltage dip itself is used to initiate the correction. The series capacitor compensates for the voltage drop caused by inductive reactance in the distribution circuit, and thereby improves the regulation.

The voltage drop in one phase of a distribution circuit is approximately $E = j\,R\cos\Theta + j[x_1 - x_c]\sin\Theta$ where R and x_1 are the resistance and the reactance of the distribution circuit and x_c is the reactance of the series capacitor. From this formula it is evident that the distribution circuit must have appreciable inductive reactance and that the load must have a low power factor, if the series capacitor is to be effective.

If a low power factor load results in excessive steady state voltage drop, the series capacitor should not be used. This condition can be corrected with greater ease and less cost with a shunt capacitor.

In case of a line fault the voltage across the series capacitor may be many times its maximum working value. It is generally uneconomical to install a capacitor having a current rating high enough to withstand fault conditions. Instead, a capacitor having a lower current rating but equipped with a voltage limiting device, is usually installed. However, care must be taken to select a capacitor of sufficiently high rating that a momentary overload, caused by motor starting currents, will not cause the protective device to bypass the capacitor just when it is needed.

Gas Turbine Research

From *A Laboratory for Gas-Turbine Development*, by Winston R. New, March, 1948 *Mechanical Engineering*.

Reviewed by Howard Freers, sr., m.e.

The early Westinghouse jet propulsion engines were produced with only the small development facilities owned by the corporation before the United States' entry into the war. It became apparent that engineering development facilities would be needed to continue the sound pioneering in all forms of gas-turbine motive power. Under sponsorship of the U. S. Navy, Westinghouse agreed to design, erect, equip and put into operation a gas-turbine component-development laboratory.

The need for a component-development laboratory is due to the compactness of an aviation gas-turbine power plant. This compactness makes it difficult to obtain reliable single values of component performance of an assembled unit. Progress in improvement requires the availability of facilities for testing of separate components under simulated operating conditions.

The capacity of the plant was arbitrarily set at full scale tests on all components of a power plant of 4000 hp net output. The available power comes from two 75,000 pounds per hour steam boilers, delivering at 600 psi gage and 800°F.

The laboratory contains essentially four functional subdivisions: (1) high-power turbine, (2) high-power compressor and low-power models, (3) variable pressure combustion, and (4) accessories, lubrication, and mechanical development. An elaborrate scavenging system is included to dispose of fumes.

Two multistage wide-speed range steam-turbine driven compressors are run individually or in series as to the demand. The air passes from the compressors to a large combustor which provides combustion products

(*Continued on page 26*)

Campus Survey

by Jim Morris, jr., c.e.
and Michel Cvengros, jr., e.e.

Rose Relays

The first annual Rose Relays were held at the Rose track on April 24, with the Little Giants from Wabash emerging the winner after being neck and neck with the Franklin Grizzlies all afternoon.

The last three events, the javelin, the discus, and the broad jump, were the deciding factors. Wabash picked up 10 points in these events while Franklin was able to pick up only 6 points.

Canterbury finished third with 22½ followed by Anderson with 19½; Earlham, 19; Indiana Central, 16; St. Joseph's, 1; and Rose Poly, ½.

The Indiana Central team of Eggleston, Martinez, De Baun and Langford won the distance medley with a great finish by Langford. When Langford, running anchor, started on his mile jog, he was a full eighth mile behind the leader but gained steadily and outsprinted his nearest opponent in the home drive for one of the outstanding runs of the day.

Cox of Canterbury also brought the crowd to its feet when he cleared the 12-foot, 6-inch mark in the pole vault.

Anderson's great all-round athlete, Johnny Wilson, won the 100-yard dash in 10 seconds flat and tied Ryan of Earlham in the high jump event at 5 feet 11¼ inches.

Since this was the first running of an annual event, all times and distances were recorded as records for the boys to shoot at next year.

Around the Campus

As spring blossoms forth in her full glory, the campus begins to take on a new bright and clean appearance. The buds on the trees are bursting forth and the lawn in front of the main building is covered with a profusion of Civils eagerly pounding stakes into the oft punctured sod of Rose. Even the Mechanicals seem affected by the spirit of spring as many of them have taken baths. A serene silence seems to have crept over the whole place as the annual epidemic of spring fever sets in. As you pause to listen, all that can be heard is a gentle vibration from the Electricals quietly knocking their heads against the wall in the Electronics Lab.

The spring social season was ushered in by the fraternities on April 11, when they held a midnight swimming party for the freshmen in Deming Hall. The absence of a diving board was somewhat embarrassing to the hosts; however, several of the men present volunteered to assist the freshmen in performing whatever type of dive they might wish to attempt.

The new freshman class has been receiving a rather liberal education from the Sophomores. Aside from the instruction in the usual yells, songs, and traditions, the class was given a demonstration in the boiler room on the effect of grease upon the various portions of the skin. The question of whether the grease should be permeated with soot before application to the skin or after application was discussed fully and suitable demonstrations were performed.

Sports

Rose Polytechnic opened the 1948 track season Saturday, April 10, meeting Indiana Central in a dual meet. Although the Engineers went down in defeat to a score of 93½ to 37½, Rose appeared strong in a few places.

—Photos by Fessenden

Nice try.

Hi Diddle Diddle . . . and Grant jumped over the bar.

—*Photo by A. Silverman* **Faculty and Freshmen get acquainted.**

Haupt in his first try at the high hurdles, won an easy first after Phil Brown had offered Indiana Central the event. Haupt added to his point total by placing second in the pole vault.

The relay team of Hauser, Davis, Pittman, and Kuehl took the mile relay without too much trouble.

On the following Wednesday, Rose traveled to Franklin College for another dual meet and went down in defeat to the score of 115 to 16. The pole vault team of Phillips, Grant, and Haupt swept the pole-vault event, all three tying for first place. Rose floundered through the rest of the meet picking up a point here and there.

To date Rose has played two baseball games, losing both. The first was lost to Indiana Central by a score of 13 to 1. A. E. Smith and Meurer handled the pitching assignment with Gardner behind the plate.

The second game was lost to Franklin by a score of 6 to 3. A freshman, Gene Hudson, handled the pitching and showed promise of becoming a winner before the season is much older. Gardner was again behind the plate.

Glee Club

The Glee Club has begun its spring concert season with appearances at Terre Haute high schools, churches, and civic organizations. The Club has already sung at Garfield, Gerstmeyer, and Laboratory high schools, the First Baptist Church, and the Woman's Department Club. Programs at Wiley High School and Terre Haute organizations are scheduled for the latter part of May and June. President Karl Hauser reports plans for a formal concert in the early part of June.

A committee from the Club is preparing a new constitution and by-laws to be presented to the Club. After these have been accepted, there will be an election of officers.

A. I. E. E.

Rose Student Chapter, A. I. E. E., held its last meeting of the term on Thursday, March 4, 1948. At this session John Bartholome presented a talk, entitled "Effects of Electric Current on the Human Body." John discussed the extent to which various magnitudes of current and voltages are hazardous to the body. The subject is of interest to all persons concerned with safety, both in the home and in the factory.

A number of members of the Chapter attended a meeting of the Central Indiana Section, A. I. E. E., held in Indianapolis on Friday, March 19, 1948. The speaker for the evening was Dr. Everitt, Head of the Electrical Engineering Department, University of Illinois. His talk was entitled, "Fundamentals of Engineering," in which he pointed out the necessity of providing engineering students with basic fundamentals for a broad field instead of specialization. Along with other examples of the use of fundementals in the solution of complicated engineering problems, Dr. Everitt described the binary

(Continued on page 30)

—*Photo by M. Lowenstein* **Casper Haupt takes a lead.**

Alumni News

by Edward Meagher, sr., ch.e.

Alumni News

'95 L. D. Gwin reports that William S. Speed, '95, was recently awarded a scroll as Honorary Member of the Engineers and Architects Club of Louisville. The presentation was made by Francis H. Miller, '95, who is now Chairman of the Board of the Louisville Railway Company.

'26 Professor Ralph W. Tapy has been elected a Fellow of the American Institute of Electrical Engineers. Professor Tapy is head of the electrical engineering department at the University of New Mexico.

'35 Gordon L. Burt was recently appointed to the position of city manager of Hayward, California. Burt has been located in Oakland, Cal., for the past several years. During the war he served with the Army Engineers as sanitary engineer for several posts on the west coast. Since leaving the service he has been associated with the East Bay Municipal Utility District as a senior civil engineer.

'40 Milton Hosack was married to Miss Miriam Egger on March sixth in Pittsburgh, Pennsylvania. Best wishes from the TECHNIC.

'41 John L. Combs and Miss Kathryn S. Rutt of Philadelphia were married April third in the Dale Memorial Church in Philadelphia. They will reside in Roselle, New Jersey. Best wishes from the TECHNIC.

'42 Mr. and Mrs. John Mehagan announce the birth of a son, Michael Warner, on April 15 at La Grange, Illinois. Congratulations from the TECHNIC.

CHANGING YOUR MAILING ADDRESS? FOR PROMPT SERVICE, NOTIFY THE TECHNIC DIRECTLY—IN ADVANCE IF POSSIBLE.

'42 Dave Demaree has returned from Peru and has taken a position as electrical engineer with Lescher and Mahoney, Architects and Engineers, in Phoenix, Arizona.

'43 William A. Yoder is resident engineer for the firm of Johannessen and Girand, consulting engineers, in Phoenix, Arizona. The firm has been supervising the expansion of the water system in Phoenix.

Mr. and Mrs. Ralph Brown announce the birth of a daughter, Cathy Anne, on January 5, 1948. Congratulations from the TECHNIC.

Mr. and Mrs. William Soudriette announce the birth of a daughter, Helen Ann, on March 6, 1948. Congratulations from the TECHNIC.

'44 W. Alan Winslow and Miss Peggy Treat were married in Evansville, Indiana. Best wishes from the TECHNIC staff.

Mr. and Mrs. James L. Johnston have aannounced the birth of a daughter, Pamela Sue, on March 2, 1948. Congratulations from the TECHNIC.

'47 John R. White has accepted a position with the industrial supply firm of Crawford and White in Terre Haute. Previously he had been associated with the American Can Company in Indianapolis.

John Stewart and Miss Mary Elizabeth Estes were united in marriage last April third in Saint Mary's-on-the-Highlands Church in Birmingham, Alabama. Best wishes from the TECHNIC.

A recent change in the administration of the Louisville Railway Company should be of interest to Rose alumni in as much as two Rose graduates were involved. Frank H. Miller, '95, was promoted from president of the company to chairman of the Board of Directors. He has been with the company ever since his graduation. John W. Leake, '28, was promoted from general superintendent to vice president and general manager. Mr. Leake also has been with the company ever since his graduation.

RESEARCH & DEVELOPMENT

(*Continued from page* 10)

to three-eighths of an inch thick. These batteries are designed primarily for use in small radios and hearing aids.

Jet-Propelled Helicopters

Establishment of new facilities for the development and testing of component parts of proposed jet-propelled helicopters has been started at General Electric as a part of a long-range program in the development of revolutionary aircraft. The program to date has included the flight testing of jet engines, turbo-superchargers, automatic pilots, a flight recorder, radar, and other aircraft instruments and equipment. The new division is working on new-type jet powerplants for helicopters and other component parts for the rotary wing aircraft. The new facilities include an outdoor bowl-shaped pit, one hundred and fifty feet in diameter and thirteen feet deep, with propelling mechanism for the testing of jet units located at the tips of the whirling helicopter blade, an all-steel structure, forty by eighty feet, which is used for laboratory and workshop activities, and control and instrument facilities for the propelling mechanism.

A special observation room, adjoining the pit, has concrete walls three feet thick to safeguard engineers during the testing of the rapidly-whirling jet-helicopter blade.

Believed to be the first of its kind and unique in design and size, the jet-helicopter development section was constructed at a cost of more than $100,000, not including special equipment, such as diesel generators, superchargers, and army tank engines, which drive the superchargers to produce air for the jet burners.

The development program is a two-phase one. The first or preliminary part of the project was a study phase, covering evaluation, performance and design of various types of power plants, an aerodynamic testing of critical components. This included the static testing of burners—various types of jet-propelled tips—to determine which type would be the most satisfactory. Burner units determined to be the best type to date were designed and built.

The second phase of the program is the power testing of the burners, which use kerosene fuel, in the outdoor test pit. In addition, the prototype jet engine to be used as a helicopter power plant will be erected and tested, supplying air to the

(*Continued on page* 16)

Fraternity Notes

Lambda Chi Alpha

With the beginning of the Spring term, activities are again being resumed at 2111 So. Sixth Street. The brief, but very much enjoyed, between-terms vacation was spent by all members in their respective homes. This enabled them to catch up on all the local gossip. In addition to the return of all of last term's house men, three members and their stacks of books have moved into the sanctuary of the fraternity. These new house men are Dave Smith, Carl Wokasien, and Verle Fiegle.

The fraternity was saddened at the end of last term to lose three excellent fraternity brothers, George Kyle, Donald Spencer, and Dick Raysinger. However, the members of the fraternity extend their sincere congratulations to these men on their graduation and wish them all of the success in their respective fields.

With the graduation of President George Kyle, Claiborne Motsinger, vice-president, assumed the responsibilities of Chapter president. The chapter elected Al Schmidt to fill the vacated office of vice-president. Brother Schmidt was also chosen to represent the Rose chapter at the Lambda Chi Alpha National Convention. Richard Fairbrother was elected as alternate delegate.

The Lambda Chi's are busily planning for the spring social functions. The Mothers' Club has plans of sponsoring an informal dance and get-together for the fraternity in the near future. From all indications, the chapter is going to be very well represented by alumni and actives at the Lambda Chi Alpha State Dance to be held May 8 at the Claypool Hotel at Indianapolis. The Chapter also has hopes of viewing the spring greenery by having a picnic soon, if the weatherman will only cooperate.

Alpha Tau Omega

On April 16 the fraternity attended the wrestling matches which are held currently at the armory. The feature of the evening was a match between two feminine wrestlers. Following the wrestling matches the remainder of the evening was devoted to the enjoyment of good fellowship at MacGregor's billiard parlor.

Among the events on our future social calendar, is a combination wiener roast and skating party. If all goes as planned, the wiener roast will be held at Deming Park, followed by skating at the Wigwam Roller Rink.

Another event that the members are looking forward to is the V. M. I. Ball that is to be held on May 15 in conjunction with the Sigma Nu fraternity. Both fraternities were founded at Virginia Military Institute shortly after the Civil War, hence their histories are somewhat similar. On several campuses throughout the country the V. M. I. Ball is an annual affair. This is the first of such dances to be held at Rose, however, as far as we know. At any rate, it is the sincere hope of the fraternity that the dance will prove to be a success and that it may become an annual affair on our campus here at Rose.

The fraternity extends heartiest congratulations to its former social chairman, Tex Hudson, on his recent marriage to Miss Matilda Bell. The wedding was held on April 24 in St. Stephen's Episcopal Church and was followed by a reception at the Terre Haute Country Club.

Sigma Nu

Growth of the chapter was continued recently with the pledging of seven men to the chapter. New pledges are Edward Dudek, Jack Gruenholtz, Frank Marjetko, Malcolm Meurer, William Miller, Clyde Winkler, and Lester Wright.

At an election of officers, Ben Richardson was elected Commander, Michael Schaefer, Lieutenant Commander; Pierce Walinsky, Chaplain; Kenneth Sheetz, Recorder; Wayne

(Continued on page 30)

RESEARCH & DEVELOPMENT

(Continued from page 14)

whirl-test blade in the pit and simulating ultimate operating conditions.

A 1000-horsepower electric motor is used to drive the blade when the jet-driven tip is not fired in order to study drag of the test setup prior to "firing up" the burners. When the burners are operating under their own power, the large motor is used as a generator to measure the thrust produced by the jets.

Gold and Copper In Solder

Gold and copper are alloyed to make a special-purpose solder. Preferred proportions are 37.5% gold, 62.5% copper. The solder is used on such difficult metals as copper and iron-nickel-cobalt alloys. Also, because its expansion characteristics are close to those of glass, it is well suited for making high-vacuum seals between glass and metals.

Use of Infra-Red Ray In Spectroscopy

Methods of using infra-red rays, invisible heat radiation, to investigate aviation fuels, synthetic rubber and other materials by means of the spectroscope have been completely transformed during the past seven years. Much advancement was made during the war and further improvements have been made since. It is now possible to have an instantaneous picture on a cathode ray screen of a reasonable portion of the spectrum of the material being studied. By using a lead sulphide photo-conductive cell, the resolving power attainable in the short-wave region is much increased, and by using ultra-short-wave techniques developed in radar, the region that overlaps the extreme long-wave limit of the infra-red becomes accessible.

Superior Aviation Fuel In Military Use

Military planes are now using an aviation fuel as much superior to 100-octane as premium grade motor gasoline is over regular grades. The new fuel is claimed to increase speed and range of planes from 12% to 15%.

This new super fuel, a petroleum product, is known as 115/145 grade. The present high-grade fuel known as 100-octane is 100/130 grade in the industry. The new fuel was developed toward the end of the war and plans were made to use it in B-29's; that use did not materialize. However, oil companies are able to supply the fuel and nearly 2,000,0000 barrels were delivered to the armed services before the close of last year.

The 115/145 grade fuel is harder to make than the 100-octane because it requires a larger proportion of synthetic hydrocarbons, such as alkylate. Further details to it are not yet revealed.

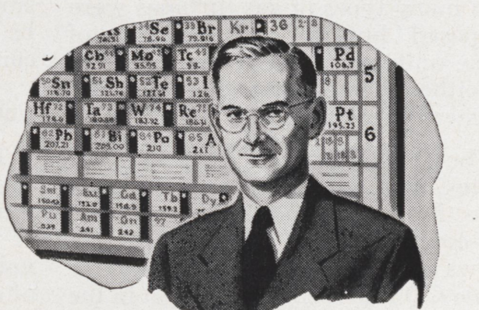
Careers at GENERAL ELECTRIC

'PILE' ENGINEER . . . ACCOUNTANT . . . SILICONES SPECIALIST

for each, General Electric has assignments to his liking

General Electric is not one business, but an organization of many businesses, ranging from the building of transformers at Pittsfield, Mass., to the molding of plastics at Anaheim, Calif. Graduates of American colleges and universities are finding that the 125 plants of General Electric offer opportunities to all degrees of specialists, all sorts of enthusiasms, all kinds of careers.

'PILE' ENGINEER

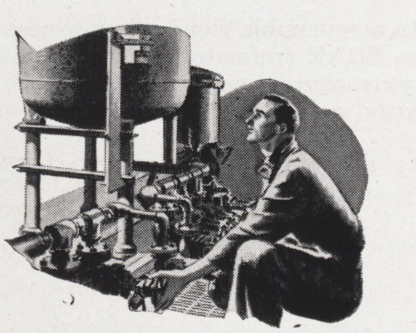


Quoting Dr. W. I. Patnode (Cornell '27) of the G-E Nucleonics Project: "Seldom has the engineer been offered the opportunity to achieve greatness that is contained in the development of atomic power . . . The pile engineer must know radiation as the aeronautical engineer knows air flow, as the electrical engineer knows electromagnetism . . . There is work for more pile engineers, educated men who comprehend the nature and magnitude of controlled nuclear energy."

UP FROM BTC

Donald L. Millham (Union '27), today the G-E Comptroller, is one of the many top officials of General Electric who got their start in the company's Business Training Course, the oldest nontechnical training program offered by industry. BTC trains nontechnical college graduates for managerial accounting positions such as department comptrollers, division accountants, district auditors, operating managers, and treasurers of affiliated companies.

SILICONES SPECIALIST



"The field of silicon chemistry has only been touched, with new developments continually appearing"—that is the opinion of Jerry Coe (M.I.T. '42), now helping start up the new G-E silicones plant at Waterford, N. Y. Oils, resins, greases, "bouncing putty," and rubber having silicon as a basis of the molecule are now being marketed in increasing quantities, as they gain recognition for their striking temperature stability and other unusual properties.

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GENERAL ELECTRIC

GAS TURBINE . . .

(*Continued from page* 7)

sion into two or more steps and reheating between each. By this means, a greater amount of the expansion is accomplished at a high temperature.

To summarize, adding the regenerator boosts the effciency to the vicinity of 30%, and this value is exceeded by the use of intercooling and reheating. These improvements add to the complexity of the gas turbine and must be weighed carefully since one of the principal attractions of the gas turbine is its simplicity.

Thermodynamic Considerations

During the long experimental period many types of gas turbines were proposed, but the vast majority of these units were designed to operate on either the constant volume or the constant pressure cycle.

The explosion type gas turbine operates on the constant volume cycle (see Fig. 2). Line AB represents pre-compression of the charge; BC shows explosion at constant volume while CD represents expansion in the turbine. The constant volume cycle is not used as widely as the constant pressure cycle.

The Brayton cycle, or constant pressure cycle, consists of two isobaric and two isentropic state changes as theoretically shown in Fig. 3. The isentropic compression of the air in the compressor is shown by line AB. Line BC shows isobaric addition of heat to the air and gas mixture in the combustion chamber. Line CD depicts the isentropic expansion of gas in the turbine, while DA portrays the assumed isobaric removal of heat from the exhaust gas, thus completing the cycle.

In a reversible steady flow process area FBAE (referring to Fig. 3) represents, theoretically, the amount of energy required by the compressor to compress one pound of air, while the area FCDE represents the theoretical amount of energy created by the expansion of one pound of air in the turbine. Therefore, the theoretical amount of energy which would be available for power purposes, per pound of fluid, would be represented by the difference between these two areas, ABCD. Because of the fact that fuel is introduced into the cycle after the compression of the air occurs, a correction must be applied when determining the excess power for the slightly greater quantity and different composition of the fluid undergoing expansion than that being compressed. While not necessarily negligible, these corrections, under normal operating conditions, are small, as the amount of fuel used will be less than 1% of the weight of air compressed.

Construction

The compressor, commonly called the heart of the gas turbine plant, must provide a highly efficient means of increasing the pressure of large volumes of air. There are three types of compressors in use today: the centrifugal type, axial-flow type and the positive displacement type. The axial-flow type is most widely used in non-aviation designs because of its high efficiency.

The axial compressor is made up of a large number of rows of moving and stationary blades, and each row contributes to the pressure rise. The blade contours resemble miniature airplane propellors and their design has been based on aerodynamic theory. By utilizing a large number of stages, high pressure ratios can be attained as well as high efficiencies. It is designed to produce nearly straight axial flow through the compressor.

The function of a gas turbine combustor is essentially to raise the temperature of the air from 600°F. to 800°F., and it should, therefore, be considered as a direct-fired air heater. A theoretical air supply of about 750 to 770 pounds per million BTU of heating value is required for the burning of the fuels. This means that an air-to-fuel ratio of eighty to one is required. The mixture is too lean if the fuel is burned directly in the total air supplied. Therefore, the air is divided and the approximate theoretical quantity is supplied to an inner shell, within which the fuel is burned completely before the remaining air is added. The double shell design takes advantage of the excess air to maintain the temperature of the metals below their critical temperatures and thereby avoids the use of refractories. This is the principle upon which combustion chambers are designed. Ignition of the fuel supply (usually a liquid such as oil, or finely pulverized coal) is obtained by an electric spark. After combustion has started, the spark can be cut off.

Turbine blades have been made by forging, machining from rolled bar stock and shapes, and precision casting. Forging will allow any desired shape, but it must be remembered that the same metal must resist deformation in gas turbine operation at temperatures not much less than forging temperatures. Machining offers cost savings and simplified metallurgical control, but compromises on the shape.

A serious problem is presented by the rotors and disks in that large forgings of heat resistant alloys have not as yet been produced dependably. Because of this, many forms of built-up rotors consisting of disks welded together have been made. No major difficulties have been encountered in turbine casings, with forged or cast alloy sections being available. However, in all designs, a

(*Continued on page* 28)

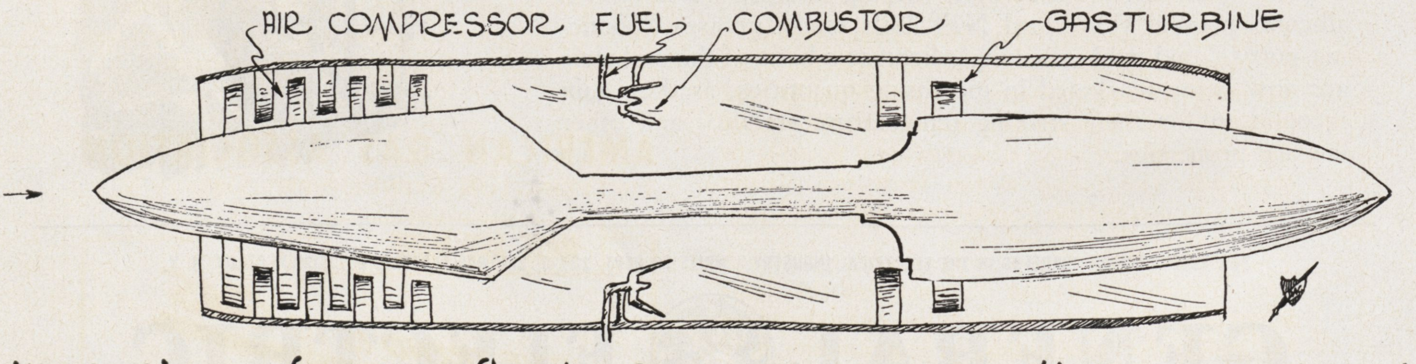


Illustration of an aircraft *JET-PROPULSION* engine with *AXIAL-FLOW* and In-Line Combustor & Turbine.

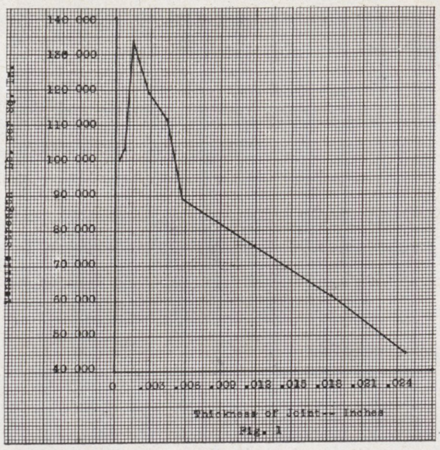
BRAZING . . .

(*Continued from page 9*)

during the brazing process. If gravity contact cannot be relied upon, tack welds, keys, or press fits are used to prevent movement during the trip through the furnace.

The proper application of these precautions will produce a joint that is stronger than that produced by conventional methods of fastening. Riveted, bolted, or spot welded joints depend upon the strength of the individual joints, while in brazing the entire contact area forms one joint whose area is greater than the sum of the individual areas of the other fastening methods. The greater strength of the brazed joint is derived from this greater area.

The temperature used in brazing varies over a wide range (1250 to 2050° F). The temperature used must be selected to fit the combination of circumstances to be met. It must be high enough to insure wetting of the base metal by the molten filler, but cannot be so high that it will have undesirable effects upon the base metal. For instance, zinc and cadmium may be distilled from the parent metal, vanadium and aluminum



form objectional oxides, and steels may show considerable grain growth at elevated temperatures. These high temperature problems may be solved by using a filler with a low melting point. The silver alloys are good examples of low temperature brazing mediums.

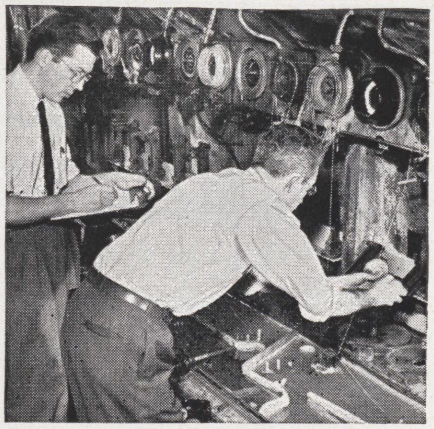
The time cycle used is a function of the temperature at which the brazing is done and also of the mass of the piece being brazed. It is worth while to note, however, that a part may have several joints to be brazed but one trip through the furnace will braze all the joints simultaneously.

The present trend in production is towards the use of electric furnaces because they are economical, have a high production rate, and produce a high quality product. There are four types of electric furnaces in common use for brazing. They are the roller-hearth, belt-conveyor, push or batch, and bell type. Each of these furnaces is very well adapted to brazing in controlled atmospheres.

The roller-hearth furnace is used where continuous production of heavy work is required. The work moves through the furnace on a series of chain driven rollers whose speed may be regulated so that the heat input to the work may be at the proper rate. As its name implies the belt-conveyor furnace has an endless belt on which the work moves. The belt is made of woven wire and travels through the furnace on heat resistant alloy rails which are an integral part of the furnace floor and spaced to permit proper heat circulation. Both the roller-hearth and the belt-conveyor types are similar in construction. The heating chamber is heavily insulated with a refractory

(*Continued on page 22*)

DU PONT Digest
For Students of Science and Engineering



Determination of spinning tension by C. S. McCandlish, Chemical Engineer, Northwestern University '44, and A. I. Whitten, Ph. D., Physical Chemistry, Duke University '35.

Many Theoretical and Applied Studies Behind Development of "Cordura" Rayon

Stronger, lighter tires made possible by teamwork of Du Pont chemists, engineers, and physicists

On the surface, the viscose process for rayon seems fairly simple. Cellulose from cotton or wood is steeped in NaOH to give alkali cellulose, which is treated with CS_2 to form cellulose xanthate. Adding NaOH gives molasses-like "viscose," which is squirted through spinnerets into a coagulating bath of acid and salt to form from 500 to 1,000 filaments simultaneously:

$$\underset{\text{(cellulose)}}{R^{*}\text{-}OH} + NaOH \longrightarrow \underset{\text{(alkali cellulose)}}{R\text{-}ONa + H_2O}$$

$$R\text{-}ONa + CS_2 \longrightarrow \underset{\text{(cellulose xanthate)}}{R\text{-}O\text{-}\overset{\overset{S}{\|}}{C}\text{-}SNa}$$

$$R\text{-}O\text{-}\overset{\overset{S}{\|}}{C}\text{-}SNa + H_2SO_4 \longrightarrow \underset{\text{(cellulose)}}{R\text{-}OH} + CS_2 + NaHSO_4$$

$$R^{*} = C_6H_7O_2(OH)_2$$

Du Pont scientists were working to improve on the properties of rayon made by this process when, in 1928, a rubber company asked for a rayon yarn that would be stronger than cotton for tire cords. The problem was given to a team of organic, physical, and analytical chemists, chemical and mechanical engineers, and physicists.

Theoretical and Applied Studies

In developing the new improved rayon, a number of theoretical studies were carried out: for example, (1) rates of diffusion of the coagulating bath into the viscose filaments, (2) the mechanism of coagulation of viscose, (3) the relationship between fiber structure and properties by x-rays, and (4) a phase study of spinning baths.

Concurrently, applied research was necessary. This proceeded along many lines, but the main problem was to perfect the spinning technique. It was known that a short delay in the bath between the spinneret and the stretching operation allowed greater tension on the filaments. Du Pont engineers, therefore, designed a series of rollers, each revolving faster than the previous one, to increase the tension gradually.

In addition, a textile finish was developed that combined just the right amount of plasticizing action and lubricating power, allowing the filaments to twist evenly in forming the cord. A new adhesive was prepared to join the yarn with rubber. New twisting techniques for cord manufacture were found, since the usual methods caused loss in rayon strength.

Engineering Problems Solved

Chemical and mechanical engineers were faced with the design and operation of equipment for more than 15 different types of unit operations. Equipment had to operate every minute of the day, yet turn out perfectly uniform yarn. It was necessary to filter the viscose so carefully that it would pass through spinning jet holes less than 4/1000th of an inch without plugging. Some of the most exacting temperature and humidity control applications in the chemical industry were required.

Out of this cooperation among scientists—ranging from studies of cellulose as a high polymer to design of enormous plants—came a new product, "Cordura" high-tenacity rayon, as strong as mild steel, yet able to stand up under repeated flexing. Today, this yarn is almost 100% stronger than 20 years ago. Tires made with it are less bulky and cooler running, yet give greater mileage under the most punishing operating conditions. In "Cordura," men of Du Pont have made one of their most important contributions to the automotive industry.

Questions College Men ask about working with Du Pont

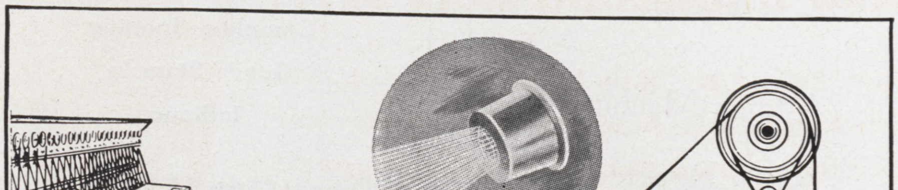
How are new men engaged?

Most college men make their first contact through Personnel Division representatives who visit many campuses periodically. Those interested may ask their college authorities when Du Pont men will next conduct interviews. Write for booklet, "The Du Pont Company and the College Graduate," 2518 Nemours Building, Wilmington 98, Del.

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING ...THROUGH CHEMISTRY

More facts about Du Pont—Listen to "Cavalcade of America" Monday Nights, NBC Coast to Coast



Rayon spinning machine. The spinning solution is pumped through a spinneret immersed in a hardening bath. Filaments are guided over a rotating glass wheel and down into the whirling collecting bucket. Inset shows close-up of spinneret; each hole forms a filament.

BRAZING . . .

(*Continued from page* 20)

which supports the ribbon-type heating elements. The cooling chamber is made of two concentric shells through which water is circulated. Work is continually passing through these furnaces so the doors must be kept open. A flame curtain (a flame of burning atmosphere gas) is maintained at each door so that air cannot enter the furnace.

The batch furnace is constructed similarly to the roller-hearth and conveyor-belt furnaces. It differs mainly in that the work must be pushed manually and is not carried through the furnace on driven rollers or a belt. It, too, has a heating chamber and a cooling chamber. The doors are protected by flame curtains.

The bell furnace is used when the assemblies are too heavy or bulky to be brazed in the continuous type furnaces. The furnace consists of a hearth, on which the work rests, and a large metal bell which covers the work and is sealed to the hearth with chrome oxide. In this furnace the work is brought up to temperature and cooled in the same chamber while protected at all times by a non-oxidizing atmosphere.

Regardless of the type of furnace used in the brazing operation, the procedure is the same. The component parts are thoroughly degreased and then assembled with the brazing metal in the form of a wire ring, washer, foil filler, or powder placed at the entrance to the joint. The assembled parts are then placed in the heating chamber of the furnace and allowed to come to heat. When the filler metal reaches its melting point it forms liquid puddles at the top of the joints, and under the action of capillary attraction penetrates the entire joint. The assemblies now pass into the cooling chamber where the molten filler is allowed to solidify. The entire cycle is carried out in a protective atmosphere so that the part emerges from the furnace clean and bright, inspection is made easier and further cleaning is made unnecessary.

Controlled atmosphere brazing is one of the most economical methods of metal joining in use today. Because production may be continuous and several joints may be brazed at once, savings of as much as 70% over other methods have been effected. Its versatility, high production rate, and low cost assure it a prominent position in the field of metal joining.

SEWAGE . . .

(*Continued from page* 8)

into streams, lakes, or harbors without regard for consequences. Under proper conditions disposal by dilution may be considered as a scientific process that may be used to lessen the cost of sewage treatment.

Sewage solids, when discharged into a body of water, undergo the usual cycle of decay. Putrefaction, with its attendant nuisances and fish destruction, will result if insufficient oxygen is available. With abundant oxygen the desirable aerobic action takes place. The bulk of this oxygen must come from the water itself, and water, even when saturated, holds only small amounts of oxygen in solution. Extreme care must therefore be taken when contemplating the discharge of sewage into a body of water, making sure that sufficient water is present. Satisfactory dilution is sometimes expressed as four to seven cubic feet per second of diluting water for each 1000 persons contributing sewage.

Other agencies also assist disposal by dilution. Sedimentation results in solids settling to the bottom of the river, harbor, or lake. There, these solids will undergo anaerobic decomposition, without offense if thinly scattered, but with nuisance if sludge banks form. Various water organisms, such as green algae, help oxidation by using carbon dioxide and releasing oxygen. If the water is agitated quicker reaeration of the diluting water is permitted; hence, under such conditions, the dilution factor may safely be somewhat smaller. On the other hand, high velocities hinder sedimentation and the work of algae. From what has been said it may readily be seen that this form of sewage disposal can be carried on only by cities bordering on large, relatively quiet bodies of water where the tide conditions are suitable and where the dumping of the sewage will not harm the water supply, marine life, or bathing beaches.

Probably the simplest and most suitable method of disposing of the sewage in towns not able to employ the above methods is to convey it to an irrigation area or sewage farm, where such facilities exist. In some cases it is possible to dispose of the crude sewage in this way merely by directing it through a suitable system of channels to a sufficiently great area of land where it percolates through the soil. This method not only retains the solid portions, but also, by assisting in the aeration and decomposition, considerably purifies the effluent in its passage so that it can find its natural way to the nearest water course without risk of polluting it. The solids left on and near the surface of the soil are turned in by ploughing. Thus, by working a large area in sectional rotation, great quantities of the constituents, which have already served their purpose in sustaining human life, are returned to the soil and may be again used for the production of food.

On flat land the ground is generally laid out with slightly raised parallel ridges, intersected by a network of irrigation channels. These are fed by brickwork or concrete distributing channels that may be blanked off at suitable points by stop boards or iron plates, so that the sewage is made to overflow at either side and soak into the soil. On sloping ground a similar result is obtained by contour drains formed at intervals down the slope. Another scheme, known as irrigation with ridge and furrow, consists of a layout of long rows of ridges separated by furrows. The sewage can be directed into the furrows from which it gradually percolates sideways to the roots of the crops grown on the ridges. The practicability of this meth-

od of sewage disposal, together with reasons of economy, make it a widely adopted method in foreign countries and to a lesser extent in the United States.

Since the aforementioned methods of sewage disposal require certain conditions to be successful, it is apparent that sometimes means of purifying the sewage before discharging it must be adopted. The discharging of untreated or insufficiently treated sewage into streams has brought serious troubles to cities. Law-suits are frequent on the part of riparian-land owners because sewage has made the waters of streams unpleasantly odorous, unfit for domestic use, for watering cattle, or for industrial purposes, and has destroyed fish life. The germs of various diseases, particularly typhoid, paratyphoid, and dysentery, which will be found in sewage, may result in the infection of water supplies, make bathing beaches unsafe, and contaminate oyster beds.

For many years various processes have been tried in attempts to purify sewage. Chemical methods have never proved as advantageous as might be expected, generally resulting in an increase in the volume of sludge without any compensating improvement in its manure value. Quite often chemical treatment has resulted in producing an effluent of high acidity fatal to the fish living in the water into which it was discharged.

It has been found that by passing an electric current through sewage, the water and chloride salts contained in it are separated up into their elements, oxygen and chlorine being liberated at the positive pole. These gases exercise a very powerful deodorizing effect on the sewage, but the main difficulty is to arrange to subject the whole of the sewage to the electrolytic action since it is localized at the plates past which the sewage is made to flow. In another electrolytic process, known as "oxychloride sewage purification," an electric current is passed through sea water or a solution of magnesium and sodium chlorides. This causes it to yield magnesium hydrate and hypochlorous acid, the former being precipitated and the latter acting as a disinfectant. This liquid has given satisfactory results when used for flushing the sewers.

The best solution of the difficulties connected with sewage disposal in inland districts was discovered some years ago. It was then realized that under certain natural conditions bac-

(*Continued on page 26*)

REVIEWS . . .
(*Continued from page* 11)

for gas-turbine tests. These gas-turbines under test do not have their outputs diminished by a factor of three or four since they do not pump their own air, and they consequently approach outputs of 18,000 hp at speeds up to 15,000 rpm. The torque is absorbed by controlled torque water brakes.

For full speed high-power tests of compressors alone, a closed circuit of 36-inch pipe is used, along with a steam turbine dynamometer to run the compressor. The turbine drive has upper limits of 6000 hp. and 20,000 rpm. The low power model tester contains all the functional elements of the high speed plant, differing mainly in capacities and apparatus arrangement.

Provision are made for thorough testing of all of the accessories to be used.

The test areas were put in service as completed and have operated for periods ranging from six months to two years. Experience has already proved that the laboratory will do much to speed the adoption of gas-turbines as reliable and superior power plants.

SEWAGE . . .
(*Continued from page* 25)

teria could bring about all the desired changes and render sewage not only pure but highly beneficial, as it restores nitrogen to the soil in a form readily available to plant life.

There are two distinct species of bacteria that bring about the desired changes in sewage. One species, known as "anaerobic" bacteria, flourishes best out of contact with air. It causes putrefaction of sewage, brings about the liquefication of the solids, and generates noxious gases in the process. The other species, called "aerobic," requires air to support its existence. These bacteria work with the oxygen of the air in reducing the liquid sewage to water, carbon dioxide and nitrates without producing offensive odours.

There are many ways in which the changes just described are brought about in practice. The two most important are the filtration and activated sludge treatment plant. In both these processes, to overcome difficulties which are sure to arise, it is advisable to remove the heavier solids and inorganic matter as the sewage enters the treatment plant. This is accomplished by first allowing the raw sewage to pass through what is known as the grit chambers. The grit chambers are narrow tanks in which the velocity of the sewage is controlled so as to settle out the grit and larger organic solids. Next, the sewage is passed through a sedimentation tank in which the velocity of the sewage is cut down so as to allow gravity to pull down the suspended solids. The chemicals described above are also added here.

In the filtration treatment plant, the sewage passes from the sedimentation tank through an intermittent sand filter, contact bed or trickling filter. The object of all these filters is to provide accessibility for the aerobic bacteria. In the intermittent sand filter a bed of coarse sand about two or three feet thick is provided. Through this filter the liquid is passed slowly in moderate quantities for a period, followed by a rest period during which the filter is fully aerated in order to ensure adequate aerobic bacterial action. Contact beds are a series of watertight tanks connected by syphons and filled with pieces of coke, broken stone, or clinker. Here again the operation is intermittent to ensure the continuance of the purifying action by encouraging the aerobic bacteria.

In the activated sludge treatment plant the sewage is passed from the sedimentation tanks to a group of aeration tanks. Here the sewage is greatly agitated while being exposed to the air, causing the remaining suspended material to become rich in oxygen and hence in aerobic bacteria. This vigorous agitation, a necessity in this method of treatment, moves the activated sludge about in the sewage where, owing to its flocculent nature, bacteria become attached to the remaining organic material and oxidize this suspended and dissolved material. The detention period here is from four to ten hours, depending on the sewage. After the aeration period the sewage-sludge mixture is allowed to settle in what is called the final settling tanks, and the clear effluent is then discharged.

The sludge which is collected in both of these treatment processes is piped to a sludge digester where the sludge is allowed to digest under the action of the anaerobic bacteria. Under favorable conditions the digestion period will be less than fifty days.

Perhaps this story of how a town disposes of its sewage has indicated to a certain extent how much we owe to the engineers and sanitary authorities and to the rules of sanitary science. It is safe to say that without them town life as we know it today could not exist.

ONE OF A SERIES OF STORIES ABOUT ALLOYING METALS...WHERE THEY COME FROM AND HOW THEY ARE USED

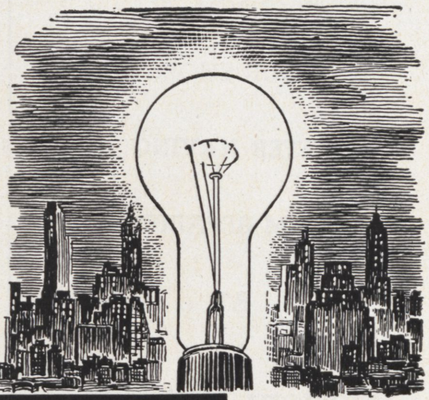
THE STORY OF TUNGSTEN

DAMASCUS SWORDS

1 Tungsten has been found in medieval Damascus swords—so hard they could cleave iron spears at a blow, so keen they could cut floating gossamer, so elastic they would spring back to shape after being bent to a right angle. Yet it is only for about 50 years that tungsten has been known as a valuable alloying metal.

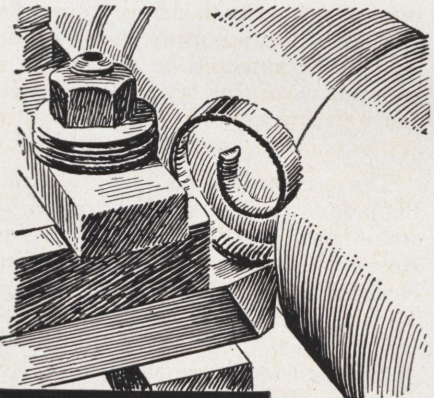
"DAMNED BLACK IRON!"

2 The exciting flash of gold was the dream of miners in gold rush days. They cursed when their pickaxes rang against a stubborn black rock—one of the tungsten ores, which has since sold for as much as gold ores. Tungsten ore is mined in the United States and many other countries throughout the world.



HOT AND HEAVY

3 Tungsten (which is Swedish for "heavy stone") gets hotter than any other metal before it melts—6,100° F. That's why it is used in electric lamp filaments and has many valuable industrial applications where high heat resistance is needed. Electromet produces pure tungsten powder, ferrotungsten, and calcium tungstate.



FOR CLOSE SHAVES

4 In cutting tools of high-speed steel and tungsten carbide and in the well-known HAYNES STELLITE non-ferrous alloys, tungsten produces a hard edge that stays hard even under extreme friction and high temperatures. Tungsten has other important uses, such as in the heat-resisting metals of gas turbines and jet engines.

MAN-MADE HARDNESS

5 Nature made the diamond, but man has created something almost as hard —tungsten carbide. This highly abrasion-resistant material is used for dies and tools and as a welded deposit on parts exposed to extreme wear. For instance, this tungsten alloy applied to drill bits enables oil men to drill wells almost three miles deep.

Help Wanted?

If you need help on some specific application of ferro-alloys or alloy steels, let Electromet work it out with you. Our modern, completely equipped research laboratories at Niagara Falls, New York, are staffed by men who have had years of experience in helping ferro-alloy users solve problems that arise in their plants and in the markets served by them. You can learn more about this unique service by writing to our Technical Service Department for the booklet, "Electromet Products and Service."

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GAS TURBINE . . .

(*Continued from page* 18)

high degree of symmetry is desirable.

In addition to the above mentioned conditions, provisions must be made to take care of expansions up to one-eighth inch per foot due to the high temperature encountered in the turbine. Radial expansion is usually taken care of by supporting various components on radial pins in such a way that correct centering is maintained while allowing for the radial expansion. The axial expansion is taken care of through the use of linkages. Air cooling is employed by allowing air, under pressure, to enter the turbine at the first row of blades. A positive pressure blower then circulates the air throughout.

Applications

In the United States, the combustion gas turbine had its initial commercial application in the oil refining industry employing the Houdry process, a catalytic cracking method of manufacturing gasoline.

The most advanced gas turbines are used in aviation. A continuous-combustion gas turbine as a prime mover is employed in the jet-propulsion engine and in the geared-propeller drive engine. However, it must be pointed out that the newscomers should not be viewed as competitors of the reciprocating engine, but as a means of extending the limits of aircraft to larger and/or faster planes.

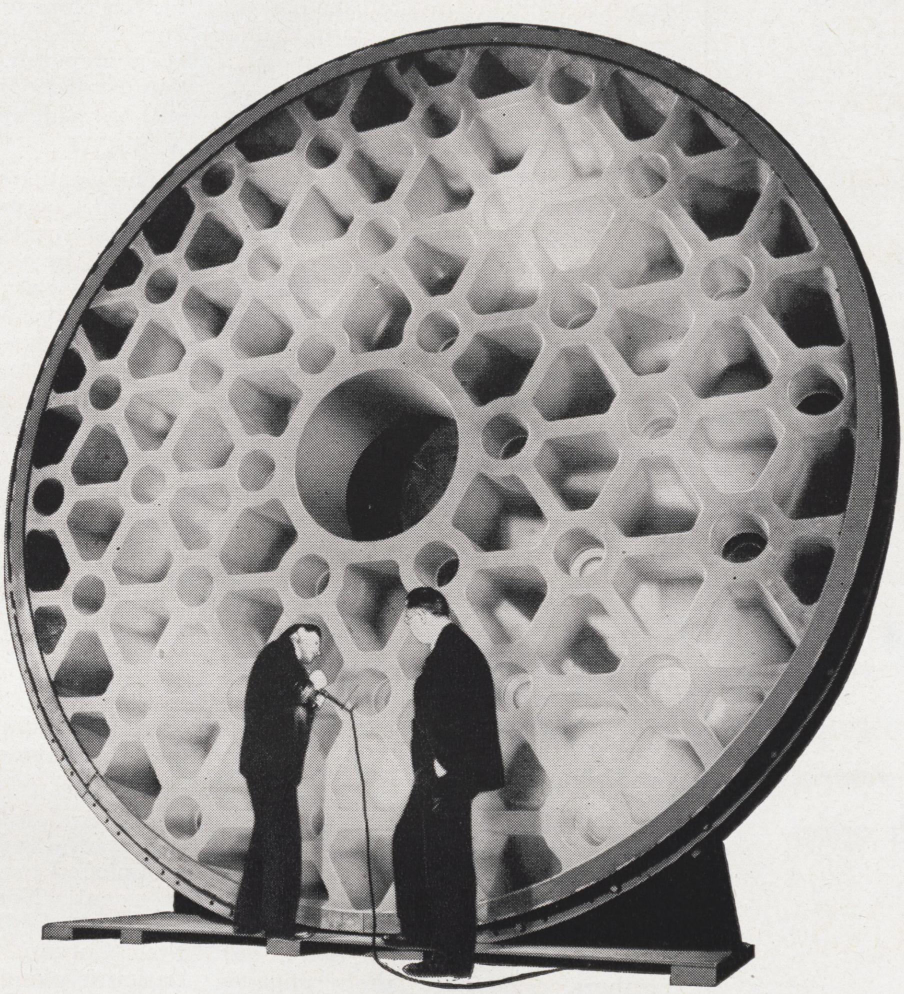
In the gas turbine jet engine all of the power is used to accelerate the air taken into the engine to a jet of approximately acoustic velocity and this is then discharged through an exhaust nozzle. A resultant thrust is then experienced by the engine housing due to the acceleration of the air. Simplicity and light weight being the principal advantages of the jet engine, the installed weight of the jet-propulsion engine is just a little higher than the bare engine weight, no external cooling provisions and very little oil for lubrication being required. The gas turbine, however, must operate at or near full load and full speed for low specific fuel rates; i. e. speeds over 500 mph. The turbine propeller airplane has the advantage of the jet engine with respect to drag reduction and ease of installation and at the same time it retains the high propulsive efficiency of the propeller at low speeds. Propeller efficiency reduces the usefulness above 500 mph, but this may be increased through propeller research.

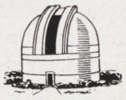
As a locomotive power plant, the gas turbine has great appeal because it is simple, requires no cooling water, has low maintenance and high availability characteristics, and large capacities can be built within a single cab. Fuels of different types are used, such as oil, kerosene, and coal. The fuels, except for coal, are conventional in their use, but the use of coal as a fuel is unique. Mr. John I. Yellott, Director Research, Locomotive Development Committee, Bituminous Coal Research, Inc., is the man responsible for its development. The locomotive takes lump coal from the bunker, crushes it into smaller particles and then sends a flow of this solid (which acts as a liquid) through a coal pump where it is forced into an air line under pressure. The crushed coal and air are then fed to a nozzle. During passage through the nozzle, the rapid expansion of air trapped in the pores of the coal disintegrates it. The particles, reduced to twenty-micron diameter, enter the combustor and burn at approximately 2800°F. Here centrifugal separators eliminate the fly-ash from the hot gases, which might otherwise damage the turbine blading. The hot gases are expanded through the turbine which in turn drives generators. The generators supply motors which are gear-connected to the axles. A locomotive of this type is to be tested early this year.

The gas turbine is rendered practical for marine application by its small space and weight requirements. Research is being carried on by the Bureau of Ships, U. S. Navy, on a 3500 hp, 1500°F. gas turbine. For this temperature, this unit is the largest gas turbine in the world. It consists of an axial flow compressor driven by a turbine, while a second turbine operating in parallel on another shaft supplies the useful output. Up to the present time, no gas turbine is known to have been installed on any large vessel, but they have been used on smaller craft with promising results.

Other applications include processes which require large quantities of compressed air, such as a blast furnace. A unit is being built by Brown Boveri of Switzerland, for a steel mill in Baracaldo, Spain, will deliver 120,000 pounds of air per hour as twenty-nine psi gage to a Bessemer converter, using blast furnace gas as a fuel.

THE EYE THAT SEES 6,000,000,000,000,000,000,000 MILES





Tomorrow a new door to the secrets of the universe will begin to open. A door through which astronomers will be able to see 6,000,000,000,000,000,000,000 miles into space—twice as far as ever before. It is the giant telescope atop Mt. Palomar, so powerful that the canals of Mars, if there are any, will for the first time be photographed.

It all began 12 years ago when Corning cast the glass for the famous 200″ telescope mirror—the world's largest piece of glass—after most experts said it couldn't be done.

For this big disc Corning scientists developed a special glass—the only practical material that would insure the permanence, stability and accuracy demanded by the telescope's designers. This glass is similar to that used for Pyrex ware and Pyrex industrial glass piping. Making the disc was a job Corning took in its stride, because it is accustomed to finding practical solutions to all kinds of glass problems. Its research laboratory has contributed to the development of more than 37,000 different items, ranging from simple custard cups to television bulbs, laboratory ware, optical glass, and Steuben artware.

If Corning has a specialty, it is the ability of its skilled engineers and craftsmen to translate research into glassware to solve modern problems. With labor and raw material costs constantly on the rise, glass may some day help you keep down the cost of your product.

Or glass may help you make your future product easier to sell. In either case, remember to write Corning Glass Works, Corning, New York.

IN PYREX WARE AND OTHER CONSUMER, TECHNICAL AND ELECTRICAL PRODUCTS ▶

CORNING
means
Research in Glass

FRATERNITY NOTES . . .

(*Continued from page* 16)

Walter, Reporter; Ted Kadel, Marshal; William Slagely, Sentinel; Robert Ragsdale, Treasurer, and Perry Ray, Alumni Contact Officer.

A social committee, selected for the present term, has kept the social calendar well filled. Several open houses have been held and a scavenger hunt was planned for April 30. Even the work "parties" in the house have become a type of social event and the redecorating of the second story has been continued.

Theta Xi

On Saturday, April 24, the annual Founders' Day banquet, sponsored by the Theta Xi Alumni Club, was held at the Severin Hotel in Indianapolis. The banquet at Indianapolis was attended by active members from three schools, Purdue University, Indiana University, and Rose.

Some of our brothers journeyed to Louisville where another banquet was held. In a report from Brother Jarrett the chapter was happy to learn that the dinner at Louisville was just as successfsul as the one held at Indianapolis.

At the first meeting of the Spring term, Harvey Hill of Chicago was pledged to Theta Xi. The chapter is happy to have Brothers Al Long and Ernest Brumitt back in school with us this term.

During Spring vacation, two of our brothers announced their engagements: Don Springman to Miss Donna Conner of Indianapolis and Alex Vogl to Miss Henrietta Clayton, also of Indianapolis. Roy Potts has pinned Miss Louise Smith of Terre Haute and James Stieff has pinned Miss Mary Bisch of St. Mary-of-the-Woods.

CAMPUS SURVEY . . .

(*Continued from page* 13)

number system which has been used in the recent development of electronic computers.

The Chapter is looking forward to the new term. The Program Committee has plans for an organization banquet, a schedule of student talks has been prepared, and an inspection of the installations of an open strip mine will be made in May.

A. S. C. E.

The election of the new A. S. C. E. Student Chapter officers was held at the first meeting of this term on April 8. The new officers elected were William Berling, President; George Chamberlain, Vice President; Shinji Soneda, Secretry, and Arthur Eble, Treasurer.

The Fourth Regional Conference of the A. S. C. E. Student Chapter will be held on the campus of the University of Minnesota on April 16 and 17. At the conference lectures will be given on "Civil Engineering Opportunities" by professional men in the various fields of Civil Engineering. Field trips will be taken to the St. Anthony Falls Hydraulic Laboratory and the Twin Cities Sewage Disposal Plant. At least five Rose students, including two official delegates, are planning to attend.

A. I. Ch. E.

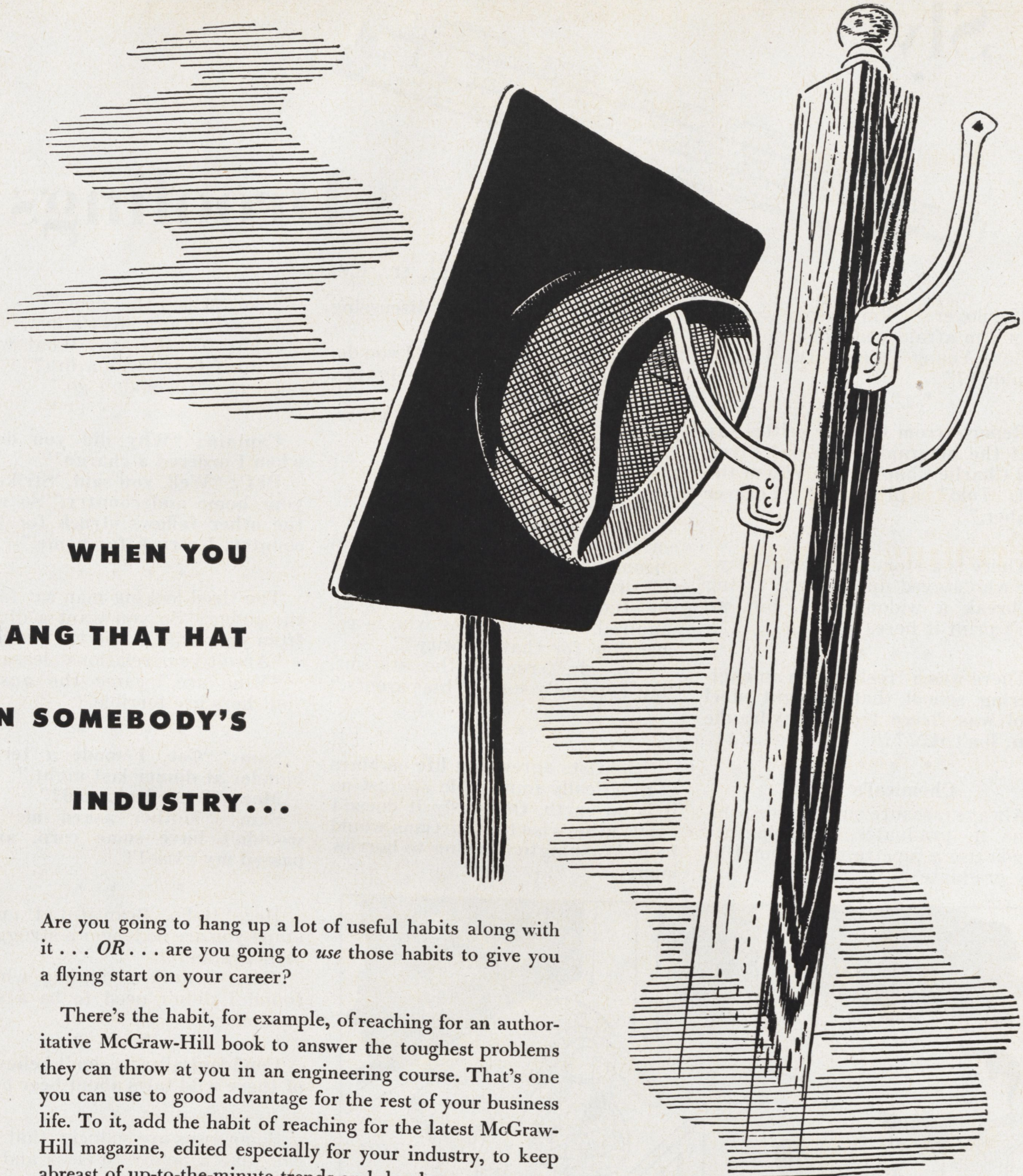
The A. I. Ch. E. has started the spring term in high gear. With a new group of officers in charge, Tim Kelly, president; Norman Brenton, vice-president; Willard Ham, secretary; Fred Corban, treasurer, the organization is planning an extensive program for this scholastic year. There will bt an evening A. I. Ch. E. meeting on the second Thursday of each month. The first of these meetings was held in April and featured a motion picture on aluminum. The attendance and the enthusiasm shown got the series off to a good start.

WHEN YOU

HANG THAT HAT

IN SOMEBODY'S

INDUSTRY...



Are you going to hang up a lot of useful habits along with it . . . *OR* . . . are you going to *use* those habits to give you a flying start on your career?

There's the habit, for example, of reaching for an authoritative McGraw-Hill book to answer the toughest problems they can throw at you in an engineering course. That's one you can use to good advantage for the rest of your business life. To it, add the habit of reaching for the latest McGraw-Hill magazine, edited especially for your industry, to keep abreast of up-to-the-minute trends and developments.

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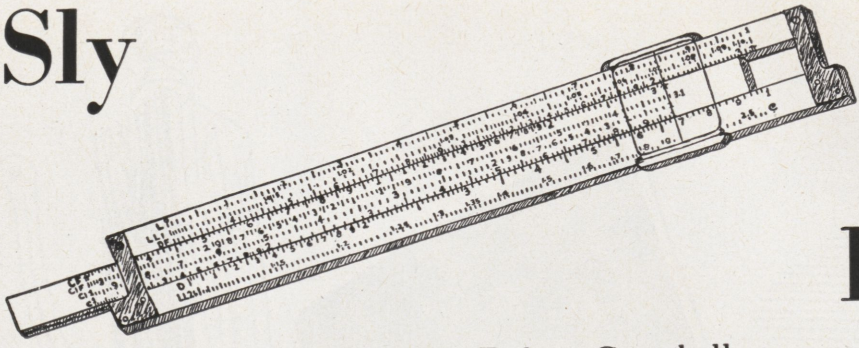


Droolings

By Robert Campbell, sr., c.e.

Employer: "I'm sorry, young lady. I'm afraid you won't do."

Cute Young Thing: "Did I say I wouldn't?"

* * * *

Reports from literary critics say that the biography of Errol Flynn and Charlie Chaplin "On Whom the Gals Told" will outsell "Forever Amber."

* * * *

There is a story of a certain lawyer who stayed up all night trying to break a widow's will, but we can't print it here.

* * * *

There was a freshman in an engineering school that thought steel wool was fleece from a hydraulic ram. Isn't it????

* * * *

Chemical's Note

Always measure out cyanide solutions in graduates, not pipettes. If you use a pipette there won't be any graduate.

Two old maids were discussing men.

Asked one: "Which would you desire most in a husband—brains, wealth, or appearance?"

"Appearance," replied the other, "and the sooner the better."

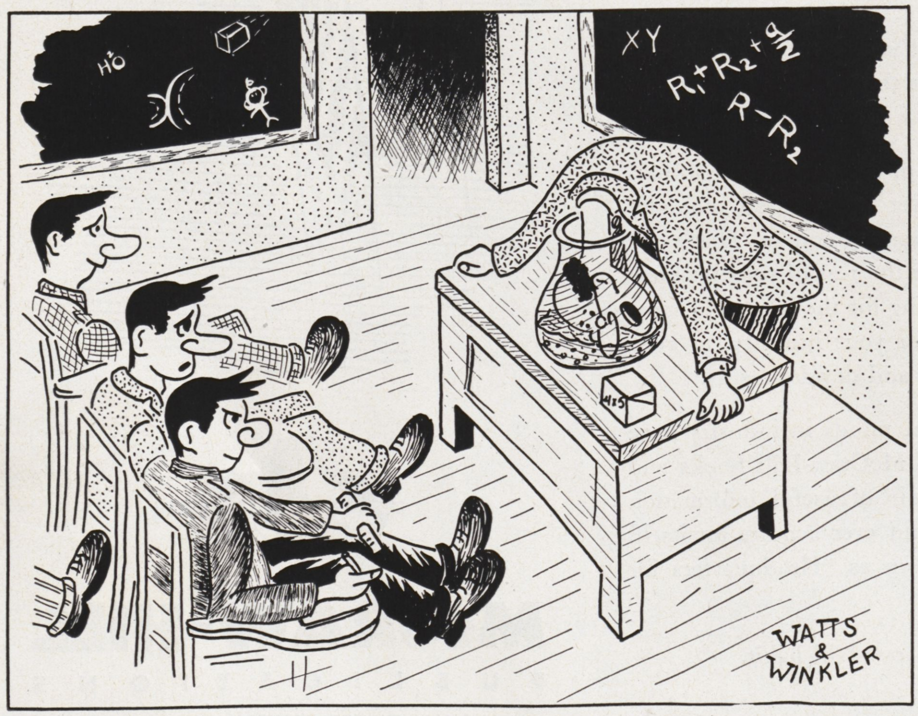
* * * *

A professor, coming to one of his classes a little late, found a most uncomplimentary caricature of himself drawn on the board. Turning to the student nearest him, he angrily inquired, "Do you know who is responsible for that atrocity?"

"No, sir," replied the student, "but I strongly suspect his parents."

* * * *

Scientists agree that life on Mars is practically impossible — just as it is on earth. Obviously it doesn't exist; otherwise the Martians would be in Washington, trying to borrow money.



Observe closely as I do and—

Jake: "Open this door."

Larry: "Can't. Key's lost."

Jake: "Good Gosh! What would you do if there was a fire?"

Larry: "I wouldn't go."

* * * *

Captain: "Why did you desert when I ordered a charge?"

PFC: "Well, you said, 'Strike for your home and country.' So when the other fellows struck for their country, I struck for home."

* * * *

The tired-looking man sat facing the judge. "So you want a divorce from your wife," said the judge.

"Aren't your relations pleasant?"

"Mine are," came the answer, "but hers are terrible."

* * * *

Sam: "Gee, I made a terrible blunder at dinner last night."

Moe: "What happened?"

Sam: "Mother asked me if I wouldn't have some corn, and I passed my glass!"

* * * *

He: "Hello, Beautiful, I understand you are no longer a struggling stenographer."

She: "I quit struggling when I found I didn't need to be a stenographer."

* * * *

Confidentially, we don't believe all of these wild tales about beer busts.

* * * *

Some guys are so lucky that they can take a penny to class and still make 97 on a true and false exam.

* * * *

From the chemistry department comes the word that the first alcohol was distilled in Arabia — which might partially explain those nights.

* * * *

"Just between the two of us, you should remember to pull your blinds down. When I passed last night, I saw you loving your wife."

"Ha, that's one on you! I wasn't home last night."

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For science, ultra-speed photography—with cameras capable of operating at speeds in excess of five million frames a second—is, among other things, helping researchers study electrical discharges, explosive phenomena, and shock front effects.

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