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TEELE '39

The good record for employment made by engineers during the depression is perhaps the major cause of the continuing growth of enrollments in technical colleges. Large enrollments, however, make early registration important, especially when an institution limits the size of its freshman class. Assurance of admission and preference in the selection of a dormitory room are the advantages of prompt application.

ROSE POLYTECHNIC INSTITUTE

TERRE HAUTE, INDIANA

Surveying This Issue

BEFORE paper can be manufactured, pulping of the wood or other cellulose-bearing material is necessary. This pulping can be accomplished by various means, both mechanical and chemical. "The Manufacture of Paper Pulp," this month's lead article, deals with these processes.

THE effort to speed up production by improving cutting tools dates back at least to Frederick Taylor, noted engineer of the past generation. In his extensive time and motion studies Taylor found that in order to progress at any rate, new cutting tool alloys had to be developed, and he contributed a great deal toward their development. Today cutting speeds are many times what they were when Taylor began his studies, and such materials as Carboloy and Stellite give promise of even greater speeds in the future. "Cutting Tool Materials" brings the story up to date in a concise discussion of cutting alloys.

ALTHOUGH until recently considered a rare metal, titanium is tenth in abundance of all the elements composing the earth's crust. It's use in pigments has been highly publicized, but its use as an alloying agent is not so widely known. It is this function of titanium that "Titanium as an Industrial Material" emphasizes.

THE photograph for this month's cover, an aerial view of part of the campus, was taken by William R. Bell.

THE frontispiece, courtesy Allis-Chalmers Co., show the casing for a large centrifugal pump.

—*R. S. K.*

THE ROSE TECHNIC

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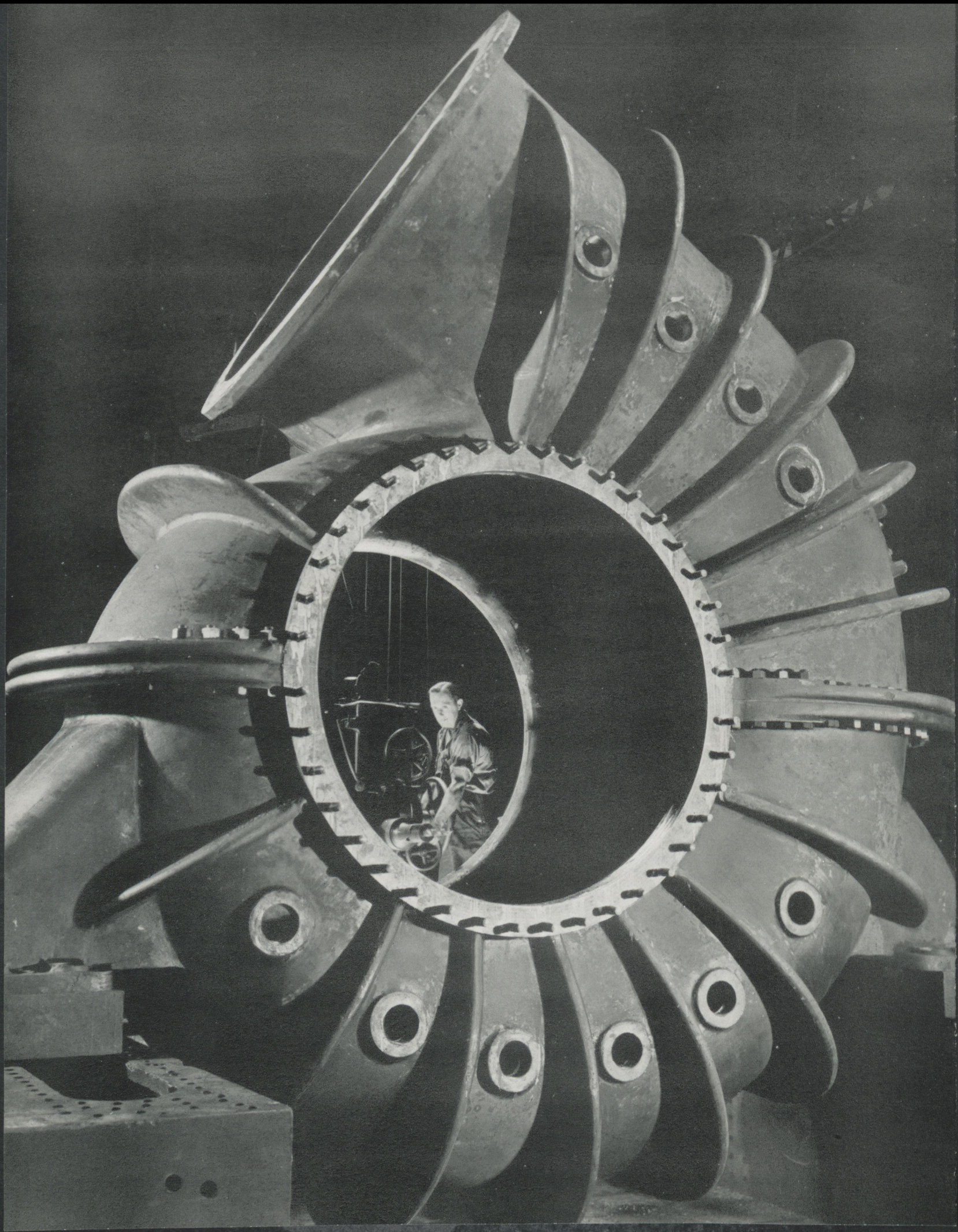


The Manufacture Of Paper Pulp

by Richard D. Altekruse, ch., '39

The desirable material for pulping in all fibrous materials is the cellulose. In wood it is the chief constituent, and it must necessarily run high in any material used for paper manufacture. In order to prepare this cellulose-bearing material for use in paper, it must first be broken up into fine pieces and then treated. This treatment may consist of the mechanical process, the sulfite process, the chlorine process, or one of several alkaline processes. All of these are covered by Mr. Altekruse in this article.

ALTHOUGH the pulp and paper industries are often thought of as one, there are two industries involved. The pulp industry converts wood or other fibrous plant materials into pulp, and the paper industry converts the pulp into paper. Often both of these industries are combined in one plant, but more often the pulp plant is located near large forests and the paper plant is located nearer the center of consumption. The pulp form is the form in which the product can be transported most economically. This paper deals with the pulp industry.

Wood is the chief raw material for the manufacture of pulp and paper. Other fibrous plant materials are used but wood forms the greater part of the material.

Pulp mills are usually located on waterways because water is the cheapest transportation medium for the logs. They are floated downstream, towed in rafts, hauled in barges, hauled by rail, or hauled by local farmers.

Source of Cellulose

The desirable component of the wood is cellulose. All of the processes for the manufacture of woodpulp have as their object the purification of this cellulose. Although all wood contains a large amount of cellulose, some woods are much more desirable than others. The length of the cellulose fibers is one of the most important factors governing the desirability of wood. Coniferous woods are most desirable, broadleaf woods are next most desirable, and hardwoods are least desirable for pulp manufacture. The average length of broadleaf fibers is about one millimeter and the average length of coniferous fibers is about three millimeters.

The problem of forest preservation is not so great as it may seem on the surface because of the many substitutes for wood. Straw is now used and cornstalks offer a great source of cellulose. Enough cornstalks could be produced in one good county of Illinois or Iowa to furnish the cellulose for the annual rayon production of the United States.

Wood has been sold by the cord for quite a long time, but the cord is not a very satisfactory unit because of the lack of uniformity. The actual amount of wood in a cord depends on the diameter of the logs. The unit which is replacing the cord is the cunit or 100 cubic feet of solid wood. A cord usually contains 90 to 95 cubic feet of solid wood. Weight units are not very satisfactory for wood because of the great variance in the moisture content of the wood.

The chief constituent of wood other than cellulose is lignin. A general analysis of wood is:

Cellulose	50 %
Lignin	30 %
Other carbohydrates	16 %
Protein	0.7%
Resins and fats	3.3%

Preparation of Pulpwood

Pulpwood passes through many preparatory stages before the actual pulp manufacture begins.

When the logs arrive at the mill, they are taken to the slasher. The slasher saws the logs into convenient lengths of 2 or 4 feet.

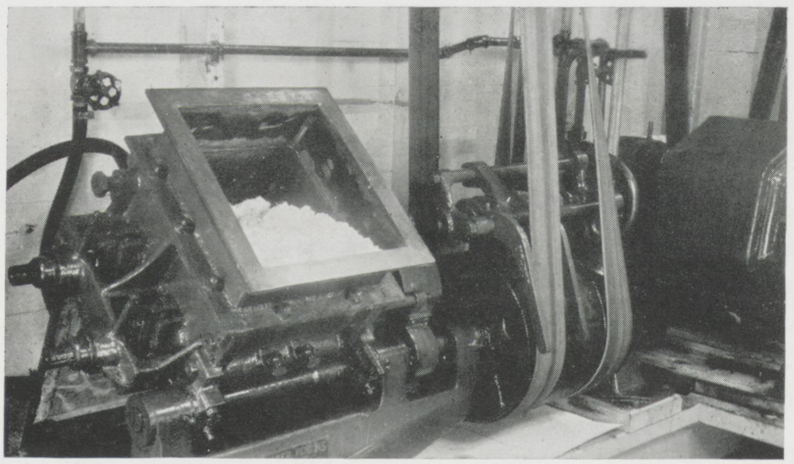
From the slashers the blocks are taken to the block pile for storage, and from the block pile they are taken to the barkers. The three types of barkers used are rotary barkers, stationary barkers, and knife barkers. In the rotary barkers the logs are put in rotating cylinders and the bark is rubbed off by contact during rotation. The stationary barkers have arms which rotate and cause the logs to rub against each other and rub off the bark. The knife barker cuts off the bark with rotating knives. The knife barker does the cleanest and most thorough job, but it wastes more of the wood than do the others.

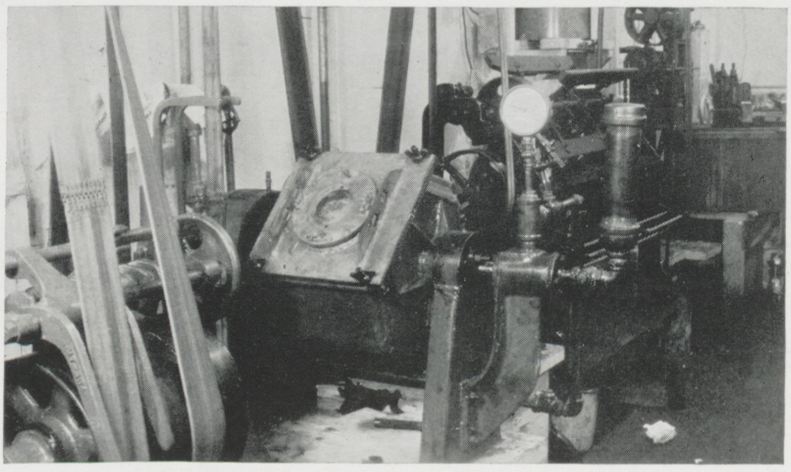
This completes the preliminary treatment if the logs are to be converted to mechanical pulp. If they are to be converted to chemical pulp, they must be chipped. The chippers consist of rotating disks with knives fastened to them. The end of the log rests against the disk and is chipped as the knives pass it. The chips are one half of an inch to one inch long and one eighth of an inch to three sixteenths of an inch thick. The chips are screened and the wood is ready for the digester.

The refuse from each of these operations is taken to the boiler room where it is burned in large furnaces called *Dutch Ovens*. This waste wood furnishes a large part of the necessary fuel.

Mechanical Process

The simplest method for producing pulp from wood is the mechanical method. In this method wood is pressed against grindstones which





rotate partly submerged in water. The wood is ground away and the water washes it from the stone.

Large magazine grinders have replaced the old hand-fed pocket grinders because of the cheapness of operation. In the magazine grinder, wood is fed into a large hopper and the only concern of the operation is that the hopper be kept full.

Since no impurities are taken out in this process, only certain woods are suitable. These woods are spruce, balsam, and hemlock.

The water which washes the pulp from the stone is filtered several times before all of the fiber is removed. The final filtrate is called *white water* and is recirculated.

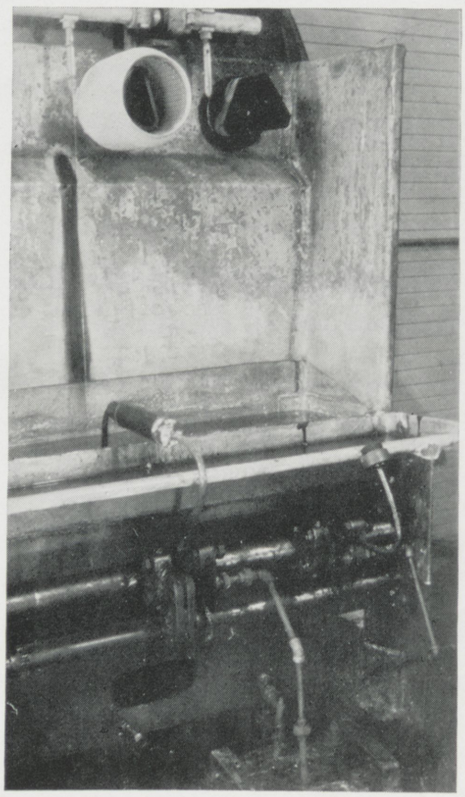
Groundwood is the cheapest of pulps and is used for newsprint, wall paper, and many grades of carton stock.

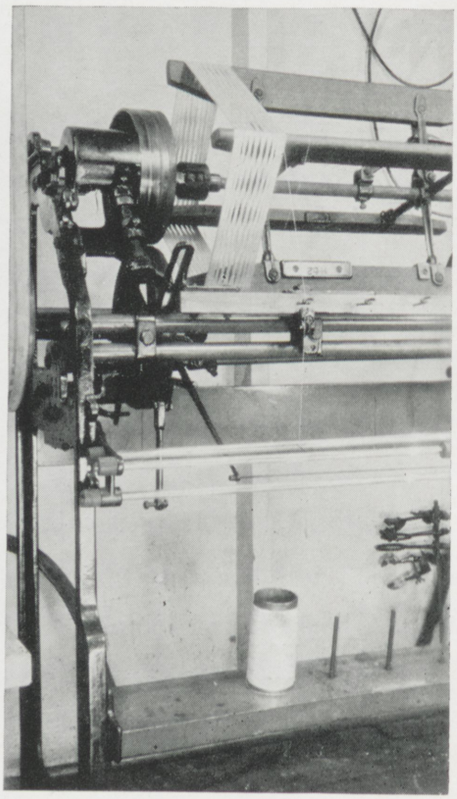
Sulfite Process

In 1866 and 1867, Benjamin Chew Tilghman was granted the British patent for the process of cooking wood in a solution of sulfur dioxide in water, with or without the addition of bisulfite of an alkali. From this grew the sulfite pulping process.

Analagous to the manufacture of paper pulp is the process shown here for the conversion of wood into rayon.

Cuts courtesy Industrial and Engineering Chemistry





One of the most important of the raw materials for the sulfite process is sulfur. In most cases sulfur is bought as sulfur, hauled to the plant, and burned there to sulfur dioxide. Pyrite may be bought and roasted in place of sulfur. The relative prices determine which of the two will be used. The sulfur used in the United States comes from the mines of Texas and Louisiana, and some is imported from Japan.

Lime or limestone is the other important raw material of the sulfite process, the choice depending on the system used.

The first step in the sulfite process is the formation of sulfur dioxide from the sulfur or pyrite. There are several different types of sulfur burners and pyrite roasters used in different plants. An important precaution in the manufacture of sulfur dioxide is the rapid cooling of the gas to prevent the formation of sulfur trioxide. The gases are cooled in pipes surrounded by cool water or by a thin film of evaporating water. Cooling not only reduces the formation of sulfur trioxide but also makes the sulfur dioxide more soluble in water.

The next step in the preparation of the cooking liquor is the absorption of the sulfur dioxide. This may be done by either of two processes. In the tower process the gas passes through one or more towers packed with limestone over which water trickles. The sulfur dioxide reacts with the water to form sulfurous acid, and the sulfurous acid attacks the limestone and forms calcium bisulfite. Towers are operated in series, the acid drawn off the bottom of the first tower is pumped to the top of the second, and no water is added to the second. The other method is the milk-of-lime method, in which the sulfur dioxide is absorbed in a suspension of calcium hydroxide in water. The calcium hydroxide is prepared by slaking burnt lime with water. The sulfur dioxide is brought in contact with the calcium hydroxide suspension in especially designed towers and reacts with the calcium hydroxide to form calcium bisulfite as was formed in the towers of the tower-process.

Pressure blowers for causing the gas to flow through the towers have been used as a means of controlling the strength of the acid.

The important factor in the composition of the cooking acid is the free sulfur dioxide, as this is found to have the greatest effect on the cook. The amount of calcium base is relatively unimportant. The strength of the cooking acid runs about 6 percent sulfur dioxide.

The most important reaction of the cooking process is the formation of soluble calcium salts of lignin sulfonic acid formed from the lignin in the wood. Other reactions include the formation of turpentine and methyl alcohol, but these are unimportant. Resins and gums are not affected, and for this reason high resin woods cannot be used in the sulfite process.

In the actual cooking, the digester is filled with chips and acid is run in until they are covered. The cover is clamped on, the steam is turned on, and the pressure is brought up to 75 pounds per square inch.

The digester consists of a steel shell lined with acid proof brick set in acid proof mortar. The usual design is a cylindrical shell with a conical bottom and a hemispherical top.

There is no standard time or temperature of cook because of the differences in the wood cooked. The time varies from 9 to 12 hours, and the maximum temperature varies from 140 to 160 degrees Centigrade. Either saturated or superheated steam may be used. Usually direct heat is used but sometimes indirect heat is applied through coils. Indirect heating has the disadvantage of local overheating.

The raw materials required for 1 ton of sulfite pulp are: 1.7 to 2.2 cords of wood, 200 to 300 pounds of sulfur, and 260 to 370 pounds of limestone or 150 to 210 pounds of lime. Each ton of pulp requires about 2300 gallons of acid and 6500 to 7000 pounds of steam.

The sulfite process produces a high grade pulp which is used for wrapping paper of light color, bond paper, and envelope paper.

Alkaline Processes

There are two processes known as the alkaline processes. They are the soda process developed by Watt and Burgess in England in 1853 and the sulfate process developed by C. F. Dahl in Danzig in 1879. Since these processes are so similar they will be discussed together.

The most important chemical in either process is sodium hydroxide. Since this chemical is hard to handle and hazardous to store, it is never bought but is always made from other chemicals at the plant. Sodium carbonate, calcium oxide, and sodium sulfate are the important raw chemicals used in the two processes.

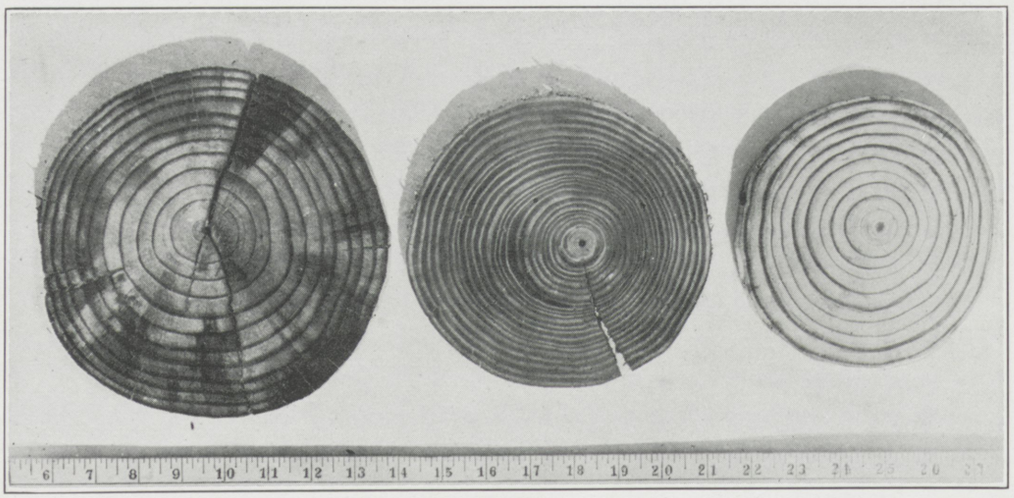
Liquor room operation is much the same for both processes. The operations in the liquor room are receiving the *green liquor* from the recovery process, causticizing it, filtering it, testing it, adjusting it, and pumping it to the digesters as *white liquor.*

One operation which takes place in the liquor room is the slaking of the lime or the reacting of lime with water to form calcium hydroxide.

The composition of the green liquor varies greatly. The important component from the soda process is sodium carbonate. The green liquor from the sulfate process contains many sodium-sulfur compounds in addition. This green liquor is analyzed and any deficiencies are made up by the addition of sodium carbonate.

The liquor is now causticized by the addition of slaked lime. The calcium hydroxide reacts with the sodium carbonate to form sodium hydroxide and calcium carbonate. The degree of completion of the reaction is determined by the strength of the carbonate solution. Not more than 95 percent causticity can be obtained with a solution of 19 degrees Be. and 15 degrees C. The amount of carbonate present determines the amount of hydroxide to be added.

The reaction in the digester is essentially the hydrolysis of lignin.



A. Loblolly B. Longleaf C. Loblolly

Cross Sections of Pulpwood (x¼)

The exact mechanism of the experiment is not understood. In the sulfate process there is an equilibrium set up between the sodium sulfide in the liquor and the water. As sodium hydroxide is used up, more is formed by the equilibrium reaction and more is released. This provides the hydroxide as it is needed.

There are no standard digester designs. Some are spherical, some are cylindrical, some are vertical, some are horizontal, some are rotary, and some are stationary. The digesters are made of steel and are not lined. The trend is toward rotary digesters.

The cooking solution is not only a strong solvent for lignin, but it also takes out the resinous material. The sulfate process was first introduced in this country in the Northern Section of the United States and in Canada, but it has been developed to a point where it is used for the pulping of southern pine. The low cost of pine has caused the installation of large plants in the South.

In the process the best results are obtained when the quantity of active alkali present is about 20 to 25 percent of the bone dry weight of wood. The temperature used is from 320 to 350 degrees F. and the time of cook is 3 to 5 hours.

Such a large amount of chemicals is used in the alkaline processes that the price becomes prohibitive unless some of them are recovered. Recovery of the chemicals forms the complicated portion of alkaline pulping operation. It has developed very economical equipment and practice. This is one of the few industries which make use of quadruple effect evaporators.

When a cook is discharged from the digester, the liquid is drained off and sent to the recovery plant. This liquor is known as *black liquor*. The first process which the liquor passes through is a process of evaporation of the excess water. Multiple effect evaporators are used in this operation. Many types of evaporators have been used but the present trend seems to be toward the use of long tube evaporators, both natural and forced circulation.

When almost all of the water is evaporated off, the residue is ignited in a small recovery furnace. In the first stage the small amount of remaining water is evaporated. In the second stage the organic soda compounds are broken up and the volatile ones burned. In the third stage the non-volatile carbon is burned and the sulfate is reduced to sulfide.

Three important reactions occur in the first stage. Sodium sulfide, water, and carbon dioxide react to form hydrogen sulfide and sodium carbonate. If the temperature is high enough, the hydrogen sulfide is burned to sulfur dioxide and water. Free sodium hydroxide combines with the carbon dioxide to form sodium carbonate and water.

In the second stage several organic substances are formed. These need not be discussed as they are immediately converted to carbon dioxide and water. There are also some sulfur containing compounds formed in this stage. At this point the sodium sulfate and sodium carbonate are in their original form.

In stage three the sodium sulfate is reduced to sodium sulfide by the carbon present. This stage is unimportant in the soda process and may be omitted.

In the old type of recovery furnace stage one occurred in a rotating cylinder. In the new type the black liquor is sprayed directly into the furnace, and stage one takes place while the substance is still in the air. The substance at the end of stage one is known as black ash.

The sodium sulfate for the make-up in the sulfate process is added at the end of the first stage if a rotary furnace is used or at the beginning of stage one if a spray furnace is used.

About 85 percent of the chemicals are recovered. Another 10 percent could be recovered but the recovery would cost more than the purchase of new chemicals.

Sulfate pulp has a dark brown color because of the dyes formed in the process. As a consequence the pulp cannot be completely bleached without seriously destroying the fibers.

Sulfate pulp forms a strong paper. It is used for wrapping paper and other strong papers which do not have a light color. Soda pulp is very easily bleached, but it has short fibers and is not very strong. It is used extensively for book papers.

When sulfate pulp is bleached, about ten times as much chlorine is required as is required for other pulps. A recent trend toward the bleaching of sulfate pulps has caused the industry to be transformed from an unimportant to the most important of the chlorine consumers.

Chlorine Process

An entirely different process for the isolation of cellulose fibers has been developed in the last twenty years. This process is known as the chlorine process. The chlorine process uses straw and other seasonal plants as raw materials.

There are three steps in the chlorine process:

(1) The fiber is treated with 10 percent sodium hydroxide solution at 80 to 90 degrees C. and atmospheric pressure. This occurs in a tower in which the rate of flow of both the fiber and liquid can be controlled.

(2) The fiber is subjected to a countercurrent flow of chlorine gas. The temperature, rate of flow, and concentration of chlorine are all carefully controlled.

(3) The fibers are washed in dilute (1 percent) sodium hydroxide solution.

The requirements for the process are: For each kg. of bleached wheat straw cellulose are required; 15 to 16 kg. of soda for cooking, 22 to 24 kg. of chlorine for chlorination, 2 to 3 kg. of chlorine for bleaching, 3 to 4 kg. of soda for washing, 80 kilowatt-hours of direct current for electrolysis, and 40 kilowatt-hours of alternating current for motive power.

Although this process is still in its infancy, it will undoubtedly become more widespread in the future as it offers a method of producing first grade cellulose from very cheap raw materials.

Pulp Refining

The pulp from any process must be put in form for shipping after it is made and washed. This preparation involves filtering, screening, and compressing.

The first operation is a screening process. After the pulp has passed the coarse screens, it passes through a riffler where sand and other heavy impurities settle out. The pulp is now taken to the fine screens which are usually rotary screens. Much of the water is removed during the fine screening. The pulp is now made into sheets or laps and the water is squeezed out by means of hydraulic presses. The pulp is now in form to be shipped to the paper mills.

Bleaching of pulp is an integral part of the manufacture. Chlorine is almost the sole agent used for the bleaching of pulp. Calcium hypochlorite, bleaching powder, was formerly purchased for the purpose of bleaching pulp, but now the powder is made at the plant. Liquid chlorine is evaporated from cylinders or tank cars and passed through milk-of-lime to form bleaching powder.

Recently a process has been developed by which the pulp is bleached by gaseous chlorine. About 75 percent of the bleaching is done by the gas, the hydrochloric acid formed is neutralized, the pulp is washed, and it is given a final bleach with hypochlorite.

The theory of the bleaching process is that the hypochlorite unites with the remaining lignin to form soluble chlorohydrins.

Since chlorine has an oxidizing as well as a solubilizing action on lignin, there is a loss of chlorine if the pulp is in contact with it too long. As the pulp bleaches, protective coatings are formed around the fibers. Because of these two facts, a system of multistage bleaching has been developed. The pulp is alternately exposed to chlorine and washed. This results in a great saving of chlorine.

Size of Industry

The pulp industry of the United States has become quite a large industry. In 1935 the pulp production of the United States amounted to 167,000,000 dollars.

This pulp manufacture was distributed among the processes as follows (1935):

	Tons	*Dollars per ton*
Mechanical pulp	1,400,000	18.50
Sulfite pulp	1,600,000	44.80
Soda, semi-chemical pulp	490,000	37.20
Sulfate pulp	1,500,000	24.50

The following figures show the trend of the industry over several years:

Year	*Tons of woodpulp produced*
1937	4,313,000
1928	4,510,000
1929	4,860,000
1930	4,630,000
1931	4,410,000
1932	3,760,000
1933	4,330,000
1934	4,280,000
1935	4,990,000

The principal states producing pulp are Washington, Maine, Wisconsin, Virginia, New York, and Louisiana.

Conclusions

From these figures it can be seen that the pulp industry is a large industry well distributed over the United States.

This paper has attempted to set forth some of the salient points of the paper pulp industry. Several processes have been discussed. When one looks at such an industry he must not see only the technical aspects; he must also see the social aspects. Some of these were brought out in connection with the source of raw materials. The important social aspect of this industry is probably best stated by Riegel, who says:

In a democracy, it is necessary to disseminate news readily and cheaply; one of the indispensible agencies in that process is an abundant supply of paper. For the transfer of knowledge from generation to generation, hence for the preservation of knowledge, paper is required. This material is therefore not only a convenience, but one of the cornerstones of our civilization.

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Cutting Tool Materials

by Frederick Thodal, m., '40

Modern cutting tools may be classified generally as high speed steels, Stellites, and carbides. Each of these has its certain properties which give it a specific field of application, although in many cases there is considerable competition among them. Mr. Thodal discusses each of the three groups, their properties, and their applications.

HIGH speed production of today makes severe requirements on production machinery. Many new machines have been developed, and the older types have been improved. All of these developments and improvements would have been for naught if the cutting tools and the materials from which they are made had not also been improved. It can truly be said that a machine tool is no more efficient than its cutting tool. Prior to 1928, high-speed steel and cast iron were about the only materials used for making cutting tools. Furthermore, the high speed steels of ten years ago were not as efficient or satisfactory as they are today.

The automotive industry uses more modern machinery than most of the other industries. This means a constant demand for cutting tools that will stand the gaff of stepped-up production. About ten years ago two new materials began to take the place of high-speed steel for use in some cutting tools. Neither of these contained any iron. The first was known as Stellite and the other as Carboloy. Although Stellite had been known for nearly twenty years, it had never been very important as a cutting tool material. The composition of Stellite is tungsten, cobalt, and chromium, whereas that of Carboloy is tungsten, carbon, and cobalt. Carboloy was the forerunner of the many carbide cutting tools of today. Each year since the discovery of Carboloy, carbides of other elements or different combinations of the carbides have been introduced, and the years to come will probably bring still more improvements.

High Speed Steels

The discovery of high-speed steel was the first major step in the development of the efficient cutting tools of today. The advantage of high-speed steel over the regular carbon steel lies in the fact that it retains its hardness even at a red heat. Before the discovery of this steel, all cutting operations were necessarily slowed down, and furthermore, many tools were ruined by over heating during their grinding.

Many elements are used in making high-speed steels. The more common ones are: tungsten, chromium, nickel, carbon, cobalt, molybdenum, vanadium, copper, silicon, and boron. The most common alloy is one containing tungsten, carbon, and vanadium. The composition is 18 percent tungsten, 4 percent chromium, and 1 percent vanadium. This alloy is the most satisfactory all-around material available at present for the many different types of metal cutting tools in daily use. Another advantage of this steel is found in its wide hardening range and freedom from heavy decarburization. Another grade of high-speed steel known as the "double-vanadium" type proved more efficient than the single vanadium type when used as a material for making high-speed broaches. This steel can be used for any kind of turning tool where a slight sacrifice in toughness is permissible. The only difference between these two steels is that the former contains two instead of one percent of vanadium. Molybdenum high-speed steels, containing 8 percent molybdenum and 2 percent tungsten, together with some chromium, vanadium, and carbon, are used in the manufacture of hacksaw blades, reamers, drills, milling cutters, and lathe tools. Tools made from this molybdenum steel sell for a lower price than tools of 18 percent tungsten steel, and they are also tougher. A molybdenum-vanadium high-speed steel having 2 percent vanadium replacing the tungsten is also on the market. One disadvantage of the molybdenum steels is their tendency to decarburize during the hardening process. To overcome this, experiments have been made with a molybdenum steel containing 1.5 percent of copper and a slight amount of boron. This copper-boron-molybdenum steel will not decarburize during hardening, but it is not as tough as the tungsten-molybdenum or vanadium-molybdenum steels, and it also is very difficult to manufacture. One manufacturer has been experimenting with cast turning tools having the following approximate composition: carbon, 4 percent; chromium, 16 percent; nickel, 2 percent; molybdenum, 8 percent; cobalt, 5 percent; and vanadium, 1 percent. This material, as cast, has a Rockwell hardness of C-67. It can be heated to 1900° F. and air-cooled without any appreciable change in hardness. The secret in producing a good cutting tool from this high-alloy material lies in the proper melting procedure.

A small amount of an element when alloyed with steel will sometimes produce a tremendous change in the physical properties of that steel. The following is a list of the alloying elements and their properties:

CARBON: adds hardening property; increases tensile strength, toughness, and wear resistance.

MANGANESE: increases hardness, wear resistance, and strength; decreases toughness.

CHROMIUM: forms carbides and

increases hardening power; decreases warpage by producing a depth of hardness; increases shock resistance.

VANADIUM: refines the grain; increases fatigue resistance; adds strength; decreases distortion.

MOLYBDENUM: hardens and adds red hardness; increases wear resistance and strength.

TUNGSTEN: refines the grain; adds red hardness; increases wear resistance, strength, and shock resistance.

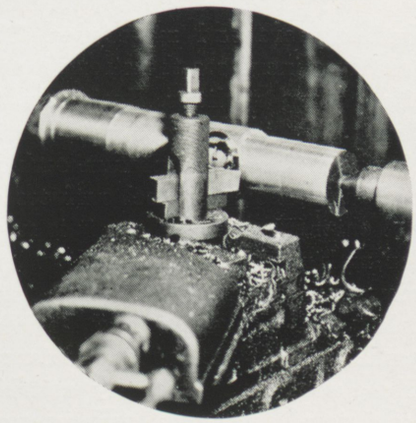
COBALT: refines the grain; increases red hardness and strength.

NICKEL: increases strength, toughness, and hardness.

SILICON: increases hardness and the elastic limit.

Stellite Tools

Steel as a cutting tool has several undesirable properties. Both individuals and companies have experimented to find a suitable substitute. As early as 1891 Mr. Elwood Haynes succeeded in making an alloy of nickel and tungsten. His objective in this research was to find an untarnishable alloy that could be made to take a cutting edge. It was to be used in the manufacture of table and pocket knives and other types of cutlery. Later he made alloys of nickel and metals of the chromium group. While experimenting he discovered that an alloy of cobalt and chromium would not only resist oxidation but that it was extremely hard and at the same time very tough. About 1910 he became interested in using his discovery as a material for making lathe tools. He used an alloy of cobalt and chromium with tungsten or molybdenum as a hardener. This new alloy he called Stellite, and it was in every way superior to the high-speed steel cutting tools. The cutting speed could be more than doubled, and the life of the new alloy tool was nearly 100 times as great as for the high-speed steel cutter when used on a hard grade of cast steel. Furthermore, it was found that Stellite would not lose its hardness at a red heat and also that it would cut metals that could not be machined before. It has only been, however, in the last ten years that Stellite has been used to any great extent as a tool material. Before this it was used only for special purposes. The last ten years have shown a very marked difference in machine shop practice. New machines that are more powerful and much faster require this type of tool. Increased production and greater use of alloys, both ferrous and non-ferrous, also require this type of tool. Plastics are being used more and more, and although they are not as hard as steel, they produce a very high heating effect on the cutting tool. Some of them also have an abrasive effect on the tool. Both of these difficulties have been overcome by the use of Stellite. The Stellite used today is a cobalt-chromium-tungsten alloy which is known as J-metal. There is no iron in Stellite. This alloy cannot be forged but must be cast. It is available in different sizes of square and rectangular tool bits, welded tip tools, and milling cutter blades. Also, various special small tools such as reamers, counterbores, and forming tools can be made from it. Recently a new Stellite called Stellite-2400 has been placed on the market. This new tool material is to be used wherever longer tool life and higher machinery speeds are required.



—courtesy Scientific American

High-speed cutting of steel is easy for cobalt-chromium-tungsten alloys.

Carboloy Tools

In 1928 the General Electric Company introduced a new cutting tool material called Carboloy. This was made of tungsten carbide and cobalt. The carbide gave the tool hardness, and the cobalt gave it strength. This discovery came as a result of research for a tool that would stand up under the turning operation on motor and generator commutators. High-speed steel worked fine on the copper, but the abrasive action of the mica insulation between the copper segments would dull the tool in a very short time. Diamond tools worked well on the mica but would snap off when they hit the copper, and diamond-tipped tools were expensive. Bakelite and other such plastics which had metal inserts required two machining operations for the same reason as was just stated. Therefore, this new alloy resulted in a large saving in just this field alone.

Carboloy is twenty-five to seventy-five times as durable as high-speed steel. The sapphire, which is next in hardness to the diamond, can be scratched by tungsten carbide. It has a tensile strength one-half that of high-speed steel. It will not pit or tarnish and can be dissolved by acids only with difficulty. Carboloy is so hard that it will machine alloy steels that were previously listed as commercially non-machinable. It is also used for cutting threads on glass and for machining glass and porcelain insulators. Drills for use on concrete and rocks are another of its uses. Machining aluminum pistons which had hard spots and also the machining of hard cast iron covered with scale were two more operations that ruined high-speed steel tools but had no damaging effect on the Carboloy tool.

When the remarkable success of tungsten carbide tools was noticed, other companies experimented and later developed other carbides. These materials are called cemented carbides because of the fact that the particles of the carbide of some element are cemented together into one mass by some other element such as cobalt. At present there are four classes or groups of cemented carbides:

(1) Tungsten carbide cemented with cobalt.

(2) A combination of tantalum carbide and tungsten carbide cemented with nickel and/or cobalt.

(3) Tantalum carbide cemented with nickel or cobalt.

(4) Titanium carbide and tungsten carbide cemented with cobalt.

The wearing properties of some of these cemented carbides run as high as one hundred times that of high-speed steel. Their hardness ranges from 87 to 92.5 Rockwell "A", and their transverse rupture strength will run from 130,000 to 250,000 pounds per square inch. This compares with a Rockwell "A" hardness of 82 to 83 and a transverse strength of approximately 450,000 pounds per square inch for properly drawn and hardened high-speed steel. The cutting speed is more than double that used for high-speed steel tools.

The Pontiac Motor Company gives the following nine advantages of carbide tools as used in its plant: faster cutting, longer tool life, reduction of cut, smoother finish, greater accuracy, minimum distortion due to lighter feed and higher speeds, absence of breaking away of edges of work, reduction in heat, and possibility of machining harder materials. The following materials are satisfactorily machined by cemented carbide tools: cast iron, brass, bronze, nickel, phosphor bronze, aluminum, babbit, malleable and die cast metals, molded fiber for brakelinings, laminated phenolic material, window glass, porcelain, hard rubber, and mica. A carbide-tipped core drill was used for drilling cylinder blocks at a speed of 73.5 feet per minute. The tool had a life of 100,000 cylinder blocks and had to be ground after every 5000 blocks. The piston ring grooves in a piston made from a hard silicon aluminum alloy could only be cut by using carbide tools. Another example of the use of carbide tools is at the Ford Motor Plant where twelve single-point titanium-tungsten-carbide cutting tools operate simultaneously in turning drive shafts. These shafts are made from cold-drawn high-manganese steel (SAE 1350) which has been annealed to a Brinell hardness of between 286 and 321 prior to the turning operation. The shaft to be turned is 65 inches long and is machined to a diameter of 0.950 inch. Cuts are taken at a surface speed of 260 feet per minute, the depth of the cut being 0.060 inch and, the feed 0.022 inch.

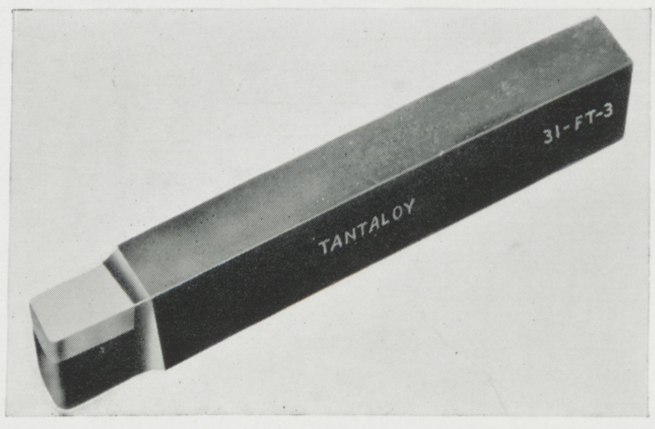
Tantalum carbide cutting tools are finding more and more uses. The tantalum increases the strength and the cutting qualities. Resistance to "cratering" is due to a decrease in the friction of the tantalum carbide composition on the steel surfaces of the chips. For this reason it is used for making wire drawing dies. Because of increased strength, greater rakes and clearances may be had, resulting in an increase in efficiency. These tools are especially suitable for intermittent cuts, such as machining castings with sand holes or eccentrics.

The following statements will serve as a summary of the kind of cemented carbide to use for different jobs. The softer grades of the carbides should be used for heavy or roughing cuts on non-metallic materials, non-ferrous metals, and cast iron. Medium grades are used to machine copper-silicon castings, malleable iron, cast steel, and corrosion-resistant cast chromium alloys. The harder grades are for use in machining non-metallic materials, non-ferrous metals, and irons where high-speed and light cuts are to be used. They are also used for machining alloy steels containing nickel, chromium, vanadium, and molybdenum; and stainless steel.

Conclusions

It must be borne in mind that the application of these hard alloys is not confined to cutting. Their adaptation has been effected so as to bear upon almost all of the common commodities. Consider the ordinary automobile. From bumper to bumper it has been shaped by dies and tools hard faced with or made of solid cobalt-chronium-tungsten alloy. Many parts of the engine and transmission have been machined with this or similar alloys. Many of the body stampings have been made of cobalt-base materials, which are also used in the knives to cut the upholstery cloth and tire fabric. The oil and gas on which the car operates have been produced from wells drilled with hard-faced tools and handled in the refinery by means of Stellited pumps and valves. And finally, even the cement in the concrete road upon which the car runs has been ground in mills of a wear-resistant alloy such as has been described as a cutting tool material.

The fact that the carbides and Stellites are replacing some of the high-speed steel cutting tools does not at all mean that steel is on its way out as a cutting tool material. New alloys of steel have improved their qualities so that they are still holding their place with the newcomers. The common tendency today is to produce more in less time and at a lower cost per unit. New machine tools will have to be developed to take care of this, and at the same time new developments in cutting tool materials will have to be made because, as stated before, "a machine tool is no more efficient than its cutting tool."



—courtesy Railway Mechanical Engineer

Tantaloy, a tantalum carbide alloy, brazed to a steel shank.

Titanium As An Industrial Material

by Robert L. Anderson, e., '41

Metallic titanium has become an important factor in modern metallurgical practice. That it was destined to be such was foretold by the fact that it exhibits so many unusual characteristics and causes so many difficulties in its refining. Mr. Anderson here explains the properties, method of production, and uses of titanium. These uses embrace both the fields of ferrous and non-ferrous metallurgy.

UNTIL recently titanium has been considered a rare metal. It was discovered by Gregor in 1789, previous to the discovery of aluminum, calcium, chromium, magnesium, vanadium, etc. Titanium was first noticed to retard slag formation and for the formation of infusible titanium cyanonitride in the blast furnace. Dr. A. J. Rossi was chiefly responsible for pointing out the usefulness of titanium.

The manufacture of pure titanium can not be accomplished by the use of aluminum or silicon or carbon. Aluminum especially enters solution when the aluminum powder reduction method is used. However, calcium or sodium can be used to reduce the ore to the pure metal. In recent years Kroll in Germany has done some very interesting work in the reduction of titanium ore to the pure metal. He used calcium shavings to reduce the ore. The result of this reduction left the metallic titanium in fine granular form. Kroll then sintered this titanium powder in a vacuum and rolled it into hot sheets. The metal could not be melted in a crucible, because as yet no crucible had been found which would withstand the reducing effect of titanium at this high temperature (1800 degrees C.). Even beryllium, zirconium, and thorium could not stand the reducing action of melted titanium in a vacuum. Kroll made some high titanium alloys which as yet have found no important applications. He also reduced titanium oxide by the use of calcium hydride. The metallic titanium obtained by this method was also in the powdered form.

Another method of making pure titanium is the reduction of the chloride of titanium with sodium in a closed vessel under pressure. Hunter adapted this method from some German experimenters. This method had a decided advantage over the Kroll process, because the titanium obtained is in the form of pure coherent metal, very suitable for alloy making. Because the titanium by the Hunter method is coherent, it is by far the more economical and convenient to industry. Fairly large amounts of titanium have been manufactured commercially by the Hunter process. This form of titanium is used chiefly in copper, nickel, aluminum, and mercury. Mercury treated with metallic titanium corrodes mercury boilers less rapidly and less severely than does untreated mercury.

Properties of Metallic Titanium

The symbol for titanium is Ti, atomic wt. 47.90 and atomic no. 22. It has valences (2), (3), and (4). Titanium is soluble in sulfuric acid, hot concentrated hydrochloric acid, aqua regia, and readily soluble in hydrofluoric acid.

Since its discovery in 1789 the physical properties of titanium have been thoroughly investigated. It has a density of 4.49, it melts at 1800 degrees C., and boils at 3000 degrees C. Titanium is very brittle when cold and bears a marked resemblance to polished steel. Carbon-free titanium is harder than glass and has an electrical conductivity which equals that of aluminum. At 800 degrees C. titanium unites directly with nitrogen. Ilmenite and rutile are the principal ores of titanium. Ilmenite is an iron bearing ore, while rutile, although of less commercial importance, is the dioxide of titanium. Rutile (TiO_2) is found in Virginia, Canada, Norway, Australia, and Madagascar. Titanium is tenth in order of abundance in the crust of the earth. It is more plentiful than copper, nickel, lead, and zinc. Niagara Falls is the center of titanium ore reduction and obtains ores principally from Canada, India, Australia, and Brazil. In this country titaniferous deposits are found in northern New York, and in Virginia and Wyoming. Three or four years ago ilmenite production was 10,000 tons. About the same tonnage was imported into the United States. At the present price, 99% pure titanium is worth $6.50 per pound.

Titanium Alloys

Ferrotitanium is used to deoxidize steel. To the structural engineer this use is nearly as important as is the use of titanium oxide in paints, because structural steels must be strong and resistant to corrosion, and to have these qualities the metals must be as pure as possible. Ferrotitanium is also used as an alloying element with aluminum, copper, nickel, and iron. It finds a very beneficial use as a coating for welding rods, where it is employed to protect the arc, and also as a flux.

Copper can be hardened with titanium in much the same way that it can be hardened by beryllium, but the process produces a slightly softer

metal than the copper-beryllium alloy. After the alloying process is finished the copper-titanium alloy may be "tempered." During this "tempering" process the strength and electrical conductivity of the alloy are greatly increased. The following table will serve to show the effect of "tempering" upon two sample castings; the first a copper-beryllium alloy, and the second a copper-titanium alloy.

In tempering these alloys, a compound of the two metals is precipitated from the solid solution in extremely finely divided particles. This precipitation increases the purity of the solid solution, which increases the electrical conductivity of the alloy. The presence of the finely divided precipitate also makes the alloy harder by offering more resistance to deformation. The best temperature at which to quench the titanium-copper alloy is generally 1650 degrees F. The tempering of this alloy, however is usually carried on at about 850 degrees F. for a period of 24 hrs. If the best alloy is desired, then some silicon should be included along with the titanium in the Ti-Cu alloy. A satisfactory proportion is 0.8% titanium to 0.35% silicon. When properly heat treated, this alloy will have 45% conductivity, 85 Brinnell Hardness and a 25,000 lb. per sq. in. yield point. As can be readily seen this alloy is a better electrical conductor than any other copper alloy of comparable strength, and it is also much stronger than pure copper.

Nickel and its alloys are also hardened by titanium in the same way as is copper. It is shown in recent patents that a new permanent magnet steel has been developed which has the following composition: 16% nickel, 28% cobalt, and 11% titanium. After being annealed at 1250 degrees F., this alloy has double the coercive force of that of Alnico, and nearly five times the coercive force of the cobalt-chromium-tungsten permanent magnet steel, but with a little less residual induction than the Co-Cr-W alloy. Properties of some of these strongly magnetic alloys are given in Table II.

TABLE I.

Hardness and Conductivity of Two Copper Alloy Castings After Various Treatments

Alloy Content Percent	*Rockwell E*	*Electr. Conduc.*
Heat Treatments (Temp. °Fahr.)	Hardness	%
None as cast	90	22.0
Quenched from 1475 degrees	74	18.8
2.04 Be		
Tempered 5 hrs. at 700 degrees	118	32.8
Tempered 35 hrs. at 700 degrees	115	36.8
None as cast	80	27.3
0.87 Ti		
Quenched from 1650 degrees	49	26.9
Tempered 24 hrs. at 850 degrees	85	40.1
Heat Treatments (Temp. °Fahr.)	Hardness	%
0.35 Si		
Tempered 48 hrs. at 850-950 degrees	87	46.5
Tempered 24 hrs. at 1000 degrees	79	66.2

The chief use, however, of titanium in nickel is as a deoxidizer or degasifier in welding. Titanium is almost indispensable in the manufacture of good nickel welds. It is usually added to the weld by being melted from the welding rod and mixed thoroughly throughout the weld by the arc.

Although the function is little known, titanium is used to quite a large extent by some aluminum ware manufacturers for the purpose of hardening their product. Not only does the addition of titanium to the aluminum increase the hardness, but it also lends refinement of grain, increased ductility, and soundness of castings to the aluminum. An addition of 0.1-0.2% of titanium refines the grain enough to increase the strength 15-20%.

Let it not be thought that the nonferrous metals are the only ones with which titanium is alloyed, for as previously mentioned, titanium added to steel and iron produces very beneficial effects. In 1892 Dr. A. J. Rossi was hired to smelt titaniferous iron ore in the Adirondacks. His attempt was successful, but this ore has not been used extensively because of the scarcity of railroads in that section of the country.

Rossi's first experiment resulted in some excellent cast iron containing titanium. This satisfactory result soon resulted in the titanium-iron alloy idea. Not long after, the first production of this titanium-iron alloy by Rossi steel alloy manufacture was started in Niagara Falls. Meanwhile, in Germany, Dr. Hans Goldschmidt had developed a low-carbon ferrotitanium alloy in competition with Rossi's product. Both of these metals were of practically the same composition and properties. Even at the present time these two metals are widely used in separate fields, despite their striking similarity. Rossi's reduction produces 16-21% titanium and 3-8% carbon, while Goldschmidt's powdered aluminum method gives low-carbon ferrotitanium of 22-42% titanium and 3-8% aluminum.

In 1909 Dr. Becket of the Electro Metallurgical Co. proposed a process of reduction of titanium ore, which differs from both Rossi's and Goldschmidt's methods. Becket's method consisted of the reduction of titaniferous ores with silicon in an electric furnace. This process was patented in 1909.

Because of the very good oxidizing properties of titanium at steel-making temperatures, it is virtually impossible to obtain a steel alloy by the open-hearth process containing more than 0.25% of titanium. The only way in which a higher content of titanium may be obtained is by basic electric smelting practice.

In producing a true titanium alloy steel, thorough deoxidation must have taken place before the alloying

titanium is added. The second requisite is that the slag be liquid and free from all reducible oxides. When this state has been reached the titanium may be added to the steel and the heat should be tapped soon after adding the titanium. At present the purpose of using titanium in steel is to remove carbon from an active form to a relatively inactive form, titanium carbide. By this means intercrystalline corrosion is averted. Such alloy steels can be welded and cooled rapidly without losing machinability or ductility. This property is attaining added importance year by year as more and more industrial building is being done with the aid of welding.

Rossi's process requires electric practice for high temperature, while Goldschmidt's process obtains its heat from the burning of aluminum powder. Since the development of these two processes, many others have been devised. The use of carbon as a reducer produces a cheaper titanium alloy. This titanium-carbon alloy is used very extensively as a deoxidizer in steel. It is used in preference to manganese, silicon, and aluminum because it is a stronger oxidizer than either manganese or silicon, and, although somewhat weaker than aluminum, it does not leave its oxide in the steel as does aluminum. The oxide of titanium is an active flux for the slag and is a substitute for fluorspar in the open-hearth furnace. Thus the titanium oxide is very conveniently floated out by the freezing steel.

The largest amount of titanium consumed in this field is used in effervescing steel to produce better rimming ingots and hence a higher yield of a better product. This benefit is not wholly due to deoxidizing, but partly to the fluxing action of the titanium oxide. Cast pearlitic manganese steel offers a field because titanium is a stronger oxidizer than silicon. The use of aluminum produces poor ductility, because of a network sulphide arrangement typical of over-reduced cast steel. When titanium is used, inclusions are globular and scattered. Titanium is used in steel castings, therefore, to give the proper degree of deoxidation for fine-grain characteristics such as good ductility, high impact value, and repression of grain-coarsening in heat treatment above the best temperature, without so much deoxidation as to incur inclusion trouble.

Low-carbon titanium alloys are required for adding titanium effectively to cupola-melted cast iron, nickel, copper, and aluminum, or as an alloying element in steel. A low-carbon alloy is produced by reduction with aluminum, in a bath of molten aluminum or in a cold crucible of powdered aluminum. In the latter iron or nickel oxide must be reduced also, since aluminum does not generate enough heat when used alone. Titanium alloy is used in most cast iron to decrease the size of graphite flakes because it is more effective than other alloy additions. As a result of the finer grain structure of titanium cast iron, the strength is usually increased 5-25%, with a slightly increased hardness, although the machinability of the metal is better.

Titanium also acts as a graphitizer, reducing the hardening effects of chill at thin sections and corners. Therefore titanium is used with chromium cast iron, or vanadium cast iron, where it permits full value of the hardening effects without producing chilled and unmachinable thin sections and corners. The soundness of sand-cast test-bars of gray cast iron is improved when titanium is used as a deoxidizer.

It has recently been discovered that titanium cyanonitride may be used as a source for nitrogen for refining the grain and improving the properties of high chromium steels. The use of nitrogen for this purpose has been known for some time. In the process the nitrogen gas is not passed through the molten metal as might be expected but is found to be most easily obtainable where it is needed, if first entered into the steel as titanium cyanonitride. Not only does this procedure evenly diffuse the evolved nitrogen throughout the steel, but the residual titanium is very conveniently used to deoxidize and clean the steel.

Non-Metallic Titanium

Titanium white (titanox, titanium oxide) is a white pigment of exceptional body and covering power, far exceeding that of white lead or zinc oxide, in admixture with which the latter pigment is often employed. Pure titanium oxide is precipitated from a sulphate solution. The oxide is a white powder of high refractory index. A perfect covering is secured with fewer coats than ordinary paints are capable of rendering. Nearly 90% of the production of titaniferous ores in this country are used for paint pigment. Owing to its chemical inertness, it is unaffected by atmospheric influence and is non-poisonous. As a paint its films do not crack or peel but show a strong tendency to "chalk", a defect arising from the gradual destruction of the film in moist air. This oxide pigment is much used in linoleum, rubber, artificial leather, plastics, cosmetics, and paper.

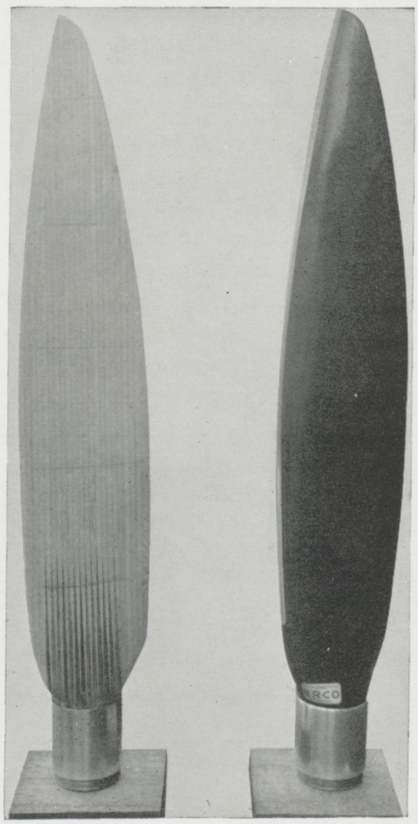
TABLE II.

Properties of Permanent Magnet Steels
(Data taken from 1936 A. S. M. Handbook and U. S. Patents)

Name	*Composition*							
	C	*Mn*	*Cr*	*W*	*Co*	*Ni*	*Al*	*Ti*
Chrominum	1.00	0.35	6.00	.....	.....	.....	.....	.....
Tungsten	0.70	0.30	0.20	5.5	.....	.....	.....	.....
Co-W.	0.85	0.50	3.50	8.7	17.0	.....	.....	.....
High Cobalt	0.90	0.60	4.50	5.5	38.0	.....	.....	.....
Alnico	.....	.....	.....	.....	7.0	27.0	11.0	0.5
Mishima	.....	.....	.....	.....	.....	30.0	12.0	.....
Honda	.....	.....	.....	.....	28.0	16.0	.....	11.0

Research and Development

edited by Lloyd O. Krause, e., '40



—*courtesy Aviation*

Finished and unfinished blades. Note plastic laminations solid at hub and feathering into solid laminated spruce structure of the blade proper.

Lightweight Laminated Propeller Blades

The weight of a propeller increases more rapidly than the power which the propeller must absorb. That is, if a rated 300 hp propeller weighed, say, 60 pounds, a rated 600 hp one would weigh more than 120 pounds. This fact has gained increasing importance of late because of the progressive increase in the size of airplane motors, and, with the consequent greater increase in the weight of the propeller, propeller weight has become a problem. In an attempt to solve the problem there was developed a composite wood and plastic blade, orginally by the Schwartz Company in Germany. The United States, through the efforts of the Engineering and Research Corporation of Washington, D. C., has now obtained a license to manufacture these propellers. The composite blades have been entirely successful, and besides being used in one-piece construction propellers they have also been manufactured with controllable-pitch hubs. They effect about a 1/3 saving in weight in the larger sizes.

The Schwarz blade consists essentially of a core of laminated spruce, which merges by means of a long scarf joint into a root of impregnated and compressed hardwood, called compreg. This compreg root is threaded and screwed into a steel ferrule which supports the blade in the hub. The entire blade is then heavily coated with cellulose-acetate sheet, the leading edge also being protected with a flush strip of metal. The core is thus completely protected from the elements and any other harmful conditions.

Compreg is formed from laminated slabs of hardwood veneer 1/8 inch thick. The bending modulus of rupture ranges from 35,000 to 60,000 psi, the latter value corresponding practically to that of duralumin, which is on the order of 50% heavier. In certain cases, longitudinal shearing strengths of 11,000 psi were obtained. The modulus of elasticity varies between 3,000,000 and 4,000,000 pounds per square inch.

The portion of the blade just exterior to the steel ferrule is protected with a coat of cellulose-acetate plastic in which is embedded linen fabric for reinforcement, the whole being 0.04 inch thick. Applied in a soft state, the covering is maintained under a high pressure for a considerable time so that it soaks into the pores of the wood. After curing, the surface is smoothed and painted with a synthetic enamel.

The Schwarz type of leading-edge is relatively thick and narrow so that it can flex readily without buckling or cracking. It is secured by soldering to a wire mesh which is tacked to the blade and embedded in the cellulose-acetate coating.

The greatest advantage of these composite blades is probably their light weight, but they offer other advantages too, such as a tendency toward damping out vibrations, freedom from fatigue, and the ease and cheapness with which they can be constructed for special experimental cases. Further, of all the thousands of these plastic propellers in use, there has been no report of ice ever having formed on one, though the rest of the plane was coated.

"Threshold" Water Treatment

Traditional chemical treatment of water has it that the quantity of chemical used must be sufficient to convert the mass of water impurities into other compounds. Micromet (sodium hexametaphosphate) is a new "threshold" treatment for preventing scale in condensers and boiler-feed lines, and, as the name implies, the metaphosphate concentrations maintained are little more than traces—about two ppm, and thus the treatment is wholly unlike traditional treatment. In the case of boiler-feed water, the treatment is used as an auxiliary to other treatments, and does not replace them.

The main application of the Micromet threshold treatment in boiler-feed water is found in the prevention of secondary deposits of lime scale subsequent to the softener. In ordinary operation there gradually accumulates a lime deposit in feed lines between the water softener and the boiler. Minute portions of Micromet (2 ppm) are said to effect sustained solution of the lime and thus to prevent this secondary precipitation. It is also claimed that Micromet will prevent the deposit of lime scale

on feedwater heater and hot-process softener trays. Scale formation in closed heaters at higher temperatures is also greatly curtailed.

Another important application is the prevention of lime-scale deposits in condensers, heat exchangers, and cooling equipment, especially where the water is continuously recirculated with a consequent loss of carbon dioxide, higher temperatures, and concentrations favorable to precipitation. It is claimed that 2 ppm of Micromet will prevent all further deposits in originally clean condenser tubes if sufficient blow-down is maintained to prevent unduly high concentrations of impurities. With a "once-through" cooling-water sys-system, Micromet must be fed continuously, but with recirculation Micromet feeding need be only intermittent, or hexametaphosphate "glass" may be suspended in a basket in the water and allowed to dissolve gradually.

Scientific Instruments Check Tolerances of Automobile Parts

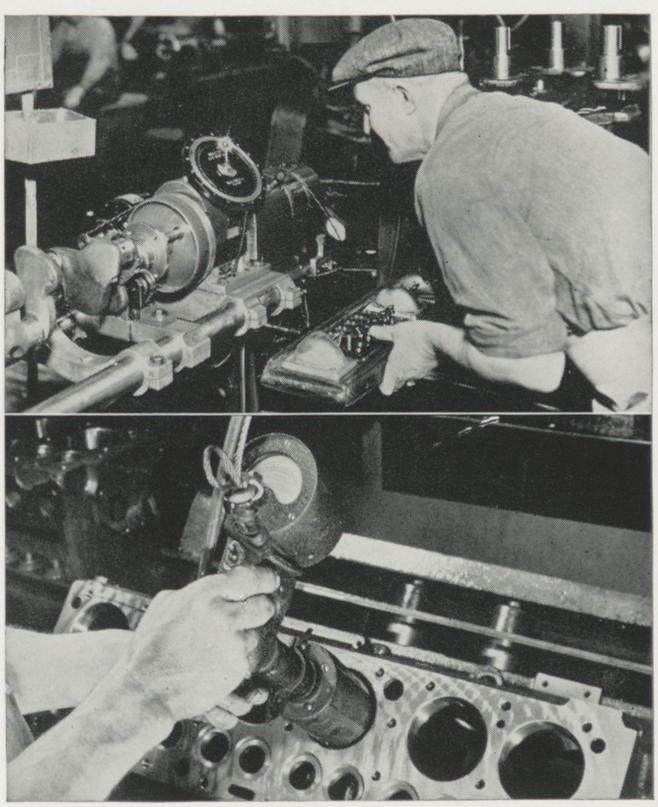
Today's automobile is a more efficient machine for many reasons, an outstanding one of which is the close tolerances to which present-day automobile parts are made. Large machines, operating with accuracies far above those which human hands can attain and producing parts day in and day out which do not vary in size by more than a fraction of the thickness of a human hair, backed by inspection devices which detect minute imperfections without the meticulous testing methods of a laboratory, extend the life of today's motors and prolong the time which the car goes free from repairs.

Scores of an automobile's component parts pass speedily through tests that detect variations imperceptible to human senses. Even the lowest priced car is subjected to some 2000 separate inspections.

Pistons are held to a mass tolerance of 1/16 of an ounce during production, and are graded during inspection to insure a clearance of two ten-thousandths of an inch between the cylinder-bore and piston. The following precision measurements will serve to show the production accuracy now obtained in the manufacture of one low-priced car: 14 measurements of parts must be accurate to within one ten-thousandth of an inch, more than 200 accurate to within five ten-thousandths, and more than 700 accurate to one one-thousandth of an inch. At least 600 gage applications are made on every car turned out of the factory.

The most inspected single part is the cylinder block which requires 50 separate checks to determine the exact size and spacing of cam and crankshaft bearing holes, cylinder bores, valve seats, tappet holes, and other details. Chassis and chassis parts are subjected to 1600 examinations by a host of inspectors. All forged parts are tested by the Magnaflux process, and any parts showing small fractures are immediately rejected.

Ten years ago all precision measurements were dependent on comparison with a set of master blocks —a slow process. Today such instruments as the electric profileograph are employed in which by amplification a needle registers differences as small as one one-millionth of an inch.



—courtesy Automobile Facts

Above: Speedily checked on the dial of a super-sensitive electrical gauge, the pistons are graded to .0001 of an inch.

Upper Right: The spark on the dial will show when this crankshaft for a low priced car is in perfect balance.

Lower Right: The close precision of cylinder bores is verified. The testing device is counterbalanced to eliminate weight lifting when the operator moves it to the next bore.

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Faculty Advisors

HERMAN A. MOENCH — HENRY C. GRAY

Swan Song

With this, the April issue, the *Technic* staff performs its annual fade-out. There will be no blare of trumpets or roll of drums—just a typical "senior thesis sigh". And, if you've observed the seniors, you'll know that we do mean sigh. The sigh will, admittedly, be partially one of relief, but it will certainly contain a strong undercurrent of a kind of sadness. It's been work—hard work. But it's also been fun—great fun.

No swan song is complete without a "we-who-are-about-to-die-salute-you" note. And so this editorial farewell adds a note of sincere appreciation to the fine cooperation which has been given by the entire staff. But for really keeping things going, our thanks to the Gunga Din's of the outfit, faculty advisers Herman Moench and Henry Gray.

Finally we direct a brief remark at the new staff about to be inaugurated. We found this damn orphan on our doorstep a year ago and have tried, at least, to maintain it at equilibrium. It may be robust and it may be emaciated, but whatever it is, you've got it. And with it you have our best wishes that you will attain that for which we have striven.

—*R. S. K.*

Rights of Human Bondage

"If we are ever to have law and order in the West, we should take out all.....and.....!" and indoctrinating lead-in, is finding increasingly frequent use with respect to alien residents in the United States. Concern over the activities of this foreign element has lately been accentuated by turmoil on distant shores. Indeed, the agitation has reached the point where the administrative branch of the government has seen fit to deprive numbers of these peoples of a privilege next in importance to freedom, the privilege of honorably earning a livelihood.

The error in according this group such differential treatment is fundamental. This country's progress has been made by a population originally of foreign extraction, and the debt to them for indispensable contributions of every form should be eternally acknowledged. For this reason class legislation should be weighed very cautiously if we are to observe the law of the divine right of fellow men. Those who have fled the unpleasantnesses of their native lands and have been allowed to settle here should be given every opportunity to become good citizens.

In this wise, the mass dismissal of aliens from the rolls of the W.P.A. appears to establish an untoward example. The week's news reveals such influences. In 1830 a German engineer immigrated to New York and organized a company which later constructed one of that city's most famous landmarks and, incidentally, created a new era in suspension bridge building. Strangely enough, this company recently dismissed all alien employees who had served it less than ten years.

Of course, actions and utterances subversive to the American form of government are not to be tolerated from elements not represented by it, but this is very much the place for selective and not mass reprisals.

—*J. E. T.*

From the President's Pen

Many people believe that technological progress is the chief, if not the sole, cause of continued unemployment. Statistics from unbiased reports of the Federal Census Bureau and the Department of Labor have been analysed repeatedly by economists and engineers to verify the reasonable assumption that, in the long run, technology by lowering costs provides more jobs than it destroys. In spite of these proofs, however, technological unemployment remains, in many minds, both an explanation of existing difficulties and a threat for the future.

A moratorium on scientific and engineering research has been seriously proposed as a remedy. Of course, if this were a logical step to take, we should take the second step and discard all labor saving devices in the reverse chronological order of their introduction until everyone is at work.

Charles F. Kettering, president of the General Motors Research Corporation, made an interesting contribution to the discussion of this question in a recent issue of the New York Times. Mr. Kettering offers no apologies for the temporary effect of technical progress on employment, but proposes even more rapid progress as a means of putting men back to work. Scientific investigation and engineering application may be divided into two major types. One includes all efforts to develop improved methods and machines for manufacturing more efficiently those goods already being produced; the other includes all research devoted to developing new products which can be put into production. The first type leads to temporary unemployment until increasing demand for the goods offsets the decreased labor requirements for making them. The second type, when financed by capital, creates employment directly, not only for making the new products, but often for making the manufacturing equipment to be used.

Mr. Kettering advocates a vigorous concentration of research on new products for the immediate future with a temporary relaxation on the development of labor saving machinery. The tremendous stimulus to employment which could follow can be appreciated if one thinks of the frightful decrease in employment which would result from the elimination of the automobile, radio, and motion picture industries; only three of the many twentieth century technical creations.

D. B. Prentice

Braintwisters

by William A. Reddie, ch., '39

Editor's Note: The problems presented in this issue have been kindly submitted by Mr. J. F. Richardson of the Class of '31. Credit is also due Mr. Richardson for his correct solution of several problems which have already appeared in this column.

1. In a 45-degree triangle lines drawn from the three vertices intersect at a common point within the triangle. If these lines are in the ratio 3:4:5, what is the length of the side of the triangle?

2. At what time between 3 and 3:30 must the hands of a clock be in order that they may change positions within an hour? That is, the minute hand takes the original position of the hour hand and the hour hand assumes the position of the minute hand. Also, how many minutes apart must the hands of a clock be in order that they may change positions within an hour?

3. A mine contractor had two lots of metal bars. Eight of the larger size were as heavy as 13 of the smaller bars. Altogether there were 49 bars which he wished to have carried over a mountain pass.

The contractor made a bargain with two brothers who owned seven mules, to transport the metal over the pass. He paid them an even number of dollars, which they divided equally between them. They took no other money on the trip.

Because of the weakness of some of the mules, it was necessary to adjust the weight of the packs to the individual capacities of the animals. This was done and no two mules carried the same weight, although each pack contained seven bars, and

(*Continued on Page* 26)

—*Photo by White*

It has taken an entire year to get a complete lab group and a professor at the same place at the same time, but we have succeeded. Observe the fruits of our labor.

Around The Campus

with

Chuck Howlett, e., '41

Freshman Days End

The arrival of St. Pat's Day brought to a conclusion, for new students, six trying months of conformity to the written and unwritten Freshman laws of the Institute. Twelve o'clock, March 17, seemed to carry with it a feeling of liberation. As the emancipated Freshman walked down the cinder path for the first time—that is, first time to the knowledge of the Sophomores—pipe in mouth, ankles free from garters, matches cast aside, and head bare, he felt that now he had become a part of Rose.

The morning was predominated by vivacious physical encounters in which the Sophomores endeavored to force the reluctant Freshmen to roll their pants above the knees. Following the Sophomores' final lake party of the terminating laking season, everyone was in fine shape for the dance which later ensued.

Debate Club

The Rose Debate Club has just completed one of its most successful seasons. The club encountered several midwestern colleges in verbal contest; and among their opponents are listed such schools as DePauw, Earlham, Evansville, Olivet, and Anderson. Either or both of the teams participated in the separate debates, and in many instances emerged victorious. Several of the debates were non-decisional. In addition to the dual debating, the Rose team was entered in the annual Manchester tournament, which was held at Manchester College on February 24-25.

Speech work is of vital importance to the engineer, and this fact is being recognized here at Rose since both scholastic credits and honor points are awarded those who participate in this activity. Speaking of speech work, it has been said that debating offers one experience in expressing himself far superior to the much heard of "bull-sessions"; and combined with the pleasures of the debate trips, these should be sufficient factors to arouse a far greater amount of interest and enthusiasm in this activity from the students of this institution.

The club for the year 1938-39 is composed of the following men: Robert Kahn, President; James Ducey, Secretary-Treasurer; Robert Phelps, Ed Coons, Hulit Madinger, and Gene McConnell.

St. Pat's Dance

In honor of St. Pat, one of the greatest engineers of legend, a gala dance is held by engineering schools every year on March 17, in keeping with tradition.

This year the affair was held at the Terre Haute Country Club, where a crowd of one hundred and fifty couples, consisting of students, faculty, and alumni, danced to the music of Wayne McIntyre and his orchestra. The dance was under the direction of the Student Council.

In the decorations green was the predominating color. Most impressive was a mural, the work of Malcolm Steele, depicting an Irish boy and girl engaged in a dance. The favors consisted of St. Pat pipes for the ladies and green hats for the gentlemen.

Wayne McIntyre added to the festivity by imitations of the various well known orchestras. Everyone seemed to be enjoying the party in his own fashion, and when the matutinal hours approached, the crowd fully agreed that the occasion was a success.

Camera Club

At a recent meeting of the Camera Club it was decided that the operation of the club should be more efficient. As a result, Norman Eder was placed in charge of keeping the dark rooms cleaned; Gordon King and George Schull were appointed to supervise maintenance and repair of the club's equipment and property; and Willard Louthen and John Taylor were asked to keep the bulletin boards supplied with interesting material.

The program of talks on the subject of photography has been progressing smoothly. Dr. Crozier presented the first talk on the subject "Composition of Pictures". He stressed the four points, unity, rhythm, harmony, and balance, as necessary to attain excellent picture composition.

Professor Hutchins gave a very interesting review of photography as it was used by the engineers in the T. V. A. as the second of the series of talks.

This non-credit course in photography, as it has been called, seems to be a very up-to-date idea. Not only is the program of aid to the Camera Club members in their pursuit of an interesting hobby, but also it appears to be very practical for the entire student body as potential engineers. An increasing use of photography is being made in the preparation of engineering and industrial reports.

A.I.E.E.

The Rose chapter of the American Institute of Electrical Engineers met Wednesday, March 15. The meeting was opened at 7:30 P. M. with several announcements. The students were especially interested to learn that the annual tri-school meeting of the A. I. E. E. is to be held this year at Purdue on May 5. The chapters of the society at Illinois, Purdue, and Rose have made it a custom to meet once a year for a program of student talks and demonstrations. Last year the meeting was held at Illinois.

Following the short business session Professor Edwin W. Mann was introduced. He spoke on "Bacteriology", a subject one would hardly expect in a meeting of Electrical Engineers yet one which proved to be of considerable interest. Professor Mann explained the necessity for the existence of bacteria, outlined the classification of the different types, and spoke briefly on the methods of destroying the harmful species. He illustrated many of the points in his discussion with a projection lantern.

Several questions were raised, and after Professor Mann had supplied sufficient answer the meeting was adjourned for refreshments. Hot-dogs and soft drinks were furnished in abundance, and while the assembled throng munched contentedly the indomitable Nicholas Smilanic introduced his version of the mystic rites of "Black Magic". Thus, amid fun and perplexity, the meeting was adjourned.

Rifle Club

The Rifle Club has brought to a close its firing for the present school year. The team has enjoyed the most successful season in resent years, competing in the Wabash Valley Rifle League and placing very high in intercollegiate competition.

In concluding the season, sweaters were awarded to those members of the team who participated in seventy-five per cent of the matches and fired a score of 345 out of 400. Meeting these requirements were the following men:

Seniors: Edward A. Coons, Victor W. Peterson, and Robert W. Underwood.

Juniors: Maurice W. Johns and Maurice C. Fleming.

Sophomores: Somers E. Blackman, Paul R. Bell, and Charles A. Howlett.

Freshmen: William C. Leedy and James H. VanPelt.

Ping-Pong Tournament

The recreation room has resounded of late to the clatter of ping-pong balls, the shuffle of feet, and the cheers of excited fans, as the annual tournament has gotten under full swing. The award of beautiful cups has made the competition especially keen, and enthusiasm has been great especially in the final singles matches.

Bob Wright, freshman, and artist in the handling of the little celluloid, emerged victorious in the singles competition by defeating consistent "Rosie" Colwell.

In the doubles, John Quinn, last years singles champion, and Wright have advanced to the finals in the upper bracket; but at the time of this writing, two matches remained to determine their opponents.

The ping-pong tournament is sponsored by the Blue Key, and in recent years it has become one of the more popular of the intra-mural sports competitions.

Radio Club

The Rose Radio Club reports that work is progressing rapidly on its new club room. Saturday, March 12, the 160-meter transmitter was moved into the new location. The major part of the wiring of the room has been completed, and conduit has been used almost entirely for the sake of safety and permanence. Arrangements have been made so that the station may be operated either from the school's power or from city power in order to insure operation at all times. Special care has been taken to run the circuits to the separate transmitters through switches which may be locked. Thus, only the licensed operators, who have keys, can operate the station.

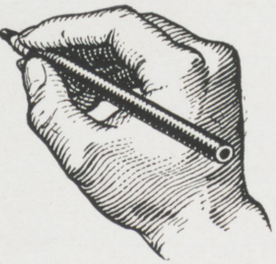
On Thursday, March 16, the club met to hear a report from George Schull on the work he has been doing in building a 40-meter set. He also explained the fundamental features of class "C" amplifiers.

Glee Club

The members of the Rose Glee Club are enjoying a successful season. It is reported that they gave fine programs at both Glenn and Gerstmeyer Technical High Schools. Many favorable comments also have been heard on their recent performance, a broadcast from station WIRE in Indianapolis on Saturday, March 18. Following the broadcast Dr. Prentice took the singers to dinner at the well known Canary Cottage.

Those who made the trip are: Joseph Dreher, Raymond Hogan, Edwin Martin, Louis McWilliams, Robert King, John Cundiff, Hulit Madinger, Richard James, Gordon King, Maurice Fleming, Vernon Whitehouse, Winston Cundiff, Franklin Doenges, Richard Mullins, Roger Howle, and John Carroll.

Fraternity Notes



Theta Kappa Nu

Theta Kappa Nu is pleased to announce the pledging of William Thomas from the class of '41.

At the meeting on March 6 William Ringo was elected worthy Archon for the ensuing year and Thomas F. Lane was elected scribe.

The chapter held a dinner meeting on Sunday evening, March 12, at Mother Eaton's Dining Room. This meeting was attended by a number of alumni, including Professor Stock, Bill Haynes, Mr. Potter, Steve Rozgony, Dick Metz, Clarence Reid, and John Whitesell.

Sigma Nu

The Mother's Club of the Beta Upsilon chapter of Sigma Nu has been reorganized. Under the direction of Jack Wilkerson the mothers were assembled at the fraternity house on Sunday, February 26. Mrs. H. E. Menefee was elected president, Mrs. Hugh Wilkerson, vice-president, and Mrs. William Rockwood, secretary-treasurer. Meetings are to be held on the first Wednesday of each month.

On Monday, March 6, the chapter elected its officers for the coming year.The officers elected were: John Quinn, Eminent Commander; Richard A. Mullins, Lieutenant Commander; George Schull, Recorder; Fred Bradshaw, Chaplain, and John Heltsley, Treasurer. The remaining officers of the chapter are to be elected after the initiation in the spring.

The chapter was honored by the visit of Lawrence Reedy, assistant general secretary of the national chapter. The chapter held a dinner meeting in his honor on Monday, March 13, the new officers presiding The chapter was glad to have its faculty adviser, Mr. Edward MacLean, as a guest at the dinner.

Alpha Tau Omega

The annual dinner and banquet for the four chapters of A.T.O. in the state was held on Saturday, March 4. This affair took place in the Riley Room of the Claypool Hotel in Indianapolis. The Gamma Gamma chapter at Rose Poly was well represented, almost the entire pledge and active chapters being present. At the banquet Merton Scharenberg, class of '38, was highly honored by being presented with the Province 17 Thomas Arkle Clark award, and he was also congratulated for winning the national award. The chapter was honored by being presented with a cup standing for the highest scholarship of any chapter in the state.

On Friday evening, March 24, the pledges gave an open house for the active chapter. This open house was well attended, there being some 40 couples present at some time during the evening. An enjoyable evening was spent dancing, playing cards, and playing ping-pong. The refreshments consisted of soft drinks and cakes.

On April 14 the outstanding social event of the semester took place. This was the annual Spring Formal which is given for the pledges by the active chapter. The dance, as usual, lasted from 9 o'clock until 1 o'clock, and took place in the Mayflower Room in the Terre Haute House. The chapter was very fortunate in securing Wayne McIntyre and his orchestra for the affair.

Theta Xi

Kappa chapter of Theta Xi is now making plans for attendance at the tri-state convention to be held this year under the auspices of the Cincinnati Alumni Club. Another event now occupying our attention is the seventy-fifth annual national convention to be held at Rennselaer Polytechnic Institute, Troy, New York.

The local chapter has had quite a round of activities under the new social policy. The pledge dance on February 18 was followed by an open house on March 10, with an attendance of thirty-two couples. On Monday night, March 20, a dinner meeting was held. Mrs. Grove, under the able supervision of George Harper, served the dinner, at which twenty-eight were present. Talks were given by Mr. Henry C. Gray, Bob Dispennet, Bob Burger, and Nick Smilanic. Each pledge then gave a short talk on his home town.

Following the dinner, a study table was installed, with the idea of improving the chapter's scholastic rating.

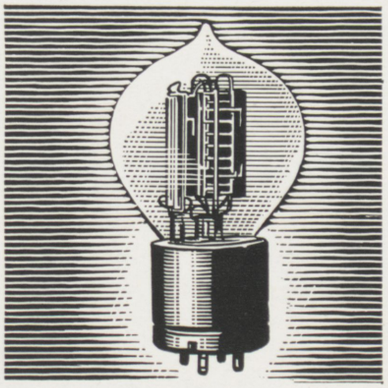
Plans are being completed for our Spring Formal to be held on April 22. This will be preceded by a Hell Week and initiation for the new pledges.

RIGHT OR WRONG?

A 2-minute test for telephone users

1. The Bell System handles about 48,000 telephone calls per minute, on the average.

RIGHT ☐ **WRONG** ☐



2. One of the first uses of vacuum tubes was in telephony—years before commercial radio telephony.

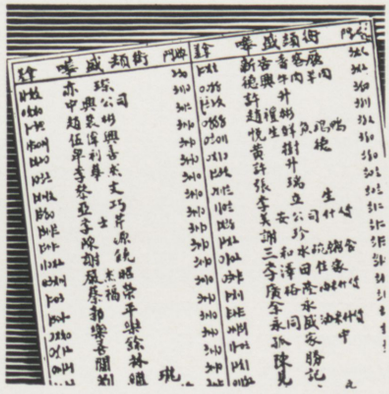
RIGHT ☐ **WRONG** ☐

3. The largest telephone cable used by the Bell System contains 2424 wires.

RIGHT ☐ **WRONG** ☐

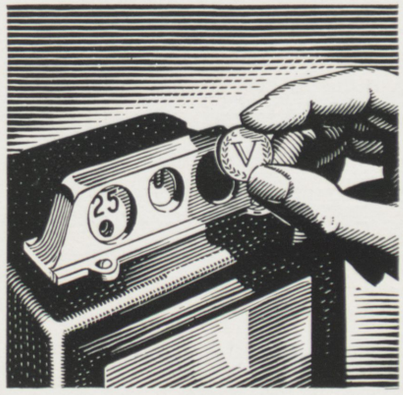
4. The Bell System employs about as many people as live in the city of Dayton, Ohio.

RIGHT ☐ **WRONG** ☐



5. This is part of a page taken from a telephone directory published in the United States.

RIGHT ☐ **WRONG** ☐



6. Lowest rates to most out-of-town points are available every night after 7 P.M. and all day Sunday.

RIGHT ☐ **WRONG** ☐

ANSWERS

1. *Right.* In 1938 the average number of calls per day was about 70 million.

2. *Right.* The repeater tube, which makes possible long distance telephony, was first used in 1913.

3. *Wrong.* 3636 wires are packed into a cable about the size of a man's wrist.

4. *Wrong.* The population of Dayton is about 200,000 — while there are nearly 300,000 telephone employees.

5. *Right.* It is from San Francisco's Chinatown telephone directory.

6. *Right.* Why not telephone family and distant friends oftener?

AMERICAN TELEPHONE & TELEGRAPH CO AND ASSOCIATED COMPANIES — BELL SYSTEM

BELL TELEPHONE SYSTEM

Sports

edited by Robert N. Ladson, ch., '39

The Rose basketball team scored more than its share of victories to hang up the best record any Rose basketball team has made in the last fifteen years. This was largely due to the undying spirit of the team and the genuine desire to win its games. As a great aid to the Rose cause there came to Rose this year five freshmen who in many games were the margin of victory. These men are Bowsher, Meurer, Keeler, Mehagan, and Brown. Naturally, great things are expected of them in future years. Of course, there are also Colwell, a junior, and Dreher, a sophomore, who have been mainstays on this year's team who will be depended on in the future.

By way of statistics the totals for the season are very interesting. Rose won a total of eight games while losing six, a record unheard of in the past few years. After only two days practice Rose took the count from DePauw University by 30 points 55-25. This game speaks for itself as the Engineers showed a great lack of practice. Next came Earlham who beat the Rose team 48-36. This also showed the team's lack of practice, but Rose showed flashes of good basketball.

Wabash, traditional rival and stumbling block, came next to Rose and left with an eight point win, 34-26. Rose was badly outplayed in the early part of the game but were in the midst of a rally when the final gun sounded.

The next foe for the Engineers was Taylor University. This game was played shortly after the holidays and Rose showed its poorest basketball of the season to lose 36-30. At this point there were already four losses, but the situation began to improve as will later be seen.

In a free scoring contest Rose showed rare form to down N.C.A.-G.U. 63-57, and the season really began. Colwell, high scorer of the team, gained his basket eye and twenty-two points in this game. Inspired by this win the Engineers next encountered the cagers from Joliet College and, after trailing 17-11 at the half, turned on the steam and beat the highly-touted Joliet team 35-32.

Wabash was next on the schedule and despite the desperate efforts of the entire Rose team, Wabash eked out a 41-35 victory. The old Wabash jinx still held. In as near a perfect game as can be desired, the Fighting Engineers played excellent basketball to defeat the Earlham team in an overtime contest by a score 37-34. It was the opinion of many onlookers that this was the best team that Rose had ever put on the floor.

In a return contest with N.C.A.-G.U. the team had lost some of its sparkle but managed to win 28-25 after a listless game. A newcomer to the schedule was next when the team traveled to Milton College in Wisconsin. The team was again in excellent form and took the measure of a lower Milton team by nine points, 41-32. In the second game with Joliet College Rose played very good basketball to score 47 points but lost 50-47. This was the same score by which Rose had previously defeated Joliet.

Returning to the home floor for the next game, the Engineers demonstrated the improvement they had made during the season and swamped Taylor University by a score of 41-25. One of the brightest spots on the records for the season was the result of the next game. Shurtleff came to Rose with a season record of 17 wins and two losses, but Rose sent them home with a record of 17 wins and three losses. The whole team played very good basketball in this game and won 31-28. As a fitting finale to a very successful season the Fighting Engineers won from Concordia College in a very rough game 40-33.

The Rose team had the following percentages:

210 field goals from 1085 shots for a percentage of .1935.

95 free throws from 195 attempts for a percentage of .4871.

A list of the five high scorers of the team with their records follows:

Colwell	137 points
Meurer	116 points
Bowsher	91 points
Ladson	75 points
Keeler	31 points

At a meeting of the Athletic Representatives of Rose major letters and sweaters were awarded to the following men:

Seniors: Captain Ladson, Smith, and Forsythe.

Juniors: Colwell.

Sophomores: Dreher.

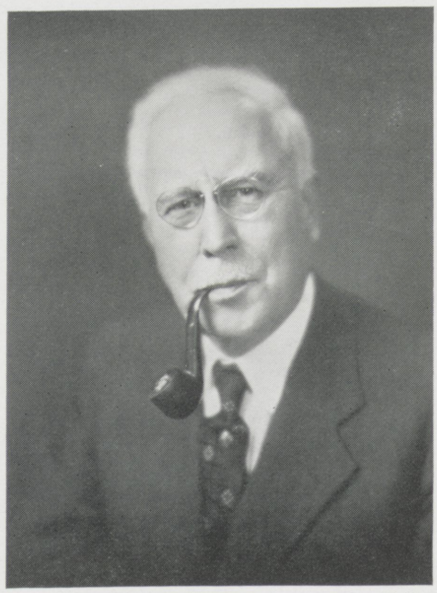
Freshmen: Bowsher, Meurer, Keeler, and Mehagan.

Manager: McKee.

At a meeting held shortly after the season closed, Robert Colwell, three letter winner in both basketball and football, was elected captain to take the place of Ladson who graduates. Bob has been a power on the team for three seasons and will make a great leader. Coach Brown, as well as the whole school, is looking forward to a very successful season next year.

Track

Rose is fortunate this year to have two high school track stars enrolled. Winston Cundiff was Indiana state high hurdle champion, and Irwin Keeler was state high jump champion. These two boys are practicing daily and plan to enter several meets later in the season. This is a small beginning for a track team but next year and future years this small start may be the basis for a well balanced track team.



Arthur M. Hood, e., '93

Here and There With the Grads

edited by

Nick Smilanic, e., '40

Arthur Hood, former Newsboy, now Prominent Attorney

"Every boy has an inherent and constitutional right to work if he wants to—and to work for pay."

That is the opinion of Arthur M. Hood, Rose, '93, of Hood & Hahn, attorneys and counselors in patent and trademark cases.

Mr. Hood worked when he was a boy, a pretty small boy, in fact. He carried *The Indianapolis News,* and the money he made went into the family treasury. His father's philosophy was that whoever eats must work, if he is able, and young Hood was deemed "able." Mr. Hood began carrying newspapers when he was twelve years old, about the time he made up his mind to become a patent attorney. Every afternoon he reported at the newspaper office, received his papers, and covered his extensive route. It was dark when he trudged homeward after delivering his last paper and dark when he left home the next day, for he also carried a morning paper route which made it necessary for him to start out at 4:30 a. m.

When he was fourteen years old, Hood worked at the Sinker-Davis Company sixty hours a week for $3.50 throughout the summer. Then during the school year he was a cash boy in a dry goods store. Out of his earnings he kept 50 cents for "spending money" and turned the rest over to the family as he was expected to do.

Hood's high school days began in the Roberts Park M. E. Church of Indianapolis while the high school building, later known as Shortridge, was under construction. He quit school at the end of two years and worked for three years. By studying at night, he qualified to enroll at Rose Polytechnic Institute, from which he was graduated in 1893.

Going to Washington, D. C., he became an examiner in a patent office and studied law at night in Columbian University, now called George Washington University. He returned to Indianapolis and in 1895 began practice in his father's office. His father retired the day he "took over." His son, Harold B. Hood, is carrying the family professional tradition through the third generation.

Mr. Hood, whose home is in Indianapolis, has been a member of the Chamber of Commerce since 1895 and the Columbia Club since 1911. He is a charter member of the Scientech Club and has been treasurer since 1923. He joined the Indianapolis Athletic Club at the time of its organization. He is a member of the bar of various federal courts throughout the country and of the bar of the supreme court of the United States. He also belongs to the national, state, and city bar associations.

Rose Tech Club Meeting

On March 16 the Chicago Rose Tech Club held its annual meeting with Doctor Prentice as an honor guest. Reports were heard of current activities at the Institute, and

upon conclusion of the official business, the assembled members participated in an informal discussion of items of particular interest concerning the Institute. The officers elected for 1939 are as follows: Corban, '26, president; Schlossberg, '26, vice-president; Austermiller, '17, secretary-treasurer. Seventy-two alumni were present, and Doctor Prentice reported the affair to be one of the best alumni meetings held. Many of the alumni inquired about various members of the faculty and sent their best regards to these men.

Births

Mr. and Mrs. Alfred L. Kasameyer are the proud parents of a son born on March 12. The baby has been named Robert Arthur. Mr. Kasameyer is a graduate of Rose, class of '28.

Mr. James E. Goddard, Rose '28, is the father of a baby son born on March 11. The boy was named James Elmer.

Weddings

John R. Merrifield, Rose '38, was married to Miss Elizabeth Anne Dayer at the home of her parents, Mr. and Mrs. Michael J. Dayer. Mr. Merrifield is the son of Mr. and Mrs. Hugh D. Merrifield of Indianapolis. After a motor trip south, the couple returned to their new home in Louisville.

Obituary

A notice has been received of the death of John F. Regan, Jr., class of '04. Mr. Regan, up to the time of his death, was superintendent of the coke plant at the Youngstown Sheet & Tube Company in Youngstown, Ohio.

What They're Doing

'19 Adolph A. Geiger, with the York Ice Machinery Corporation, has been transferred to York, Pa.

'23 Harold H. Johnson, with the National Malleable and Steel Castings Company, has been made metallurgist of the plant at Sharon, Pa.

'24 Leslie E. Garrett, with the Pennsylvania R. R., has transferred to Bucyrus, Ohio.

Robert L. Wolfe, with the Continental Can Company, has been transferred to Chicago.

'26 E. Wayne Watkins has taken a position with the U. S. Engineers. He will be located in Pittsburgh.

'28 Harold A. York, with the Indiana Bell Telephone Company, has been transferred to Indianapolis.

'33 J. Dunlap McNair has taken a position with the Indiana Steel and Wire Company at Muncie, Indiana.

'35 Deforest W. Colburn, with the Warner Construction Company, is now located at Kremmling, Col.

'36 Raymond J. Harrod has returned to work with the Pennsylvania R. R. at Altoona, Pa.

Carrol R. Merriman, with the Pennsylvania R. R. has been transferred to Terre Haute.

'37 Robert A. Averitt has been transferred from Schenectady to Lynn, Mass. He will do work on turbine tests for the General Electric Company. His new address is 35 Baltimore Street, Lynn, Mass.

'37 John B. Stineman is a junior engineer with the Emery Industries Inc., at Cincinnati.

'38 John F. Weinbrecht has taken a position with the Fairbanks Morse Company in Chicago.

BRAINTWISTERS

(*Continued from Page* 17)

no pack weighed as much as 300 pounds nor as little as 150 pounds.

After they were well started, one of the brothers found that he had left his pipe at the ranch, but his brother had an extra one, which was new, and sold it to him for just what he had paid for it, which was an integral number of dollars.

After this transaction the product of their respective money holdings, which were both prime numbers, was nine dollars less than it would have been before the sale of the pipe; and exactly seventy dollars more than the total weight in pounds of the seven packs carried by the mules.

What was the weight of the larger size and what was the weight of the smaller size bar?

Sarah P. Burton

Thirty-seven years Registrar at Rose

Sarah Peddle Burton

Mrs. Sarah P. Burton, for thirty-seven years registrar of Rose Polytechnic Institute, passed away March 9, 1939, at Union Hospital in Terre Haute. Mrs. Burton was born in Terre Haute December 1, 1852, the daughter of Charles R. Peddle who had come to this city the year previous at the solicitation of Chauncey Rose to take charge of the mechanical equipment of the Terre Haute and Indianapolis R. R.

She was married Sept. 30, 1875, to Charles T. Burton, a young lawyer who died five years later.

When the new Rose Polytechnic Institute opened its doors to students in 1883, Mrs. Burton became Secretary to the President, Charles O. Thompson. She also acted as registrar and this position she held until her retirement in 1920. During this long period she knew personally every student who entered the Institute.

Mrs. Burton was a woman of marked ability and noble character, actuated at all times by a strong sense of duty, right, and justice. Through her long years of service she was rarely absent from her office while school was in session. She ever held the respect and esteem of students and faculty alike. She loved Old Rose and served it faithfully. It was her great interest in life, an interest she never lost till the end.

Outside the school Mrs. Burton's life centered in the church. She was reared in the Sunday School of the First Congregational Church, united with the Church at the age of fifteen, and was never absent from its service when she was able to attend.

After a long and useful life she has gone the way of all flesh, but she still lives and will continue to live in the hearts of her many friends. Hers is an honored name upon Rose Polytechnic Institute's roll of servants and benefactors.

Albert A. Faurot.

Cracked Gas

edited by
John E. Bartmess, m., '41

FRESHMAN DEFINITIONS

Chlorine—a dancer in a night club.

Carbon—a storage place for street cars.

Barium—what you do to dead people.

Boron—a person of low mentality.

Mole—a subterranean fur-bearing animal.

Catalyst—a western ranch owner.

Centimeter — a hundred-legged worm-like animal.

Flask—a measuring vessel carried on the hip and graduated in fingers.

Electrolyte—a thing which when it is dark you turn on and it gets light.

Nitrate—special price on telegrams and telephone calls after dark.

"Little boy, why aren't you in school?"

"Hell, lady, I ain't but three years old."

"Taxi sir?"

"Gawantahell"

"Sorry sir, I can't leave the city limits."

The proud father whom a college education had been denied met his daughter at the train on her return home.

"But Helen," he said, "Aren't you getting fat?"

"Yes," she replied, "I weigh 140 stripped for gym."

Her father looked dazed for a minute and then thundered, "And who is Jim?"

—Nebraska Blue Print.

I metcha
Before, I betcha
And just look
What I'd have been
If I hadn't
A metcha.
But when I metcha
I letcha
And I betcha
If I metcha
Again, I'd letcha
I betcha.

—Minnesota Techno-log.

Jo: "If you don't leave this room immediately, I'll call the whole police department to put you out."

McKee: "My love, it would take the whole fire department to put me out."

And then there was the little girl who swiped her mother's corset but didn't have the guts to wear it.

—Penn. Triangle.

Sweet young coed: "Professor do you think it's right for me to sit on your knee while you explain your theory of Reincarnation?"

Prof: "Why in hell not? We only live once."

—Iowa Engineer.

Place: Machine design room.

Question: "If you start on a given point on a given figure and travel the entire distance around it, what will you get?"

Answer (by Noel): "Slapped, sir."

Will the gentleman who picked up the fur coat at Wassell's last night please return the blonde who was in it? No questions asked.

G-E Campus News

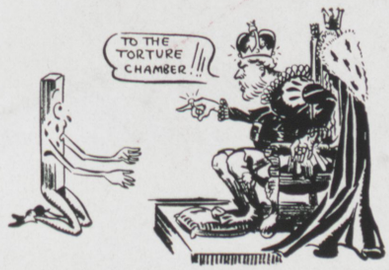
LIGHTNING TAMERS

ALADDIN had his lamp, and Robinson Crusoe had his man Friday. But they run poor seconds to General Electric's lightning makers, as visitors to the New York World's Fair will see.

For years at the world-famous G-E high-voltage laboratory in Pittsfield, Mass., visitors have seen powerful man-made lightning crash across 30-foot gaps, and power arcs twist and curl their way into the air. But the apparatus does more than produce merely spectacular demonstrations. It makes possible many experiments that provide data for the constant improvement of transmission equipment.

The star of the public demonstrations has been a 10,000,000-volt generator. Now the star has had her face lifted, and the lightning makers have a new streamlined unit. It will be a feature of the G-E building at the New York Fair. Housed in Steinmetz Hall, it will be a tribute to that great G-E pioneer in artificial-lightning experimentation—the late Charles P. Steinmetz.

Karl B. McEachron, Ohio Northern '13 and ex-Test man, noted lightning investigator for General Electric, is in charge of the exhibit. A specially trained group of engineers will assist him in presenting the more than 4000 shows planned for the fair.



MODERN TORTURE

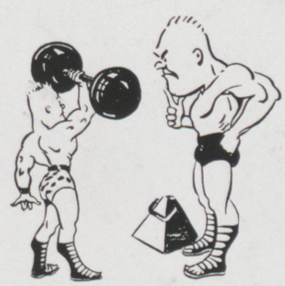
THEY ARE hung by their thumbs, pulled by their toes, and put into furnaces for ten years.

These are the well-organized tortures conducted not by villains of a medieval novel but by G-E engineers. They are the "creep" tests conducted on sample rods of various steels before these steels are used in the manufacture of turbines.

As explained by E. L. Robinson, St. Lawrence, '11, Harvard Engineering School, '14, G-E engineer, the excessive heat under which a turbine operates softens the metal of which it is made, and the metal extends, or creeps. If this creeping exceeds a dimensional change of a hundred-millionth part per hour, or is not symmetrical and uniform, the turbine shell may leak or the speeding rotor may get out of line.

To avoid these troubles, types of alloyed steels that restrict creeping must be used. Therefore, the creep tests. Sample rods are held fast and stretched until they break. They are put into electric furnaces and kept there for as long as 10 years; temperatures as high as 1200 F being maintained. Careful inspection of the results shows whether the steel is of the proper type.

This creep test is only one of the many made on each G-E turbine. For many other engineers—veterans and Test men alike—conduct other exacting tests.



WORLD'S CHAMPION

SITTING complacently on his new throne in the G-E Research Laboratory is the new midget weight-lifting champion. Not only does he completely outclass other contenders, but it seems probable that he will continue to do so for some time.

This champion is the world's most powerful permanent magnet for its size. Even though he weighs only 1/250th of a pound, he is capable of lifting nearly 1500 times his own weight.

The midget is made of a material known as Alnico, introduced by the Research Laboratory as a heat-resisting alloy. Alnico magnets have been used for some time in radios, motors, generators, and other electric equipment, replacing electromagnets, which require current for their operation.

GENERAL ELECTRIC

90-136C

The Right Combination does it...

THE SECRET of Chesterfield's milder better taste...*the reason why they give you more smoking pleasure* . . . is the right combination of the world's best cigarette tobaccos rolled in pure cigarette paper . . . the blend that can't be copied.

Chesterfield

THEY SATISFY