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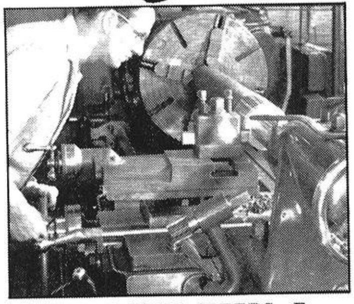
WISCONSIN ENGINEER

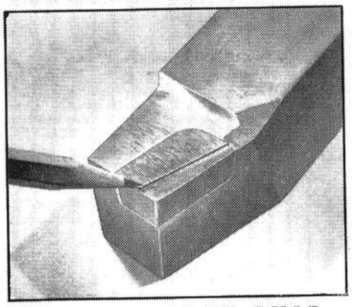
September, 1943

MEMBER ENGINEERING COLLEGE MAGAZINES ASSOCIATED

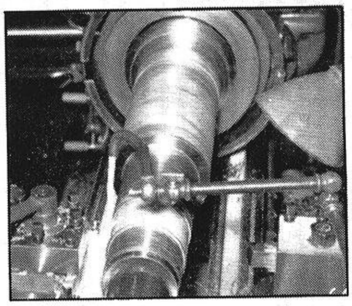
6 STEPS TOWARD TOP PERFORMANCE, WITH CARBIDES, WHEN YOU CUT STEEL



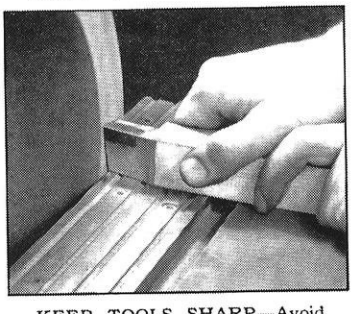
CUT AT HIGH SPEEDS—For top performance on the average steel-cutting job, don't cut at speeds less than 200 *feet* per minute. Slow speeds often cause failure.



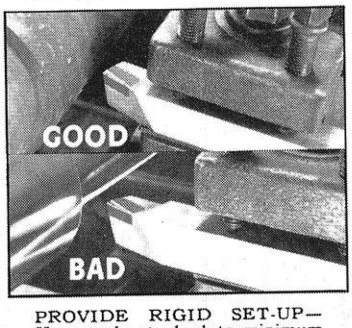
USE CORRECT CHIP BREAKER—When you break chips, break them right. Fit breaker to the job. The ground-in step-type shown is usually best.



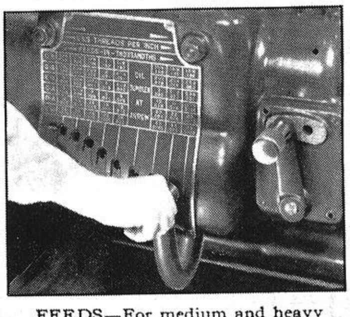
COOLANT—*IF* you use a coolant, provide a heavy, continuous stream, preferably under pressure. If you can't provide ample coolant, it is better to cut dry.



KEEP TOOLS SHARP—Avoid running tools until excessively dull. This causes breakage or drastically shortened tool life. Grind tools at regular intervals for best results.



PROVIDE RIGID SET-UP—Keep tools at absolute minimum overhang necessary to clear work. Chuck part firmly. Rigidity is important with carbides.



FEEDS—For medium and heavy cuts on steel, use feed not less than .010" per revolution, and preferably .015" to .025". Light feeds "rub" tool, causing rapid dulling.

● Important in getting top performance, when cutting steel with carbides, are the six steps shown above. When correctly applied, carbide tools produce results far surpassing the performance of ordinary tools. They operate at machine speeds as high as 4 to 5 times faster than ordinary tools, stay sharp up to 10 times longer, and increase output often as much as 300%.

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What goes on under a Nazi pilot's cap?

PUT YOURSELF IN HIS PLACE . . . in his cockpit climbing swiftly away from an Axis airfield into a pitch-black night . . . bomb racks loaded . . . heading for Yank-held territory.

How would your mind work (under a Nazi bonnet), if you knew Radar's sleepless, X-ray "eyes" were waiting up to greet you . . . on warships, airfields, and lookout posts of the United Nations' forces?

What would you be thinking . . . knowing that Radar was robbing you of "surprise", the attacker's one tactical advantage . . . detecting you as much as 130 miles from your target? *Always* watching you . . . in storm, clouds, and fog . . . five miles up or skimming the waves! . . . *marking you for ambush and destruction!*

When the flak whams accurately through the clouds to rip jagged wing holes; when you meet night fighters who need no flame from your exhausts for true aiming, wouldn't you momentarily doubt the infallibility of the "master race"?

Wouldn't you nurse a scowling respect for American ingenuity? For Radar was developed in the United States . . . pretty much the product of Navy and Army research laboratories who weren't as unprepared as you thought.

And shouldn't it occur to you that a fellow can't win when he's fighting against a nation with the inventiveness and resources to produce weapons like this?

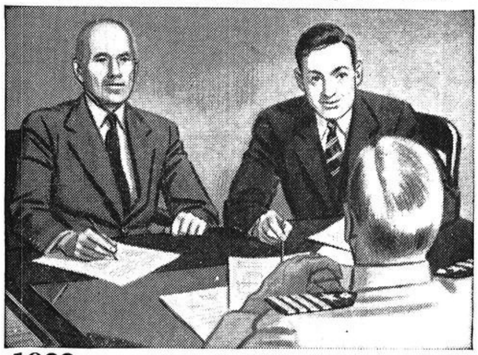
Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa.

Westinghouse was making Radar 18 months before Pearl Harbor. Since then, Westinghouse production of radio communications equipment, including Radar, has increased 41 times!

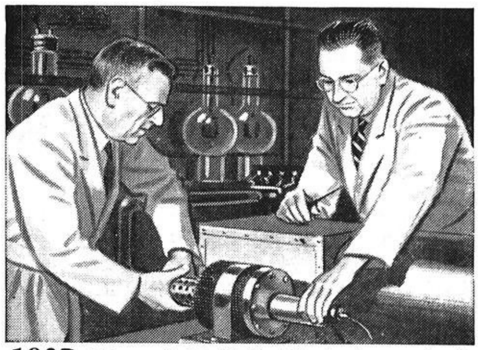
Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

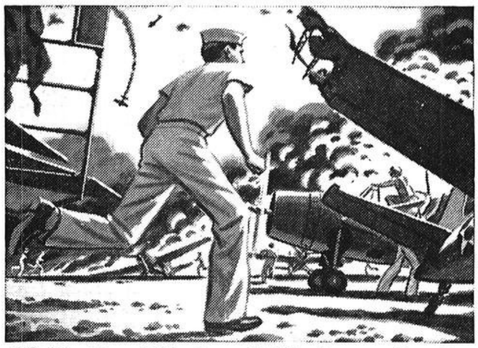
Famous dates in the history of Radar



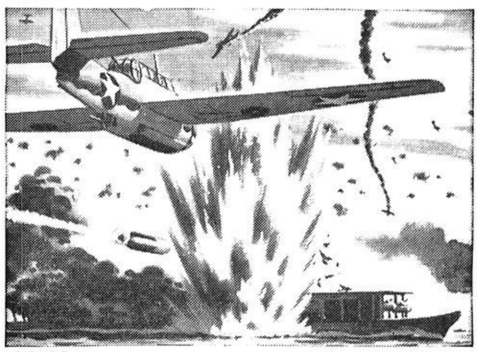
1922. Naval Laboratory, Anacostia, D.C. Dr. A. Hoyt Taylor and Leo C. Young, observing that radio signals were reflected by passing ships, saw in it a means of detecting enemy vessels in darkness and fog. This was the birth of Radar!



1937. Bloomfield, N.J. Westinghouse developed the key electronic tube for the U. S. Army's *first* Radar equipment used to detect aircraft. Radar focuses invisible, ultra-high-frequency waves traveling at 186,000 miles per second.



1941. Pearl Harbor, T.H. Approaching Jap bombers were detected by a Westinghouse-made Radar when 132 miles distant. Because a flight of American planes was expected, no warning was sounded.



1943. On every front Radar has revolutionized naval and air battle tactics . . . and multiplied a hundredfold the range of human vision In days to come, Radar will guide air transports and ocean liners safely through fog and darkness.

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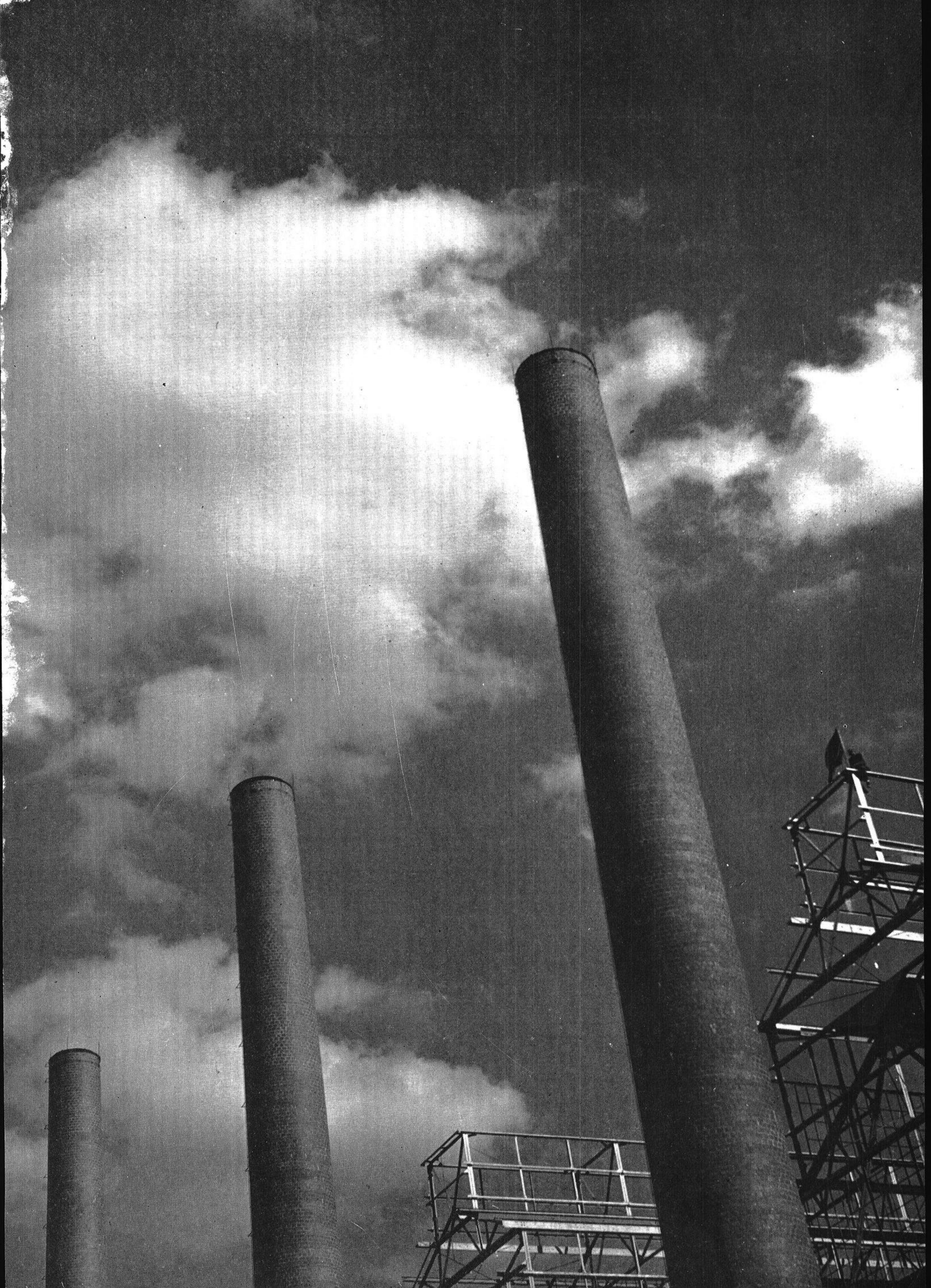
In This Issue . . .



METALLURGICAL ENGINEERING

by Jerome Baird, min'43

Editor's Note—"This is one of a series of articles by recent grads on their work in their line of engineering."

METALLURGY embraces all of the phases of processing and fabricating metals and their alloys. It is usually split into two distinct fields, the one reduction metallurgy where the virgin metal is obtained from its ores, and the other industrial metallurgy where alloys of the various metals are made and these alloys are cast or fabricated into usable articles of commerce. Each of these fields is subdivided into the ferrous and the non-ferrous branches. Although the ferrous metals today compose about 97% of all the metal produced, the non-ferrous metals are coming into prominence and are being produced in ever increasing quantities.

Reduction Metallurgy

The best known of the reduction processes is the iron blast furnace where iron oxide is smelted to pig iron. To produce steel the pig iron is further refined in an open hearth furnace. Copper sulfides are smelted in a reverbratory furnace to form a matte, and the matte is poured into a converter where air is blown through it to produce a rather impure copper which is then cast into anodes and refined electrolytically. Zinc sulfides are roasted to form oxides which are then placed in retorts and reduced to metallic zinc. Aluminum oxide is reduced electrolytically in a bath of cryolite to form the metallic aluminum. A majority of the magnesium is obtained by electrolyzing its chloride, and the rest by reducing its oxide with ferrosilicon or carbon and distilling the residue. The metal from the above processes is usually cast in the form of pigs and shipped to foundries, rolling mills, or other industrial plants.

Industrial Metallurgy

Industrial metallurgy involves taking the virgin metal, adding small amounts of other metals to form alloys, and then casting it into molds that have been designed for a certain article, or into ingots for rolling or extrusion. Nearly all of the castings are made in sand molds in grey iron, steel, malleable iron, aluminum, brass, and magnesium foundries. The non-ferrous metals are adapted to die casting where permanent iron molds are employed. The non-ferrous metals can also be extruded into a variety of forms because of their relatively low working temperatures compared to steel. The process consists of placing a small cylindrical cast block of metal in a chamber and then applying pressure with a hydraulic piston to force the metal out through a die at the other end of the chamber.

Metal for rolling mills is usually cast into large ingots and these ingots are rolled down to blooms, and the blooms are later rolled to any desired shape and size. The important rolling metals today are steel and aluminum. Rounds, squares, hexagons, rectangles, sheet, and special structural shapes such as rails and I-beams are the principal rolled products. Most of the metals can be forged commercially, with steel being the most prominent in that field. Although an aluminum, brass, or magnesium forging will usually weigh only a few pounds, steel forgings may run up to several tons.

A very important phase of industrial metallurgy is the heat treatment of the various alloys to obtain higher strength, or increased ductility, or a tougher metal under impact depending on the application of the finished product. The hardening of carbon steels on quenching, the precipitation hardening of aluminum alloys a few days after heat treating and quenching, and the increased ductility in brass after annealing are notable examples of the use of physical metallurgy in industry. As the list of commercial alloys increases day by day the importance of physical metallurgy becomes more apparent, and it is a new and intriguing field for young industrial metallurgists.

Aluminum Rolling Mill

Now that I have given you a fleeting glance at the fields of metallurgy, I will give more detail in a description of the flow of metal through an aluminum rolling mill, and my work in the mill.

In the melting room the aluminum pig from the reduction plant is charged into the melting furnace and the necessary amounts of copper, magnesium, manganese, silicon, and chromium are added to make the desired alloy. The metal is then tapped from the furnace and poured slowly into special water cooled molds to permit a rapid quench and prevent segregation. Samples are taken at the start of each pour, and the analysis of the metal is found by means of a spectrograph. The usual ingot is 12 inches square and from 80 to 105 inches in length. The ingots are then placed in the preheating furnaces, brought up to the rolling temperature, and held there for several hours to get all of the alloying constituents into solid solution with the aluminum. In the blooming mill the ingots are generally rolled to square blooms varying from 5″x5″ to 8″x8″ in cross sectional dimensions by rolls patterned after those in a steel mill. Rectangles are also rolled, but there is not much demand for them. After the metal is sheared to the desired length, it is allowed to cool for a day before it is scalped. Scalping consists of cutting a fraction of an inch of metal off of each side of the bloom with a large vertical milling cutter. This removes any surface defects caused by rolling as well as dross and some slight segregation that tend to occur at the surface of the ingot when it is poured. A thin slice of metal is then cut from the bottom of the bottom bloom of each ingot, dipped in a hot solution of sodium hydroxide for a few minutes, rinsed in water, and then momentarily immersed in nitric acid. Any internal defect in the metal such as a dross area, segregation, split, non-metallic inclusion, or porosity is shown up by this test. If the ingots are scalped prior to pre-heating and rolling, they must be conditioned on the surface after rolling with chipping tools and rotary files to remove rolling defect such as slivers, surface checking, or small corner cracks.

Next the blooms are charged into the continuous preheating furnaces in the various merchant mills and rolled through several sets of rolls to produce the desired shape. One of the mills rolls a large variety of rounds for forging stock; and this material is dipped in large tanks of hot caustic for 10 minutes, rinsed in hot water, and dipped in nitric acid to show up any surface defects that might cause the metal to crack when upset by the forging operations. Because forging stock is only an intermediate product in the fabrication of aluminum, it is supplied to the forge shop in the as rolled condition, for it will be heat treated after forging. Any rounds, squares, hexagons, rectangles, and special shapes that are to be used for structural purposes are heat treated and aged before shipping to the customer. Another merchant mill rolls the blooms down to ⅜″ rod which is then coiled, annealed, and drawn cold through die blocks to the desired diameter for rivet wire.

So far I have worked mainly in the blooming mill. Checking pre-heat temperatures and length of pre-heat, watching the rolling of certain alloys, and trying to discover what causes bad metal keeps me busy a good share of the time. Each alloy must be rolled with different reductions at certain specific temperatures with varying lengths of preheat.

The new alloys that are introduced must be worked on by cut and try methods until a good ingot is cast in the melting room and it must be further experimented on to find the optimum rolling conditions. There are many things which we do to the metal that improves the quality of the metal, but we are not sure of the mechanism of the reaction or of the theory behind our actions. We are gradually building up our knowledge of the metal through experience so that when difficulties arise in the future they can be more readily dealt with.

However, the most important part of my job is to be able to get along with the workers in the plant. Although I have no men to supervise, I work with them when some difficulty arises. The metallurgists are responsible for the overall quality of the metal and are constantly trying to improve the metal. A metallurgist uses his knowledge of physical metallurgy to trace down the difficulties and to make improvements, but his engineering education is worthless to himself and to the company if he cannot put his ideas into use. You may see a worker doing his work in such a manner that you think it is harmful to the quality of the metal, but his procedure has been standard practice for years. If you go to the worker or his foreman and tell him that he is doing it all wrong and that he should do it your way, you will be called, in addition to other names, a young whipper snapper fresh out of college that doesn't know what he is doing. Under such circumstances the man will dislike you and be uncooperative so that you are unable to make any improvement. On the other hand if you talk to the man, get him interested in your plan, find out what he thinks about it, tell him the reasoning behind it, and make him feel that he has a part in improving his work, he'll only be too glad to cooperate with you. As an engineer you can get ideas and formulate improvements, but you must be a politician and a diplomat to put your plan into practice.

TURBO SUPERCHARGERS

by Lyle L. Arnes, me'43

IN MANY of the nationally distributed magazines now in circulation there recently appeared an advertisement that asked the question, "How high is 'up'?" In aviation parlance, "up" is the maximum altitude at which an airplane can fly. During the last few years this has been steadily increasing; engines have been, and are being built to carry heavier-than-air craft higher and higher into the atmosphere. This recent, and very marked improvement in aircraft and aircraft engines is, of course, due to the second World War. The present conflict brought with it the realization that bombers and fighter planes are essential to victory, and that the nation possessing planes tha can fly higher, faster, and farther than those of the opposition has a distinct advantage. As evidence of the mounting importance of military air power, one has only to look at the bomb-shattered wreckage of the fortress of Pantelleria, in the Mediterranean Sea. This island was taken by the Allies through air power **alone**; not a solitary allied soldier set foot on its soil until **after** it capitulated.

The problem of designing an engine that would carry tons of steel and explosives high into the air was not an easy one, and the obstacles encountered can not be appreciated without an understanding of the atmosphere, and its components, the troposphere and the adjacent limitless stratosphere. Many people are not aware of the fact that air has weight just as other more "distinct" and clearly outlined substances such as a chair, or automobile, etc The weight, or mass density of air is a variable quantity, however, depending on its temperature and the pressure acting upon it. At increasing distances above the earth's surface both the temperature and the pressure are decreasing, and the density of the air becomes less. This decrease in temperature with altitude continues until the temperature has been reduced to about minus 72 degrees Fahrenheit; then no further decrease in temperature occurs with increased altitude. The altitude above which the temperature of the air is constant is called the tropopause; the space below this altitude is the troposphere, and the space above is referred to as the stratosphere. The altitude of the tropopause is about 38,000 feet over the United States.

The pressure acting on a unit area of air is equal to the weight of the air "piled" on top of it. Obviously, at high altitudes the pressure is less than at lower altitudes, and cubic foot of high-altitude air weighs much less than a cubic foot of sea-level air. Mountain climbers are we aware of this; the slightest exertion causes them to accelerate their breathing in an effort to regain their breath. Their lungs have to work at an increased rate in order to supply their bodies the oxygen they need.

Gasoline engines, like human beings, require oxygen to function; and, like human beings, they must have a minimum amount of oxygen to function most efficiently. It is rarely appreciated that a powerplant consumes a quantity of air approximately equal to five times its own weight, for every hour of operation. As an airplane rises higher and higher, the engine experiences the same difficulty as the mountain climbers. It has trouble getting enough oxygen. The power produced by an engine depends primarily upon the quantity of fuel that can be burned in the cylinders in a given period of time. The maximum amount of fuel that can be burned is dependent upon the amount of available oxygen, which, in turn, is a function of the density of the air. It must be understood that a given quantity of fuel combines, chemically, with a **definite** amount of oxygen. If the oxygen supply is limited the fuel consumption is limited, and, therefore, the output of the engine is limited. At an altitude of 25,000 feet, the power loss, due to the rarefaction of the air, may be as much as 50%. The obvious remedy for this condition is to get more air into the cylinders by some means or another. Hence the supercharger.

The main element of a supercharger is nothing more than a centrifugal air compressor, which is a machine designed to increase the pressure of compressible fluids by means of a high-speed wheel called an impeller, succeeded by a diffuser which has passages designed to convert velocity head into pressure head. The impeller imparts a high velocity to the fluid and the diffuser changes the velocity to a pressure. Since the impeller rotates at high speed, the impeller blade angles, diffuser passages and other items must be designed with great care so that the high-speed flow is handled without shock or energy losses.

During the first World War when enemy planes frequently engaged in rough and tumble "dog fights" high in the sky the value of a supercharged engine was realized. At altitudes that were considered great at that time the planes were sluggish and lacked maneuverability due to the reduced power developed by the engine. That a supercharged engine could fly circles around an unsupercharged one at such altitudes became the general consensus of opinion and resulted in the birth of aviation supercharging. It was obvious to the first World War

That's not an ant hill below the port wing of this Fortress. That's a mountain.

aviation experts that the centrifugal compressor could be operated either of two ways; the impeller could be driven off the crankshaft through an appropriate gear train or it could be made to rotate by direct-connecting it to an exhaust turbine. Due to turbine design difficulties the gear-driven supercharger, initially, looked more promising.

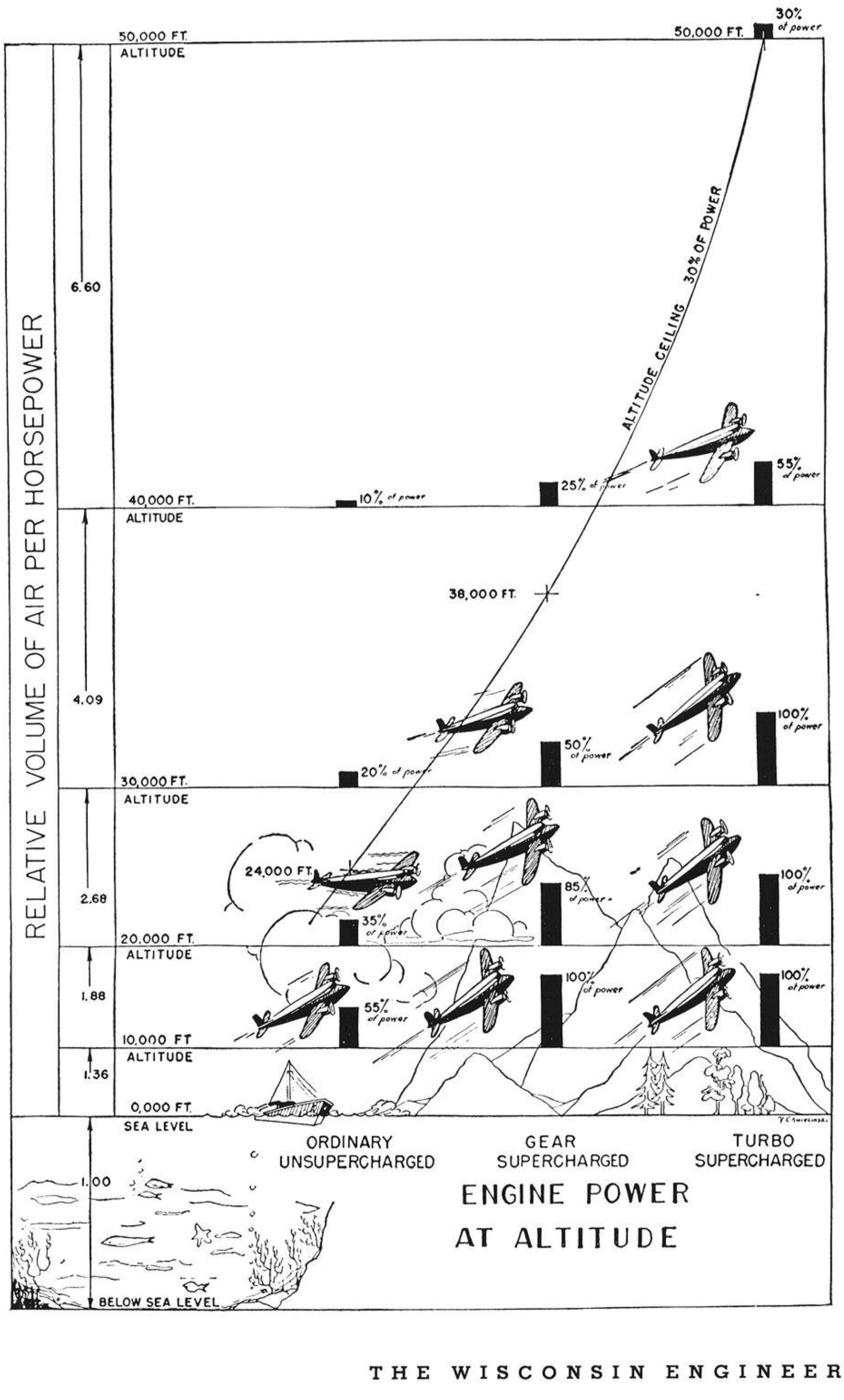
The first geared superchargers were driven from the ends of in-line engine crankshafts. During the power strokes the rotational speeds of crankshafts is somewhat greater than the **mean** rotational speed, so that "whipping" or torsional vibration occurs. Since the supercharger impeller rotates at a terrific speed, it has a very large inertia and large forces are needed to make it follow the accelerations of a whipping shaft. Initially, therefore, many failures occurred but eventually a number of methods were devised for making the crankshafts more flexible and today geared superchargers can be driven very successfully from the ends of in-line engine crankshafts.

The amount of supercharging at the outset was very small, the primary purpose was to improve the fuel-air mixture and to maintain sea level power at **moderate** altitudes. Since these superchargers were driven off the crankshaft it is obvious that the degree of supercharging at any moment depended on the speed of the engine. At take off (at low altitudes) little, if any, supercharging was needed so that the supercharger power was wasted. However, any supercharger added to an engine to give it sea level power at altitude, permits of "ground boost" so that the power developed at sea level can be increased when needed. In the early days, over-zealous pilots sometimes couldn't resist the urge to supercharge their engines at sea level; as a result, many engines were damaged before the pilots learned to hold themselves in.

The rotational speed of the geared impeller is a function of the speed of the engine and the gear ratio between the impeller and the crankshaft. The greater the rotative speed for any given diameter of impeller, the greater the supercharging effect. From this it is apparent that a supercharger can be designed to restore sea level power at any altitude within reason simply by changing the gear ratio, or the diameter of the impeller. The greater the altitude designed for, however, the greater the waste of power at sea level when little of the available supercharging is needed. These considerations led to the development of the multiple speed geared supercharger that is in common use today. It was apparent that a supercharger that could automatically vary its speed, and thus the supercharging effect, with variations in altitude would be the ideal mechanism. Then there would be no power loss at low altitudes, and the supercharging needed at high altitudes would be available. With this consideration in mind, a few of the more far-sighted European aviation enthusiasts decided that turbine driven supercharging units had far greater possibilities, so they rolled up their sleeves and went to work on it.

In 1917 the French engineer Auguste Rateau installed a turbosupercharger in an aviation engine and tested it atop a mountain peak in France. The results of the tests were encouraging, to say the least. By means of the World War I system of interchange of information between the Allies, the plan was communicated to the National Advisory Committee of Aeronautics, and Dr. William F. Durand, chairman of the N.A.C.A., introduced the idea to the United States. At that time, as today, the General Electric Company had a large business in steam turbines and centrifugal compressors, and a certain Dr. Sanford A. Moss, who was far more than candidly acquainted with turbine principles; so the idea was turned over to Dr. Moss and the General Electric Company for further development.

As stated before, the turbosupercharger consists of two main elements, a turbine and a centrifugal compressor, with their rotating elements mounted on a common shaft. The turbine is driven by the exhaust gases from the engine; the gases are led from the cylinders into the exhaust manifold, so arranged that there is maintained within it practically sea-level pressure at all altitudes. The exhaust manifold discharges into a nozzle box which has openings, or nozzles, exactly like those of a steam turbine. The pressure within the nozzle box is the same as that within the exhaust manifold and the pressure outside the nozzle box is the low pressure at altitude. This pressure differential causes the exhaust gases to flow, at high velocity, through the nozzles and against the vanes or buckets of the turbine wheel. The action of the gases causes the turbine to revolve at a velocity dependent on the pressure differential. Since the turbine and the compressor are mounted on the same shaft, they rotate at the same speed. Therefore, the higher the plane flies, the faster the centrifugal compressor operates, thus making it possible to compress the increasingly rarefied air to sea level pressure. It doesn't follow that a turbosupercharged engine can carry a plane to an infinite altitude, however; there is a critical altitude beyond which the turbo is incapable of supplying air at



sea level pressure. At the present this critical altitude is in the neighborhood of 30,000 feet; at altitudes greater than this the power drops off until about 30% of sea level power remains at an altitude of 50,000 feet.

In August, 1918, Dr. Moss, his assistant, Waverly Reeves, and five army men loaded a turbosupercharged Liberty motor on a truck and hauled it to the top of Pike's Peak. At an altitude of 14,109 feet the engine developed 230 horsepower without the turbo and 356 horsepower with it. The same Liberty engine developed 350 horsepower at Dayton, Ohio, before it was taken to Pike's Peak. The success of the test added impetus to their efforts but the armistice was signed soon after the experiment and all war projects came to a sudden halt. The turbo looked like too good a thing to neglect, however, just because there wasn't any immediate use for it along military lines, so a period of development followed. Before long it was noted that in compressing rarefied air to sea-level pressure, the increase in temperature was so great that it could not be overlooked or neglected. Remember that air, or any other gas under a constant pressure, increases in volume as its temperature increases. As stated before, it is the **weight** of air that can be drawn into a cylinder that is important, and hot air weighs much less per cubic foot than does cold air. Therefore, since a cylinder can contain only a certain **volume** of air it is desirable that this air be at a low temperature. This observation resulted in the installation of an air cooler between the compressor and the intake manifold, which has remained an essential part of the equipment ever since. The air cooler, obviously, must be located so that a stream of low temperature air may be directed over it; similarly, the compressor intake must be in an air stream and facing in the direction of flight so that the incoming air will have a "ramming" effect. These pieces of equipment cause disturbances in the air stream and thus increase the drag; in the early days of relative low-speed planes drag wasn't given the consideration that it commands today, but as faster planes were developed the cooler and compressor intake were streamlined accordingly so that at the present time they offer very little resistance to flight.

The early flights were all made with the water cooled Liberty engine, and at high altitudes the normal operating temperature of the engine was above the boiling point of the water and it rapidly evaporated. This necessitated the development of a sealed cooling system, but later this was superseded by the advent of air cooled engines and the "boiling" problem no longer existed. However, there still remained a variety of obstacles to be hurdled; for instance, the aerodynamic design of planes using supercharged engines had to be altered. The principles involved are slightly different at high altitudes and unless a plane is designed for such heights, flight is not efficient.

In those days variable pitch propellers were unknown; there wasn't any need for them. As an unsupercharged plane gained altitude the power decreased at the same rate as the resistance to the motion of the propeller so that the engine operated at approximately the same speed at all altitudes. But with a supercharger that maintained sea-level power at altitude, the decrease in density of the air tended to cause a marked increase in engine and propeller speed. Obviously something had to be done or the engine would be turning over at a terrific speed and the plane would be getting "nowhere, but fast." At first propellers of very large diameter were developed in order to keep the engine speed at a reasonable rate at altitude. Some engineers predicted that in a plane with a turbosupercharger, a propeller of properly large diameter for altitude performance would so lower the engine speed at sea level that the plane would never be able to take off from the air field. With such a black future staring the pioneers in the face, they went into a huddle and came up with the variable and controllable pitch propellers that are finding such widespread use at the present.

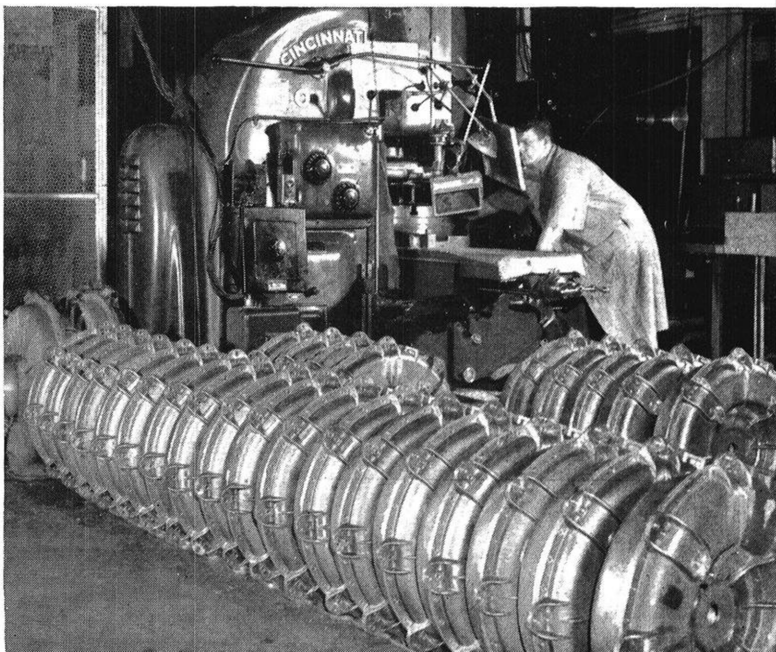
Not the least of the early supercharging problems was that of finding a metal or combination of metals that could withstand the terrific punishment meted out to the rotating element of the turbine. Turbine wheels revolve at a speed of 20,000 to 30,000 revolutions per minute, and the gases actuating them are at a temperature of 1200 to 1500 degrees Fahrenheit. The centrifugal forces acting on the turbine wheel sometimes reach the astounding figure of **70,000** times the weight of the wheel. When it is considered that the buckets are red hot when they are subjected to this stress, it is no wonder that the metallurgists had a rather rough time developing a material that would work. They rose to the occasion admirably, however, and modern turbine wheels (usually a heat treated forging of aluminum alloy) are very satisfactory.

Today the world is again engaged in a fierce, bloody battle that is making the first World War of twenty-five years ago look like a nice, quiet game of chess. The philosophy of war has suffered a marked change since Der Fuehrer introduced his Luftwaffe and Wermacht to the rest of the world. The rules have changed and the artillery and infantry units that played the major part of the first war have been relegated to second and third place.

The invasion of Hitler's "European Fortress" began a short time ago with the invasion of Sicily and Italy. Military tacticians generally agree that "knocking out" this

(turn to page 20, please)

Supercharger Casings



This is the first of a series of articles on our faculty members whose biographies are found in "Who's Who in Engineering." Many are also in "Who's Who in America."

PROFS IN

F. ELLIS JOHNSON

The dean of our college was born at LeRoy, Michigan, on May 27, 1885. He received his A.B. in 1906, and E.E. in 1909, both at U. W. Along the way, he picked up membership in Tau Beta Pi, Eta Kappa Nu, Phi Kappa Phi, and Sigma Xi. The year after graduation, in 1910, he was married in Seattle, Washington, to a Madison girl. (My gosh, how that fellow did get around.) He has four children, Ellis, Margaret, Florence and Helen.

While in school, he engaged in many extra-curricular activities. He's one of the few engineers to get a major letter, and got it on the crew. He worked on the first student council. Also, he received an honor that is no longer given. He was an Iron Cross man. Look at the row of crosses in the Union, near the Rathskeller, and on the one for 1906, you'll see Dean Johnson's name.

After graduation, until 1912, he worked on power plant construction in Washington and British Columbia. In 1912 he entered teaching, this time at Rice Institute at Houston, Texas. In 1915 he travelled to Kansas and stayed for 15 years when the wanderlust hit him again and he resigned as head of the E.E. department to take the parallel job at Iowa State. In 1935, he went to Missouri to become Dean of Engineering.

Wisconsin's Dean Turneaure retired in 1937, and the next year the regents asked Dean Johnson to come here. Although Missouri had a good college and was just in the process of rebuilding, the call of his Alma Mater was too strong to resist and he has been here ever since.

That is something for the students to note, by the way. No matter how sick of school one gets when attending, after you're out, the urge comes to get back.

•

L. F. VAN HAGAN

L. F. Van Hagan, better known as Van to the civils he rules, was born in the metropolis of Chicago on September 13, 1878. (Too bad the magazine wasn't out a little earlier this month.)

He came to the University of Wisconsin to study civil engineering and got his Bachelor of Science degree in 1904. Later, he returned and got his professional C.E. degree in 1919. He picked up a Tau Beta Pi key along the way.

For one year after graduation, he taught drawing. But in 1905 he became engineer for the Interoceanic Railway of Mexico.

In 1907, he became assistant engineer of maintenance of ways for the National Lines of Mexico. This job turned out to be exciting because one of Mexico's perennial revolutions started in 1910. Madeiro and Pancho Villa decided they didn't care for the government's railroads so they proceeded to burn down bridges as fast as Van could put them up.

In the meantime, Van had been married and became a papa. So, when the shooting started, he proceeded to get his family out. He started to take them on the Mexico Central, only to find that the rebels took it first and it wasn't operating very well any more.

Finally, he got Mrs. Van and the baby to Milwaukee, and then he returned to Mexico. (Never knows when he's had enough.)

Back in Mexico, he returned to his bridge building. While constructing a bridge across a gulf, some people came from a village within sight of where they were working, to report that the rebels had taken over the town and had the mayor and council locked up. At the moment, they were recruiting men in the village to come down to burn the bridge, and incidentally to slaughter any government workers they came upon. Needless to say, the bridge was completed in record time.

On his way back to Mexico City, he was informed that everyone at the farmhouse where he'd just stayed, had been massacred.

When Van returned to Milwaukee, he received an offer from Wisconsin and one from Iowa, to teach. He took the one from his Alma Mater, planning only a short stay, This month the interviews and articles are by Don Niles, but starting in November, they will be taken over by Harold May. Here goes—

WHO'S WHO

this in 1911. In 1913 he became head of the railway engineering department and chairman of the civil engineering committee. He stayed at this post until 1931 when the college was reorganized into the present five departments, at which time he became head of the civil engineering department.

He's still going strong.

•

GUSTAF LARSON

Better known as Gus (but not to his face unless you're a senior) this ruddy-faced individual has a bad bark, but he can chew your arm for hours without breaking the skin.

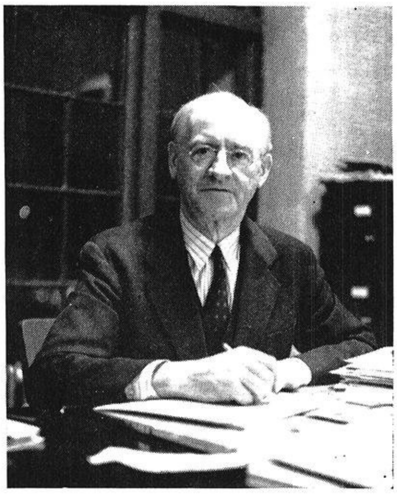
Gus was born in Sweden on June 30, 1881. After coming to the United States, he went to the University of Idaho (the home of the spud) where he received his E.E. in 1907. Then he came to Wisconsin where he earned his M.E. in 1915.

He went out for athletics at Idaho a bit, in fact, in track he engaged in some of the lighter activities like shot put, hammer throw, etc., was on the football team which won the Northwestern Championship in 1905, and was elected captain in 1906.

Among his honors can be found Phi Delta Theta, Sigma Xi, Tau Beta Pi, and Pi Tau Sigma. He was national president of Pi Tau Sigma from 1926-1929. Phi Kappa Phi and Gamma Alpha are also on the list.

He took the fatal plunge in 1915, and has two children, Dorothy and Foster.

From 1907-1909 he worked as test engineer for General Electric. From



here he went to Idaho as professor of mechanical engineering and manager of athletics. In 1914 he came to Wisconsin, as assistant professor of Steam and Gas, although he did not think our hills were high enough at first. He became an associate professor one year later and professor in 1920. At the same time he became head of the mechanical engineering department and stayed until he retired the chairmanship in 1942. He still has plenty of good years left as prof. (Don't let the pun tire you.)

He was a member of the Advisory Committee of the 12th National Mechanical Engineering and Power Exposition, chairman of the Rock River Valley section of A. S. M. E. in 1940 and has been on the Wisconsin Athletic Council.

He's never grown tired of sports and his present chief hobbies are camping, fishing, and golf.

•

JOSEPH OESTERLE

Known as Joe to the mining and mets, Joe Oesterle is the burly fellow with the black mustache who scares everyone silly at first meeting, only to come away with the idea that Joe is a real fellow.

He was born in Philadelphia (no wonder he's in mining and met) on October 18, 1888. He, too, came to Wisconsin where he received his B.S. in 1913, and, returning, took his Ph.D. in 1929. Alpha Chi Sigma, Gamma Alpha, Sigma Xi, and Alpha Phi Omega all boast his membership.

After graduation he worked as metallurgist for the Pennsylvania Railroad until 1916 when he went to work for the Illinois Steel Company. In 1918, he joined the Army and served as sergeant in the Chemical Warfare Service Bureau of Standards for a year.

He left the Bureau of Standards in 1921 to become assistant professor of metallurgical engineering. The next year he was married, and according to latest reports, there are five young Oesterles, David, Joseph, Ellen, John and Mary.

When he first came here, he worked on research on blast furnace slag and sulphur solubility and viscosity.

Joe has been president of the Milwaukee chapter of the A.S.M., was on the engineering education committee of the American Foundryman's Association, and chairman of the same committee in the A.I.M.E. (argue for yourself as to whether the M is mining or metallurgy—actually it stands for both).

At present, he is working on armor-piercing shot.

Watch out, Adolf!

A New Field for Engineers

Especially with these high power transmission lines which cover great distances . . . the spacing can make or break a contractor.

ELECTRICAL CONTRACTING

by Tom Jepson, ee'44

CONTRACTING today is a firmly established profession and as a profession has developed its own specialized branches. The day of the "General Contractor," as such, is waning; today such a company is a more or less supervisory organization which gathers together a "staff" of specialized contracting firms, such as plumbing, heating and ventilating, earth removal, concrete, and electrical. Each firm deals with the purchaser while the general contractor coordinates the activities of each, i.e., calls each one to the job as his particular work can be done to the best advantage. Thus the general contractor would call the electricians before the plasterers, the carpenters before the painters, and so on.

This article will confine itself to the electrical contractor, his organization, and his need for engineering ability besides the usual qualifications of a successful businessman.

The place of an electrical engineer in such work may perhaps be the difference between profit and loss to the contracting firm. When employed by such a concern he is expected to thoroughly familiarize himself with the plans and specifications of the work to be done, to check these plans for sound engineering practice, and, if possible, to recommend changes which will benefit both his employer and the purchaser.

For example, in a large construction job near Madison it was necessary to construct three phase feeders from the main power lines to the distributing station of the plant. This necessitated a pole line of about two miles. In the original specifications the sag specified would have permitted dangerous conditions, such as possible short circuit in high winds or heavy strain on the bell insulators in case of ice formation. The engineer with the contracting firm called attention to this and recommended a reduction in sag. The design engineers in charge refused to change, but when the job was completed their error could be noticed by even the inexperienced. The purchaser was required to have the entire line resagged at an additional cost of about 10%. Thus the engineer of a contracting firm must be constantly on the alert for such errors, and must try to correct them with diplomacy and tact. This is a crucial test of a contracting engineer. There is no other business in which the good feeling and cooperation of purchaser and contractor means so much.

The technical ability of the contractor will gather him as much good will as his ability to complete his contract to the letter. Thus in installation work in a plant already in operation he may be able to suggest methods whereby little or no increase in feeder size will be required. In an older factory with a heavy motor load, additional motor HP without feeder size change may sometimes be obtained by correcting the power factor of the load. Here the purchaser saves a great expense and the contractor will gain immeasurable good will.

The electrification of large industrial plants is the primary field of which I'm speaking. In such work a surprising amount of the installation layout, specifications, and design is left to the electrical contractor. His suggestions for changes to either improve or reduce the cost of the installation are, in most cases, gratefully received. Thus the contractor builds his reputation and as a consequence is often given jobs outright with no other bids being asked.

For instance, on a large construction job where several electrical contractors were working it was found that the design and layout of the feeders from the substation to the main switchgear had not been made. One electrical contractor, because of the quality of work he had been doing and the ingenuity he had used, was given the job of layout, design, and installation of these feeders without the formality of a bid. Thus a contractor with engineering ability and ingenuity has a great advantage over those who have merely grown up with the business. Electrification of industrial plants does provide an opportunity for use of engineering ability. Many engineering schools of today are offering courses to the student electrical engineer which give him some insight to the problems of contracting work.

Estimating the cost of the job for bidding is perhaps the most important duty of the engineer in the contracting firm. This, of course, requires many years of work with an experienced man plus actual experience with the tools. Material prices must be negotiated before the materials are actually bought and labor costs of installation must be accurately determined, all depending on the locale, the temperament of labor in that locale, and past experience with the type of work involved.

(turn to page 24, please)

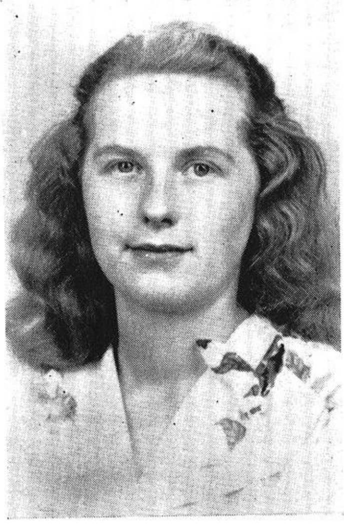
THE GALS
ENGINEERING

Last spring, a representative of the Pratt and Whitney Aircraft Engine Corporation, East Hartford, Connecticut, came to the midwest with some very attractive fellowships.

These fellowships were to be offered to juniors, seniors, or recent graduates, and were marked "For Women Only." For the course, which would last approximately twelve months, the girls would receive their tuition, and $1223 to cover room, board, books and incidentals.

Nine Wisconsin coeds were finally selected and enrolled for special

Janet Edwards



Genevieve Sherwin

JANET EDWARDS

Janet Edwards is a resident of Madison. She attended East High School before coming to the University.

Before accepting the Pratt and Whitney offer, Janet was a junior at the University, and was enrolled in chemistry. She belongs to Chi Omega, social sorority, and Sigma Epsilon Sigma, freshman girls' honorary society.

Her course is enough to make any of you engineers stand back in respect. She has organic lab (chemistry 121B), math 110, physics 118, M.E. 70 (steam and gas lab), mechanical drawing, and is working on her thesis. Out of that list, Janet prefers working on her thesis, and would be glad to dispense with math entirely.

Mechanical drawing is taken along with freshman engineers, who probably don't object at all to have their sacred precincts invaded by the "weaker sex." For her part, Janet thinks the men are "quite all right."

After the war, Janet's plans include returning to the field of chemistry, rather than remaining in engineering. At any rate, she advises that "You'd better stay out of planes after next year."

•

GENEVIEVE SHERWIN

Here's a girl who is a long way from home, since "home" refers to a ranch 18 miles outside Sterling, Colorado.

She attended high school in Sterling, where, as might be expected, her favorite activities dealt with the "great-out-of-doors," and included riflery and riding. She is also fond of dancing and music, and played in the high school band.

Genevieve came east to go to Lindenwood College in Missouri, and she spent her freshman year at this girls' school. As a sophomore, she came to Wisconsin and enrolled in the College of Engineering, intending to become a chemical engineer. Later that year, she enrolled in the Letters and Science School, as a math major, and in her junior year, came back to the occupation of engineering, by accepting the Pratt and Whitney course, even though still in the L. and S. school. She'll graduate next June with a school of education, math major, degree.

Genevieve's main activities here include sports, dating, and, "last but certainly not least," flying. She is learning to be a pilot out at a Madison airport. She flies a TaylorCraft and hopes to have her pilot's license by December. Right now, she's a member of the Civil Air Patrol, and would like very much to continue that work. Just in case Pratt and Whitney should decide not to keep the girls she'd like to join the Ferry Command.

The Pratt and Whitney offer seemed just about ideal to Genevieve, to help the war to a speedier finish. She also has a pretty important personal reason—her fiancee, a pilot, has been reported "missing in action" since last spring. And who knows but that Genevieve's building planes may in some way help bring him back again.

After the war, Genevieve doesn't intend to keep on in industry. Instead, when that flier comes back, she'd like "To keep house and have a dozen kids."

•

JANE MORRIS

Jane calls Madison "home" now, but also has lived in Arkansas and West Virginia, before her family settled down here.

She attended West High School here in Madison, worked on the paper and annual, and was a memcourses fitting them to be assistants to engineers in the aircraft engine plant.

At the end of this semester, the girls will travel to East Hartford to get acquainted with the general layout and atmosphere of the plant. All expenses on this trip will be paid by the company.

This article also deals with two other exceptional Wisconsin coeds. These are two girl engineers, both sophomores, and one enrolled in mechanical engineering and the other in electrical. These girls are enrolled for the regular four-year course.

Jane Morris

Genevieve Sewall

ber of the English club, besides singing in the chorus.

Jane already has received her degree in English education. Consequently, to fulfill the Pratt and Whitney requirements, she's taking almost all freshman courses. These include physics, math, chemistry, mechanical drawing, and steam and gas lab (which Jane, along with all the rest of the Pratt and Whitney girls, calls mechanical lab). Chemistry is her favorite subject, and she likes physics least.

Student activities took up a good deal of Jane's time while she was at the U. She is a member of the Local Students' Association, Sigma Epsilon Sigma, Pi Lambda Theta, and the Y. W. C. A. She also spent a good deal of time in student work at St. Andrew's Episcopal church.

Jane has a special reason for accepting the Pratt and Whitney offer. She tried to join the Waves but both height and eyesight requirements were against her. This Pratt and Whitney offer seemed the next best way of helping end the war in a hurry—so Jane is becoming a lady engineer.

Her plans for after the war are not yet definite. She rather thinks the aircraft industry will have to get along without her, as she'd like to apply her English training in writing. Have you considered "How to Become an Engineer in 37 Not-So-Easy Lessons" for the title of your first book, Jane?

•

GENEVIEVE SEWALL

Genevieve is a representative of the city of Racine. She attended high school there with not the slightest inclination toward engineering. She didn't even take any physics or chemistry, although she did manage quite a lot of math, and stuck mainly to language and business subjects.

While attending the University, where she majored in Spanish, Genevieve found time for quite a few outside activities. She was a member of Dolphin Club (the girls' swimming club), Hoofers, Badger, Freshman Orientation, Sigma Delpha Pi, and Alpha Chi Omega. Incidentally, Dolphin club played water polo with the boys' swimming club. (Applicants for boys' swimming club form three lines around the M.E. building.)

Genevieve received her B.A. degree in Spanish last June. After looking around for a job using her Spanish, she came to the conclusion that none were to be found. She still wanted to get into war work, so she snapped up the Pratt and Whitney offer. This job will hold her for the duration, but she hopes to be able to combine it with her Spanish after the war.

When asked the $64 question as to what she thinks of engineers, she wasn't flustered at all. It seems her father is an engineer, and she's been going with a senior M.E. for some time (no names mentioned). Genevieve says she now realizes why engineers have comparatively little time for dating—figure that one out for yourselves.

•

ROMAYNE O'DAY

Romayne is another Pratt and Whitney recruit hailing from the fair city of Racine. She's a journalism student who wandered astray (in the L. and S. sense of the word, of course). With the completion of her Pratt and Whitney course in June, she'll receive her degree in physical science.

Her subjects include chemistry, physics, steam and gas lab, and me-

(turn to page 22, please)

INVADE THE SCHOOL

by Lou Niles

ALUMNI NOTES

by Charles Tomlinson ch'44

Civils

ALVORD, JOHN WATSON, honorary degree in 1913, passed away July 31, 1943. In his early life he did extensive sewer, water works, and street pavement construction in Chicago and suburbs. Mr. Alvord traveled, and studied sanitary problems, in England, France, Germany, Italy, and Austria in 1888, and again in 1894. He was a consulting engineer in the latter part of his life. He was the inventor of a deep, well balanced centrifugal pump, and the author of several papers on floods, sewage plants, and valuations.

DRIESSEN, THOMAS A., '41, is in training with the Sea Bees at Camp Peary, Va.

LAIRD, CARLTON W., '40, is an engineer on special assignments in methods and standards for the U. S. Rubber Co. in Milwaukee.

NERO, ENSIGN MILTON A., '42, announced the arrival of a daughter, Nancee Jean, on June 2. He is in the Sea Bees at Camp Peary, Va.

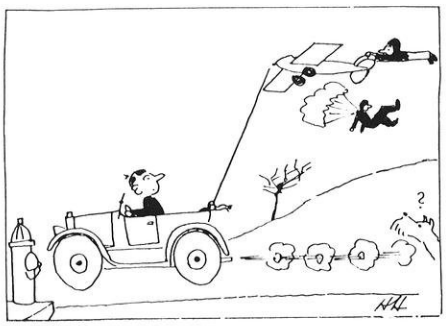
NERODA, EDWARD K., '35, a lieutenant in the Civil Engineer Corps, USNR, is public works officer at the Naval Air Station, at Dallas, Texas.

OTIS, EDWARD N., '24, engineer with the Chicago Sanitary District, died suddenly at his home on May 24.

POLLACK, MAX, '41, is reported to be an ensign in training at Camp Peary, Va.

SANDNER, ENSIGN FRANK K., '42, was married on June 20 to Mary Ellen Rudesill of Madison.

SMALL, ALVAN L., '40, has been commissioned a lieutenant (jg) in the USNR. He will be in the special devices section of the Bureau of Aeronautics.



SPICKERMANN, JOHN C., '42, is reported to be an ensign in training at Camp Peary, Va.

SODEMANN, PAUL F., '42, who is with TVA, was married on June 1 to Elizabeth Francis of Madison.

Mechanicals

DORMAN, 1st LT. CLIFFORD W., '42, sent the following letter to Prof. Joseph F. Oesterle, Dept. of Min. and Met.:

"Dear Prof. Oesterle,

A few days ago I received your letter of May 31. While I still have the opportunity I thought I might tell you a few of the experiences I've had in the Tunisian campaign. Our regiment are the corps engineers (combat) for 2nd Corps and acted in that capacity throughout this African campaign. We landed near Oran on the afternoon of Nov. 8th! After about a week in this area we moved to Sidi Rel Abbes where we guarded communication lines and rail roads until Jan. 1, at which time we moved 700 miles east to a point east of Tebessa, Tunisia. My company worked on roads between Telepa and Kasserine for a few weeks and then moved north to work on a road near Faid Pass. The night before the Germans broke through this pass we moved back to Kasserine and then into Kasserine Pass where we laid mine fields for 2 days and nights and set up defensive positions. Before the big tank battle, our regiment and our infantry outfit fought the Germans for three days in the post before they broke through the pass. This was about the middle of February just before the drive on Gafsa. In March my company put in a 40 mile road in three days. Later we moved to a place between Gafsa and Moknasey where we picked up many thousands of enemy mines. We believe our company holds the record for picking up the largest enemy mine field during these operations. Later we moved north to Baya and put in the road which the 1st Armored Division used when they hit Mateur. More mines in this area to pick up. That's the story briefly. We've learned a lot; of course, we had to pay for our experiences, and dearly sometimes. But that's modern war. I hope this letter finds you well. I know you must be very busy. Wish I were back on the old campus. Those were the days!

Sincerely,

Cliff"

Electricals

BONCYK, CLARENCE J., is now a first lieutenant, serving as an engineering officer in a Bombardment Squadron in North Africa.

MAXFIELD, DR. F. A., '29, who is on leave from the E.E. Dept., is busy at the Naval Ordnance Laboratory, Washington, D. C.

GARLOCK, ROBERT G., '29, is Asst. Electrical Engineer for Underwriters Laboratories, Inc., Chicago, Ill. He reports that he has instructed several ESMWT courses during the last year and one-half at Harvey, Ill. He visited the UW campus on July 9, 1943.

Chemicals

BAMBAS, LOUIS, '32, of Grosse Point Woods, Michigan, announces that he has developed a compound that is now being tried clinically. The details of the disease, the compound, and the results could not be given out.

BRANDLHOFER, AL, '32, has had a change in occupation from Merk & Co. (pharmaceutical manufacturers) to the Rubber Reserve Corporation. He now lives in Westfield, N. J.

JUSTL, OTTO, '32, was married May 29. His fiancee is a graduate of the Appleton High School and the Illinois Normal University.

MARTER, DICK, '32, is now the Superintendent of the O'Niel Duro Co. in Milwaukee, Wisconsin. Having started out in that company after graduation, he switched to the Cook Paint and Varnish Co. in Kansas City, Mo., in 1935 and after a few years returned to O'Niel Duro.

WALTERS, ROY H., MS '34, has been appointed director of engineering research for General Foods Central Laboratories. He has worked on chemical projects since he joined General Foods in 1934.

STATIC . . .

by Gene Daniels, c'45

The devil sat by the Lake of Fire
On a pile of sulphur kegs;
His head was bowed upon his breast,
His tail between his legs.
A look of shame was on his face,
The sparks dripped from his eyes;
He had sent his resignation to the throne up in the sky.

"I'm down and out," the devil said,
He said it with a sob;
"There are others that outclass me;
And I want to quit my job.

"Hell isn't in it with the land
That lies along the Rhine;
I'm just a 'has been' and a 'piker',
And therefore I resign.

"The ammunition slingers
With their bloody shot and shell,
Know more about damnation
Than all the imps of hell.

"Give my job to Adolf Hitler,
And the army of the Rhine.
Goering or Goebbels
Or some such child of mine.

"I hate to leave the old home,
The spot I love so well;
But I feel I'm not up to date
In the art of running Hell."

•

Jacobson: "What is the difference between an accountant and an engineer?"

Niles: "An engineer is a damn fool running around with a slide rule whereas an accountant doesn't own a slide rule."

•

Cursing and yelling on a London street was Clancy holding a doorknob in his fist. "Them damn Nazis will pay for this—blowin' a saloon right out of me hand."

•

"Where in hell have I seen you before?"

"I don't know. What part of hell are you from?"

•

Woerpel: "Friske, don't you know that drinking will ruin your stomach?"

Friske: "So what? I always keep my coat buttoned."

•

Wish the editor would let us tell that dirty joke.

The little old woman bent over the cherub in the cradle. "Ooh, ooh! You look so sweet I could eat you."

Baby: "The hell you could. You haven't any teeth."

•

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

"Gosh, yes, tell me a couple."

•

I had a bunny,
His name was Jim.
Got sixteen now,
Her were no him.

•

THEME SONGS FOR THE VARIOUS KINDS OF ENGINEERS

Chemical
Iodine Know Why
Amino Cow Hand

Mechanical
Motor on Monday
Machines to Me I've Heard That Song Before

Civil
Structure Gigolo
I Was Cement for You
On the Sewerage Mountains of Virginia

Electrical
Down by the Old Milliamp Stream
Ohm, My Resistance Is Low
Watts Ammeter with Father?

M&ME
Vein the Moon Comes Over the Mountain
Well Ore Right!

•

Still wish the editor would let us tell that dirty joke.

•

"When I was a little child," said the sergeant sweetly, addressing the men at the end of an exhaustive hour of drill, "I had a set of wooden soldiers. There was a poor little boy in the neighborhood, and after I had been to Sunday School one day listening to a stirring talk on the beauties of charity, I was soft enough to give them to him. Then I wanted them back and cried, but mother said:

" 'Don't cry, Bertie. Some day you'll get your wooden soldiers back.'

"And, believe me, you lopsided, mutton-headed, goofus-brained set of certified rolling pins, that day has come!"

(turn to page 26, you mug)

TURBOSUPERCHARGERS . . .

(continued from page 9)

fortress will require tremendous offensive power **plus** plenty of time. From the north the allies have already given the enemy a taste of allied offensive power, and the effect of frequent daylight high-altitude bombings are beginning to tell. The allied strategy centers around the obvious truth that it is far less costly and laborious to destroy an industrial plant than it is to destroy the machines of war that the plant produces. The allies are concentrating their efforts on smashing vital industries, railway stations, power plants, etc., with an eye to reducing the fortress to such a chaotic state that ground units can break through the enemies front lines with the least loss of life and equipment.

All nations are struggling to make warfare at high altitudes, but so far as is known, the airplanes of the United States are the only ones equipped with turbosuperchargers. Practically all military planes of any nation are supercharged, but their geared mechanism is no match for the American turbo. It seems strange that other countries should have overlooked its possibilities; they certainly had every opportunity to develop it. Possibly the answer lies in the now outmoded belief that the battle of the air would be won by increase of power, speed, armor and guns, without particular attention to performance at altitude. The world knows now that power at altitude is necessary to keep out of range of rapidly improving anti-aircraft fire, to battle successfully with the enemy by having better performance at altitude than he has, and to attack without warning from altitudes where the planes are unseen and almost inaudible to persons on the ground. At any rate, the situation was aptly worded by a prominent aviation expert of another country when he stated that his country had "missed the boat."

The Flying Fortress is a highly publicized four-engined bomber manufactured by the Boeing Aircraft Company of Seattle, Washington. During the early part of the war a squadron of these turbosupercharged Fortresses was sent to England. The first use of a turbo in war was reported by the British Air Ministry as follows:

> "On July 24, 1942, the bomber command made the heaviest daylight attack since the war began (on the German battleships SCHARNHORST and GNEISENAU at La Pallice, south of Brest, France) . . . New tactics of aerial warfare played an all important part . . . The spearhead was a formation of Flying Fortresses. These great four-engined bombers arrived at a fantastic height, scarcely visible and certainly inaudible to anyone on the ground. In all probability, the scream of their bombs was the first sign that the Boeings were there."

By 1941, the Lockheed P-38 and the Republic P-47, interceptor pursuit ships, were being equipped with turbosuperchargers, and production of them was increased astronomically. It took some time for the radically new P-38 to prove its worth; it was regarded as something of a "flop" until it had a chance to show its stuff at high altitudes, but now military men speak very highly of it. The British ordered a few of them, but they didn't want any turbosuperchargers or counter-rotating propellers. They got what they ordered, but they certainly were not satisfied. Removing the turbo was like cutting the heart out of it.

High-Flying Thunderbolts

The value of the turbo was made evident once and for all when General Kenney of the U. S. Army Air Forces issued the following statement for publication:

> "America is producing the best military planes in the world today . . . and at high altitudes the Lockheed P-38 (Lightning) and the Republic P-47 (Thunderbolt) can lick anything. There are only two honest 400 mile an hour planes in the world, and we've got both of them. There are only two heavy bombers that can operate above 30,000 feet (one could almost say above 20,000, as European-built bombers seldom get over that height); the Boeing B-17 (Flying Fortress) and the Consolidate B-24 (Liberator) . . . The Boeing is a 1935 model 'souped up' from year to year. Its new turbosupercharger attached to the engine has made it a superior high-altitude plane, carrying a heavy bomb load at 34,000 feet. I defy the enemy to duplicate or copy our turbo within five years."

The war won't last forever, but in all likelihood the turbo is here to stay. Long after nations have ceased hurling high explosives at one another, high-flying "stratoliners" will wing their way across oceans and continents bringing foreign lands closer to our doorsteps. The future of aviation looks very bright indeed, and very much of its brilliance is a reflection from the red-hot buckets of American turbosuperchargers.

No Picture Available of Romayne O'Day

(continued from page 15)

chanical drawing. Of these, she likes physics best and chemistry least.

After meeting so many engineers, Romayne has decided that she'll now change her opinions about them. She finds the males "cultured, so well-rounded, and really brilliant." (Three guesses as to what she thought about them before!)

Since journalism is really her field, Romayne would like to return to it after the war. To be fitted for technical journalism, a field she has been considering, she comes to the conclusion that it would be wiser to specialize in engineering and have journalism as a side line, rather than the other way around.

•

JUNE DVORAK

Racine maintains its lead in the number of Pratt and Whitney students, with the help of June Dvorak who has her degree in psychology. June would have gotten her master's degree in June (confoosin', all these Junes) but now must finish her thesis.

One reason for June's accepting the Pratt and Whitney offer is that she likes learning new things. It's quite a distance (both figuratively and literally) from psychology in Bascom to steam and gas lab in the M.E. building. Her subjects now include physics, quantitative chemistry, math 3a, and steam and gas lab. Math rates highest and chemistry lowest in her list of preferences.

None of June's relatives or acquaintances were enrolled in engineering, and, consequently, she had no previous idea as to what the course would be like. Since starting her engineering training, however, June is getting quite a bit more respect for her male contemporaries, and thinks they're o.k. She's beginning to understand why "they wear old clothes and always draw pictures" (graphs, to you uninitiated).

June is not decided as to whether she'll remain in industry after doing her part to help win the war. This is partially due to her personal preferences, and also to the fact that she feels popular feeling may turn against women holding men's jobs when members of the armed forces return.

•

DOROTHY WILSON

Kenosha is also represented among the Wisconsin cities having girls enrolled in the Pratt and Whitney course. Dorothy is a senior math major who was attracted by the offer of the industrial concern. She will receive her B.A. in math in June, and previously planned to be a statistician.

It was mainly her interest in math

June Dvorak

Dorothy Wilson

that influenced Dorothy to accept the Pratt and Whitney offer. She'd like very much to continue in this type of work after the war.

We were getting pretty curious about this "mechanical lab" and got some idea of what goes on from Dorothy.

In steam and gas lab, it is explained by the patient (?) D. W. Nelson what engines look like, and the girls "know all about indicator cards, planimeters, and calibrating gages." The girls also took an engine apart to see what made it run, and the mechanic said he could reassemble it more quickly by himself than the nine girls could. By strange good fortune, none of the girls had the platform piston fly out with an accompanying oil shower when calibrating the gages, which is more than we can say about all the mechanical engineers.

In answer to our "leading question," Dorothy believes engineers are all pretty much alike, and that they aren't wolves "because they have to study too hard" — anyone interested in proving or disproving the preceding statement, please form line No. 4 around the Mechanical Engineering building.

•

NATALIE BERNSTEIN

Natalie is the only Pratt and Whitney student who'll be closer to

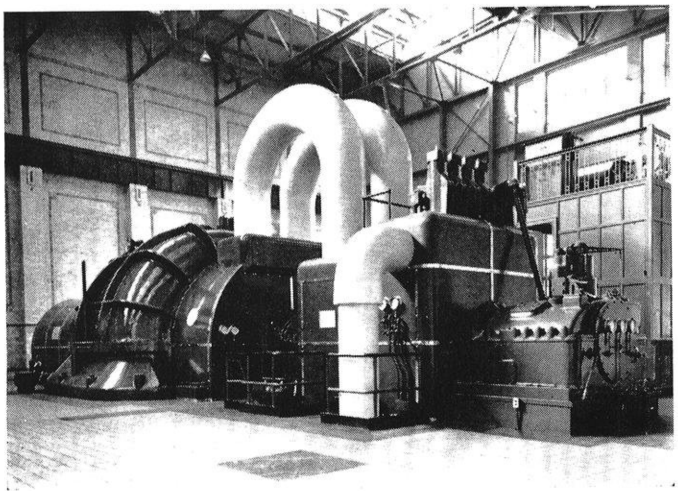
(turn to page 30, please)

ELECTRICAL CONTRACTING . . .

(continued from page 12)

The procedure followed in estimating such a contract is roughly thus:

The contract and specifications are carefully examined to note any peculiarities of the work involved, such as grounding procedure, supporting of conduit (as from rods or chains on high ceilinged factories), wire types and sizes, class of work to be done, as dust-tight, explosion proof and/or weather proof, and just what the contractor is to furnish. If the contract is for inside wiring he may or may not have to provide service from the distribution line to the building. Such things as these must be carefully noted and if any question arises in any respect consultation with the eventual purchaser or his agents should take place. Items as the above often prove to be the difference between a safe margin of profit or just getting under the wire.



When such points have been decided and noted the actual estimating is begun. From the blue-prints furnished the engineer makes what is known as a "quantity take-off." That is, he determines from the prints all the material that is needed to do the job. A certain number of fittings of a given type and size will be called for, various sizes of conduit will be necessary, and there will be many different wire sizes, etc. These items and perhaps hundreds more are listed separately. Then each is priced according to the market list, and the labor cost of installing each item is set down. Thus a 100 foot run of ½ inch rigid conduit on a 12 foot open ceiling will take an electrician 5 hours to install. Each fitting may take an hour, a special fixture 5 hours, and a 10 circuit panel 8 hours. All these labor hours are added up and the contract price is primarily dependent upon them.

Material prices will not vary from contractor to contractor enough to influence the contract price. Of course, this may prove an exception on very large installations or where the contractor is doing a large volume of business and can place large orders with the same manufacturer to gain reduced prices.

The National Electrical Contractors' Association has established a volume available to member contractors which somewhat standardizes the labor hours for a particular type of work, as the cost of fitting 100 feet of a particular size wire, the hours for installing a given size panelboard, etc.

The primary items upon which the contractor bases his price will not vary greatly from one contractor to another. The difference then in the contractor price between individual contractors comes from the constant factor K which each contractor has. K is dependent upon his ability to foresee, to coordinate, to organize, and to maintain his contracting organization in an efficient working machine. Thus the bidding price will be the sum of the labor cost, material cost, overhead cost, and insurance cost times the factor K. Typical figures would run something like this, (based on the labor cost).

Overhead	15%
Insurance	7%
K	from 1.1 - 2.0

The organization of a contracting firm is a good indication of the factor K of each contractor. For such a firm is even more dependent on efficiency and speed than our mass production factories. Necessarily such a firm has a harder time to maintain such conditions due to the nature of the business. One year they may work only six or seven months, another, be going full blast all year around. The maintenance of key personnel, therefore, is of primary importance to the contractor. He must be able to assemble from 50 to hundreds of men in a few weeks and mold them into an efficient working organization. This necessitates the maintenance of a nucleus of engineers, bookkeepers, accountants, supervisors, and foremen who are familiar with company methods and operations. For these men there is permanent employment and this is the place the engineer will be. The contractor who is able to maintain such a nucleus will have a lower factor K and thus will be able to obtain a greater amount of work.

Due to the rigid specifications of the National Electrical Code of the American Standards Association all contractors are required to furnish about the same standards of work. Thus the whole field of contracting falls upon the ability of the contractor to render the greatest service a' the least cost.

Once the job is obtained the work really begins. I once heard it said by a man long in the business that he considers the job half over when he gets the men and material on the location. Perhaps nothing is more important, in normal times, than getting the material on the job—**all of it.** I have seen times when the lack of a few conduit straps or a simple coupling has held up the work of a gang of 15 or 20 electricians for hours. In general practice, when materials are ordered the quantity bought is 10%

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CAMPUS NOTES

by Bill Jacobson

TAU BETA PI INITIATES

Tau Beta Pi initiated 25 members this month, 6 juniors and 19 seniors. Summer initiation was made necessary due to the fact that several students will graduate this fall. Here are the names of those initiated.

Juniors

Edward Brenner
Preston McNall
Robert Manteufel
Warren Young
Roland Wetzel
Joseph Blinka

Seniors

Richard Mason
Roy Anderson
Wayne Garside
Ken Hoffman
Max Tauscheck
Phillip Charley
Harmon Lewis
Gordon Jaehnig
Thomas Swoboda
John Lovell
Harold Martin
James Duddleston
James Keating
Edward Rawson
Soloman Disman
John Caldwell
Charles Yundt
Stanley Wilk
Richard Hoenig

SOPHOMORE HIGH HONORS

Chemical Engineering

Brenner, Edward J.	2.91
Fein, Richard S.	2.69
Fischer, David W.	2.81
Manteufel, Robert J.	2.73
Wendt, Ernst A.	2.62

Electrical Engineering

Earle, David H.	2.74
Knight, M. Berwyn	2.81

Mechanical Engineering

McNall, Preston E., Jr.	2.89
Rose, Lewis W.	2.97
Young, Warren C.	2.78

SOPHOMORE HONORS

Chemical Engineering

Adams, Alfred L., Jr.	2.14
Blinka, Joseph	2.63
Jacky, Germaine F.	2.27
Johann, John, Jr.	2.25
Koehler, Franklin J.	2.42
McMahon, Robert E.	2.53
Miller, Wm. S.	2.35
Morse, Dan	2.21
Nowak, Ted J.	2.27
Tschernitz, John L.	2.42
Young, Eugene P.	2.55

Civil Engineering

Birkett, Richard B.	2.35
Mrazek, Stanley J.	2.45
Robeck, Gordon G.	2.25

Electrical Engineering

Baumgarth, Verlin H.	2.40
Blust, Frank A.	2.24
Boettcher, Harold P.	2.18
Collins, Robert E.	2.36
Hyland, Francis G.	2.35
Oleson, Merval W.	2.68
Scheets, David F.	2.30
Shaw, John L.	2.32
Tanghe, John H.	2.38

Mechanical Engineering

Diels, Melvin F.	2.14
Kaesberg, Paul J.	2.52
Mohr, James W.	2.27
Rowlands, Morris J.	2.58
Steinhart, Victor	2.41
Wachtl, Wm. W.	2.38
Wendt, Wm. R., Jr.	2.18

STATIC . . .

(continued from page 16)

It isn't such a terribly dirty joke.

•

Late to bed and early to rise
Makes a man saggy,
Draggy and baggy
Under the eyes.

•

Honest Hector Hawkins was returning answers based upon his family history as the medical examiner went through the long list of questions furnished by the insurance company. His mother died at the age of 42 of tuberculosis. At what age did his father die? A little past 39. Of what? Cancer.

"Bad family record," said the doctor. "No use of going any further," and he tore up the blank.

Convinced that one shouldn't make the same mistake twice, Hector applied for a $10,000 policy with another company.

"What was your father's age at death?" asked the doctor.

"He was 96," Hector replied.

"And the cause of his death?"

"Father was thrown from a pony in a polo game."

"How old was your mother at death?"

"She was 94."

"Cause of death?"

"Childbirth."

•

Aw come on, Don, let us tell it.

•

Professor: "Who is smoking in the back of the room?"

V-12 Student: "No one, sir. That's the fog we're in."

•

A lady bought a parrot from a pet store, only to learn that it cursed every time it said anything. She put up with it as long as she could, but finally one day she lost her patience.

"If I ever hear you curse again," she declared, "I'll wring your neck."

A few minutes later she remarked rather casually that it was a fine day. Whereupon the parrot promptly said, "It's a hell of a fine day today." The lady immediately picked up the parrot by the head and spun him around in the air until he was almost dead.

"Now then," she said, "it's a fine day today, isn't it?"

"Fine day," sputtered the parrot, "where in the hell were you when the cyclone struck?"

•

First M.E.: "Busy?"

Second M.E.: "No, you busy?"

First M.E.: "No."

Second M.E.: "Let's go to class then."

•

Professor: "You missed my class yesterday, Joe, didn't you?"

Marsh: "Not a bit, not a bit."

Oh, oh, the editor's going out pretty soon.

•

Coed (to doctor): "I blush so easily, Doctor. Whenever I sit down and think, I blush. What can I do about it?"

Doctor: "Try to think about something else."

•

Puckett: "What is the advantage of a long pump handle?"

Harold May: "You can get somebody to help you pump."

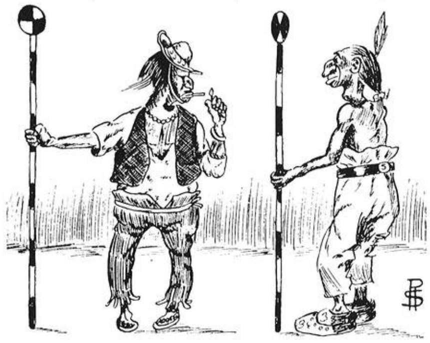
•

He who laughs last has found a double meaning.

•

He: "Do you like O. Henry?"

She: "No, the peanuts always stick in my teeth."



Did you hear about the new model 1046 Keuffel and Esser city transit equipped with stadia hairs?

•

STAIRS

Stairs are a contraption to transport a person from one level to another. Some stairs are good stairs and carry you up without you having to work. Those are given a special nice name and are called escalators. Other stairs are lazy, and you must walk up these. Some stairs don't have steps. These are called elevators. Therefore, these are not stairs.

Some stairs go up, and some stairs go down. Those which go up end at the top, and those which go down end at the bottom. Some go both ways depending whether you are on the top or the bottom. Unlike stairs, escalators never go both ways at once. This is no doubt still another plan of the Nazis to tear down the morale of the Americans.

Stairs are the only things which one may fall up as well as down. This has been experimentally proved!

Spiral stairs are for screwballs. This is so that they may become straightened before reaching the top;—however, do not worry, for whatever goes up must come down—upon reaching the bottom, the users of the stairs will have returned to their original condition once more.

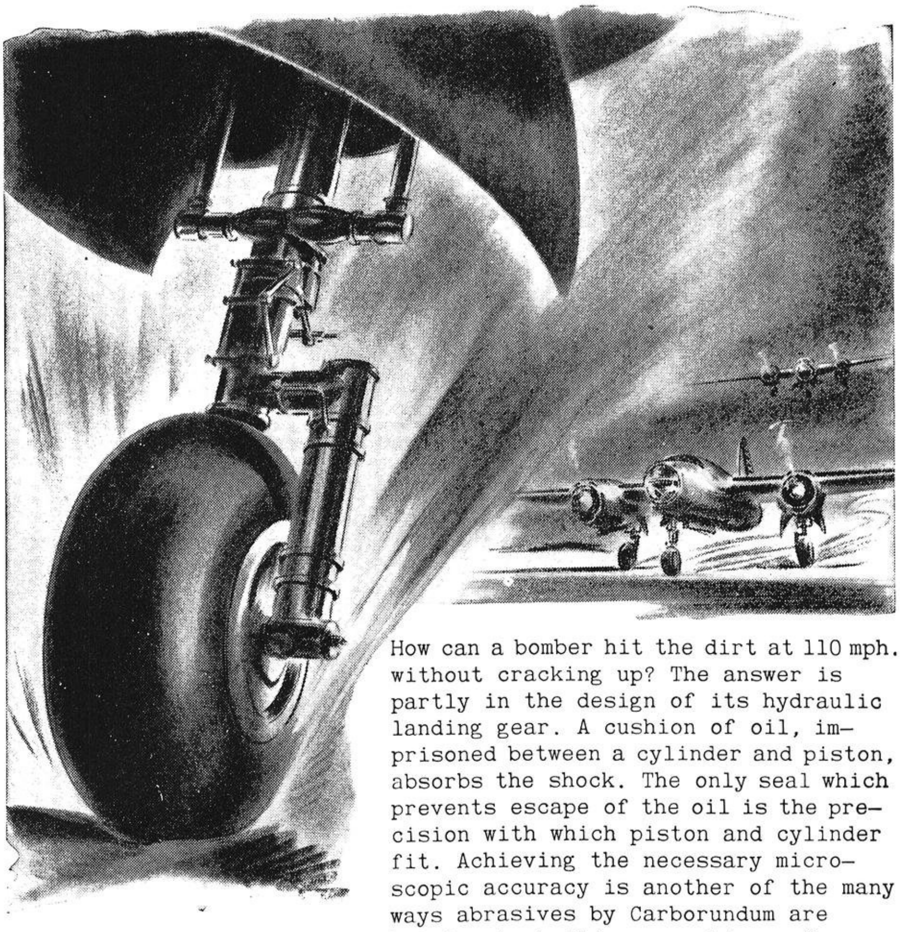
Do YOU keep YOUR stairs in proper condition and wax your bannisters every day? Your stairs are for your convenience—use them correctly.

Here's that dirty joke we wanted to tell:

[redacted]

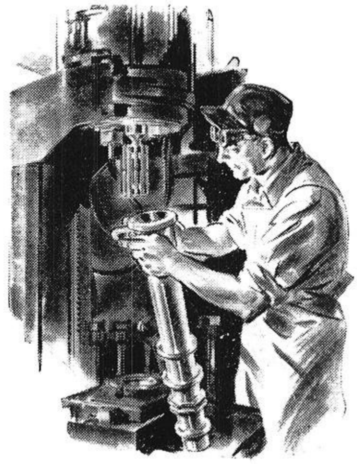
Ed. Note: They forgot I proofread the column.

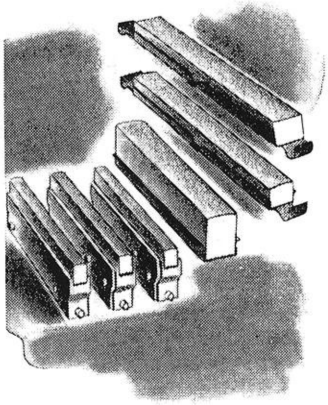
Landing at 110 mph. on a cushion of oil...



How can a bomber hit the dirt at 110 mph. without cracking up? The answer is partly in the design of its hydraulic landing gear. A cushion of oil, imprisoned between a cylinder and piston, absorbs the shock. The only seal which prevents escape of the oil is the precision with which piston and cylinder fit. Achieving the necessary microscopic accuracy is another of the many ways abrasives by Carborundum are helping to build our machines of war.

The interior surface of the landing gear cylinder is finished with a honing machine, as illustrated, fitted with abrasive sticks made by Carborundum. Similar honing machines are helping to produce engine cylinders, bearing races, and thousands of other products requiring an accurately finished internal cylindrical surface.





The future holds many possibilities for new uses of abrasives. When you take your place in industry, keep Carborundum in mind. The Carborundum Company, Niagara Falls, N. Y.

ARMY NAVY

CARBORUNDUM REG. U.S. PAT. OFF. BRAND
ABRASIVE PRODUCTS

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ELECTRICAL CONTRACTING . . .

(continued from page 24)

over that estimated as necessary. This insures adequate materials on hand at all times to cover breakage loss and fittings to get around unforeseen obstacles.

The maintenance of friendliness and a spirit of cooperation between the seller and the purchaser depends greatly upon the contractor. Nothing can do him more harm than to have the purchaser down on him or, as it is sometimes put, have "inspectoritis." If ill-feeling exists the purchaser will be more than ever sure that specifications are rigidly met. An inspector made electricians move a conduit strap 6 inches because the specifications stated that conduit should be supported every 6 feet! This inspector was later transferred to another job where he did very well with other men. However, due to the lack of tact and diplomacy of the foreman, this inspector made the work doubly hard. Such occurrences are not uncommon and it is the duty of the contractor to guard against them if he would save his money.

If there is any kind of a job where things are done, have to be done, this is the field. Obstacles are constantly seeming to spring up from nowhere. On one job post holes were being dug by an automatic digger operated by two men unfamiliar with its mechanics. They were working overtime without supervision to dig as many holes as possible in preparation for the next day's work. The next day, a Sunday, an expensive crane was to come and set the frames. Due to carelessness early in the evening the two men managed to twist the digger into a seemingly hopeless mass at the bottom of one of the holes.

When the contractor was informed of the accident he rushed to the scene (40 miles from his home). He roused a welder from bed at midnight and had him get down in the hole to cut away the jammed parts of the digger. Then they took the digger to a handy man's machine shop in a nearby town and made parts to replace those damaged. When the digger was finally repaired about 6 a. m. the contractor took it out on the job and ran it himself until the regular crew arrived.

Many men would have simply called off the next day's work after looking at that twisted and jammed steel in the bottom of a narrow and deep hole. But this man, using his ingenuity and ability, found the right man at the right time and was able to carry on the next day's work without a hitch.

Construction work is fascinating work. There is something about the work that keeps men constantly on the move from job to job as each is finished. It is surprising to hear them talk when they first meet on a job. Old friends will meet that haven't seen each other since they were on that job down in Mexico. Or perhaps one followed the other from the job in Kentucky. These men have an esprit de corps that is hard to beat. They have a language all their own. In most cases, they are rough and tough but they are good and surprisingly loyal and kind to one another. I believe that is the sense of accomplishment and creation that draws them so to this work.

(continued from page 22)

home when she goes to work in the Pratt and Whitney plant; this because her home is in New York City.

Natalie came to Wisconsin to get out of the East, and also because Wisconsin has a good reputation for its chemistry courses. She is a junior this semester, and will receive her Bachelor of Science degree in chemistry next June.

Before starting college, Natalie seriously considered going into engineering, but was afraid the course would be a little too tough for a girl. Now, if she were starting over, Natalie would enroll in engineering.

Natalie is, however, still undecided about remaining in this type of work after the war. At least, she refuses to commit herself indefinitely and says she may stay in for a while, or until she finds something she'd prefer to do (meaning, until "the right man comes along").

•

LILLIAN FEINGOLD

Lillian Feingold, whose home is in Janesville, is the mechanical's "claim to fame" as one of the two sophomore girls enrolled in engineering.

Lillian spent her first two semesters up here in L. and S. and then decided to transfer to something more practical. She had been considering engineering for some time, and then the war decided for her as to whether or not that was to be her career. She started engineering last February and will graduate in the winter of 1945.

Natalie Bernstein

Lillian likes engineering a lot and thinks engineers are very gentlemanly, **especially sailors** (civilians, please note). She's quite accustomed now to other engineers looking surprised and thinking she's in the wrong class. She doesn't remember her own reactions, but going to school with hundreds of men is run of the mill now.

Her subjects are those of any other sophomore engineer, and include machine shop, foundry, machine design (M.E. 41), economics and math 52. Just to be different from the rest of you mere males, she enjoys economics, and to be **really** different, Lillian doesn't use use a slide rule. Although she once mastered the use of the stick-supreme, she let the art drop and has not yet recovered its use. According to the gentle (?) insistence of one of her instructors, Lillian would do well to learn its use before the end of the semester. (The fifth line interested in teaching the elements of the slide rule will join the others around the M.E. building.)

Lillian Feingold

Lillian has what seems like a pretty good idea for after-the-war plans. She wants to go into the design of household appliances and certainly will be well equipped to enter the field. Incidentally, she'd like to continue working even after she marries. And she doesn't want to marry an engineer!

Viola White

•

VIOLA WHITE

Viola White is an out-of-state girl attending the University. Her home is in New York, but she considers that Wisconsin is pretty much "home" after working in Milwaukee for several years before deciding to attend school here.

As a sophomore in electrical engineering, she's taking chemistry, physics, drawing, and electrical engineering courses 1 and 51, as well as lab. She likes math best, especially calculus, and dislikes mechanical drawing. Viola is too busy with her school work for outside activities right now.

She enjoys working with men engineers. She worked in a government office in Milwaukee before coming here to school and worked mainly with men. Consequently, she believes the men were more taken aback than she when she entered their classes.

None of Viola's relatives have been engineers, nor have close acquaintances, and she entered the field for the best reason of all—because she finds the work especially interesting. For her, this is no "duration job" and after her graduation in 1945, Viola would like to continue electrical engineering as her life work.

What's he got that you didn't have?

AMONG MANY THINGS already certain are endless human comforts made possible by plastics . . . shoes without leather . . . hats without felt . . . new kinds of suit and dress materials, as well as an almost endless number of home conveniences, that "neither moth nor rust doth corrupt."

You, perhaps, think of plastics as substances which can be molded into articles such as the toy in the child's hand . . . or into a telephone hand set . . . or colorful kitchen ware. But imagine beyond that. Imagine man-made materials which can be made as strong, pound for pound, as metal . . . or which can be spun as fine as the most delicate fibers. Imagine substances which can be made as clear as crystal . . . or as colorful as the rainbow . . . as elastic and flexible as rubber . . . or as rigid as stone.

Imagine materials which can be made acid-resistant or weather-resistant . . . shrink-proof, warp-proof, insect- or mold-proof. Imagine materials which are new substances in themselves, and which also transform familiar substances like wood, cloth, paper, leather, and even glass into new and more useful materials. Then you will begin to see what plastics can mean in the way of better houses, better cars, better clothes, better food containers . . . for your child . . . and for you.

The research which has characterized both BAKELITE CORPORATION and CARBIDE AND CARBON CHEMICALS CORPORATION, Units of UCC, has enabled them to show the way in the development and application of plastics and resins.

Resins and plastics, developed during the years before the war, are proving of extreme importance in essential activities of today. BAKELITE and VINYLITE resins and plastics help to insure the unfailing performance of battleships, aircraft, and tanks. They also extend the service life of military clothing and equipment, and hospital and surgical supplies. They are serving on all fronts.

These resins and plastics, and the new uses for them which are being developed today, will be important in the peace to come. They are among the things which will make a better world for you.

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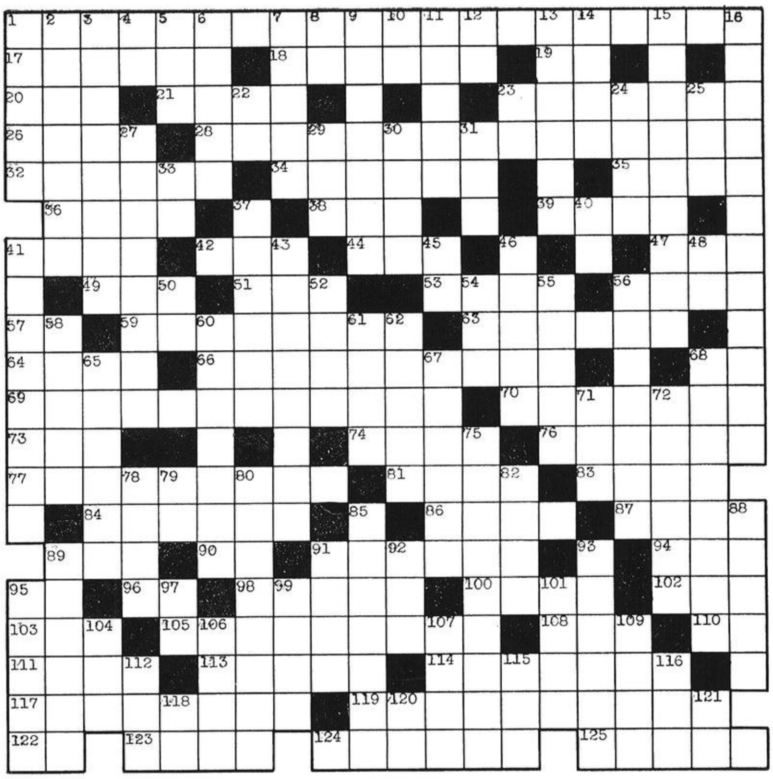
The Linde Air Products Company
The Oxweld Railroad Service Company
The Prest-O-Lite Company, Inc.

PLASTICS
Bakelite Corporation
Plastics Division of Carbide and Carbon Chemicals Corporation

HORIZONTAL

1. The intelligentsia of the University belong to this select group
17. A movie actress who won the academy award for her work in "The Good Earth"
18. Well-known
19. Doctor of Divinity
20. And so forth
21. A British elevator
23. Edibles
26. Ending of a prayer
28. Juggler
32. Threaten
34. Fastened by means of pointed bits of wire
35. Proverbial gal who likes to leap
36. American Society of Mechanical Engineers
38. Nickname for Delbert
39. Consider
41. On the lee side
42. Preposition meaning "on account of"
44. Distinguished service medal
47. Hawaiian food
49. Distinguished service cross
51. Last name of engineer who was president of "W" club
53. This one's a bargain
56. Divorce center of the nation
57. Abbreviation of each
59. Lively
63. Threat
64. Nickname of No. 1 American pilot from World War I
66. Skunks and Thermo exams
68. Rhode Island
69. Not legal
70. A dank hole used for punishing innocent victims, such as the physical chemistry lab.
73. Civil Engineers' Organization.
74. Seines
76. A favorite pastime of engineers on State Street on Saturday night
77. Recommended
81. Carries out
83. The abbreviation written most during registration
84. What must be done to the jokes before they are sent to the printers
86. A village in England
87. In place of
89. Form of be
90. Printer's measure
91. A state of temporary insanity in the genus homo sapiens brought about by excessive partaking of fluids of the organic CH_2OH group
94. Also
95. Latin for "and"
96. Our good neighbors
98. Tools used for tilling the soil
100. Federal agency engaged in aircraft research
102. A simplified form of most assuredly
103. What we have all done at some time or another
105. Robert Fulton's pride and joy
108. Annex
110. Largest group of engineers
111. A prop for the nether regions
113. Command
114. Not one of two
117. Came in
119. Supposedly
122. Abbreviation for load
123. American Institute of Naval Designers
124. Windowshade
125. Nickname of British Westland tailless fighter plane of some 5 years ago



By DON and LOU NILES

VERTICAL

1. Cow juice with high fat content
2. Old-time breakfast cereal from favorite horse food
3. What all autos must be before being driven
4. Abbreviation for loan
5. A long fish
6. A thing which too many people do
7. Frequently
8. Musical note
9. Vacated
10. How much meat can be obtained when your points are used up
11. Lead
12. Form of be
13. Whorled
14. To publish a periodical
15. Something which actors call temperamentalness
16. All cars carry a symbol of this on the window
22. Initials of a great American president
23. That is
24. A common way of shipping hay
25. Period of time
27. Person named after someone else
29. Unhappy
30. Troubles
31. A girl's name, forever linked with apple cider
33. Students chasing around with transits
37. Lay-out
40. Nickname of "The perfect fool"
41. Luckiest person in the world
43. Understood
45. Engineer's first degree from postgrad work
46. To approbate
48. Upon
50. Chemical symbol for most potent poison known
52. You could hold many of these in your hand
54. Bustle
55. To follow
56. One of two or more chemicals which react in a mixture
58. Didn't feel good
60. Mimic
61. Education Division of Army Nurses
62. Bestowed excessive affection
65. Grazing animal's favorite food
67. To put front on shoes again
68. Russian city in which we predict that peace terms will be signed
71. Name of famous American senator
72. Ripe old age
75. Book by Booth Tarkington
78. Type of poem
79. Iron with carbon content between two and four per cent
80. Drawn steel
82. Bicarb
85. Uncouth person
89. See too
91. Part of
92. Soldier's entertainment organization
93. Gotten if you fall on your hip, — —
95. Artist's stand
97. Like
99. The star of "This Gun for Hire"
101. Felines
104. One of the best ways of getting rid of excess food
106. Ripped
107. Against
109. Money you owe
112. Beverage which comes in bags
115. Common suffix
116. Reserve Line Engineers
118. Rock Island
120. Symbol for tin
121. Abbreviation for year