The Wisconsin engineer. Volume 47, Number 3 December 1942

Madison, Wisconsin: Wisconsin Engineering Journal Association, [s.d.]

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WISCONSIN ENGINEER

December, 1942

MEMBER ENGINEERING COLLEGE MAGAZINES ASSOCIATED

Get Ready Today

FOR THE ENGINEERING TASKS OF TOMORROW . . . LEARN TO KNOW YOUR BEARINGS . . .

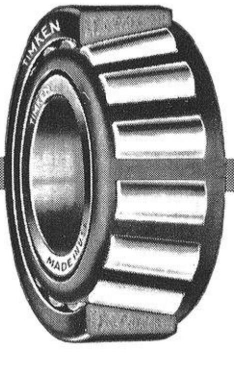
The thousands of experienced engineers who are doing so much to help win victory were students once, and no doubt often wondered what they would do after graduation—just as you probably do now.

But they didn't permit thoughts of the future to interfere with the present. They prepared for whatever might be ahead. Among other things *they learned to know their bearings*—knowledge that has proved to be one of their most useful engineering assets. You'll find it one of yours, too.

After world-wide destruction must come world-wide reconstruction; Timken Tapered Roller Bearings will play as important a part in the new machines of peace as they are doing in the machines of war.

If you have not done so already, begin now to acquire a thorough understanding of the design and application of the Timken Bearing. Our engineers—bearing specialists of many years' standing—will be glad to help you.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO



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Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.

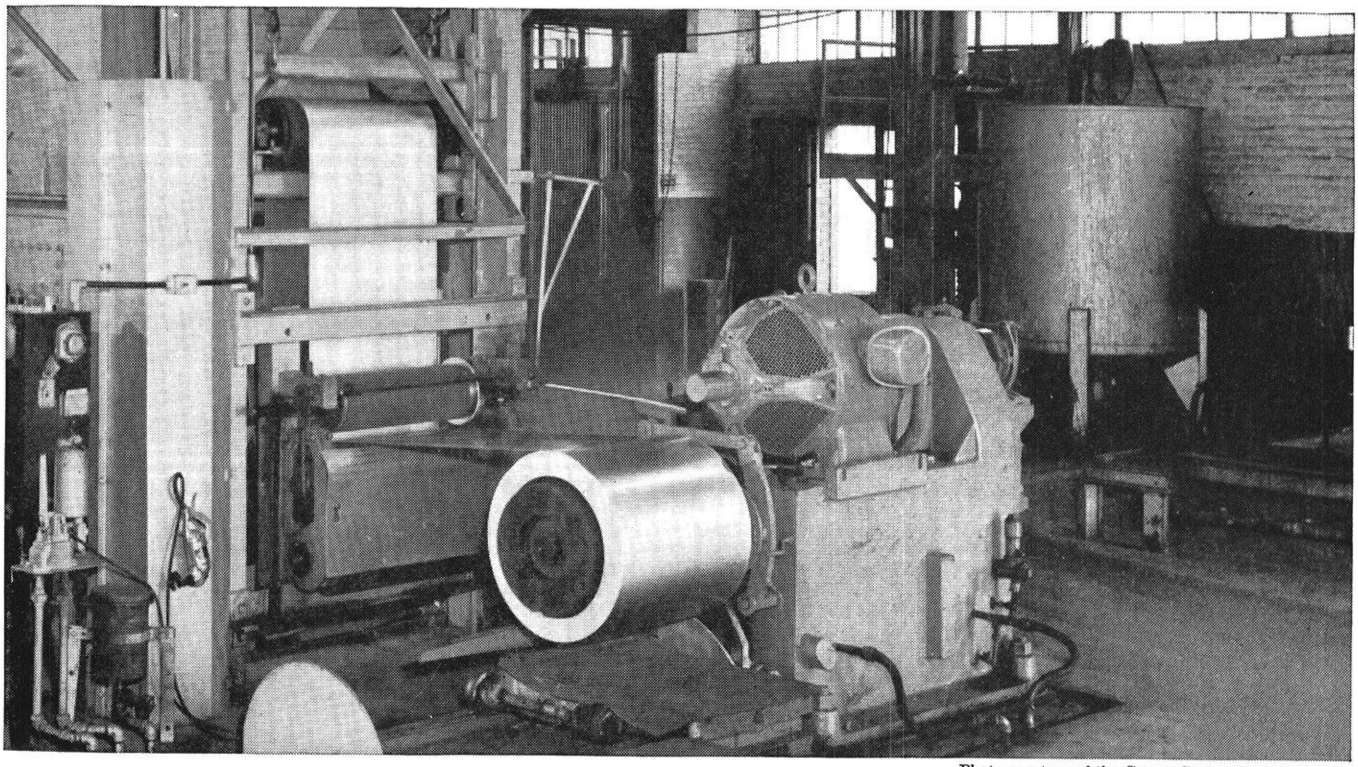


Photo courtesy of the Crown Cork & Seal Company

The best news about tin since we went to war

WHEN THE JAPS overran Malaya and the East Indies, they thought they had dealt a staggering blow to America.

For, overnight, tin became a most critical raw material, because America relies upon this bright metal for tin plate, bearing alloys, solder, collapsible tubes . . . *but mostly tin plate.*

However, Uncle Sam had an ace in the hole . . . *electrolytic tin plate.* In this process tin is deposited electrolytically . . . not hot-dipped . . . on steel strip. And only *one third* the normal thickness of tin is required.

Unfortunately, electrolytic tin plate is far from perfect as it comes from the plating baths. It is porous and not completely resistant to corrosion,

In order to make electrolytic tin plate usable, the tin deposit must be re-heated and *flowed* after plating. But until recently, even the best available re-heating and flowing processes were painfully slow.

Right here is where Westinghouse "know how" stepped into the picture.

R. M. Baker, Westinghouse Research Engineer, together with Glenn E. Stoltz, of the Westinghouse Industry Engineering Department, decided that the porous tin coating could be *fused* . . . through the magic of electronics . . . to give the tin plate the desired corrosion-resistant property and surface brightness.

Baker and Stoltz built a high frequency coil, using radio broadcasting oscillator tubes for their power source. Through this coil they passed electrolytic tin plate. The inductive heating effect melted the tin coating . . . and it fused smoothly and evenly over the porous surface.

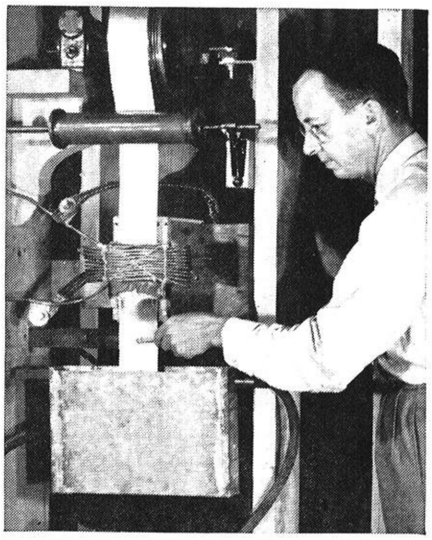
The new Westinghouse tin reflowing process is now in actual use, turning out gleaming ribbons of tin plate at better than 500 feet per minute. It will save many thousands of tons of tin every year!

• • • • •

What Baker and Stoltz did for the tin plate industry many engineering students in college today will do for other industries tomorrow.

Westinghouse knows where to find the future scientists America needs so badly on the industrial front . . . many will be among the technical graduates of the Class of '43.

Westinghouse Electric & Manufacturing Company, Pittsburgh, Penna. Plants in 25 cities, offices everywhere.



RADIO WAVES FUSE TIN . . . R. M. Baker, Westinghouse Research Engineer, examines a test strip of tin plate which is passing through the experimental tin flowing mill. Baker joined Westinghouse after receiving his B.S. at Texas University. He earned an M.S. degree at the University of Pittsburgh.

Westinghouse

. . . making Electricity work for Victory

WISCONSIN ENGINEER

Founded 1896

Volume 47 — DECEMBER, 1942 — Number 3

Entered as second class matter September 26, 1910, at the Post Office at Madison, Wisconsin, under the Act of March 3, 1879. Acceptance for mailing at a special rate of postage provided for in Section 1103, Act of Oct. 3, 1917, authorized Oct. 21, 1918.

Published monthly from October to May inclusive by the Wisconsin Engineering Journal Assn., 356 Mechanical Engineering Bldg., Madison

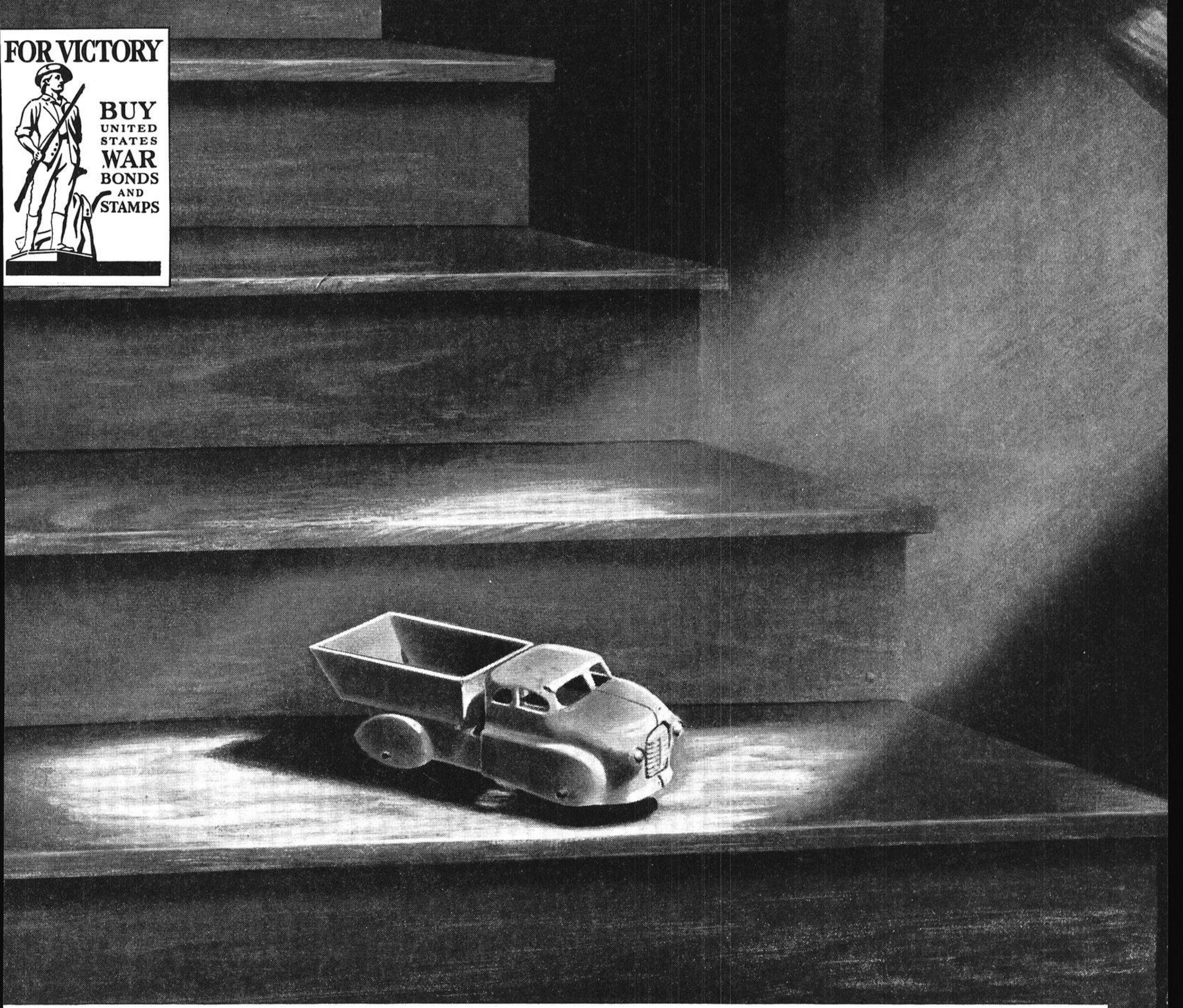
Subscription Prices

$1.00 PER YEAR . SINGLE COPY 15c

In This Issue . . .

In Memoriam

We were deeply grieved when we learned of the recent death of Mr. C. E. Beeb, '96, the first editor of the WISCONSIN ENGINEER. *In June, 1896, the first issue appeared containing many technical articles as well as a large engineering index. With the passing years the magazine grew from a quarterly to a monthly publication and assumed a semi-technical nature while fulfilling its initial object of disseminating knowledge and giving experience to those who worked with it. We are very grateful to Mr. Beeb for having taken the initiative in producing the first magazine and for having set a high standard of technical journalism for us to follow. We sincerely regret the passing of this leader who pioneered in technical journalism at this institution during his undergraduate days.*



DEATH CAR...

ONLY A CHILD'S TOY on an unlighted stairway. Yet as lethal as a speeding truck for killing or crippling. For causing heartbreak and tragedy in someone's home.

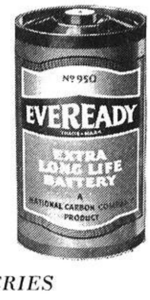
Accidents . . . in the home . . . on the highways . . . in factories and offices . . . cost this nation 102,500 lives last year. This tragic toll, preventable to a great extent, was augmented by the permanent disabling of 350,000 other people . . . by 9,000,000 lesser casualties.

Production-wise, America's war effort lost heavily. In all, 480 *million* man days were lost forever. Enough to have built a total of 20 battleships, 100 destroyers, 9,000 bombers, and 40,000 tanks! Money-wise, the loss was almost 4 *billion* dollars!

Where did these accidents happen? Two-thirds of them happened outside of industry. In the home, where workers take chances they would not dream of taking on the job. They happened in darkened hallways . . . in bath tubs . . . in garages and basements. They happened in industry where someone gambled with safety.

No matter what you do, your life is precious to this nation. Don't take chances with it. Guard it for America . . . at day . . . and at night. Fight carelessness, the Master Saboteur! Join the anti-accident crusade! Help save a life!

The perfection of the famous "Eveready" fresh DATED flashlight battery called for coordination between various Units of Union Carbide and Carbon Corporation. The exact grade of graphite necessary for the "mix" was developed by the Acheson Graphite Corporation. Special alloy for protecting molds and machinery was produced by the Haynes Stellite Company, and Carbide and Carbon Chemicals Corporation provided a specially prepared paint made of "Vinylite" resins for the spun metal cap.



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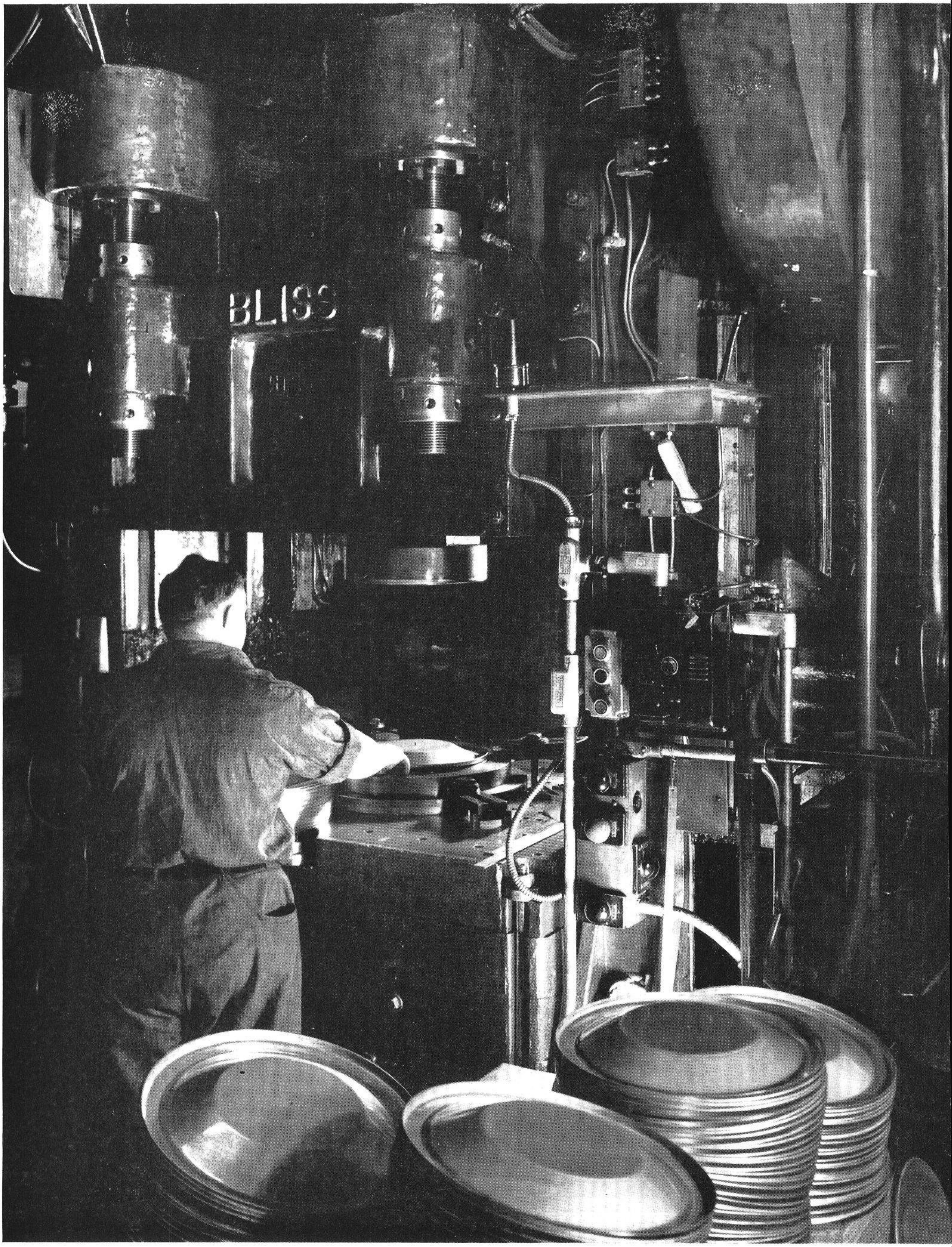


—Metals a

Cold Drawing Airplane Cover Wheels from Magnesium Sheet

Railway Problems Of Today and Tomorrow

by Wilbur M. Haas, c'45

This article is adapted from a talk of the same title given by E. T. Howson '06 before the Wisconsin Section of the A.S.C.E., the University student chapters of A.S.C.E., A.I.E.E., A.S.M.E., and S.A.E., at the Hydraulic Laboratory, Friday, November 20, 1942. Mr. Howson was on the Board of Editors of the WISCONSIN ENGINEER *from 1902 to 1906, serving as Alumni Editor during 1904-1905, and as Editor-in-chief during 1905-1906. At the present time, he is Vice-President and Western Editor of* RAILWAY AGE, *and Editor of* RAILWAY ENGINEERING *and* MAINTENANCE.

"ONE of the great jobs of the war is being done by our American railroads. Indeed, it may be the greatest of all our civilian war efforts in point of successful operation. It is the one enterprise that has not broken down or even faltered in the war effort. Without the railroads, our nation would be sunk." This is not, as you may suspect, the statement of a railroad man, but it was made by one of our well known columnists in one of his syndicated writings. Because this statement comes from one who is a trained observer of trends or public concern it is very significant.

Those who lived through the last war will remember the confusion, congestion, and waste that accompanied the government's operation of the railroads, which were taken over nine months after we entered that conflict. This time, twelve months after hostilities began, there is no agitation for government operation of the railways, because of the very commendable record they have made in that time.

E. T. HOWSON

—*Allied Photo*

Let us first get a clear picture of what has been taking place. In June, 1940, our country started its preparations for war. This has resulted in a greater increase in rail traffic than in any other two and one-half year period in railroad history. Over the entire country as a whole, freight traffic, measured in ton miles, is now exceeding that of only a year ago by 33%, and passenger traffic, in passenger miles, has increased 73%. The problems caused by such a drastic increase in traffic should be very obvious.

Now let us compare the initial two-year periods of the last war and the present one.

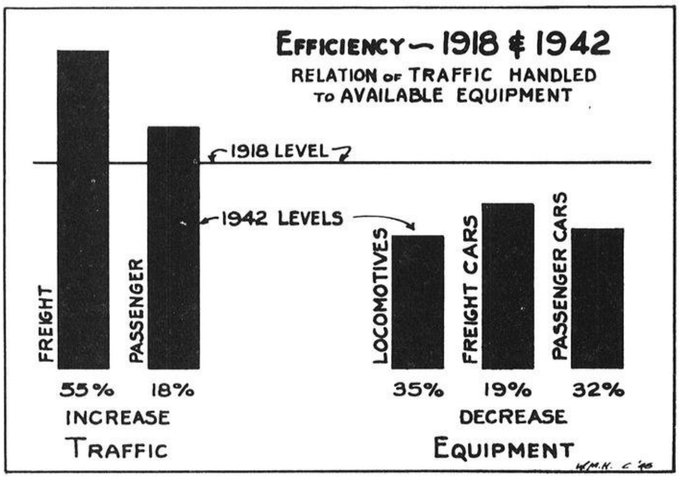
Freight traffic increased 18% in 1918 over 1916, but the increase in July, 1942, was 83% over July, 1940. In a similar fashion, pasenger traffic in 1918 was 23% over that of 1916, while the volume in July, 1942, was 112% above that of July, 1940. Also, it is very significant that in July, 1942, the railroads, under **private** management, handled 55% more freight and 18% more passenger traffic than they did in 1918, under government management. Furthermore, this greatly increased volume of traffic is being handled with 35% fewer locomotives, 19% fewer freight cars, and 32% fewer passenger cars than were available in 1918.

What are the causes of this spectacular increase in traffic volume? One is the tremendous dislocation in many well-established channels of transportation. A great deal of the transcontinental traffic has come back to the railroads because the ships plying between the East and West coasts via the Panama Canal have been shifted to transoceanic service. The submarine attacks on oil tankers along the Atlantic coast has put another great burden upon the railways. Furthermore, our war production consisting largely of "heavy goods," is about 50% greater than in 1918. After Pearl Harbor it was necessary to immediately transfer vast numbers of men and immense quantities of materials from the industrial East to the distant Pacific coast. Also, in the first World War, we depended upon our Allies for a large part of our equipment and supplies, while in this war, we are not only supplying much larger forces of our own, but are also producing immense quantities of lend-lease materials for our Allies.

In passenger traffic, too, the great specialization of modern warfare requires that troops be transported an average of six times before embarkation, instead of three, as in the last war.

Obviously, figures showing the volume of this military traffic cannot be given, but it is possible to indicate the efficient manner in which it is being handled by showing how efficiently civilian traffic is being taken care of. As the grain harvest of 1941 approached, there was some concern in the wheat belt that the railroads wouldn't be able to handle the crop as it was harvested. It was evident that it would be a bumper crop. To meet this trying situation, the railroads moved thousands of box cars into the wheat belt, and also sent in car service officers who would direct and supervise the placement of cars for loading. That the railroads were equal to the task is shown by the fact that at all times there was an adequate supply of cars on hand, and the grain reached the elevators so fast that they could not handle it. Due to the congestion at the elevators, the railroads had to limit loadings to the capability of the elevators to handle the grain. Also, in handling iron ore, the railroads have broken all previous records. Again, the number of boats available to take the ore down the lakes was the only factor that limited the amount the railroads could handle.

The railroads really came through with the goods in moving oil to the East from the fields in the Southwest. For many years this traffic was handled by ocean tankers, but with the beginning of the war, this could not be continued, as many tankers were transferred to Great Britain, and many more were being sunk by enemy submarines. In the summer of 1941, a Senate committee investigated this situation with a view toward reverting to the railroads.



More traffic is being handled now than in 1918, and with less equipment than was available at that time, due to more efficient use of cars.

During the course of the investigation, J. J. Pelley, president of the Association of American Railroads, told the committee that he thought that the railroads could increase their oil movement to the East from the rate of 60,000 barrels a day to 200,000 barrels per day. Secretary of the Interior Ickes, upon hearing of this, made the remark that it was no time for idle words. But, the railroads not only made good Mr. Pelley's statement, but actually **quadrupled** that estimate, and reached a maximum movement of 850,000 barrels per day. Mr. Ickes was among the first to commend the railroads upon the accomplishment of this remarkable feat.

The movement of soldiers and sailors is also a spectacular achievement. Over a million a month are being moved, exclusive of those on furlough, and in one month, 835,000 of these were moved in Pullman sleepers. About 40% of the sleepers and 15% of the coaches are devoted exclusively to troop movements, and the military forces have first call on all the remaining equipment. Troop trains take the right-of-way over all other trains. All troops are moved with their own equipment, so that they are integral fighting units.

The Watchword—Efficiency!

When the present-day efficiency in handling this traffic is compared to the congestion and delays of the last war, one wonders what has brought about this improvement. The answer is simple, but vitally important to those concerned with future transportation policies in this country.

Perhaps the most important part of this improvement is the determination of the railroads, shippers, and government agencies that the cars should not be used for storage, but for transportation only. In World War I, thousands of cars were tied up with their loads, clogging the terminals, and keeping these cars out of active transportation service. The reason for this was the loading of materials for which the consignee had no use for several months. Today, this is different, as the railroads will not permit a shipper to load a car until he guarantees that it will be unloaded immediately upon arrival. Because of this system, the car supply is fluid and readily adaptable to changing needs. Also, at the present time, fewer cars are out of service for repairs than ever before. Lately the railroads have been pooling cars to prevent periodic shortages on any particular line.

After the last war, railway and military authorities established a joint committee to study the difficulties experienced during that period. A plan was developed to avoid repetition of this trouble, and this plan was put into effect as soon as we started preparing for war. The basis of this plan is a most intimate liaison between military and railway authorities, and this very successful arrangement has won the enthusiastic commendation of our military authorities.

Since the last war, American railroads have spent over ten billion dollars for improvements in plant and rolling stock. These improvements included more powerful locomotives, larger freight cars, stronger tracks, second main tracks, modern freight classification yards, new signaling systems, etc. These improvements have made possible a large gain in the efficient use of equipment.

One of the most unique measures to keep cars rolling is the self-policing that is being done by the shippers. Through the thirteen Regional Shippers Advisory Boards, the shippers themselves correct any delay in loading or unloading cars. That this program has been a success is shown by the fact that while in 1941 it took five days to load and unload a car, it is now being done in three. This is equivalent to adding 183,000 cars to the regular supply.

Immediate Problems

That is the current situation. We are now concerned with the ability of the railways to continue to meet wartime transportation demands. The labor situation is becoming somewhat of a problem for the railroads. They have been losing men to the selective service just as other industries are, but up until now they have been able to get replacements in most cases. However, as the nation's labor supply continues to dwindle, and the railroads actually need more men to handle the increased traffic, they will be faced with a definite labor shortage. The railroads have been able to get deferments for key men such as track and shop foremen, but are now having difficulties in obtaining ordinary labor. To hold and increase the personnel, the railroad companies are allowing their men overtime at time-and-a-half pay, and giving them very much improved living accommodations in the work trains. However, in some cases, this has not been sufficient, and in a few instances, women have been put on as crossing flagmen, and one western railroad is using a women bridge crew. Brotherhood restrictions also keep men from working as much as they might. Of course, there is some basis for their reluctance to give up hard-won advantages, but it seems likely that in the face of the wartime labor shortage, these rules will have to be given up for the duration to alleviate the situation.

Rationing

A subject of great interest and speculation is the matter of passenger traffic rationing. However, according to the opinions of most railway men, including government officials, rationing will be neither practical nor necessary. There is, of course, some crowding on trains, there may be more, and one cannot always get the sleeper accommodations that he would like, but on the whole, it appears quite likely that all reasonable needs will be met. This will be brought about by more efficient use of available equipment, and the cooperation of the traveling public in avoiding peak traffic periods. Just what effect gas rationing will have on passenger traffic is very unpredictable. In the East, where gas rationing has been in effect for some time, rail traffic volume is up 75%. In the Midwest, where gas has been rationed only since December 1st, traffic has jumped about 115%. This is obviously not what one would expect.

The freight traffic problem is not so simple, as the railroads will need additional maintenance materials and equipment to handle the anticipated increase in freight traffic in 1943. The railroads have reached the peak of efficient utilization of equipment, so to handle the additional volume, additonal units must be added. The president of the Burlington Lines, Ralph Budd, estimates that the railroads will need 100,000 freight cars, 1,000 locomotives, and two million tons of rails to keep going in 1943. Recently, the War Production Board released a small amount of the materials required for this equipment. Whether more will be forthcoming remains to be seen, but it seems imperative that the railroads be supplied with their needs if the transportation system is not to be crippled.

After the War—?

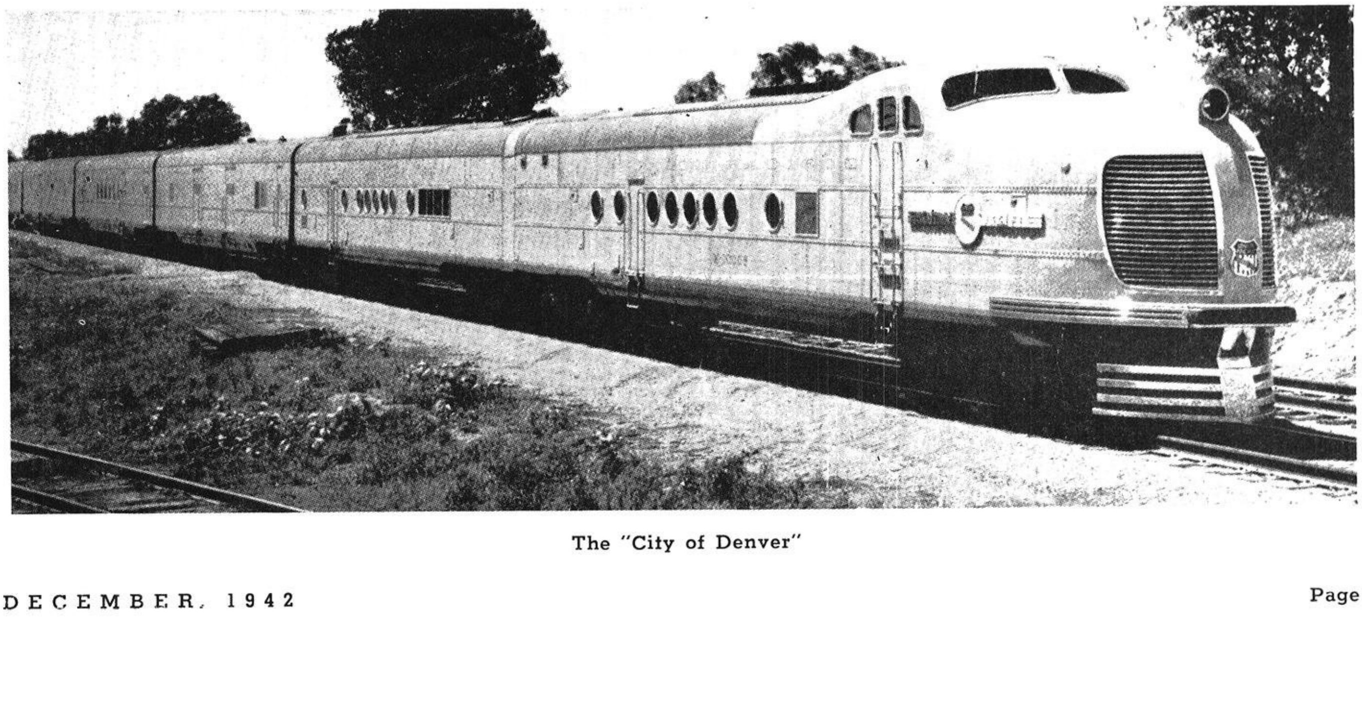
After the war, there will probably be very active competition for business. It is thought that because of the relatively high cost of air transportation, it will remain highly selective in the future. True enough, a lot of cumbersome freight is now being handled by air, but isn't this being done largely because of the necessity for the utmost speed? It is certain that air transport will make certain inroads into freight traffic, but it seems likely that the railroads will handle most of overland bulky and heavy goods.

At the present time, much passenger traffic is being diverted to the railroads because of the rationing of air travel and of gasoline for automobiles. The automobile will still probably be a very popular form of transportation. After the war it seems likely that the railroads will hold a good deal of this extra traffic, because millions are now being introduced to the comforts of rail travel for the first time. The modern, high-speed, streamlined train has become fixed in the imagination of the traveler. This may be speculation, but one thing is certain; competition for this business will be most keen.

Progress in the development of Diesel locomotives has been very rapid. They originated in switching service, then were put into the light-weight streamline passenger train. Later they were used on standard passenger trains, and today they are often used on heavy freight runs.

One disadvantage of the Diesel is its high initial cost—about three times that of a steam unit of equal power. Steam units are constantly being improved, so it appears doubtful that they will ever be entirely displaced by the Diesel locomotive. The Diesel, however, is low on maintenance costs. In fact, they often become obsolete before they wear out. The first streamliner, that belonging to the Union Pacific, was recently scrapped for that reason.

In summary, if the railroads meet all post-war competition problems as well as they have stepped up the service performed per unit in the past three years, it seems likely that they will still constitute the backbone of our national transportation system for many years to come.



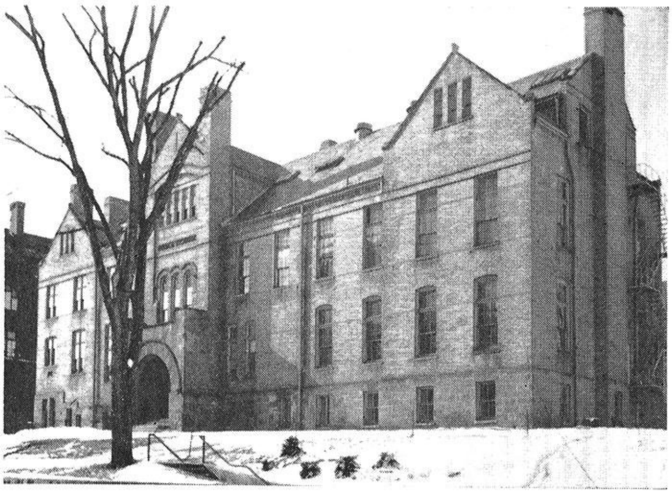
The "City of Denver"

CHEMICAL ENGINEERING

by Bill Jacobson, che'44

WHEN most students hear the chemical engineering building mentioned, they remember vaguely, "Oh, yes, that old yellow brick building across from the Union theatre—the one with the smells coming out of it." That may be the impression in the minds of many, but the chemical engineering building means more than that to the junior or senior chem engineer, who spends a large share of his waking hours there. There is a great deal of activity going on there, from the basement to the attic.

The building was built in 1885 as a chemistry building, and it was here that the late Professor Louis Kahlenberg began his work with engineering students which continued over four decades. Shortly after 1900 the present engineering building was opened to use, and what was then the recently organized Department of Chemical Engineeringing and Applied Electrochemistry moved into its present location. At that time the Medical School had part of the top floor for anatomy labs, but they were moved to the present Science Hall when it was completed.



Chemical Engineering Building

The Department of Chemical Engineering here has continuously remained on the accredited list of the American Institute of Chemical Engineers since the latter instituted its accrediting program. Under the direction of Professor Roland A. Ragatz, department chairman, it continues to send out the type of successful graduates who have established such an excellent reputation in the chemical and allied industries. In addition to this work, an excellent research program has also been carried out.

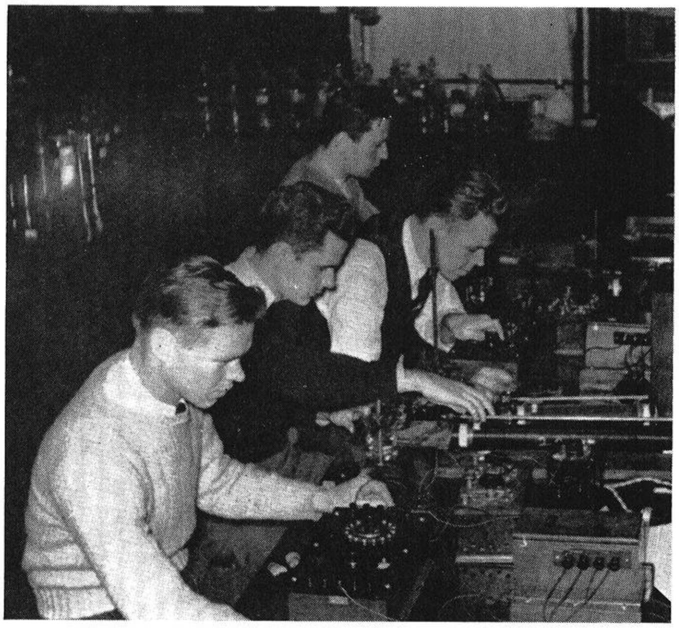
Laboratories

The microscopy lab, located on the third floor, is used for the microscopic examination of industrial materials such as natural and artificial textiles, pulp and paper, refractories, paint, leather, etc. A separate chemical laboratory is provided for the preparation of samples. Other types of microscopic work are also done, such as micrometric measurements, the determination of dust and pollen in the atmosphere, and the study of minerals with polarized light.

The electrochemistry lab, at the north end of the second floor, is well equipped for the theoretical and practical investigation of all types of electrolytic action. There are all types of equipment and measuring instruments for electroplating, refining, and electrotyping, chiefly with the use of commercial units. There is an extensive study of corrosion, its causes and its cures, and considerable work in the electrochemical oxidation and reduction of organic compounds.

The chemical engineering measurements lab, also on the second floor, is devoted largely to pyrometric measurement and control. It is well supplied with thermocouples, resistance thermometers, optical and radiation pyrometers, and the instruments needed for their standardization and use. In addition to this, the several industrial temperature controllers and recorders contribute toward giving the student an excellent training in measurement and control work.

The laboratory at the north end of the first floor is devoted to the analysis of fuel, gas, water, and lubricants.



Seniors in the Electrochemistry Lab.

This includes both chemical analysis and calorimetry, besides the measurement of physical properties of these materials. The apparatus and methods used are those found in control work at any modern gas plant or power plant.

The metallography laboratory has recently been moved to the Mining and Metallurgy building, and it is there that chemical and mechanical engineers learn the principles of metallographic inspection. There are facilities for the preparation of the metal specimens and for visual and photographic study of the samples with the microscope, including a darkroom for developing and making prints. The work also includes the use of such accessory apparatus as furnaces for heat treatment, pyrometers, polishing apparatus, and quenching devices.

The hydrogenation lab in the basement of the Chemical Engineering building was given by the Universal Oil Products Co. Considerable research has been done here on the catalytic hydrogenation of iso-octylene to iso-octane, for use in aviation gas.

The unit operations lab, also in the basement, has equipment for specific experiments on various unit operations, including fluid flow, cooling, humidification, drying, gas absorption, heat transfer, etc. The equipment used includes various types of stills, filter presses, ovens, hydraulic presses, crushers and grinders, etc.

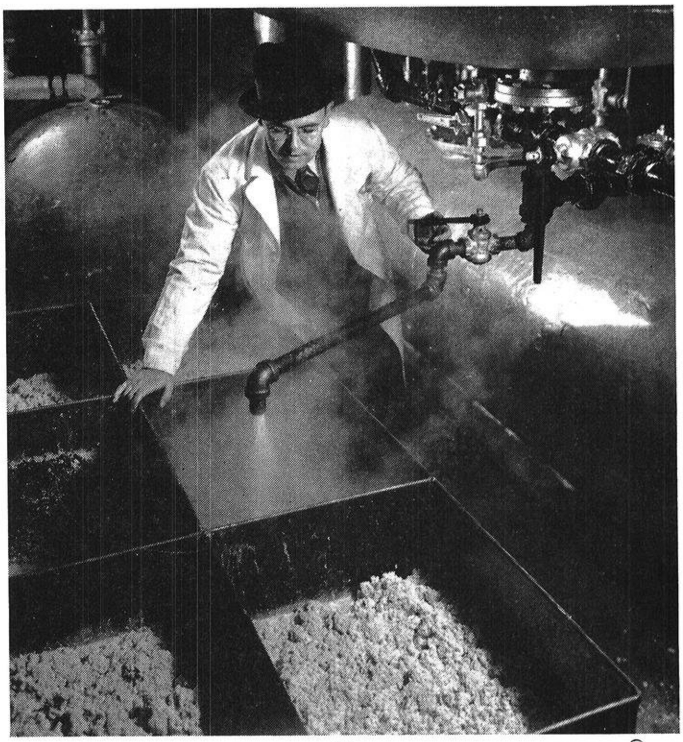
The industrial chemistry lab, using some of the same equipment, gives the student practice in doing problems of chemical manufacture. These may include the manufacture of paint, the purification of alcohol wastes, soap manufacture, the purification of aluminum ores, zeolite method of softening water, etc.

Work in these last two labs is combined for the required summer course in chemical manufacture. The purpose of this course is to show the student certain semi-commercial methods of manufacture, and to give him practice in setting up and carrying out work on his own responsibility, so that the course is chiefly practical industrial chemistry. Last summer some of the students took the course in five weeks, putting in about forty hours weekly, while others spread the same amount of work over a twelve-week period along with their other engineering summer session courses.

There is a chemical engineering museum which contains things of historical interest, such as early types of electric furnaces and early samples of chemical equipment. There is a large collection of exhibits showing electrochemical phenomena, and a large model, donated by Universal Oil Products Co., of a manufacturing installation of the Dubbs process of cracking petroleum.

Research

An increasing emphasis, though not to the detriment of undergraduate instruction, is being placed on research and graduate study. The Department of Chemical Engineering has been fortunate in receiving a grant of $10,000 per year for a period of ten years from the Wisconsin Alumni Research Foundation, and this will make it possible to extend and intensify the department's research program in the coming years. In order to get the program started effectively, Professors Olaf A. Hougen and Kenneth M. Watson have been appointed to hold Research Professorships, and at present they are devoting most of their time to organizing the various research projects that are being financed by the grant.



Typical chemical engineering—synthetic rubber production

In addition to the many graduate students working on research at present, there are four undergraduate research apprentices. Bob Buckley and Jim Felix are working under Professor Kowalke on methods of increasing the output of gas produced from coal. Jerry Fallon is working under Professor Watson, and Roger Lescohier under Professor Hougen, both investigating the thermodynamic properties of hydrocarbons.

All seniors in chemical engineering are assigned special problems, and this year many are taking them the first semester since they plan to graduate or leave school in February. John Cutler is working with Professor Daniels of the chemistry department on the fixation of nitrogen—work along somewhat similar lines to that the TVA is doing. Art Hoekstra is working with the Madison Board of Health on the problem of waste disposal at Oscar Mayer's. Research Fellow William Bain has Wally Spiegel and Milt Lange working with him on the investigation of flooding velocities in absorption towers. Chet Feczko and Joe Schultz are working with Instructor T. C. Fong on the carburization of steel. Pat Martin and Jack Knight are working with Research Assistant David Schilling on the drying of solids. Norm Ednie is working under Professor Hougen on the thermodynamic properties of hydrocarbons.

Casting and Fabrication of . . .

MAGNESIUM ALLOYS

by Jerome Baird, met'43

THE casting and fabrication of magnesium alloys have been given a tremendous impetus by the war in aircraft and pyrotechnic industries. These ultra light alloys with a specific gravity of 1.8 are playing an important part in the construction of our fighter and bomber planes by adding strength and saving weight. It also goes into the casting of incendiary bomb shells and the manufacture of flares. Magnesium shavings have been used for many years in the preparation of the Grignard reagents that are of importance in the laboratory synthesis of organic compounds. As a minor alloying element, it is used in quantities up to 10% in nearly all wrought and cast aluminum alloys. Compared with aluminum which is 50% heavier, cast iron four times and brass five times as heavy, magnesium as a structural metal, has many weight reduction applications.

Applications

The fabrication of magnesium alloys is an interesting and fascinating work because the metal can be sand cast, die cast, extruded, rolled, forged, deep-drawn and even welded. Prior to the war this metal was just coming into its own and had many peace time applications, such as housings for portable tools, truck mounted pumps, truck bodies, safety blocks, dock boards, and vacuum cleaners, in addition to aircraft construction. The airplane industry used it in their landing wheels, furniture, instrument panels, oil pumps, superchargers, etc. At the present time all of the magnesium produced is devoted to war work. Pre-war production figures (4,800 tons in 1939) pass into oblivion in the face of the estimated output of over 150,000 tons for 1943. Magnesium, with its outstanding lightness, adequate physical properties, excellent machinability, and reasonable cost, should maintain a permanent place in the structural field after the war. The price of magnesium has been on a steady decline from the peak of $5.00 per pound in World War I, to the present price of 23c per pound for virgin ingot metal.

The Dow Chemical Company was the only commercial producer until the past year, when the government subsidized numerous plants to increase the magnesium output for the war effort. Since World War I they have operated on the electrolysis of magnesium chloride which has been obtained as a by-product from the brine wells of Michigan for many years, and just recently from sea water. (Magnesium Production, **Wisconsin Engineer,** October, 1942.) Other processes, especially the ferrosilicon reduction of dolomite, will offer stiff competition to the electrolytic process in the future, and the price is expected to drop.

Dow Chemical Company and the American Magnesium Corporation, a subsidiary of the Aluminum Company of America, have been fabricating the metal for a number of years. Since Dow has been the pioneer in the development of magnesium alloys, their nomenclature will be used to designate the alloys for the various methods of fabrication.

Crystal Structure

Magnesium has a hexagonal crystal lattice in contrast to the cubic structure of iron. The crystallography is important in understanding the fabrication of the wrought alloys. When stress is applied, the metal slips along only its basal plane up to a temperature of 415° F. and fails by shearing. However, above this temperature twelve more slip planes are added and the metal deforms plastically. This is the reason for extrusion, forging, and rolling taking place above 415° F. The orientation of the

CHEMICAL COMPOSITION OF COMMON COMMERCIAL MAGNESIUM ALLOYS

Alloy	Aluminum %	Manganese %	Zinc %	Relative Resistance to Salt Water	Applications
C	9.0	0.1	2.0	B	Sand and Permanent Mold Castings
FS	2.7	0.3	1.0	C	Extrusions, Forgings
H	6.0	0.2	3.0	B	Sand Castings
J-1*	6.5	0.2	1.0	B+	Extrusions, Forgings, Sheet
M	—	1.5	—	A	Extrusions, Sheet
O-1*	8.5	0.2	0.5	B+	Extrusions, Forgings
R	9.0	0.2	0.6	B	Die Castings
X	3.0	0.2	3.0	B	Extrusions, Forgings

*High Purity Alloys, Iron and Nickel each limited to .005% to conform with Army and Navy Specifications for improved salt water resistance.

crystal structure also plays a large part in determining the physical properties of the wrought alloys.

Magnesium resists the attack of most alkalis and many organic chemicals and oils, but it is attacked by both strong and weak acids with the exception of hydrofluoric and chromic. Most aqueous solutions of salts, especially the chlorides, attack the metal. However, this disadvantage has been overcome by the use of protective coatings which are effective against salt air and occasional contact with sea water. The corrosion of magnesium by salt water is due to faint traces of iron and nickel. By limiting the nickel to .005% and the iron to .005%, superior resistance is also attained. The corrosion ratings in the above table are relative in regard to sea water. In ordinary atmospheres the alloys are approximately equal and compare favorably with other engineering metals. The bright metallic surface is soon dulled due to the formation of a stable oxide film which gradually darkens but does not flake off under weathering conditions. Almost all cast and wrought magnesium alloys are given a chrome pickle or some other surface treatment to protect during handling and to give them a good base if painting is desired.

Alloying Elements

At the present time, there are only three metals that are extensively alloyed with magnesium. They add little weight to the base metal while improving its physical properties and corrosion resistance. These alloys possess an average specific gravity of 1.8 and have the same modulus of elasticity (6,400,000 psi) as does the pure magnesium. **Aluminum** increases the hardness, yield strength, tensile and compressive strengths more than any other element in both the cast and wrought condition. Alloys of 6% to 10% aluminum lend themselves to solution heat treatment with a resultant increase in tensile strength and elongation; and this can be followed by aging to increase the hardness and yield strength with a drop in the elongation. Because of the iron and nickel impurities, magnesium-aluminum alloys do not stand up in salt water and they must be stabilized by the addition of manganese and zinc. **Zinc** is used in combination with aluminum to secure the best properties. It is slightly less effective than aluminum in regard to the physical properties but improves the salt water resistance. It is limited to less than 4% by increasing hot shortness. **Manganese** solubility in magnesium is 2% and it decreases in the presence of aluminum. A small amount added to magnesium-aluminum-zinc alloys steps up their salt water resistance considerably. Magnesium containing 1.5% manganese has the best corrosion resistance of the alloys. Since manganese contributes little to the physical properties, this alloy does not possess the strength the others do, so it is therefore used where the maximum resistance to salt water or the best weldability is desired.

Physical Properties

As the stress strain curve of magnesium does not exhibit a break as does the stress strain curve of a low carbon steel, the yield points of magnesium alloys are arbitararily taken as the stress where the curve deviates .2% from the modulus line. When reference is made to yield strength in this article, it is understood to mean tensile yield strength. Although the ultimate compressive strength of magnesium alloys is considerably higher than the ultimate tensile strength, the compressive yield strength is some-

Melting and superheating are done in these small furnaces. Flux must be sprinkled on the melt to prevent burning during these operations.

—*Metals and Alloys*

what lower than the tensile yield strength. Magnesium alloys are very notch sensitive, and sharp breaks in the contour which will permit stress concentrations to build up must be avoided in design work.

SAND CASTINGS

Magnesium alloys are usually melted in portable cast steel crucibles in oil or gas fired furnaces. These low carbon steel crucibles, ranging in capacity from 60 to 600 pounds, are dipped in molten aluminum to prevent scaling on the outside from the combustion gases. It is necessary to use silicon carbide crucibles to cast magnesium alloys with less than .02% iron, but they are less convenient to handle.

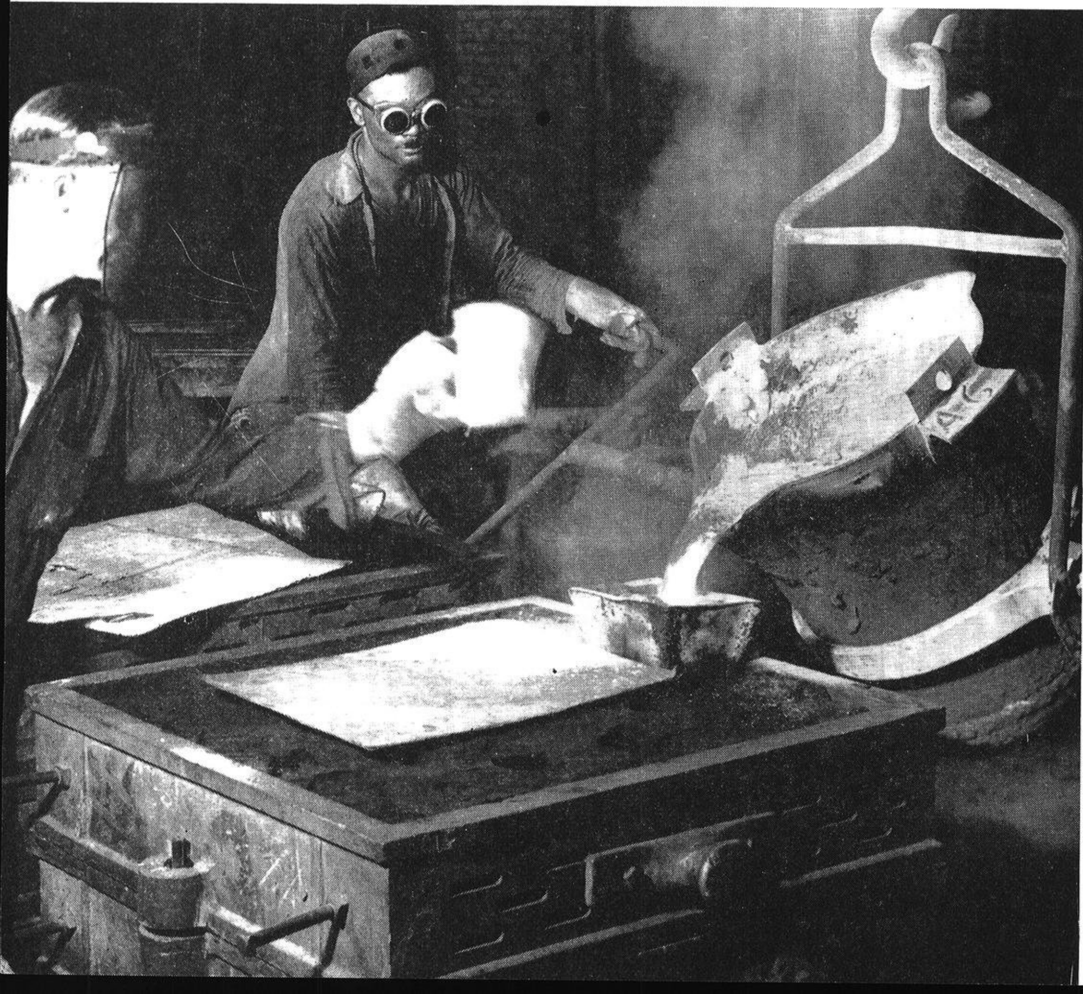
In melting down, the crucible is sprinkled lightly with a chloride base flux and charged with ingot and scrap metal. Enough flux is dusted on the surface to prevent burning during the melting process. Melting points of magnesium alloys vary from 1100° F. for high aluminum contents to slightly over 1200° F. for the pure metal. When exposed to air at temperatures over 1300° F., the alloys burn readily. The metal is purified below 1300° F. by adding a heavy layer of flux and stirring it into the melt with an iron rod. This stirring causes the flux to wet the oxide particles so that they become heavier and sink to the bottom of the crucible.

Superheating

Next a thermocouple is inserted and the surface of the melt thoroughly covered with flux. The metal is heated to 1600° to 1650° F. and held there roughly one-half minute for each pound of metal. This "super-heating" refines the grain size and improves the mechanical properties, although the mechanism of the reaction is not clear. Casting temperatures vary from 1500° to 1600° F., depending on the wall thickness and the size of the casting. The crucible is transported to the casting floor just prior to pouring. As the crucible is tilted the molten crust breaks free from the walls of the crucible and floats on the melt. The oxide and loose particles of flux are skimmed from the pouring lip. Immediately sulphur powder containing boric acid is dusted on the molten metal to form a sulphur atmosphere that prevents burning. The casting must be poured slowly and uniformly. Throughout the melting and casting process care must be taken to avoid placing damp skimming or stirring rods in the melt if severe explosions and fires are to be prevented. Grain size control and the degassing of the melt to prevent blowholes and porosity are probably the most annoying tasks that confront the metallurgist in a magnesium foundry today.

Sand

The sand used in magnesium foundries must be controlled very closely. Castings are made in either green sand or dry sand molds with the former being used most frequently. Synthetic sands containing 3% to 4% bentonite are employed successfully in several large foundries. It is conditioned after each use in the standard equipment for tempering, mulling, and aerating. Since molten magnesium recacts readily with moisture, all green molding sand must be treated with an inhibiting agent to prevent a reaction between the water vapor and the hot metal. These inhibitors which are usually mixtures of sulphur, boric acid, and ammonium fluorides make up 4% to 8% of the



As the casting is poured, sulphur powder containing boric acid is dusted on the molten metal to envelop the stream of metal in a sulphur atmosphere and prevent burning.

—Metals and Alloys

sand. The cores, consisting of sharp sand with small amounts of sulphur and borax and a minimum of binding oil, are baked at 400° to 450° F.

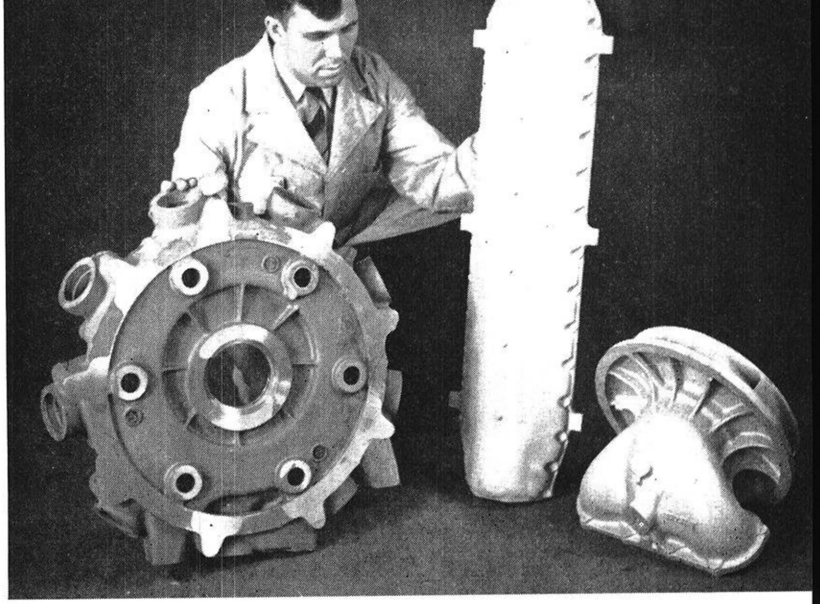
In the design of molds, allowances must be made for the low specific gravity of the metal. The casting should be filled through a number of gates rather than a few large ones. The fillets must be designed liberally to provide for the metal shrinkage of 5/32 in. per foot. A minimum section thickness of 5/32 of an inch is necessary. To insure the soundness of castings, risers are used freely. Upwards to 80% of the metal goes into gates and risers, depending on the type of casting. Generally patterns for aluminum castings can be used with small modifications, such as increasing the size and number of gates and risers. After the casting has cooled sufficiently it is shaken out by vibratory screens. The cores are removed with air chisels, or a hydro-blast if one is available. The gates and risers are cut off by large band saws.

Heat Treatment

Alloys C and H are used for sand castings. Alloy C gives the maximum pressure tightness while alloy H has slightly better salt water resistance. Since each of these alloys contain at least 6% aluminum, they can be solution heat treated and aged if necessary. Solution heat treatment consists of heating H for twelve hours at 730° F. or C. for twenty hours at 760° F. followed by cooling in air. The physical metallurgy of this heat treatment is the solution of the magnesium-aluminum phase that precipitated while cooling in the mold. This is a slow process and the more aluminum present and the larger particles the more time it requires. The air quench is sufficiently rapid to prevent the precipitation of the phase. The homgeniety of the casting accounts for its increase in ductility and tensile strength. If increased hardness and yield strength are required they may be obtained at the expense of the ductility by aging the casting at 350° F. for sixteen hours to uniformly precipitate the phase. The room temperature aging of solution heat treated magnesium alloys proceeds far slower than that of aluminum alloys and can be disregarded in most cases. The solution heat treatment is applied to airplane landing wheels where toughness and resistance to shock are required. Aircraft engine parts are frequently used in the heat treated and aged condition where a high yield strength is desired.

Alloy	Condition	Tensile psi	Yield psi	% E.
C	As cast	24,000	14,000	2
	Solution heat treated	39,000	14,000	10
	Solution heat treated and aged	39,000	21,000	3
H	As cast	27,000	12,000	5
	Solution heat treated	38,000	12,000	11
	Solution heat treated and aged	38,000	19,000	5

Following the heat treatment the castings are cleaned by grinding, filing, and buffing. Rotary files remove metal inaccessible to the grinding wheels. Lathes are used to cut the finishing surface on the circular outer surface of airplane landing wheels. Magnesium dust is a distinct **fire hazard.** All dust must be removed from grinding or filing operations by an air stream and wet with a heavy water spray to prevent serious explosions and fires.



Typical magnesium airplane engine castings.

—Do

If the casting must be pressure light, such as a supercharger housing, it is impregnated in a vacuum-pressure treatment with Chinese tung oil. The oil is later polymerized into a insoluble solid within the minute pores of the casting by heating to 500° F. for a short time. Substitutes are being sought for the imported tung oil in view of severe shortages. Alloy C is less subject to inter-crystalline shrinkage and is therefore easier to make pressure-tight than alloy H.

Permanent Mold Castings

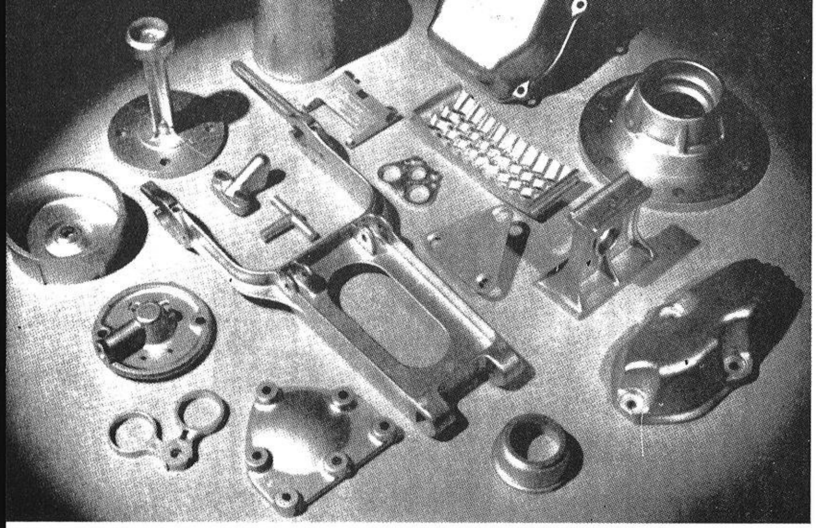
Often the casting design and the numbers involved will permit a gravity poured, permanent mold casting to be made rather than a sand casting. Substantial savings can be made in the cost of simple castings with medium sections and without complicated coring. The metal, usually alloy C, is hand ladled from a special melting pot at a temperature just above its melting point, and poured into split cast iron molds. The casting has a smooth surface and about the same physical properties as though it were sand cast.

Airplane motor application of magnesium and castings are blower sections, front and rear sections, supercharger and accessory housings, intake manifolds and oil pumps. Every airplane manufactured today has magnesium landing wheels. Additional weight saving uses are tail wheel forks, control wheels, cover plates, etc. When used in industry as housings for portable drills and grinders it reduces workers' fatigue.

Magnesium alloys are employed extensively in airplane engines at temperatures of 300° F. or better, but their use is not recomended for temperatures in excess of 400° F. as the mechanical properties are drastically reduced.

DIE CASTINGS

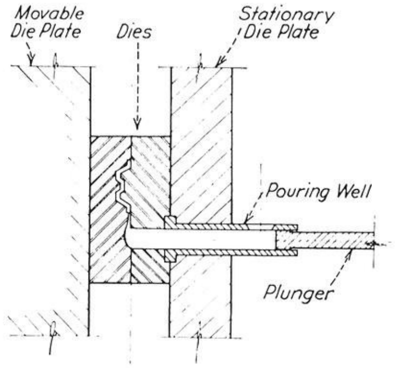
Die casting of magnesium alloys is a development of the last twelve years and it has been in commercial production only seven years. However, these products exhibit excellent physical properties and smooth surfaces and are an important part of magnesium alloy fabrication. To make



A variety of commercial magnesium die castings.

—Dow

the process economical several thousand castings are usually needed. Primary requirements for a good die casting are a machine with strength and rigidity and a die that fills rapidly through well placed gates. One of the most



Diagramatic sketch of high pressure cold chamber die casting machine with the dies in the closed position.

—Dow

successful machines is the high-pressure cold chamber machine. Its working details are shown in the accompanying sketch. The dies are held together by a direct hydraulic pressure of 500 tons, the metal is hand ladled into the slot, and the injection ram, backed by oil pressure at 1,000 psi, swiftly forces the molten metal into the die where it quickly solidifies. The die is opened for the removal of the casting and flash and then closed for another cycle of operation. Pressures of 4,000 pounds psi are sufficient to satisfactorily over come internal porosity. This machine is flexible in operation and has operated at as high as 100 cycles per hour on medium sized castings. The over-all metal efficiency is 90% compared with 20% for sand castings, and its casting efficiencies average 95%.

Melting

The crucible method of melting used for sand castings is unsuitable here. To prevent oxidation of the metal by the air, and a contamination by the flux, a 400 pound capacity cast steel pot is surmounted by a double walled, dome shaped cover partially filled with sulphur. The heat from the pot vaporizes the sulphur and causes it to pass through holes surrounding the ladle opening in the side of the cover. These vapors burn in contact with the air and introduce SO_2 into the air within the cover, thus preventing oxidation of the melt. No cover flux is used, although the metal is fluxed occasionally to clean it, the sludge being removed with a perforated skimmer.

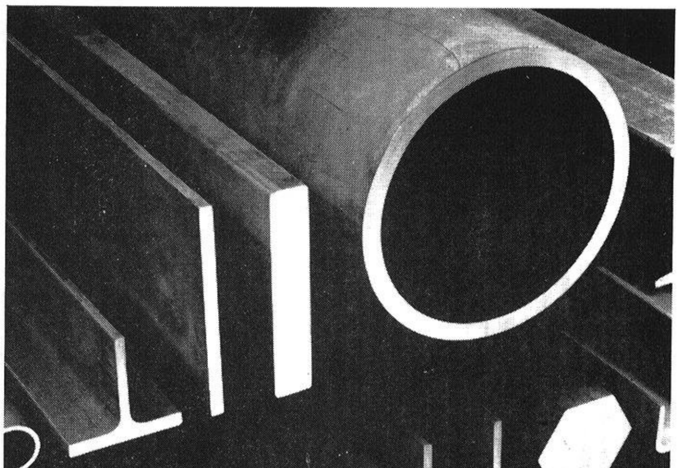
Alloy R is usually employed at a casting temperature of 1175° to 1250° F. For relatively short runs, carbon tool

Alloy	Condition	Tensile psi	Yield psi	% E.
R	Die cast	33,000	21,000	3

steel is sufficient for the die while chromium alloy steels are needed for longer runs. To avoid entrapping air, the die must be adequately vented. The best operating results are obtained with a die temperature in the neighborhood of 350° F. Some die castings weigh up to six pounds while others have projected surface areas of 250 sq. in. or lengths up to 74 inches. Magnesium die castings are used in engine parts, covers, and instrument housings for airplanes as well as in vacuum cleaners, typewriter cover plates, goggles and motion picture cameras. They have the best strength weight ratio of all the die cast metals today.

EXTRUSION

Tubing bars, and structural sections are produced by forcing the hot solid metal through steel dies under high pressures between 650° F. and 860° F. These relatively coarse grained cast billets are fed into the rear of the machine, heated to temperature, and moved to the extrusion chamber. The metal is forced out of the chamber according to the contour of the die as a fine grained fibrous product. The ease of plastic deformation depends on the temperature. If the temperature is too low the metal will bind in the die. If too high, it will be hot short and have poor properties. The dies and container are made from alloy



Extruded magnesium bars, shapes and tubing. Note the channel with a beaded edge in lower right hand corner.

—Dow

A large round shape coming out of the hydraulic extrusion press.
—*Metals and Alloys*

steel. The die is designed to allow the metal to slide across a friction surface. For sections with a uniform wall thickness the friction surface is uniform. For unsymmetrical sections this surface is increased for large cross-section profiles to retard the flow, and is decreased for small cross-section profiles to accelerate the flow. Thus unsymmetrical shapes are straight that would otherwise be distorted as they emerge from the die. Spontaneous grain growth takes place immediately as the material leaves the die. This can be prevented and the physical properties improved by spraying the product with water as it comes out of the die and ageing at a low temperature. The accompanying table shows the physical properties in the extruded condition for section sizes up to 1½ in. Medium sizes give slightly lower properties and large sizes considerably lower because they are neither as fine-grained nor as uniform in structure. Tubing and thin walled sections also give lower properties.

Extruded Shapes

Extrusions come in hundreds of available forms. This includes all of the standard angles, channels, I beams up to seven inches, bar stock in rounds, squares, or hexagons up to four inches; rectangles up to six inches; and tubing in many wall thicknesses from one-quarter inch to seven and one-half inches in diameter. Many special sections can be easily made which give maximum strength in airplane construction with a minimum of weight. By placing beads at edges of channels, the rigidity is considerably increased with a small increase in weight. This is due to the increase in the section modulus I/c, where I is the moment of inertia of the section about the neutral axis and c is the distance of the outermost fiber from the neutral axis. As the section modulus increases, the bending moment that can be applied to the section also increases and more rigidity is developed. In contrast to their excellent physical properties and design characteristics, extruded shapes have very marked directional properties on account of the preferred crystal orientation in the direction of extrusion. All of the properties noted so far are in the direction of extrusion (longitudinal). The transverse properties, especially in thin walled channels and shapes, are far below their longitudinal properties. This should be kept in mind in designing special sections so that only relatively small stresses are applied in the trans-

Alloy	Condition	Tensile psi	Yield psi	% E.
FS	Extruded	40,000	29,000	16
J-1	Extruded	43,000	30,000	17
M	Extruded	40,000	27,000	6
O-1	Extruded	47,000	33,000	11
X	Extruded	42,000	30,000	19
X	Extruded and aged	44,000	34,000	13

verse direction. The aircraft industry uses extruded sections in special design work, furniture, flooring, and instruments. Commercial applications are truck bodies, dock board, safety blocks, etc.

FORGING

Magnesium forgings may be made by either hammer or press forging, the latter being more important and giving better physical properties. Extruded stock is generally employed because of its initial fine grained structure. Working temperatures are below 700° F. because of hot shortness, but above 415° F. due to lack of plasticity. Since the residual internal stresses of hot worked forgings are low, recrystallization will take place near the working temperature. Forgings can be subjected to temperatures below the working temperature without fear of coarsening the grain. There is some recrystallization and grain growth taking place as the metal is forged. If the product is water-quenched and aged instead of air-cooled, the grain size is finer and the yield and tensile strengths increased. During working operations the projected areas are subjected to pressures that vary from 50,000 psi for simple forgings, to considerably higher values for thin walls and high lifts. The cast or forged steel dies that are used must be thoroughly preheated. Alloys J, O, and X are employed in press forgings, and have higher physical properties than alloy L (3% Al, .2 Mn, .3 Zn, and 3.5 Cd)

Alloy	Condition	Tensile psi	Yield psi	% E.
J-1	Forged	40,000	24,000	10
O-1	Forged	45,000	30,000	8
	Forged, aged	46,000	33,000	6
X	Forged	41,000	24,000	16
	Forged, aged	42,000	28,000	14
L	Forged	37,000	26,000	11

which is used in hammer forgings. Typical applications are in hydraulic accumulator shells, valve bodies, and cylinder bodies.

ROLLING

Extruded or cast blocks are the starting materials in the production of rolled sheets. The rolling capacity of magnesium alloys depends on the plastic deformation which in turn is a function of the working temperature, speed of working, crystal orientation and grain size. All sheet is initially hot rolled with several intermediate heatings. Grain growth and recrystallization are continually occurring at hot rolling temperatures, so to obtain a fine grain size, the small final reduction is accomplished by cold rolling. A soft or annealed product is obtained by heating at relatively low temperatures to permit recrystallization to take place. Maximum rolling temperatures are limited by the hot shortness of the alloy employed and excessive grain size. The amount of rolling below 415° F. is limited. Because rolling and annealing introduce some unevenness and warping, it is necessary to flatten the sheet in a special machine containing numerous small rolls. The surface of magnesium sheet is very sensitive during the rolling and annealing operations and it is essential to have the rolls and furnaces absolutely free from metallic dust of all kinds to prevent surface defects. Alloys M and J-1 are normally rolled with four foot widths in thicknesses varying from .016 to .500 inches. Alloy M is for moderately stressed parts such as tanks which require maximum formability and weldability. Alloy J-1 is for highly stressed parts that do not require severe forming. Both alloys have excellent corrosion resistance.

Alloy	Condition	Tensile psi	Yield psi	% E.
J-1	Annealed	42,000	24,000	16
	Hard rolled	45,000	35,000	8
M	Annealed	32,000	16,000	9
	Hard rolled	37,000	27,000	15

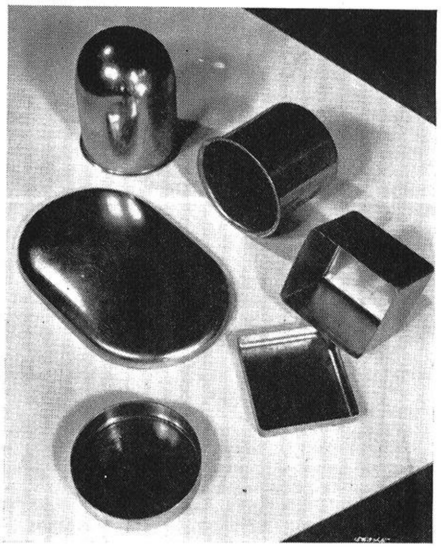
Sheet is used in truck and trailer bodies and in airplanes as fairings and dust covers for landing wheels, furniture, and instrument panels. The longitudinal properties are usually designated in specifications, although the transverse properties are higher due to crystal orientation during rolling.

Design

From a theoretical standpoint, the thickness of magnesium sheet only has to be increased 15% over duralumin to compensate for its lower modulus (6,500,000) to make it as rigid as duralumin with a modulus of 10,000,000. A weight saving of 25% remains. If substituted for duralumin on an equal weight basis, the bending strength is almost doubled and the stiffness increased two and one-half times. However, it has been found on tests that a low compressive yield strength has offset to a large extent the lower specific gravity. The development of new alloys is expected to remedy this shortcoming.

MISCELLANEOUS

Moderate deformation of magnesium sheets can be done at room temperatures, but the amount of cold working is definitely limited. Alloy M is almost exclusively



Parts drawn from annealed magnesium sheet by hydraulic presses operating at slow speeds.

—Dow

employed in drawing cups at 500° to 750° F. Slow speeds are necessary to give the metal time to flow and stretch without fracturing. Soft steel die parts are satisfactory for most operations.

Riveting of magnesium structures is done with aluminum rivets, as magnesium rivets cannot be hot-driven. They must be driven carefully to avoid over-stressing of surrounding material which will lead to an early failure.

Welding

Gas welding is done by either oxy-acetylene or oxy-hydrogen torches with a chloride base flux. Castings, sheet or extruded shapes may be welded to one another. Alloy M, the most weldable of the alloys, is used for welded oil tanks. There must be no flux inclusions in the weld and all the flux must be cleaned from the weld by scrubbing with a brush and hot water and a chrome pickle treatment. The recently developed process of arc-welding in an atmosphere of helium eliminates the possibility of flux inclusions. An envelope of helium around the arc between an electrode and the work prevents the oxidation of the molten magnesium in the weld. Either a magnesium alloy welding rod or an infusible tungsten electrode can be used. Electric resistance spot and seam welding can also be applied to extruded or sheet magnesium alloys.

Machining

The machineability of magnesium alloys is outstanding. The metal forms fine chips or small rolls and leaves a smooth finish with no tendency to drag or tear. Since the cutting pressure of magnesium is lower than that of any other metal the power consumption is small, being 3/5 of that required for aluminum and only 1/6 of mild steel. The metal rapidly conducts heat away and neither coolants nor cutting fluids are used. Because of the fire hazards, cutting swarf should not be allowed to accumulate on the machines. Standard tools, with a small increased clearance, can be used for nearly all machining operations, but they must be kept very sharp. High cutting speeds with large cuts are employed in roughing operations. For fine cuts the machine is run at maximum speeds. It is believed that the machinability of magnesium alloys can be further exploited when higher speed machines become available.

Corrosion

Corrosion occurs as pitting and stress corrosion. Pitting, the most common form, is due to several factors, the main one of which is the presence of foreign metals. These dissimilar metals form small galvanic cells with the magnesium and produce overvoltages. This is the reason the low impurity alloy J-1, has good corrosion resistance. It also explains the need for lacquering the contacting surfaces when bolts and inserts of dissimilar metals are used. This does not include high aluminum-magnesium alloys, such as duralumin. Stress corrosion is dangerous because it takes place in the simultaneous presence of stress and corroding solutions, and leads to internal cracks without any external signs of attack.

Surface Protection

As pointed out earlier, surface protection can be afforded magnesium alloys by pickling. First, all foreign matter must be removed from the surface of the metal. This is best accomplished by wire brushing or sanding to remove dirt and oxide, and the use of solvents to remove grease. Although sand blasting is very economical, magnesium is sensitive to this treatment and corrosion is accelerated. The usual surface treatment is a chrome pickle consisting of one-half to two minute dip at room temperatures in water containing 1.5 lbs. sodium dichromate and 1.5 pints of nitric acid per gallon of water, followed by a final warm water rinse. This removes but .0005 of an inch of metal and leaves a bronze colored surface that serves as an excellent anchorage for subsequent painting. For superior protective value combined with small dimensional changes, the Army and Navy specify for aeronautical use a five minute dip in 15% to 20% hydrofluoric acid followed by a 45-minute boil in 10% sodium hydrofuoric dichromate. The yellow or brown coatings from these dichromate treatments are probably a mixture of magnesium and chromic oxides. Other surface treatments are available to meet special types of corrosion. The reason manganese has such a beneficial effect on magnesium corrosion resistance is that the excess insoluble manganese effectively precipitates the finely divided insoluble iron and drags it to the bottom of the melt, thus removing it from the magnesium and preventing its harmful corrosion effects. Metallic coatings will not adhere to magnesium. To obtain best painting results, a zinc chromate inhibitive primer is used on a pickled surface with a finish coat of the synthetic resin enamel or lacquer types.

Cast fittings are welded to an oil tank by means of an oxy-acetylene flame and a protective flux. The baffle sheets within the tank are joined to the shell by spot welds.

—*Metals and All*

The foregoing material has covered in a general manner the present methods in the casting and fabrication on magnesium alloys. Germany foresaw the possibilities of magnesium in the early twenties and has developed its technology and use to a greater degree than we have. However, our production has been stepped-up enormously and we expect to become the leaders in both quality and quantity in the near future.

The English translation of the German author Beck, "Technology of Magnesium Alloys," 1939, contains the best available data on the physical properties and fabrication of magnesium alloys. The following references, from which information was also drawn, are publications of the Dow Chemical Company, Midland, Michigan.

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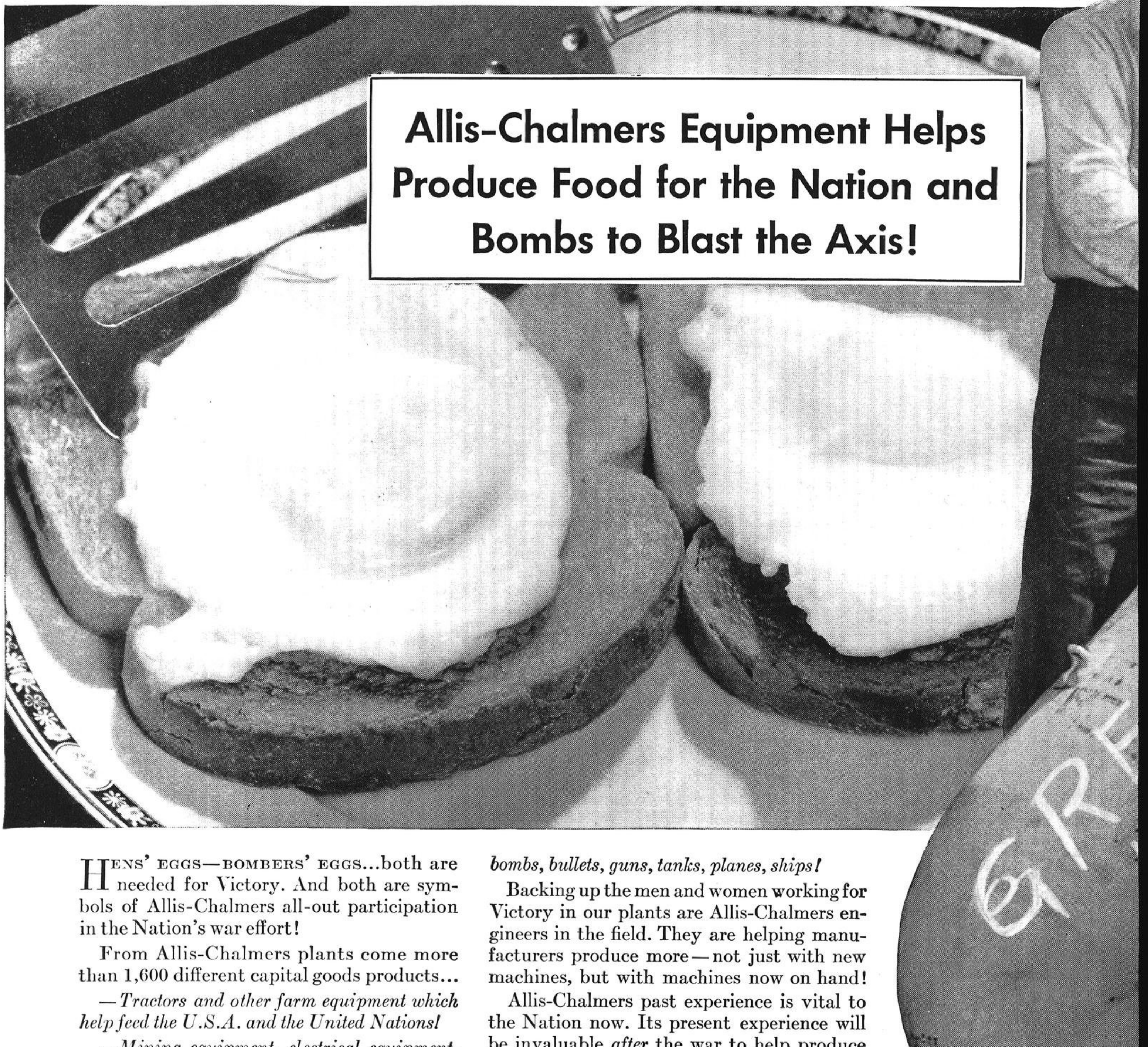
EGGS...ON TOAST OR



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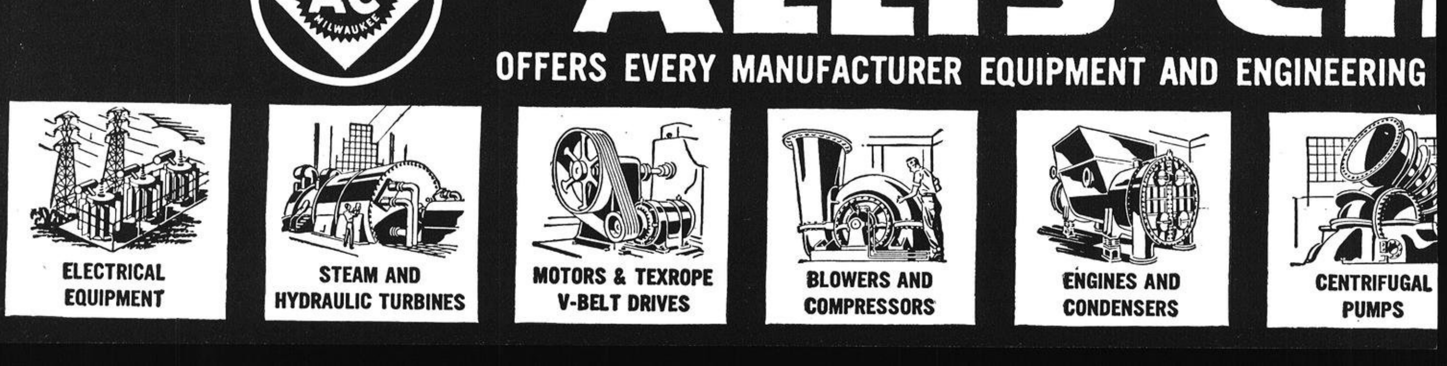
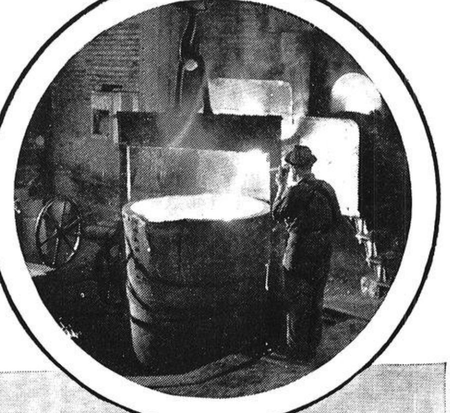


TOKYO!

A-C Equipment helps produce both steel and explosive charge for demolition bombs like the one here.



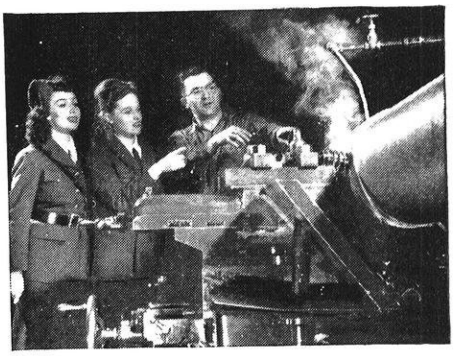
A-C Plants are casting and finishing industrial machinery at a record rate!

…is-Chalmers tractors and grad… equipment are helping build …itary roads and airports.

VICTORY NEWS

Rosiclare, Ill.—91 Allis-Chalmers motors constitute the major portion of a connected load of close to 1,000 hp driving the new fluorspar mill of the Mahoning Mining Company here.

The efficient layout of flexible motors and drives is largely responsible for the plant's record production of high-grade fluorspar zinc-lead ore. Throughout the mill, the Allis-Chalmers motors operate dump hoppers, flotation cells, vibrators, kilns, pumps and many other machines.



"We're Buying and Building," an A-C workman tells MGM bond rally starlets, as he machines a Navy propeller shaft.

Milwaukee, Wis.—The "feed-back" system, which utilizes 85% of the enormous power expended in breaking in aircraft engines on test stands, has been adopted by Buick in its new plant in a mid-western city.

The new engines are connected by flexible shaft couplings to water-cooled magnetic couplings, which transmit power to 1200 kva synchronous generators.

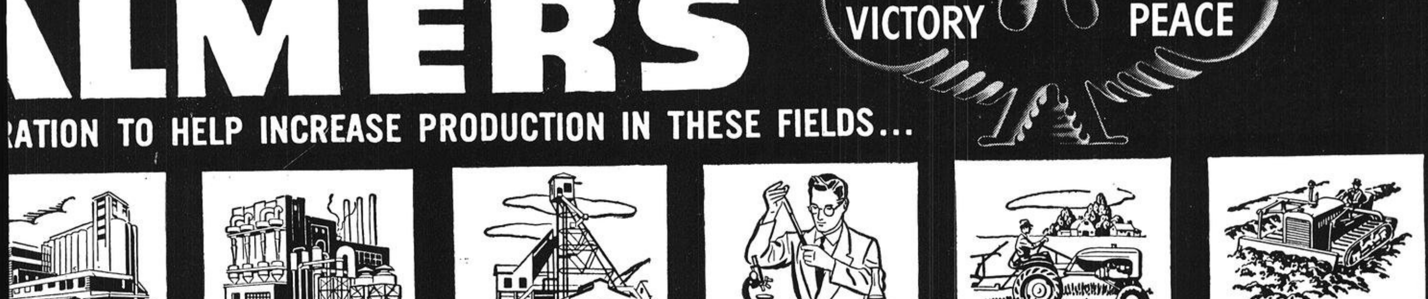
Allis-Chalmers alternating current units are at work here. They not only help to crank the new engines, but they also operate as current absorption-type dynamometers—receiving power from the aircraft engine, turning it into electrical energy and feeding it back into the line. This test set-up provides a high percentage of the power required by this company's manufacturing operations.

FOR VICTORY
Buy United States War Bonds

…LMERS

WE WORK FOR VICTORY — WE PLAN FOR PEACE

…RATION TO HELP INCREASE PRODUCTION IN THESE FIELDS…



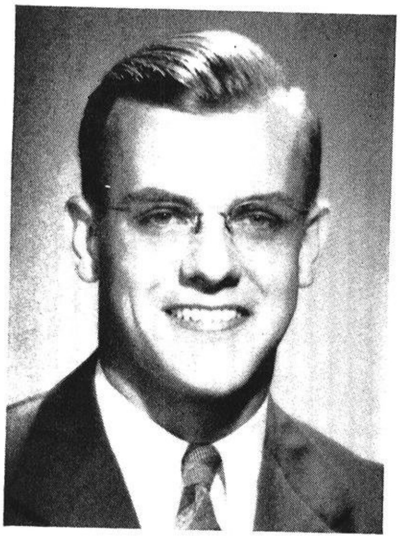
…OUR AND SAW …L EQUIPMENT | CHEMICAL PROCESS EQUIPMENT | CRUSHING, CEMENT & MINING MACHINERY | BOILER FEED WATER SERVICE | POWER FARMING MACHINERY | INDUSTRIAL TRACTORS & ROAD MACHINERY

Honorary and Social Engineering Fraternity

PRESIDENTS

ROBERT BORCHARDT

Tau Beta Pi, the highest of the honorary engineering fraternities and the engineer's equivalent of Phi Beta Kappa, has been directed by Bob Borchardt for the past semester. Being self-sufficient at school



as an assistant in the advanced drawing department, and as a defense training instructor, has kept him five years in the mechanical engineering course.

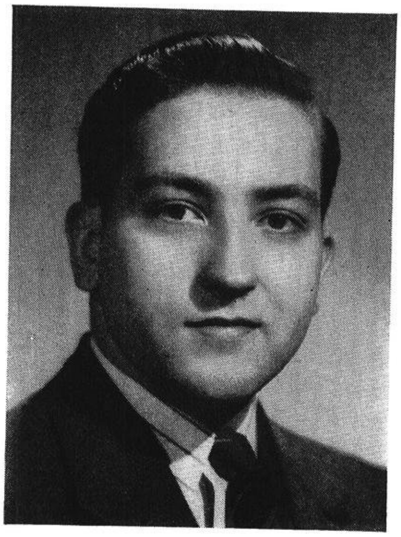
He comes to Madison from North Division high in Milwaukee and has received numerous honors here. He is a member of Phi Eta Sigma, freshman honorary fraternity, and Pi Mu Epsilon, honorary math fraternity, and Pi Tau Sigma, honorary mechanical engineering fraternity, and is listed in "Who's Who in the University," a book which includes the outstanding college students in the country. He has also found time to belong to the American Society of Mechanical Engineers and to be an exhibitor at the Engineering Expositions.

Bob spent last summer doing design drafting in the engineering office for the construction of the barracks at which is now known as Truax Field, the Army Air Force Technical Training School located just outside the city of Madison. He has also worked three summers for the Harnishfeger Corporation of Milwaukee in the materials department. After graduation Bob expects to join the Navy as a specialist instructor in academic courses.

•

HENRY GEISLER

Henry Geisler, from Manitowoc, presides over Pi Tau Sigma, honorary mechanical engineering fraternity, which is one of the most active of the honoraries, having many parties and meetings. He played tennis and was circulation manager of the yearbook at the Lincoln high school. Henry continued along business lines of literature on the engineering campus and has been on the business staff of the **Wisconsin Engineer** since his freshman year. He has worked on both campus and alumni circulation, and has been circulation manager for the past year. He is also a member of Phi Eta Sigma and Tau Beta Pi. At the present time Henry, as part time



instructor in the Physics laboratories, is having his difficulties trying to impress the theory of Physics into the hill students. He participates in all of the dormitory athletics at Chamberlain House.

Several of his summers were occupied by drafting of equipment and plant lay-out for the Manitowoc Shipbuilding Company. Henry took the twelve weeks' session last summer and is graduating in January. He is going with North American Aviation Corporation, Inglewood, California, as a member of the preliminary training group. He expects to do design work or stress analysis.

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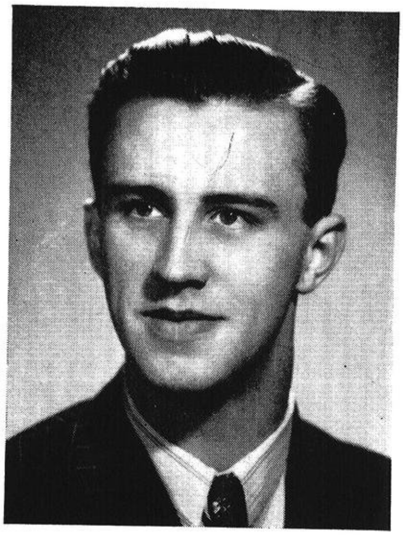
PAUL HOFFMAN

Paul, president of Eta Kappa Nu, honorary electrical engineering fraternity, is one of the most active seniors in the College of Engineering. He attended Milwaukee Extension for a year after graduation from Milwaukee Washington high.



In high school he was active in debating, sports editor of the school annual, and an excellent polt vaulter. He won the state track meet and his record still stands at the Waukesha relays. Here at the University he won his numerals in track, but his outside work has kept him from Varsity competition. He is an outstanding piano soloist and almost entered the Music School instead of Engineering College.

Paul is vice president of Tau Beta Pi in addition to being a member of A.I.E.E. and Phi Eta Sigma. In his sophomore year he did statistical research for the math department, and the last two years he has been working as an inventor in the Electric Standards lab under Professor Royce Johnson. This year he also has a research apprenticeship from the Wisconsin Alumni Research Foundation in the Standards lab. Among the numerous things Paul has invented is an electric washing machine which he declares washes five times as fast and costs initially but one-fourth of the ordinary commercial machine.

Last summer at Barber - Colman Company, Rockford, Illinois, he did research and experimental engineering. He enjoys a combination of development and research work, and likes to follow a project through from the initial research to the finished product.

•

MERTEN VOGEL

Merten presides over Chi Epsilon, honorary civil engineering fraternity. He is a product of Milwaukee West high where he was active in gymnastics and tennis. He continued as a gymnast here and won his numerals doing apparatus work. Merten is a member of Tau Beta Pi, Phi Eta Sigma, and American Society of Civil Engineers. In addition

to his studies he has been entirely self-supporting during his four years of school. At the present time he is an assistant to Professor Cottingham in the structures course.

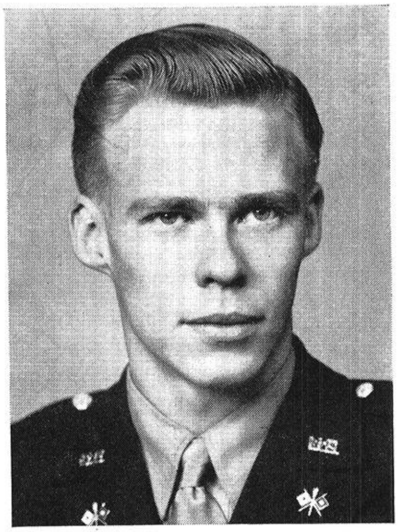
He has spread out his education this semester by taking eleven credits on the hill. Philosophy is his favorite subject, and he highly recommends the liberal arts course as a good supplement to engineering training.

Several of his summers have been spent working for the Highway Commission as draftsman and materials inspector in the make-up of concrete. Merten expectcs to go into the Army after graduation and is interested in the meteorology training course.

•

DAN AULT

Dan Ault, a junior from Monroe, heads Kappa Eta Kappa, professional electrical engineering fraternity. In spite of the title "professional fraternity," the eighteen boys at the house lead an active social life and have their share of parties and dances. He is a member of ad-



vanced R.O.T.C. Signal Corps and A.I.E.E., in addition to being an assistant code instructor in the Naval Radio School. Back in high school he was a swimmer and spent several summers as a life guard and counselor at a boy scout camp. Here at Madison he has little time to follow up his swimming ambitions.

Dan has his heart set on the communications field, having been interested in the telephone and telegraph since he was in grammar school. Two summers ago he roamed over southern Wisconsin doing construction and repair work for the Commonwealth Telephone Company. Last summer he was a draftsman with United Telephone Company. In the course of his work he drew up a complete layout, including switchboard and reserve generator, for a new office building.

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EDWARD BOSLEY

Ed, president of Triangle, the engineering social fraternity, for the past semester, hails from far off Schenectady, New York. Graduating from high school in 1935, he

was accepted as an apprentice drafter with General Electric and received his diploma after four years of intensive training. Not satisfied at stopping there, Ed packed his duffle bag and headed west to further his education. He chose mechanical engineering and started out as a freshman at Iowa State. Shortly thereafter he jumped at the opportunity of becoming an instructor in mechanical drawing at the University of Wisconsin and since then has kept himself "mighty" busy both as a student and member of the faculty.

He is vice chairman of the student chapter of the A. S. M. E. and was an active participant in the Engineering expositions. We can't overlook his fancy handball playing and his smooth skiing.

Rumor also has it that Ed is more than just friendly with a petite number on the feminine side back home. As a matter of fact, we wouldn't be at all surprised to see engagement yield to matrimony shortly after he casts aside his U. of W. cap and gown next August.

Structural Steel Shortage Is Relieved By . . .

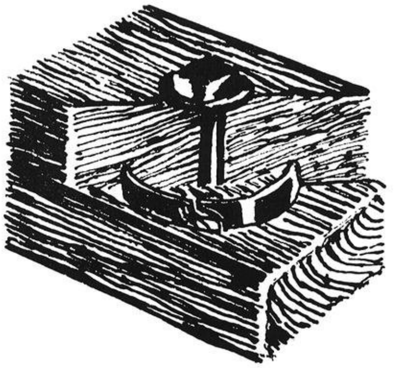
LAMINATED WOOD

by Harvey Johnson, m'45

IN THESE crucial times when our structural steel is at a premium, it is imperative that our engineers find suitable substitutes for this important war material. Out of the combined efforts of research and field work, alloys and plastics are continually finding new uses. But the quantity of these materials is small compared to the amount of steel they could be called on to replace. Wood is a natural material of which we have an abundant supply, and it is not surprising that it has stepped up to play the role of a leading construction medium for at least the duration. It is only strange that it has not reached its full usefulness before. It is, pound for pound, one of the strongest engineering materials and it resists impact very well. Extensive research has been carried on for the past two decades, with the Forest Products Laboratory producing many new developments in recent years.

Problem in Truss Design Solved

The chief indictment against heavy timber construction, originally known as mill construction, is that working details have not been conveniently available in simple form. Also, proper proportioning and suitable column spacing is essential to prevent failure. Because many industrial enterprises demand maximum space, the truss was introduced. However, until recently the trusses called for costly metal fittings and excessive bearing areas at the joints to accommodate all of the required bolts. This difficulty has been solved by the use of a metal ring concentric with the bolt and extending half of the depth of the ring into each of the contacting surfaces. To make it more efficient the ring is split so that both its inner and outer surfaces provide bearing action in its groove. In effect, it is a method of laminating wood to its strongest form. This development has enabled the construction of bridges and large buildings and has released many tons of steel to war



This small metal connector has made possible more extensive use of truss construction.

production. Structural steel and re-enforced concrete are being replaced successfully by timber structures which measure up to temporary and permanent specifications.

Other Laminating Methods

Wood can also be laminated by either cold setting or thermal setting glues. The most recent development is the cold setting urea glue which has found an important use in the construction of laminated boat members. This glue is completely waterproof and will not delaminate under normal conditons. The relatively new combined column and truss has an element of structural beauty in addition to its strength. Several thicknesses of thin wood sheets are glued together in any desired shape or length. This utilizes material too small for large structural pieces. The thermal setting or hot press glue is used only when high temperatures can be applied to the glue line. It is used

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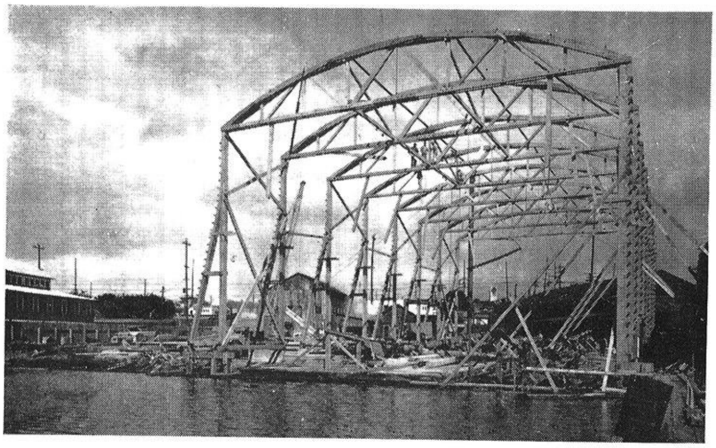
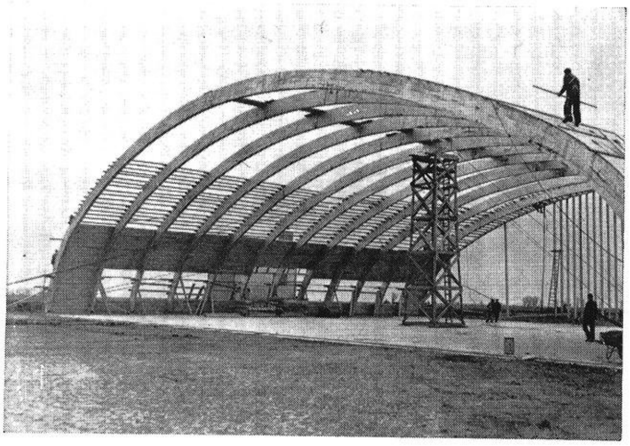


High Bays using prefabricated arched trusses are easily erected.



The laminated arch, a recent development, is adapted to hangar design.
—Courtesy Civil Engineering


COMMUNICATIONS
...directing arm of combat
This battle drawing was prepared with the aid of Army and Navy authorities.
IN modern battle, our fighting units may be many miles apart. Yet every unit, every movement, is closely knit into the whole scheme of combat—through communications.
Today much of this equipment is made by Western Electric, for 60 years manufacturer for the Bell System.
Here are some examples of communications in action.
1 Field H.Q. guides the action through field telephones, teletypewriters, switchboards, wire, cable, radio. Back of it is G. H. Q., directing the larger strategy... also through electrical communications. The Signal Corps supplies and maintains all of this equipment.
2 Air commander radios his squadron to bomb enemy beyond river.
3 On these transports, the command rings out over battle announcing system, "Away landing force!"
4 Swift PT boats get orders flashed by radio to torpedo enemy cruiser.
5 From observation post goes the telephone message to artillery, "Last of enemy tanks about to withdraw across bridge..."
6 Artillery officer telephones in reply, "Battery will lay a 5 minute concentration on bridge."
7 Tanks, followed by troops in personnel carriers, speed toward right on a wide end-run to flank the enemy. They get their orders and keep in contact—by radio.
Western Electric
ARSENAL OF COMMUNICATIONS
ARMY E NAVY
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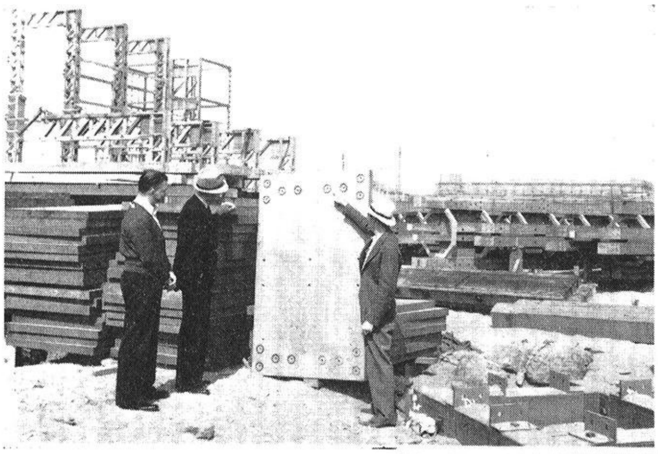
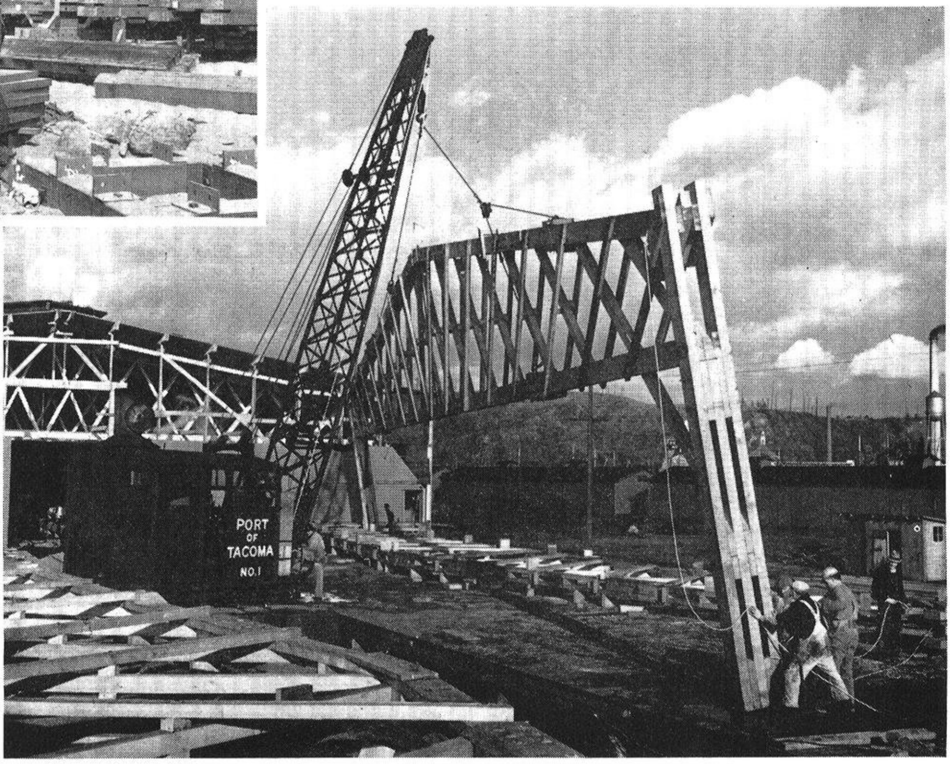


Left—Prefabricated panels having timber connections for attachment to columns and trusses.



Right—Large units of lattice truss and columns can also be built on the ground or in the shop which which makes them ready for erection by cranes on the job-site in a minimum of time.

— *Courtesy Civil Engineering*

(continued from page 22)

extensively in the manufacture of plywood panels. This process does not apply to heavy timbers because it is too difficult to transmit heat to the glue line. However, work is being done on an electric process which will overcome this problem.

The army and navy are using structural timber in increasing quantities as is evidenced in their hangers, ports, bridges, dams, boats, and cargo truck bodies. One of the difficulties encountered is the procurement of sufficient supplies for their construction. Kiln drying is necessary due to the high moisture content, and it requires as much as three weeks to get the wood in proper condition.

Timber is indispensable as an aid in dam construction for its properties make it superior to steel penstocks. The only steel required is in the straps that bind the wooden staves. Wood is hygroscopic and will absorb moisture in damp atmospheres until its cell walls are saturated. When it is subjected alternately to water and air it should be treated with a preservative to prevent attack from fungi and bacteria that cause deterioration.

In a recent survey made to determine the relative merits of wood and steel, it was discovered that in a typical 35,-000 man cantonment, a saving of nearly a quarter of a million dollars was made by using a wooden pipe water system. One reason for this enormous saving was that unskilled labor could be used for most of the work instead of the semi-skilled labor required for cast iron.

Prefabrication

Although pre-fabrication was used to a limited extent before the war in permanent housing, it is still in the process of development and is being given a tremendous boost by the war. Trusses, columns, and girders as well as panel sections can be made in the shop and carried to the job site where they are assembled with a saving of time and labor. Although the unions have opposed pre-fabrication methods, the saving in time and labor is vital in our war effort. Its peacetime future will probably depend on whether or not a majority of the people can profit by it.

Each instance in which wood can be substituted for steel or cast iron contributes to the war effort. One of the latest developments, a pressure treated manhole cover, promises to find extensive use throughout the country. The idea was originated by Los Angeles County, California, to accommodate war workers in unincorporated areas. This seemingly small item made with laminated wood strips in either a hexagonal or circular shape will save approximately 500 pounds of metal in each cover. Multiply this and other similar small savings, and an important economy results.

These are but a few of the uses and developments before us today and if the progress to date is any indication, we can expect to see wood reach greater importance following the war. Possibly one of the reasons we have not seen better advantages taken of its qualities is that most

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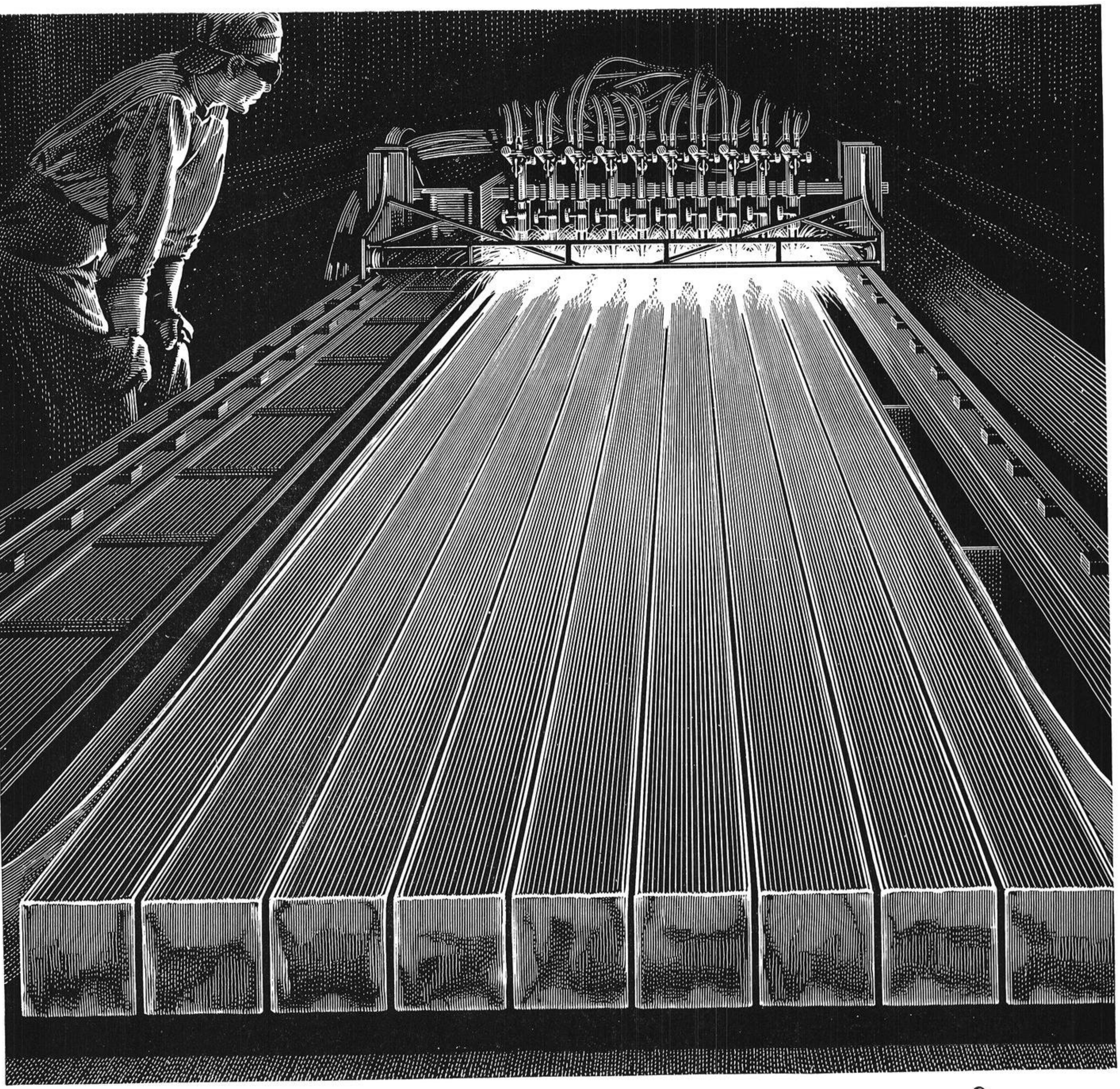

SLICING STEEL SLABS—and production schedules

STEEL billets were needed. Only slabs were available. That was the problem presented by expanded war-time demands which had to be licked, quickly. It was—by the process illustrated above. Ten oxyacetylene cutting torches, mounted on a frame propelled by two Airco Radiagraph machines, streak down the 140" steel slabs and slice them into billets.

It's one of the many examples of how American resourcefulness, teamed with specialized knowledge, is making minutes more productive. Oxyacetylene cutting and welding and the electric arc are blazing new trails to faster and better production in almost every war industry. The minutes, hours, even days of production being gained by these modern tools are now helping us to overcome our enemies' headstart.

If you work with metals you should know the complete story of the oxyacetylene flame and the electric arc—their speed, efficiency and broad range of usefulness in metal working. This knowledge is vital today—invaluable in the peace to come.

"Airco in the News" shows many interesting uses of the oxyacetylene flame and electric arc. Write for copy.

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In Texas:

Magnolia-Airco Gas Products Co.
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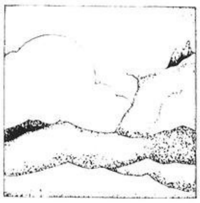
ANYTHING AND EVERYTHING FOR GAS WELDING OR CUTTING AND ARC WELDING



AZO VALLEY
And the Legend of the Augurino

by Howard Schutz, met'43

THE tale came to me through a real Western old-timer, the kind of drifter who has lived a little while in almost every famous mining camp from Cripple Creek to California's Klamath River. He didn't claim that he was in the Azo Valley when it all happened, but he swears that the grandfather of a friend of a friend of his will vouch for every word of the story. And here is the story:

Back in the days before the white man invaded the West, the Azo Valley, deep in the vastness of New Mexico, was visited only rarely, and then just by a wandering tribe of Indians. It wasn't any paradise; it was too dry for that. But one day an army of engineers and workmen came into the valley, and went to work surveying along the river and nearby territory. It wasn't long after that when a big dam arose to tame the river and make available billions of gallons of water for irrigation. Soon crowds of homestakers arrived, and long networks of irrigation ditches began to radiate from the dam to all parts of the valley. In no time it became a thriving farming community. Then a strange thing happened.

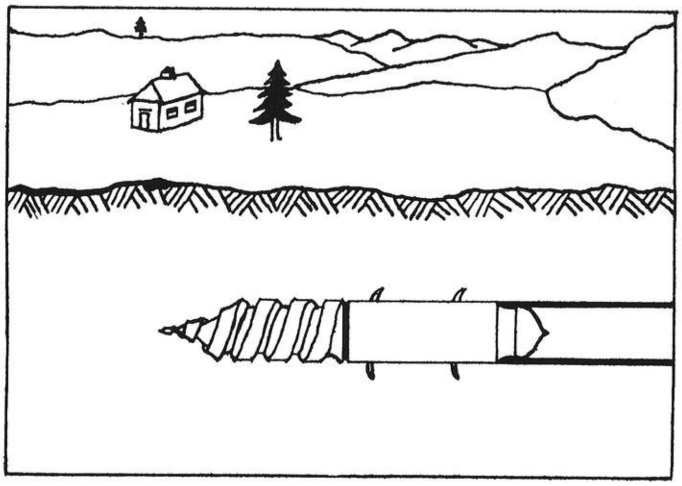
The irrigation ditches wouldn't hold water. It would disappear almost as fast as they could pump it into the ditches. A thorough checkup revealed that someone—or something—had been boring tunnels into the sides of the ditches. But what tunnels! — exactly 0.786 feet in diameter, perfectly cylindrical, and lined throughout with some glassy substance. Now how and why was this being done? Water was cheap.

One day a farmer was working near a ditch when he heard a peculiar noise under him. It was a sort of drilling under the ground, and was slowly moving toward one of his ditches. In about half an hour the side of the ditch caved, and out came what looked like a large drill, about nine inches in diameter. Here was the source of all the trouble—and furthermore, "it" was actually alive! This Rube Goldberg nightmare consisted of a "snout" (the drill) about two feet long and revolvable about the rest of its body, which looked like a cylinder, with an occasional claw jutting out to serve as a brace for the drilling. At the rear was an opening running completely around it, and out of which was exuding a molten glassy substance—pure fused silica! Here, for the first time ever seen by man, was the AUGURINO!—the only animal ever known to subsist on rock and soil alone.

Attempts to trap it proved useless. The drill was composed of some material harder than any known substance. If caught in any trap, it would simply bore right through it and away into the ground. Meanwhile, thirsty crops were withering under the merciless July sun.

About then, a peculiar character arrived in the valley from the north. But everyone was too busy to be interested in anything but an augurino. And this man wasn't an augurino, but he was about the closest kind of humanity to an augurino. He was a geologist.

You can imagine what an appeal an augurino would have for a geologist. Soon he was speeding about the valley, intent on locating one. When he finally did, he brought transit, tape, and other measuring instruments, and set to work observing the movements of the animal for several days without a letup. He carefully plotted the position and rate of movement of the drilling noise, and he discovered some amazing things: The augurino travelled, where possible, in perfectly straight and horizontal lines. Not only that—it moved exactly 364.94 feet per day. This greatly simplified the problem of keeping track of augurinos. Now it was just a matter of taking a portion of a map and making a straight line time-and-motion graph out of it.



Author's conception of the augurino.

The geologist became consumed with one burning ambition—to catch an augurino and see what made it tick. Of course, everybody told him he was crazy—that an augurino was one animal that just couldn't be caught, because of its terrifically hard drill. But, as you probably know, a geologist is not one to take "You can't catch an augurino" for an answer.

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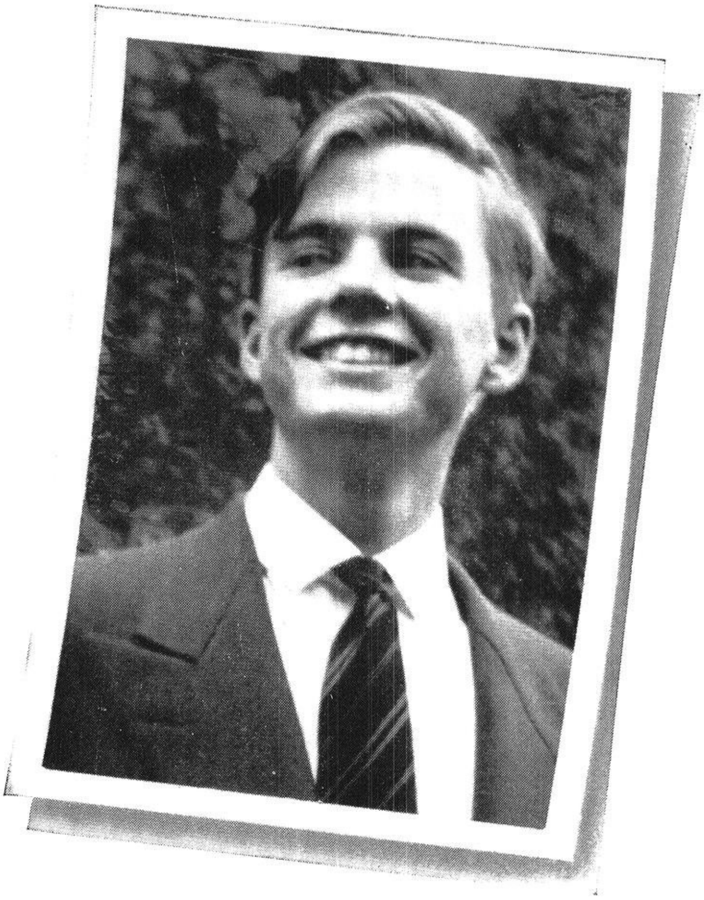
Son...



HE has just turned eighteen. Shaves twice a week and maybe a hair or two is sprouting on his chest. He shies away now when his dad tries to be affectionate and we noticed some lipstick on one of his handkerchiefs after a country club junior dance not so long ago. But it seems only yesterday, perhaps it was the day before, that he was a chubby legged kid swinging from the arch of the doorway, leading to the dining room, in a gadget that was something like a breeches buoy and he was sucking at the end of a turkey bone.

He went back to school this Fall, a tall, athletic lad, budding into manhood, but there was something else on his mind beside the football and hockey teams or the little blonde girl with whom he had "palled" around during the Summer. It seems as though he was listening for a certain call—the Clarion call that poets sing about—and, perhaps we just imagined it, but we thought we saw an upward jutting of his chin, a certain light in his eyes, and a sort of a rearing-to-go expression in his face.

It chilled us a bit in the region of our heart, when we thought of his discarding the sports coat for the "O.D." of the Army or the blue of the Navy. There was a bit of a catch in our throat as we thought of his putting aside his football helmet for one of steel; of his hanging up his hockey stick and reaching for a gun. After all we still regard him as just a little boy.

They tell us that the eighteen and nineteen year old lads are to be called to the service. When that day comes to us there will be prayers, but no tears. We shall not mourn nor shall we be fearful. Rather there will come welling up from our hearts that warm feeling of pride that millions of other parents will sense when their beloved lads marched away. Our lad is no different than the others. We are no different than other loving parents, nor is our sacrifice any greater. They are going to make great soldiers, sailors, marines and fliers out of these youngsters. And they will become a mighty force when they take their places beside their brothers in arms. They too know what they fight for. They too know full well of the sacrifices that must be made before the evil powers that threaten the world can be overcome.

And let us not forget that they are counting on us. They know that we shall not fail them.

God be with them and their brothers.

ALUMNI NOTES

by Arne V. Larson, m'43

Chemicals

McKEE, FRANK, '31, is now a First Lieutenant in the Sanitary Corps. He was formerly with the Wisconsin State Board of Health.

ANDERSON, HERBERT, '33, formerly with the Wisconsin State Board of Health, is also a First Lieutenant in the Army, where he is doing Sanitary Engineering work.

JANETT, LESLIE, '35, has received a commission as an ensign in the Naval Reserve, and will enter indoctrination school at the Naval Training School, Dartmouth College, Hanover, New Hampshire. He is classified as an engineering volunteer specialist. Janett was a former editor of the Wisconsin Engineer, and has been with the J. O. Ross Engineering Corporation of Chicago, Illinois.

BARGANZ, ARNOLD, '41, announces the birth of a son, Robert on October 30, 1942. At present Barganz is stationed at Jackson, Mississippi, where he is working for the United States Health Service. He is engaged in malaria control in the army camps in that locality, and has charge of a crew of about thirty men. While awaiting call from the Air Corps, in which he has enlisted as a Meteorology Cadet, he will continue with his job at Jackson.

HUSSA, OWEN L., '42, a First Lieutenant in the Chemical Warfare Service is now located at Camp Sibert, a Replacement Training Center in Gadsden, Alabama.

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Electricals

BURGESS, CHARLES F., '95, EE '98, HON. D. SC., '26, was honored at the recent meeting of the Electrochemical Society at Detroit with the award of the Edward Goodrich Acheson Medal and Prize. Burgess was for many years head of the Chemical Engineering Department at Wisconsin.

GERKS, IRVIN H., '27, is a Lieutenant Colonel in the Signal Corps at Wright Field, Dayton, Ohio. He is Chief of the Communication and Navigation division of the Aircraft Radio Laboratory.

PLOETZ, GEORGE, '41, an ensign in the Navy is attending radio school at Harvard University in Cambridge, Massachusetts. He writes that Harvard law school has been overrun by engineers.

ELMERGREEN. G. L., '42, a Second Lieutenant in the Signal Corps is attached to the Electronics Training Group section attending the Eastern Signal Corps School at Fort Monmouth, New Jersey. After attending a six-weeks course in general army tactics and organization he is scheduled for special training in electronics.

RICHARD, VICTOR W., '42, is working in the Signal Corps Laboratories at Fort Monmouth, New Jersey. He is a Junior Radio Engineer, employed by Civil Service.

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Mechanicals

MURPHY, THOMAS, '36, has been with the Civil Engineer Corps of the United States Navy since June 1941. At present he is building a large central heating station for the Marine Barracks at New River, North Carolina.

SANNA, ENSIGN CHARLES A., '39, has been promoted to the rank of Lieutenant (j.g.) in the Navy. He is assisting in the construction of submarines at Portsmouth, New Hampshire. Sanna, who formerly was with the United States Steel Corporation at Gary, Indiana, has just returned from a six-weeks officers' indoctrination school at Newport, Rhode Island.

BOSSART, DON, '42, was married to Ruth Lynch of Madison on November 26, Thanksgiving day. Bossart is an engineer for General Electric at Fort Wayne, Indiana.

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Civils

BEBB, EDWARD C., '96, first editor of the **Wisconsin Engineer,** died on August 7 in Washington, D. C. He was principal engineer in the Bureau of Water Power of the Federal Power Commission and an authority on hydro-electric projects. His daughter Louise received her bachelor's degree in civil engineering from the University of Wisconsin in 1934.

JOHNSON, FREDRICK M., '06, is supervisor of design and construction for the United States Public Roads Administration at Chicago.

CUMMINGS, ALBERT E., '15, Chicago manager for the Raymond Concrete Pile Co. and a recognized authority in the field of foundation construction, has been appointed lecturer at the University of Illinois.

JOHNSON, ROBERT C., '17, who holds the rank of Lieut. Commander, USNR, has been transferred from the Virgin Islands, where he has been located for the past two years, to the Naval Station at New Orleans, where he will succeed Lt.-Comdr. L. F. Rader as Public Works Officer. The latter has been transferred to the base at Norfolk, Va.

BANDELMAN, OLIVER J., '24, is associate airways engineer with the Civil Aeronautics Administration. He supervises the surveys and design of airway facilities and acts as resident engineer on the construction.

SCHUDT, JOSEPH A., '24, formerly construction engineer with Consoer, Townsend & Quinlan, is director of utilities at Grand Rapids, Michigan.

SMITH, RALPH A., '25, formerly office engineer with Consoer, Townsend & Quinlan, is a Lieutenant (j.g.) CEC, USNR.

HEIMERL, GEORGE J., '27, resigned as assistant engineer with the City of Milwaukee to accept an appointment as associate civil engineer with NACA, the National Advisory Committee for Aeronautics, at Langley Field, Va., where he reported early in November.

MILLER, PHILIP S., '33, resident engineer for S. R. Rosoff, Ltd., contractors on heavy construction, is joint author of a paper on "Driving a tunnel in fractured rock formation carrying water under high static head,." The paper was presented at the New York meeting of the American Institute of Mining and Metallurgical Engineers in February, 1942.

DYSLAND, LLOYD S., '34, is at Hampton, Va., working for the Navy in a civilian capacity.

ENGELHARDT, ROBERT L., '34, is field engineer for the Austin Co. on the construction of a plant for Consolidated Aircraft near Fort Worth, Texas.

SCHILLER, ROBERT A., '34, is with Consoer, Townsend & Quinlan, working at present on the new airport at Cudahy, Wis.

HENRY, JAY EVERETT, '36, has recently been promoted to the rank of major in the Corps of Engineers, USA. He is stationed at Atlanta, Ga., with the Fourth Service Command Staff, in charge of the engineering in connection with repairs and utilities.

TER MAATH, BERNARD H., '36, is employed in the United States Engineers office at Rock Island, Ill. His work is forecasting the river flow. This data is then dispatched to be used in the operation of navigation dams on the Mississippi River in the Rock Island district.

BJELAJAC, VASO, '38, is a First Lieutenant in the Sanitary Corps, and is stationed at Brooklyn Field, Mobile, Alabama.

SCHMIDT, MILTON L., '38, is employed as an instructor in Civil Engineering at the Carnegie Institute of Technology at Pittsburgh.

BIENDARRA, HOWARD H., '39, of the United States Geological Survey is working on river hydraulics for the Water Resources Branch at Iowa City, Iowa.

KRYSHAK, JOSEPH S., '40, was sworn into the Air Corps Enlisted Reserve on October 2.

SCHUETTE, EVAN H., '40, is doing research work on aircraft structures for the National Advisory Committee for Aeronautics. He is stationed at Langley Field, Virginia.

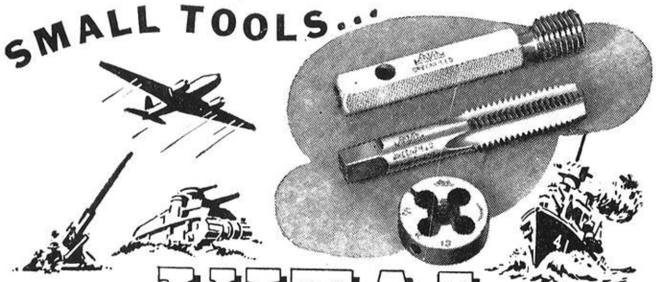
WARD, WILLIAM P., '40, is with the Extension Division of this university, engaged in administering the war courses that are being offered by the university under federal sponsorship.

FINTAK, GERALD G., '41, was sworn into the Air Corps Enlisted Reserve on Nov. 3.

HOGENSEN, ROBERT C., '41, was married on August 26 to Starr Gehr of Westminster, Md.

KUENZI, EDWARD W., '41, is a civil engineer doing research work for Forest Products Laboratory at Madison.

TRAGAKIS, C. N., "Tragedy," ex '41, is a private in the 7th Tech School, Sq. 378, Chanute Field, Ill.



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So he laid a plan. He computed just where one of the animals would be at a certain time, and had a hole dug in the ground there. Then he made a strange request: At the north end of the valley was an old, abandoned sawmill. Would the citizens help him to bring the main driveshaft and its bearings from the mill to the pit which had been dug? By this time the people were ready to try anything, so they did. Then he had the shaft placed on its bearings so that its axis coincided with the line of travel of the augurino, with the forward bearing placed directly in front of the spot where the augurino was expected. Then they waited.

The original Azo settlers are perturbed about their predicament. (Redrawn from Daguerreotype of 1848)

At the calculated time and spot, the snout appeared, entering onto the main bearing, which had been well lubricated. When the "drill" struck the main shaft, the natural impulse was to bore through it. But when the augurino tried this, the main shaft simply rotated in the main bearing along with the drill, and he was completely powerless to move further. In seconds the geologist had the animal packed in dry ice and frozen stiff. Now to move it to his laboratory and dissect it.

When he opened the head end of the cylinder, he found a very odd gadget. A little ball would roll along on a very unusually shaped track, whose form is known to higher mathematicians as a reincompensinatory discombobulated hyperbola. Obviously this was the device by which the augurino was enabled to regulate its travel so as to bore those perfectly straight, horizontal holes. A light dawned in the geologist's brain. He took the little ball off the track and replaced it with a steel ball bearing. Then, leaving the augurino frozen, he went about the valley and secured several options on large pieces of land. Then back he went to the laboratory, patched up the augurino, and took it out to one of the places on which he had an option. Soon the hot July sun evaporated the dry ice and began to warm the body of the grotesque rock-borer (the augurino, not the geologist). Once more the drill started to rotate. But this time, due to the heavy steel ball-bearing, it headed straight down! And it just kept on going down, until everyone lost interest in the hole—except the geologist. There he camped for over a week.

On the eighth day he was seen to put his ear to the ground, jump up, yell "Eureka!" and then run like blazes away from the hole. In a few seconds, up the hole and high into the air spouted a black fountain — Oil! The news spread like the Chicago fire. The geologist, with the aid of the slightly revised augurino, had struck it rich.

Soon everyone was bringing the augurinos, frozen, to the geologist who alone knew how to make them drill downward. He charged them enough, but it was worth it to them. Soon every landowner in the valley had augurinos at work making a fortune for him. Millionaires became commonplace, and within a few months the valley teemed with activity of all sorts. It was just one gigantic boom town.

One day there was a big commotion at the original well: the geologist's well had begun to give gasoline! And soon the other wells followed suit. Well, that was fine, because it saved high refining costs. However, the next day the geologist offered several of his leases for sale. Within a week he had made deals for all his property, netting him a cool ten million. Several days later he disappeared over the hills to the north from whence he had come, and was never seen in the valley again.

Then a second commotion swept the valley. The wells that had been giving gasoline quit giving it and started to give natural gas. The valley was in a tumult. No one was equipped to handle natural gas in the quantities that were coming up. And what had happened to their oil? Well, it wasn't long before even the natural gas petered out.

In a few years the Azo Valley settled back to some semblance of normalcy. It again became somewhat of a farming community, but people didn't look like they used to. They looked as though they thought they had been the particular object of some evil curse, and went around with perpetual expressions of mystification about what had happened. But out in the East, boarding a luxury liner that was to take him on a world cruise, was a man who gave his occupation as "geologist," who wore no mystified expression. Rather it was usually a sly smile. He alone knew at that time what had happened. He alone knew that, even after the augurino had struck oil, it had not stopped drilling, but had bored right on down through the rock until it had gone completely through the earth's crust, through the outer layers of metal in the earth's core, and at last simply melted in the red hot regions "way down deep." The hole bored by the augurino had of course provided a course for this terrific heat to travel upward toward the earth's surface, and when the geologist saw gasoline coming from a petroleum well, he knew almost immediately what had happened and what would happen. The heat had begun to make the well a natural refinery. Realizing this, he knew it was time to turn his fast-wasting assets into cash, so he did, and cleared out.

A backwoods mountaineer one day found a mirror which a tourist had lost. "Well, if it ain't my old dad," he said as he looked in the mirror. "I never knew he had his picture took." He took the mirror home, stole into his house and hid it in the attic, but his actions did not escape his suspicious wife. That night while he slept she slipped up to the attic and found the mirror.

"Mm-m," she said, looking into it, "so that's the old hag he's been chasing."

We Salute

The Ag Engineers

WHEN asked what kinds of engineers are trained at the University of Wisconsin, most students would say mechanical, chemical, electrical, civil, and mining and metallurgical. The sixth — the agriculturals — are completely forgotten.

There are two reasons for this. First, ag engineers are not part of the college of engineering but rather are listed in the college of agriculture. Second, their subdivisions of mechanical, civil, and electrical tend to make one confuse them with the plain engineer of the same breed.

The chairman of the department of agricultural engineering is Prof. W. F. Duffee. Prof. Duffee also engages in research such as working on a machine to make ensilage out of grass by adding some sugar containing material to cause the fermentation preventing rot. Prof. Bruhn of the ag engineering staff is working on an improved electric chicken brooder. One which is simple in manufacture and sure in operation.

There are 35 ag engineers, about half the number of M. & M. E.'s. Their professional society is the American Society of Agricultural Engineers. Bob Meier, senior ag, is president. Vice president is Bob Wilson; secretary and treasurer is Chuck Owens; reporter, Bill Plier; and Russ Kilpatrick is Ag Student Council representative.

The A. S. A. E. is a national organization and was started in 1909, about 15 years after agricultural engineering first came to be recognized by universities. Wisconsin, incidentally, was one of the first universities in the country to inaugurate a course in ag engineering.

The ag engineers' course consists of 45 credits of agriculture and 133 credits of engineering, either mechanical, civil, or electrical. The course normally takes 5 years to complete. At the end of four years the successful candidate is awarded a B.S. in agriculture, and one year later a B.S. in engineering. As one can easily see, the engineering part is about the same as the regular course, but there are 15 credits of ag engineering subjects (surveying, machinery upkeep, etc.) and 30 credits of agriculture courses added.

In general, they regard themselves more as engineers than agriculturalists. Very few intend to work on a farm after graduation, instead they will mostly head for factories and research centers just as the rest of the engineers do.

They are in the same engineering classes as other engineers, in fact you probably have several in your classes without knowing they were ags. They have no identifying odor like chems, nor do they wear breeches like civils; they just carry a sliderule on their belt and a frustrated look on their face to identify them as engineers.

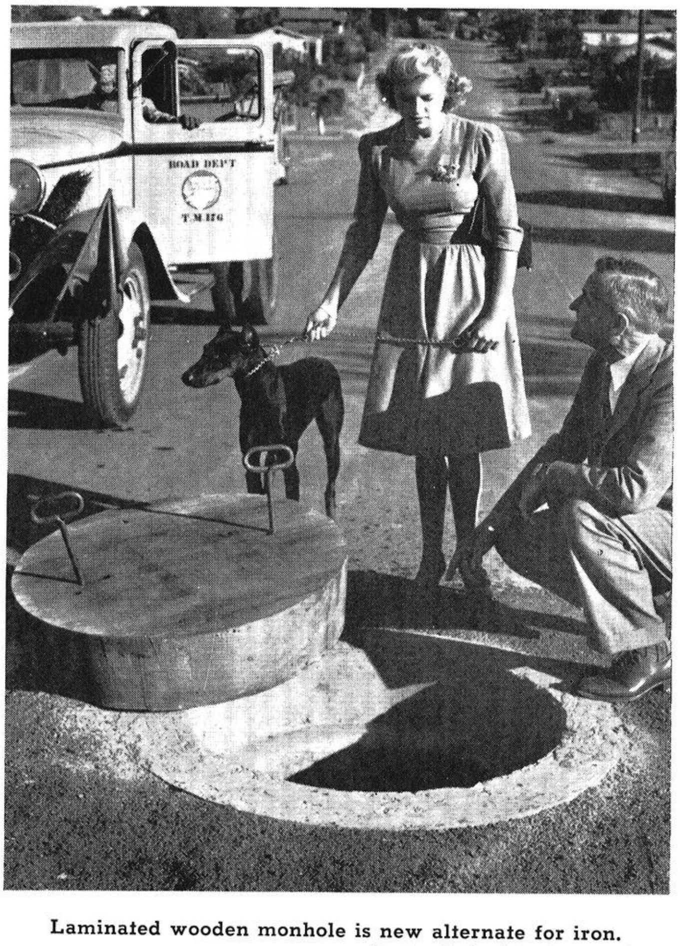
On the other hand, in agriculture they have special classes. None of this business of attending classes with home-ecs. (We're all in the same boat unless we elect music appreciation or work in outside physics labs.)

Another surprising bit of information is this—there is an Ag Engineering Building! As such they stand better than the electricals and civils (and practically better than the chems as all chems agree). It is south of Ag Hall, and not far from the M. E. and M. & M. E. buildings.

Laminated Wood . . .

(continued from page 24)

of the engineering schools have not as yet introduced modern courses in scientific timber design. They will undoubtedly do so in the future. When large structures are built with wood, especially bridges and viaducts, which we heretofore associated only with steel and concrete, we can acknowledge wood as a leading construction medium of the future.



Laminated wooden monhole is new alternate for iron.
—Courtesy National Lumbermans Assn.

Bibliography: **Civil Engineering**, October, 1942; November, 1942; National Lumber Association Manufacturers

On The Campus

POLYGON DANCE

The engineers danced to the music of Bob Rapp's campus band at the Polygon Dance held Nov. 28 in Great Hall of the Memorial Union. Although the Thanksgiving week-end together with the advent of gas rationing sent many engineers scurrying home, the 160 couples enjoyed the dance from start to finish.

During the intermission several engineering songs were rendered by the crowd (above photo). Highlight of the evening was the selection of the slide rule queen by Polygon Board. The honor went to Miss Virginia Healy who was escorted by Don Paquette, senior metallurgist.

Polygon Board members Harold Holler, Mike Dunford, John Meigs, Earl Maas, Bill Wilcox, and Ed Dickinson are to be congratulated for their fine work in sponsoring and promoting the dance.

A.S.C.E.

The evening of November 20, the Wisconsin student chapter of the A.S.C.E. met with the Wisconsin Section. The student chapters of A.S.M.E., S.A.E., and A.I.E.E. were also invited. A banquet was served at the University Club. Mr. H. H. Brown, chairman, introduced Mr. Elmer T. Howson, speaker of the evening, Dean F. Ellis Johnson, Prof. L. F. Van Hagan, and Prof. J. G. Woodburn of the University of Wisconsin, Mr. D. W. Meade, past president of A.S.C.E., Mr. Lloyd Knapp, secretary of the Wisconsin Section, and Mr. John Wilson and Mr. Richard Andrae, presidents of the Wisconsin student chapters of A.S.M.E. and A.S.C.E., respectively. After the banquet, those present went over to the Hydraulics Laboratory to hear Mr. Howson discuss "Railway Problems of Today and Tomorrow." This topic is reviewed elsewhere in this issue of the **Engineer.**