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OCTOBER
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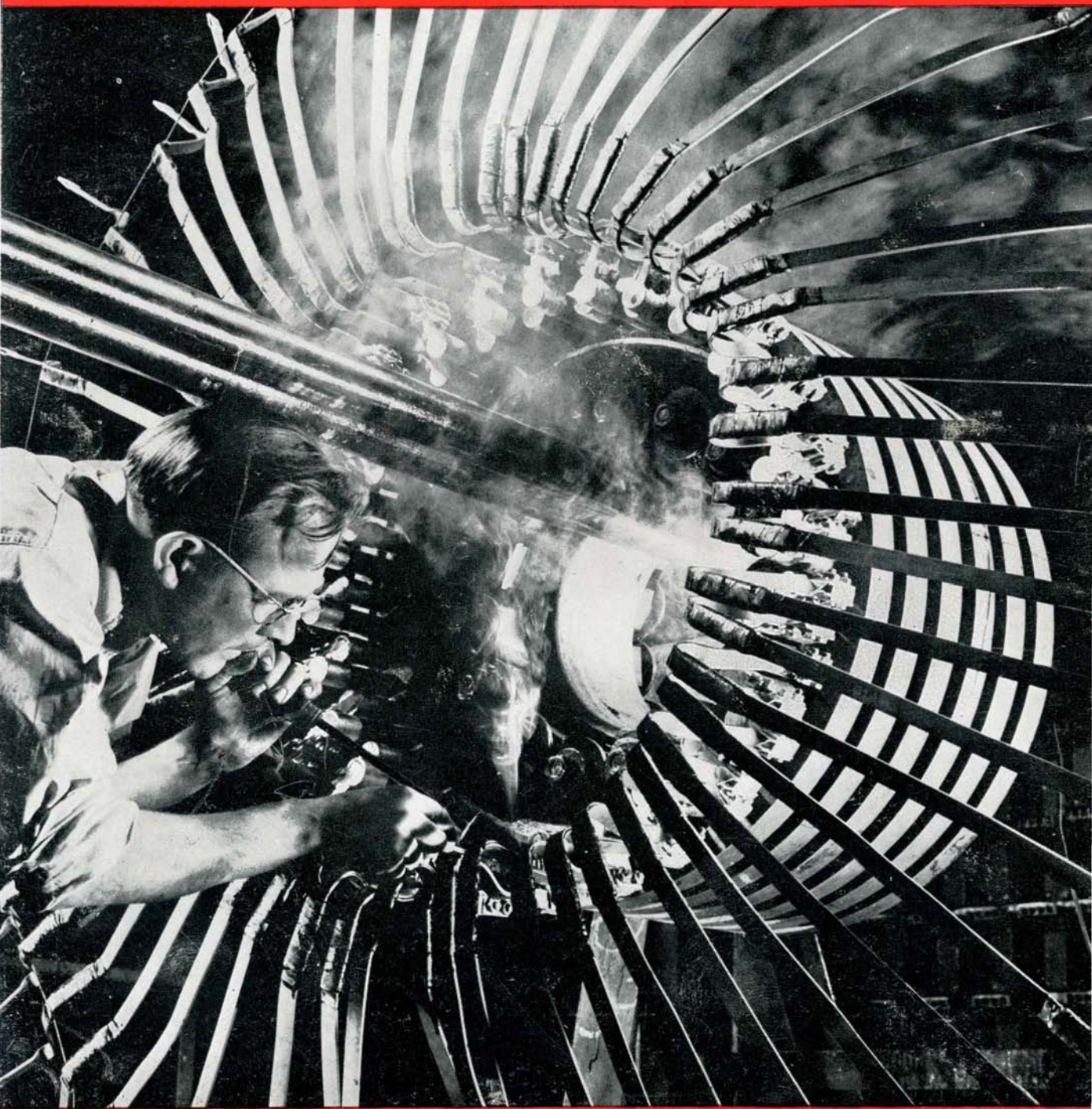

A Industrial "Spiderweb". . . See page 145

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Here is a Hallicrafters communciations receiver with an amazing range and capacity. Right now all of Hallicrafters production goes into war communications equipment. But the time will come when you can own a set like this, a set that has been tried under fire and refined and perfected to the highest degree. Keep an eye on Hallicrafters to keep you in touch with the exciting new world to come.

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COVER: As he solders armature connections on the collector of a synchronous converter, this workman adds one more link in an electrical chain that eventually will play an important part in aluminum production. These converters change alternating to direct current. In the finished machine the "spiderweb threads" will be bent around the central unit. Photograph courtesy Westinghouse Electric and Manufacturing Company.

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Previews of the Industrial Horizon

By A. P. Peck

DON'T WAIT FOR GEORGE

THE hectic days of preparing for "national defense," prior to Pearl Harbor, and for all-out war immediately thereafter, are not far enough in the past to be completely forgotten. Everyone blamed everyone else for slow conversion to war production, and industry in general had its pants soundly kicked from all directions. Yet, despite handicaps, industry muddled through. The tools of war were fabricated and delivered in record time and in record quantities.

Now, whether you like to believe it or not, industry is terribly close to a similar situation, one in which the beat of drums and the waving flags will be lacking. As the end of the war with Germany draws near (and this is written with full cognizance of the dangers of "complacency"), industry approaches another conversion job. This one is to peacetime production and here the stimuli of war will not be present. It will be a heart-breaking job, filled with grief and hard work. So far as is known, real honest-to-goodness governmental plans for this important work are as yet lacking.

Thus industry is faced with the problem of making its own plans for the day after V-day. These plans must be aimed from a platform of knowledge of what has gone before in the way of controls, labor problems, and the like. Industry itself must work out these plans in minute detail and be ready to apply them quickly and with a minimum of lost motion. If industry fails in this respect, its pants will be even more soundly kicked than they were a few years ago.

Never before has industry had a brighter horizon in prospect. How bright will be the fulfilment of the promise depends on industry taking the initiative and planning now for production for peace. It will be a tougher job than war-production planning. But, once the hump is passed, industry will have shown again that it is no mewling baby, dependent entirely upon its nurse. It will have shown once more that it cannot only deliver the goods but that it can plan the delivery as well.

UBIQUITOUS PAPER

TODAY everyone is being asked to save paper. Magazines and newspapers are on short rations. People in every walk of life are becoming paper conscious. Although civilians are suffering to a minor degree as a result of paper shortages, a bright gleam is visible for the future.

Waterproof papers of many types have been developed to fill military needs ranging from cargo parachutes to wraps for a number of things from airplane engines to blood plasma. Paints and other liquids are being packed in paper "cans." In more ways than can be told now because of Ol' Man Military Secrecy, paper is serving to do jobs that it could never do before.

A brief survey of patents issued recently shows a large number of developments in the paper field whereby the lowly pulp can be processed into forms that will be waterproof, flexible, fusible, and resistant to oils and greases.

It is apparent that here is no *ersatz* flash-in-the-pan that will disappear from the industrial field once the emergency is over. The improvements in paper are such that they should, with the necessary amount of diligent application, make permanent places for themselves in many lines.

WHAT ABOUT LIQUID FUELS?

ALTHOUGH the extent of the petroleum resources in the earth is a controversial subject—and has been so for many years—it is unanimously agreed by technologists that processes for the production of alternate liquid fuels should be investigated and developed now. Thus, in a plea for a long-range research program based on sound scientific and industrial principles, Dr. Robert E. Wilson, president of Pan American Petroleum and Transport Company, makes the following statement in a report to the American Chemical Society:

"Regardless of the possibility of adequate petroleum supplies for several decades to come, the probable ultimate source of raw materials for liquid fuel manufacture lies in those solid substances which will have to be mined, such as oil shales, tar sands, and coal. The sum total reserves of bituminous matter contained in these substances is tremendous, and they could supply our probable needs of liquid fuels for more than a thousand years."

Disclaiming any intention of creating the impression that he considers the large-scale use of alternative sources of liquid fuel imminent or definitely necessary to "oiling the next war," Dr. Wilson asserts that there will be increasing use of various intermediate processes to help stretch available petroleum supplies. This will be done in an endeavor to maintain production costs similar to those now prevailing. These intermediate processes will have the added advantage of making available a vast accumulation of technical knowledge that could be obtained in no other way.

To end on a Pollyanna note: There is less need for concern today about the future of our liquid fuel supplies than there was immediately after World War I, when pessimistic estimates of crude reserves caused widespread concern and when there was no thought of making gasoline from coal.

GLASS IN FABRICS

FABRICS woven from flexible fibers of glass are not by any means a new product, but they are materials that you are going to hear a lot about in the future. Present and continuing experimental work has brought forth a number of coated and uncoated fabrics that have remarkable properties. Various synthetic resins have been applied to fiberglas cloths, making them far more resistant to the effects of flexing than are uncoated fabrics. Then, too, glass fibers have been combined with cotton and asbestos to produce fabrics that are strong in one direction and that lend themselves very well to lamination where strength in both directions can be had by correctly placing the succeeding layers.

Much of this work with glass fabrics is still so new that details are not yet available. But these materials are going to pop up in unexpected places where their resistance to heat, acids, and oil give them advantages over other materials now in general use.

FOR FUTURE REFERENCE

ONE guess about the future of synthetic rubber, based on a thorough knowledge of the rubber business, is that the existence of America's synthetic rubber production facilities will so influence cost that these facilities will pay for themselves within four years after Far Eastern plantations resume normal production. The influence of synthetic, thinks James J. Newman, vice president of Goodrich, will force raw material costs to a price ten cents a pound lower than it would be if the facilities were not available. . . A power trend is seen in the fact that more Diesels have been installed for marine service alone during the past six years than were in existence in this country prior to 1938. . . Phosphor crystals, light source in fluorescent lamps, have possibilities in production of luminescent plastics and for indirect interior illumination where they will be part of walls and ceilings.

Why CORRONIZING makes one scrub pail last as long as four!

This amazing new armor for metal products keeps them safe against rust up to 4 times as long.

LOOK FOR THIS LABEL

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CORRONIZING MAKES METALS LAST UP TO 4 TIMES AS LONG

SOME of the "wonders" soon to come will be familiar things, which the new "Corronized" label will tell you are 4 times as good a buy as before!

Think of the bonus in your budget when this metal magic makes one scrub pail last as long as four! It will keep refrigerator shelves and hot water heaters rust-free years longer . . . stretch the life of heating and air-conditioning equipment, ash cans and automobile mufflers, kitchen ranges and farm equipment.

Corronizing has been developed thru years of research in the laboratories of Standard Steel Spring Company.

The Corronizing process is available to all makers of metal products. When peace returns, the "Corronized" label will be your guide to greater value in scores of everyday products . . . your guarantee of extra years of service without extra cost.

CORRONIZING

Division of

Standard Steel Spring Company

Dept. B-4

CORAOPOLIS, PENNSYLVANIA

ARMY E NAVY

Other peacetime products of Standard Steel Spring Company are automobile bumpers and springs, precision mechanical coil springs, universal joints, floor gratings and stair treads.

Victory Is Still Many Dollars Away. Buy War Bonds.

Q. What Is Corronizing . . .

A. Corronizing is an inexpensive, tissue-thin armor against rust, made an integral part of the metal by a patented treatment. Corronized metal can be formed, drawn, welded, soldered, sheared, blanked, pierced or embossed with minimum loss of rust-resistance, and offers an ideal bonding surface for paint or other finishes. **Sales and production executives are invited to write for complete information.**

50 Years Ago . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of September, 1894)

MOTOR CARRIAGES — "In the United States, with cobblestone pavements, and with sandy and muddy roads disgracing city and country alike, much has to be done before the work of producing a successful traction engine or motor carriage can be accomplished. But the production of the bicycle has done so much to facilitate progress, and has solved so many of the mechanical problems of the perfect road vehicle, that it seems a pity that the power problem cannot also be solved. The motor is now what is wanted."

CAR DOORS — "Let any practical mechanic, or any practical railroad superintendent, go through any large yard where cars of all railroads are stored, and examine the doors on freight cars, and he will find that with a monkey wrench in his hand he can enter nine-tenths of the cars inside of five minutes, without breaking a seal. This because the fastenings are put on with lag screws, or ordinary bolts with the nuts on the outside of the car. There is no one road that is more subject to criticism in this respect than another, except that a few have apparently realized that this is all wrong, and made a few feeble and unmechanical attempts to better it, with very little real success."

WOOD — "Many of the finest woods in existence are yet unknown, or only slightly known, to the manufacturers of wood in the civilized world. The woods of Central and South America are, perhaps, the most remarkable as well as the least known. In the yet untouched forests of this continent are many woods far finer than any of those now in use. These woods range from pure white to jet black in color, and many of them are most beautifully marked and veined."

ALUMINUM BOAT — "The aluminum torpedo boat which Messrs. Yarrow & Co. have constructed for the French government was recently subjected to trial. . . The material of which the hull is constructed is, of course, not pure aluminum, but an alloy consisting of 94 percent of aluminum and 6 percent of copper. . . The chief result of using the lighter metal has been that a speed of over 20½ knots was obtained on the official trial. . . The maximum speed of torpedo boats of this class in the British navy is about 17 knots."

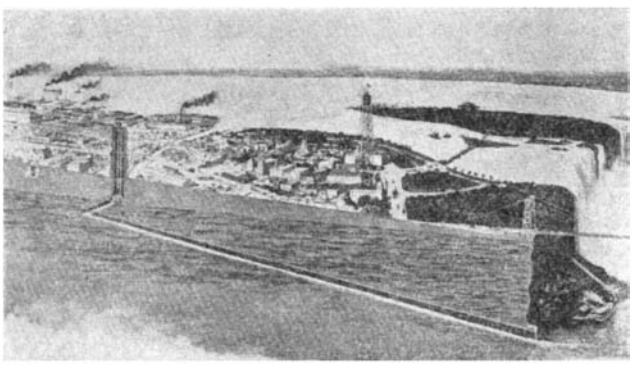
PEANUT OIL — "The report of the American consul at Marseilles contains some facts concerning the manufacture of peanut oil, which is coming into use for various economic purposes. Extraction of oil from peanuts is rapidly increasing, no fewer than seventeen factories being at present engaged in the industry. . . The oil is largely devoted to the manufacture of white soap, for which it is highly prized. It is also used as salad oil and in the composition of margarin. Large quantities are also sold as olive oil, principally in the United States. A smaller amount is used for illuminating purposes."

FLIGHT — "Mr. Maxim has demonstrated his ability to soar by mechanical means on a scale which will permit a greater lifting power than that necessary to carry the men and machinery, and there can be very little doubt that he will ultimately succeed in soaring through the air, and thus add, as he designs to, one of the most unique and most formidable engines of destruction in modern warfare."

GLASS — "The manufacture of glass has progressed so rapidly in the last twelve years that it may now pertinently be asked what cannot be done with glass. M. J. Henrivaux, a prominent French manufacturer of this article, an original and enthusiastic inventor, has recently proved to us, by means of a veritable museum of curious samples, that everything is becoming possible to the modern glassmaker. Even conducting pipes of large diameter have been made of it, tiles, drains, tubs, curtains, furniture, chimneys and even houses."

LOCOMOTIVE HEADLIGHTS — "It is the opinion of a number of locomotive engineers and other practical railroad men witnessing tests of a new improved Pintsch gas headlight recently made in the Delaware, Lackawanna & Western yards at Hoboken, N. J., that the light furnished is at least three times as powerful as that of oil headlights, while at the same time it meets the very important requirement of not in any way obscuring the signal and other lights around the yard."

NIAGARA POWER — "The first mill to make use of the power rendered available by the 7,250-foot water power tunnel at Niagara Falls is that of the Niagara Falls Paper Company, for some months past using 3,000 horse power, to be increased to 6,000 horse power. A concrete subway is also ready for the wires of the Pittsburgh Reduction Company, whose plant is about 2,500 feet from the power house, from which the company will be supplied with about 3,000 horse power for use in the reduction of aluminum. The arrangements for the electrical transmission of power to the city of Buffalo are also nearly completed. This power is to be transmitted by means of wires carried upon poles from a 50,000 horse power electric station which the Niagara Falls Power Company have near completion on the main canal. The right of way has been acquired, and all the contracts made for two lines, one of which crosses Grand Island while the other follows down the shore."



OIL FRICTION — "Petroff, who has occupied himself very extensively with the examination of lubricants, has investigated the interior friction of oils by means of an apparatus invented by himself, and has given his results in tabular form and graphically by a series of curves. . . It was also frequently observed that samples of the same oil that were received in the factory at different times did not yield the same characteristic curve, though filling all requirements. This fact is naturally important to consumers on economic grounds."

BEARINGS — "Ball bearings are successful only when the balls themselves are of the highest quality, and the shells and axles are of the best steel, hardened and ground to the highest perfection. . . The limit of error in the best does not vary more than one-quarter of one-thousandth of an inch, or one-fourth the thickness of tissue paper. Such perfection is very costly, and the least dirt destroys the whole gain, for if the balls be stopped by any impediment, they are very soon ruined."

GAS METERS — "Automatic vending mechanism is used in a new gas meter so that a user of gas may purchase a certain amount of gas by simply placing a coin in a receiver, which is so connected to the meter as to allow a certain number of feet of gas to be used for a given amount. . . Five quarters can be fed into the apparatus, so that $1.25 worth of gas can be paid for at one time. By this means a person can pay for gas in small installments, rather than wait until the sum accumulates."

What's the Rush?

It's the telephone rush. Every night thousands of service men and women dash to the nearest telephones to talk with families and friends at home. Most of the Long Distance calls from camps and naval stations are crowded into a few short hours.

Many circuits are likely to be crowded at that time and it helps a lot when you "give 7 to 10 to the service men."

BELL TELEPHONE SYSTEM

Over 21 million gallons of gasoline a day to put the

ALLIES ÜBER DEUTSCHLAND

THE American fighting forces aren't the only users of "made in U.S.A." high-octane gasoline. Millions of gallons are going to the British, Russians, Australians, Canadians and our other allies. What's more, this gasoline is all high quality—and practically every gallon is improved with Ethyl fluid.

You can see that as long as the war is on there isn't much hope that civilians will be able to get gasoline unlimited as to quantity and quality. But it won't be long after the fighting is over that gasoline of far higher quality than you've ever had before will be available for running your automobile, truck or bus.

Ultimately, post-war engines will be designed to get more power and economy from this greatly improved post-war gasoline. We of Ethyl look forward to working with the automotive, petroleum and aviation industries in making these hopes come true as quickly as possible . . . but with us, as with you, the winning of the war comes first.

✢ ✢ ✢

ETHYL CORPORATION

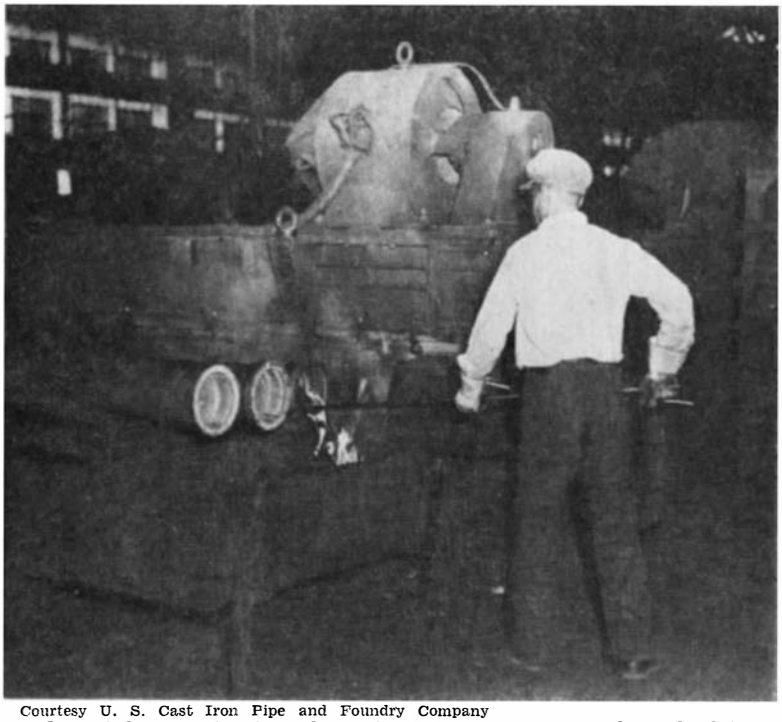
Manufacturer of Ethyl fluid, used by oil companies to improve the antiknock quality of aviation and motor gasoline.

ETHYL BRAND OF ANTIKNOCK COMPOUND — ETHYL CORPORATION — TRADE MARK REG. U.S. PAT. OFF.

GASOLINE POWERS THE ATTACK—DON'T WASTE A DROP!

METALS IN INDUSTRY

Conducted by FRED P. PETERS



Courtesy U. S. Cast Iron Pipe and Foundry Company

One of the centrifugal machines for casting iron pipe and, to the left, some of the centrifugally-cast pipe after removal from the machine

Centrifugal Casting

Assuming an Increasingly Prominent Position in the Metal Industry, this Process Offers Advantages of Economy in Metal and Machining Cost. While its Forte is in the Pipe and Tubing Fields, it can be Applied to the Production of Shapes Other than Cylindrical

By EDWIN F. CONE

Consulting Editor, *Metals and Alloys*

MUCH MORE often today than formerly does the average man hear the term "centrifugal casting." In many instances it means very little to him. He knows what a casting usually is—a product made by pouring molten metal into a sand mold, letting it cool to a solid, and separating it from the sand. Such castings may be made of gray iron, steel, malleable iron, or a nonferrous metal like brass or aluminum.

Besides the ordinary or conventional casting made in a sand mold there are also die castings, made by forcing a metal into and through a metal die; permanent-mold castings, made by pouring hot metal into a mold, usually metal, which can be used many times as contrasted with a sand mold which can be used only once; and centrifugal castings.

The object of this article is to describe in a general way the centrifugal casting process, confining it largely to castings made of iron or steel, though there are many types of centrifugal castings made of the so-called nonferrous metals such as brass, bronze, or other alloys containing copper, tin, lead, and so forth. One reason for dealing largely with iron and steel in this discussion is that centrifugal iron and particularly steel castings have been increasingly important factors in the war effort and have consequently made rapid progress.

In general a centrifugal casting is one that has been made by pouring molten metal into a rapidly revolving mold. This mold is usually made entirely of metal though a sand-lined metal mold is sometimes used. The immediate result of rotation of the mold is to throw the metal to the outside of the mold where it cools first. The size of the casting and its thickness are determined by the amount of metal poured into the revolving mold. The centrifugal process is largely but not entirely confined to pouring cylindrical shapes—castings that have a central axis—like pipes or tubes.

ADVANTAGES—It can readily be seen that a casting so made will have a definite density and solidity, with most of the imperfections—slag, inclusions, and so on—left behind on the inside surface. The process also has the decided advantage of speed in production and can be used with molds revolving on either a vertical or a horizontal axis. Such castings can be made with nothing like this rapidity in a conventional sand mold where there is also the disadvantage that slag and dirt more often lodge in the main body or exterior surface of the casting than on the interior surface.

The centrifugal casting process has been further developed so that castings that are not cylindrical can also be made. Often even a sand mold is re-

volved, in order that the liquid metal will be thrown from the center where the metal is first poured. "Centrifuging" is the name used to designate this process.

One of the earliest applications of the centrifugal process for making iron castings in this country was the production of cast iron pipe by the so-called de-Lavaud process. The first work was done by deLavaud (a Brazilian) in Buffalo on a very small scale and in an improvised small machine that produced cast iron pipe about four to six feet long. Not long after this the process was taken up on a large scale by industrial makers of cast iron pipe. A company was soon formed in Canada to produce the iron pipe centrifugally and later the U. S. Cast Iron Pipe and Foundry Company obtained the rights to use the process in the United States. Today that company makes most of its pipe in its several foundries by the deLavaud method.

In the deLavaud process the revolving mold for pipe is made of metal. For some time no little trouble was experienced in the life of these molds. It was later found that a molybdenum alloy steel mold would last much longer. Today such molds are the usual practice.

Because of the chilling effect of pouring hot metal into such a mold it is usually necessary to submit the pipe after casting to a mild heat treatment.

Shortly after the introduction and use of the deLavaud process, a method was developed and perfected for casting pipe in a sand-lined metal mold. The American Cast Iron Pipe Company developed this process—called the "sand-spun" method—and is now producing pipe on a large scale in sand-lined molds. It is safe to say that today a very large percentage, probably over 95 percent, of the cast iron pipe made in the United States is centrifugally cast.

Progress in the application of the centrifugal process to casting molten steel has been markedly accelerated because of the war. Previous to this there were a number of cases where steel products were made centrifugally. A pioneer and progressive organization in this was and still is the Ford Motor Company, in its foundries at Dearborn, Michigan.

An outstanding example of Ford's activities in this has been the centrifugal casting of steel gear blanks for automobiles—for the cluster transmission gears and the rear axle gears—formerly made entirely as forgings. The company has now been producing them centrifugally for over six years, and it is now making steel sprocket wheels for tanks by the same process.

METAL SAVINGS—The reason back of this development as well as back of several other metallurgical engineering ones adopted from time to time by Ford engineers, is a cardinal principle of Henry Ford—that whenever it is possible to produce an automobile part so that about 25 percent or more metal could be dispensed with at no sacrifice in quality, such a process should be used. Casting gear blanks centrifugally takes much less metal than making them as forgings and eliminates a large proportion of machining.

In the Ford gear casting process the molds are metal—a low carbon chromium-molybdenum steel. They are set on a vertical axis so that rotation is in a horizontal plane. The speed of rotation (a motor is located underneath the mold) averages from 300 to 400 revolutions per minute. The molten metal is poured into the top center of the flask.

Besides the centrifugally cast sprocket wheel for tanks, an interesting war development of the Ford company is the centrifugal casting of airplane engine cylinder barrels. As in the case of the gear blanks, the barrels were formerly made as forgings. Today many hundreds of these are being produced by the centrifugal casting process. Not only is much metal thus saved but there is also great economy in time since the barrels can be produced faster centrifugally.

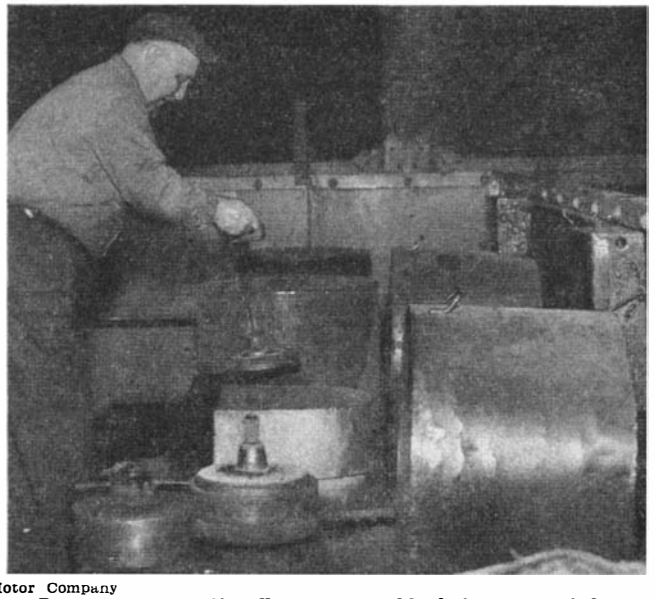
The mold, of a special alloy steel, is made in two sections. The main section is so constructed as to form the upper portion of the barrel. Into this there is inserted and clamped down a smaller piece which forms the other part of the cylinder barrel. Between the two sections is an aperture which forms the flange or protrusion on the side of the barrel. In contrast to the mold for gear blanks, this mold revolves on its horizontal axis and the molten metal is poured into the side.

Speed in production, saving in time in operating technique, and a product equal if not superior in quality to those produced by forging or any other method are among the advantages claimed for this process, based on the experience of the Ford Motor Company. Besides the gear blanks, the airplane cylinder barrels, and the tank sprocket wheels, this company also produces landing gear axles, solid projectiles, and so on, centrifugally.

Spurred by war conditions, several other companies have taken up the centrifugal casting method for steel. Prominent among these is the American Cast Iron Pipe Company, the company responsible for the sand-spun process for iron pipe. This company has installed electric steel melting furnaces and a large number and variety of centrifugal casting machines to make many different products of steel. In over 100 casting machines the company is producing airplane engine cylinder barrels, sheaves and gear blanks, pipe and tubing, track wheels, and so on. This company has become a major factor in this branch of the casting industry.

Some time ago the Steel Founders Society of America, of Cleveland, made a survey which revealed that there were some 16 companies actually producing centrifugal cast steel products. Besides these there were at least four others which were installing such equipment. An editorial in a recent issue of *Metals and Alloys* states that "it is reasonable to calculate that this total of 20 has at least been increased, some say to certainly 30 companies. But the process is not confined to ferrous castings—its use in the non-ferrous field has reached large proportions."

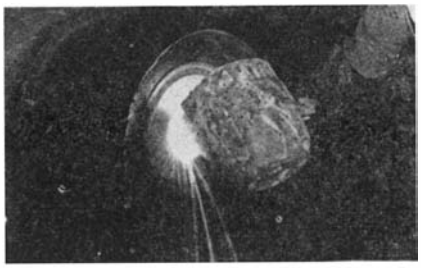
Centrifugally cast steel castings will be more in competition with forgings

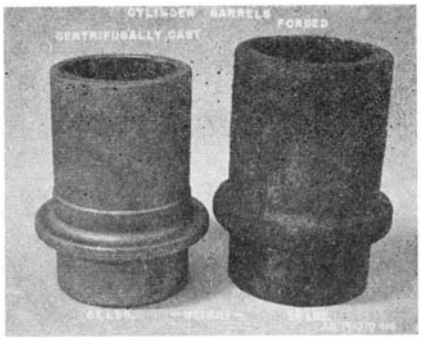


Courtesy Ford Motor Company

Pouring steel into a revolving mold in which gear blanks are centrifugally cast. Mold revolves on vertical axis

Removing a centrifugally cast gear blank from one of the casting machines shown in the illustration at the left





Above: Molten steel being poured into a centrifugal mold for making cast airplane engine cylinder barrels. The mold revolves on its horizontal axis. Right: A centrifugally cast engine barrel weighs only 37 pounds as compared with a weight of 58 pounds for a similar barrel produced by forging methods

and other wrought steel products than with static steel castings. As compared with static castings the economic field for centrifugal castings is somewhat limited. The centrifugal process is not easily adaptable to the economical production of intricate shapes, nor will it be economical for the general run of "jobbing" work.

Compared with steel forgings, centrifugally cast steel castings may be made to closer dimensional tolerances, with consequent reduction in machining cost; the castings entail lower capital investment for production equipment; and they are free from the marked directional properties characteristic of forgings.

Chromium-molybdenum steel castings, centrifugally cast, are being used in place of forgings for engine flywheels, gear blanks, radial cylinder barrels, bomber landing gear parts, and so on. These castings have ultimate tensile strengths higher than 175,000 pounds per square inch and yield strengths in excess of 165,000 pounds per square inch.

It is safe to predict that centrifugal casting will continue to advance and that its present prominent position in the metal industries will be even higher in the post-war era.

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HELMETS

Presented a Challenge to Metal Workers

THE M-1 soldier's helmet, now the standard personal headgear for all American ground forces, is a triumph both of metal product design and of metal-working ingenuity.

Soon after we entered the war the Army sought a redesigned helmet—one that would protect the soldier from missiles from below and give more protection below the ears and at the base of the skull than the hemispherical helmet painfully familiar to the veterans of World War I, and which would also fit the head without rocking and tilting.

Additional requirements were that the weight of the helmet plus its plastic liner must be less than three pounds. It must withstand a .45-caliber bullet fired at point-blank range with a muzzle velocity in excess of 700 foot-seconds, and it must be nonmagnetic to avoid interference with instruments.

The production problems were that the helmet was specified to be Hadfield manganese steel, which, while hard and highly protective, is at the same time one of the toughest steels to draw, especially for the depth of draw required with this helmet.

The problems were finally solved by the McCord Radiator and Manufacturing Company, who now complete the 27 separate operations required to make this helmet, from the first stamping operation to packing, in just 22 minutes. The spectacular feature is that this difficult draw (the new helmet is seven inches deep compared to only four inches for the old "trench helmet") is made in a single press operation.

METAL POWDERS

Now Being Produced in Large Quantities

ALTHOUGH surprisingly large amounts of aluminum and magnesium powders are now manufactured, very little is used in the production of parts by sintering and pressing—the field usually designated as "powder metallurgy."

In an address on aluminum powders before the recent meeting of the Metal Powder Association in New York, A. Galbraith of WPB indicated that some of the post-war uses for aluminum powder might be (a) for producing lightweight parts that would require considerable machining if made by conventional methods, (b) for deoxidizing and grain control of steel melts, (c) in improved paint pigments, (d) as additives in paper manufacturing, (e) as an ingredient of concrete to achieve combinations of light weight and high strength, and (f) in thermit welding and similar applications.

Since the start of the war the production of magnesium powder has expanded 600 times, it was reported by Col. L. J. Pasternak of the Ordnance Department at the same meeting, and post-war markets have not yet been studied. Most of the magnesium powder is now used in incendiary bombs and in flares.

At present flares are produced that yield a million candlepower for a period of one minute. For airplane use the white light of magnesium powder is so glaring that coloring agents are added to reduce it.

DIE CASTING SYSTEM

Makes Use of Newly Developed Technique

THE scope of die casting is being broadened by a new type of machine that makes possible the production of larger, heavier parts from aluminum, magnesium, and copper alloys than were formerly considered possible by die casting, according to F. C. Ziesenheim, writing in *The Iron Age*.

Known as the prefill injection system and applied by Lester-Phoenix, Inc. on its cold-chamber die-casting machine, the method was developed to eliminate porosity, which it does by combining slow injection velocity (as slow as the chilling of the metal and the thickness of the casting will permit) with high final injection pressure on the metal as it chills against the die.

By this "slow-squeeze" method, aluminum, brass, and magnesium die castings can now be produced with strength and densities previously available only in sand or permanent mold castings. The National Cash Register Company, for example, is using the system to make 12 carburetor parts originally designed for sand casting. All have unusually heavy gates and are able to pass X-ray and air-pressure inspection tests without trouble.

SPECTROGRAPHY MAKES STRIDES

Is Finding Wider Uses in Routine Analyses

WARTIME experience with the spectrograph has provided abundant evidence that this instrument for rapidly determining the composition of metals will occupy a position of growing importance as a metal-working inspection tool in the post-war period.

One large metal plant, faced with an ordnance program that would tax the personnel and facilities of their materials laboratory far beyond its capacity, installed a spectrograph. A grating-type machine (as distinct from the prism variety) was chosen and within a month the laboratory was running routine spectrographic analyses of iron and steel—controlling four gray iron cupolas, checking incoming forgings and bar stock, and making frequent analyses for control of heat-treating processes.

By using a flat-surface sparking technique this company (The Farmall Works of International Harvester Company) can analyze a singe sample in 15 minutes for eight elements. Nine such samples can be checked in 30 to 45 minutes. Two operators can easily analyze 100 to 150 samples per eight hour day. Total cost will average about 15 cents per sample, or 3 cents per determination.

Does that beat your wet analysis costs? And it's accurate, too, to 3 to 5 percent of the percentage of the element being determined.

They Do Practically Anything

Making Industrial History Today, but Not Making News Headlines, is a Broad Class of Versatile Chemicals, the Ion Exchangers, a New Tool of Amazing Aptitude and a Master of All Trades. With them Industry is Solving Some Problems that have Plagued it, and is Resolving Some Headaches

By JEAN MATER

A FIELD of sugar cane growing tall in the Louisiana sun used to supply enough table sugar for nearly 250,000 cups of coffee. Two years ago a new chemical problem-solver applied for a job in sugar refineries. Sugar chemists put it to work. Now the same field yields table sugar enough to sweeten thousands of additional cups of morning coffee.

Wine is the major objective of vineyards, but buried deep in winery barrels lies a substance essential in making munitions, synthetic silk, and photographic materials. The substance is tartaric acid, long familiar to housewives in baking powder. Last year the chemical problem solver which increased table sugar yields entered vineyards; it promises to add several million pounds of tartaric acid to present yearly production.

Aviators met one of these problem solvers for the first time last year in their new sea-water desalters which extract fresh water directly from the sea. The new chemicals have been put to work removing copper impurities from gasoline, and they supply needed minerals to plants growing without soil. The problem solvers help purify vitamins and enzymes, and in gas masks they absorb ammonia fumes.

Jacks of all trades, and masters too—what are these chemical problem solvers?

"Ion exchangers" the chemist calls them, and they are making industrial history. Ion exchangers don't make the news headlines; they are the behind-the-line chemicals working diligently to back their buddies at the front. Penicillin, the sulfa drugs, atabrine, and others equally distinguished rescue us from the death grip of disease. We know them well and intimately. We shall never take ion exchangers to down a fever with dramatic speed but they are nonetheless vitally important, for they are the new tools with which the chemist "trouble shoots" to make the products we daily use more cheaply and more abundant. We may never realize when ion exchangers are working for us.

Ion exchangers are a breed of chemicals with more abilities than we can name—and work with them has just begun. Their aptitude for problem solving is amazingly versatile. They act as scavengers, cleaning up impurities in water and foods. They salvage gold, silver, copper, and other precious metals thrown into mine and factory wastes. They recover nicotine lost in tobacco curing. They separate and purify vitamins and proteins and drugs.

Ion exchange itself is a familiar everyday occurence. Recognition of ions themselves dates back over half a century, to 1887 when the Swedish chemist, Svante Arrhenius, defined them as electrically charged wanderers (hence "ions," Greek for wanderers). Ion exchange means simply, as it says,

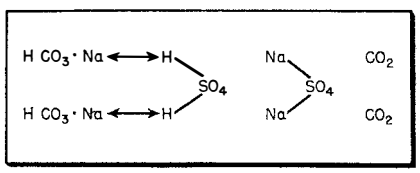


Figure 1: A typical ion exchange

exchange of ions and is the basis for many common phenomena. In using a portable fire extinguisher we exchange the sodium ions in baking soda for hydrogen ions to produce flame-smothering carbon dioxide. The hydrogen ions are supplied by the bottle of sulfuric acid released when the fire extinguisher is inverted. Figure 1 shows how the chemist pictures the exchange of ions in fire extinguishing: baking soda and sulfuric acid produce sodium sulfate and carbon dioxide gas.

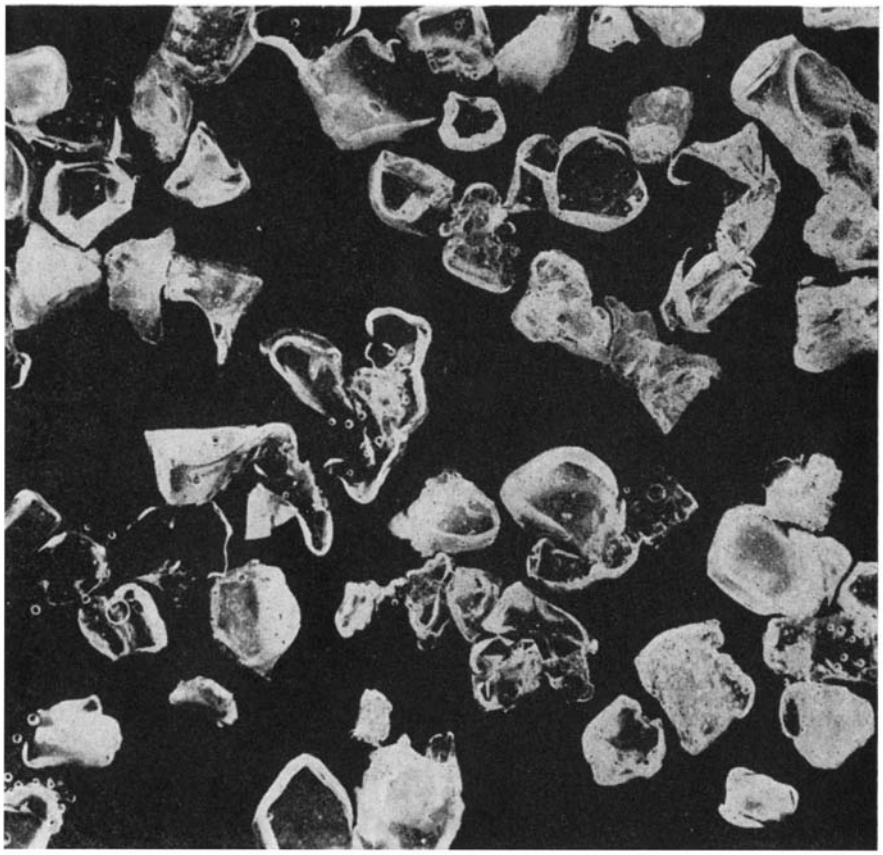
Baking powders work by ion exchange. Baking powders are a mixture of an acid and baking soda. Exchanging the hydrogen ions in the cream of tartar —or alum or whatever the baking acid used—for the sodium ions donated by the baking soda produces enough carbon dioxide to make the cake rise. The curd formed in lathering soap in hard water is an ion exchange process. Soap is a mixture of the sodium salts of fatty acids. Hard water contains calcium salts. When we try to lather in hard water the calcium salts exchange places with the sodium in the soap, depositing a curd on the wash basin. Ion exchange is at work in our blood stream 24 hours a day. Our blood acidity remains constant despite all the acids added to it by the process of living because it contains a so-called "alkali reserve"—bases such as sodium bicarbonate, sodium phosphate, and other sodium salts upon which the blood can draw to neutralize acids. When we exercise, our muscles throw lactic acid (the acid in sour milk) into the blood stream. The sodium ions supplied by the "alkali reserve" exchange places with the acid ions to form harmless sodium lactate and so preserve our blood stream neutrality.

THEY ITCH TO SWAP—Fire extinguishing and baking and preserving our internal neutrality are all ion exchange phenomena. The industrial problem-solving ion exchangers work exactly the same way—except that they are definite compounds which devote their chemical lives solely to exchanging ions with whatever other compound would like to swap. Usually they are of no use in themselves; their claim to fame lies in their generosity with the ions in their possession. Ion exchangers is a broad term—like sulfa drugs—used to denote many similar compounds. Some exchangers will swap for metallic ions—such as calcium, magnesium, copper, and the rest of their family. These are cation exchangers (cation because in electrolysis the metallic ions are drawn to the cathode). Other exchangers adsorb acids on their surfaces. They are the anion exchangers (because the acids go to the anode). Some cation exchangers are old and familiar. Natural and synthetic zeolites—"greensands" being the natural type—have long been used for water softening in the classical Permutit process. But the "greensands" and zeolites are limited in use almost entirely to water conditioning. It is the new stable, synthetic cation exchangers which are doing the chemical tricks. These come from two sources. Treat coal, lignite, or peat with an organic sulfur compound and we produce "carbonaceous zeolites," one class of ion exchangers. Other cation exchangers are plastics prepared from phenol-formaldehyde resins.

How plastics became ion exchangers is an interesting story. In 1935 two Englishmen, Basil Albert Adams and Eric Leighton Holmes, of the British Department of Scientific and Industrial Research, had a hunch about a team of oxygen and hydrogen, called the *hy-*

droxyl group—pictured OH—in Bakelite, a phenol-formaldehyde resin. They reasoned that since the hydroxyl group was not involved in forming Bakelite it should be free for ion exchanging.

As the chemist sees it, Bakelite is a chain-like linking of phenol and formaldehyde. In chemical pictures, the wedding takes place with two molecules of phenol attaching themselves to formaldehyde (Figure 2). The two *hydroxyl* groups sit idly by during the reaction. On these two hydroxyl groups Adams and Holmes counted for ion exchange. Experiments proved their hunch good. The discovery opened up a new field for plastics and unexpected new vistas for chemists. Previously Bakelite and other plastics were judged solely on their capabilities as materials for fountain pens and telephones and steering wheels. Now they could be re-evaluated as chemical compounds with more uses than any chemist had dared dream. The advent of the new resins and the carbonaceous zeolites plunged ion exchangers into a whirlwind of industrial activity, an event with almost startling repercussions in expanding the sphere of activities of many companies. The Resinous Products and Chemical Company, for example, was making phenol formaldehyde resins for cementing plywoods when ion exchangers poked their head in the door. Now with ion exchangers the company's chemists find themselves investigating vineyard wastes and metal recovery in mining. Other companies, such as Permutit and Infilco—who have been using the older zeolites for conditioning water—have become involved in industries far removed from water. The Permutit Company developed the first carbonaceous zeolite to improve water treatment, but the zeolites led their creators into new worlds. This is a type of industrial expansion becoming more common as research interrelates chemistry.



Magnified granules of Decalso zeolite

HOW THEY WORK—Here's how the cation exchangers work. In softening water, where we want to remove calcium—or it might be magnesium which also hardens water—we add a sodium exchanger. The sodium exchanger takes up the calcium and leaves sodium sulfate in the water. Sodium sulfate is all right; it does not leave a sticky scum with soap. Now, all we need do is get rid of the sodium sulfate in the water and we have water with no ions at all—in other words, distilled water. And that's where the anion adsorbents or exchangers come in. Anion exchangers are resins of complex composition which have the power of adsorbing on their surface acids, thereby removing them from the water. To produce synthetic "distilled" water we start with a hydrogen exchanger and form an acid like sulfuric acid instead of sodium sulfate. An acid adsorbent next lifts the sulfuric acid bodily from the water, leaving water with no ions. Thus ion exchangers "distill" water chemically. The ion exchange method for producing distilled water often gives even purer water than mechanical distillation. Water distilled with ion exchangers is playing an important war role in preparing the large amounts of very pure water needed for synthetic rubber, pure chemicals, and drugs. When we remember that up till now distillation has been the one method of producing very pure water we realize that ion exchanged pure water is a history-making achievement. Now, for the first time, it is possible to make more "distilled" water more quickly than ever before thought possible, and at as low as one quarter the cost. Synthetic "distilled" water is quite a feather in the ion exchanger cap.

Carrying our reasoning further: if we can remove all the ions from water why not desalt sea water to fresh drinking water? This appealing idea has caught many fancies and has been the subject of much research. For, despite all the advances of modern science, our aviators forced down at sea found that "water, water everywhere and not a drop to drink" was as true as the day the Ancient Mariner first said it. But all attempts to use the standard ion exchange process on sea water were fruitless. Each man would need such a large quantity of exchangers that the idea was entirely impractical. It looked hopeless until the Permutit Company came along with its widely heralded sea water desalter, an ion exchanging device which removes both cations and anions—the sodium and the chlorine in salt—at the same time. How, must remain another military secret for the duration.

However, standard ion exchangers do some interesting desalting tricks on brackish waters which periodically are a nuisance to industrial plants in certain sections of the country. The Delaware River, for example, becomes salty during droughts and low water periods. Along the industry-jammed span from Philadelphia to Wilmington the salt content has often been high enough to hinder boiler plant operations and in some cases even to force a boiler plant shut down. Ion exchangers have nipped this source of trouble in the bud.

An attractive fact about ion exchangers is their ability to be regenerated. That they have exchanged all their sodium for calcium, or adsorbed

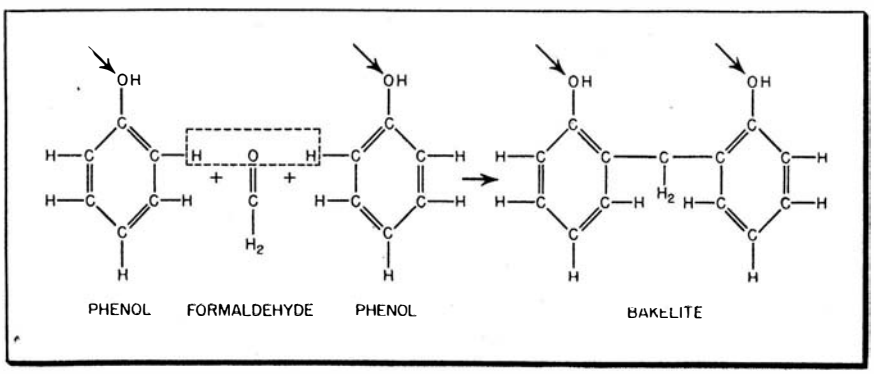
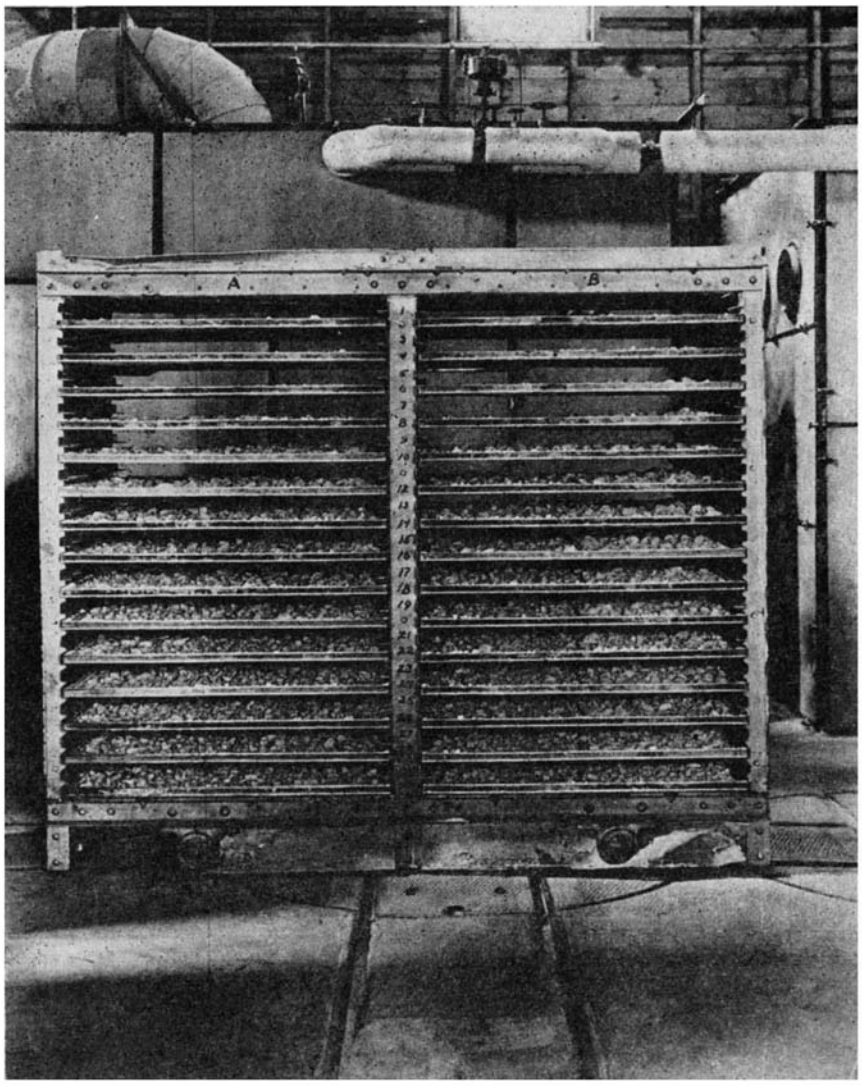


Figure 2: Structural formula for the wedding that produces Bakelite



In the manufacture of synthetic zeolites, the solutions of aluminum and silica compounds are combined to form a gel, which is then dried and broken into grains

all the acids they can hold, does not mean that they are used up and done with. Simply passing a solution of common table salt over the exchanger washes out the calcium and brings sodium back to the fold. The exchangers are then ready to remove more calcium. To regenerate acid adsorbers it is necessary only to clean them with ordinary washing soda. The regenerative ability of the exchangers cuts the cost of their use almost to the initial cost of the operating equipment.

To date, the largest application of ion exchangers has been to water treatment —softening water for breweries, paper and textile mills, bottling companies, power plants, and other industries. Soft water is so essential to some products that process plants usually locate in areas where the water is good. That is why so many textile and paper mills are in the soft-water districts of New England and why so many breweries are located in New York City and Newark. The water in these cities is soft enough so that it requires very little further treatment. With excellent water conditioning at hand, location near good water will in time probably become secondary.

But ion exchangers promise to be most valuable as problem solvers in other fields. One of the most difficult industrial problems ion exchangers have solved is purification. Ion exchangers are perfect scavengers for cleaning up metallic impurities. A patent has been issued for the application of ion exchangers to freeing gelatin from metallic ions. Absolutely pure gelatin is essential for photographic and medicinal use. Formaldehyde must be free of acids when it is used in making plastics. Since most formaldehyde comes today from methyl alcohol by a process which also yields a very small amount of acid, it is difficult to obtain acid-free formaldehyde. The acid could be neutralized with a base, but this is a tedious process and the resulting salts produced are as objectionable as the acid itself. Activated carbon will remove the acid but that is a cumbersome and expensive method. An acid adsorbent simply lifts the acid out of the formaldehyde, purifying almost immediately. After the war we may expect the ion exchange technique to purify the solvents used for dry cleaning our clothes. Ion exchangers have performed heroic feats in completely freeing organic acids, glycerol, wines, and enzymes from any traces of harmful calcium, iron, copper, or lead. These metals are difficult to remove with any other method, if indeed older methods remove them at all.

Ion exchangers have considerably enhanced their reputation in the last few years by their unique salvaging abilities. Ion exchangers are valuable in recovering precious metals from wastes. Copper has been reclaimed from brass mill pickling waste and from rayon waste. Leftovers which used to be dumped into local streams, polluting and fouling the waters, are now reexamined for possible reclaim value. Removal of metals from waste water is a favor to the community and profitable to the remover as well, for precious metals recovered more than repay the cost of salvaging. Ion exchangers also have a talent for rescuing valuable organic chemicals from an otherwise useless end. Tartaric acid reclaim has been mentioned. Ion exchangers save pectin—the familiar jellying agent found on kitchen shelves and recently proclaimed a substitute for blood plasma in some cases—from grapefruit and orange rinds. Citrus fruits have always been rich in pectin but it has been so difficult to recover that the attempt was considered useless. Ion exchangers do the job in a few simple steps. In curing tobacco much nicotine is lost to waste. Nicotine, as every gardener knows, is a valuable insecticide. Ion exchangers can rescue nicotine from the waste and can put it to work killing insects. In time ion exchangers should cut the cost of nicotine to consumers. Reclaiming possibilities are legion and many laboratories throughout the country are busily delving into others destined to become important.

EVEN VITAMINS—Ion exchangers scored a victory in the large-scale production of essential amino proteins such as arginine, histidine, and lysine—three leaders of the protein family that make up to our tissues the wear and tear of daily living. Ion exchangers have stepped into our vitamin pills too. Thiamine, one of the B vitamins, occurs with riboflavin, another member of the B complexes. These two cling tightly to each other and are extremely difficult to pry apart. But when they run through a bed of ion exchangers, thiamine divorces riboflavin and hugs the ion exchangers. Riboflavin passes indifferently by. With this technique thiamine is successfully recovered from rice bran extracts. Solutions containing thiamine and riboflavin passing through a five-inch-thick bed of ion exchangers at the speed of seven gallons a minute are almost completely separated.

It is almost 100 years since the English chemist, J. T. Way, made the first observations on ion exchange. Way studied the exchange of ions in soils. Today the branch of chemistry Way helped initiate has given birth to ion exchangers which are used in growing plants without soil. In soiless growth cation exchangers hold sodium, potassium, calcium, and other mineral ions in tow. Anion adsorbers are bound to the important phosphates, carbonates and sulfates. Put the two together in water, add a plant and we have a balanced system. When the plant needs a mineral ion the exchangers simply give it up.

What About the Gas Turbine?

Will these Simple and Potentially Efficient Power Plants Out-Mode Steam, Gasoline, and Diesel Engines Overnight? What are the Fundamental Reasons Why the Gas Turbine, Based on Four Centuries of Thinking, is Only Now Emerging from the Dream Stage? A Searching Analysis Gives the Answers

THE GAS TURBINE, one of the oldest ideas for power plants, is just emerging from the dream stage and poking its head up into reality.

The gas turbine idea really is old. Leonardo da Vinci had it all worked out about when Columbus first set foot on the western hemisphere. Bishop William wrote the whole thing up while our soldiers starved at Valley Forge; John Barber, an Englishman, took out the first gas turbine patent in 1791. Since then the correct answer to the question "who invented the gas turbine?" almost has been "who didn't?" Yet with almost every engineer and his brother thinking about it, the gas turbine got nowhere while the reciprocating steam engine, the gasoline engine, the steam turbine, and the Diesel brought power generation to where it is today.

Two problems—high temperatures and air compressor efficiencies—held the gas turbine back.

Lick those two, and the gas turbine becomes the simplest, most efficient, most desirable power-plant on earth. All there is to it is rapid combustion of fuel, confining the gases of combustion within a pipe so that they can flow only to the point of work, and running those gases through turbine blading to generate power from their expansion. The air compressor in the gas turbine (Figure 1) serves the same primary purpose as the supercharger on a gasoline engine; it supplies the necessary volume of air for combustion.

This utter simplicity of the gas turbine idea has tantalized inventors for five centuries. Yet if they let gases at combustion temperatures go to the turbines, then the turbine blades melted like lighted candles. If they increased the load on the compressor and supplied excess air to the combustor—the obvious way to cool down the gases—they could not get a turbine-compressor combination efficient enough so that the turbine would drive its own compressor, let alone supply useful power.

Hard at work on all these same problems right now are gangs of practical machinists, "long-haired" researchers, mechanical draftsmen, metallurgists, college professors. Back of them, and spending money so fast that a million dollars will not buy a white chip, are outfits like Westinghouse, General Electric, Allis Chalmers, Worthington Pump, DeLaval, Brown Boveri, Northrup Aviation, the United States Army, and the United States Navy. And working just as hard are a horde of little fellows. With all the basic ideas so old, the patent situation of the gas turbine is as wide open as Grand Central Station.

A high percentage of the researchers working for the big companies were brought up on the steam turbine and thus they are old dogs trying to learn a new trick. Some of the jackpots therefore may go to "fresh minds" who are banging away in the backs of their garages.

WHERE IT STANDS—Today's researchers can solve problems which beat them yesterday, because they have so many other developments to borrow from. They are getting air-compressor ideas from 40 years of steam turbine experience (the compressor generally used is a turbine in reverse), intricate blade shapes from the precision castings industry, high-temperature-high-stress blade metals from steam-turbine and high-speed metal cutting tool practice, combustion knowledge from oil burners, fuel performance data from the airplane engine and the Diesel. Old timers lacked these resources; had to fumble in the dark.

Exactly how far gas-turbine researchers are getting in a practical way, these people are not yet telling. An interviewer cannot probe beneath the skin of this subject anywhere without poking into a military secret of some kind.

A few of the facts, however, can be told without violating confidences. For example:

Gas turbines are supplying compressed air for pressure fired steam boilers. Waste gases from these boilers are at 800 to 900 degrees, Fahrenheit; they can be led through turbines to generate power and compress the air to the 35 pounds pressure at which it is fed to the furnaces.

Gas turbines make excellent airplane engines, either to turn propellers or to compress the air required for combustion in jet-propulsion power plants.

Gas turbines have been tried successfully on railroad locomotives by Brown Boveri in Switzerland and studied by General Electric in the United States.

But if the gas-turbine men cannot yet tell all the things they are doing, they at least can tell some of the things that they know they can do in the near future.

First of all, they can enter engine markets which are not now satisfactorily supplied. There is no inherent

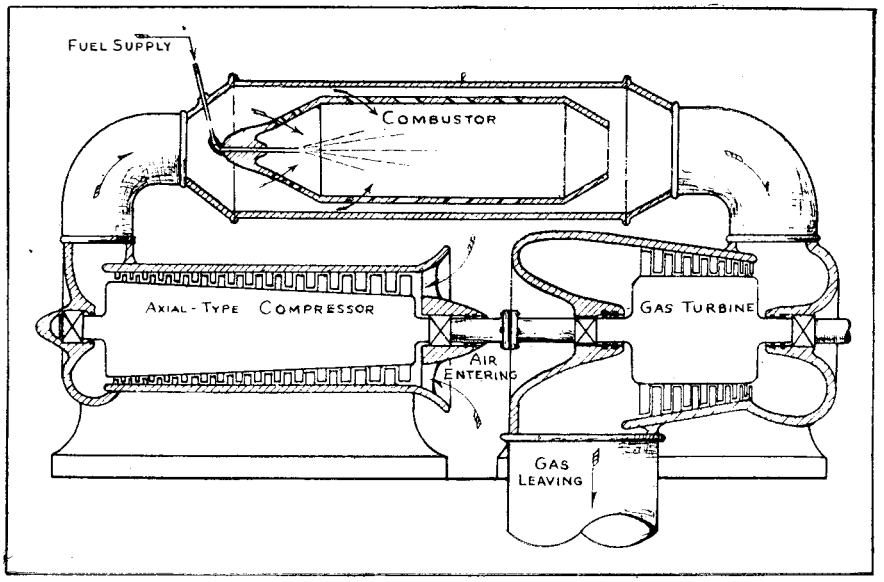


Figure 1: Major elements of the gas turbine cycle

limitation on gas turbine size; no reason why a gas turbine cannot be made as small as a thimble or as big as a warehouse. But with reciprocating engines for airplanes already developed and working well up to the 3000 horsepower range, why not leave that range alone and start on the 4000-and-up behemoths needed for the skyways of the future? Working that way, the gas-turbine builders can get a lot more of their development money out of aircraft builders than they would if they were to aim at markets for which there already are satisfactory power plants.

The same point applies to railroads, with the difference that a simple gas turbine has 16 percent thermal efficiency compared to about 8 percent for ordinary reciprocating steam locomotives, and might pay for its development out of fuel and weight savings in the smaller sizes. But engine sizes are going bigger and bigger, with 4000 horsepower units in use and 6000 horsepower ones being built. The 4000 horsepower Diesel-electric job is made up of two 2000 horsepower units with a total weight of 506,000 pounds. With only 364,000 pounds—a saving of 66 tons—a gas-turbine locomotive could put out 4500 horsepower.

IN MOTOR VEHICLES—Your automobile engine has up to 25 percent thermal efficiency, and a gas turbine at a nominal operating temperature of 1200 degrees, Fahrenheit, ought to have at least 39 percent, but the reciprocating engine has a tight enough hold on this market so that no automobile maker is planning to put a gas turbine under the hood of your car—or, at least, if anyone is he has not said anything about it. But the big overland trucks with their trains of trailers could use that extra flow of smoother power with less engine weight and no water needed for radiators or anything else, and some gas turbine maker is likely to give it to them.

For ship propulsion, the gas turbine can save space and weight, and get rid of the boiler and steam condenser—the condenser being the pest of the engine room, with its changing performance as sea temperature changes, and its corrosion, clogging, and leaking problems. But nobody has yet come out with a reversible gas turbine (there is no reason why somebody should not) and the gas turbine would have to have electric drive or else mechanical gearing for stopping the ship and backing her up, or be connected to a variable pitch-reversible pitch propeller. Furthermore, the main drive gas turbine would not run the ship auxiliaries—the winches and steering engines and all—unless some new type were to use the 600 degrees, Fahrenheit, gas exhaust to generate steam for this or to work some other stunt.

Factories and public utility central stations have fewer unsolved power problems, therefore offer less of an immediate market to the gas turbine. There would be a big demand here if the gas turbine could run on coal, but right now it needs high grade ash-free Diesel fuel. A 20,000 kilowatt simple cycle gas turbine might be helpful for remote unattended or stand-by service; it would start up in a few seconds where other plants take minutes.

Airplanes offer juicy prospects. The fact that the simple cycle gas turbine could be switched on by the pilot and be ready for the take off by the time he had glanced at his instruments, could save hundreds of military planes which now are destroyed on the ground by enemy action. And in peacetime, too, this quick getaway would show a profit by cutting out warm-up time costs and by letting extra ships be ready quickly when needed for heavy traffic. Add to this the savings in weight and space, the lack of need for air cooling or chemical cooling of the engine, and you have something. That is, you have something when the turbine designers can get away from "speed at any price" military needs and spend some time on commercial plane power plants.

One development engineer believes that markets for the gas turbine will be attacked in this order:

1. Airplane
2. Airplane locomotive
3. Chemical industries and oil refineries
4. Ships
5. Utilities
6. Trucks
7. Factories.

He was, of course, speaking only for his own company. He did not know what his 16 bigger and 160 smaller competitors have in mind. He could not speak for an outfit like Westinghouse, which is so deep in war experimental work that its engineers have to clamp the censorship lid on dramatic developments while its publicity men gnaw their finger-nails in pure frustration. But behind his views was some solid reasoning. These markets will probably be ready for the gas turbine in the same sequence as development work will progress.

The first development is the simple cycle. This is low in thermal efficiency. At the nominal 1200 degrees, Fahrenheit, operating temperature at the turbine blades, some 2.95 out of every 3.95 horsepower it develops is used to run the air compressor. About one fourth of the turbine power then can be used at the coupling. Nevertheless, its complete simplicity, its savings in weight, space, piping, electrical devices, and mechanical gadgets, makes the simple cycle attractive for airplanes. This puts the aircraft market first in line.

The simple cycle could be used on a railway locomotive, too. Its increased thermal efficiency over the reciprocating steam engine would pay its way. But locomotives must supply more than power; trains need heat. And this gives the development engineers a chance to go a little bit further.

Intercooling can be applied to the compressor to take heat out of the compressed air and thus increase the volume of air delivered at the same pressure. This is a common practice with air compressors everywhere. It requires cooling water which enters the compressor cold and comes out hot. In an airplane this would be something of a

How One Engineer Rates the Thermal Efficiencies Of Power Plants

Type of Plant	Ordinary Thermal Efficiency
Steam Locomotive	8%
Gas Turbine (at 800-900 degrees)	16%
Automobile Gasoline Engine	20-25%
Marine Steam Turbine (6500 horsepower plant as used in C-2 or AP-2 ships)	25%
Central Station Steam Plant (25,000 to 75,000 kilowatts)	30-33%
Gas Turbine (at 1200 degrees)	39%
Mercury Cycle Steam Plant	40%
Diesel Engine	36-42%
Gas Turbine (at 2000 degrees)	57.5%

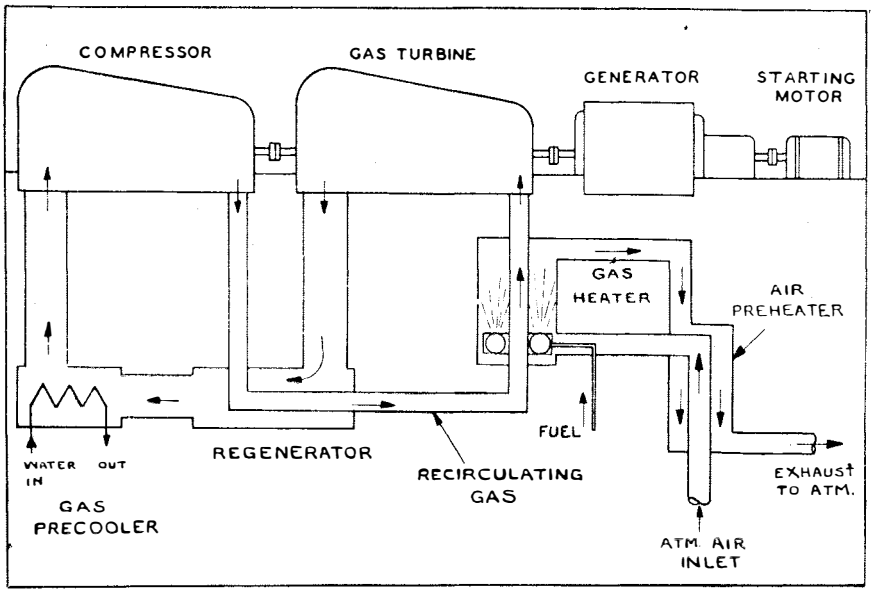


Figure 2: The Escher Wyss closed cycle turbine in block form

nuisance, but a railway train can use hot water. One stage of intercooling can reduce the work of the compressor 15 percent and make that much more power available at the draw bar.

The locomotive can make use of regenerative heat, too. This means taking heat from the 600 degrees, Fahrenheit, exhaust of the turbine, and using it to warm up the combustion air entering the combustor. Every bit of heat applied here means just that much saving of fuel. But exhaust heat can be used further in a waste heat boiler. If separately fired, this boiler could make steam for starting the turbine. No gas turbine announced so far is self-starting; that is another of the developments which may come any minute.

Reheating is practical in a locomotive turbine. Reheating is helpful because as the gas passes through the turbine it cools down and loses power so that the exhaust end of the turbine has less power than the inlet end. If fuel is burned in the cooled gas—and this is easy to do, as the gas contains some 85 percent of excess air to cool it down from the combustion temperature and save the turbine blades—then the temperature of the gas can be kept nearly uniform throughout the turbine and the power of the same sized turbine can be greatly raised.

With all these gains in efficiency at his hand, the locomotive gas turbine designer can do either of two things. He can keep his working temperature at the blades at 1200 degrees, Fahrenheit, or higher. Or he can reduce his operating temperatures and save his turbine blading.

INCREASING EFFICIENCY—Compare the two procedures. A simple cycle gas turbine at 1200 degrees might run at 20.2 percent thermal efficiency. Add intercooling, reheating, and regenerating, and the efficiency goes up to 32.2 percent. This means a great saving of space and weight for the same draw bar pulling ability. But cut down the temperature to 800 degrees and about 16 percent thermal efficiency may be left—these figures change with design features.

Metals which will stand up at 750 to 800 degrees, Fahrenheit, are much easier to find than those which will take 1200 degrees. The obvious answer is a locomotive which runs at 800 degrees or more for ordinary pulling but has the higher temperatures and efficiencies on tap for short-time use on steep grades.

When a locomotive gas turbine is developed that far, it has everything that the open cycle can have for any application. Chemical plants and oil refineries could use such a turbine; they need the power and the waste heat, and in many cases—especially in refineries—they have waste gases which could be used for fuel.

Sequence In Which Gas Turbine Fuel Problems Should be Conquered

1. It uses high grade ash-free Diesel oil now.
2. Next should be light-bodied fuel oil.
3. Then Bunker C fuel oil.
4. Crude petroleum.
5. Fuel oil with colloidal or peptized coal mixture.
6. Pulverized coal.
7. Solid coal.

(This is the normal sequence of progress. But somebody may come out with a solid coal burning gas turbine to-morrow.)

The next step beyond the open cycle is the closed cycle turbine.

Here is the difference. In the open cycle, the products of combustion go from the combustor, through the turbine, and out of the exhaust. But in the closed cycle the products of combustion either do not go through the turbine at all, or if they do go through it then they do not go immediately through the exhaust.

In one closed cycle, the Escher Wyss (Figure 2), the gases from the combustor are used to heat a second gas as if it were water in a boiler. Hydrogen makes a good second gas for this; it has 6.8 times the thermal conductivity of air and 14 times the specific heat, and can pick up and use the combustion heat that much better. The second gas gains in pressure as it is heated, but loses pressure when delivering power through the turbine. After leaving the turbine it therefore flows through a compressor which increases its pressure, then goes to the combustor gas heating chamber to pick up more heat and pressure, and the cycle is repeated.

Westinghouse has a closed cycle machine in which the products of combustion pass through the turbine. Instead of being exhausted, these hot gases then go on into a compressor. They still contain 85 percent of excess air and plenty of heat units. Enough make-up air is added by a second and independent compressor to keep the system in balance.

The advantage of the closed system is that it gets the same power out of much smaller equipment. In a simple cycle turbine the inlet pressure is less than 100 pounds per square inch absolute when working at 1200 degrees, Fahrenheit. In a closed cycle the absolute pressure can be much higher. And when that pressure goes up the size of the equipment can come down at the same rate; increase the absolute pressure five times and the size can be reduced by 80 percent.

Savings in size like this seem unimportant until the capacity of the equipment reaches 7500 kilowatts or more. Therefore most of the closed cycle systems exist on drafting boards and in experimental laboratories. Very few are actually at work.

But the notion that closed cycles are for big sizes only is another of those ideas which may get knocked into a cocked hat at any minute. Westinghouse, General Electric, and others have been generous in publicizing performance figures, but they could not talk about all they have even if they wanted to.

The gas turbine is working, enormous sums are being spent to make it work better, its temperature and efficiency problems are being solved, and it is going to make a big difference in the entire power generation field. But nobody really knows what improvements in it are coming next.

Basic Facts About Gas Turbines

1. After 500 years the turbines are working economically.
2. Basic patents are wide open. Anybody can get into the game.
3. Any type of turbine can be used; radial flow, axial flow, tangential, reaction, single stage, compounded, or what have you.
4. The turbine can run its own air compressor when both have about 65 percent efficiency. Turbines of 84 percent and compressors of 85 percent efficiency are in use; therefore the turbine delivers power.
5. A good many of the high temperature problems have not been solved.
6. Present fuels are limited to high grade ash-free Diesel oils.

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SLIME CONTROL

Aided by Dehumidification of Air in Dams

DEHUMIDIFICATION of air has been found effective in reducing slime accumulations in the inspection galleries of large dams. This new use of air conditioning, developed in connection with the operation and maintenance of large dams and power plants, is reported by S. O. Harper, chief engineer of the Bureau of Reclamation in a recent issue of *Engineering News-Record.*

During the humid season of the year, the normal temperatures of the galleries and of mechanical and electrical equipment within the dams are appreciably below the dew-point temperature of the outside air. This leads to condensation of moisture on the walls and galleries as well as on the mechanical and electrical equipment. Moisture accelerates the growth of microscopic organisms and the formation of slime upon the walls of the galleries, causing rapid deterioration of paint film and corrosion of metal surfaces. Also, moisture permeates electrical installations and causes breakdowns.

One installation of equipment for dehumidification purposes is now being made at the Marshall Ford Dam in Texas, and a second is projected for the Grand Coulee Dam in Washington.

Electronics in Transportation

Radio and Radar Equipment Developed for Military Use Will be Available After the War to Expedite Routing of Mobile Units in the Transportation Industry. Even Manufacturing Plants can Benefit from Two-Way Radiophone Service, Television, and Almost-as-Fast Facsimile Transmission

WITH MILLIONS of man-hours and dollars being poured into electronic research during these war years, and with greatly expanded factory facilities now fully tooled up to produce the new products resulting from this research, the inevitably high experimental and tooling costs of new electronic developments will, in most cases, have been written entirely off the books by the end of the war. Except, then, for minor post-war conversion expenses, war-created electronic developments can be manufactured after the war at production costs unpadded by high research expenses.

Probably the most glamorous electronic gadget so far revealed to the public is radar. Installed in military planes, ships, and ground locations, it detects approaching enemy aircraft and surface vessels at night or in fog, far beyond the capabilities of human vision, and automatically aims guns to hit those enemy targets miles away. To the industrialist, such uses as railroad collision prevention, guidance of marine traffic at sea during darkness and fog, and detection of obstacles in the path of aircraft flying blind mean greatly increased speed of transportation of their raw materials, supplies, and finished products, with simultaneously reduced loss risks.

Although electronic developments now under restrictions of military secrecy must wait until after the war for industrial utilization, considerable progress has already been attained in the case of some newly improved equipment, notably two-way radiophone service between mobile units and between mobile units and one or more fixed stations. As examples, in recent months several railroads have installed various types of equipment, plans have been set up in Cleveland for routing cabs by radio, and ship-to-shore radiotelephone service has greatly reduced Great Lakes shipping losses. Street railway lines, buses, truck delivery services, and isolated factory facilities are now in a position to profit from radiophone service based upon commercial utilization of highly effective military handi-talkies and walkie-talkies utilizing frequently-modulation principles, just as have police, fire, ambulance, forest protection, and similar public services.

In applying radio and other electronic signalling principles as a means of increasing efficiency and safety in the railroad field, engineers have developed a number of practicable train communicating methods. Although each method employs electronic tubes, the various modes of operation differ widely and have individual advantages and disadvantages under various conditions. Technically these methods can be divided into three groups: space radio systems; induction radio systems; and rail carrier telephone systems.

Space radio systems can use either conventional amplitude modulation or the newer frequency modulation principle, both of which provide flexible and versatile means of train communication. Space radio systems will continue to function with full efficiency when wayside wires or tracks are damaged by storms, floods, wrecks, or other causes since they do not depend upon metallic wire signalling circuits as do the other two systems. This is a highly desirable feature since maintenance of positive communications along railroad rights-of-way is most urgently needed during such emergencies.

Instructions given by radiotelephone to an engineman must be followed in minute detail unless they are countermanded. Should central-station equipment fail after issuance of orders, or should locomotive receiving apparatus become inoperative for any reason, the engineman, if not advised of such failure, would proceed to follow the original instructions while in ignorance of attempts by the dispatcher to change these orders. This might cause trouble.

In the railroad system of one ordnance plant, precautions are taken by transmitting carrier-wave energy from the central station at periodic intervals by means of an automatic pulsing device which momentarily keys the transmitter at predetermined intervals. Concurrently with emission of the carrier, a tone signal is impressed on the input circuit of the transmitter. In locomotive cabs, the recurrent pulse signal actuates a check light, while the tone signal is reproduced by the cab loudspeaker.

Right: The engineman on a Seaboard Air Line Railway train uses the radiotelephone installed in his cab to communicate with the conductor in the caboose of a Diesel-electric freight train

Left: In the caboose the conductor uses the radiotelephone as conveniently as he would the ordinary wire telephone in his own home

The frequency of the tone signal is such that it may be heard above normal background noise within a cab.

A system of this general type provides a check on overall operation of the radio control system. In event of failure of the central-station transmitter, or any portion of the locomotive receiver, including the loudspeaker, the audio-visual signals are not repeated in the cab, thereby warning the engineman that the radio system is inoperative.

Protective radio control techniques are of particular value during freight classifying operations when a locomotive is pushing a long string of cars over a "hump" where freight cars are uncoupled, usually one at a time, and allowed to coast down to a particular track in the classification yard. Inasmuch as the engineman is frequently out of sight of critical yard operations in this case, it is important for him to know that he is in constant touch with the control point at the "hump" and that in event of equipment failure a positive indication will be given.

INTRA-TRAIN TELEPHONY — Radiotelephony is also expected to be of particular value in intra-train communications services such as cab-to-caboose signalling. The longest test of radio communication in point of mileage so far reported was made recently by the Santa Fe Railroad. A 70-car train traveled 2200 miles from California to Chicago, using radiotelephone communication between caboose and engine under all conditions of weather. After the trip, railroad officials forecast a rosy future for radiotelephone on rails. An ultra high-frequency amplitude modulation system, supplied by Bendix, was used. A telephone hand set, loudspeaker, low-powered transmitter, superheterodyne receiver, and power supply were installed at each end of the train. The only hitch in receiving signals on the trip came when various parts of the long train were in three tunnels simultaneously.

Several railroads are trying two-way communication for various purposes, using both audio and frequency modulation. Whatever is learned will be made available to the railroad industry. To eliminate duplicate testing, other railroads are watching these experiments.

Induction radio systems operate at radio frequencies, but the signal energy travels primarily along wayside telegraph wires instead of through space. No wire conductive connections are required to rail or wire circuits. Privacy of communications, as compared with normal space radio systems, is maintained, and equipment may be operated without Federal licensing.

Since telephone, telegraph, or electric power lines follow closely most railroad trackage, the extensive wire network required for operation of induction radio systems on a comprehensive basis is already largely existent. In the limited number of instances where wires leave the vicinity of the railroad right-of-way for distances greater than several hundred feet, inexpensive installations of one or two wires across the gap will carry the carrier signals to the points where the normal wire circuits again are in proximity to the tracks. Signals impressed on wayside wires will follow the curvature of trackage in sections where space-radiated signals cannot readily be received without the aid of repeating equipment.

In rail carrier telephone systems, carrier signal energy is fed directly to the rails. Current flow is through the rails, with return through ground, and the concentrated induction field produced by the rail current is utilized in reception by means of pickup coils under the cars.

Rail carrier telephone communication systems are useful only within a short lateral distance of rail circuits. Since appreciable radiation of radio wave energy does not occur, such systems do not require Federal licensing or frequency allocation. As signals are confined substantially to railroad property, a degree of privacy exists which is not ordinarily obtainable with space radio systems. Rail carrier telephone systems offer means for effecting transmission of signals over comparatively long distances, sometimes in excess of 100 miles between wayside stations and trains and over distances of 10 miles or more between trains, with relative absence of "dead spots" at bridges, tunnels, and other obstructions to normal space radio propagation.

The system permits the crews of freight trains and block operators in wayside towers to talk to one another at any time for the transmission of orders, reports, and information on matters affecting train operation. The conductor in the cabin car and the engineman in the locomotive cab may also communicate with one another and the crew of one train may talk with the crew of another train several miles distant.

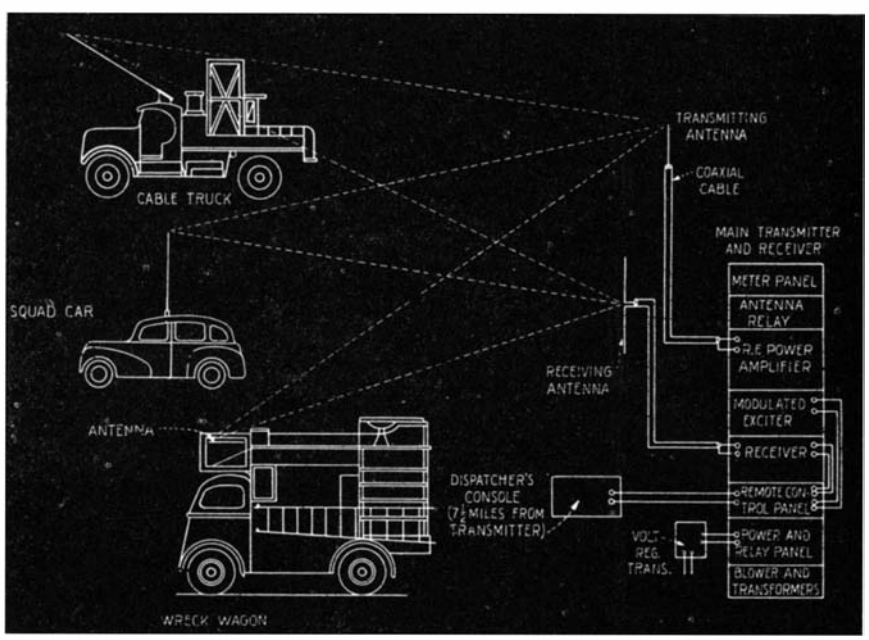
The elimination of stops at telephones alongside the tracks, to enable train crews to get in touch with block operators, has resulted in a considerable gain in operating efficiency, and no change in the operating rules governing the movement of trains has been found necessary. The same formulas are used.

Manufacturing plants can also profitably use two-way radiotelephone equipment for speedy and efficient communication between executive positions and personnel walking or traveling continually around the plant on floor trucks. Here portable battery-operated walkie-talkies such as are now used by the armed forces will provide ample signal power for communication over the ranges existing within the average factory and grounds. This type of equipment has also been used successfully by broadcast stations for remote program pickups from convention floors, golf courses, and similar locations where usual power facilities are not available.

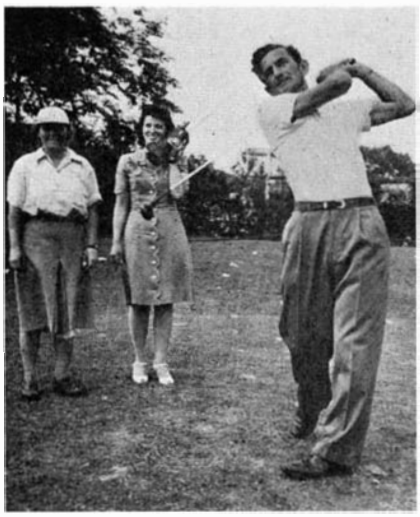
Another of the railroad communication systems, that involving carrier signals over wires, has been successfully used for keeping the operator of an overhead factory crane in continuous touch with men directing lifting operations from various points on the factory floor.

Just as hand-written telegrams are being transmitted by facsimile from unattended machines to Western Union central stations, so can facsimile radio transmitting and receiving equipment be utilized for getting blueprints and diagrams from one plant to another within a matter of minutes even though the plants are at opposite ends of the country. It is today technically possible also to install television equipment that will permit an executive to watch from his desk the manufacturing operations in any part of his plant merely by pushing buttons to switch-in appropriately positioned television pickup tubes throughout the plant.

EMERGENCY SERVICE—The form of frequency-modulated radio communication system which is being used by the Chicago Surface Lines to provide city-wide coverage for emergency operation now has a background of two years of successful operation. Forty-four mobile units with two-way radio equipment and seven supervisory cars with receivers keep streetcars and buses oper-



Block diagram of the Motorola radio system used by Chicago Surface Lines



Handie-talkies, of the type shown here in use to report a golf tournament, can be applied to a number of industrial communication purposes

ating smoothly under all emergencies, proving the effectiveness of low-power radio in covering 190 square miles of territory.

The system fulfills an important need when fires, floods, accidents, or other emergencies endanger life and property and normal communication is not readily available. It has even been called upon to obtain medical attention for streetcar passengers suddenly taken ill, and in at least one case a company car became an emergency maternity ward. Furthermore, by bringing company cars to accidents promptly, the system has materially aided in adjustment of claims and reduction of losses.

Fifteen wreck wagons equipped with two-way units are located throughout the city of Chicago in the company's garages, which are connected by telephone lines to a dispatcher's office. These wreck wagons serve to remove stalled vehicles from the right of way; clear collisions between vehicles when these occur at locations which would block the passing of the company's passenger-carrying units; guard fallen wires and feeder cables while awaiting arrival of regular repair crews; cooperate with the fire department at fires to maintain regular transportation and to safeguard life and property; and perform similar emergency functions.

Eleven two-way mobile units are located on trucks equipped to handle the installation and repairs of overhead contact wires and feeders. These trucks are also available for emergency service. The remaining installations are in cars that cruise along trolley lines throughout the day.

A plan proposed by Cab Research Bureau, Inc., representing the taxi industry, and the Electronic Department of General Electric Company, would make it possible to establish contact by radio with any cab at any place in Cleveland, reduce cruising mileage, and eliminate unattended call boxes connected to telephone lines. If approval can be obtained from the FCC, this would be the first two-way taxicab radio system in the country. The plan calls for one main transmitter for the downtown area and two others to cover the rest of the city. Each transmitter would have four channels, with 100 cabs assigned to each channel.

RADIO ON THE LAKES—The Great Lakes shippers are using radio and exploring radar as protection against the peculiar perils that beset their vessels. The radar system is expected to minimize the danger of collision in blinding fogs of early spring even as the radiotelephone has helped reduce the hazards of wind and current. The ship-shore telephone system has been developed to the point where it keeps 580 vessels in constant touch with each other, home offices, Coast Guard stations—any point with a telephone.

More than 400 of these vessels are served by the Lorain County Radio Corporation. One shore station at Lorain, Ohio, communicates with ships on all five of the Great Lakes. Another station at Duluth reaches ships and ports on Lake Superior. A third at Milwaukee serves Lake Michigan ships and ports.

Because the sets are operated by navigation officers generally unskilled in radio, fully automatic equipment has been developed. Lifting the handset turns on the transmitter. The channel appropriate to distance and conditions is selected by dialing two digits, and the land call is placed with the shore station operator. Call cost is 75 cents station-to-station, 90 cents person-to-person. Long distance toll charges on land are not included.

A six-frequency ship station costs about $2500 installed. Usually sources of interference on board must be eliminated. There is a flat monthly charge of $25 for maintenance. It includes a monthly inspection, and dispatch of a serviceman upon the report of trouble.

With the production tempo of military communications equipment due to ease shortly and with FCC and other governmental agencies now considering the problem of post-war frequency allocations to transportation radiotelephone services, this commercial application of electronics is already well started. The railroads have been able to obtain modern equipment in recent months for exhaustive tests preparatory to large-scale installations, and mass-produced commercial versions of military radio equipment may even be available before the end of the war as the WPB gradually lifts restrictions on non-military production.

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ELECTRONIC DRYER

Applied to Speed Production of Penicillin

PRODUCTION of penicillin has soared to a point where the output in March, 1944, was a hundred times that in the first five months of 1943. Civilians are promised supplies of the new drug sufficient to treat all urgent civilian cases in the relatively near future.

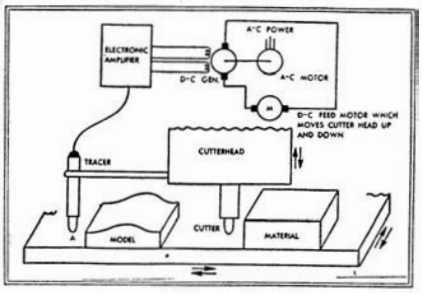
One reason for this increased production may be found in the recent use of an electronic dryer. Formerly, the final bulk reduction of penicillin solutions required approximately twenty-four hours. Recent tests at the Squibb plant disclosed that it can now be accomplished within 30 minutes. The equipment was developed by Dr. George H. Brown, RCA research engineer. High-frequency current boils the solution at 50 degrees, Fahrenheit, under moderate vacuum, resulting in evaporation at the rate of two liters an hour. In more conventional processing, solutions are dried—while frozen—under extremely high vacuum.

ELECTRONIC TRACER

Speeds Machining of Irregular Surfaces

A NEW electronic tracer mechanism has been successfully applied to several machining operations that involve irregular surfaces, such as propellers, dies, and cams.

The machine contains a probe which is used to follow the contour of an accurate model, either actual size or to scale. As the probe is moved across the model, an electronic amplifier feeds motors that move a cutting tool correspondingly with respect to the work.



Probe *A* follows the model's contour

With a well designed machine tool and an actual sized model, the contour of the model can be duplicated within two or three thousandths of an inch when a feed speed of twenty to thirty inches per minute is used.

SOUND ON FILM

Recorder Embosses Sound Track With Sapphire Needle

THE now famous broadcast by George Hicks, Blue Network correspondent, (an eyewitness account of a Nazi aerial attack on Allied ships in the first stages of the invasion) was made on a recorder using 35mm movie film.

The machine embosses a sound track on blank film and can record 120 lines across the width of the strip. This provides a 12,000-foot sound track on a 50-foot film—about five hours of steady recording. The embossing is made with a sapphire stylus mounted in a magnetic head that presses against the film when it is supported by a resilient pad. A second sapphire in a magnetic head is used for playback.

An important feature of the machine is that starting and stopping are controlled by either a manual switch or electrical impulses of voice or sound.

Chemical Guardians of Fabrics

Processes Have Been Developed Which Protect Various Textile Materials Against the Ravages of Fire, Water, Mildew, and Moths. Cotton has been Made Shrink-Set and Crease-Resistant. The Goal of the Industrial Textile Chemist is Now to Develop an All-in-One Treatment

By STEVEN M. SPENCER
E. I. du Pont de Nemours and Company

THE FABRICS of war have been equipped, through chemical research, with various kinds of invisible "armor" which have enabled them to resist fire and water, arctic cold and tropical humidity, mildew, moths, and soil bacteria, in a manner our grandfathers would have considered to be nothing short of miraculous.

Civilized man has for many centuries used the fleece of the sheep, the fiber of the cotton boll and flax stalk, the filament of the silkworm, to keep himself and his family decently and more or less attractively clad. With these natural fibers he accepted their natural limitations. He recognized that moths ate wool, that mildew attacked cotton and linen, that few fabrics shed water, that most of them shrank and wrinkled, and that all of them would burn. But he did little to alter the fibers themselves, aside from combing them out straight, spinning them into yarn, and dyeing them in more or less attractive colors.

It was not until the modern chemist came along, with his penchant for improving upon nature, that modifications were made which gave the natural fibers and some of the synthetic ones valuable added properties, but which did not change their feel or their appearance. The emphasis on high performance of military fabrics did much to speed up textile treatment and finishing developments during the past few years, and the experience gained during this time has without doubt prepared the way for a much more extensive application of these processes to civilian clothing and other textile articles after the war.

WRINKLE-PROOF CLOTH—The textile chemists are talking, for example, about suits and dresses that won't wrinkle in the rain, children's clothes that will stay clean longer, and stockings that will snag less easily. House furnishings will also be given the advantages of invisible guardians of the fibers.

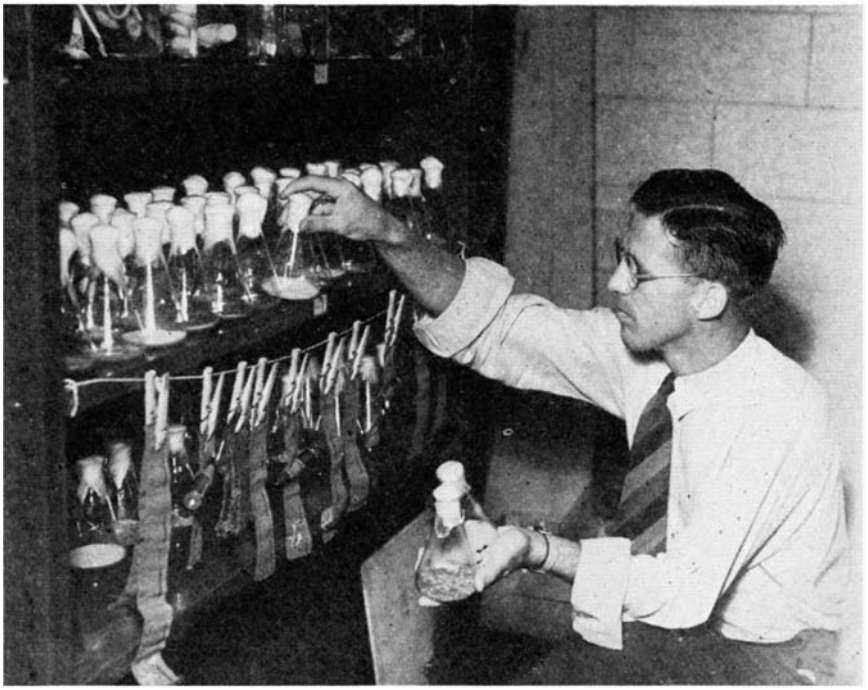
Among the most widely used fabric treatments are those which make garments water-repellent. This is distinguished from water-proofing processes, which render the fabric not only impervious to water but practically air-tight. The modern concept of rainwear is that the garment should keep the wearer dry without interfering with his natural cooling mechanism, the evaporation of perspiration. This objective has been achieved by water-repellent chemicals, which cause the fabric to shed water but which leave it porous so that it can "breathe."

There are also two broad divisions of water-repellent chemicals. One includes the wax-aluminum type of dispersion or emulsion, which forms a thin film on the fibers of the cloth and which comes off when the garment is laundered or dry-cleaned. It is possible to apply these treatments to the finished garment, renewing the treatment after each cleaning.

The second type is represented by "Zelan" durable water-repellent, which is a quarternary ammonium salt. This substance must be applied to the fabric before the garment is made. The process involves impregnating the fabric with the solution, passing it through a drying oven at a temperature of 350 degrees, Fahrenheit, and then washing it lightly.

The exact mechanism of the durable water repellent is not known, but one theory is that the chemical splits up during its application to the cloth and that the reaction products combine with the textile fibers to form a complex which repels water. It is interesting that in the treatment bath the ammonium salt is a wetting agent and penetrates easily into the fibers, but after the reaction has taken place it repels water and cannot be dissolved off by water or dry-cleaning solvents.

Every American soldier is familiar with water-repellent garments. One of the most popular items in his wardrobe is the field jacket, made of treated fabrics. Other military articles on



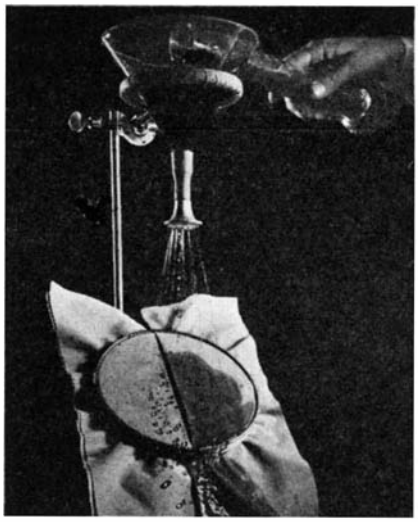
Fungi cultures, used to test the effectiveness of mildew-proofing chemicals, are examined in the Du Pont Pest Control Laboratory by Dr. Norman E. Borlaug. Strips of machine-gun belting, treated with water-repellant and mildew-protective chemicals, are hung in this special high-humidity room. Dummy shells are included to indicate any possible effect of the chemical agents on the metal

which durable water-repellents are used include combat jackets and trousers, ski suits, paratroopers' suits, officers' and nurses' trench coats with hoods, and mountain and arctic sleeping bags. Even machine-gun belting is treated to shed water.

In addition to keeping the wearer dry, the water-repellent fabrics have a weight advantage in wet weather, which is important to troops already heavily laden with equipment. If a soldier is wearing ordinary clothing it will soak up several pounds of rain during a march, which adds to his fatigue. Wading a stream will also pile pounds onto his burden. But water repellent garments absorb very little water and dry out quickly.

Through the use of various testing methods, in the development of which George A. Slowinske, of the Du Pont Company's Technical Laboratory, has been a leader, it has been found that the construction of the fabric and of the garment is of importance in the performance of water-repellent treatments. The cloth should be of fairly close weave, such as a poplin, and if there is an under layer of flannel or other resilient material to act as a "shock-absorber" for the raindrops, they are less likely to drive through the fabric. In some cases both layers are treated.

SPOT RESISTANCE—The "molecular umbrellas" formed by the repellents not only shed water but make the garment spot-resistant. Non-fatty substances do not soil the treated garment as easily as they do non-treated fabrics, and when spots of these substances do get on they are easily sponged off with water. For these reasons the treatments are employed on children's play clothes, women's dresses, sports clothes for both men and women, and it is anticipated that they will be much more widely used after the war, not only on clothing but on upholstery fabrics.



Spray testing equipment used to determine the water-repellancy of a Zelan treated fabric (left) versus a sample of untreated fabric (right)

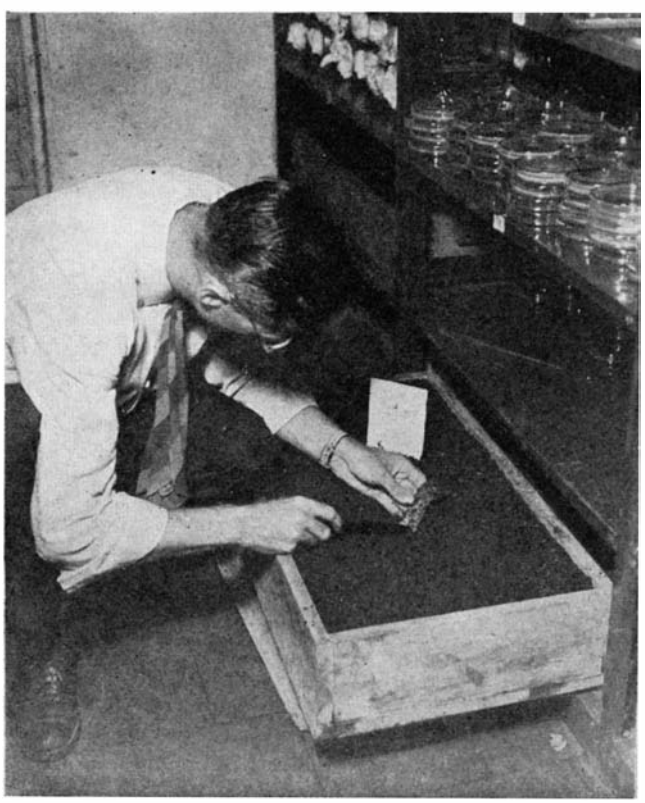
Water in a different form, that which we know as humidity, poses another problem for the textile chemists. Humidity promotes the growth of mildew, one of the most destructive enemies of cloth and of textile raw materials. It is estimated that mildew damage to raw cotton alone averages from 25 to 27 million dollars in the United States each year. The fungus growths produce musty odors, stains, and weak spots in the fabrics. Those which cause decay of the fabric usually consume the cellulose as food, first secreting enzymes which help in the digestion.

The problem has been particularly acute during this war, much of which is being fought in tropical regions, where everything from shirts to shoes will mildew almost overnight. In the Pacific areas, canvas-topped jungle boots and ordinary shoe laces rotted away in a few weeks. The shoe lace difficulty was solved by making the laces of nylon, which resists fungus and bacteria attack. The same material is now being used for the uppers of the jungle shoes and for mosquito netting. But tents, hammocks, camouflage netting, and other cotton fabric articles had to be treated with mildew-proofing chemicals.

Where the fabric is exposed to soil bacteria, as in the case of cotton or jute sand bags for military revetments or for flood-control work, copper naphthenate has been extensively employed. Copper ammonium fluoride is another commonly used mildew-proofing agent.

A newer development in the field of rot preventives for cotton fabrics is phenyl mercury oleate, which has the advantage over copper naphthenate for tentage that it is odorless and does not cause stiffening or tackiness of the fabric. It is being tested on machine gun beltings, where its compatibility with water-repellent compounds is a point in its favor. Phenyl mercury oleate is non-volatile at temperatures up to 250 degrees, Fahrenheit, and is not leached out by water.

FIRE-RETARDING—Efforts to protect fabrics from damage by fire have been made periodically for the past three centuries, but it has only been within recent years that chemicals have been



Removing fabric after soil burial test to determine effect of chemical treatment in protecting against fungi and bacteria. Concentration of organisms accelerated tests

Untreated and undyed piece of tent fabric, second from left, shows rich growth of mold after 21 days contact with culture. Piece in center, treated, was protected

developed which are easy to apply and which do not affect the appearance and feel of the cloth. One of these is ammonium sulfamate, a salt of sulfamic acid. The acid itself had been known since 1876, but it did not become available in quantity until a few years ago, when an economical process was developed for manufacturing both the acid and the ammonium sulfamate on a large scale.

Fire retardants based on this salt have been employed for flame-proofing draperies and curtains in theaters and other public gathering places. During the war they have found important uses on certain confidential military items and in industries where workers are exposed to sparks or open flames. Garments and gloves, safety blankets (used to smother fires), welders' screens, and other types of fire screens are among the articles which have been treated.

Cloth treated with ammonium sulfamate merely chars when held in a flame, but stops burning when the flame is removed. In other words, it will not support combustion—will not add fuel to the fire.

Another type of flame-proofing composition, a mixture of chlorinated paraffin with antimony oxide, has been used to flame-proof military tarpaulins and tents, applications for which ammonium sulfamate is not suitable because of its water solubility. Some of these treatments are also combined with mildew proofing.

MOTH WARFARE—The battle against moths is a never-ending one. It has been calculated that under favorable conditions—favorable to the moth, that is—the progeny of one female moth may in a year consume 92 pounds of wool fiber. And the damage to the wool, feathers, furs, and so on, in the raw and in manufactured articles, has been estimated at from 200 to 500 million dollars a year. The damage is much less if the wool is scrupulously clean, as every good housewife knows. And the moth-proofing of clothing, carpets, and upholstery is by now a fairly well established process, involving a dip or spray with one of a number of chemical compounds. Many of them contain fluorine.

An interesting new approach to the moth problem is that of Geiger, Kobayashi, and Harris, of the United States Bureau of Standards, who have conducted experiments in changing the structure of the wool itself to make it less edible to the moth larva. By chemical reactions they changed certain of the molecular linkages and reduced the content of cystine, an amino acid. The "built-in" moth-proofness is still in the experimental stage and is not being applied commercially.

Perhaps the commonest of all complaints against cloth articles is that they shrink or stretch when wet. Textile scientists call it "lack of dimensional stability" and they consider this their most serious problem. Shrinking is simply the result of the fibers' efforts to return to their original dimension after being stretched and held under tension during the weaving or knitting process. A single cotton fiber, picked from a boll in the field, won't shrink when washed. But when a number of them are twisted together and then drawn taut in a loom they are in an unusual position. While dry, and particularly if the fabric has been treated with a sizing preparation, the state of tension is retained. As soon as the fibers are wet they swell, become more plastic, and are released from tension. They then seek to return to their original dimensions, and the result is shrinking.

Untreated cloth burns rapidly. Sample treated with ammonium sulfamate only chars, does not burst into flame

Methods of pre-shrinking, such as the Sanforizing process, have brought about a great improvement in cotton fabrics, but they cannot be applied to woolens and rayons. Impregnation of the fabric with formaldehyde or urea-formaldehyde resins has been employed on cottons and rayons, and melamine resins have also been used. These treatments are designed not only to shrink-set the cloth but to make it crease-resistant. There are complicating factors in the picture, and much work remains to be done on both rayon and wool, but there is every expectation that the problem will be solved.

Other resins and chemicals are being made ready to do additional textile jobs. A urea-sulfuric acid treatment can be used to make organdy fabrics soft or crisp, transparent or non-transparent. Lucite methyl methacrylate resin, the transparent plastic which today makes bomber noses and which in pre-war days made many useful as well as attractive articles, will perform a new kind of practical and decorative function in providing a snag-resistant finish for women's stockings.

Processes have been developed for simultaneously making a fabric crease-proof and water-repellent, and the textile chemists' goal is an all-in-one treatment which will apply all the varieties of invisible protective "armor" at the same time.

FLOOR CLEANER

Paves the Way For Better Waxing

FOR LABOR-SAVING maintenance of floors, the Finishes Division of the Du Pont company announces the development of Pre-Wax Floor Cleaner as a companion to Du Pont Self-Polishing Wax.

The new dirt-chaser is a concentrated, heavy-bodied product of about the consistency of heavy cream, which is reduced with water for use on all types of floors before waxing or re-waxing. It is said to provide a good base for subsequent waxing, setting up a "bite" on the surface to give the wax better adhesion. Only worn areas will need re-waxing after use of the cleaner, as it rejuvenates the wax finish.

Directions for routine cleaning of waxed and finished floors call for one quarter cup of the cleaner to two gallons of water. The solution is applied with a saturated mop or cloth and allowed to dry before waxing.

For extremely dirty floors, one cup of cleaner should be used in one quart of water. This is applied liberally and allowed to remain on the surface for two or three minutes. On the extremely dirty areas it may be necessary to scrub with a stiff brush, steel wool, or scrubbing machine while the solution is still wet. After removal of the cleaner with a mop, squeegee, or cloth, the floor is rinsed with clear water to which a small quantity of the cleaner has been added. When dry, the floor is ready to be waxed.

ADHESIVES

Perfected from Synthetic Rubber

DEVELOPMENT of a new line of synthetic rubber adhesives is announced by The B. F. Goodrich Company. One is for general "utility" use and is a type of adhesive which will adhere to almost any clean surface. It serves these purposes as well as natural rubber cements in the same field, the company says.

Synthetic cements are available for heat vulcanization, air curing, or cold adhesions. The compounded synthetic cements are suitable for fabric, leather, and synthetic adhesions, to themselves or to each other. These adhesives have a non-toxic solvent, and will give an excellent bond with a large variety of materials. They give the same bond, when used with cured or uncured Neoprene, that rubber cements give with natural rubber.

For metal adhesion, two special cements in what is known as the Plastilock 300 series, have been developed. The first is used with vulcanized Neoprene when it is bonded to porcelain, metal, and so on, while the second is used with uncured Neoprene.

Progress in Instrumentation

The Wartime Impetus to the Aviation Industry will Be Reflected in Many Ways Post-War, to the Benefit of American Aviation and of Other Peace-Time Industries as Well. The Philosophy of Instrument Research. Should Research be Kept Separate from Production? If Not, Where Should the Emphasis Fall?

No WAR can ever benefit a country in modern times, but war does provide impetus to certain types of instruments and appliances, to methods of development, and to production. In these connections a recent visit to the Eclipse-Pioneer Division of Bendix Aviation Corporation proved of tremendous interest.

During this war Eclipse-Pioneer has developed, under the stringent demands of military and naval aviation, the most advanced instrumentation for the control and navigation of aircraft, and at the same time has immensely advanced the speed and accuracy of production methods. The improved instrumentation will benefit post-war commercial aviation, the better production methods will have an influence on American industry as a whole, and the methods of automatic control which have been fostered by flying will be adopted in modified form for a great many industrial purposes.

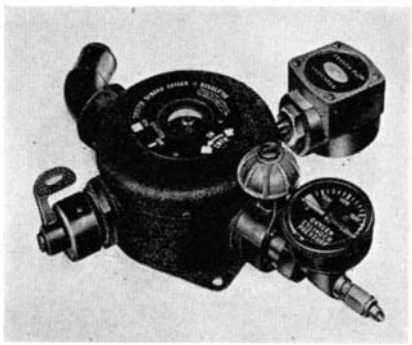
RUSSIAN ENGINEERS—In no direction was the *Herrenvolk* so mistaken as in its contempt for the Russians, for their ability in engineering and manufacture, and hence for their ability to wage modern war. We have proofs of their complete misjudgment in the great names of men of Russian origin who have contributed mightily to American science and industry: Sikorsky, the inventor of the helicopter; Zworykin, the originator of the electron microscope; Karapetoff, a leader in engineering experimentation and teaching—to mention but a few.

To these contributors to American life we can add W. A. Reichel, the Director of Engineering of Eclipse-Pioneer. A graduate of the Petrograd Polytechnical Institute in electro-mechanical engineering, son of a father who himself led in Russian instrumentation, Mr. Reichel has for 20 years (after initial experiences on our shores which involved hardships and taking any job he could get) pioneered in developing one aircraft instrument after another, beginning with an automatic steering device for aircraft and ending with the numerous advanced aviation instruments and controls now being built under his leadership.

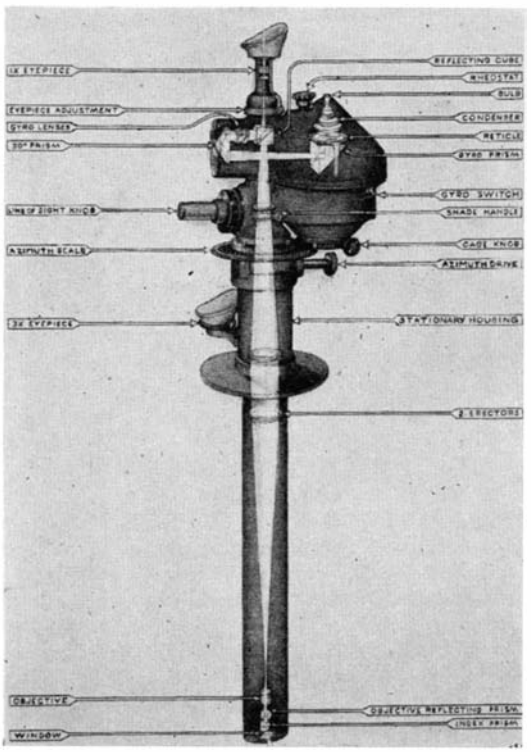
The word research, Mr. Reichel urges, is greatly abused. Used alone, it should be reserved for the achievements of an Einstein or a Langmuir in the fundamentals of science and not allotted so freely to industrial experimentation —though this is thoroughly deserving of respect. In industry experimentation should be well and carefully guided. Ingenious ideas are plentiful. The skill of our directors of research and engineering lies in guiding activity to useful and concrete ends, also in rejecting the majority of the ideas submitted, no matter how clever, if they appear to lead to no useful goal or salable product. On the other hand, if our industrial research is to be practical, it should make every effort to keep abreast of optics, heat, electricity, magnetism, chemistry. The experimental staff should include physicists as well as engineers, mathematicians as well as practical shop men.

To this universality of talent there should be added, Mr. Reichel insists, an eye to production methods from the earliest inception of the design. In many centers of development in industry the experimental development is divorced from the manufacturing side. As a result, instruments and machines are first built in an experimental manner, with attention concentrated solely on function. Afterward the actual production mdel is undertaken. Mr. Reichel is of the strong opinion that therein lies an indefensible waste of effort—that such procedure amounts to developing two machines or instruments instead of one, and that it is impractical and unwise to separate engineering from manufacture.

Eclipse-Pioneer experience has indicated that it is perfectly possible to train both engineers and draftsmen to keep in view the dual ends of function and manufacture; that such training can be rapid; and that once a man has assumed the appropriate attitude, he can design experimental devices with production kept in mind, just as rapidly as if he had adopted the "prima donna"



The Diluter Demand Oxygen Regulator, showing oxygen pressure gage and, at the upper right, the flow indicator



Right: Phantom diagram of the Eclipse - Pioneer Driftmeter, showing the light path

outlook on life and made "research design" his sole objective.

With this philosophy permeating the engineering department, it is not surprising to learn that the skilled experimental designers have also found means of simplifying and cheapening production methods.

Another important lesson in the conduct of research for industry has to do with invention and development. The old conception was that of an inventor starving in a garret, finally to succeed by the strength of his own genius, and with limited, improvised tools and instruments. With the complexity of modern technology, one man's work and limited scientific resources can no longer achieve all that we need. The lone inventor, however, had great advantages: individual initiative and enthusiasm, freedom from too much direction and from too many committees and conferences. The question is: How can the individuality and enthusiasm of the lone worker be combined with the resources of a modern industrial plant where many men in different lines of science are backed up by fine and specialized laboratories?

HERE IS THE SOLUTION—Everyone should co-operate, but for each new development a project engineer should be appointed whose business it is to see the whole thing through—from the very inception, through the construction of the first experimental device, to its testing in the laboratories and, finally, in the case of aviation, through actual flight tests at Army or Navy fields, and sometimes even to inspection in combat areas.

But, while Eclipse-Pioneer thoroughly believes in production coupled with engineering, not too many models of a given device are built at first. Ten or perhaps twenty new instruments will be constructed, to give a sufficient number for testing and for discovering bugs, but not enough to cause delay and financial loss in scrapping larger numbers should tests reveal serious errors. No amount of work in drafting or laboratory can reveal all the imperfections that can creep into a new design.

Director of Engineering Reichel brought up another marked advance in production processes. In making small and accurate parts, the objective is to fabricate in such a way as to remove the least possible amount of metal. Under stress of war needs, a process termed "coining" has come to the fore. In coining, an enormous pressure is exerted on a piece of metal—200 tons on a metal piece not more than two inches in diameter, for example. Under such a large local effect the metal flows like water. A single blow or percussion of an electrically operated toggle transforms the raw piece of metal into almost any complicated shape desired. Next to no metal is removed, labor is reduced to the minimum and, above all, inspection is no longer needed.

Here are some of the guiding principles of the philosophy of instrument research, according to Mr. Reichel and his associates, Messrs. Moran, Noxon, and Baring-Gould. When an attack is made on a new idea, there should be no undue loss of time in its experimental construction. Cogitation and mathematical analysis are big helps, but it is impossible to foresee every point in the behavior of an instrument. The gadget must be built and tried out. At first it looks splendid, and early experience is satisfying. Then troubles develop, enthusiasm cools off, matters look so bad that despair replaces elation. Tenacity and persistence are needed just as much as ingenuity—and courage above all.

Where difficulties are really serious, workers should not be afraid of fundamental and original thinking—of turning to the physicist capable of leaving the beaten track and of reaching the very ends of science.

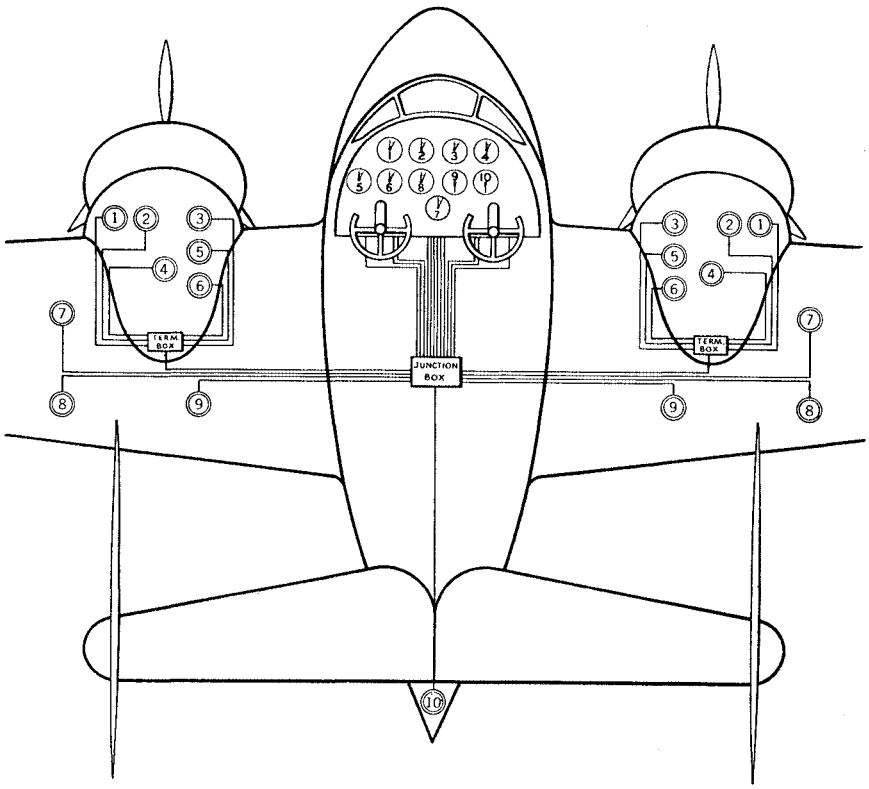
As has been stated, the war has hastened development. There has been rapid improvement in three types of instruments: navigational aids, controls for flight and engine, and in what might be called the standard navigational instruments. For example, consider the "Diluter Demand Oxygen Regulator." Lack of oxygen plays strange tricks on the flyer, giving him a species of jag and rendering his judgment very poor. The regulator takes in oxygen from "bottles" at 2000 pounds per square inch pressure, and delivers it to the pilot in just the right amount and just at the right pressure, with pressures and flows clearly indicated, and with the lungs and breathing needs of the pilot as the unconscious and completely satisfactory guide.

The engineer should not be satisfied with only a single application of the instruments on which he is working. He should seek many applications, and learn association of ideas and purposes. For example, aviation demanded a system of remote indication, needed in placing the magnetic compass where it is not affected, or not much affected, by the presence of steel in the airframe. Once remote indication was achieved, was it not logical to proceed to remote control? So remote control grew from remote indication. Next, effective remote indication and remote control led to the development of an electric motor of very low inertia which will swing lightly and instantaneously from one side to the other as the exigencies of the situation demand.

The needs of remote indication led to the "Autosyn." Then, to furnish remote control as well as remote indication, "Autosyn" developed into "Magnesyn." The special needs of aircraft instrumentation led, in turn, to changes in the design of electronic tubes; to the development of tubes giving a logarithmic indication instead of the linear indication or amplification which satisfies radio; to a species of electronics more precise and accurate than anything required in voice transmission or even television; to electronic tubes with better shaped electrodes and other improvements.

In principle the Autosyn system represents an adaptation of the self-synchronous motor principle, wherein two widely separated units operate in exact synchronism—the rotor of one moving at the same speed as the rotor of the other.

In the Autosyn, the rotors neither spin nor produce power. Instead, the rotors of two connected Autosyns come into coincidence when energized. Thereafter the rotor of one Autosyn moves only the short distance necessary to match any movement, no matter how slight, of the rotor of a second Autosyn. Transmitter and indicator Autosyns are essentially alike. Each has a



Typical Autosyn instrumentation in a twin-engine aircraft. See text

rotor and a stator. When alternating current is applied and a rotor is energized, transformer action causes three distinct voltages to be induced in the secondary stator windings. The voltage values vary with the position of the rotor relative to the stator. For each minute change in the position of the rotor, a new and completely different combination of three voltages is induced. When the two Autosyns are connected and their rotors occupy the same position relative to the stators, no current flows in the interconnected stator leads. Consequently both rotors remain motionless. However, when the two rotors do not coincide in position, the combination of voltages in the two stators are dissimilar and rotation occurs, continuing until both rotors are identically positioned.

The transmitting or measuring part of the system is connected to a pressure gage, a float arm, or any other source of power or indication. The indicating Autosyn moves the pointer on the instrument panel. The Autosyn system has been applied to flowmeters, pressure gages, oil gages, and so on.

For overseas navigation our boys have some wonderful instruments to help them. The Driftmeter, an adaptation of the telescope, will show them drift to one side of the course, and tell them their ground speed instead of air speed. The war has brought to perfection many devices to help navigators on long range flights. Because of their confidential nature they cannot be disclosed at this time.

Eclipse-Pioneer has developed a very quick response automatic control, using a rate signal, superimposed on a departure signal. This automatic control is very fast and employs the latest developments in electronics and electronic servos. It can be used post-war for industrial controls or automatic pilots.

Of course such efforts as those of Eclipse-Pioneer, only briefly described here, will redound to the benefit of American aviation post-war. Planes, not only military and naval, but commercial and those intended for private flying, will benefit by new and accurate instruments for navigation and control. But it is also probable that these refinements in the instrument art will have a profound influence on many other American industries. Additional knowledge will have been obtained in mechanical, electrical, hydraulic, magnetic, electro-magnetic, pneumatic, and electronic devices and controls. The almost miraculous accuracy, rapidity, and "dead-beatness" of a device such as the automatic control will give to industry methods of automatic control of the most varied character in metallurgical processes, in the manufacture of synthetic rubber, in fuel and oil refineries, in the chemical industries, in steel manufacture. The watchfulness and skill of human operators will yield to the far greater alertness and accuracy of the robot.

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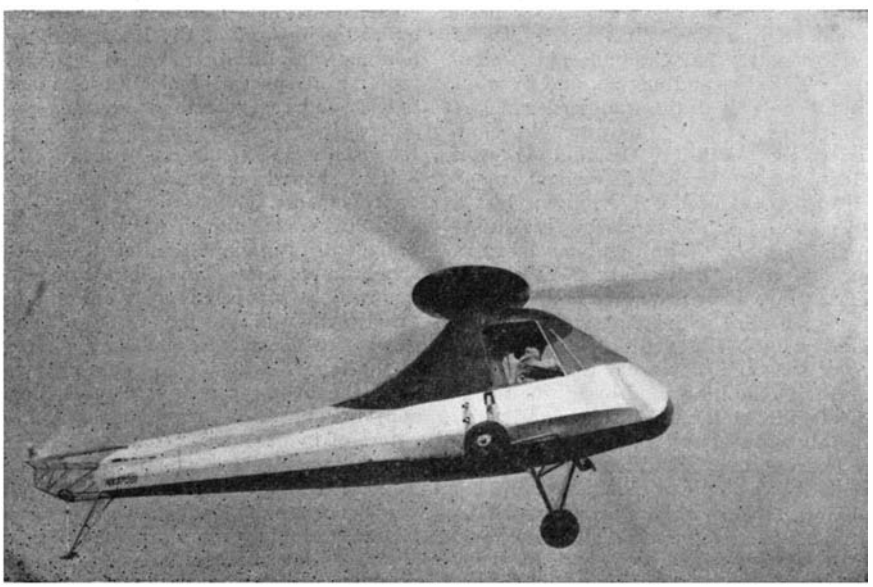
THE PIASECKI HELICOPTER

Features Ease of Control and Reduced Vibration

While it has semi-conventional lines and a tail rotor, the helicopter designed by Frank N. Piasecki has some interesting and novel features. For example, the center of the rotor is completely enclosed in a three-foot discus, so there is no drag-producing void at the roots of the blades. Excellency of control and reduction of vibration are other features of the design; the well streamlined form and the neat way in which the tail rotor is supported on the extension of the nacelle are others.

The helicopter is equipped with a four-cylinder, 90 horsepower, air-cooled Franklin engine and has a high speed of between 90 and 100 miles per hour. The gross weight is only 1000 pounds. The rotor blade diameter is 25 feet, it turns at a speed of 350 revolutions per minute, and the chord of the blade is constant at 9½ inches. The anti-torque propeller at the rear has a diameter of five feet and rotates at about 1600 revolutions per minute while the ship is cruising. The control stick is suspended from the roof of the cabin, with conventional rudder pedals acting on the pitch of the anti-torque propeller. It is interesting to learn that the pitch control can be set and the craft flown with the throttle alone. For take off, the pitch control is set in the forward position and the throtttle opened until the craft ascends vertically. The stick is then pushed forward for forward motion, and subsequently the throttle can be eased back to maintain cruising speed.



Interesting and novel features characterize the Piasecki helicopter

AIR TRAMPS

May Find a Place in the Air Transportation Picture

When our war pilots come back and turn, perhaps reluctantly, to prosaic peace-time pursuits, some of them will perhaps find in the "air tramp" an adventurous, satisfying, and lucrative activity. At least that is the opinion of Mr. Thomas Olsen, partner in a Norwegian shipping company, one of the directors of the Norwegian Air Line, and fully qualified to discuss the air tramp on the score of this dual activity.

Surface liner shipping has not superseded the tramp steamer. Why should scheduled airlines preclude the coming of the air tramp? Certainly in these days of mass organization, of governmental regulation and indirect subsidy, the bulk of the world's air traffic will be in the hands of the regular air lines. Yet there will still be a place for the air tramp.

Aviation's chief contribution to international transport is speed, but there are other advantages such as the availability of smaller units, flexibility in arranging new routes, the short time in which a plane can be refitted to the needs of particular cargo. In the post-war period many strange tasks will be placed before the transportation man, involving the use of delicate machinery and the carriage of costly raw materials, and calling for great speed. Perhaps the air tramp will be very useful indeed. In the old days the captain of the tramp steamer roamed the four corners of the earth, picked up cargo wherever he could, and even advised merchants as to commercial possibilities. Why should not the captain of the air tramp engage in similar exploits?

AIR SAFETY

A Number of Organizations Co-operate Fully

In the article "Safety In The Air," published in our August issue, mention was made of the work of the Cornell University Medical College. To this should be added the fact that credit is also due for work on crash injury research to the National Research Council Committee on Aviation Medicine working with the Committee on Medical Research of the Office of Scientific Research and Development. Also that the photographs used in the article were used by courtesy of *Aero Digest*.

Continuous Hardening

High-Frequency Process is Being Commercially Applied to Treatment of Steel Bars of Various Diameters, Shapes, and Lengths. Results Thus Far Show Appreciable Savings in Costs, Plus Increased Machinability. Equipment is Virtually Automatic and Requires a Minimum of Man-Power

PROBABLY destined to have far-reaching effects in the field of steel treatment is the successful application of high-frequency induction to the continuous heat treatment of steel bars.

Already on a commercial basis, this first bar application may prove to be one of the major contributions made by induction heating to industrial operations. Inductively hardened bars reveal improved machinability while heat-treatment costs are, in most cases, lower by 50 percent than those for conventional methods long considered standard. An actual saving of $15 per ton is possible.

Success of this development is reported to be due to The Ohio Crankshaft Company, designers and manufacturers of Tocco equipment that is now being used by The Caterpillar Tractor Company.

Says President Wm. C. Dunn of the Tocco manufacturers: "The development of this new method of heat-treatment of steel bars provides an easy means for treating small lots as well as large quantities. One has only to push a button to accomplish the hardening. Now for the first time complete uniformity of hardness has been accomplished so that bars inductively treated by this process have greater machinability because of the elimination of hard spots. In every way, quality of stock and the end result is improved."

The Caterpillar Company is treating bars from ½ to 1¼-inch outside-diameter, hardened through their entire diameter and free of scale and decarburization. Growth is negligible and the heat-treating cost per lineal foot is the same for one bar as for a thousand bars. Therein lies one of the most interesting aspects of this application, which has proved itself to the point where it is now no longer in the experimental stage.

In the perfection of this application there was close co-operation between Tocco engineers and the top metallurgists of Caterpillar. The bar unit is an adaptation of the method for continuously hardening track pins which was introduced some time ago.

The equipment comprising this initial bar-hardening installation consists of four identical hardening units and two standard power units. The hardening units, built on rigid cast bases, are 11¼ feet long by 37 inches wide by 38 inches high. Three roller housings rise above this heavy base to a height of 16 inches. These housings are 16 inches square and contain the roller mechanism for passing the bars into and through the inductor coils.

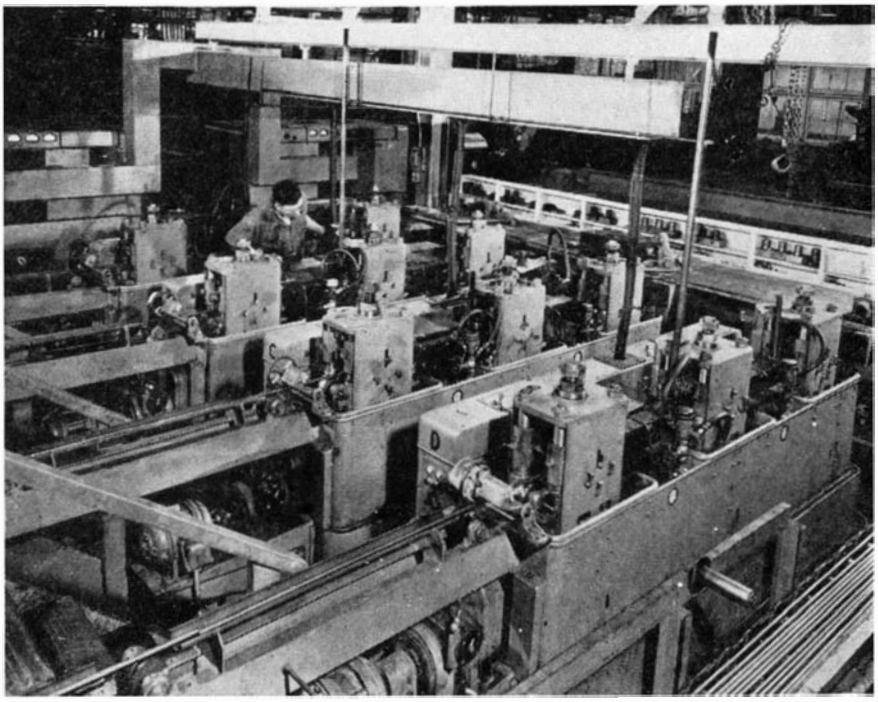
The four hardening units, which are set parallel, each carry two water-cooled copper inductor coils, one for hardening and the other for drawing. Spaced between the roller housings, the coils are 17 inches in length and have a diameter sufficient to treat 1¼-inch steel bars. A quartz tube liner protects the inductor.

Bars are passed into and through the heating coils at controlled speed by means of three sets of special feed rollers located in the aforementioned housings. The rolls are adjustable, allowing for a variation in bar diameters, are driven by the same motor, and are governed by the same variable speed control unit, thus insuring uniformity.

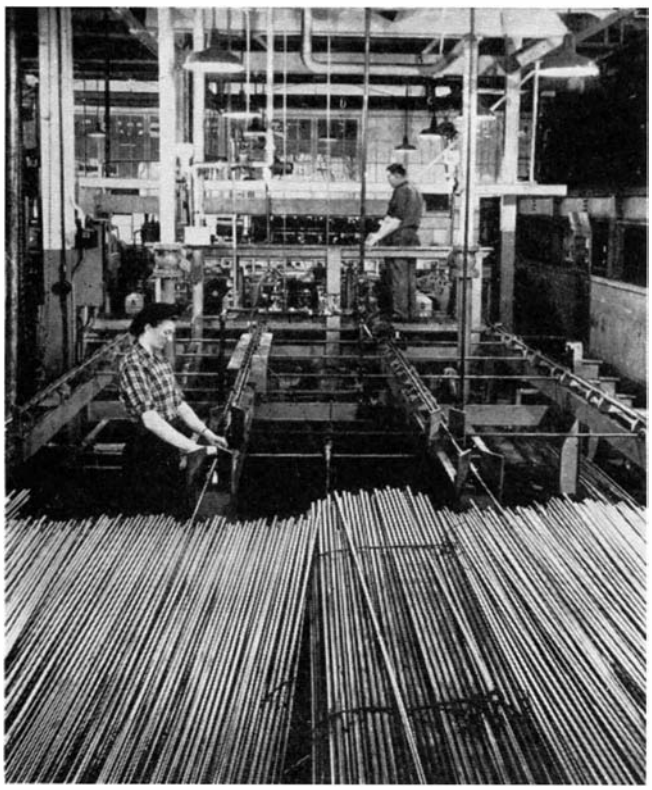
Power is developed by two standard 9600 cycle, 440 volt motor-generator sets; one, of 125 kilowatt output capacity, operates the four hardening coils which are in parallel and the other, of 75 kilowatt capacity, is for the draw coils and is also in parallel. Voltage on each group of coils is held constant by an amplidyne voltage regulator.

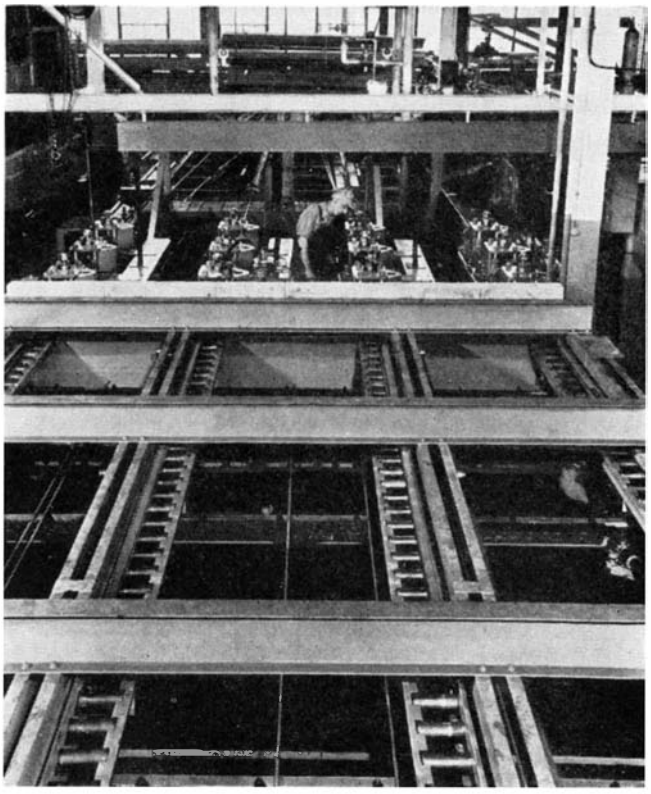
Success of this continuous operation is closely related to the positive drive that governs the rolls. Because of this device, uniformity of hardness is duplicated in all bars and along every inch so that there is complete freedom from hard spots. In a 20-foot bar hardness is held to within two points on the Rockwell C scale for the full length of the piece.

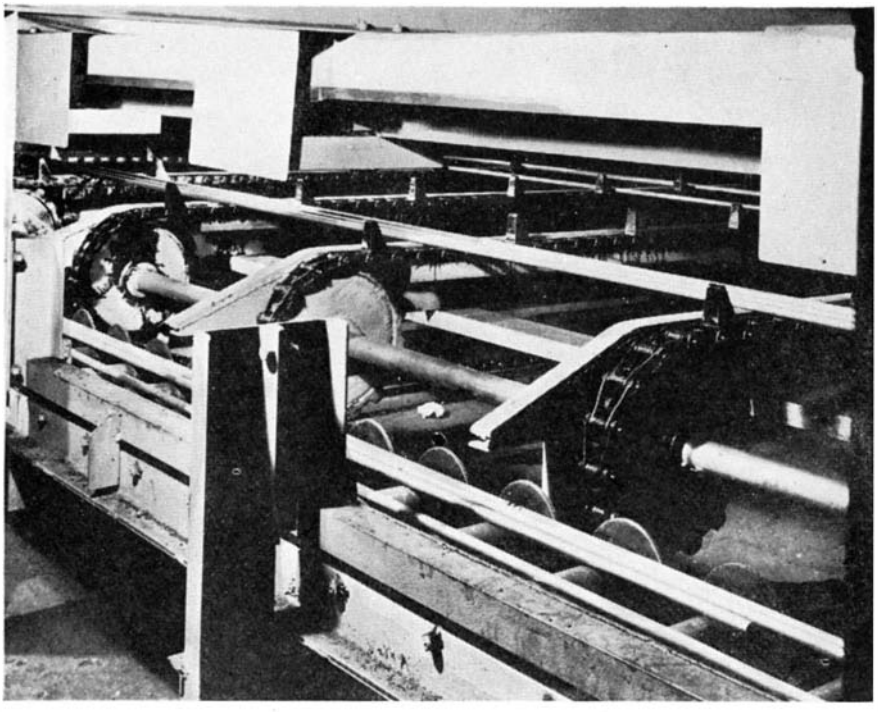
At Caterpillar it is reported that S.A.E. 1035 rounds currently comprise the majority of bars being treated. The resultant hardness averages 28 Rc. Yield strength runs about 112,000 pounds and tensile strength 129,000 pounds. Elonga-



Overall view of continuous hardening units. Speed control rollers are in the three housings on the base, with induction heating coils located between them







Upper left: Bars to be heat-treated are fed end-to-end from a stock pile into a motorized conveyor that carries pieces directly to the inductor coils. Only two operators are required to handle the four units

Above: Following hardening and drawing, the bars emerge onto the narrow roller conveyor in foreground

Left: From the roller conveyor the bars are dropped to this chain type conveyor which, in turn, drops them to another roller conveyor that carries the bars to the storage area

Below: Every fifth heat-treated bar is checked for Rockwell hardness

tion averages 23 percent, reduction of area 62 percent, and Izod impact strength 80 to 100 foot pounds.

Bar hardening is applicable to all hardenable alloys as well as simple carbon steels. Further, hardening is not limited to rounds; hexagon and other shapes can be treated with but a minimum of effort required to change inductors and rate of feed for the new bar.

The bars are fed into the treating units over a motorized conveyor which passes them through a sodium phosphate wash before engaging the first rollers prior to entry into the hardening coil. The cleansing spray is heated to 190 degrees, Fahrenheit, and removes any foreign matter that might otherwise fall off in the induction heater.

Typical of the functioning of this installation is the hardening of 7/8-inch bars. Four bars are fed through the four hardening units, each bar being heated throughout its cross-section to 1600 degrees, Fahrenheit, while traversing the hardening coil. As the piece leaves the first inductor it is quenched in a solid cone of water that surrounds the bar. The water, held to 80 to 90 degrees, Fahrenheit, is under 60 pounds pressure. The bar then passes into and through a reheating coil where it is drawn at a temperature of 1125 degrees, Fahrenheit, after which it is usually passed through a cooling quench to facilitate handling. Natural gas is intro-

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RADIONICS is the vast new science of our age. Besides radio and electronics, it includes sensational new developments so secret that not even a whisper about their existence has reached the public!

Every Zenith worker, from chief engineer to the man or woman on the assembly line, is a highly trained specialist in "RADIONICS EXCLUSIVELY."

Zenith does not "spread itself thin" over unrelated fields like washing machines, refrigerators, electric irons, cooking ranges, vacuum cleaners. We have no intention of competing with lifelong specialists in these fields. Zenith *concentrates* its leadership in engineering and precision manufacture on "RADIONICS AND *ONLY* RADIONICS."

That's the big reason why millions of owners of prewar Zeniths are still getting top radio enjoyment with least service expense in America today!

THAT'S the big reason for Zenith's outstanding war record... the reason why fighting men swear by Zenith-made Radionic Equipment on battle fronts from Normandy to the South Pacific!

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"RADIONICS EXCLUSIVELY" is the basic policy that has kept Zenith always ahead... brought Zenith from building radios on a kitchen table 25 years ago to one of the world's largest manufacturers in Radio today.

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duced into the coils to provide an inert atmosphere for the prevention of scale.

Speed of the 7/8-inch bars through each of the units is at the rate of 22.8 inches per minute. Other sized bars travel at a different rate of speed so that the ultimate production of this particular installation is approximately one ton every 120 minutes.

The bars pass through the final set of rollers and out onto a narrow conveyor moving forward until a limit switch is tripped. This rolls them onto a chain drive conveyor which carries the pieces to a third conveyor running parallel to the entire assembly back towards storage.

Close check of treated stock is maintained. Every fifth bar is tested for hardness and end samples are frequently cut for laboratory inspection.

Significant to other industries is the fact that, by actual check, 90 percent of steel bars 7/8 inch and over come from the inductors without the need for any subsequent straightening while 85 percent of sizes under 7/8 inch are ready immediately for machining.

Bars treated in this continuous process are not limited in length. Caterpillar is treating pieces ranging from 18 to 24 feet. Material may be either cold finished or hot rolled if straight. The diameter of the steel bar determines the diameter of the heating inductor and the closer an inductor is to the outside diameter of the bar, the greater is the heating efficiency.

It is estimated that one man can operate four of these units with ease. At Caterpillar a man and a woman handle the entire installation including checking of hardness.

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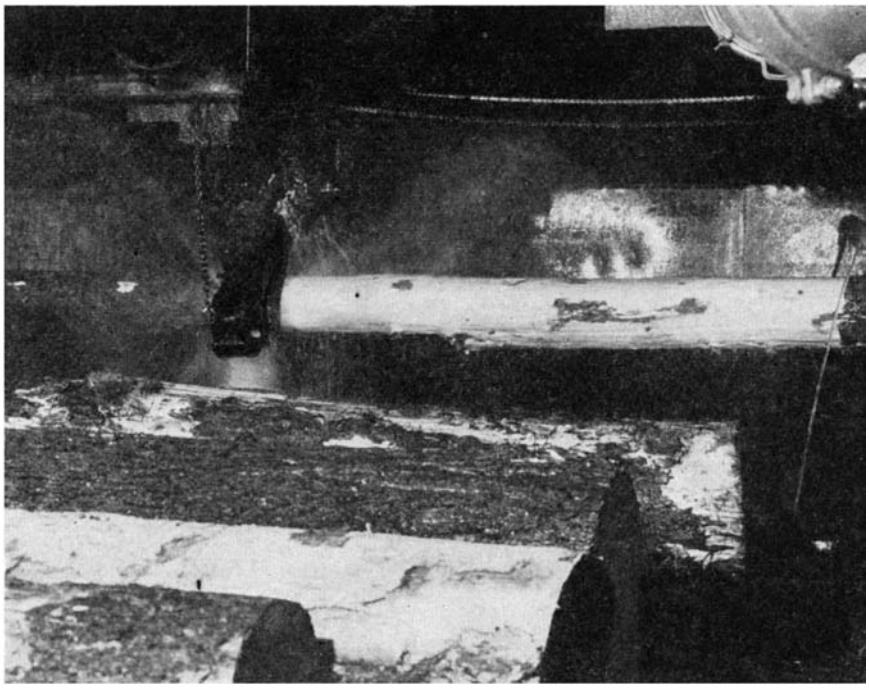


To the logging and pulp industries the hydraulic barker means more pulp tonnage for a given number of trees cut. Debarking waste is virtually eliminated

HYDRAULIC BARKER

Debarks Pulpwood

Logs Without Waste

INGENIOUS mechanics in the far northwest corner of the United States have designed a machine to take the bark off pulpwood logs without taking useful wood with it. This accomplishment of Harry Bukowsky, Plant Engineer, and E. W. Erickson, Resident Manager of Crown Zellerbach Corporation, has far-reaching implications. It means, for example, that anywhere from 6 to 20 percent less wood need be brought from the woods to a mill to produce a given pulp tonnage. This is equivalent to boosting forest growth by a similar proportion or to the addition of new reserves in the woods.

The tiniest piece of bark will ruin paper pulp, and the old-fashioned debarking methods, in order to remove all the bark, also removed part of the valuable wood. The new barker permits no such waste since it removes only the bark from a log.

Working on the lathe principle, the new hydraulic barker is simple in design and operation. Instead of a cutting edge of steel, a cutting "knife" of water, under high pressure, played on the rotating log, removes all bark and will clean nearly 100 logs an hour. It will handle western hemlocks as big as 54 inches in diameter and as long as 22 feet.

Logs are brought to the barker on a chain transfer. Powerful steel loading arms lift them off the chain. A nozzle with a four-inch pipe, suspended from a carriage which travels on a trolley above the log, is lowered into position for the barking operation. The log is rotated and the nozzle, controlled by an air cylinder, travels lengthwise alongside it. A jet of water strips the log of its bark by hitting it at an angle with a pressure of 650 pounds per square inch. The nozzle advances its own width for each revolution of the log. Thus it will cut off a seven-inch swath of bark with each revolution. The nozzle carriage is fitted with swing joints to permit a 24-foot travel.

Refuse from the barker is carried away by a conveyor. Examination of this refuse confirms the efficiency of the barker because it rarely contains even a sliver of wood. The bark peeled from the logs is put to good purpose—going into the furnaces of the paper mill boiler room to be transformed into power.

DRIED, CANNED

Foods Show Best

Keeping Qualities

DEHYDRATED vegetables and fruits retain their original flavor, vitamin content, and form best when packed in metal containers and hermetically sealed in nitrogen or carbon dioxide, experiments conducted by the Chicago research department of Continental Can Company reveal.

Undertaken in co-operation with the Subsistance Research Laboratory of the Chicago Quartermaster Depot of the United States Army and with the help of many food processors, these experiments represent the first comprehensive attempt ever made to determine the effect of packaging, storage time, storage temperature, and moisture absorption on the quality and vitamin content of packaged dehydrated fruits and vegetables. Heretofore, very little has been known on this subject, despite the rapid war-time growth of this relatively new food processing industry.

Eleven representative dehydrated fruits and vegetables were submitted to four experimental packings. In three cases, samples packed in No. 1 tin plate cans were sealed in nitrogen, carbon dioxide, or air; in the fourth, each food was packaged in three-ply paper bags. Samples of each packaging method were stored at temperatures of 80, 98, and 130 degrees, Fahrenheit, for periods ranging from six to twelve months, and then opened and examined. With the exception of beets and Irish potatoes, the products packed in metal containers and sealed in gas preserved their flavor, appearance, and vitamin content better than those sealed in air or packed in paper cartons.

High storage temperatures, it was found, have an adverse effect upon most dehydrated foods, regardless of the way in which they are packaged. However, most dehydrated foods will retain their original quality and vitamin content with little change for periods ranging from six months to more than a year, provided they are held in an atmosphere comparatively free from oxygen and are not subjected to temperatures above 80 degrees, Fahrenheit. Foods least affected by high temperatures are hominy, beets, apple nuggets, and tomato flakes, while those most sensitive to temperature above this figure are cabbage, onions, Irish potatoes, tomato juice cocktail, and carrots.

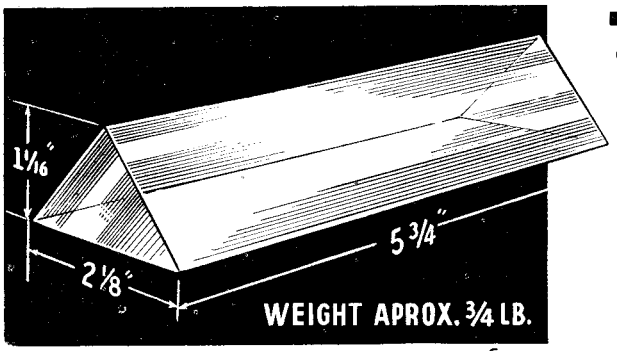
Although these experiments indicate that gas packing in metal containers is the best way to package most dehydrated fruits and vegetables, Continental Can Company is unwilling to

SENSATIONAL WAR BARGAINS

in LENSES & PRISMS

All Items Finely Ground and Polished but Edges Slightly Chipped or Other Slight Imperfections which We Guarantee Will Not Interfere with their Use.

The Government is urging that War Surpluses be disposed of during the war. We are making every effort to cooperate and in keeping with our low price policy on war surplus items, we are passing on to you excellent purchase opportunities at quotations substantially below cost of manufacturing. Individuals, colleges, high schools, researchers should take advantage of these bargains at once.



TANK PRISMS

In order that the tank driver shall not get shot in the face, two of these Silvered Prisms are used to make a periscope (without magnification). We have secured a number of these that are very slightly chipped, making possible their sale at a very low price. They are 90-45-45 degree prisms of huge size —5¾" long, 2⅛" wide, finely ground and polished.

Stock #3004-S . . SILVERED TANK PRISM — Price $2.00 each Postpaid
Stock #3005-S . . PLAIN TANK PRISM — Price $2.00 each Postpaid.
This one is excellent for projecting all the colors of the spectrum — a beautiful sight.

FOUR PRISMS — Special $7.00 Postpaid.

. . . This is the most sensational bargain we have ever been able to offer.

WAR SURPLUS ACHROMATIC LENSES

Stock No.	Dia. in Mms.	Focal Length	Comments	Price
6016-S	12	80 mm.	Uncemented	30¢
6017-S	*12	80 mm.	Cemented	50¢
6018-S	15	41 mm.	Uncemented	40¢
6019-S	*15	41 mm.	Cemented	60¢
6020-S	18	49 mm.	Uncemented	50¢
6021-S	*18	49 mm.	Cemented	60¢
6022-S	25	95 mm.	Uncemented	50¢
6023-S	*25	95 mm.	Cemented	75¢
6024-S	25	11 inches	Uncemented	60¢
6025-S	*25	11 inches	Cemented	75¢
6027-S	30	140 mm.	Uncemented	60¢
6028-S	30	64 mm.	Uncemented	70¢
6029-S	35	60 mm.	Uncemented	70¢
6030-S	36	171 mm.	Uncemented	70¢
6031-S	36	178 mm.	Cemented	80¢
6032-S	36	178 mm.	Uncemented	70¢
6033-S	37	51 mm.	Uncemented	70¢
6034-S	38	178 mm.	Uncemented	70¢
6036-S	39	51 mm.	Uncemented	70¢
6037-S	41	57 mm.	Uncemented	70¢
6038-S	43	57 mm.	Uncemented	70¢
6039-S	48	11 inches	Uncemented	$1.00
6040-S	51	11 inches	Uncemented	$1.00

Free Cement and Directions included with all uncemented sets.

*—Definitely available with magnesium fluoride low reflection coating. Others of these also have this coating but at time this is prepared we do not know exactly which ones. Coated lenses will be priced at 10¢ more than the prices shown above. If you want coated lenses, mark "coated" after stock number and include 10¢ extra. If no coated lenses are available on certain items, your extra payment will be refunded.

ROOF (Amici) PRISMS #5BS ..... $1.50 Postpaid
A few chipped but most were rejected because roof angle was off trifle more than 2 seconds. Excellent for most uses except for instruments of over 3 power.

Sorry . . . ROOF PRISM #5AS, priced at $2.50 each with corrected Roof no longer available.

PORRO ABBE PRISMS #3006-S ..... 25¢ each Postpaid
Size 9 mm. by 17 mm. . . . another war bargain. Normal prices would be 10 to 20 times above quotation.

RIFLESCOPE LENSES Set #2000-S .... $11.00 Postpaid
5 achromats matched by manufacturer. Cemented, ready for construction of fine 3½ power 'scope which would retail up to $50.00. A rare opportunity! Full instructions included.

LENS SET 120-S "The Experimenter's Dream" 60 lenses with 40-page illustrated booklet "FUN WITH CHIPPED EDGE LENSES" — $10.00 Postpaid.
The variety of lenses in this set will enable you to conduct countless experiments and build many optical gadgets. All our lenses are neatly packed and marked for diameter and focal length.

OUR SECOND ANNUAL GADGET AND OPTICAL CONTEST NOW ON. FREE DETAILS FURNISHED WITH ALL PURCHASES

REDUCING LENS SET #1004-S ..... $1.20 Postpaid
Contains a 2½" diameter and 1¾" diameter reducing lens of different powers.

50-PAGE ILLUSTRATED IDEA BOOKLET ... $1.00 Postpaid
Describes wide variety of uses for our lenses and contains much information especially designed for beginners in optics.

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make any predictions about the extent to which these packaging methods will be used after the war. The company points out that the current heavy demand for dehydrated foods is due to various war conditions, such as limited shipping space and the shortage of certain materials. When these factors are removed, dehydrated foods will again have to compete with canned and frozen foods on the basis of cost, quality, and convenience of preparation.

CHARCOAL GAS FOR MOTORS

American-Made Unit Available for Motor Vehicles

INQUIRIES received by the editor during recent months reveal that there is a considerable interest in "producer-gas" units for use on motor vehicles in the United States. Such a unit, using charcoal for fuel, is now available. One of the illustrations shows a standard motor truck equipped with one of those Gasogene generators. It is stated by the manufacturer that such a truck, without motor alterations, will cover approximately the same mileage on one ton of charcoal as it would on 160 to 180 gallons of gasoline.

Essentially the Gasogene unit consists of a generator with a fuel storage capacity of approximately 100 pounds of charcoal. This is connected through temperature reduction and purification filters to a centrifugal carburetor where the gas and air are mixed and sent into the intake manifold.

Within the gas generator is a combustion chamber where the charcoal is burned under forced draft. The incomplete combustion results in the production of carbon monoxide. At the same time, water is permitted to drip slowly into the generator so that hydrogen is liberated and oxygen combines with the carbon. The resulting gases are fed through the filtering units mentioned above and serve to operate the gasoline engine with an efficiency comparable with that of gasoline.

When a Gasogene generator is mounted on a motor vehicle, a change-over valve is installed on the intake manifold and the gasoline carburetor is attached to this valve. It is then possible to operate the motor on either fuel by a single movement of a lever. It is claimed it is almost impossible to tell whether the engine is operating on gasoline or charcoal gas.

While the usual procedure with a Gasogene generator is to start the engine on gasoline and then to switch over to charcoal gas, it is possible to use the charcoal for starting as well as running. When this is to be done, a hand-operated or electric blower can be used while igniting the charcoal and starting the generation of gas. It is stated that the motor can be started within 1½ to 3 minutes after lighting the charcoal.

Tests made by the United States Forest Products Laboratories show that a two-ton truck equipped with a Gasogene generator and operated over fairly hilly roads averaged a speed of 30.5 miles per hour using 1.4 pounds of charcoal per mile.

Courtesy M and R Products, Inc.

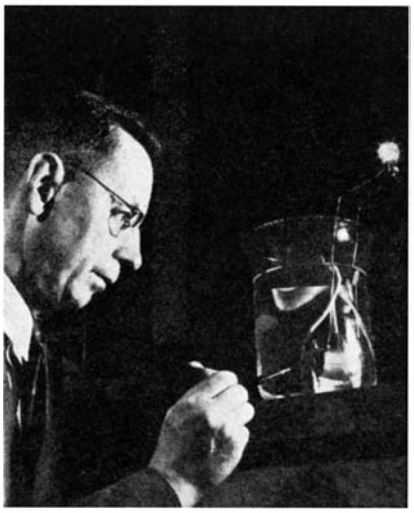
A charcoal gas generator mounted on a conventional light truck

MOISTURE-PROOF

Plastic Completely Seals Electrical Equipment

A TOUGH new moisture-proof plastic, called Fosterite, which seals radar and radio parts against harmful moisture, has been developed at the Research Laboratories of the Westinghouse Electric and Manufacturing Company. This new plastic will greatly lengthen the life of radio and other communications equipment used by Allied armies, according to Dr. C. F. Hill.

"In tropical climates where the humidity of the air is high," Dr. Hill explains, "moisture seeping into electrical equipment often caused short-circuiting and breakdowns in service. Even replacement parts were sometimes made useless by moisture absorbed from the air.



Plastic seals a transformer

"Fosterite is proving to be the answer to many of these problems," Dr. Hill declares. "First, because the impregnant is almost as fluid as water, it fills completely every tiny space in electrical windings and coils. Second, a special coating form of the material can be applied to the apparatus, leaving no air gaps through which moisture could seep. This happens because Fosterite, unlike varnish, requires no liquid solvent which would evaporate during the heating process and cause tiny cracks to appear."

To demonstrate the plastic's waterproof qualities, the Westinghouse scientist coated an electrical transformer with Fosterite and submerged it completely in a jar of water. An electric light bulb attached to the transformer continued to glow brightly.

"A transformer coated with ordinary materials would last only a few minutes under such conditions," Dr. Hill declares. "But Fosterite-coated transformers can stay under water for weeks or even months and still give satisfactory performance."

SYNTHETIC LATEX

Offers Expanded Fields for Vinyl Chloride Resin

CREATION of a true colloidal latex of Geon vinyl chloride resin in water, without the use of any organic solvents, is a recent achievement of Goodrich research chemists, according to William S. Richardson. Sought since the first practical use of the vinyl chloride resins was accomplished by the company 17 years ago, the production of this latex will vastly expand the uses of this type of synthetics in peacetime, Richardson says. Vinyl resins, including the new latex, are under allocation by the War Production Board. Quantities for experimental use are available, however.

Adaptable to a wide variety of applications in coating textiles, wire and

other materials, and film manufacture, the latex allows all the advantageous properties of the vinyl resin to be utilized without the expense and hazards of flammable and toxic solvents necessary in older methods. It also permits use of much existing equipment which cannot handle other forms of vinyl resins and eliminates the necessity for expensive recovery systems required where these resins are applied from solution.

Major potential applications of the Geon latex are in coating paper, paper board and boxboard, textiles, insulating wire, casting continuous films, treatment of glass fibers and fabrics, manufacture of gloves and other products in which rubber latex has been used, treatment of leather for added wear and moisture protection, and use in corrosion-resistant paints.

Upon deposit, at the end of the drying cycle, the latex is fused almost instantaneously at temperatures of 275 to 300 degrees, Fahrenheit, to yield flexible, tough, stable, resistant coatings or films.

The new latex in clear or colored form can be brushed, sprayed, or dipped. It can be made to conform to fiber structure, thus allowing the materials treated to "breathe." It can also be applied as a flexible, impervious coating. Improved pliability, more thorough impregnation, and greater adhesion of the fibers are obtained than in older methods of vinyl resin use.

POWER TRUCK TIRES

Conserved by Care and Effective Repair

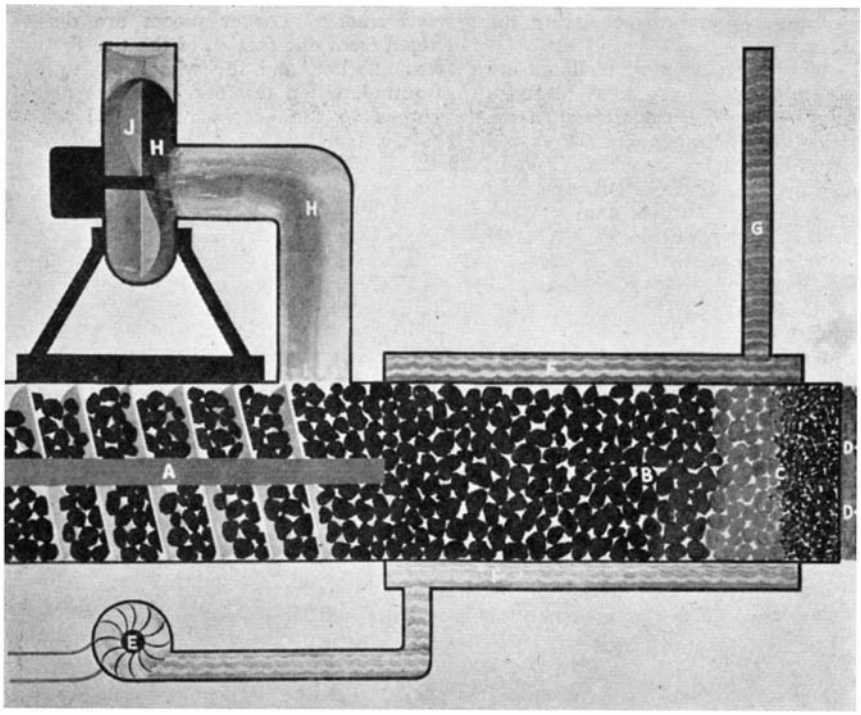
SOLID rubber tires on drive and trail wheels are practically the only parts of the power industrial truck that are vulnerable to wear, and when rubber is plentiful the cost of keeping spare tires on hand for replacement is unimportant. Tire life varies from three months to five years, depending on floor conditions and on the care given to the tires. However, conservation must pinch-hit for replacement during the emergency period. When maximum service is obtained by making repairs before the tires have become too badly worn, rubber is conserved for other uses and trucks can be kept in operation instead of standing idle while waiting for replacements. In the plant of Warner and Swasey Company, effective methods of making repairs to power truck tires have been developed by the electrical maintenance, industrial truck department. These conservation measures have resulted in longer useful life for the tires and better operating efficiency of the trucks.

Vibration due to lumpy tires cuts down the operating efficiency of the material handling system, sometimes by inducing operator fatigue and sometimes by causing damage to the loads, such as finished precision parts. Also, tires which are out of round will wear out very much faster; and travel vibration does the truck itself no good. These are all good reasons for keeping a watchful eye on contours as well as on thickness, particularly in plants where floor conditions tend to accelerate the rate of wear.

Tire wear is reduced when floors are smooth, when they are kept clean of grease, chips, metal parts, and so on, and when drivers take care to avoid hitting curbs, holes, machines, walls, columns, and similar obstructions. But with all the precautions that can be taken it is impracticable to eliminate oil and chips from some floors—nor can holes be repaired the instant they appear. So a toll is taken on the tire surfaces. The principal observed causes are: the deteriorating effect of oil or grease; the effect of imbedded chips; the effect of hard smashes on obstructions and pitted floors.

Tires which are subject to these excessive service conditions are seldom worn smooth. Larger pieces are dislodged from one section of the tire than from another, and the wheel goes out of round. When this condition has developed to the extent of several flat spots, a truck running at five miles an hour is subject to excessive vibration. The truck handles like an automobile with a bad shimmy, and the operator naturally reduces the speed in order to preserve normal control as well as to avoid the fatigue induced by the more difficult handling.

One very satisfactory method which has been developed at Warner and Swasey for reconditioning a lumpy tire is to remove the high spots by turning in a lathe, making the circumference true with the center of the wheel. Life of the remaining rubber is prolonged by



Diagrammatic drawing of new anthracite burner. Worm *A* introduces coal into the tube where it burns at *B*. Ash is discharged at *C*. Draft is provided by air entering at *D*, drawn through coal by fan *J* in smoke pipe H. Water *F* is circulated around the tube by the pump *E* and carries heat to the house through the pipe *G*

the smooth contour and more uniform distribution of load; and the efficiency of the truck is restored by enabling it to handle at normal speed. The removed rubber is not wasted because it usually has been so injured that it has no value.

In the Warner and Swasey plant trucks are used on three shifts seven days a week, and tires have a normal life of one year. After turning they run about four more months before needing further attention. After the first treatment no difference is noted in the performance of the tire. After a second cutting the tires feel a little more solid; and if a third cut is possible a still more pronounced effect of solidity is noticed. Reconditioning has been estimated to add 70 to 80 percent to the life of the tire. Care is always taken to replace tires in pairs having the same outside diameter, so as to keep the truck in a level position.

ANTHRACITE COMBUSTION

Speeded, Made More Efficient, By Application of New Principle

AN ECONOMICAL, completely automatic, highly-compact heating unit operates on an entirely new principle of burning anthracite. Of far-reaching significance to the five million homes which now depend upon anthracite for heating and the hundreds of thousands of new homes which will be built in the post-war era, the new development substitutes a concentrated, fast-burning fire of great intensity but small size for the former method of burning anthracite slowly in a firebox of relatively large size.

Utilization of the new principle will make is possible, according to Frank W. Earnest Jr., president of Anthracite Industries, Inc., for manufacturers to produce in the early post-war period an automatic unit, suitable for heating the average sized home, that can be enclosed in a space less than two by two by three feet.

In contrast to present home heating equipment, which burns anthracite at the maximum rate of approximately 10 pounds per square foot per hour, the new development makes it possible to burn 50 to 60 pounds per square foot per hour, liberating more than 500,000 Btu per cubic foot as compared to approximately 50,000 liberated with present-day equipment. As a result, the heat absorption per square foot of heating surface is raised from 6000 Btu to 40,000 or 50,000 with a reduction in the total amount of coal consumed.

Equally effective with either hot water, steam, or warm air systems, the mechanism for applying the new principle is simplicity itself. It consists of a tube six or eight inches in diameter and approximately 18 inches long. The anthracite is fed into the tube automatically; the coal burns in the center of the tube, and the ash is discharged at the other end. Water or air, circulated around the hot part of the tube in a small, compact jacket, carries the heat throughout the house in the same manner in which it is distributed by present-day heating systems.

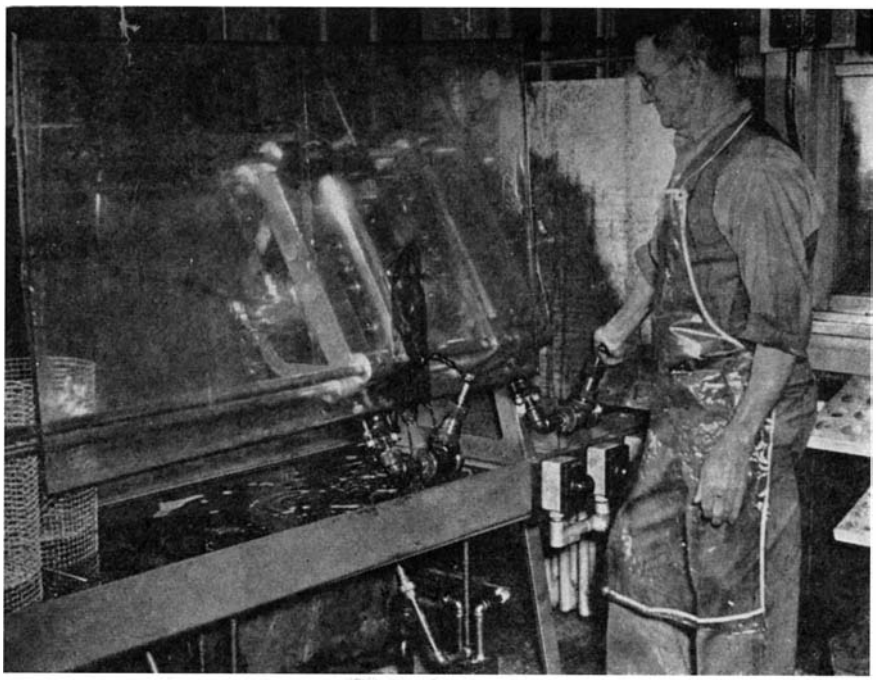
The principle is founded upon a basic characteristic of anthracite combustion which has been confirmed by research in the laboratory. Anthracite, unlike most other fuels, under proper conditions can be made to burn to complete and perfect combustion within its own area.

In adaptation to fully automatic equipment, the anthracite is fed into the tube by a conveyor leading directly from the coal supply. The ash is discharged into enclosed, dust-proof containers, which would need to be replaced only two or three times a week, or directly into pits prepared for the purpose outside the basement. The amount of heat desired is regulated automatically by thermostatic control.

SPLASH CURTAINS

Protect Machine Operators, Keeps Floor Areas Clean

FOR THE protection of machine operators, splash curtains made of transparent sheets of compar—the flexible rubber-like synthetic developed by Resistoflex Corporation—have been tried out in a large electrical manufacturing plant in front of machines that threw oil, subjecting the operators to the dangers of oil-soaked clothing and necessitating the continual cleaning



A curtain of compar protects the machine operator

of large areas surrounding the machines. Large sheets of compar, a vinyl resin derivative that is entirely immune to oils and solvents, are mounted on frames and installed between the operators and their machines. Since the compar is completely transparent, performance of machines is visible at all times and, in addition, operators no longer are subject to skin troubles resulting from the contact of oil.

These splash curtains also are highly advantageous in testing departments where hydraulic fluids are carried under great pressure. Serious accidents are prevented in case the hose line breaks, because the great tensile strength of compar protects workers from the impact of the fluid.

INCREASED PRODUCTIVITY

Essential for Maximum Post-War Employment

JOINT action by labor and management to eliminate restrictive and inefficient practices that raise production costs is absolutely essential to assure full output and maximum employment in the post-war period, according to Albert W. Ramond, industrial engineer.

Asserting that management has long pointed to "feather-bedding," "slow-downs," and other restrictive devices of labor as contributing to economic waste, Mr. Ramond says:

"Unquestionably, there is considerable truth in this charge. Restrictive practices making it necessary to employ more men than are really needed and, consequently, increasing costs are largely a heritage of the earlier days of our industrial history. Basically, they stem from insecurity—from the fear of 'working oneself out of a job.'

"On the other side of the picture, however, there are many management practices and policies which also promote low productivity and high costs. Often, little or no distinction is made between the pay on jobs requiring a high degree of effort and attention and that on 'soft' jobs requiring only a fraction of the work or attention. Delays are frequently caused by improper planning and scheduling; wasted time and effort results from faulty tools or materials or incorrect methods of doing operations."

Such management practices, Mr. Ramond states, tend to undermine workers' morale. They discourage workers who are willing and able to do a better job, and cause workers to doubt management's sincerity in urging the need for high productivity.

"It is generally recognized by the industrial engineering profession," he continues, "that the unused manpower and equipment capacity in industry that can be laid directly at management's door adds up to a much greater total than the waste caused by 'feather-bedding' by workers. By actual measurement in many hundreds of plants, it has been found that losses in industry due to improper utilization of men, machines, and materials run from 10 percent to more than 50 percent of the available potential capacity. In some cases the losses are known and tolerated, because they are considered unavoidable. More often they pass unnoticed because management does not know they exist or does not realize their importance.

"This gap between our actual and potential industrial productivity," Mr. Ramond points out, "offers the soundest solution to the all-important problem of producing goods at low costs in the post-war era while maintaining high real wages. In the face of our extraordinary wartime production achievements, this statement may sound over-optimistic. But it must be remembered that our production results during the war were due mainly to full mobilization of productive resources rather than to a high level of productivity. We had to get things at any cost—and frequently we got them at very high cost. In the post-war period we shall have to get down to rock-bottom levels of costs.

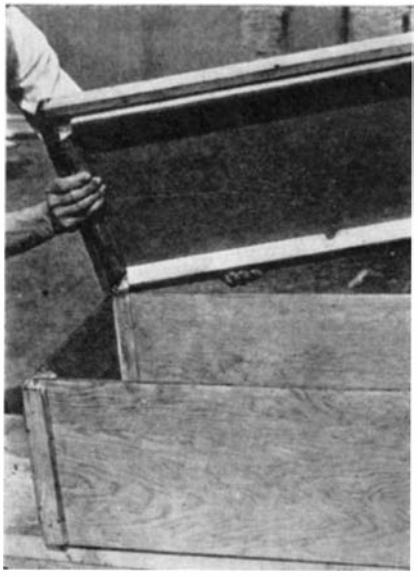
"This will demand real co-operation between management and labor. After the war there may be a strong tendency among workers to 'spread the work' and to favor, if not to force, conditions making for higher costs. Nevertheless, I believe there is solid ground for hope in a change for the better. There are many labor officials who are convinced that increased productivity is the best way to raise real wages and living standards. It is clearly management's responsibility to support this belief, not only with words but with deeds."

AIR CONDITIONING FIRES

Can be Prevented by Correct Design and Maintenance

AIR CONDITIONING system fires, like those of the automobile in its early days when the car which didn't burn up was usually the one which won the road race, will be largely eliminated when the causes are fully understood, says fire-preventionist John Neale, chief engineer of Underwriters' Laboratories, Inc.

"Loss of life and property has resulted from air conditioning system fires but can be prevented in the modern air conditioning system," he con-



Above: A lock-joint plywood box nearly completed. Right: These boxes can be made in any mill that has the usual woodworking machinery

tinues, "by proper design and maintenance and the use of such safeguards as fire-resistive air filters tested by Underwriters' Laboratories, non-combustible ducts, fire-resistive duct linings and insulation, automatic fire shutters in the duct systems to prevent the spread of fire, and electric-eye smoke detectors coupled with alarm systems and electrically connected to shut down the system when fire breaks out.

"Smoke, as well as fire, introduces a panic hazard," Neale says. "This is particularly serious, since air conditioning systems are usually installed in public buildings where crowds are present."

Screening of the intake openings, frequent cleaning of the ducts, and proper location of the intakes well above the floor level will help prevent accumulations of all manner of combustible trash and lint in the ducts.

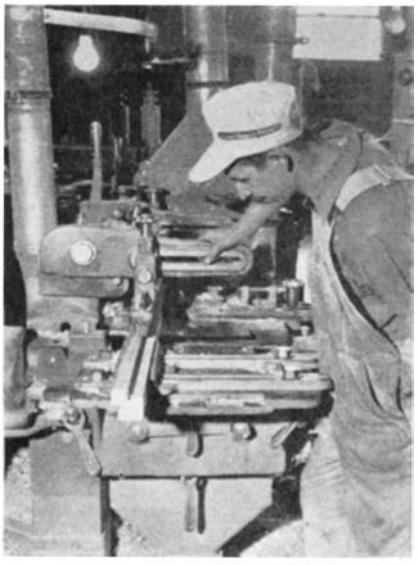
WOOD LOCK JOINT

Results in Rugged Plywood Boxes

CONSIDERING the great need for efficient means of packaging war materiel and the challenge of so many hazards for the packing cases now being used extensively, it is no wonder that much experimentation has been going on in the field of packaging.

One of these experiments has been carried out under the supervision of Roy Klomparens, president of the Klomparens Lock Joint Manufacturing Company. The wood lock joint was developed when shortages of metal anglebars and fastenings made it difficult to manufacture rectangular ducts for air-conditioning. It was only a step from the lock-joint principle in manufacturing the ducts to the development of a lock-joint plywood package to be used in transporting war supplies. Parts of this type of joint are a small-diameter rod (made of wood, metal, fiber, or other available material) and two grooves of semicircular cross-section—one cut parallel with the edge of a flat piece of plywood or other material; the other cut within the slot of a piece of wood or metal corner framing. When the flat piece is thrust into the slot of the framing, the two grooves come opposite each other, forming a long circular hole into which the rod is slipped to lock the parts together.

Not only does this method save time and cost of assembly, but the lock-joint boxes may be manufactured in any mill which has the usual woodworking machinery. The lock-joint package has been tested for strength and ruggedness



at Rockaway Package Research Laboratory and at Forest Products Laboratory. Strongest parts of the boxes are the corners, it was discovered. The boxes were tested with a sand load on a rough-handling wheel where they went through 3567 falls before being demolished.

FINE DUSTS

Prove the Undoing of Many Insects

NEW studies of extremely fine dusts that kill costly insect pests by making them thirst to death are reported in *Chemical and Engineering News*. Coal ash clinkers, it was found, are one ready source for such a dust—nonpoisonous but lethal in a different way—which kills grain weevils, an insect destroying some $3,000,000 worth of grain annually in the United States alone.

Dusts likewise are effective against the rice weevil, flour beetle, Mediterranean flour moth, fig moth, cocoa moth, meal worm, saw-toothed grain beetle, spider beetle, and bedbug.

The studies were made by Dr. H. V. A. Briscoe of the Imperial College, London, and his associates. They were seeking new facts about an old story, for the use of dusts to kill weevils probably was known to the Egyptians some 4000 years ago.

These inorganic or chemically inert dusts do not kill by affecting the digestive or bronchial organs of the insect, they proved, but by the action on the outside casing or skin of the weevil.

This casing or epicuticle holds the moisture needed to maintain the insect's water balance. Apparently the coating of dusts keeps out enough water so that this balance breaks down. The insect literally dies of thirst.

Silica dust has been most generally used as inert and non-toxic. Very fine diamond dust, cleaned and purified repeatedly, proved far more effective in killing weevils than any dusts previously tried. Carborundum dusts likewise were extremely effective.

To be practically useful, the report of Briscoe's work said, a dust must be very hard, very fine, should not contain free silica with a risk of silicosis for workers, and raw materials must be reasonably cheap and plentiful.

The most suitable material was tentatively found in coal ash clinker.

Particle size and distribution are particularly important, since particle size governs the degree of adhesion of the dust. The harder the dust particles, the more effective they are.

The English workers developed a method of testing dusts, and also established that wet grinding is essential in preparation of the material. In dry grinding, there is greater friction, and this apparently rounds the corners and polishes the surfaces of the dust particles, making them less effective.

CAST BUTTONS

Made of Plastics by New Technique

BUTTONS made of plastic by casting are being produced by a technique which, together with determinations of the most suitable materials, have been worked out in the laboratories of Sam Tour and Company, Inc., engineers and consultants.

It has been established that buttons can be made in attractive designs suitable for various types of ornamental finishes, at costs that compare favorably with older methods of manufacture, using materials available in quantity.

SILICONES

Developed to Provide Heat-Resisting Insulation

SAND, brine, coal, and oil are providing the basic elements for opening a new field of chemical manufacture to produce silicones, materials of far-reaching industrial performance.

In revealing the performance of the first commercial production of these silicones, W. R. Collings, Vice President and General Manager of the Dow Corning Corporation, states that they are the result of research to utilize silicon and oxygen, the elements of which sand is essentially composed, in the production of new temperature-resistant materials. "Among the most important of these silicone materials," says Mr. Collings, "are high temperature insulating resins, but silicones can be produced either as solids or liquids in an indefinite variety of forms.

"Silicone chemistry makes possible the building of lighter and better electrical equipment for the war effort, for the home, and for the factory," Mr. Collings states. "Exhaustive tests by engineers of the Westinghouse Electric and Manufacturing Company have brought reports of unusual success in the use of silicone insulating materials.

"An outstanding result attained in the electrical industry is the special instance in which Westinghouse engineers redesigned a three horsepower motor to provide an output of ten horsepower by using high temperature resistant silicones for the electrical insulation."

The first of these silicones was developed by research scientists of the Corning Glass Works in their search to find suitable coating resins for use with glass fibers for electrical insulation or for other purposes where high temperatures are likely to be encountered.

Where ordinary insulation varnishes consist of carbon and hydrogen—a combination known to be inflammable—this new insulation is formed into resins and varnishes by a union of silicon and oxygen. It is the inherent stability of this combination of elements that is yielding products of exceptional heat resistance.

COLLAPSIBLE TUBES

Can be Made from Transparent Thermoplastic

SHAVING cream and toothpaste in attractive colors after the war are possibilities as a result of the adaptation of Goodyear Pliofilm for collapsible tubes. Pliofilm is a thin, thermoplastic sheet with a rubber base, which can

be produced in transparent as well as in colored form. Thus post-war shaving cream, toothpaste, creams, lotions, and similar materials may be produced in various shades and packaged in transparent Pliofilm to distinguish them from one another in medicine cabinets and closets.

Other advantages which Pliofilm is said to hold over current materials, such as lead-sheathed tin for collapsible tubes, include resistance to ingredients in many substances which deteriorate the metal used in current and pre-war collapsible tubes. Also, Pliofilm is economical and lighter in weight and is as readily printed or otherwise identified as other materials.

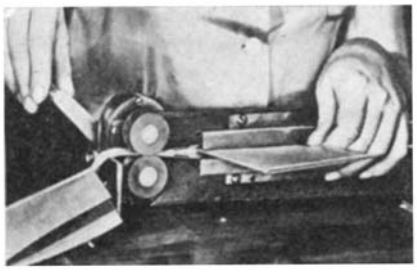
Collapsible tubes are made by wrapping strips of Pliofilm spirally into a heat-sealed tube. Then the Pliofilm is heat-sealed at the bottom into an integrated bond.

PACKAGE SEALER

Creases Tape,

Closes Package

PARTS packaging at the Studebaker military truck plant has been greatly



Sealer for flat packages

speeded up by the introduction of a sealer for flat packages of gasket sets. In the original practice, girls were called upon to crease acetate tape by hand around the open edges of the packages. With the sealer, an operator merely inserts the package edges at right angles to the flat face of the tape and turns a crank. Movement of the crank draws the tape and package between two rollers. The rollers form the tape into a closing lip which seals the opening. At the completion of the process, the tape is clipped.

PROCESS CONTROL

Urged on Vital

Casting Industry

COMPILATION of basic engineering data on process control procedure in the manufacture of malleable, gray iron, and steel castings, begun months ago by SAE War Engineering Board, now promises to aid in establishing process control in every plant as a preventive method of policing manufactured processes and of reducing the excessive rejections and large-scale scrap losses which currently are the greatest barrier to increased output.

Urging close co-operation, from design to completion of castings, the recommendations suggest analysis of every detail and phase of manufacture in the individual plant, preparation of plant production manuals, and rigid adherence to the specifications thereafter. Proper inspection and selection of raw materials, segregation of scrap, proper operation of furnaces, cupolas, and other equipment, and repeated quality control checks additionally are recommended.

The problem of increasing foundry production is regarded as one calling not only for increased manpower, but for changes in operating methods to assure satisfactory production of complicated castings.

PLYWOOD BOX CARS

Are About Two Tons Lighter

Than Conventional Cars

THE Great Northern Railway recently dispatched to the Pacific Northwest a freight train containing 100 cars made partly of plywood. Use of plywood cuts about two tons from the weight of an average conventional box car. The new cars were the first of 1000 being built in Great Northern shops in St. Cloud, Minnesota. They are painted a bright orange to distinguish them from standard box cars. The understructures and frames of the new cars are built of steel and lumber, but plywood is used for the inside and outside sheathing.

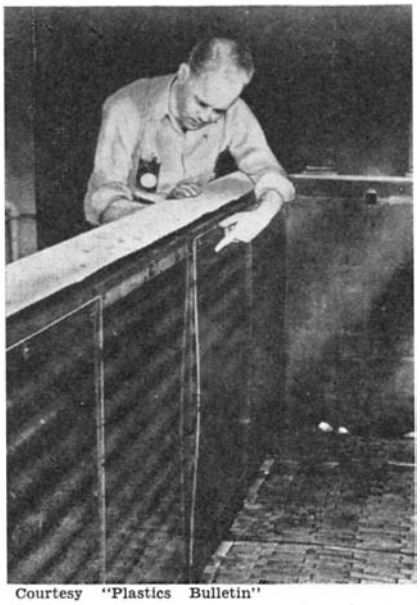
TANK LINING

Made from Plastic for

Electroplating Use

SO successful has been its experience with tubes of Lucite methyl methacrylate resin for insulators in their electroplating baths, that a leading aircraft plant has now installed transparent sheets of the same plastic for the lining of its anodizing tanks used in the electroplating operation. The sheets of plastic insulate aluminum alloy aircraft parts from the metal sides of the 28,000-gallon tanks holding chromic acid and anodizing solutions.

The use of Lucite has extended the life of the tank linings indefinitely,



Courtesy "Plastics Bulletin"
Lucite tank lining resists acid

since it is not affected by sudden temperature changes and by the 15 percent chromic acid solution. Plant officials report also that Lucite has proved less expensive, less subject to breakage, lighter, and easier and safer to handle than the material previously used. Lucite tubes used for protecting parts in the electroplating bath are credited with doubling plating output at this plant.

ICE FOR SURGERY

Mechanically Produced in the Tropics

REFRIGERATION anesthesia, a technique in surgery that is said to be bloodless and shockless, is being used successfully on the battlefront by units of the Navy's Medical Department attached to Construction Battalion detachments in the South Pacific. This was revealed when medical officers recently returned from that area listed the new method among the various medical uses of flake ice in the tropics.

The flake ice required for anesthesia, known also as "cold surgery" and as "protoplasm anesthesia," is made available, at the flick of a switch, by ice-making machines developed for peacetime use by the York Corporation. Because the machines, called "FlakIce," are self-contained, portable, and are capable of producing ice within 60 seconds after being connected to the power source, they have proved especially suitable to the wartime needs of Seabee detachments in isolated island outposts. Utilizing stored water or any available local supply, the ice makers can produce a ton of flake ice every 24 hours. At least one such machine is allotted to every 250 Seabees.

In addition to its use in anesthesia, other medical uses of flake ice reported by the Navy include general treatment of face and head wounds, reducing fevers and swellings, and relieving pain. Moreover, the flakes have numerous other applications important to Seabees' health, comfort, and general welfare.

FILM STORAGE

Air Conditioning Protects Sensitive Photographic Materials

VALUABLE film and photographic papers are protected from the deleterious effects of excessive temperature and moisture in the atmosphere by means of an unusual application of air conditioning at the Orlando Airfield. One Chrysler Airtemp packaged air conditioning unit used to maintain a temperature of from 65 to 70 degrees was installed by the H. A. Daugherty Company to serve a small room used for the storage of sensitized materials.

Many air fields use domestic refrigerators for the storage of film. These boxes are designed to operate at approximately 50 degrees, Fahrenheit, which has been found to be too low a temperature for satisfactory film storage.

At the Orlando Airfield a small room was constructed, insulated, and equipped with slatted shelves. The Airtemp unit was equipped with reheat, spray type humidifier, and installed to operate with both temperature and humidity control. Design temperature of 70 degrees, Fahrenheit, and 50 percent relative humidity has been found to be satisfactory for this service.

SELF-VULCANIZING

Synthetic Rubber Promises Myriads of Uses

DEVELOPMENT of a liquid synthetic rubber that promises to open vast new fields of application for rubber-like materials is announced by the Thiokol Corporation, manufacturers of America's first synthetic rubber. Designated LP-2, the unique polymer is 100 percent liquid synthetic rubber. It has no water or solvents and can be cured in controlled periods of from 10 minutes to 24 hours without heat or pressure by the simple addition of chemical vulcanizing agents.

Combining the excellent low-temperature flexibility and solvent, ozone, sunshine, and aging resistance of other high-grade synthetics, the new rubber is particularly noteworthy for its ability to set without shrinkage at room temperature.

Application possibilities for this new material are expected to be almost limitless. Because it does not shrink when set, LP-2 offers an excellent filling material in the isolation of parts against vibration or from one another, particularly in the electrical field. As a

sealant and caulking compound for pressurized airplane cabins, integral wing fuel tanks, solvent containers, and the like, LP-2 has already proved its effectiveness together with a rapidity and low cost of application that surpass other materials. In coating formulations, it offers an excellent gasket and paper or cloth container coating, particularly in building a heavy coating or where solvent resistance and low-temperature flexibility are required. Printing rolls, valve seat disks, plaster molds, and a broad variety of other objects can be formed from this liquid rubber. A wide number of post-war consumer uses are also seen.

MANIKINS

Aid in Design of Airplane Interiors

PLASTIC "ghosts" which are mathematically accurate averages of the trim feminine dimensions of the WASPS are now enabling designers to make correct adjustment of plane interiors and equipment so that the girl flyers can operate safely and efficiently in quarters primarily scaled to the bulkier male dimensions of the United States Army Air Forces. The transparent life-size manikins made of Du Pont "Plastacele" cellulose acetate plastic are sculptured to dimensions representing composites of the measurements of all the members of the WASP.

The manikins are made in sections and the mechanical action of each joint is reproduced by means of elastic "tendons" making possible "in action" studies of operating space requirements even though the plane is on the ground.

A "ghost" for plane designers

Being transparent, the manikins afford a clear view of points of contact. Applications are foreseen for the principle in post-war planning of automobiles, furniture, and personal equipment.

PORTABLE SPEEDLAMP

Will Stop Action At 1/5000 of a Second

IT'S HERE and for use by the armed Services, but for civilian photographers and other "lens artists," unless they rate a high priority, it is one of those "things to come." With most of the limited production going to the government, Eastman Kodak Company is releasing the new Kodatron portable Speedlamp which, with its ability to stop extreme, dramatic action, has been one of the favorite dreams of press photographers, especially for indoor sporting events.

High speed portable photo lamp

This Speedlamp offers in compact, portable form, a flash outfit capable of making about 200 consecutive flashes when the battery of the power unit is employed, or an indefinite number of flashes when operating with a standard A.C. circuit. The power unit, which weighs 18 pounds, is supplied with a shoulder strap for convenient and rapid transportation.

The light output is sufficient to produce a fully timed negative of an average subject at 15 feet with high speed film, exposed at *f*/11. The flash itself has a duration of about 1/5000 second, a speed far above that of any mechanical shutter. The only time lag involved is the time that it takes to change the film.

Production is limited and deliveries can be made only after government requirements are fulfilled, and then high priorities are necessary with deliveries subject to availability.

OIL SHORTAGE

Not Likely if Research and Technology Are Unhampered

THERE WILL be no shortage of oil in this country if research and technology are unhampered by regimentation, Dr. Robert E. Wilson, president of Pan American Petroleum and Transport Company, says in *Chemical and Engineering News*.

"The only thing that can prevent our country from having abundant liquid fuel for many generations, at reasonable prices—certainly much lower than those of 25 years ago—is interference with the free play of technology and competitive enterprise," Dr. Wilson declares.

The most convincing demonstration of the industry's faith in the future of petroleum, he points out, is that since

the outbreak of war the petroleum industry has invested about $525,000,000 of its own money in new refinery equipment to meet war needs.

"The most serious and imminent danger to the future of the industry is not the possible shortage of satisfactory raw material, but lies in certain threats to the future of the very research and technology which is the indispensable multiplier of our natural resources." Dr. Wilson asserts.

"Demands in certain quarters for regimentation and government domination of research, if yielded to, could easily devitalize our whole research program. Equally serious are the attacks on our patent system, without which we would not only lose much of the incentive to research, but most of those who did continue their research would revert to the dark ages of secret processes and cease prompt publication of their discoveries. Such action would tremendously retard the progress of science."

This is by no means the first time that this country has been concerned about the future of its crude petroleum reserves, Dr. Wilson says. At the close of World War I, he recalls, the total recoverable reserve was estimated to be about 6.5 billion barrels.

"Since 1918 cumulative production has totaled 23.5 billion barrels," he adds. "And yet we had, at the end of this 25-year period, really proved reserves in excess of 20 billion barrels of crude oil. The miracle of feeding the multitude with five loaves and two fishes, with twelve baskets left over, seems to have a modern counterpart! Small wonder that geologists have ceased trying to estimate any limit on the amount of oil which may yet be discovered."

The "feast or famine" characteristics of the petroleum industry before the general adoption of conservation on practices in crude production caused it to be regarded for many years as highly speculative, Dr. Wilson continues.

"Lord Curzon and others gave the petroleum industry a large share of credit for winning the previous war. However, our daily output of gasoline for military use in this war is running about 18 times as great, and that of aviation gasoline about 80 times as great, as in the last year of World War I, and the improvement in quality is equally amazing."

Undoubtedly the greatest single factor in improving our oil-finding technique has been the development of geophysical methods of locating underground structures favorable for the trapping of oil, Dr. Wilson says.

"Of fully equal importance from the standpoint of getting the most out of our natural resources, have been the amazing developments in refinery technology since 1918.

"The outstanding development of recent years in this field is catalytic cracking, the giant towers of which dominate the landscape in most of our refining areas.

"Cracking is, however, only one of many processes which have made important contributions to the yield and quality of modern motor fuel. Polymerization processes now make possible many thousands of barrels daily of high-quality gasoline from refinery gases which in the past were wasted or burned as fuel.

"Hydroforming, hydrogenation, isomerization, and many other additions to the family of chemical processes used by our refineries, have come out of our research laboratories to make major contributions to the air superiority which is so largely responsible for our present situation in the war.

"Tetraethyl lead is another outstanding development of the past quarter century making for better anti-knock gasoline. That single invention increased the available horsepower of the automobile engines made in the year 1941 by an amount equal to 75 Boulder Dams!

"Despite the outstanding accomplishments of the new oil-finding and producing techniques, if it had not been for the developments in refining technique we would today have barely half enough crude oil to meet our gasoline demands, and the quality would be such that modern automobiles could not even operate, let alone modern airplanes."

TELEVISION RELAY
Points Toward Post-War Networks

MUCH of the fundamental work to form the basis for the post-war televi-

sion industry has now been completed, and over the years television should duplicate and indeed surpass the remarkable record of growth and progress of radio, it is predicted by John Ballantyne, president of Philco Corporation.

"When television standards have been established by the Federal Communications Commission and the materials situation eases to the point where new equipment can be produced, television promises to grow rapidly in public esteem and popularity," Mr. Ballantyne believes.

A New York to Philadelphia television relay transmitter link, connecting the two cities for video broadcasts, has already been officially dedicated. This new link, installed near Princeton, New Jersey, replaces previous experimental installations and marks the beginning of the first regularly scheduled television relay system capable of providing commercial service in the United States.

"The new television relay, developed by Philco engineers, is the first of its kind, and is capable of providing dependable, high-quality service at all times and under all atmospheric conditions," Mr. Ballantyne states. "It is entirely possible that similar links, which can be constructed at a cost of about $15,000 each, located approximately 50 miles apart, may form the basis for a nation-wide television system in the post-war period."

SWITCH PLATE
Is Illuminated When Lights Are Out

AN electrically lighted wall switch plate that operates for less than two cents a year and adds materially to the utility and convenience of ordinary light switches, has been introduced by the Associated Products Company. Known as the LumiNite wall switch plate, it

Built into this switch plate is a small electric light bulb that is always "on" when the switch is "off"

features a tiny shielded light that comes on automatically when room lights are turned out, and remains off whenever room lights are burning. Thus it not only makes the switch easy to locate in the dark but also serves as a safety or pilot light at night, and helps keep walls free of smudges and fingerprints from hands groping for light controls.

Another important advantage of the LumiNite plate is that it saves on light bills by indicating whenever porch, basement or upstairs lights that can't be seen from the switch location have been inadvertently left on, either in the daytime or at night. It should have equal advantages in many shop locations.

New Products

VAPOR LAMP

A NEW modulating light consisting of a high-pressure mercury vapor lamp with associated controls has been developed in the research laboratory of Hanovia Chemical and Manufacturing Company. The new lamp provides "a perfectly steady light as a source for printing sound track on film." The controls, it is announced, "automatically adjust the light intensity to various levels for printing photographic films, especially those used in motion pictures."

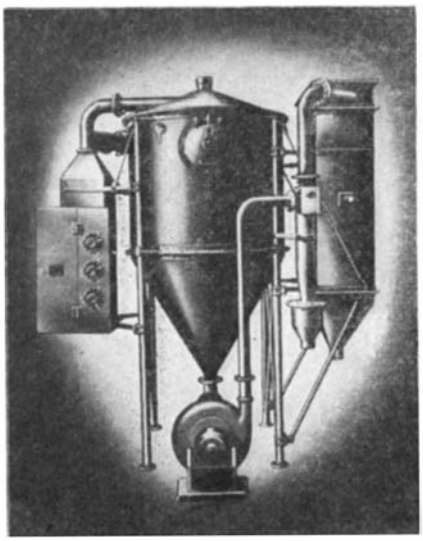
Created on demand of the motion picture industry, the new device has other applications in the fields of photofinishing and of processing microfilm, where a steady light source whose intensity can be readily controlled is a definite requirement.

Electronic control of the light is provided through the use of electronic tubes and photoelectric cells so arranged that film densities automatically change light intensity as required.

SPRAY DRYER

TO MEET an increasing demand for an inexpensive small-capacity spray dryer for the commercial drying of high value products, for use in laboratory research, and in pilot plant operation on specific materials, Western Precipitation Corporation has announced development of the Type N Turbulaire spray dryer.

This versatile unit offers a number of important advantages for drying products such as fine chemicals and pharmaceuticals, and for investigation of spray drying problems. Standard equipment includes electric heater, four foot desiccator with cone bottom and hand-operated mechanism for sweeping surface accumulations from the conical section, Multiclone collector, fan, bag house, and control instruments mounted on a single frame for maximum compactness and ease of installation. Only electrical, compressed air and feed line connections need be made.

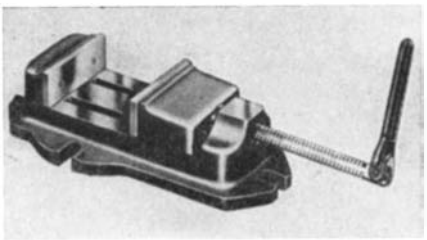


Dryer for laboratory or pilot plant

The desiccating chamber is provided with a secondary inlet for introducing tempering air at inlet temperature, or precooled to any desired temperature. This permits investigation, for example, of the dryability of thermoplastic and heat sensitive materials as well as those having a tendency to case-harden.

HEAVY DUTY VISE

A FAST locking heavy duty vise of radically new design, developed by the Mechanics Engineering Company, is set and released by means of a Bar-Lok push-pull pressure unit. This has a positive locking contact at four points and will develop pressure up to 20,000 pounds. Only a quarter turn of the handle is needed to lock and release. The Bar-Lok vise is precision built for heavy duty, especially around milling machines and drill presses and wherever severe vibration might affect holding.



Operates on a quarter turn

LOW PRESSURE GAGE

DEVELOPED by Wallace and Tiernan Products, Inc., a new gage is so sensitive that it will register the pressure exerted by a head of 0.02 inch of water. Developed for use in aerodynamic testing and research, the gage has numerous applications in the processing industries, as well as in many different kinds of laboratory work where it is necessary to make accurate measurements of gases and liquids at low pressures.

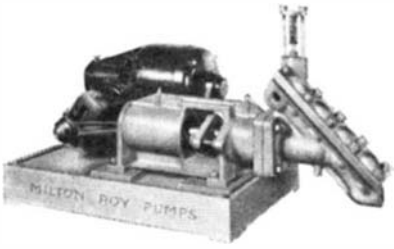
This new gage, sensitive to one part in 500 and accurate to one part in 300, possesses a number of novel features. Backlash has been eliminated by an ingenious method, so that the action of the extremely sensitive series-connected beryllium copper capsules, which serve as the pressure sensitive element, is transmitted to the pointer with maximum accuracy.

This precision low pressure gage can be furnished to cover a pressure range as low as 10 inches of water, and the 330-degree scale may be calibrated to meet any need. Gages can be con-

structed with an expanded scale at the lower pressures and a contracted one at higher pressures. A compound instrument measuring both vacuum and pressure is also available.

STEP-VALVE PUMP

DESIGNED specifically for controlled volume against negative differential pressures, a new step-valve pump retains all the essential features of the Milton Roy double-ball check valve.



Pump parts are completely accessible

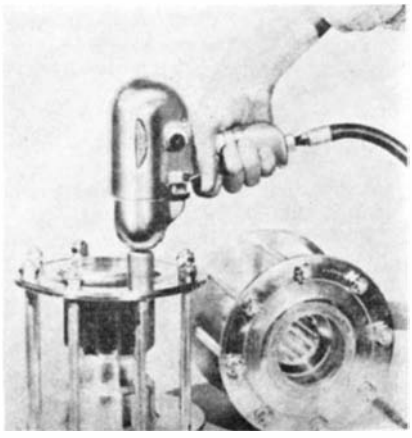
Outside spring-loading provides ready adjustment for desired load. The single cover plate is readily removable and provides complete accessibility without disturbing intake or discharge piping. This valve affords complete freedom from air-binding. There is minimum restriction of passages since the pumped liquid moves in an almost straight line under the ball checks, not around them.

This type is supplied for pumping viscous materials such as liquid latex, acid sludges, tars and asphalts, salt slurries, and textile fibres in suspension.

IMPACT WRENCH

OPERATING with controlled torque, a new 3/8" impact wrench is announced by The Aro Equipment Corporation. This pneumatically powered tool, which the manufacturer says completely prevents stretching or "burning" of threads, is capable of both forward and reverse rotation and has a calibrated adjusting screw on the side of the motor that enables the operator to set any bolt or nut to any desired tension.

The control is obtained primarily through the construction of the roller clutch impacting mechanism, which consists of only four major parts—anvil, hammer, and two cylindrical steel rollers. When in operation, the centrifugal force throws the two steel rollers out against the hammer where they are caught in shear between the hammer and anvil members. This transfers the full torque through to the work in the form of a sudden impact.



Reversible impact wrench

When the selected torque is obtained, the rollers rebound from the anvil face and do not allow the hammer to engage for impact. This method of impacting prevents any stretching of the threads and guarantees maximum torque. By the same token, in removing nuts or bolts, there is no "burning" of the threads.

COMPARATOR

THE BASIC feature of the new DoAll Comparator is its wide range of magnification, which enables one comparator to do the work which formerly required as many as four standard comparators. To accomplish this, each DoAll Comparator has four magnification ranges, enabling work to be checked over a wide range of tolerances. For example, a work piece may be checked with the comparator to determine size variations as small as one millionth inch, and on the same comparator, a work piece can be checked to determine size variations as great as four thousandths inch.

Does the work of four comparators

The spindle of the new comparator is equipped with variable pressure adjustment to provide the exact pressure required for measuring thick or thin sections, as well as for hard and soft materials. The spindle pressure is readily adjusted by a calibrated dial located at the top of the unit.

The spindle movement is magnified electrically. This assures exact repeat readings, since there are no moving parts which could cause the spindle to stick or bind. The spindle head is provided with an adjusting collar for raising the spindle to accommodate the work, also with a hair-line adjustment knob for setting the indicating pointer on the comparator dial. The gage head swivels 360 degrees in horizontal and vertical planes, making it simple to check irregularly shaped parts or multiple jig fixtures. The protractor provided shows the angle to which the gage head is tilted. The gage head can be re-

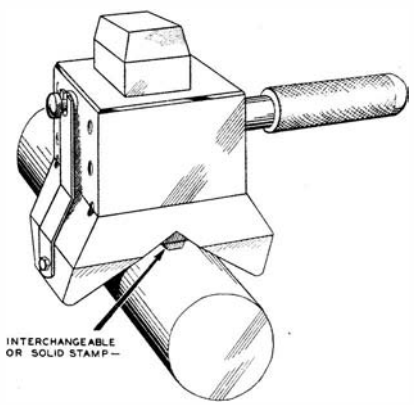
moved from the stand and used on a surface plate, machine tool, multiple gaging fixture, or for any other special application.

NEEDLE PYROMETER

QUICK and accurate temperature determinations are possible with the Cambridge needle pyrometer, which was originally designed to obtain subsurface temperature of rubber and plastic masses. This needle pyrometer, however, has now found a new and very important use in determining the temperature of preforms heated by high-frequency current when either thermo-setting or thermo-plastic materials are used. A reading is obtained instantly upon insertion of the needle into the preform. Thus a means is provided for adjusting the time-cycle of the preheater for close temperature control. The instrument may also be used in checking the uniformity of heating throughout a single preform.

ROUND BAR MARKER

A UNIVERSAL marking device for stamping numbers and letters on round shafts, announced by New Method Steel Stamps, Inc., consists of a single vee block which serves to hold the actual stamping device—using either solid or interchangeable type—and automatically centers the stamps on the bar being marked so that all numbers will be stamped in line and with equal clarity.



A knurled stud, held tight by a flat spring, fits into a slot which is machined in the shank of the solid stamp or type holder. In this manner, the stamp possesses the necessary amount of vertical play but is kept firmly in line in all other directions since the shank is finished to a smooth sliding fit in the holder. A knurled handle permits this shaft marker to be held firmly in place on the bar stock while the actual stamping is being done.

ABSORBING COMPOUND

A SIMPLE, economical, and labor-saving method of reclaiming oil or grease soaked shoes, clothing, belting, rope, and heat-treated parts is achieved by covering these articles with AleXite Absorbit Floor Compound. This multi-purpose compound, resembling uncountable numbers of tiny sponges, is fire-proof, vermin-proof, and sterile. It absorbs many liquids from floors, including water, oil, grease, syrup, chemicals, inks, wax emulsions, and paint ingredients. It will absorb several times its weight in liquids.

GLOVE GUARD

THE SERIOUS shortage of cotton and leather palmed gloves has been relieved to a considerable extent by the Industrial Gloves Company, who have designed the thumb and two finger guard illustrated.

This guard is made of chrome leather and is large enough to fit over the regular cotton gloves. On most jobs the heaviest wear comes on the thumb and first two fingers so that the new guard not only makes for increased service from the new cotton glove when put on the job, but it makes possible the salvaging of many practically worn out gloves. As illustrated, this guard is inseam cotton thread sewed. It may be had outseam steel stitched if desired.

Protect where wear is heaviest

DRILL PRESS TURRET

AN ATTACHMENT for drill presses that is said to increase the capacity of any drill press four times, has recently been announced by the Chicago Drillet Corporation under the trade name Quadrill.

The new unit is a precision built rotary device that holds four tools. The desired tool can be placed in work position by a "flick" of the finger, thus eliminating the necessity of changing tools as in the single chuck drill press. Only the drill in working position rotates while the other three remain stationary for safety purposes. The entire unit is assembled to the quill and is driven from the spindle.

Current Bulletin Briefs

Conducted by K. M. CANAVAN

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

INCENTIVES FOR SUPERVISORS AND EXECUTIVES, by Albert Ramond, is a 15-page pamphlet that discusses methods of rewarding industrial key men in proportion to their value to the employing organization. This is a direct approach to an industrial problem of far-reaching importance to industry as a whole. *Albert Ramond and Associates, Inc., Chrysler Building, New York 17, New York.—Gratis.*

RADIO SERVICING MADE EASY is a 48-page illustrated manual presenting essential radio fundamentals and simplified radio servicing techniques. *Supreme Publications, 328 South Jefferson Street, Chicago, Illinois.—25 cents.*

3-M ADHESIVE DATA is an eight-page booklet covering the viscosity, bonding range, and method of application of various coating materials, impregnators, spray-on insulators, and sound-deadening compounds. *Minneapolis Mining and Manufacturing Company, Saint Paul 6, Minnesota.—Gratis.*

HOLE PUNCHING UNITS is an eight-page illustrated pamphlet describing equipment designed to punch holes in flat sheets, to provide maximum stripping action, and to be set up to punch unlimited patterns of holes for various purposes. Request Catalog BC. *Wales-Strippit Corporation, North Tonawanda, New York.—Gratis.*

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Telescoptics

A Monthly Department for the Amateur Telescope Maker

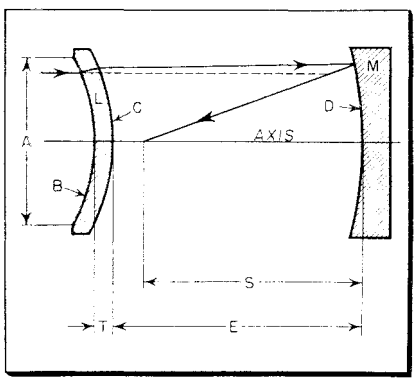
Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

SOMETHING new—destined, many think, to become big in telescoptics—has suddenly burst forth like a nova: the Maksutov telescope.

First publication of design data concerning this intriguing invention appeared in the May number of the *Journal of the Optical Society of America* and at once this department began to hear from those of the more advanced amateurs who have access to that professional journal. They obviously were somewhat excited—plainly the Maksutov telescope "stirs up the animals." But, after all, why not? Thus far it looks stirring.

After a period for ingestion and digestion of this large, 15-page meal (just a bit hard going in spots for ordinary mortals) an invitation was extended to Norbert J. Schell, an engineer, 1019 Third Ave., Beaver Falls, Pa., widely known as the amateur who, with T. G. Beede, was responsible for the much-discussed off-side, or unobstructed reflector (this department, April, 1939) and the off-axis and criss-cross off-axis (May, 1940), to "put the Maksutov into such plain, simple terms that larger numbers of amateurs—the many who have made perhaps two or three mirrors but who are not yet optical design sharks—could take real hold of it." Schell was known to be in sympathy with the honest, direct presentation of technical subjects and of minimizing rather than inflating confusion for sweet confusion's sake. It has long been suspected, and one perpetrator has smilingly admitted the allegation, that a few whose brains function better than those of the rest of us in mathematics actually enjoy exploiting this advantage—keeping the suffering soul who isn't a genius as mystified and frustrated as possible; one adjunct to this kind of exhibitionism being the use of complicated, high-hat symbols and other slowing underbrush. In his article Schell substitutes for a possible flock of $64 symbols plain old-fashioned *A, B, C, D,* and so on, and avoids other minor impediments to the unhappy. The article by N. J. Schell:



Meniscus-concave mirror "Mak"

THERE HAS just been released for publicity in this country the details of a new optical system invented in August, 1941, by D. D. Maksutov, of the State Optical Institute, Moscow, U.S.S.R. The inventor refers to it as "Meniscus Catadioptric Systems" and describes its general application to telescope systems, although it is stated that the system is applicable also to other optical instruments. The release is given in a very friendly fashion, with special appeal and consideration for amateurs. It appears to the writer that the design will prove of very great interest to amateurs, due to its advantages.

The system consists of combining the action of a single meniscus lens of rather deep curvature and of nearly constant thickness, with a concave spherical mirror, for the purpose of compensating the aberrations of the latter. The location of the lens in the fundamental design is in the path of light preceding the mirror, but the system also includes a modification permitting the lens to be located in the converging cone of light from the mirror near the focal point. Only the fundamental design will be covered in this description. The drawing shows this design. [For Newtonian, add diagonal. —*Ed.*]

By way of prelude, it should be understood that a spherical concave mirror reflecting parallel light from a distant point, such as a star, does not form a sharp image, since rays reflected from the outer parts of the mirror come to a focus closer to the mirror than those from more central parts. This effect is known as "spherical aberration" (negative in this case). If we change the sphere to a paraboloid of revolution, this effect can be eliminated, but such a mirror still will produce distorted images of points other than those confined to a more or less restricted field of view surrounding the axis of the paraboloid. This effect is known as coma, and is usually not troublesome in the fairly narrow fields meeting requirements of visual observations in focal lengths *f*/8 and longer, but is detrimental in the wider fields desired for visual observations and photography, in shorter focal-length instruments.

The meniscus lens, on the other hand, can be designed so that it will have very little power as a lens, but with sufficient positive spherical aberration to compensate for the negative spherical aberration of the spherical mirror. In addition, by suitably locating the meniscus, the coma is effectively eliminated for an adequate field.

The meniscus thus pre-conditions the light ahead of the mirror—much the same as in the case of the correcting plate of the Schmidt camera, but with the difference that the surfaces of the meniscus are spherical and much easier to produce than those required for the Schmidt correcting plate.

Also, the meniscus, acting as a very long focus negative lens, has very small chromatic aberrations (color), claimed by the inventor to be very much smaller than those of the usual doublet achromatic refractor objective; so that, even in short focal lengths, it gives images practically free from color on this account.

The important advantages claimed for the system, as compared with refractors and reflectors, are as follows:

1—Images freer from color, also much shorter focal lengths than refractors, as well as a wide choice of glass for the lens, permitting photographs in ultra-violet light.

A/*F*	1:3	1:3.5	1:4	1:4.5	1:5	1:8
B:*A*	1.264	1.399	1.528	1.651	1.770	2.414
C:*A*	1.323	1.458	1.586	1.709	1.828	2.471
D:*A*	6.204	7.219	8.232	9.242	10.250	16.270
E:*A*	3.884	4.530	5.391	6.166	6.953	11.880
A–max.	7.56"	15.5"	27.6"	40" plus	unl.	unl.

2—Closed tube construction, as compared with reflectors, thus reducing the effect of tube currents and abrupt temperature changes, giving much better protection to mirror coatings and, if desired, eliminating secondary supports by means of auxiliary mirrors fastened directly to the meniscus.

3—More exact and uniform correction due to the facility afforded by the deep spherical surfaces of the meniscus; particularly as compared with reflectors of short focal length, other aplanatic systems, and off-axis arrangements.

The elements of the system may be computed by the usual methods, of course taking into account the characteristics of the glass from which the lens is to be made. A complete mathematical treatment will not be attempted here but, instead, we may take the dimensions from certain empirical formulas which the inventor has supplied, to indicate a typical design. These dimensions are sufficient for practical purposes if for a chosen aperture the theoretically greatest ratio of aperture to focal length is not approached too closely, thus allowing for usual variations in different melts of the type of glass indicated. These dimensions apply to optical glass for the meniscus having a refractive index n_D 1.5163 and medium dispersion V 64.1, and with the stipulation that the meniscus thickness at center is 1/10 of its active theoretical aperture.

In the drawing the following may be identified:

L—meniscus lens.
M—spherical mirror.
A—aperture of meniscus.
B—radius front surface of meniscus.
C—radius rear surface of meniscus.
D—radius of mirror.
E—distance mirror to lens at center.
S—distance of focal plane from mirror at center.
T—thickness of meniscus at center.

The figures in the table give factors, which, in each case, when multiplied by the chosen aperture in inches, give the dimensions applicable for a given ratio of aperture to focal length (A/F). These are tabulated from A/F of 1:3 to 1:5, also 1:8. The table also gives the maximum theoretical apertures for visual use in which all aberrations are within the Rayleigh limit, according to the inventor. For photography, these limits can be greatly extended, also A/F ratios greatly increased.

Taking as an example, a design of 8" aperture and 32" focal length—that is, an aperture-focal ratio of 1:4—we find the dimensions as follows:

$A = 8''$
$B = 12.224''$
$C = 12.688''$
$D = 65.856''$
$E = 43.128''$
$T = .800''$ (1/10 of A, as stipulated)

In this case S will be approximately 33.6", as this figure is not included in the empirical formula and must be calculated.

From the above example we find that the depth of the concave surface of the meniscus is .673", which, added to T, gives 1.473", the minimum thickness of glass required for the lens before shaping. In actual practice this should be upward of 1½", to allow for working, edging, and so on. As a comparison, the following are dimensions for two of the more familiar $f/8$ (1:8) Newtonian designs, usually favored by amateurs:

$A =$	6"	8"
$B =$	14.486"	19.314"
$C =$	14.825"	19.767"
$D =$	97.620"	130.160"
$E =$	71.28"	95.04"
$T =$	.600"	.800"

The light diverges within and after leaving the lens, so that the active aperture of the mirror is slightly larger than the lens. The diameter of the mirror should be such as to take this into account, plus an allowance for full illumination of the field of view desired in any particular case. A trace of a ray (exaggerated) near the periphery is shown in the drawing, also a dotted line indicating the path it would follow if the lens were not used. The point of intersection of this dotted line with the ray reflected from the mirror determines the focal length, and explains the difference between dimension S and the focal length. Note also that, since all three surfaces are concave to incident light in this fundamental design, the radii would be indicated as minus (negative) in design calculations.

To avoid possible misunderstanding, it is emphasized that the above table and examples apply only to the particular conditions specified, and that almost any desired modification in design can be made—for which, of course, the elements must be specially calculated by trigonometrical methods. Regarding the glass for the lens, whether for the given example or not, the refractive index is more important than the dispersion, as it is the former which governs the accuracy of the correction for spherical aberration and coma. The dispersion is not critical; it being desirable only to keep it as low as possible (greater V value)—preferably a type of crown, as indicated, for visual purposes—thus ensuring the most color-free images. The mirror, of course, may be made of any kind of glass desired.

The system can be extended beyond the limits imposed by spherical surfaces, even though these seem adequate, by slightly altering or retouching the surfaces.

While this short description covers only the fundamental principle involved in image formation, it is obvious that practically any of the familiar arrangements of reflecting telescopes can be used in connection with it, and the inventor has in fact given most of these as examples, along with several innovations, not the least of which, in the writer's opinion, is an off-axis application in which all surfaces are spherical. There is also a suggested method of reducing the size of the central obstruction in Newtonian types.

Perhaps the feature having greatest appeal for amateurs is that of closed-tube construction, which should give much steadier images than reflectors, and at the same time provide an instrument practically as permanent and foolproof as the usual refractor, with the advantage of much shorter length.

It is anticipated that an extended discussion of this interesting improvement will be forthcoming, in which the various arrangements and technical details will be fully developed. In the meantime, it seems that it would be appropriate if we referred to this design as the "Maksutov Telescope."

END of Schell's contribution.

The name Maksutov is pronounced Mack-soo-tof, stress on the soo.

As Schell hints, other articles on the Maksutov will be forthcoming, short of the unforeseen.

KNOWING of the recent tight situation on optical glass, and to get things started, your scribe scurried around and dug up promise of some 7.9" x 1⅝" disks and then advised a few advanced amateurs. Ten ordered the disks, and in this "Mak Club" are: Schell; Broadhead and Paul of western New York State; and the following members of the Long Island Astronomical Society: King, Cristman, Luechinger, Franklin, Cameron, Thorne, Rekouski. After a few months their findings should become available for the benefit of a later wave of aspirants, and by then it is hoped that the glass situation will not be so tight as it is at present.

However, this new Maksutov thing isn't going to run away, and a slow, level-headed evolution may prove more desirable than a big sudden blaze that cannot long endure.

KEEPING UP WITH *Electricity*

BUMPLESS RIDES in trains and automobiles are forecast, because of a new-type stabilizer. Present job of the stabilizer is to make it possible for American tanks to fire with deadly accuracy, even when traveling at full speed over rough terrain. No details until after the war, but it is another of the many Westinghouse wartime developments with peacetime applications.

LIGHTNING UMBRELLA. A wire stretched over the top of a building, then grounded, forms a better protection against lightning than the old-time lightning rod, the Westinghouse High-Voltage Laboratory finds. Effect is like an umbrella, keeping the bolt entirely away from buildings where even the slightest spark might be dangerous.

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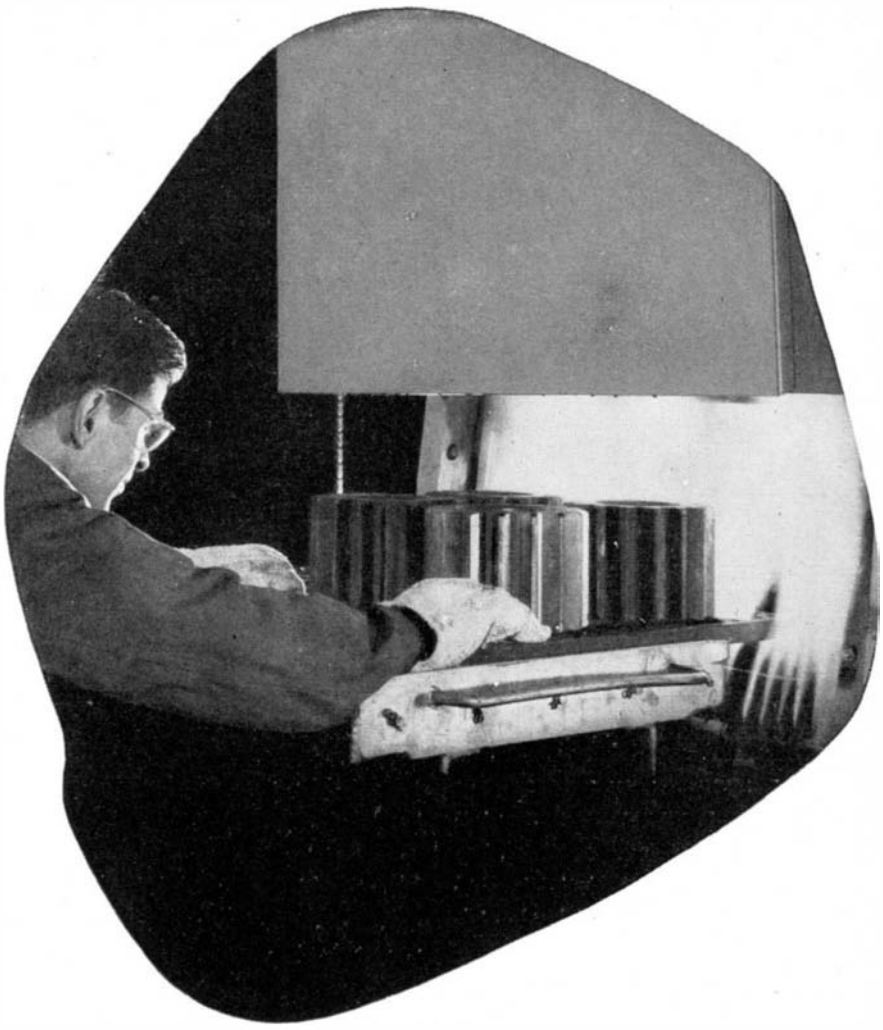

Handcuffs for escaping carbon

Airplane propeller speed-reducing gears must be *tough and strong* to withstand the terrific punishment of long flights over enemy territory.

Westinghouse research engineers have found a way of toughening these gears so that *their former life expectancy is doubled.*

These engineers developed a process of heat-treating the gears in an *Endogas** atmosphere that prevents the escape of carbon from the steel parts.

Ordinarily, in a heat-treating furnace, the carbon-hungry oxygen actually *devours the carbon* on the outer skin of the steel, softening the surface and depositing a layer of scale.

In a furnace employing an Endogas atmosphere, any carbon which may escape from the steel is instantly replaced. The carbon content is undisturbed. Furthermore, no scale is formed—thus reducing, and in some instances, completely eliminating the cost of finish machining of Endogas-treated parts.

Another example of how Westinghouse research helps America outproduce all the Axis powers combined! Westinghouse Electric & Manufacturing Company, Pittsburgh 30, Pennsylvania.

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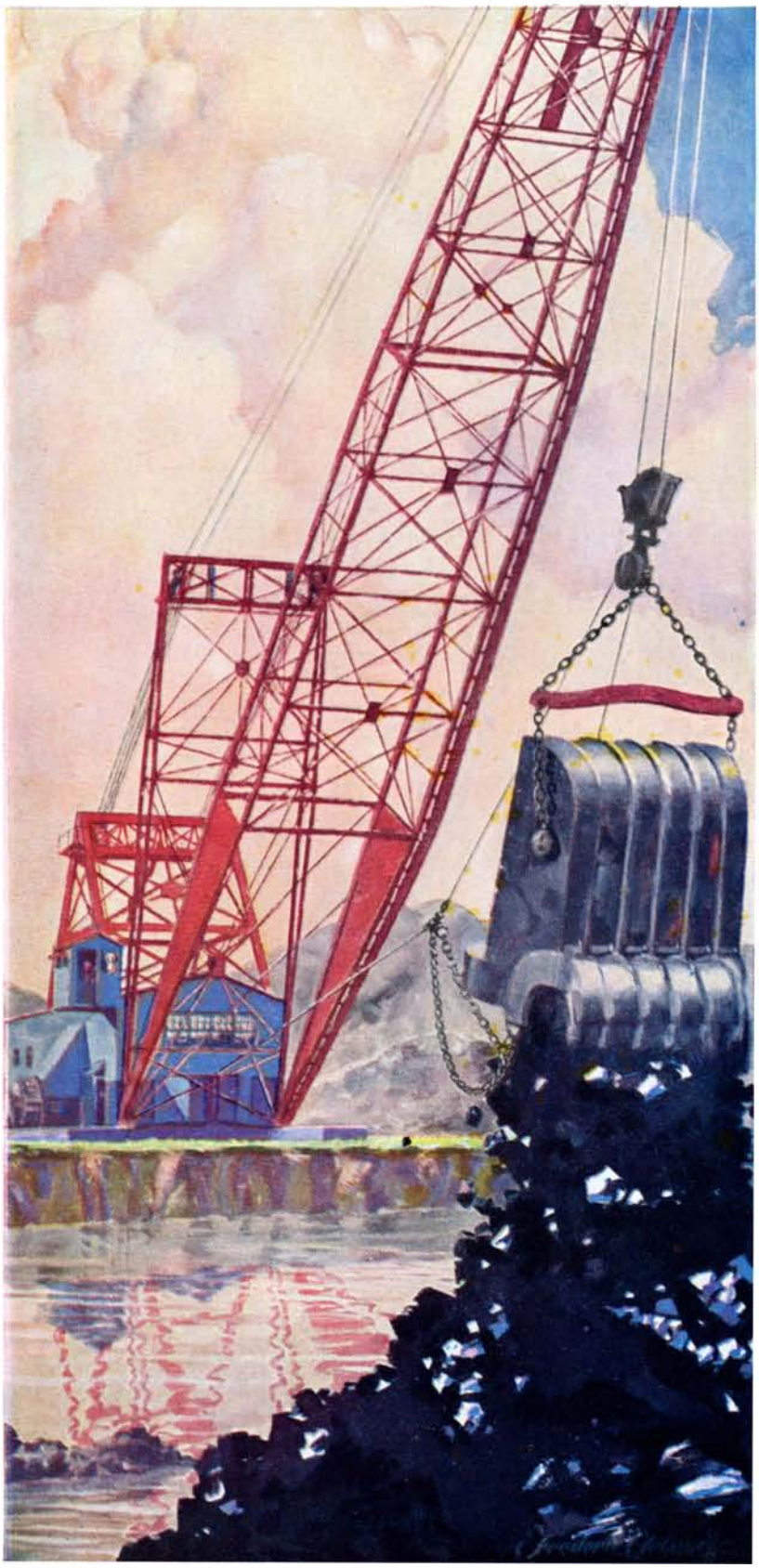

Nine and a half tons of coal at one bite—that's the appetite of this giant Walking Dragline. When it has moved all the coal within reach of its towering boom, it lifts itself by its own bootstraps and *walks* to its next chore.

A remarkable performance, but not more so than the effortless manner in which *one* man controls every motion of this huge machine from the cab—scooping, hoisting, swinging, dumping and *walking*—with finger-tip control.

The secret is control by a Hycon high-pressure pump and hydraulic system. Incredibly small beside the massive machinery it regulates, the Hycon hydraulic system develops tremendous controlling forces which are released through valves with finger-tip control—easier than shifting gears on a modern automobile.

As a result, the operator works steadily throughout his shift without let-down due to fatigue. And the machine works at peak efficiency around the clock and the calendar—moving mountains!

Hycon hydraulic systems and hydraulic parts are standard equipment on the Lockheed P-38, the Grumman "Avenger" and other weapons of war.

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The compact high-pressure Hycon "Stratopower" pump, furnishing *variable volume of pressure up to 3000 pounds per square inch*—when no longer restricted by wartime needs will do a great many hydraulic jobs better.

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