# Scientific American

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Tools by the Thousand—From Powder . . . See pages 193 and 199


Four engines . . . twelve hundred horsepower each . . . that's forty-eight hundred horsepower total, and every one of them will eat high-octane gasoline all the way to Berlin or Tokyo.

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## — somebody may go hungry

▶ To send a thousand bombers over Germany for just *one raid* takes somewhere in the neighborhood of a million and a half gallons of high-octane gasoline.

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We look forward to the time when our research facilities, now engaged in war work, will be free once more to work hand in hand with engineers of the automotive, aviation and petroleum industries in developing the better, more economical transportation of the post-war world.

* * *

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COVER: Methods of fabricating and processing metals for specific purposes are much in the industrial eye today, as can be graphically gleaned from the article starting on page 199 of this issue. One of these methods—powder metallurgy—has found unusual applications in many ways. One of these is illustrated on our front cover, where a powder metallurgy press is shown producing carbide tool shapes at the rate of several hundred per hour in a plant of the Carboloy Company, Inc.


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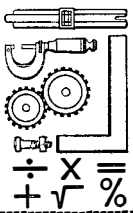

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# Previews of the Industrial Horizon

*By A. P. Peck*

## A THREAT TO INDUSTRY

RECENT agitation for grade labeling of various commodities has raised many questions in the minds of industry and consumer alike. In order that there may be no possible misunderstanding regarding this subject, a distinction must be made between grade labeling which is purely informative, and grade labeling of the compulsory type which would do away with brand names, stifle all incentive for improvement, reduce rather than improve the quality of products, lower standards to a minimum, and place a ceiling on quality rather than a floor under it.

With purely *informative* labeling, whether called grade labeling or not, we have no quarrel. We *are* seriously concerned with the governmental project under which removal of all brand names from packaged goods is contemplated and which likewise contemplates the placing of a ceiling price on each grade.

That this attack on trade marks is by no means imaginary, but on the contrary quite real and imminent, is evidenced by a recent investigation in the House of Representatives of contemplated requirements with respect to labeling, production, marketing, and distribution of articles and commodities. The Congressional Record for April 10, 1943, page 3301, contains the following significant statement by Congressman Lanham of Texas, speaking on House Resolution 98:

"I should like to make this inquiry and observation. If it is contemplated that there is to be a standardization with reference to goods and the labeling of goods which would eliminate trade marks, which are a very natural and normal part of our commercial processes, it seems to me that by all means a situation of that kind should be investigated. There will be created great confusion and lack of confidence on the part of the public if goods are simply to be standardized according to one pattern regardless of their origin in point of manufacture. . . .

"I see no particular objection to grades being posted on a label under a trade mark, because that would further inform the public, but to do away with trade names and to do away with trade marks would to me seem unconscionable. . . ."

The consumer, as well as industry, would suffer under compulsory grade labeling. Under a directive from a government board or commission or a federal grade labeling law, a federal inspector would examine the contents of a package and label the container "Grade A," "B," or "C," according to the following procedure:

After the inspection, a number of points would be given to the goods so that the grade letter—A, B, C—may be assigned. Certain features are to be examined by the government inspector. Each of these characteristics of the product will be credited and given an estimated certain number of points for scoring purposes. The total number of these points will determine the grade. For example, the product that scores from 90 to 100 points will be marked "Grade A," from 75 to 89 points, "Grade B," from 60 to 74 points, "Grade C."

Wholly apart from the obvious impossibility of having every federal inspector grade alike and even if it be assumed that such uniformity of grading were possible, the net result of such system would be to permit a product totaling, let us say, 91 credits or points, to be marked "Grade A," but another product totaling 100 points could receive no higher credit than "A." Thus, as between two competing products with a nine-point variation in grading, both would receive the same identifying characteristic of "Grade A." Both would be sold at the same price, the ceiling for Grade A. Since the poorer or 91-point product would command the maximum price, there would be no incentive for a manufacturer to raise the quality, but, on the contrary, the 99- or 100-point product would soon deteriorate to the minimum 90 or 91 requirement and in the long run the consumer would lose.

Efforts and money spent in acquiring consumer acceptance for well established trade-marked products would be wiped out and the consumer would be deprived of the symbol by which he or she had learned to recognize a tested product over an unknown product. There are many other factors which from a consumer's standpoint are deplorable in the proposed grade labeling program. Space does not permit an extended discussion but it must be remembered that no system of grading can possibly take cognizance of such intangibles as, for example, the priceless ingredients of the honor and integrity of the maker whose reputation has been long established by the use of well known trade marks.

## PAINT PROGRESS

PAINT is one of the industries that is going to come out of war-time production with a minimum of headaches and a maximum of business. Many of headaches, in the shape of materials shortages that have been amply met by substitution (see page 205), are already past and can be converted in the future into desirable assets. Also on the plus side of the paint ledger is the fact that war-time business has stepped up almost 10 percent during 1943 over 1942, to an all-time high. This has been accomplished with very little expansion of facilities, a factor which will be decidedly favorable to the industry when output swings from military requirements to supplying a consumer demand which has been held in leash.

## ITS DONE WITH OIL

RESPONDING precisely to the lightest finger touch, hydraulic power is now doing jobs on Flying Fortresses and battleships, in anti-aircraft batteries, and elsewhere, that could not be done so readily and accurately by any other means. Hydraulic power transmission—remember Pascal's Law?—originally used water but now almost universally employs oil as its working fluid. It has long been applied to heavy industrial jobs, and, just before the war, came into the public limelight in fluid-power transmissions for automobiles.

Now, however, through military applications, hydraulic power transmission has been refined to a point where it can be utilized in many ways formerly unthought of. Wherever precision of control is needed, wherever power must be transmitted to remote points, wherever smooth power flow is required, there will be found possibilities for hydraulics.

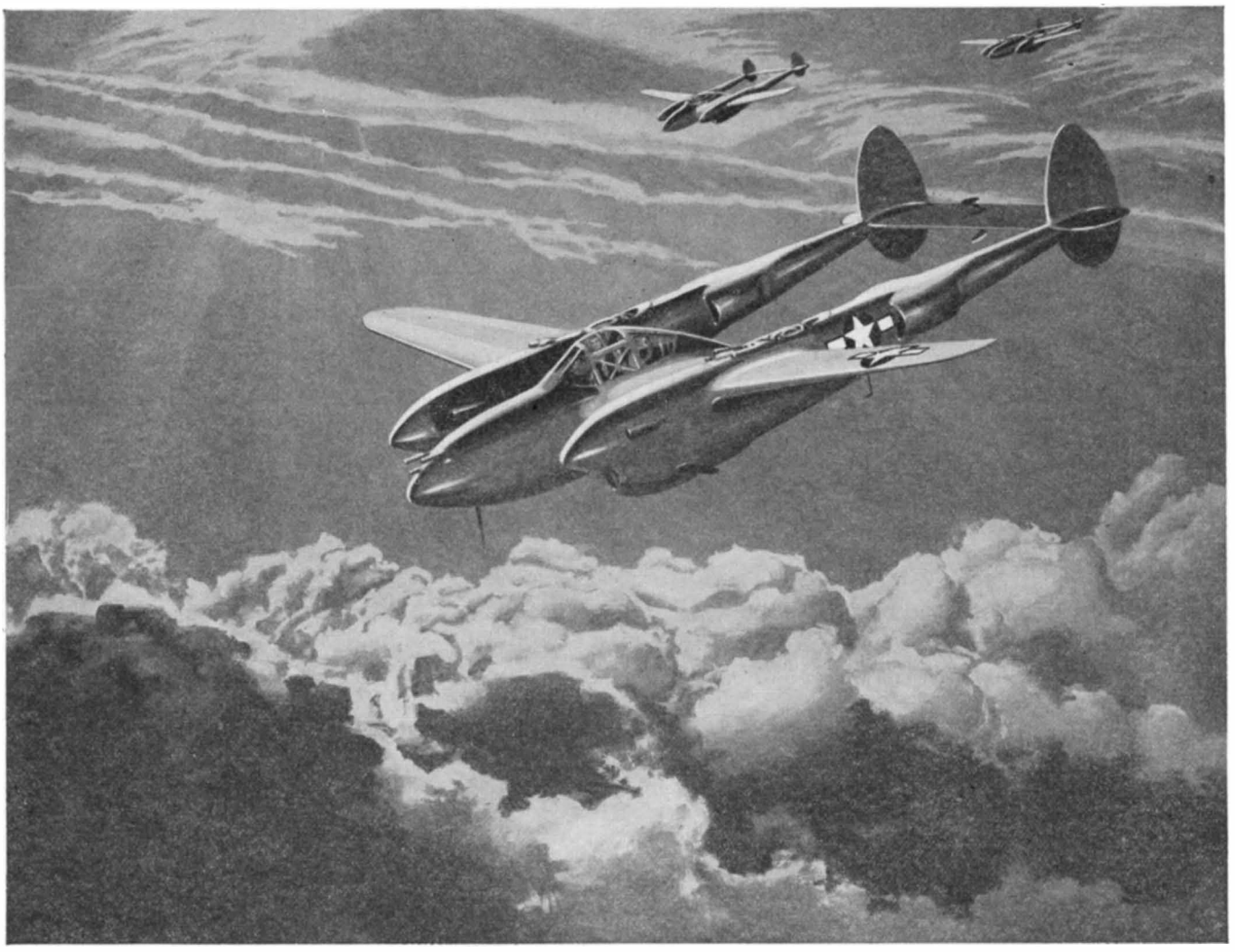
## SMILES CAN HELP

INSTRUCTION sheets which accompany tools and other equipment are usually pretty dry reading, which may frequently account for the fact that they are often unread. Such instructions, no matter how essential to the efficient use of the tool or whatever, are useless unless read. At last one company has realized this fundamental fact and has not only made its instruction sheets attractive to look at and read but has added simple cartoons that instruct as they amuse.

Here is one of those little things in life than can be built up to something worthwhile by any manufacturer with imagination, no matter what type of buyer he may hope to reach.

## "MIRACLE" HOMES OF THE FUTURE

DON'T put too much faith in some of the more glamorous promises of "miracle" homes for the immediate future. Materials and designs will improve considerably, but the main considerations will be conservatism and livablity. Progress will continue, but there will be no sudden burst of homes of a radically different type than we have today.



# FINGER-TIP CONTROL FOR SPEED FASTER THAN SOUND

When an Army Air Forces officer power-dived the Lockheed *P-38* faster than the speed of sound (780 m.p.h.), he proved that the plane was appropriately named *"Lightning".*

Now Lockheed engineers have given "finger-tip control" to its fantastic speed by installing aileron boosters actuated by the revolutionary Hycon "Stratopower" hydraulic pump. The application of these boosters, made practical for the first time, turns the *P-38* into a *dog-fighter which out-maneuvers many single-engined ships!* And the faster response of *all* control surfaces makes it a deadly fighter—even in the thin air eight miles up.

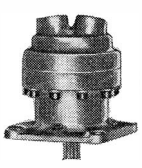
To help bring victory in 1944, we are increasing our output to the limit, and every Hycon "Stratopower" pump is reserved for our fighting planes.

*LET'S ALL BACK THE ATTACK* — BUY MORE WAR BONDS

## *At the war's end—for Tomorrow*

Because of its compactness and phenomenally high pressure, furnishing *variable volume up to 3000 pounds per square inch*, the Hycon "Stratopower" pump will do a great many hydraulic jobs *better*.

Today there are available other Hycon pumps and valves in the 3000 pound range for commercial applications to control or actuate machine tools, giant presses, dump truck lifts, materials-handling mechanisms and remote control circuits. They will operate brakes, clutches and steering devices of heavy vehicles; test high-pressure apparatus, and solve a wide variety of other hydraulic problems. Write for full information.



**HYCON** ★ ★ ★

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*Manufactured only by The New York Air Brake Company*

**THE NEW YORK AIR BRAKE COMPANY**

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# 50 Years Ago in . . .

## SCIENTIFIC AMERICAN

(Condensed from Issues of May, 1894)

**SMOKE ELIMINATION** — "In a recent experiment at Glasgow, Scotland . . . from 94 to 97 percent of the soot was removed from smoke and fully a half of the sulphuric acid. . . A Babcock and Wilcox boiler was used, driving a 220 horse power engine, and consuming 3 tons of coal and a ½ ton of scraps and chips. Before entering the usual chimney the gases ascend a short brick flue, and then descend a flue of steel plates dipped at a high temperature in a tar composition, entering the ordinary stack at the bottom. At the bottom of the ascending flue is a jet of steam at boiler temperature, while at the top of the descending flue is a fine spray of water. The carbon is thus separated, and, with the water, drops into a sump at the foot of the descending flue, being thence carried off in pipes."

**LUBRICATION** — "In a paper on lubrication, read before the Birmingham Association of Engineers, Mr. Railings the author mentioned the following as the requirements of a good lubricant: (a) It should be thick enough to keep a constant film between the two surfaces to which it acts as a separator; (b) it should be as thin as possible consistent with the first requirements; (c) it should be a good conductor of heat; (d) it should contain nothing that will act chemically upon the bearing it lubricates; (e) it should be difficult of evaporation and decomposition."

**BICYCLES** — "For many years man has attempted the construction of a successful road machine to be propelled by the rider. The first signs of real success came in the application of crank propulsion to the old velocipede. The next development was the introduction of elastic tires of India rubber. Then came the last and greatest improvement, the pneumatic tire. Meanwhile the proportions and details of the machine were constantly changing, until the wheel of to-day was evolved, with its ball bearings wherever possible, and with air-inflated tires."

**AMMONIA** — "Machinery is now being set up in Newark, New Jersey, for manufacturing ammonia from atmospheric nitrogen. Every farmer knows that nitrogen is one of the essential elements of plant food and that it is far the most expensive of the elements that are required in fertilizing mixtures. . . If ammonia can be cheaply manufactured from atmospheric nitrogen, the discovery means that a great step has been taken toward securing a material increase in the productiveness of the soil."

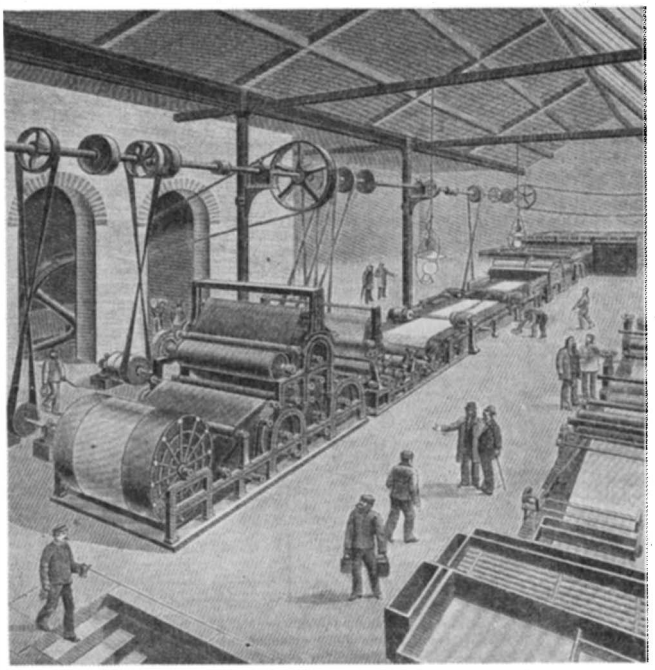
**BATTERY CHARGING** — "The employment of windmills for the charging of electric storage batteries . . . is now being done in England by the Rollason Wind Motor Company. The motor consists of a set of five curved vanes fixed to a vertical shaft. These vanes measure 7 feet by 20 feet, the longer length being placed vertically. . . The motor drives a five horse power dynamo, to which it is connected by belt gearing. The dynamo is used to charge accumulators, and the latter supply a current which may be used for lighting or power purposes. . . A magnetic cut-out is supplied, which breaks the circuit when the speed of the motor. and consequently the voltage of the dynamo, falls too low."

**SCALES** — "It is a trite saying that all modern science is built upon the balance. . . All the modern developments are due to the exact determination of weights and measures. Of late years the same fact has begun to hold in the case of the mechanical arts. The charges of flux and ore for the blast furnace and of steel for the crucible are now accurately weighed and precise results in metallurgy are obtained by the aid of scales. The same is true for many other branches of the arts."

**RUBBER** — "The authorities of Madagascar have just granted to the Hon. John L. Waller, ex-U. S. consul for Madagascar, a concession, measuring in area 15 miles square, in the district of Fort Dauphin, on the southeast coast, and which is conceded to be one of the richest rubber districts on the island. . . Mr. Waller will stop the destruction of the rubber trees and vines by the natives, as far as his own concession is concerned, and will preserve them by having the milk extracted in a scientific manner."

**ABYSSINIA** — "As the European nations divide Africa among them, Italy is taking her share and has established a protectorate over Abyssinia. The eastern portion of this country, bordering on the Red Sea, is called Eritrea. This is ruled by a civil and military governor and three councilors appointed by King Humbert, and here an Italian colony has been started in the hope of bettering the conditions of the country and of lessening the tide of emigration to America."

**CIGARETTE PAPER** — "Good cigarette paper should be very thin, very uniform as to pulp, and very strong and resistant. . . . Superior cigarette paper is manufactured exclusively from linen rags. . . Ordinary cigarette paper is manufactured from substitutes. Its pulp often contains a certain amount of wood pulp. . . In its broad lines, the manufacture of cigarette paper does not differ from that of ordinary fine paper. A single point is special, and that is the finishing, which has to take a long time and be well done. The pulp must be finished slowly, progressively, and with as short fibers as possible. The duration of the process . . . varies between 15 and 30



hours. . . It requires a special manipulation and perfect machines to obtain a sheet of paper presenting great strength with a pulp composed of so short and so divided fibers. By way of example, we give a figure of a continuous machine for cigarette paper constructed by Mr. Burot, of Angouleme."

**ELECTRIC LIGHTING** — "An article by Mr. J. H. Talbot, in the Engineering Magazine, contains valuable information for city taxpayers or investors interested in the establishment of small electric light stations. If the facts in this article had been given to the public several years ago, without doubt a large waste of capital would have been prevented, and a great many enterprises of this kind now struggling under financial burdens might be in a prosperous and flourishing condition. Mr. Talbot points out how very difficult it has been for persons desiring to establish an electric light station to obtain in advance accurate and definite information regarding its cost of construction and expense of operation, and it is his purpose to furnish such information."

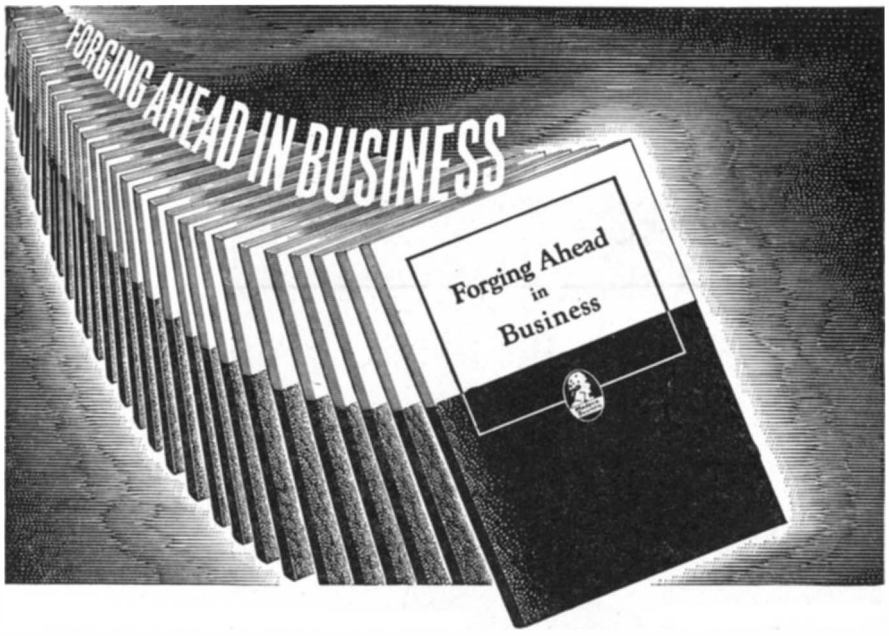
# How long for a wartime Long Distance call?

A Long Distance call may be long in miles, but we hope you will try to keep it short in minutes. War needs the wires.

When you are calling on crowded circuits, the Long Distance operator may say—"Please limit your call to 5 minutes."

That's a good suggestion. It helps more calls get through during rush periods.

BELL TELEPHONE SYSTEM

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Among the prominent industrialists who assisted in the preparation of the Course, which is described in "FORGING AHEAD IN BUSINESS" are: Alfred P. Sloan, Jr., Chairman of the Board, General Motors Corp.; Thomas J. Watson, President, International Business Machines Corp., and Frederick W. Pickard, Vice President and Director, E. I. du Pont de Nemours & Co.

### Send for "FORGING AHEAD IN BUSINESS" TODAY!

Frankly, this booklet has no appeal for the immature mind. It does not interest the man who, for one reason or another, is wholly satisfied to plug along in a mediocre job. But, for the alert, future-minded individual—the man with ambition and "drive"—"Forging Ahead in Business" has a message of distinct importance. If you feel that it is intended for you, don't hesitate to send for a copy today. Simply fill in and mail the coupon below.

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## "Quotes . . ."

*"I BELIEVE the industry should be permitted to start plans and preparations now to build a limited number of new automobiles on the day the war in Europe ends, rather than delay this preparation for conversion until Japan is defeated."* Ward M. Canaday, President, Willys-Overland Motors, Inc.

" " "

"VAST INCREASES in the technique of mass production can be expected to lower production costs. New materials will be worked into consumer goods and better qualities developed. In the long run prices can be expected to come down and qualities can be expected to rise." *David R. Craig, President, American Retail Federation.*

" " "

*"THE UNITED STATES will be finished as a progressive dominant nation, if we regiment and unduly restrict free enterprise and free effort and if we block the path of 'the boy from across the tracks' to attain through his own efforts the highest position in the land."* Harold V. Coes, President, American Society of Mechanical Engineers.

" " "

"LOWER COSTS of operation due to greater production indicate but one probable direction in which the price of aluminum can go. The price has dropped since we entered the war from 20 cents to 15 cents a pound." *E. B. Wilbur, New York Manager, Aluminum Company of America.*

" " "

*"ARMY EXPERTS now estimate that, after the end of the European War, we may be forced to cut back our munitions production by approximately 80 percent and still have enough to fight a full-scale war against Japan. . . This picture may prove to be somewhat exaggerated but it serves to emphasize the fact that the major shock to our economy will come immediately after the end of the fighting in Europe, and not at some later date after Japan has been crushed."* John F. Fennelly, Executive Director, Committee for Economic Development.

" " "

"THE FUTURE of America lies in the initiative and resourcefulness of its individual enterprises. If they manage well, the future is secure." *John R. Bangs, General Manager, Personnel and Industrial Relations, Budd Manufacturing Company.*

" " "

*"WHILE WE HAVE nothing to show at this time, we are building up a great deal of experience not only in FM but in ultra-high frequencies and microwaves; experience in components, vacuum tubes, transmission lines, antennae, and all the new things that are necessary in this field."* F. R. Lack, Vice President, Western Electric Company.

**METALS IN INDUSTRY**

Conducted by FRED P. PETERS

Courtesy International Harvester Company

**An engine crankshaft as it appears after drop forging in a 12,000 pound hammer. The flash is trimmed from the forging in an adjacent press**

# Mass Production Metal-Forms

**In Materials Engineering, the Choice of Metal-Form or Fabricating Method is Often as Important as Selecting the Metal to be Used. Process-Competition in the Small-parts Field is Especially Intense and Will Become More So in the Not Far Distant Future**

THE COMPETITION among materials will shortly dominate the industrial scene. Post-war product planners appear to be increasingly preoccupied with the relative merits of aluminum, copper alloys, alloy steel, plywood, plastics, and so on, for their automobiles, helicopters, refrigerators and houses, and our press is full of speculation on the outcome.

One phase of this materials-competition, however, that easily escapes general attention is the rivalry among the "metal-forms" or fabricating processes. For not only do *metals* compete for the designer's attention, but the *methods* that can be used to manufacture specific parts and products are also a matter for choice, and in many cases become the primary factor in deciding which metal or alloy will be used for a particular job.

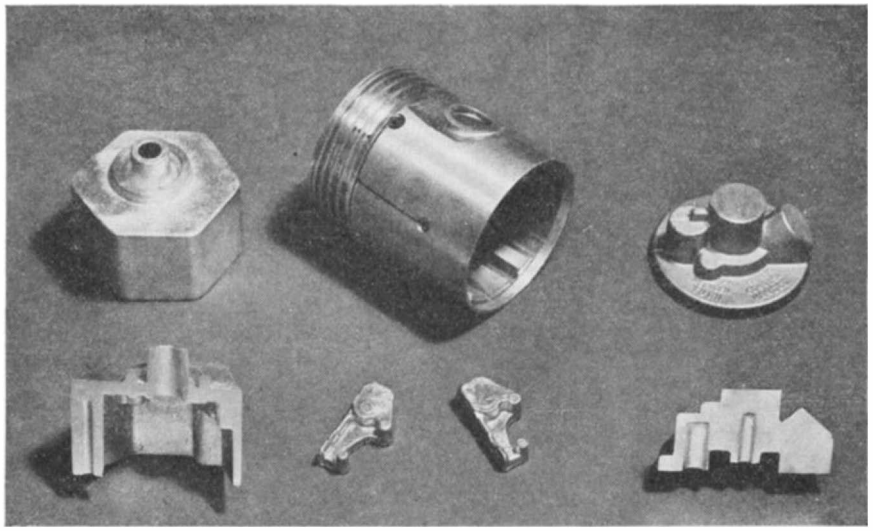
Thus, in developing his design, the engineer must give consideration to the factors of functional utility, mechanical quality, appearance, and production cost. When the product or part is to be manufactured on a mass-production scale the factor of production cost may easily predominate over the others. In such cases the first and most important choice may be how the part is to be made—shall it be a die casting, a screw-machine part, a stamping, or what?

Since the metals vary in their amenability to the various fabricating processes, the selection of the method frequently determines or at least narrows the choice of metal to be used. Some metals even find their market position directly dependent on the technical development and extent of application of a particular fabricating process, an outstanding example of this being the considerable dependence of the zinc industry on the popularity of die castings and the die-casting process.

Process-specification has become in this war a branch of materials-engineering virtually as important as selecting the materials themselves. We are at last learning that each high-production process has certain "design characteristics" which are as distinctive of it as are the typical properties of individual metals that might be considered for use.

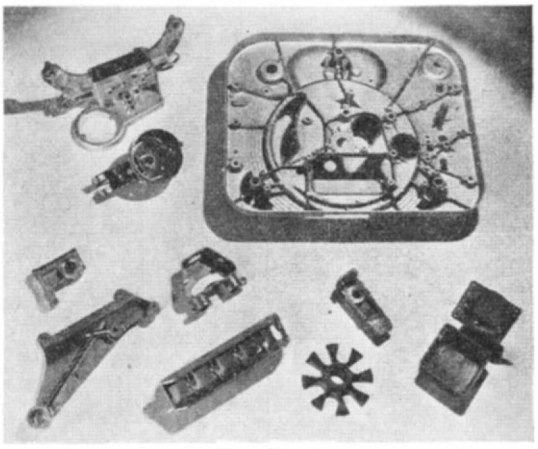
Small metal parts for industrial and consumer products may be made by any one of ten or so methods. The metal-forms most frequently met in the small part field are sand castings, permanent mold castings, die castings, precision investment castings, stampings, drop forgings, screw-machine parts, extrusions, cold-headed products, and powder metallurgy pressings.

**SAND CASTING**—Sand casting, the traditional and still the most common method of producing castings, consists in (a) making a sectioned wooden or metal model (called a pattern) of the part to be cast, then (b) packing molding sand around the pattern in a "flask," removing the pattern and drying the mold by baking it, and (c) pouring suitably prepared molten metal into the mold cavity. When it has solidified, the casting is "shaken out" of its



Above: Permanent mold castings in aluminum alloys, as produced by the Permold Company. The sectioned castings show fine-grain density

Right: Die castings typical of those produced in various alloys. The three at the top are zinc alloy; the four in the lower left corner are aluminum alloy. The box and cover at the lower right are brass and the remaining two were cast from magnesium



Courtesy New Jersey Zinc Company

mold, the latter being destroyed and the sand returned for reuse or discarded.

The casting usually must be machined to finished dimensions since its surface is rough and the sand mold lacking in precision. Sand casting's tolerances are wide—1/16 to 1/32 inch per inch being normal for the process.

For small parts, sand casting can be very rapid, since several molds may be poured simultaneously. Tool costs are low, for expensive steel dies or molds are not involved, but labor costs are likely to be high. Its design flexibility—*i.e.*, the ability to make complicated, cored, and undercut parts in one piece—is very high, since the mold is expendable and cannot interfere with the removal of even the most complicated shape after the latter has been cast.

Sand castings may be very large—several feet in height or width, but they cannot be as small nor as thin-sectioned as parts made by other methods. Gray cast iron, malleable cast iron, steel, brass and bronze, aluminum, and magnesium are the materials in which most sand castings are produced.

**PERMANENT MOLD CASTING**—Permanent mold casting (called "gravity die casting" in England) involves manual pouring of the molten metal under a gravity head into metal molds. The molds are made in sections, and assembled, and remain clamped together during pouring and solidification of the casting.

Permanent mold castings are dense and fine-grained, and can be made to closer tolerances than sand castings (although tolerances must be wider than for die castings and the other forms.) Surfaces are of course better than those of sand castings, but tool charges are higher. Permanent mold castings are made in zinc, aluminum and magnesium alloys, bronzes, and cast iron.

**DIE CASTING**—Die casting is done in fast-working machines that transfer or inject under pressure the right amount of molten metal into a metallic water-cooled die set that remains closed until the casting is solid. Some machines are able to produce 300 to 800 "shots" per hour, which may mean 6000 parts per hour through the use of multi-impression dies that are used simultaneously.

Die casting's strongest points are its excellent precision (tolerances as close as ±0.001 inch can be held) and the high production rates often achieved. Because die castings seldom need to be machined to meet tolerances and because of the high productivity of the process they are among the most economical of the mass-production metalforms.

On the other hand, die casting has its limitations. Die costs are a sizeable factor, although not so great as for some of the other methods. Casting shapes are limited in complexity, for undercuts and cross-holes cannot be included unless the dies embody expensive slides, collapsible cores, and so on. The cost of these extra die features can often be justified; sometimes the use of an exterior undercut saves metal by providing uniform section thickness, or, again, a part with necessary undercuts may still be less expensive to make by die casting than by other methods.

Because of the effect on die costs, die castings are chiefly made in low-melting-temperature metals like zinc alloys, aluminum and magnesium alloys and in general their mechanical properties are, therefore, lower than metalforms like machined steel, steel forgings, high-strength iron sand castings, and so on. But it should be remembered that die castings as a class are not at all the unsound, porous, and weak materials of many years ago, and that where maximum strength is not required they are serving nicely today for many applications even of a structural or engineering nature.

Most die castings are made in zinc alloys, although the proportion made in aluminum alloys has sharply increased, and the position of zinc as the No. 1 die casting metal may some day be assumed by aluminum. Magnesium alloys, too, are increasingly used for die castings. Where high mechanical properties in a die casting are sought, brass may be employed, although die costs are thereby raised considerably.

**PRECISION INVESTMENT CASTINGS**—The increase in use of precision castings made by the "lost wax" or similar processes (described in Scientific American, December, 1943) has been one of the important wartime production developments in the metals field. The method employs a plaster or refractory-material mold for the final casting of the metal, the mold is discarded after each cast, and hence the casting may be quite complex.

The method in fact combines the permissible design-intricacy of sand casting with precision close to that of die casting. (Tolerances may be from ±0.005 inch to 0.003 inch.) Considerable skilled labor is involved and there is some material waste in the form of sprues. Production rates may be high, but for very small parts cannot compare with die casting or powder metallurgy.

Very high melting-point metals can be cast in complicated shapes to fairly close tolerances by this method. Brass, bronze, steel, stainless steel, and heat-resistant alloys (in addition to the precious metals) are regularly made into precision castings.

**POWDER METALLURGY**—Fabrication of small parts by powder metallurgy methods involves (a) pressing of metal powders in a mold or die to form a weak, "green" briquette of roughly final shape, (b) "sintering" the briquette and bringing it to service strength by heating it to some temperature below its melting point, and (c) re-sizing or coining the sintered part to final, exact dimensions.

Powder metallurgy is able to provide certain structures or metal-combinations that are not producible by methods involving melting. For such work—

for example, the manufacture of oil-less bearings, tungsten carbide tools, porous metal filters, and so on—it is competitively out of reach of the other processes. But it is also being widely advocated and increasingly used as a method for making small parts on a mass-production scale to very close tolerances, in direct competition with machined parts.

Powder metallurgy machine parts can be made to tolerances closer than ±0.001 inch and at production speeds normally in the range of 200 to 1600 parts per hour. Metal powders, however, are among the most expensive of raw materials; tool and die costs for powder fabrication are relatively high; so far only the simplest shapes can be made by the process; and, finally, the mechanical properties of powder parts are never outstanding.

Actually powder metallurgy has suffered from over-glamorization. Its applications have been vastly extended during the war, with considerable saving to the nation in machine-time and critical materials, and this has given rise to a popular impression that the process is a fabrication-panacea that may even put the machine tool industry out of business. Intelligent opinion in the powder metallurgy field deplores this situation, for it is already leading to misapplications, disappointments, and the inevitable "black eye."

Powder metallurgy is a highly useful, economically attractive mass-production process, but it is employed within certain definable limits (no different, indeed, from any of the other fabricating processes in this respect.) Its future in the competitive phase is still uncertain and may depend on our ability to produce a good grade of iron powder at a much lower price than at present and under the kind of competition which powder metallurgy must face from the other processes.

Courtesy Chrysler Corporation, Amplex Division
**A briquetting press which forms parts in powder metallurgy**

**SCREW-MACHINE WORK**—"Screw-machine products" are usually made on a hollow-spindle turret lathe adapted to automatic operation. These products are not necessarily screws or even threaded parts, but are considered to include all types of small machined parts produced rapidly and repetitively from bar stock or tubing and involving surfaces that are turned, formed, faced, drilled, bored, threaded, or cut-off.

Screw-machining's production rates are among the highest (up to 3600 pieces per hour) and its tolerances the closest obtainable in any of the competing metal-forms. The surface finish on a screw-machine product is smooth and lustrous. There is, however, considerable waste metal involved in the process and the design flexibility is not unlimited. The materials most used are free-machining steel, free-cutting brass, aluminum alloys, and magnesium alloys—all being wrought metals with good mechanical properties.

**COLD HEADING**—Cold-heading is a gathering-up or upsetting operation in which (usually) bar stock is gripped between dies in a header and pressure is applied upon the stock ends to produce a thickened section or flange wherever desired. Because it is done with great rapidity and without metal-waste (as in screw machining) or heating (as in forging), cold heading is a widely used process, being virtually standard for making bolts, screws and rivets in all but the smallest sizes.

Cold heading is one of the least expensive fabricating methods where large production is required and the design is suitable. Tolerances may be held to ±0.002 inch per inch and finishes are excellent. Tool costs are high and limit the economical use of the process to jobs involving large numbers of parts of a given design.

The materials commonly cold-headed include plain and alloy steels, stainless steel, brass, bronze, and aluminum alloy, in the form of cold-drawn wire.

**DIE FORGING**—Die forging is a process in which heated metal is pressed, hammered or upset to its roughly finished shape between dies whose cavity is an approximation of the shape of the part desired. A press forging is made in a hydraulic or mechanical press, a drop forging in a drop hammer, and an upset forging in an upsetter.

Die forging's best known advantage is the strength or toughness of the metal part. Tolerances are fair, ±0.010 to 0.015 inch being normal, with ±0.004 inch possible at extra cost. Design flexibility is quite limited in die forging. Metal waste in forging is more than in die casting or powder metallurgy, but considerably less than in sand casting. Because of the pressures and temperatures involved, die costs are too high to allow the process to be used for anything but high production work.

For such work, however, where precision is adequate and especially where mechanical quality must be highest, die forgings (even though often more expensive than other forms) are highly satisfactory. Virtually all industrial metals and alloys are made into die forgings, according to requirements.

**STAMPING**—Stamping may be defined as the blanking, pressing or forming of metal parts out of sheet or strip, using presses (or in some cases, drop hammers with soft dies and punches). The process involves (a) punching out a flat "blank" from the sheet metal, (b) forming this by bending or folding in a suitably shaped die, and (c) drawing the metal by stretching it over parts of the die or punch.

Stampings are typical mass-production parts whose manufacture involves high tool costs, low raw-material costs, medium labor charges and some waste. Very thin parts (thinner than those possible by powder metallurgy or die casting) can be formed to tolerances down to ±0.001 inch; larger parts must usually have tolerances wider than ±0.003 inch. Production rates may be as high as 3000 per hour, and surface finishes are excellent.

Design-shapes of stampings are limited to those that can be formed out of sheet metal. The materials that can be used, however, are plentiful, numerous, and among the least expensive raw materials available. Steel, stainless steel, tin and terne plate, brass, bronze, nickel, Monel, and so on, are all widely used to make stampings.

The war has produced a sharp trend toward stampings because of the availability of presses and the fact that a cheap, non-critical metal like steel sheet can be used in replacing aluminum castings, brass forgings, and so on. (See Scientific American, November, 1943.) Much has been learned about designing for stampings and about their frequently surprising economic utility, and they should do well in the post-war era.

For the quantity type of production that the automobile industry, for example, is expected to require, stamping and die casting should continue to be highly attractive for small parts in the body and chassis. They provide the fastest production and within very close

(*Please turn to page* 235)

# Wood In War Construction

**Many of the New Uses for Wood which Have been Developed as a Result of War-Speeded Work Will be of Value in Peace-Times. Plywood, Laminated Timbers, New Connectors, and Design Improvements Point the Way. Large Industrial Buildings as Well as Small Homes All Benefit**

By A. N. CARTER
Editorial Staff, *Engineering News-Record*

FEW MATERIALS have played a greater or more versatile role in America's war construction program than wood. Timber girders of unprecedented span have been built of plywood, huge timber beams have been formed of glued laminated boards, and, with the aid of ingenious metal ring connectors, timber has been used for giant blimp hangars.

Wood and wood products are being utilized for many types of construction. These include enormous quantities of lumber for military housing accommodating several million men, huge industrial buildings, airplane hangars, wharves, water tanks, warehouses, mass housing, bridges on highways and railroads, and for mold lofts and other shipyard facilities. Likewise, wood is a ready substitute for critical materials in fabricating drainage pipe and even for such small but important items as washers for bolted connections.

So great is the demand for wood that lumber production has soared to new records. Production in 1942 of 36.3 billion board feet was the highest since 1929, and that for last year was about 33.5 billion board feet. Among other things, these unusual demands for lumber and timber have resulted in development of more economical designs of end products, and the need to economize has caused widespread use of precutting and prefabrication techniques.

To appreciate the significance of the new techniques in timber construction, it is necessary that an understanding be reached regarding plywood, laminated construction, and ring connectors.

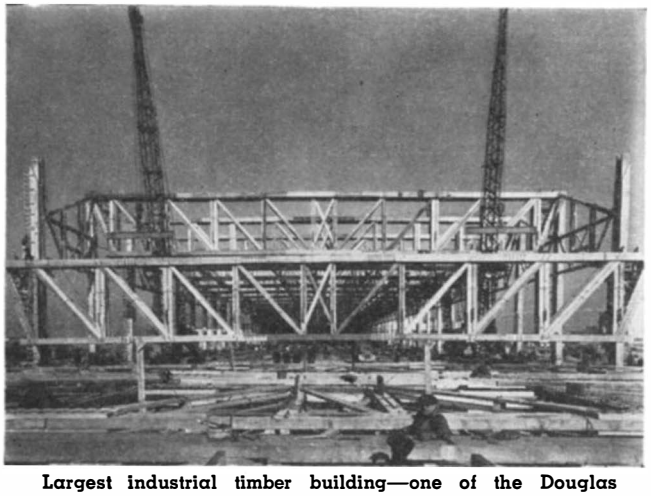
Plywood is not new, of course, but war construction needs have widened its versatility. This material consists of a combination of three or more sheets of wood veneer glued together, with the grain of alternate plies usually placed at right angles. Various glues are used, including phenolic resin, urea resin, casein, and those made from animal blood. After the glue has been applied the layers of wood are placed in a press to assure thorough bond between all layers. The presses may be of either the "hot press" or "cold press" type, the latter being used in the manufacture of water-resistant plywoods.

Laminated construction is a form of fabrication in which boards—generally of one-inch thickness—are glued together with the grain parallel. Large laminated members are often fabricated on the job, while plywood is generally a factory made product. Development of water-resistant glues accounts for much of the advancement in laminated construction.

Ring connectors are metal devices for fastening and reinforcing the joining of wood members where they meet. Two of the most common are the split-ring and the alligator types. The split-ring connector fits into grooves precut into the members joined, and the alligator type is pressed into the members to be joined. Other types fit into bored recesses. Whatever the type, they are all used for reinforcing the joint by providing greater shear resistance between members. Connectors may be employed to strengthen joints where solid timbers, laminated members, or a combination of the two are joined.

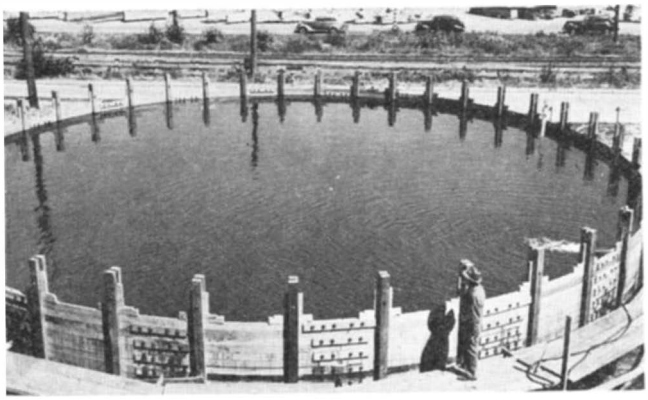
One of the most interesting bridges to be constructed entirely of timber is the Fleming Park Bridge across a branch of the Ohio River downstream from Pittsburgh to connect Neville Island and the south shore. Swift currents and deep water are encountered at the site, and neighboring bridges constructed in the past were built with reinforced concrete foundations and steel superstructures to meet the severe conditions encountered. In contrast, because of the difficulty of obtaining steel, the new crossing was constructed almost entirely of timber, including the foundations.

**SIX TRUSS SPANS**—The new bridge is not a small structure; it totals 1100 feet in length and consists of six 130-foot truss spans fabricated with ring connectors. The roadway, which was designed to carry street car and heavy truck traffic, also was built of timber

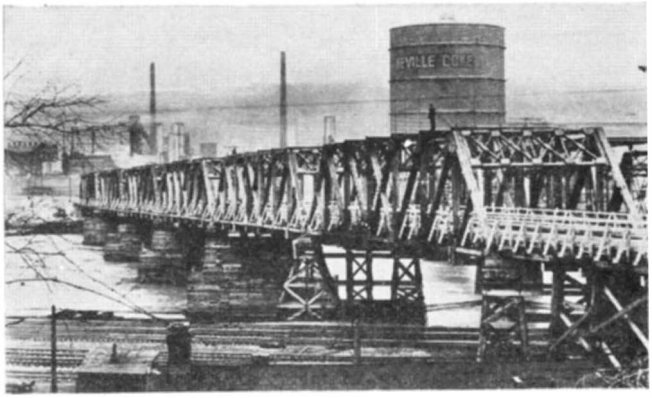


**Largest industrial timber building—one of the Douglas cargo airplane assembly plants. A total of 27,000,000 board feet of lumber was used, saving some 30,000 tons of critical materials. The huge timber trusses have a span of 150 feet**

**This huge timber hangar for blimps required 3,000,000 board feet of lumber, or sufficient to construct 250 private homes. This structure, one of many built on seaboard sites, has a floor area greater than that of three football fields**



By tightening the wedges between the vertical timbers, the horizontal staves of this new type of liquid storage tank are forced together to reduce leakage to a minimum



Designed to carry heavy truck and street-car traffic, this bridge across the Ohio River near Pittsburgh is of all-timber construction, even including the foundation

and includes floorbeams made up of solid timbers as large as 20 by 30 inches in cross-section. A total of 680,000 board feet of lumber was required for the superstructure alone.

An entirely different type of timber bridge construction is on an access railroad built by the Corps of Engineers in Florida. This structure was built of laminated timbers fabricated on the job with one-inch boards laid flat and glued together by a urea-formaldehyde adhesive. A few years ago this type of construction would have been impossible, and old time railroad men were skeptical that a bridge built in this manner could accommodate the heavy loads imposed by locomotives. The framing consists of three laminated stringers or longitudinal timbers of 9- by 20-inch cross-section under each rail. These stringers rest on timber pile bents on 15 foot centers and are capped with 12- by 14-inch laminated members. This structure is now carrying heavy railroad traffic.

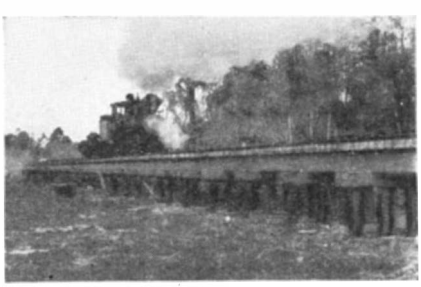
**BLIMP HANGARS**—Among the many unusual timber buildings which have recently been constructed, the most outstanding, perhaps, are the huge docks or hangars to house the Navy blimps used in patrolling our coastlines. A typical dock measures 1000 feet long, 297 feet wide, and 171 feet internal height to the crown of the roof, which means that a single hangar is large enough to accommodate three football fields, with room to spare.

The framing of these giant structures consists of timber arch trusses on 20-foot centers. The trusses are made up of solid members with all the joints strengthened by ring connectors. The secondary framing and roof also are of wood, a typical blimp hangar requiring a total of about three million board feet of lumber. Putting it another way, one of these giant docks calls for the use of as much timber as would be used in building 250 average-sized houses. All the timber used is treated to make it fire resistant.

Other aircraft hangars have been built of laminated timber construction, some of record span. For example, at the Vandalia, Ohio, modification center of the United States Army, eight hangars were built with the principal roof framing consisting of laminated arch ribs on 10-foot centers. Two of the hangars are of such width as to require ribs of 177-foot span between abutments. Each of these ribs measures 7½ inches wide by 39 inches in depth, and is fabricated of nominal one-inch boards of random lengths. The other six hangars required ribs of 157-foot span, these members being reduced in cross-section accordingly. The arches, fabricated in Chicago in three sections, were shipped to the site. When erected, they were braced with timber struts and steel diagonals and covered with a timber planking. This type of construction saved large quantities of steel, at that time badly needed for other purposes. Hangars of this design may be expected to give many years of service after the war ends.

Industrial buildings of tremendous size also have been built of wood. The largest in this country and perhaps in the world is the Douglas cargo airplane assembly plant completed last year at Chicago. This project required 27 million board feet of lumber, sufficient to construct a city of over 2000 homes. Use of timber resulted in a saving of 30,000 tons of critical materials.

Three types of timber roof framing —trusses, laminated beams, and plywood girders—have been common for industrial buildings. The trusses have been of several types, including those of the bow-string shape (that is, with curved top chord and horizontal bottom chord), those with parallel top chord and bottom chord, and still others of a shape designed to provide a sawtooth roof. Ring connectors have been used in fabricating all types, some with spans of 200 feet. With the bow-string type the top chord often is of laminated construction, but most of the truss members are solid timbers. Columns supporting the roof trusses likewise are made of timber, as are the smaller roof members.



The ties of this bridge, designed to carry heavy railway traffic, are solid timbers; the large members are laminated of one-inch lumber

Large laminated beams also have been erected as part of the roof framing of many industrial buildings. At a midwest ordnance factory, laminated beams 60 feet long, 38 inches deep, and 7½ inches wide were erected. These members, which are supported on reinforced-concrete columns, were fabricated of southern yellow pine and west coast Douglas fir lumber one inch thick, eight inches wide, and of random length. In fabricating these beams, no bolts or nails were required, the boards being held together by casein glue. Glued scarfed joints were formed where the boards had to be spliced, the splices being staggered.

**ADVANTAGES OF LAMINATION**—Use of laminated beams not only permits a large saving of steel, but also offers the advantage that they can be fabricated of lumber of a size most commonly available. Furthermore, they are economical to fabricate and the work can be done quickly. An added advantage is the fact that the height of the finished building is less than if trusses are used for the roof framing. Moreover, the beams permit rapid erection, an important factor in war buildings.

Plywood girders of large dimensions were introduced in constructing office and industrial buildings to save steel. This type of girder, which is one of the most unusual developments of the war, is easy to erect, light in weight and may be expected to have a long life. The girder also is remarkable for its length—60 feet—and the thickness (1½ inches) of its plywood web, or central portion.

The flanges or top and bottom stiffening members of the girder were each made of light 2- by 8-inch timbers. These timbers were joined to the web by wooden dowels, which eliminated large quantities of iron for bolts. When erected to become part of the roof, the girder was supported on timber columns. On most of those projects where girders of this type were used, requirements for critical materials were reduced still more by using smaller girders of the same general type for the secondary roof members.

**Formerly the Achilles' heel of timber construction, joints are now strengthened with ring connectors. Those shown are of the split type fitting grooves cut into the timber**

Greatest advance in mass housing for war workers, for which vast quantities of lumber have been required, has been extensive precutting and prefabrication at a central yard to permit assembly-line production of walls, floor, and roof in panels of a size conveniently handled by a few men. Several advantages are evident: Greater economy of materials, increased speed in erection, reduced cost per dwelling unit, and addition of demountable features that would permit the buildings to be dismantled later and moved to a new site.

Success of the prefabrication scheme in war work is proved by the many speed records established. One contractor built 5000 dwelling units in five months in an eastern city. Records on other projects were equally spectacular. Furthermore, experience of the National Housing Administration in dismantling a large number of the dwellings for erection elsewhere has shown this feature to be practical. In the dismantling work little breakage occurred and only small damage resulted in trucking the sections long distances to a new site.

**PLYWOOD IN HOMES**—Another development in housing has been the extensive use of plywood. On many projects the interior partitions and ceilings are of this material. Also, since it can be made water-resistant, large quantities are being used for the exterior walls. This latter use has resulted in the development at one large project of "single-wall" construction. By this method the greater portion of the walls was made of prefabricated panels consisting of one-inch rigid insulation board covered on both sides with plywood. Use of this type of material simplified and speeded erection. In addition, the cost was found to be low. Moreover, the construction offers certain advantages from the standpoint of demountability.

Space will not permit detailed description of all the other timber structures that have been built, but a few should be mentioned. At numerous military installations and industrial plants, elevated water tanks have been built of timber staves supported on a tower of heavy timbers. In the past a steel tank resting on a steel tower was standard practice. With most timber tanks the staves are placed vertically. However, another type of timber tank has made its appearance on the Pacific Coast. This design was used where storage at ground level was wanted. The timbers are placed horizontally and a clever arrangement was worked out whereby timber wedges could be used to eliminate leakage, steel hoops not being required. A tank of this design has high salvage value. Furthermore, such a structure may be dismantled quickly, moved elsewhere with little breakage, and reassembled in a short time. In addition, the original investment per gallon of storage is low and the tank can be used to store chemicals that would destroy other materials.

Other items of timber, which have made their appearance on war construction and can only be mentioned, are manhole covers, water and sewer pipe, derricks at shipyards, and wooden tires for construction equipment.

More has been learned about timber by American engineers in the last few years than in any equal period in history, and one of the greatest assets of the war may prove to be the increased knowledge of wood and wood products. Many of the present uses for wood are attributed to the shortages of other materials. Nevertheless, many of the new uses will continue and much that has been learned will prove of value in peacetime.

## "SAND JACKS"

### Speed Ship Launching, Save Working Time

Use of "sand jacks" eliminates the need for driving-up wedges formerly used to transfer the load of newly constructed ships to cradles just prior to launching. The new method, devised by the Houston (Texas) Shipbuilding Corporation, has saved 3000 board feet of lumber and 400 man-hours of time at each launching since its introduction last October.

Steel sand boxes, about 24 by 12 inches by 6 inches deep, made in top and bottom halves, are set on the principal load points at the keel of a ship. Similar boxes of 8- and 9-inch diameter pipe are used under the bilge cribbing. Each steel box has a filling hole in the top and a drain hole equipped with a pipe plug in the bottom section.

Before the keel is laid, the bottom sections of the boxes are filled with sand that has been thoroughly dried by heating. Next the top sections are installed and these sections filled to the top hole. Finally, the pipe plug is inserted.

The day before launching, the grease bars between the ground ways and the slides are removed, and the packing of the cradle is wedged up snugly but not sufficiently to take the weight of the ship. On launching day the ship is lowered to the launching cradle simply by removing the drain plugs and permitting the sand to flow out. To launch the ship, the top blocking in the launching way is removed, the dog shores are released, and the sole plates forward are burned off, which releases the vessel.

## PRESTRESSED CONCRETE

### Now Available For Water Pipe

An advance in the art of making reinforced concrete pressure pipe is represented in the utilization of the principle of prestressing steel in tension and concrete in compression. Manufacturing methods recently devised by the Lock Joint Pipe Company resulted in a saving of 1000 tons of steel on an installation of 75,000 linear feet of 30-inch pipe.

The new prestressed concrete pipe follows the general Lock Joint design in that it has a continuous welded steel cylinder with steel joint rings forming bell and spigot ends. However, after the cylinder is centrifugally lined with concrete to a thickness of 1⅞ inches and the concrete has been properly cured, the lined cylinder is spirally wound with number 6 high tensile strength wire under tension, imparting an initial compression in the cylinder and concrete core. The steel structure of the pipe is protected by a coating of cement and sand mortar ¾ inch thick.

The design of the pipe is such that the concrete will always be in compression under operating conditions. Recent tests on two of these pipes showed that they were able to resist pressures varying from 1450 feet of head to 1665 feet.

## CONCRETE BUILDINGS

### Exhibit Unusual Construction Details

Reinforced concrete played an important role in the construction of certain industrial buildings last year. One of the notable projects was the plant built for the Dodge Division of the Chrysler Corporation in Chicago; the main building in this plant covers an area of 80 acres. More important than its size, however, was the use of multiple thin-slab concrete roof arches supported on concrete columns, in a design that required only 2.7 pounds of reinforcing steel per square foot of floor space.

Another significant concrete building was an auditorium at an air station in the southwest wherein 91-foot span ribs having only a 25-foot rise were used. Cast on the ground, the ribs were raised a half section at a time, the hinge splice at the crown consisting of a short section of 10-inch diameter steel pipe; bottom ends of the arches were rounded to fit into recesses in the footing.

# Progress By Substitution

**A Brighter World is Promised by the Surface-Coating Industry as the Result of Substitutes Developed to Replace War-Restricted Materials. New Drying Oils, Some Produced by Synthesis, are being Used in Paints With Excellent Results. The Industry Now Has a Wide Choice**

DON'T LOOK down your nose at substitutes. You may regret it. Substitute—the word itself—seems always to carry with it a strong implication of inferiority, of paper collars and wooden nutmegs. That is unfortunate and often untrue, since industry progresses by processes of substitution. Indeed, the industry of paints, varnishes, and protective coatings has reached its present important position in our economy by a continuing progression of substitutions. And its future is now being built upon a number of additions to the series, each of which seems well on the way to becoming as firmly established as any of its ancient arts. From these new substitutions, our world, particularly our homes and our belongings, will be brighter, much brighter, as soon as wartime restrictions are lifted.

Shortages struck the protective-coating industry early, when this war was only a clash between Chinese and Japanese and long before it had taken on global dimensions. For China had supplied a large proportion of the industry's necessary drying oils, particularly tung and perilla, and the blockade of China's coast interposed itself effectively between producers and consumers. That was bad, and paint and varnish producers were severely handicapped by the shortage of two of their important oils. But the situation was saved by the ability and dexterity of the industry in substituting.

The amount of tung oil available to the industry now has dropped to somewhat less than 10 percent of the amount consumed in 1936, a shrinkage that might have caused a major catastrophe in a less versatile industry. As a matter of cold fact, the supply of tung oil available in 1943 represented something like half of the quantity of this oil used in, say, 1912. Tung oil had in little more than a score of years gone through the complete upswing of the cycle that was undone in a much briefer period by war in the Orient. Tung oil's sound position in 1936 had been attained from that of a substitute in America in a little over two decades. Now other substitutes taking its place temporarily seem destined to become permanent in the same way.

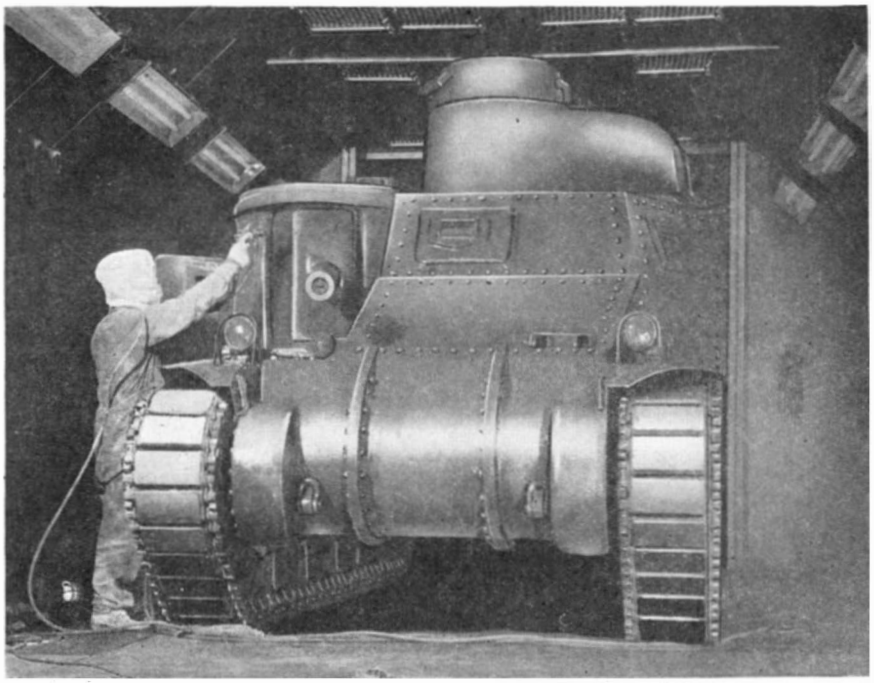
Efforts to grow tung oil in this country, extending back over a score of years, have provided groves of tung trees on our Gulf Coast that still can supply only a small part of our needs of this oil. Since the trees must be mature to yield oil-rich nuts, groves develop slowly over several years and the process cannot be hastened. Perilla oil, required in substantially smaller amounts than tung oil, comes from the seeds of an annual plant which, although not native to to North America, can be grown here, but is not.

To a limited extent, the several drying oils used in the manufacture of protective coatings can be interchanged, but the tendency throughout the industry has been to use mixtures of several to produce exactly the result desired, often unattainable otherwise. Therefore, the obvious necessity was and is to provide other oils from more plentiful sources to impart the desired qualities to mixtures, whatever may be the characteristics of the individual oil itself. Primary ingredients in customary mixtures have been linseed, tung, perilla, fish, and soybean oils. With two of the five missing, others had to be found to take their places. Current conditions are nearly ideal for developing any newcomers and for proving their worth.

Synthetic processes and a number of new separation methods now convert more plentiful oils into forms having some of the essential qualities of the missing orientals. New oils, too, are proving useful. As a result, it may even become a matter of indifference to us whether the tung and perilla oils are ever again available in their old abundance.

**INITIAL STEPS**—First among the steps taken to meet the impending shortage was, naturally, a search for other oils that might serve without modification. Oiticica oil, obtained from a nut native to Brazil, showed some promise and has been further developed. However, the limitations of a tree-borne nut, whose production could not be increased quickly, and the fact that its native soil lay outside our borders, interfered with universal usefulness. Furthermore, while oiticica oil is valuable, it is by no means as versatile as tung oil, and solves only a part of the problem. Several other oils investigated also failed to meet more than a small fraction of the need.

At this juncture, synthesis—or better,



**A tank gets a quick coat. Production of war-needed materials has placed great demands on the surface-finishes industry, already faced with shortages**

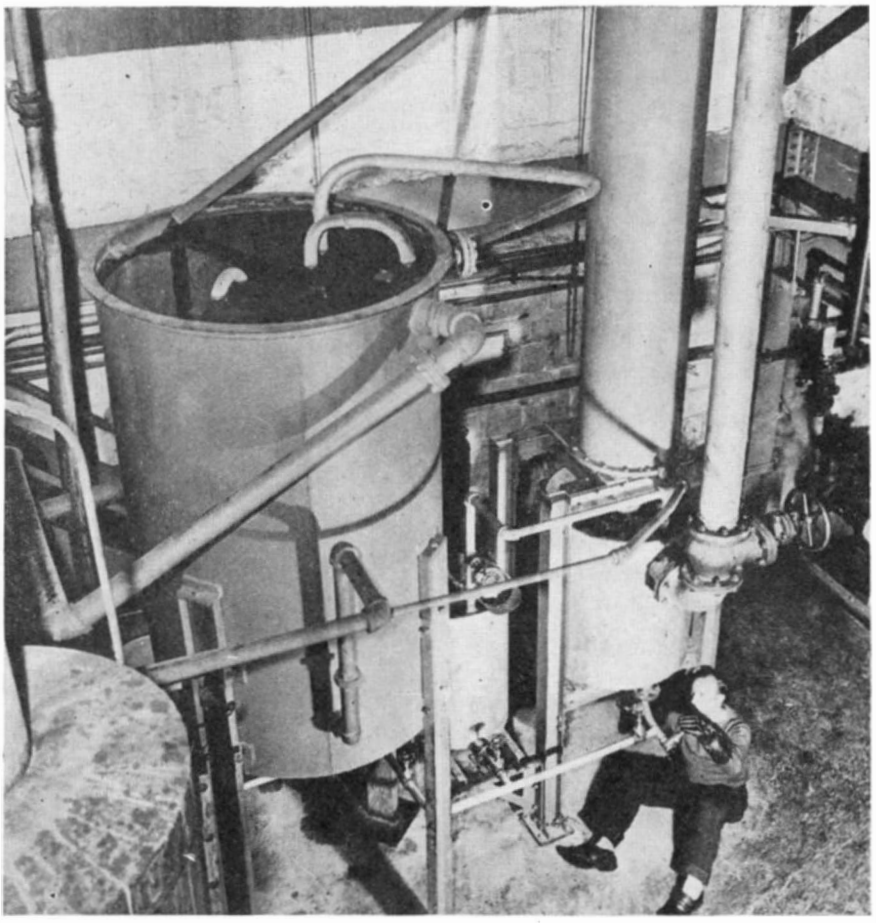
perhaps, semi-synthesis—entered the picture. Castor oil, some of whose properties are familiar to everyone, is chemically peculiar. Although in its natural state this oil possesses no drying qualities at all, its chemical constitution is such that the mere removal of water from its molecule gives it exceptionally high drying quality. The process is neither difficult nor particularly expensive, and the treated oil possesses important resemblance to tung oil. Here again the question of quantity was important, for the ordinary source of castor oil was a bean imported from Brazil and from India. However, the castor plant grows readily in most of the United States and luxuriantly in the Gulf Coast area, producing beans in a single season. Thus in the period since 1936 a substantial production of dehydrated castor oil, made by several methods, has been attained to offset a considerable part of the growing shortage of tung oil.

Let it be clearly understood that dehydrated castor oil is not a complete substitute for tung oil. Neither is any other oil yet available. However, both its similarity to the older oil, as well as its peculiar individual properties, make dehydrated castor oil too useful ever to be completely discarded, even when tung is again plentiful.

A third important phase of current development is the separation of constituents possessing exceptional qualities from oils ordinarily considered non-drying and hence of little or no value in the protective coating industry. Thus soybean oil of limited drying qualities can be separated by the relatively new technique of molecular distillation under extremely high vacuum into fractions of differing properties. One of these fractions possesses substantially enhanced drying qualities and the remainder is quite as good as, if not actually better than, the original whole oil for making soap. Similar separations can produce especially useful fractions from linseed oil, from cottonseed oil, and from several others. The treatment increases the cost of the useful drying fraction somewhat above the original value of the oil, but since it provides products of special usefulness from plentiful domestic oils, the final cost is not excessive.

**COMPARABLE RESULTS**—Solvent extraction of raw oils can effect a similar separation. This method takes advantage of the difference in solubility of drying and non-drying constituents in certain solvents—dilute methanol, for instance. The separations effected by the two methods are not identical, but the results are comparable.

Finally, changes in the chemical constitutions of the fatty acids of oils have been effected by treatment with alkalies in a process somewhat similar to the soap-making operation but more severe and prolonged. In essence this process consists of converting the oil into a soap, heating the soap, and subsequently recovering the altered fatty acids from the soap. The change effected is a re-arrangement of the double bonds within the fatty acid molecules into positions more favorable from the point of view of drying power. The resultant fatty acids from the process are recombined with an alcohol to reform the oil. The alcohol may be glycerol, recovered from the soap-making operation and a normal constituent of all natural oils and fats; or it may be another alcohol, glycol, or pentaerythritol, which yields special types of oil differing essentially from the original. Pentaerythritol, produced from formaldehyde, forms oils having exceptional drying values and particularly useful in the alkyd resins used in making modern varnishes. Thus this technique introduces types of oil not duplicated in Nature.



**In this equipment, in a plant of the Woburn Degreasing Company, castor oil is processed to obtain a drying oil that will replace tung oil in surface finishes**

The combined effect of all these various measures of substitution has been to provide the protective-coating industry with a series of new oily materials used in formulating the great variety of paints, varnishes, and protective and decorative coatings required by modern industry. Yet these are only a part of the story. The natural resins, the copals, have long been employed in making varnishes for direct use or as the vehicles of pigmented enamels. These have also been subjects of a program of synthesis as supplies of the natural products have diminished. Most important of the diminishing natural resins are the so-called fossil gums which impart hardness and brilliance to varnishes. These are typified by amber and copal and probably are products of prehistoric forests. They are found buried in the ground and deposits of them are being worked out. Pine rosin is produced by growing trees and is so cheap, as well as so efficient in admixture with tung oil, as to belong in a class quite by itself.

**REVOLUTION IN FINISHES**—The advent soon after the close of World War I of nitro-cellulose lacquers of a character competitive with paints initiated an important revolution in industrial finishes. Because they dried with almost magical speed, these new products seriously threatened enamels and varnishes, which required as much as two weeks to produce a finish attainable with lacquers in a few hours. First of the answers by the paint industry was a group of enamels based on varnishes compounded of phenol-formaldehyde resins and tung oil. These possessed practically the characteristics of familiar enamels except that they dried in a time comparable with that of the lacquers.

Subsequently quite a different type of resins, the alkyds, were developed for use in finishing automobiles. The alkyds are made from compounds of the type of glycerol and phthallic anhydride, for example, with the addition of drying oils as softening agents. They yield highly resistant films. By the application of heat, lately efficiently supplied by infra-red lamps, alkyd enamels can be dried in a matter of minutes or even seconds, in a chamber forming part of a production line. Thus delay for the finishing operation is completely avoided. Improved properties are imparted to the finishes by the addition of other resins to give the final film re-

sistance to wear, light, heat, moisture, and other destructive agencies far beyond that ever before attainable. Indeed, modern finishes of the modified alkyd type actually approach vitreous enamels in their resistance to destruction but are easier and simpler to apply. Enamels of this type can also be given the ability to dry in the air within a few hours and to yield films of extraordinary resistance to weathering, even proving satisfactory for marine use.

Because these synthetic finishes require minimal amounts of drying oils, they can be considered in a very real sense substitutes for them. In the present scarcity they extend enormously the usefulness of the meager amounts of tung oil available.

**THINNER PROBLEMS**—All of the protective coatings mentioned require a certain amount of added thinner to reduce them to working consistency. Turpentine, because of its high solvent power, has been the traditional thinner. Mineral spirit or naphtha produced from petroleum has also been widely used for this purpose. The nitrocellulose lacquers require solvents of a different type since nitrocellulose is insoluble in either of those previously used in oily vehicles. Various alcohols, esters, and ethers used are more expensive than either turpentine or mineral spirit. Indeed, the cost of the solvent required in preparing nitrocellulose lacquers constitutes a substantial part of the cost of the product, yet the solvent itself disappears as the coating dries. An advantage of alkyd finishes is their compatibility with low-cost solvents. The latest significant development in this field is the substitution of a water emulsion of the alkyd enamel—containing little or no solvent—for the customary solvent-thinned product. An emulsifying agent, such as casein, is necessary to form the combination but the result avoids costly solvents wasted in the drying of the final film. Furthermore, such emulsions are readily applied to porous surfaces to yield coating quite comparable with those formed by solvent-thinned enamels on nonporous surfaces. The presence of the residual emulsifying agent in the film reduces its resistance to moisture and rain, but for interior work these finishes are easily applied, quick drying, and highly satisfactory as to wear. Both their quick-drying character and their freedom from the "paint" odor of solvent are important considerations.

Brightness of finishes of the future will be much improved by using fluorescent pigments. These substances have the important property of glowing under ultra-violet rays, ordinarily invisible, and thus they add to the illumination of a room by employing this stray radiation. Investigations of pigments of this and other types sensitive to various invisible rays have been prompted by the need for special camouflage in war.

Thus shortages of specific drying oils, such as pertain at present, will soon be no longer significant in industrial and architectural finishes should they recur. Not, be it clearly noted, that we shall wish to forego the unusually valuable properties of tung and perilla oils when they become plentiful again. Rather we have added to the raw materials available to our protective-coating industry a number of new and valuable techniques and products that will supplement these oriental oils. Which we use will be a matter of choice and not of necessity.

And it all comes of substitutes. Don't sneer at substitutes.

### SHARK VITAMINS

**Content Varies Between Individual Fish**

FISH-LIVER oils, important sources of vitamin A, have been sought in many sections of the oceans especially since the Norwegian fisheries have come under control of the Nazis. Latest important field to be investigated is the Florida coast, where sharks abound. A recent study of oils from the livers of different sharks in that region shows a variation of more than a thousand fold in their vitamin-A content. Apparently factors other than age, sex, and species affect this value and efforts are being made to determine the variables involved for the guidance of fishermen in sorting out their catch.

### PLASTIC-GLASS

**Combination is Light, Strong, Easily Molded**

NOW BEING employed in aircraft construction and possessing hitherto unattainable strength in proportion to weight, a new material was recently described before the Industrial Minerals Division of the American Institute of Mining and Metallurgical Engineers by Games Slayter, vice president and director of research of Owens-Corning Fiberglas Corporation.

The new material is a plastic reinforced with glass fibers. Experimental samples, according to Mr. Slayter, have been produced with tensile strengths of over 80,000 pounds per square inch. While the impact strength of ordinary plastics is about two foot pounds on a standard test, samples of the glass and platic combination have shown impact resistance of over 20 foot pounds.

Another important feature of the new material, Mr. Slayter said, is that it can be molded into aircraft structural parts with low pressures and without the use of expensive molds. This reduces both the cost of fabrication and the number of man-hours required. The material can be machined and has the dimensional stability of metal.

Explaining the principle involved in the manufacture of glass and plastic combinations, Mr. Slayter said: "All materials contain imperfections. If the material is uniform in its structure, stresses accumulate around the imperfections. Cracks propagate across the material and the material fails. Nature guards against failure of her strong materials by fiberizing them. A tree consists of cellulose fibers bonded with lignin.

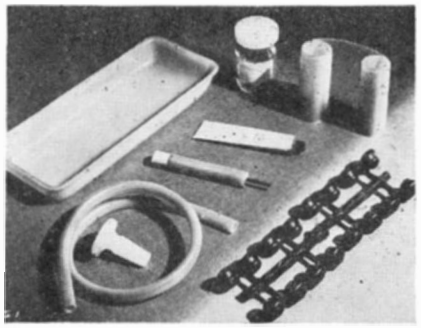
"When we draw glass into fine fibers and combine them with a plastic, we distribute the imperfections so that there is not one chance in a million that those in one fiber will match with those in another. The finer the fiber, the wider is the distribution of imperfections, and the smaller is the possibility that a stress accumulating at an imperfection will propagate through the mass."

### POLYTHENE RESINS

**Offer Desirable Intermediate Properties**

A NEW family of resins, named Polythene, recently announced by E. I. du Pont de Nemours and Company, possesses properties intermediate between those of the soft synthetic rubbers and the usual harder resins. Polymerization of the hydrocarbon, ethylene, common among the gaseous products of cracking petroleum, is the source of the new resins now being produced in quantity, but under strict allocation.

Among the uses for which the Polythenes are adapted are collapsible tubes



Products of Polythene

for toothpaste and the like; waterproof coatings for textiles; electrical insulation for wires; and tubing and piping. The outstanding characteristics of the new resins are: Toughness and flexibility over a wide temperature range; chemical inertness; unusual resistance to moisture and water vapor; and excellent electrical properties. Fabrication methods fit standard techniques and machines since the material can be extruded, injection molded, calendered on cloth, and machined by ordinary means.

### CORK SUBSTITUTE

**Made from Plant-Waste Pith**

A NEW compressible material adaptable for use in place of cork in bottle caps is reported by the Northern Regional Research Laboratory of the Department of Agriculture, Peoria, Illinois. The product is made from the pith of plant wastes and is yet in early stages of commercial development. It will be covered by a patent dedicated to the public and hence available to interested manufacturers in the United States without royalty.

# Prospecting for Petroleum

**Man's Insatiable Curiosity About the Possible Wealth of Materials Hidden in the Ground has Led Him to Employ Many Weird Contrivances in His Search. As Science Advances, the Witch-Hazel Divining Rod Used for Locating Water Has Given Way to Electronic Techniques for Subsurface Probing**

DURING the last two decades, methods of exploring for oil have undergone widespread advances due to the introduction of electronic equipment for geophysical prospecting.

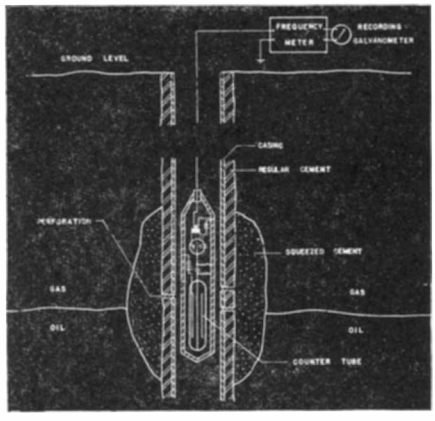
It was early discovered that oil pools occur in and around several different types of subsurface structures such, for example, as domes and faults. Once drilling operations have begun in an oil field, as much subsurface information as possible is gleaned from each well in order to map the subsurface structure. Such a map is useful in locating succeeding wells and in predicting the level at which oil may be found beneath the surface.

Within the last decade, "electrical logging" has been widely adopted. In general, the electric log shows two graphical traces as a function of depth: One a measure of the electrical resistivity of the formations, and the other a measure of the difference of potential between a point on the surface and a moving electrode in the well. These logs are made continuously as one or more electrode, suspended on a conducting cable, is moved in the well. Special trucks are equipped with power-driven cable drums and recording apparatus for making the logs.

Interpretation of electrical logs indicates that, with some exceptions, sands have a relatively high resistivity as compared to shales and also give rise to a relatively high potential peak. In many fields, new wells can be drilled between producing wells with fair assurance of success, using only electrical logs as guides. Thus, a large saving in time and money expended in examining core samples is effected. In "wildcat" or new-field wells, the electrical log sometimes shows up sands which are good bets as oil sands and which would otherwise be passed up.

**THROUGH THE PIPE**—Many established fields exist in which electrical logs cannot be used, due to the presence of steel casing. Some of these fields are known to have oil sands in the upper formations, sands which were not found when the wells were first drilled and cased. If these sands could be located *through* the pipe, production could be effected by perforating the casing with a special gun.

The fact that oil-bearing formations frequently contain radioactive materials has recently proved to be one solution to this problem. Gamma rays emanating from radioactive elements such as radium, the thorium series, and potassium can be detected through steel pipe and hence received early consideration in the search for a new well-logging technique. Lynn G. Howell, writing about the early work done in this field by the Humble Oil and Refining Company, describes their first gamma-ray de-




**Gamma-ray counter used to detect squeezed cement in an oil well**

tector as an ionization chamber filled with nitrogen at a pressure of about 500 pounds per square inch. Housed in a compartment adjacent to the ionization chamber was a detecting circuit and batteries. The ionization current was fed to the grid of an electrometer tube which was grounded periodically at three-second intervals by a clockwork mechanism. The grid voltage at the time of grounding was proportional to the ionization current, so that pulses proportional to the ionization current and, therefore proportional to radioactivity, were produced. These pulses were fed to the surface through the supporting multi-cable conductor.

The pulses were amplified at the surface and read on a galvanometer. Measurements were made at various points in the well, a number of galvanometer deflections being read at each point. The producing sections of wells explored by both methods gave a promising correlation between the radioactivity curves and electrical logs made in the same wells.

Although the curves showed the possibility of using radioactive data in logging wells, the technique was not immediately applicable to making routine measurements. It is always desirable to make *continuous* logs, with as much speed as possible.

Geiger-Müller counter tubes were next tried as detectors. Pulses from individual secondary particles produced by gamma rays coming from outside the well casing are "counted" in the G-M counter tube, and amplified by a single battery-operated vacuum-tube stage mounted directly above the counter tube in the logging unit. The resulting strong pulses travel up a cable to a thyratron-controlled frequency meter and a recording galvanometer at the surface.

In these measurements, one of the biggest problems results from the random nature of the radioactive processes. The measured "frequency" is a fluctuating quantity, which must be averaged out over as long a time interval as is convenient. A compromise must therefore be made between the desired smooth, average curve, the ability to detect sudden changes in radioactivity, and the speed of logging. A combination that has proved satisfactory permits logging at a speed of the order of 25 feet of well depth per minute. The frequency of pulses from a counter tube was of the order of five per second at this speed.

**COMMERCIAL EQUIPMENT**—In more recent work the gamma-ray technique has been adapted to commercial logging equipment. For example, cable having a single conductor, insulated in a steel sheath (used extensively in making electrical logs) is employed instead of multi-conductor cable. Various circuits have been tried in which power is fed down the cable from the surface to the vacuum-tube in the chamber at the same time as pulses are transmitted up to the surface.

An interesting application of the gamma-ray logging technique has been the tracing in oil wells of cement which has been made radioactive by addition of carnotite ore.

In present-day drilling practice all

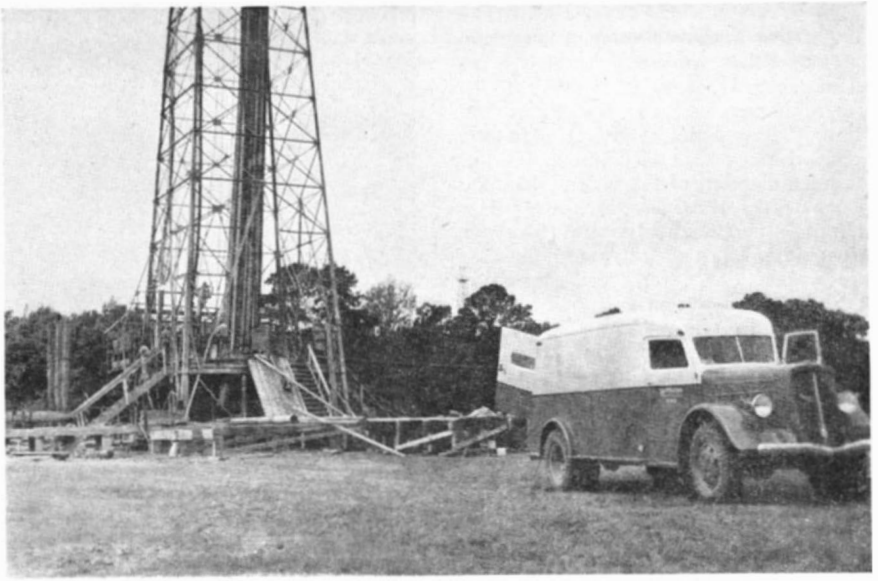
casing is set in cement in the well. The cement is pumped down the pipe and up between the wall of the hole and the pipe and it is often important to be able to trace the course and disposition of the cement. When first placed, the cement is easily detected by measuring temperatures throughout the well while the cement is setting, due to the heat developed. Sometimes, however, the cement is forced out under great pressure through holes made in the casing by bullets fired from a special gun. Very often new cement is squeezed out behind old cement, so that the heating effects are not easily detected.

By using heavily doped radioactive cement, squeezed cement is easily located by gamma-ray measurements. The cement may travel a fairly large distance, as much as 70 feet, along the outside of the pipe. Squeeze jobs are usually used in sealing off objectionable water and gas sands from producing sand.

Recent techniques of electronics and nuclear physics have thus given the oil industry a much needed tool for exploring cased wells. At present, it appears that formation logging is the principal application of the gamma-ray method. However, it is not limited to this work or to cementing operations, but is applicable also to the location of any extraneous material introduced into a well, particularly to the location of markers for future operations in the well.

**MUD ANALYSIS**—Electronic apparatus is also used in modern mud-logging equipment. While the oil well is being drilled, continuous analysis of some of the chemical and physical properties of the mud used as the drilling fluid is made possible by the application of electronic control equipment especially designed for this purpose. Data obtained enable the geologist and petroleum engineer to arrive at a clear understanding of the conditions in the bore hole and thus they aid in the final completion of the oil well. Drilling mud returned from an oil well which is being drilled by the rotary method, with a circulating mud stream, is being examined under ultra-violet light to determine the presence in the drilling fluid of crude oil. This examination is usually made by taking samples of the mud, subjecting them to rays of an ultra-violet lamp and observing whether or not any fluorescence is emitted from the sample. The fluorescence is supposed to come directly from crude oil. This procedure does not permit of any quantitative determination of the amount of oil in the mud, but is a qualitative method.

A recently developed electronic modification of this technique provides a quantitative method for determining the amount of oil in a drilling fluid. It is based on the discovery that when oil is dissolved in a non-fluorescent solvent the fluorescence of the oil under ultra-violet light is so distributed as to make possible a quantitative light measurement. Solutions as small as one part of oil in a million parts of solvent give a fluorescence which is readily measurable. Typical solvents used are benzol, carbon tetrachloride, ethers, toluene, xylene, and the like. The solvent must be one which is water immiscible.



Courtesy Halliburton Oil Well Cementing Company

**Truck set-up for making an oil-well log by use of new gamma-ray technique**

In one of the simpler forms of the same method, a sample of mud is segregated and agitated with a quantity of the solvent. The solvent, after thorough agitation, is separated from the solids of the sample and placed in a tube or cell where it is exposed to ultra-violet light. The light emitted by fluorescence is measured by any light-measuring device, such as a photocell arrangement. In a more elaborate form, measurements are made continuously and recording of the results is automatic.

In one method of geophysical prospecting, the seismic or artificial earthquake method, the geophysicist, beginning with the use of electronics in refraction seismograph amplifiers for building up the feeble earth impulse resulting from the distant dynamite explosion and in radio equipment for transmitting and recording the instant of this explosion, has come to accept the vacuum tube as a standard part of his equipment in the scientific exploration for oil and gas-bearing areas.

The successful application of electronics in field instruments has overcome the natural distrust of things that are new and untried. At the present time, electronics is applied successfully to instruments used in all the geophysical exploration methods, such as seismic, thermal, magnetic, electrical, and gravitational.

For the past ten years, the reflection seismograph method of geophysical exploration has proved to be outstanding in locating petroleum-bearing properties. By means of seismic pick-ups, high-gain amplifiers, and photographic recording galvanometers of the multi-element type, the seismic effects produced by controlled dynamite explosions are recorded and analyzed. The depths to the reflecting strata are determined from the velocities of propagation and the total time required for the seismic vibrations to travel from the point of the explosion to the reflecting interfaces and back to the seismic detectors located at the surface of the earth. The point of explosion, referred to as the shot point, is commonly located from 50 to 100 feet below the earth's surface.

**PHOTOGRAPHICALLY RECORDED**—When the seismic waves arrive at the earth's surface, their acoustic energy is converted to electrical energy by means of seismic pick-ups. This energy is then passed to high-gain amplifiers, automatically adjusted to a given level and the undesired components filtered out, and then passed to recording galvanometers where the photographically recorded seismogram is made. Timing marks at intervals of 0.01 second and the instant of explosion of the dynamite charge are recorded on this seismogram, together with the seismic refracted and reflected waves.

When such a seismogram is made with a large number of seismic pick-ups placed on the surface of the earth in line with the shot point at intervals of around 200 feet, it is possible to differentiate between the direct, the refracted, and the reflected waves, because of the difference in their apparent velocity of propagation. The time from the instant of explosion of the dynamite charge to some definite reflected or refracted characteristic of this event is counted to the nearest thousandth of a second and the depth to this reflecting horizon is then computed. By this means, contour maps can be drawn of the subsurface strata at depths of from a few hundred feet to around 20,000 feet. Carrying the survey over a large area, subsurface anomalies where petroleum might exist may be detected.

The velocity of propagation of the seismic wave depends upon certain properties of the medium through which the wave passes. If hard rocks are involved, the velocity of propagation may be 8000 to 20,000 feet per second. If the materials are soft, the velocity will be much less than this. In some instances, the velocity of propagation through certain shallow formations is even less than the velocity of trans-

mission of the sound wave through air.

The instruments employed for seismic pickups that detect the seismic reflections are somewhat similar to the microphones used in broadcast stations. They usually consist of a suspended mass that is connected to the moving element of the pickup. The frequencies of the reflections vary from about 20 cycles up to around 80 cycles, depending to some extent on the elastic properties of the deep formations and to a greater extent on the properties of the formation in which the explosion occurs and on which the seismic pickups are located. The frequencies of the direct waves are in general lower than the reflection frequencies, and the frequencies of the extraneous disturbances caused by wind and traffic are usually higher than the reflection frequencies. The usable sensitivity of the electronic equipment is, therefore, increased when filter circuits favoring the reflection frequencies are used.

Radio communication is used in preference to telephone lines when the operating truck containing the recording instruments is located a long distance from the shot point or when the intervening area is traversed by wooded sections or streams. Low-power transmitters are satisfactory for this purpose since the distance seldom exceeds five miles. When the charge of dynamite in the hole at the shot point is exploded, the electrical circuit to the cap is broken. The electrical impulse that results from this sudden break of the cap current is impressed on the modulating section of the transmitter and a signal is emitted at the instant of explosion. This signal is in turn received at the recording truck and recorded by a moving-coil galvanometer in the recording unit.

Electronic equipment also plays an important part in talk-back systems used on the drilling rig. Talk-back systems that supply the means for intelligible communication from the fourble board near the derrick's top to the noisy derrick floor decrease the hazards and help coordinate efforts in handling heavy drill pipe.

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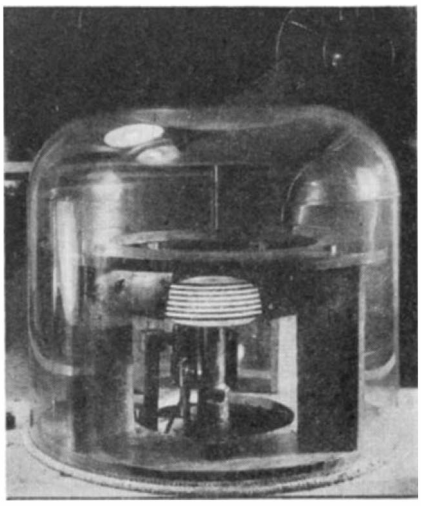
### OIL-WELL DRILL BITS
#### Are Given Tough Teeth Electronically

OIL-WELL drill bits that bore through solid rock are tough because a layer of tungsten carbide is deposited on the teeth under high temperature. Conventional practice has been to carbide the teeth one at a time with a torch. Recent experiments in the Westinghouse high-frequency laboratory, however, have resulted in carbiding all the teeth at once in a few seconds. This is accomplished by passing the toothed cutter, on which the carbide particles are held by an adhesive coating, into the inductive field produced by a high-frequency oscillator. The heat generated causes



A red-hot oil-well drill bit is hardened in an experimental induction furnace by the tungsten carbide process described in the text

the carbide particles to merge with the steel base. The new method permits the use of protective gas atmospheres to improve the quality of the carbide surface, and can be operated semi-automatically and at high-speed by unskilled operators.

### RUBBER SHEET INSPECTION
#### Accomplished by Electronic Means

PIN HOLES in rubberized canvas sheeting are detected electronically by passing the sheeting between two rollers that are saturated with a conducting liquid. The liquid penetrates even extremely small pin holes in the canvas, forming a conducting path through the canvas and between the rollers. The rollers are insulated from other objects and connected to a vacuum tube amplifier which feeds an electromagnetic relay. This relay may in turn actuate a marking device that locates the defect, or may stop the machine and actuate an alarm.

### OCTANE TESTER
#### Utilizes Variations in Cylinder Pressure

AN ELECTRONIC octane-rating indicator for use with internal combustion engine has proved extremely useful in the development of gasolines having octane ratings higher than have previously been available.

The principle of operation of the instrument depends upon the fact that the ideal internal-combustion gasoline engine operates at a constant rate during expansion of the gas within the cylinder. In an actual engine, the expansion period of the explosion consists of a number of oscillations of rather high frequency, or about 6500 cycles per second, which can cause engine knock and impair efficiency. The octane-rating indicator measures these oscillations during the expansion period.

The instrument contains a pressure-operated pick-up, similar to an electrodynamic microphone, which is inserted in the wall of the engine cylinder so that its diaphragm responds to the variations of pressure. The diaphragm, in turn, induces corresponding voltage variations in an iron-core coil, which are then amplified by vacuum tubes to a suitable level.

An electrical integrator circuit totals the energy variations so that the output of the integrator is proportional to the amount of engine knocking. A meter at the output of the integrator measures this energy, and is calibrated directly in octane rating by burning fuels of known rating in the engine cylinder.

### POWDER SEPARATOR
#### Operates on Electrostatic Action on Materials

CERTAIN dry, powdered materials may be separated from each other by electrostatic action. In the chemical field, for example, among the materials which may be separated in this manner are sphalerite and iron pyrites; graphite and mica; biotite micas and muscovites; garnet and metal particles. These materials have essentially different electrical characteristics and this difference provides a means of attack.

The electrically unlike materials to be separated are passed over or between electrodes charged to about 15,000 volts D.C. One material picks up and retains a charge, in its passage over or between electrodes, sufficient to cause it to adhere to an electrode. The other material flows unimpeded through the separator to a collecting hopper. High-voltage D.C. to operate such separators is readily obtained by stepping up A.C. power-line voltages through suitable transformers and then rectifying electronically.

### DEW POINT METER
#### Controls Moisture in Natural-Gas Pipeline

TO PROTECT gas lines from clogging due to freezing when moisture condenses inside them in winter months, a dew-point recorder using a photoelectric relay is employed at the point where the natural-gas pipeline from Texas enters the metering plant in Denver, Colorado. Whenever the continuous recordings show that the dew-point is high enough to cause freezing, instructions are dispatched to dehydrating plants to remove moisture before trouble occurs.

Part of the gas is routed through a U-shaped tube having a mirror inside each corner, with a light source at one end of the tube and a phototube at the other. The tube is immersed in an anti-freeze solution that is alternately refrigerated and heated. Chilling causes moisture in the gas to condense on the mirrors and reduce the amount of light reflected into the phototube, while heating drives off the condensation and restores full illumination. Associated electronic equipment converts the phototube output and temperature readings into desired dew-point indications.

# Modern Lubrication

**For Centuries, as Long as Lubrication was on an Empirical Basis, its Efficiency Remained Very Low. Only When a True Understanding of the Basics of the Lubrication Process was Reached Could Bearings and Lubricants be Designed to Make Possible Today's Machines**

By E. M. BARBER
Beacon Research Laboratory, The Texas Company

THE PRESENT era of our civilization depends very greatly on the continuous and reliable operation of countless numbers of machines, most of which are characterized by motion between two surfaces pressed together by comparatively large forces. Correct lubrication of these moving surfaces is essential to the continuous and reliable operation of the machines.

Without lubrication, or with inadequate lubrication, much of the energy of the machine may be dissipated as friction of the moving surfaces, leaving little excess of energy to do useful work. In addition, the wear at these surfaces may be so great that the machine will become inoperable in a very short period of time. With the best lubrication methods known, the friction loss is but a small fraction of the total energy output of the machine and wear can virtually be eliminated.

**THEN AND NOW**—Familiar examples of the machine processes on which our civilization depends are: A shaft rotating in the bearing of a steam turbine or in a vacuum cleaner; a piston moving back and forth in the cylinder of an aircraft engine or a cross head moving back and forth in its guides in the engine of a Liberty ship; a wire passing through a die in a wire mill; or a tool cutting metal to form gun barrels. All these familiar machine processes depend on lubrication for continuous and reliable operation.

In its earliest recognized and most elementary form, lubrication consisted simply of putting some form of film between the parts that are in relative motion, thus reducing friction and wear. Apparently the earliest machine builders recognized the necessity of providing some form of lubrication for their machines, and recognized further the special value of various oils, fats, and greases for this purpose. Indeed, historians report references to the use of animal, vegetable, and mineral oils among the earliest written records. They report, also, that the mechanized armies of 1400 B.C. were especially partial to the use of beef and mutton tallow for the lubrication of their chariot wheels. From the crude machines and lubrication practices of these early times to the modern machines of peace and war is a long step; moreover, it is a step that was not and could not be taken until the nature of the lubrication process was understood well enough to release the machines from their burdens of friction and wear.

Until the latter part of the 19th Century, lubrication theory and practice were still at the stage where machines commonly used as much as half of their energy to overcome their own friction and therefore wore out very rapidly. With the high friction forces that were characteristic of the lubrication methods even of that date, some of our more interesting new machines, like the gas turbine, could not have operated.

Finally, in the 1880's, partially as the result of a lucky accident, partially as a result of a brilliant theoretical analysis, a real understanding of the nature of the lubrication process was obtained. With that knowledge as a basis it is possible now for engineers to design bearings and select lubricants so that friction can be reduced to a small fraction of the total power of the machine and so that in many cases, at least, wear virtually is eliminated. It is true that much remains to be learned about lubrication but what is known already serves as a firm basis on which to build the future development of even better mechanical servants of our civilization.

The historical record of how this information was obtained is a fascinating case history of the scientific method in operation and gives, also, one of the best backgrounds for understanding the nature of the lubrication process.

**CLASSIC EXPERIMENTS**—In 1883, Beauchamp Tower reported to the Institution of Mechanical Engineers the results of friction experiments made on bearings similar to those used in railway cars. The effect on friction of the method of supplying the lubricant was of particular interest in these experiments. Therefore, a large number of arrangements for oil supply were tried. One method, that of immersing the lower part of the shaft in a bath of oil, was found to reduce friction to a fraction of that effected by other methods then in common use for the lubrication of machinery.

Toward the end of the group of experiments with bath lubrication, Tower made a further important discovery. A hole had been drilled through the center of the bearing, at the top, to accommodate a lubricator for use in subsequent experiments. When the machine was started, still using bath lubrication, oil began to flow out of this hole. The machine was stopped and a wooden plug was driven into the hole, but when the machine was restarted the plug was forced out of the hole and again oil flowed from it.

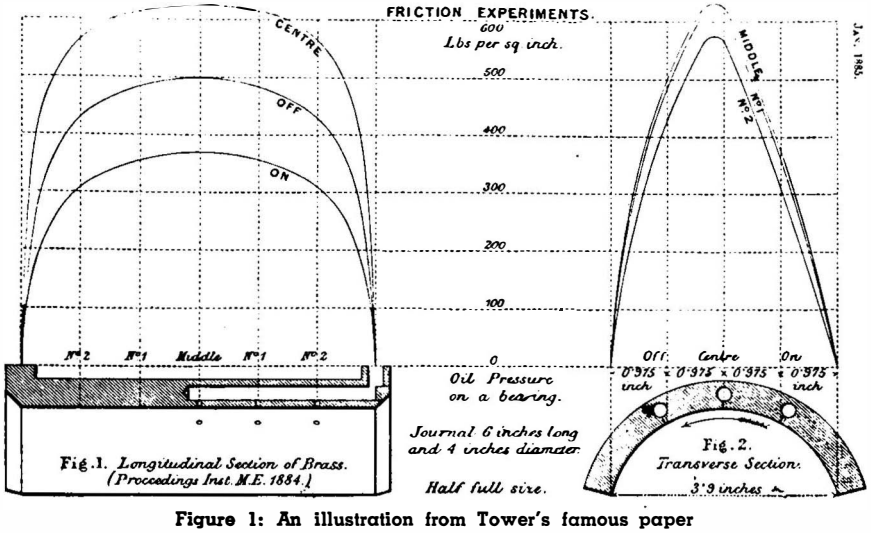



**Figure 1: An illustration from Tower's famous paper**

This appears to have been a critical moment with regard to our knowledge of lubrication. If Tower had successfully plugged this hole, our understanding of the lubrication process probably would have been retarded for many years. Instead, however, Tower applied a pressure gage to the hole and restarted the test. Very shortly afterward, the pressure was seen to be so great that it exceeded the range of the gage, which was capable of measuring pressures only to 200 pounds per square inch.

**A CORNER TURNED**—This experiment gave the first evidence that pressure could be created by the oil film of a bearing. In subsequent experiments, also employing bath lubrication, several holes were drilled in the bearing. On applying pressure gages of suitable measuring capacity to them, Tower found that the pressure at each hole was different, being zero at the edges of the bearing and greatest at the center. The pressure observed at the center hole was found to be greater than the unit load, or load per unit of bearing area, on the bearing; it was 625 pounds per square inch in one case when the unit bearing load was only 330 pounds per square inch, and the pressure increased or decreased when the load on the bearing increased or decreased. The resultant of the pressures, measured at the various holes of the bearing surface, was found to equal the load on the bearing.

Figure 1 is reproduced from Tower's report and shows how the holes for pressure measurements were located, and also gives some of the pressures that were observed.

The Scottish engineer, Osborne Reynolds, was greatly interested in Tower's experiments, particularly in the observation of pressure in the oil film and in the exceptionally low friction when these pressures occurred. To Reynolds these observations meant that, in some way or other, a pressure was built up in the film which caused the two surfaces to be separated so that they were floated by the lubricant; the pressure automatically adjusted itself to carry the load applied to the bearing and the friction was only that of the fluid in the oil film.

As a result of his interest, Reynolds undertook a theoretical study of the manner in which oil could flow in a narrow space between two surfaces in relative motion, one surface representing the rotating shaft and the other the stationary bearing that surrounds the shaft. In 1886 Reynolds published the results of this study, and our present understanding of the lubrication process is derived largely from that publication. Reynolds' study showed that there could be two domains of lubrication: One the "imperfect" or "boundary film" region, which is characterized by relatively high friction and wear caused by limited metallic contact between the moving parts. The other, which has come to be known as the domain of "fluid film" lubrication, is characterized by very low friction in which wear is virtually non-existant since the surfaces are entirely separated by a fluid film of the lubricant and no metallic contact exists. Reynolds went even further than to explain Tower's results and derived a very exact description of the lubrication process and of the conditions essential to obtaining fluid film lubrication.

According to Reynolds' description of fluid film lubrication, the lubricant is considered to be drawn into a wedge-shaped space between the bearing and shaft where, owing to its viscosity, the lubricant produces forces—the so-called viscous forces—which account for the load-carrying capacity and friction of the bearing. This description is the accepted theory of how a fluid lubricated bearing operates. According to it, the viscosity of the lubricant and its ability to wet the surfaces that it contacts are the essential characteristics of a lubricant.

Viscosity is a measure of the resistance offered by a fluid to a change of shape or to relative motion of its parts. It has been described as "what molasses has a great deal of in January." Viscous liquids such as molasses offer strong resistance to change in shape whereas less viscous liquids such as water offer much less resistance. Mineral lubricating oils having almost any desired degree of viscosity can be obtained. The ability to wet surfaces that they contact is characteristic of all lubricating oils. For example, a lubricating oil poured on a metal surface spreads across the surface and is difficult to wipe off, whereas mercury poured on a metal surface remains in the form of a small globule and will roll across the surface freely. The oil is an example of a wetting liquid, mercury is an example of a non-wetting liquid.

With the properties of viscosity and surface wetting in mind, we can now return to a study of the action of the lubricant between two surfaces in relative motion and follow Reynolds' ideas of how this action is related to the load-carrying capacity and frictional resistance of bearings.

Figure 2 shows two parallel surfaces, slightly separated, one surface, *AB*, being stationary while the other surface, *CD*, moves parallel to *AB*. Both of the surfaces are immersed in lubricant. Because of the wetting properties of the lubricant, fluid particles in contact with the stationary plate will remain fixed to its surface and fluid particles in contact with the moving plate will remain fixed to it and move with it.

**TO DEMONSTRATE**—If the surface *CD* is considered to have moved so that point *E* has moved to the point *F*, then the fluid particles at *E* will have moved to the new position *F* but the particles at *A* will have remained at *A*. The intermediate fluid particles that initially lay along the line *AE* will have been drawn into the new position *AF*.

Obviously, the triangle *AEF* will represent the quantity of lubricant that was drawn into the space between the two surfaces by the motion *EF* of the upper surface, and the equivalent triangle *BGH* will represent the quantity of lubricant that flowed out from between the surfaces. By this movement the rectangle *AEGB* has been transformed into a parallelogram *AFHB* and its shape has therefore been changed. The viscosity of the lubricant resists this change of shape, and force must be applied to the upper plate *CD*, proportional to the rate of change of shape, in order to overcome these viscous forces. This force required to move the plate *CD* corresponds to the force of friction.

This is the condition of flow of a fluid which Reynolds first visualized, and it explains the origin of the friction forces but it does not tell us why the

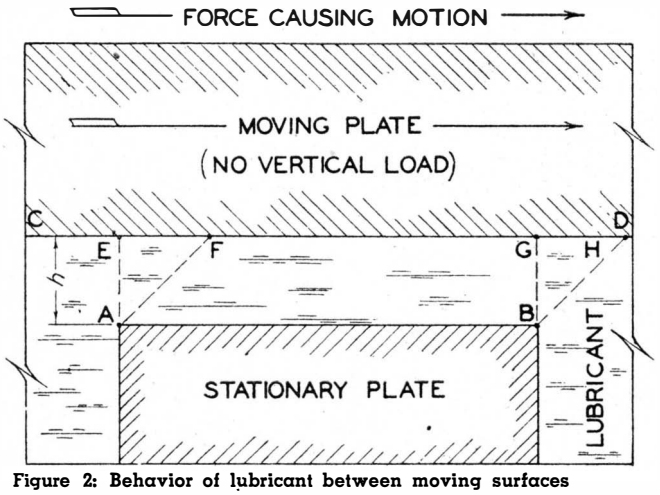



Figure 2: Behavior of lubricant between moving surfaces

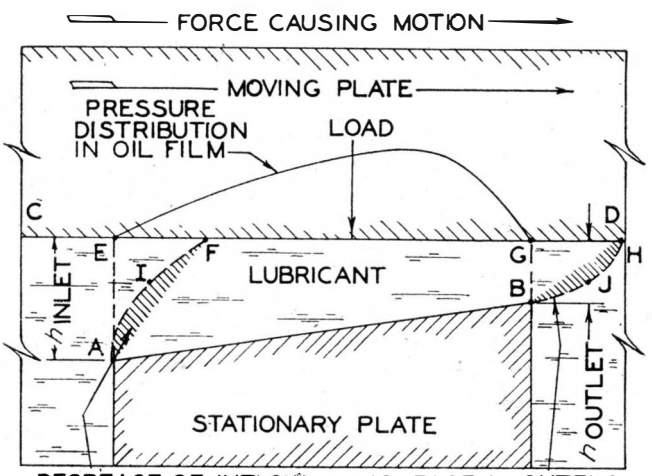



Figure 3: Why the moving plate doesn't rub the fixed plate

moving plate should remain separate from the stationary plate when they are forced together by a load.

If the two surfaces had been slightly inclined, instead of parallel, as shown by Figure 3, the space between them would be wedge-shaped and more lubricant would tend to be drawn into the space across *AE* than can flow out across *BG*. This, however, is impossible. What happens is that the forces due to viscosity attempt to wedge more fluid into the clearance space than can get out and, in consequence, pressure develops in the film, the pressure having a distribution similar to that indicated in the curve at the top of Figure 3. This pressure decreases the inflow at *AE*, and increases the outflow at *BG;* with the result, shown by the figure, that the inflow occupies a new area *AEFIA* and the outflow is increased to an area *BGHJB,* both of which are equal. As in Figure 2, the motion of the surface *CD* is resisted by viscous forces of the lubricant and these forces are the source of friction of the bearing. These same viscous forces produce the pressure in the oil film which tends to keep the two surfaces separated despite the fact that they may be pushed together by a large external force.

It is not clear at first that the wedging of the fluid into the space between the surfaces by the relatively weak viscous forces can lead to high enough pressures to account for the known ability of bearings to carry loads of hundreds of pounds per square inch. However, the sketches drawn to show the flow of liquid are of necessity exaggerated and create a somewhat erroneous impression of the operation and inclination of the surfaces. In an actual bearing, the separation of the surfaces at *BG* might be 0.0005 inch and the inclination (excess of *AE* over *BG*) 0.0002 inch in a length *AB* of several inches, so that the effect is that of a very flat wedge giving a tremendous mechanical advantage. Thus it is apparent that the production of pressures sufficient to support very large loads is much more reasonable.

The foregoing has explained the lubrication process in terms of flat surfaces. These, however, though important, are encountered in lubrication practice less frequently than cylindrical surface bearings. Fortunately, it is possible to apply the ideas developed in connection with flat bearings directly to cylindrical surface bearings. As shown in Figure 4, for a cylindrical bearing the moving surface *CD* of Figures 2 and 3 has been changed into a circle so that it becomes the shaft, and the stationary surface has been changed into a slightly larger circle so that it becomes the bearing. The wedge-shaped passage between the surfaces results from the fact that the bearing is made to have a few thousandths of an inch larger diameter than the shaft and the shaft runs with its center displaced from the bearing center. The wetting action of the lubricant, combined with the viscous force, causes pressure to be developed in the clearance space between the shaft and the bearing and the resultant of these pressures supports the shaft on a fluid film. The frictional resistance to rotation of the shaft is only the resistance required to overcome the viscous forces of lubricant in the clearance space.

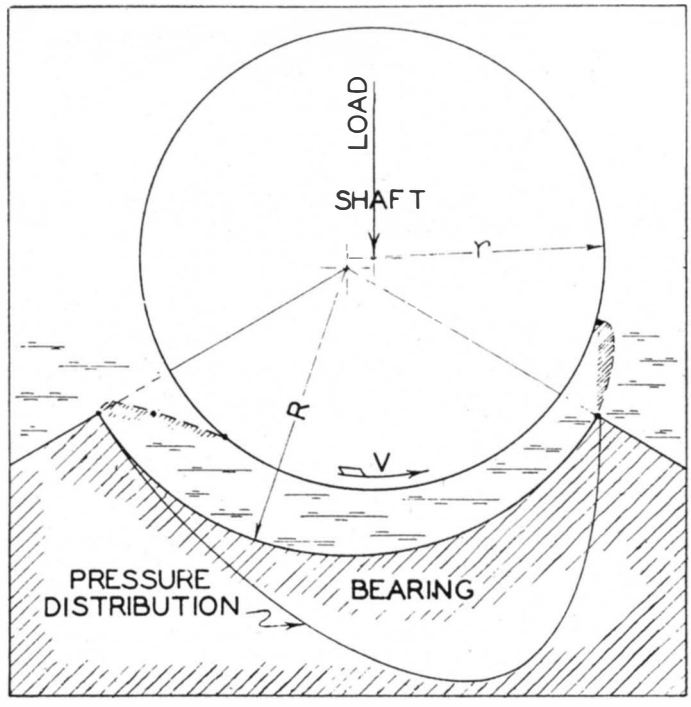



**Figure 4: The straight wedge of Figure 3 bent cylindrical**

**IN SUM**—The continuous and reliable operation of the machines which are so essential to our modern way of life depends very greatly on our ability to lubricate their rubbing surfaces so that they develop the least possible friction and thus insure a minimum of wear. Very low friction and virtual elimination of wear can be obtained by operation of these rubbing surfaces under the condition of fluid film lubrication. It has been seen that two physical conditions essential for producing fluid film lubrication are: (1) That there be an adequate supply of lubricant of proper wetting power and viscosity available at the bearing plate, and (2) that the rubbing surfaces be very nearly perfectly formed and so disposed that they form a proper wedge-shaped passage for the oil flow between them.

The theory of fluid film lubrication, founded by Tower and Reynolds and expanded by many other individuals, gives much practical information for the realization of the two necessary conditions listed above. In a given problem where, for example, the load, speed, overall size, and surrounding temperature are specified for a bearing, it is possible to select an oil of the correct viscosity characteristics and to specify the geometric features of the load-supporting oil film from theoretical considerations. The latter information determines how much larger than the shaft radius the bearing radius should be, the positioning of the bearing surface with respect to the load, and the minimum distance of separation of the two surfaces when the bearing is operating. Such analysis involves consideration of the heat generated by the fluid friction and its dissipation, and it allows computation of the frictional losses. For the suggested problem many solutions are possible. The desired solution will be one in which the variables under control are selected to give the least possible friction consistent with the desired bearing safety as measured by minimum film thickness. By guiding a machine designer in these matters the theory of lubrication renders an invaluable service.

Practical knowledge born of accumulated experience and countless experiments has added to the information at the disposal of the bearing designer and aided him in the solution of the ever more difficult problems arising with the advent of new, more efficient, and more compact machines. Lubricants have been developed for special applications; bearing materials have been found which give optimum service for severe conditions of operation; improvements have been made in surface finishing so that film thicknesses may be decreased and higher loads carried; practical knowledge of good methods of introducing and handling the bearing lubricant has been accumulated; and the information furnished by theory has been extended by experiment to fit situations too difficult for analysis alone.

For example, it is now possible to select lubricants that are satisfactory at extremely low temperatures, or that show exceptional stability with respect to oxidation. Oils may be had which aid remarkably in keeping an engine clean or which separate from water with exceptional readiness. In some cases it is important to have a lubricant which mixes well with water and forms an emulsion. Such lubricants are manufactured. The advances in lubricant technology could be listed almost without number, but before leaving this subject it may be well to stress that the most important contribution of the petroleum industry to the practice of lubrication has been the supply of graded lubricants over a wide viscosity range in practically unlimited quantities.

The development of bearing materials and construction have been of equal interest. Diverse examples ranging from the oil pads that support a giant telescope to tiny pivot bearings of instruments may be studied. The telescope bearings move at practically zero speed under heavy load; the tiny pivot bearing often with very light load, at high speed, and with little friction.

# Aviation Surveyed

**Aircraft Production, Materials, Tools, Transportation, Airports, Safety, and Design, as Viewed by an Observer at the Annual Meeting of the Institute of Aeronautical Sciences. Why and How the United States Has Achieved Military Supremacy in the Air**

THE ANNUAL meeting of the Institute of Aeronautical Sciences is always the most significant aviation event of the year; the most recent meeting was no exception to this rule. A large number of papers were read and discussed, covering the entire field of aeronautics from Aerodynamics to Production and from Power Plant to Metereology. The following paragraphs will describe as fully as possible the most outstanding of these papers.

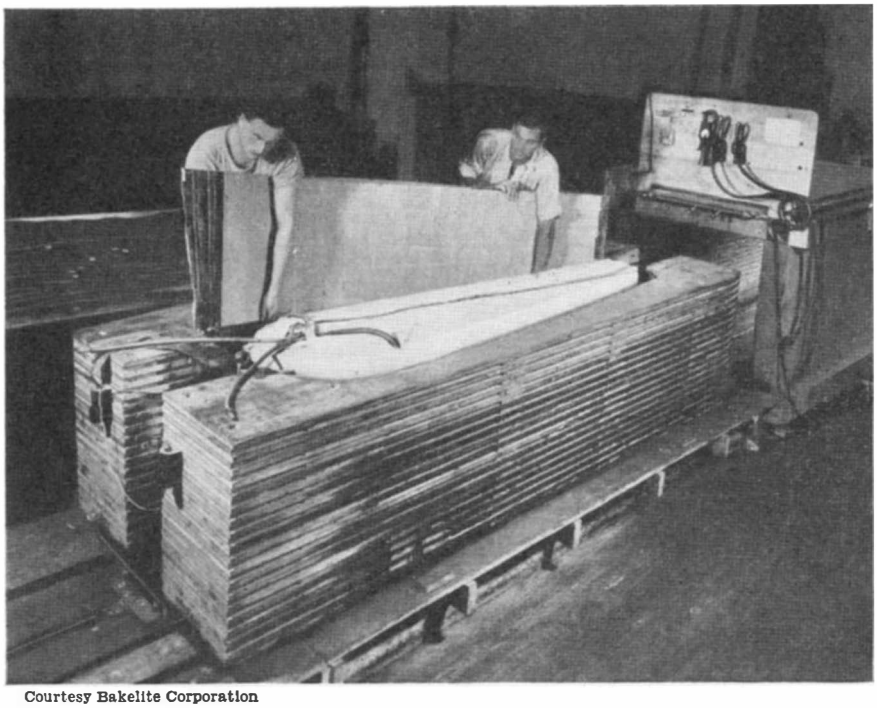
Perhaps the most important reason for our present supremacy in the air as compared with Germany is the fact that we have been able to pursue research and development in all branches of aviation, whereas the Germans, partly by design and partly by necessity, have more or less standardized their airplane designs. This was fully recognized by General Henry H. Arnold, Commanding General of the Army Air Forces, who, accepting an honorary fellowship offered to him by the Institute, said: "It is through the work of theorists and experimenters that we are better than our enemies, not merely man for man but plane for plane."

The first meeting of the conference was appropriately devoted to Aircraft Production—the most vital national task today. In the construction of aircraft, the aviation industry has drawn on the help of almost every other American industrial skill—tool making, machining, casting, wood working, metal pressing, heat treatment. But the construction of aircraft has called for so much that is new, and for such high tolerances and standards, that these methods and processes have been greatly advanced. Thus aviation will make a more than sufficient return to other American industries for their help.

**FLYING WOOD**—Robert H. Hess, of Curtiss-Wright Corporation, in "The Trend of Wood Use in Aircraft" presented facts that apply to all wood construction. The British have built in wood the famous and successful Mosquito Bomber, and the Russians have an all-wood single-seater fighter, the Lagg-3, which has a maximum speed of over 360 miles an hour. But the United States has built only gliders and training planes in wood and plywood, and there is strong opposition here to the use of wood in combat aircraft. This opposition is due not so much to the inherent limitations of wood as to our lack of knowledge in handling it.

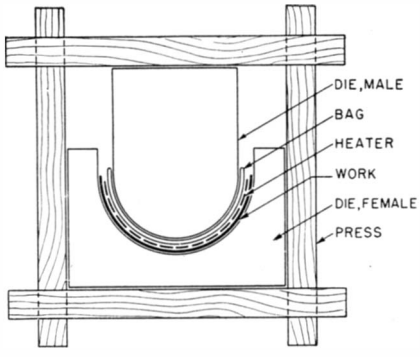
Perhaps the greatest deterrent to the use of wood for aircraft lies in the fact that most engineers have had little or no training in its use. Another difficulty lies in the lack of data on its strength and elastic properties. We have far more knowledge of steel, aluminum, or even magnesium than we have regarding wood—in spite of the fine work of the Forest Products Laboratory. The wood industry, if it wishes its products to be accepted in an engineering sense, has to become research and technical minded to a far greater degree than heretofore.

Then there is the problem of stress concentration in wood at points where bolts and fastenings are used. Wood is probably stronger in tension than steel, if its weight is taken into account, but its compressive and bearing strengths are sometimes inadequate. Still another difficulty with wood structures is caused by the fact that they absorb moisture readily, under which conditions dimensions and strength are likely to change. When the moisture content of plywood is not strictly controlled, wrinkles appear on large unsupported panels, fittings loosen, and weight increases inordinately. The moral here is that for wood manufac-

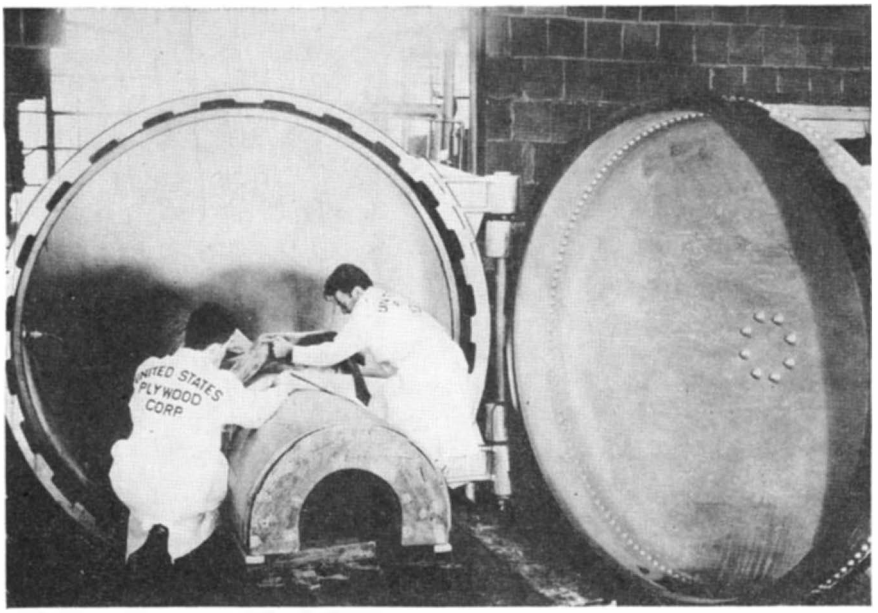


Courtesy Bakelite Corporation

**Twin wooden dies used in producing curved shapes in plywood**




**A simplified schematic diagram of plywood molding by the Thaden bag process, using male and female dies**




Courtesy United States Plywood Corporation

**Preparing a plywood unit for molding in a large autoclave**

ture there must be found methods of close air control or conditioning during construction, and protection against moisture by suitable surface finishes or coatings after fabrication. Here is something for the air conditioning people to think about, and perhaps another opportunity for this industry in the post-war period.

On the other hand, there are some very encouraging factors in the wood situation. First there is the tremendous improvement in glues. These new adhesives have eliminated the dangers that arose from glues of animal origin —fish, bone, or milk. The urea-formaldehyde, phenol formaldehyde, and other synthetic resins resist the action of bacterial growths, withstand moisture better, and give a far stronger bond. Also, by skilful handling, they allow steel to be bonded to wood and plywood—a development which has great significance in many industries besides aviation.

**BAG MOLDING**—With these splendid new adhesives have come methods of bonding at not too high temperatures, and the now famous bag molding process. With bag molding it is possible to form complicated compound curves cheaply and quickly. Still another modern advance is so-called densified wood. By compression and resin impregnation of wood, materials are available with high specific gravity, with strengths close to that of mild steels, and offering manifold possibilities.

In aircraft inspection, the Magnaflux method for testing ferromagnetic materials for cracks and other defects has now become standard. Speaking about this work, M. Mages of Magnaflux Corporation disclosed an improvement welcomed in aircraft production, but equally important to other industries concerned with the handling of ferromagnetic materials. Thus the Magnaflux method is widely used for the inspection of gun mounts, turbine blades, high-pressure piping, and a variety of welded structures, and for other ferromagnetic parts which receive severe handling during manufacture or in service. The testing of iron or steel by the Magnaflux method consists essentially of magnetizing the part under test by means of a coil, or by passing current directly through the part and applying an indicating medium such as a suspension of finely divided magnetic materials in a light oil. If there is a crack or discontinuity in the materials the magnetic leakage field formed across the crack attracts the magnetic particles suspended in the oil and a greatly magnified outline of the crack is formed.

Another process of great general value—"Plastic Tooling"—was discussed by Leonard Weiss of the Brewster Aeronautical Corporation. The outstanding features of plastic tooling are that tools may be cast in plastic to a master part, model, or mold, more quickly than by forming, milling, or hand fitting; duplicate tools may be fabricated at less cost than the original because the molds can be saved and reused. Businessmen and manufacturers will do well to pay attention to these possible advantages.

Some definitions given by Mr. Weiss will make the subject more clear.

*Cast Plastics* embrace those materials which can be cast around a contour. This type includes such materials as thermoplastics, thermo-setting resins, inorganic cast compounds, cements, and low melting point metal alloys.

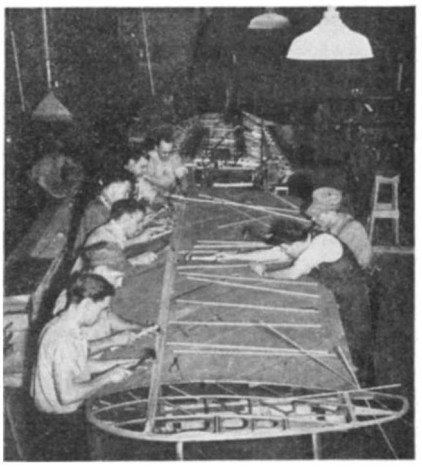
*Conventional Tooling* covers those tools which are made by the usual methods of laying out and hand work, employing various machines and materials which have to be shaped by cutting or hogging-out.

*Plastic Tools* include those types which are made by casting a material around a shape, with the aim of reducing finishing operations to a minimum. This includes castable materials, such as plastic resins, low melting point alloys, and so on.

Real interest attached to the paper on "Traffic Control for Future Airports," by M. G. Beard of American Airlines, since one of the difficulties in air transport, recognized both by the specialist and by the layman, is that of traffic control. Airline traffic, even before Pearl Harbor, was fast reaching the saturation point—at La Guardia Airport, for example. Thus, on December 1, 1941, there were 248 scheduled departures and arrivals at this airport. During the peak of the day—5:30 to 6:30 P.M.—there were 40 plane movements during the hour. Shortly after 5:00 P.M. it was not unusual to see 12 to 15 planes waiting in line for their turn to take off. Whenever ceilings went below 1000 feet, with visibility below three miles, it became necessary to institute low-approach procedures, and, the resulting traffic delays and tie-ups would frequently detain arrivals from three to four hours.

One can imagine what the situation may become after the war. Surveys of post-war traffic indicate a possible expansion many times greater than anything experienced heretofore, yet airport traffic facilities and control methods have almost reached the saturation point now. Present radio-range systems of navigation are probably adequate and present methods for instrument landings, with some improvements, may be made satisfactory. But to realize the full potentialities of these two systems will require "immediate methods of coördinating radio-range flying with approach landing systems." This is what Mr. Beard advocates: "The application of radio and radar aids now in existence in war-time application appears possible of adaptation for the solution of the traffic control problem both along traffic arteries and around central airports." Radar, stimulated by war, may yet play a great peace-time role.

**AIRPORT SIZE**—However well our airways and airports may be controlled, the fact remains that we shall have to build bigger and better airports. A. L. Morse, of the Civil Aeronautics Administration, has studied this problem and presented his findings in "The Correlation of Aircraft Take-Off and Landing Characteristics with Airport Size." With larger, heavier, and faster airplanes has come the need for paved runways of greater and greater lengths. There has also come the need for restricting the height of structures in the



**The plywood skin of an airplane wing panel being applied in one of the Fairchild aircraft plants**

areas surrounding the airport. Both of these necessities have combined to place heavy burdens on the Federal Government and on the municipalities and have made it very difficult to find sites.

In the discussion of airplane design at the Institute meeting, relatively minor topics were taken up but each had its significance in the scheme of things. Thus Albert A. Arnhym advocated strongly the soundproofing of military aircraft. It was originally thought that soundproofing and comfortization of the airplane was of interest only in civil aircraft. The war has completely disproved this notion. Military and naval pilots do not always go up for only short spells of violent fighting activity where the thrill of battle eliminates all thought of comfort; they go also on bombing missions of many hours' duration. Noises may then become an intolerable burden. The modern view is that military airplanes should be soundproofed with just as much care as the passenger transport. Noise should be diminished first at the source by muffling, gearing down the propeller, and so on, and then should come soundproofing proper, with the installation of suitable material to impede transmission and increase absorption of noises once they have penetrated into the cabin.

**SAFETY ALOFT**—To avoid aircraft accidents, non-stall, non-spin airplanes must be designed, because spinning is responsible for 40 percent of fatal accidents. There are many other items of plane, engine, accessories, landing field, and the like, which must be taken into safety considerations. Yet Dr. Hugh De Haven of Cornell intimates that accidents will happen, no matter what is done, and that when the accident does happen specialized design of the airplane can give a fair measure of protection, often replacing fatal injuries with minor mishaps. The fuselage should be rugged, resilient, and not of the eggshell monocoque type which may collapse completely in a crash. Seating should not be too far forward and should be such that the occupants are not involved in the first violence of a head-on crash. Human heads should not be in the vicinity of projecting instruments on the dashboard. Biomechanics, the study of the mechanics of the body, is being applied to the airplane and, if the findings of the physiologists are given attention, a good many details of airplane design can be readily changed with a great increase in airplane safety.

Many other ideas presented before the Institute can be mentioned only in flashes:

Pilots can be trained for night flying in the daytime by a new technique which consists of covering the windshields and windows of the plane with green acetate and having the pilot-trainee wear red goggles. Under these conditions the pilot's vision beyond the cockpit is cut down by the combination of both filters so that it approximates night vision. The instructor does not wear red goggles and so he can see beyond the cockpit and enjoy daylight. The new technique adds safety and lengthens the hours possible for night training.

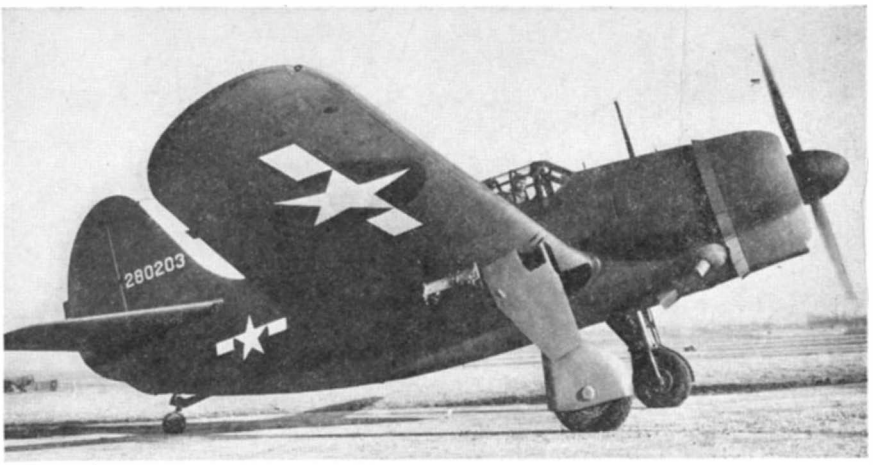
The supercharger is now controlled by an entirely automatic electronic device which is invaluable in high altitude work.

A governor combined with the variable V-belt principle is likely to give us a constant-speed propeller suitable for the light plane—low in cost and light in weight.

It can now be demanded that airplane propellers be both feathering and reversing. The reversing propeller is particularly useful for securing short landings and for maneuverability of a seaplane on the water.

Panel heating by radiant energy which does not heat the air surrounding the occupant of an aircraft cabin, but radiates heat to his body, will make him much more comfortable and will also require far less expenditure of heating energy.

**CONCLUSION**—When the meeting of the Institute of Aeronautical Sciences is reviewed, as it just has been, it is realized that the most important developments of the day were not even mentioned—the gas turbine, the jet-reaction motor, the airplane of close to 450 miles an hour, the wing that is immune from the compressibility burble, and so on. The only conclusion that can be drawn from this is that our engineers and research workers are doing much more than they are now able to tell and that the end of the war will bring astounding disclosures.




**Main bomb supply of the Helldiver is carried within the fuselage**

### ATTACK-BOMBER

#### Incorporates Lessons Recently Learned in Combat

THE Curtiss Helldiver (A-25), now being delivered to the Marines for use in the Pacific, incorporates all the lessons learned in recent combat. It is a two place, all-metal, low-mid-wing monoplane, which carries its main bomb-load wholly within its fuselage, with provisions for carrying additional bombs under the wing. It mounts four fixed machine guns and an additional gun in the rear cockpit turret. The Helldiver weighs more than 7½ tons, is powered by a 14-cylinder Wright Cyclone, and uses a Curtiss three-bladed electrically operated constant-speed propeller. In the photograph may be seen the opening into which the landing gear retracts in flight. The engine exhaust outlet is of the type which gives some forward thrust by virtue of jet reaction.

### POST-WAR FLYING

#### Will be Safer, Cheaper, For Private Flyers

IN A paper presented before the Society of Automotive Engineers, William D. Hall, Chief Engineer, Aeronca Aircraft, discussed post-war private flying and planes—subjects in which both the public and the industry are vitally interested.

According to Mr. Hall, we may expect (1) a low-powered trainer, side-by-side or tandem, to cost $1000; (2) A two-place, medium-performance aircraft for the private owner priced at $1500; (3) A four-place ship at $3000, also of medium performance; (4) A high-performance, two-seater at $3000, which will be a "cleaned up" version of the pre-war two-place, side-by-side, low-wing, retractable gear design.

Standards of design will be much higher than pre-war. We may expect many safety features and, in particular, elimination of the stall spin, which says Mr. Hall, will be accomplished by the following means: "The wing proper will be designed so that it stalls gradually with the stall originating over the center portion of the wing, and the ailerons used will not stall the remainder of the wing when they are deflected to obtain lateral control. Further, longitudinal control will be limited so that it will be impossible to place the airplane in a complete stall position without a dive and a violent pull-up."

Mr. Hall also thinks that the average user will be satisfied with a two-control airplane (aileron and elevator only), even if the maneuverability is somewhat reduced thereby. Accessories such as flaps, slots, and spoilers will be used where occasion demands and will be automatic in operation wherever possible.

# By-Passing the Sheep

**An Artificial Fiber, With Many of the Best Characteristics of Wool, Is Now Being Made Commercially from Soybean Protein. How it Will Compete With Other Fibers in Price and Uses is Still for the Future to Decide. Tests Made Thus Far Indicate Interesting Possibilities**

By H. R. DRACKETT
President, The Drackett Company

FOR HUNDREDS of years sheep have been contentedly munching nature's provender, running it through their digestive systems, and converting its proteins into wool fiber in some manner as yet unknown both to sheep and to man. But now man has been able to go the sheep one better. He has learned to feed protein into a machine, let the machine do the digesting, and subsequently extrude the protein into long filaments which, after chemical treatment, become man-made non-animal protein fibers. Not only has man thus been able to do with proteins one of the things the sheep does with them, but in the conversion he does a much more efficient job.

This newest man-made fiber is processed from the protein of soybeans and its manufacture is believed to be one of the first successful attempts in the direction of freeing man from the expensive and inefficient process of converting the protein in feed into fiber via the digestive mechanism of the animal.

Man's job is virtually 100 percent efficient in this conversion, while the sheep by comparison is frequently not more than 1 percent efficient when it converts its food intake into dry protein product. Consequently, the development of this first non-animal protein fiber becomes of more than casual importance. It is in many respects a fundamental scientific development of far wider significance than would be the mere development of a new textile fiber with a potential field of usefulness of large dimensions.

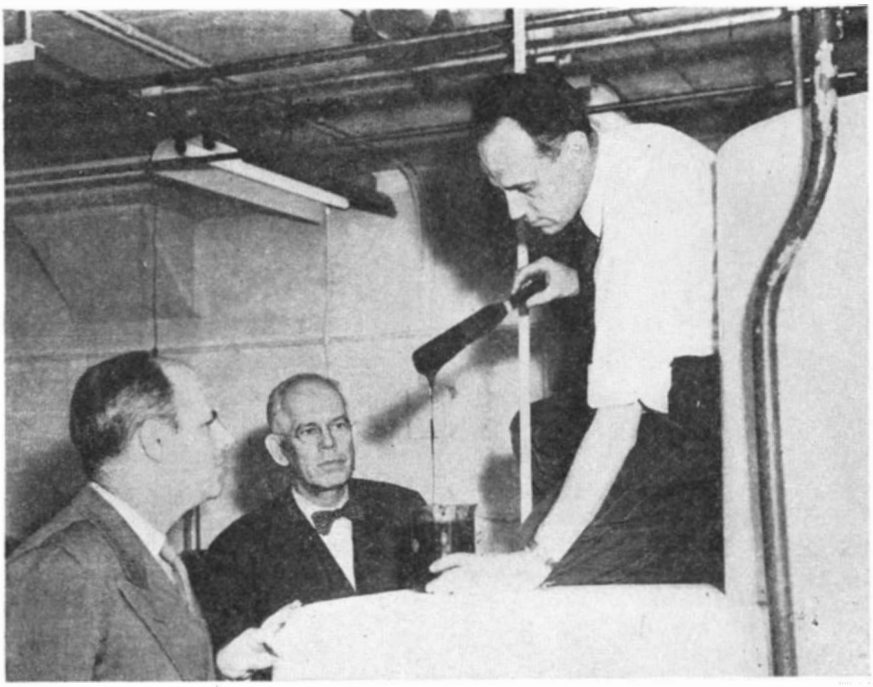
The new soybean fiber should not be viewed as a substitute for wool, cotton, rayon, or any other fiber. It is actually an entirely new raw material. It has virtues peculiarly its own. It will ultimately find its own niche in a competitive field and will be accepted on its own merits and on a true economic level with other fibers in a free market.

In appearance the soybean fiber which is currently being manufactured on a limited commercial scale is a loose, fluffy mass with an appearance similiar to that of scoured wool. Its color varies from a light tan to white. It has a medium luster somewhere between those of wool and mohair. It has a rather warm, soft feel, a natural crimp, and a high degree of resiliency. It is not so strong as wool but in the laboratory batches of it have been experimentally produced which are even stronger than wool. It is possible that fiber which has such increased strength will ultimately be made in commercial production.

Soybean fiber keeps its strength well either wet or dry. It can be blended with other fibers or it can be woven or spun by itself. It has already been made experimentally into blankets, hosiery, rugs, carpets, upholstery, underwear, hats, and suitings—among other things.

**NOT A SYNTHETIC**—This fiber is by no means a synthetic yarn, any more than it is a substitute. No other material has been synthesized in its manufacture. The fiber had its genesis in a laboratory, as did many other man-made yarns. It owes its origin to the fact that those persons who furthered its development adopted an entirely new concept of the 4000-year-old soybean, looking upon such things as soybean oil and meal not as end products but as the starting points for new chemical developments.

Most Americans think of the soybean as a staple agricultural product of the Orient which has for centuries helped the Orientals keep body and soul together. They fail to realize the place this amazing and versatile bean has gained for itself both in American agriculture and in American industry. In 1943 the United States grew more than two hundred million bushels of soybeans, making this the third largest cash grain crop in the country. Yet, back in 1930 the total production of soybeans in this country was almost negligible.



**Inspecting a batch of liquefied soybean protein which will shortly be forced through tiny holes in a spinnerette at the plant of the Drackett Company in Cincinnati. It will emerge as soybean fiber. Shown in the center is the author of the accompanying article; at left is Robert Boyer, company director of research**

The soybean has many virtues. It is very easy to grow, it does not cost much to produce, the beans lend themselves well to mass-production harvesting machinery, and they can be easily and conveniently stored. But in many ways more important than any of these features is the fact that soybean protein is the cheapest and most abundant source of vegetable protein in the world. The 1941 crop, for example, would have yielded about a quarter of a billion pounds of protein if it had all been processed for that purpose. Potentially this is the starting point, the raw material, for many industrial developments.

It was recognition of this huge available source of protein that led indirectly and somewhat circuitously to the production on a commercial scale of soybean fiber. For decades man has sought to duplicate in various ways nature's manufacture of fibers. Silk was once a costly luxury. As far back as the early 18th Century a French scientist developed a process whereby a solution made from gums and resins was forced through a small orifice and coagulated to form a silk-like thread.

**OTHER YARNS**—In 1884 the French Count Hilaire du Chardonnet patented a process in which a solution of mulberry leaves was drawn through fine glass tubes to emerge as hairlike threads that hardened on contact with air. Du Chardonnet had spent 20 years in studying the silkworm. During the early years of this century man continued the efforts to develop processes for manufacturing artificial yarns.

In recent years there has been successful commercial production of cellulose fibers which, although strong and durable, lack something in warmth, resilience, and ability to hold their shape.

With an abundant indigenous potential supply of protein in the United States it was but natural to seek a method whereby protein could be converted into a fiber, by-passing the animal and securing a product which would possess characteristics and properties as desirable as those of natural animal protein fibers. At the same time it appeared possible to do a more efficient manufacturing job than could the animal. It was known, for example, that in spite of thousands of years of breeding and developing a good strain of wool-producing animals, it still required two acres of land to support one sheep for one year and that the output of wool from this animal would not exceed 10 pounds. Whatever the virtues of the sheep as a wool producer it admittedly lacks manufacturing efficiency.

From this knowledge it was reasoned that it should be possible to process protein, available in such abundance in the soybean and elsewhere, and make a fiber out of it. The sheep does it. Man ought to be able to do it.

In the telling, the process by which the humble soybean ultimately becomes a fiber is not particularly complex. Actually, however, years of study and experiment preceded the final development of the process. Like many other industrial processes which are basically simple, it didn't get that way without trial and error, study, research, and experiment. The twins, time and effort, played a vital role.

To begin with, the oil is extracted from the soybean through the use of a solvent. The residue is a soybean meal. The protein is removed from this meal by treating it with a weak alkaline solution, such as 0.1 percent sodium sulfite. The resulting solution is then clarified either by filtering or centrifuging. The protein in the curd is then precipitated by an acid and the resulting curd is washed and dried.

The clarifying of this solution is considered a chemical engineering accomplishment of unusual merit. The precipitation must be carried out at just the right temperature and pH in order to get a curd that can be handled properly during the subsequent washing and drying.

Once the protein is removed from the meal, it is dissolved to produce a viscous solution of about the same consistency as molasses. This solution must then be controlled very carefully. It must have a high solids content, which is difficult to get because proteins in high concentrations tend to form a gel. Yet, with careful control, it is possible to produce solutions with as much as 20 percent protein.

The solution itself must then be aged at the correct temperature for an exact period of time before the required viscosity and stringiness are reached. Moreover, it must be kept free of undissolved particles or air bubbles which would affect the spinning continuity.

The next process in the manufacture of soybean fiber is a rather conventional step in the general methods of making artificial fibers. Here, fortunately, it was possible to take advantage of the experience of other industries to save what might possibly have been years of study and research. The aged solution is forced through spinnerettes into an acid precipitating bath and the resulting filaments are collected from this bath on bobbins or reels. However, these filaments must be stretched as they are collected. This is done by pulling them through the acid bath and over two glass pulleys, one of which revolves faster than the other to exert the desired stretching effect.

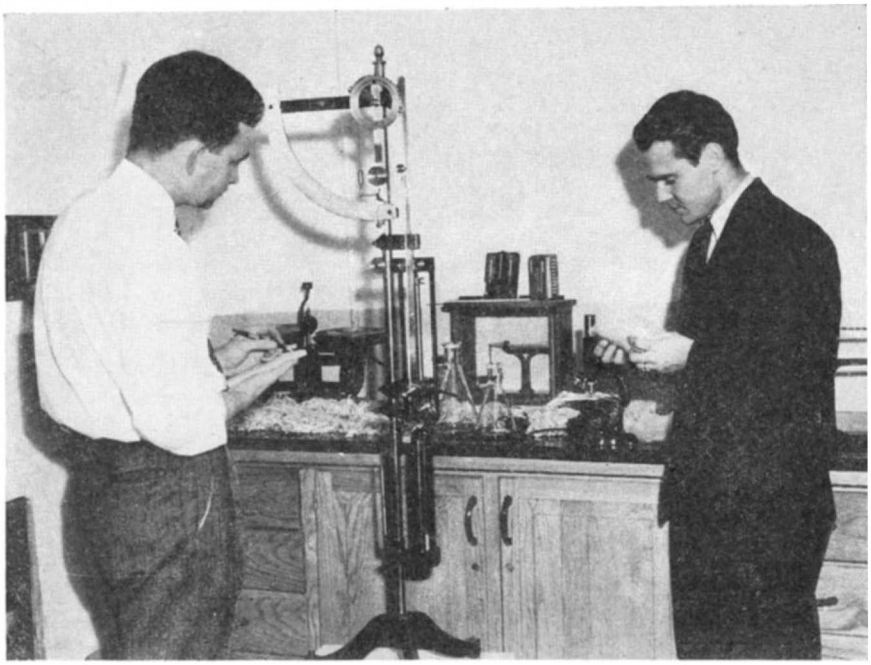
The fiber is then set by long immersion in a formaldehyde bath and is dried under controlled humidity and temperature, after which it is cut into desired lengths and is ready for shipment.

**CRITICAL CONTROLS**—This is the process itself, in brief outline. Not overly complex, it is none the less one which calls for exactitude, careful control, and constant checking all along the line. Let just one small phase of the operations get out of kilter and the entire process may well bog down.

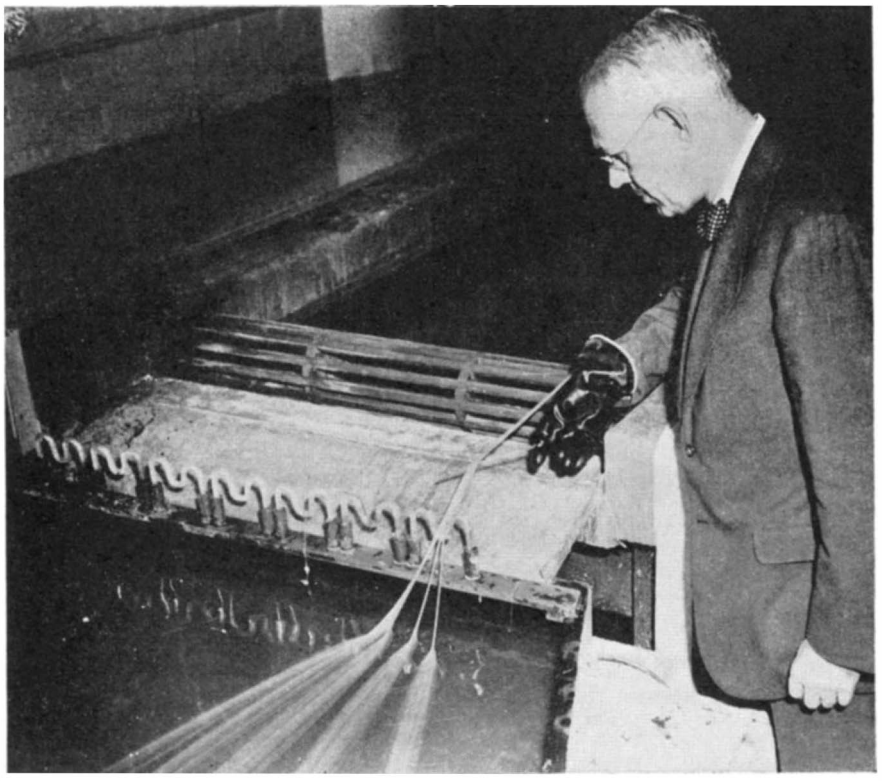
But the greatest single headache, if such it can be called, was not developing the process of making fiber out of soybean protein, so much as it was designing equipment and machinery to do this job on a production basis. It is one thing to make a product in the laboratory; quite another to make this same product on a large scale and on a basis of economy and efficiency which will permit it to be marketed competitively.

However, designs for such machinery and equipment have been perfected to a point where a continuous manufacturing process is in commercial operation, with the protein solution being mixed in one part of the plant and the subsequent operations following in sequence until the fiber itself is cut and packed for shipment.

The current output of the fiber is small; it must remain so for a time yet, as allocation of raw materials, machinery, and equipment is such as to prevent securing additional manufacturing machinery and equipment. In the meantime, improvements are being made in equipment, machinery, processes, and product. Simultaneously,



**A corner of the laboratory where soybean fibers are constantly tested as produced and where technologists conduct research in product and process improvement**



**Soybean fibers emerging from the spinnerettes are grouped first into three bands and then into one. Next processing step is a series of chemical treatments**

small amounts of fiber are being supplied to various textile manufacturers to permit them to experiment with it and see just what can be accomplished in manufacturing it into finished textiles of many kinds.

**MANY THINGS UNKNOWN**—This fiber, it must be realized, is still a very new product. Admittedly, there are many things about it which are as yet unknown. Not yet can it be made, on a commercial basis, as strong as the sheep makes his fiber. Ultimately, there is every reason to believe that a soybean fiber can be made that is even stronger than wool. As more is learned about protein chemistry, still a most complex subject, many ways of improving the fiber will undoubtedly be found.

Just what place soybean fiber will have in the textile world is still a question which time alone can answer. It is obvious, however, that a non-animal protein fiber will be useful in making various textiles. The textile industry has proved itself capable of making good use of new man-made fibers in recent years. But to predict at this time just what the range of uses of soybean fiber is, how widely it will be used, or what it will cost, is to go into the realm of conjecture.

Indications are that the new fiber will find its price level at a point where it will compete satisfactorily with synthetic and natural fibers. Its cost is not expected to be an obstacle to its widespread use and acceptance.

Virtually all radically new industrial products, at some stage or other of their development, come up against the problems of applications and costs. Who, for example, would have been so rash a few years ago as to predict all the present uses of nylon? Or who today would venture a comprehensive prediction on the future uses of the new synthetic rubbers? Nor could today's rayon or nylon costs have been predicted when those products were almost brand new.

Right now it is possible to consider only the finished soybean-fiber product itself, recount accurately its present known virtues and drawbacks, and say that while its future seems to be assured there is no basis as yet on which to predict just how it will affect the textile world.

In any event, industrial America moves rapidly. It has a receptive mind. It looks with favor upon new products. It is eager to pioneer, to experiment, to develop. Doubtless the textile industry will take this new fiber, as it is doing today, and develop its uses. In such manner are new chapters written in the history of human progress.

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## REFRIGERATORS

### Will Improve, but Not Fantastically

THE FIRST refrigerators to reach the consumer when production is resumed will not be radical or revolutionary in design, it is predicted by W. Paul Jones, vice-president in charge of refrigeration for Philco Corporation.

"This prediction is based on the premise that manufacturers, distributors, and dealers will be anxious to get back into civilian business quickly," Mr. Jones says. "Immediate production and transportation of materials will offer plenty of problems in the early months after the war, even without the complications of radical design changes and tooling-up for new models. At the same time costly experience in other industries has proved that the buying public reacts slowly and cautiously to radical design changes and a period of transition between the pre-war and real post-war models should be desirable from many angles."

Indulging in the famous indoor sport of post-war speculation on the shape of products to come, many designers and pseudo-designers picture the post-war refrigerator as a fantastic piece of equipment, Mr. Jones points out. Some of these refrigerators have revolving shelves, or transparent cabinets, or a chute on the side for ice cubes. Some picture doors that open automatically with an electric eye, doors that raise, doors that drop, and many other dream features.

"Obviously a middle track is necessary to produce a practical piece of household equipment," Mr. Jones believes. "One thing is sure—there must be ample space for frozen food in the post-war refrigerator. The trend toward frozen foods is definitely here. Of course the post-war refrigerator should have a humid area for the preservation of moist foods, cooked foods, and left-overs. The ideal post-war refrigerator would be one that limits regimentation to an absolute minimum; in other words, a refrigerator that doesn't force the housewife to put certain foods in certain places and into certain kinds of containers."

## PENETRATING PRIMER

### Assures Better Surface Finishes for Wood

A BETTER finish for home, school, and office furniture, much tougher than present practical varnishes or lacquers, is promised after the war through the use of a formulation which has been developed at the Du Pont laboratories for producing a base or prime coat. Its value lies in the extraordinary adhesion it provides for the top coat. The new so-called "penetrating primer," by affording improved "anchorage," permits the use of finishing lacquers which have extremely high scratch resistance. Such super-tough pyroxylin lacquers have long been available, but were impractical because a sufficiently strong adhesive bond with a wood surface could not be obtained.

"The big research problem in utilizing tougher furniture lacquers to resist wear, tear, and scratching," explains R. C. Peter, Du Pont Industrial Finishes Division development manager, "is a struggle between cohesion and adhesion. Visualize, for example, a table top to which has been glued sheets of paper and of metal. While it is impossible to strip off the paper, the metal can be removed with little difficulty, despite the fact that the strength of the glue is identical in both instances. The variable here is the difference in the cohesion of the two materials—that is, their ability to hold together.

"When the cohesion of a lacquer film

over a surface so exceeds the adhesion, it can be easily chipped from the underlying surface, as in the case of the metal sheets," said Mr. Peter. "The new first-coat material has a special elastomer, or rubber-like ingredient, that securely binds the top coat to the wood."

### PORTABLE PIPELINES

#### Can be Laid Anywhere, Quickly Repaired

IF THERE is any one pair of commodities that an army cannot do without for long, it is gasoline and oil. Moreover, it is equally important that these be available when and where they are needed in sufficient amounts. All of which means that sooner or later there had to be developed a faster, better method of transporting oil products under varying conditions. That method is today known as the front-line pipeline, invented by a Shell Oil Company technician.

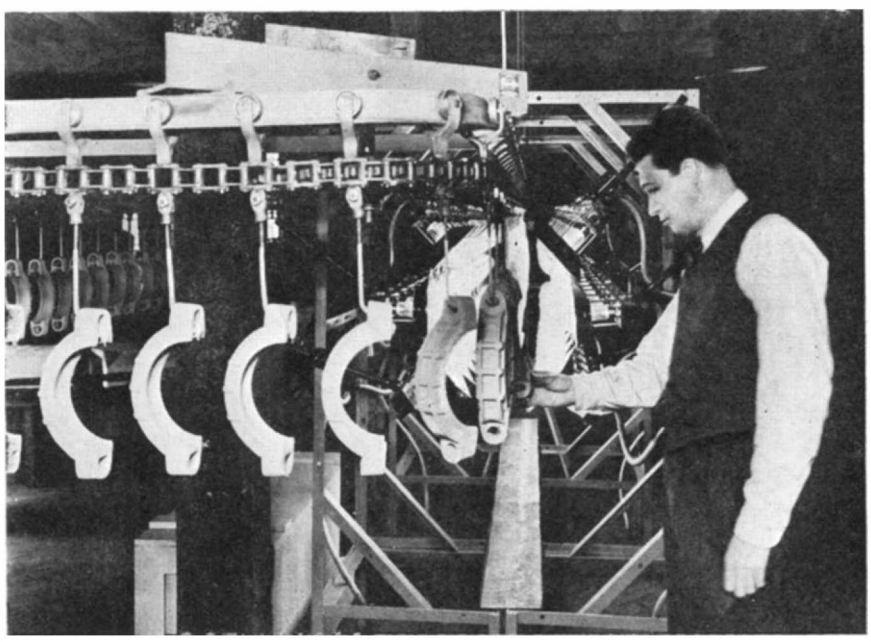
Briefly, a portable pipeline is made up of 20-foot sections of four-inch flexible steel pipe with pumping stations at 10-mile intervals. All the equipment is transported on trucks or trailers. In the field, the pipeline requires no trenches since it follows the contour of the terrain. In tests, it has been wrapped around trees, bent over hills, and curved across streams without decrease in efficiency.

Perhaps the outstanding advantages of the front-line pipeline is the speed with which it can be restored to normal service after damage by the enemy. Pumping stations are operated by gasoline-fueled engines. If put out of action, a station can be repaired in a few hours. Meanwhile, the system's capacity is reduced only 30 percent. In fact, two adjacent pumps can be damaged and the system will continue to operate.

The pipe itself is a poor target for enemy bombs. However, once a break does occur, repair crews quickly locate it, shut down valves and swing in a replacement piece of pipe, all within one to four hours! This speed is due in large measure to a simplified yet effective coupling designed for use on grooved-end pipe. It is composed of only two malleable iron castings, two bolts and nuts, and a synthetic gasket, and assures a tight seal even during movement of the pipe ends. One type, produced by the Gustin-Bacon Manufacturing Company, allows a deflection of three degrees. No special tools are required to fit the coupling—an ordinary open-end or socket wrench suffices.

Continuous exposure to the elements and contact with soil subject the couplings to many corrosive influences that might impair its operating efficiency. Consequently, it is essential that the couplings be finished so as to prevent rust and scale formation. In the finishing room of the Lake City Malleable Company, one of the larger producers of the coupling, it is the practice to finish each coupling with a coat of Sherwin-Williams infra-red reflectant, olive-drab paint. Because of the high output of the foundry, the finishing room would find it extremely difficult to maintain a fast pace were it not for an extremely efficient finishing production line.

After each casting has been dressed down, it is suspended on a hook from a monorail conveyor. It then travels to a tank containing the olive-drab paint where it dips down for a quick immersion. As the couplings come out of the paint tank and move along the conveyor, a guide tilts them to allow surplus paint to drip off. When the couplings pass this guide, they straighten out and enter the first of two infra-red ovens where the finish is dried.

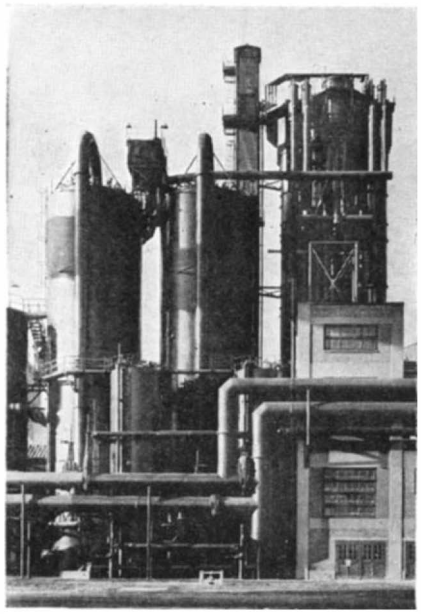


Couplings for portable pipelines emerging from an infra-red drying oven

### SULFUR RECOVERY

#### Also Eliminates Hydrogen Sulfide Troubles

PURIFICATION of coke-oven gas to protect vital manufacturing equipment has been started by the Ford Motor Company, and in the same operation another product—sulfur—is added to a long list of those already extracted in coal coke-gas processing.



Ford's gas-purification equipment

The Ford sulfur plant is now in operation, extracting approximately six tons of 99-percent pure sulfur daily. More than a year was required for construction of the plant.

The new equipment, built by the Koppers Company, extracts sulfur by the ammonia thylox method. Despite the fact that it is one of the largest of its kind in the world, two skilled men can operate the plant at peak production.

Due to its destructive corrosive qualities, hydrogen sulfide in coke-oven gas has long been a source of trouble to industry. By removing the objectionable sulfur and thus prolonging the life of millions of dollars worth of equipment, the new plant, despite its cost, will, it is estimated, be self-liquidated in three years. The sulfur itself, although valuable as a base for fungicides or for bleaching wood pulp, constitutes only a fraction of the real saving.

Actual operation of the new plant is simple. Ammonia and coal tar have already been removed from the gas by the time it reaches the sulfur plant. There it is piped into cylindrical tanks where it is cooled. Then it goes through a series of treatments with thylox and ammonia, in the last stage of which the sulfur is converted into a solid which is melted and poured into iron molds, allowed to solidify, and then stacked into piles for shipment.

### WOUND INFECTION

#### Prevented by Use of Layer of Cellophane

A WRAPPING of moisture-proof cellophane, acting as a barrier against germs which might infect the wound from the outside, is a feature of an improved pressure-dressing treatment for burns and other wounds.

The technique, which is being employed by Dr. Neal Owens, professor of plastic surgery at Tulane University Medical School, is described in a recent

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For the first time, many of them are able to hold vital wartime jobs and do their rightful share in Uncle Sam's wartime emergency. Many are hearing, *for the first time in years,* the voices of their children, their families, their friends. Handicapped youngsters, too, can now be saved from lives of failure and misunderstanding due to hearing deficiencies. 78% of all who are buying this revolutionary new instrument have never owned an adequate hearing aid before!

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**1 The fine precision quality that modern knowledge and engineering make possible in a hearing aid, yet priced at only $40,** complete, ready to wear. *One model*—no "decoys"... *One price*—$40 . . . *One quality*—our best. You need not pay more or accept less.

**2 Four-Position Tone Control.** The flick of your finger instantly adjusts it to the most effective combination of low, medium and high tones for individual needs in varying surroundings, hearing deficiencies in various ranges. No further adjustments necessary.

**3 Special Battery-Saver Circuit.** Insures economy in battery consumption . . . results in substantial saving of battery life and battery replacement expense.

**4 Zenith Quality—Zenith Guarantee.** Zenith, world's leading manufacturer of radionic products exclusively, is fortunate in having the knowledge of precision production that makes possible this quality hearing aid at a remarkably low price. Guaranteed for a full year, with unique service insurance plan.

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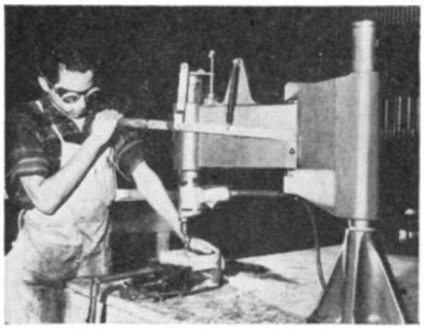
issue of *Surgical Clinics of North America.*

Dr. Owens has been perfecting the pressure method for the past ten years and has used it on several hundred cases. Before adopting the cellophane feature he had noted that even surgical wounds, such as those made during removal of healthy skin for grafting, occasionally became infected through the entire thickness of the dressing. He therefore conducted laboratory experiments which proved that germs could be drawn, by capillary attraction, through as many as 64 thicknesses of gauze. However, when a layer of a special type of moisture-proof cellophane was interposed the germs could not get through.

## PLASTICS IN TOOLS

### Light Weight and High Strength are Features

AN EXAMPLE of the use of casting resins in industrial equipment is found in the successful use of "Toolite" for structural parts of radial drills at Consolidated Vultee Aircraft Corporation.



Drill parts are made of plastic

Toolite, produced by Adhere, Inc., is now being used for a wide variety of production tools.

Light in weight, tough, inexpensive, and having six to seven times the compressive strength of similar materials, the ultimate possibilities of this thermosetting cast resin are only beginning to be foreseen, according to aircraft manufacturers. Toolite is lighter than magnesium, yet does not break nor damage easily and has compressive strength up to 20,000 pounds per square inch. It is inert to ordinary cutting compounds, passes oil and water absorption tests, and withstands a temperature of 400 degrees, Fahrenheit.

## AIR-COOLED ENGINES

### Increased in Power by Aluminum Bonding Process

A PRACTICAL method of accomplishing the hitherto impossible task of welding—or, more accurately, of chemically bonding—pure aluminum to steel has been used in the production of Ranger 12-cylinder engines for more than a year. Known as the A1-Fin process, announcement of its development has been withheld until the present for reasons of national security.

Through its application in the construction of cylinder barrels for Ranger 12s, power output of these inverted in-line air-cooled engines has been increased to the point where today they produce more horsepower per pound of weight than any comparable aircraft engine.

Up to now, two methods chiefly have been employed to assist in dissipating heat from air-cooled engine cylinders. One was to machine suitable cooling fins right out of the steel cylinder stock; the other, to shrink-fit around the steel barrel an aluminum alloy sleeve with integral cooling fins. This necessarily had to be an aluminum alloy, which has lower heat conductivity than pure aluminum, because the pure metal is too soft for a shrink fit. This method presents problems of inefficient heat transfer at the line of shrink between the steel and the aluminum.

It was to overcome this problem that the A1-Fin process was developed. When an aluminum muff is shrunk on a steel barrel, the contact between the two is mechanical and, hence, is imperfect. For one thing, steel has a rate of expansion different from aluminum alloy. Moreover, no matter how well machined are the mating surfaces, appreciable variations in the degree of mechanical contact of the two cylindrical surfaces result in minute patterns of greater and lesser heat transference. In fact, theoretically, the mechanical efficiency of the joint can never exceed 50 percent.

The bond formed between the steel and the pure aluminum by the A1-Fin process is 100 percent, since it is a chemical composition at that point. The composition of the bond forms a perfect bridge for the transmission of heat from the steel barrel to the pure aluminum cooling fins.

The bond also renders ineffective the difference in expansion characteristics of the two metals. Broadly speaking, the process makes the ductile aluminum expand and contract along with the more rigid steel and supplements the steel with the heat dissipating qualities inherent in the lighter metal. The result is a barrel with the lightness and heat transferring ability of pure aluminum plus the strength of steel.

Essentially, the A1-Fin process is a means of permanently bonding aluminum and steel into an integral whole. It may offer advantages in innumerable applications where highly efficient heat transmission with savings in weight is desirable. The automotive and air-conditioning industries are finding much of interest in the process. It may also prove useful in structural applications where thermal problems are not involved.

## INSULATION TESTS

### Conducted in Clouds and Snow-Storms Formed in a Bottle

POCKET-SIZED clouds and snowstorms that would fit into your hat are helping speed the development of more powerful electrical systems for American warplanes. Confined in a glass flask not much bigger than a milk bottle, the clouds and the snowflakes that flutter down from them are "manufactured" by Dr. Leo J. Berberich, of the Westinghouse Research Laboratories, to test the effectiveness of insulation for aircraft power systems.

With this "bottled weather," Dr. Berberich determined how climatic conditions and air pressures at altitudes up to 12 miles—65,000 feet—affect air gaps between uninsulated parts of a plane's electrical system, such as terminals, carbon-brush holders for aircraft generators, and the contacts of switches.

"A thick cloud can be created in a few seconds by pouring liquid air into warm water," he explains. "When the intensely cold—310 degrees below zero, Fahrenheit—liquid air comes into contact with the water, the liquid air evaporates so rapidly that it 'kidnaps' minute droplets of the water and carries them off into the air, forming a dense cloud.

"Then the cloud is ushered into the glass test chamber through a tube. When the test chamber is cooled below the freezing point, snow crystals form in the tiny cloud and drop onto the insulation-testing apparatus in the bottom of the flask."

To test different types of insulation in the weather bottle, Dr. Berberich fastened two half-inch squares of brass sheet to a larger slice of the insulating material. Between the brass squares he left a fraction-of-an-inch space and to each brass square he attached a wire carrying an electric current.

Then the test piece was placed in the flask and the flask closed with the wires coming out through air-tight seals.

"Pumping air out of the sealed flask simulated the low air pressures found at high altitudes," he says, "and the sub-zero temperatures of the stratosphere were duplicated by surrounding the flask with a mixture of dry ice and alcohol.

"At various 'altitudes' and temperatures, with dry air in the flask and then with clouds or snow, each specimen was tested. Voltmeters connected to the wiring circuit within the flask measured the 'pressure' at which the electricity sparked over the insulation from one piece of brass to the other."

Air gaps between uninsulated parts were tested by placing two small brass rods in the flask so that their tips were a small distance apart.

To an ever-increasing degree, Dr.

Bottled clouds for insulation tests


# What good is a $10.00 raise ...if it then costs you $12.00 more to live?

SURE WE ALL want a raise . . . but raises today are bad medicine. Bad medicine for you. Bad medicine for everybody else. And here's why . . .

Suppose you do get a raise . . . and a lot of others get one, too. What happens? The cost of manufacturing goes up. Naturally your boss has to add this increase in cost to the price he asks the retailer. And the retailer, in turn, raises his price to the consumer . . . that's YOU.

Multiply these hundreds of items that everybody has to *pay more for* by the thousands of other workers who want raises . . . and by the thousands of business men and farmers who want more money for their products . . . result . . . you and all the others need another raise to make ends meet.

And so it goes . . . wages and prices chase each other up and up . . . until prices get so high that your dollar isn't worth a dollar any more.

So what good is a raise if your living costs go up even faster? And there's so little you can buy today anyway . . . with most factories in war production.

Of course it's hard to give up the luxuries of life . . . and even harder to give up some of the necessities. But this is War! And when you think of the sacrifices our fighting men are making . . . many of them giving up their lives for us . . . no sacrifice we can make should be too great.

So if you want to be able to enjoy the good things of life in the peaceful days to come . . . if you want to speed victory and thus save the lives of thousands of fighting men . . . start doing these seven things now . . .

**1. Buy only what you *need*.** Take care of what you have. Avoid waste.

**2. Don't try to profit from the war.** Don't ask more than you absolutely *must* for what you have to sell . . . whether it's *goods* or your own *labor* you're selling.

**3. Pay no more than ceiling prices.** Buy rationed goods only by exchanging stamps. Otherwise, you're helping the black-market criminals, hurting yourself and all other good Americans.

**4. Pay taxes willingly.** They're the cheapest way of paying for the war.

**5. Pay off your old debts**—all of them. Don't make new ones.

**6. If you haven't a savings account,** start one. If you have an account, put money in it—regularly. Put money in life insurance, too.

**7. Buy and hold** War Bonds. Don't stop at 10%. Remember—Hitler stops at nothing!

**Use it up . . . Wear it out. Make it do...Or do without.**

**HELP US KEEP PRICES DOWN**

A United States War message prepared by the War Advertising Council; approved by the Office of War Information; and contributed by the Magazine Publishers of America

Pick-up coil for the railroad 'phone system is shown above, in box projecting toward rail. At right is shown hand-set in engine cab, with signal loudspeaker at upper right

Berberich explains, large planes depend upon electric power—the electrical load on big military planes has increased 10 times in the last decade. "It would be simple to 'over-insulate' a plane for safety," he says, "but aircraft designers fight to trim off every unnecessary ounce of material and to reduce the size of every single piece of equipment so their plane will fly higher and faster with a bigger bomb-load. That's the purpose of these tests—to determine safe minimums for insulation and the smallest safe air gaps between uninsulated parts of the electrical apparatus aboard a plane."

### ARC WELDER

#### Has Wide Current Range and Dual Control

RATED AT 200 amperes, and light in weight, a new "Shield-Arc" engine-driven welder is rugged of construction, with powerful enclosed rubber mounted engine of 29 horsepower. This new unit, supplied complete with base and canopy, has a current range of 40 to 250 amperes. Dual control of welding current is accomplished by adjustment of series fields and generator speed.

Designed for metallic arc welding, with bare or coated electrodes, this new Lincoln model also supplies uniform welding current for carbon-arc welding.

### RAILROAD 'PHONE

#### Permits Communication by Means of Carrier Currents

ESTABLISHMENT in practical operation of a two-way electronic train telephone system, permitting continuous voice communication with moving trains, between trains, and between the head and rear of trains, was announced recently by the Pennsylvania Railroad.

The initial installation has been made on the 67-mile Belvidere-Delaware branch, running northward from Trenton, New Jersey. Officials state that, while not yet adapted to general use, the new means of communication has now definitely demonstrated its capability of adding materially to the efficiency of controlling train movements. It has been produced in collaboration with the Union Switch and Signal Company, following several years of intensive experimentation and development which are still continuing.

This system, the only one of its kind so far established, has been applied to the freight service on the branch, which is of substantial volume. It 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 talk to each other at will, and the crew of one train may communicate with the crew of another several miles distant.

The equipment required for the new communication system has been installed on 10 locomotives and 10 cabin cars, and in a block station at Frenchtown, New Jersey, 30 miles north of Trenton. Installation is also under way at another block station in Trenton, where the branch leaves the New York-Washington main line.

The new system utilizes electrical principles employed in both radio and the wire telephone and combines the best practical advantages of both. It gives all the flexibility and ease of communication between trains and wayside stations, between the ends of trains, and from one train to another, that would be possible with radio. At the same time, by utilizing transmission paths provided for its own special purpose and confined to railroad property, instead of the universal paths of nature over which radio waves travel, it obviates the necessity of appropriating radio wavelengths from the limited range available to the crowded and competitive sphere of radio communication.

In addition, it provides a solution for certain practical difficulties which were encountered in adapting pure radio to railroad use, and leaves the air to those forms of transport which have no physical ground contacts and to which radio has been found to be ideally adapted. Commenting upon the results thus far observed, railroad officials, while emphasizing that the new system is still in the development stage, express the opinion that, when further perfected, its extension to other parts of the railroad will probably be found desirable.

The new system utilizes high frequency alternating currents transmitted along the rails, and also along wires on poles parallel to the track. These are termed "carrier" currents and have impressed upon them the impulses of the telephone currents which are produced by talking into the telephone instruments. By means of apparatus attached to the locomotives and cabin cars, these telephone currents are received into and sent out from the trains and the electrical impulses are transformed back into sound by the telephone instruments at the receiving end, whether on a train or in a wayside tower.

### COLOR CODE

#### Devised to Standardize Safety Practices in Industry

COLOR today is widely utilized in industry to promote safety. But because it has been used inconsistently and often promiscuously, to the point of confusion, a standard safety color code has been worked out for industry that should do much to improve this important phase of the science of functional color.

The color code is primarily a recommendation to industry to regularize the identification of plant safety equipment and hazards by specific colors and color symbols. The Du Pont Company Finishes Division, in developing the code, has respected traditional associations of color (such as red with fire protection, green for safety) while applying basic knowledge of color psychology and hue visibility.

If color is to contribute its maximum effect upon industrial safety, the proposal states, it must do more than merely attract eye attention. Simple logic and scientific knowledge should combine with standardization of practice in color identification procedure.

The color code avoids what it describes as common errors in current color safety practice. Probably the most frequent malpractice is overdoing color by including so many haphazard "wolf cries" that the system defeats itself by failing to impress the worker, if not by actually distracting his attention. Also, if a certain hue is used to point-up a hazard it should not be used to call attention to protection equipment. A given color should mean a given thing, or logical classification of things, so that the employee will associate that color with one precise safety message, anywhere throughout industry.

Six basic color standards are recommended in the new code: yellow, orange, green, red, blue, white (black or gray). The meaning of each color can be given added significance by employing it, when reasonable, in symbolic shapes, such as alternate black and yellow bars; an orange diamond; a green

cross; a red square; a blue circle; a white (gray or black) star.

Yellow, being of highest visibility in the spectrum, is recommended for use in conjunction with black striping to mark "strike-against," stumbling, or falling hazards.

Orange, psychologically the most stimulating and aggressive of all hues, is chosen to command attention to machine hazards such as in cutting, forming, and stamping operations. A triangle (or arrow) in "Alert Orange" may indicate the critical point of the hazard.

The traditional color and symbol of safety is a green cross. Hence, the code designates it for use over doorways to first-aid rooms, to mark locations of first-aid kits, stretchers, gas masks, respirators, and other safety equipment.

Because red has long been applied to fire protection apparatus, it should remain as standard in this respect—exclusively. The practice of identifying danger with red is discouraged. (Scientifically, red is poor, being low in visibility). Red squares on walls or bands on pillars indicate the location of extinguishers, hose connections, exits, and so on. Red squares on the floor beneath such apparatus, as well as in front of fire doors, tend to discourage obstruction with litter, cartons, and waste receptacles.

Borrowing from the railroad industry, the code sets a solid blue circle as a symbol of caution against starting, moving, or handling any machine, device, or equipment. The "Precaution Blue" sign should be hung on control valves and equipment condemned or undergoing repair.

The sixth standard includes the neutral colors—white, gray, black. These are for simple traffic direction and good housekeeping. Aisle marks and storage spaces are designated by white lines on dark floors, or black on light floors. Gray is practical for waste receptacles, cuspidors, rubbish boxes, and the like, and where management is insistent upon extreme neatness a white star may be conspicuously placed on containers or on the wall above container locations, or painted in an area on floors beneath receptacles.

In sum, the color code for industry is designed to (a) employ few colors, each distinct and readily recognized, (b) establish specific and uniform meanings for each color, (c) provide ready identification of hazards or conditions to aid in employee safety, (d) reduce to a minimum the effort required to learn and retain color meanings, (e) readily identify and locate fire protection and safety equipment, and (f) encourage good housekeeping.

## TANTALITE

### Plays Vital Role in United Nations War Effort

DEEP in the barren interior of northeastern Brazil, Americans and Brazilians are waging a hide-and-seek battle with nature to find and mine tantalite, the new black gold of the United Nation's war effort. This rare pitch-black mineral ranks as one of the most important resources in the whole Allied war chest; tantalum, the metal derived from tantalite, gives added power and range to United States and United Nations war weapons.

While tantalite's exact military uses are still military secrets, an idea of the heavy wartime demand for the mineral can be gleaned from its air priority. Of all the strategic materials sent by air to the United States from Brazil and other nations, tantalite alone holds the top rating: A-1-A.

Producing 52 percent of the world's highest-grade tantalite here is far from easy, as Brazilians and Americans toiling in the torrid sun of Brazil's bleak "sertao" (interior) have found out. Biggest problem of all is locating the black substance in this huge, mountainous area, stretching in a wide arc of 3600 square miles through the states of Paraiba and Rio Grande de Norte.

Mining men compare the tantalite operation to the proverbial "looking for a needle in a haystack"—and it isn't hard to see why. Tantalite ore usually is found clustered with other minerals in towering, odd-shaped rock formations called pegmatite dikes. Or it may be found in alluvial deposits beneath the level valley land. But the problem comes in determining which of the thousands of dikes and deposits in the region contain sufficient tantalite to warrant a big, costly mining effort.

Possibly the most amazing thing



*now wear "Plastic Overcoats"*

*Bausch & Lomb 7X, 50mm Binocular*

Denied the continued use of vulcanized rubber for binocular covering, the U. S. Navy sought a plastic material that would furnish the metal-clinging, watertight, sure-grip properties required in sea-duty binocular body covers.

Because the cooperative effort of engineers representing Bausch & Lomb, the plastics manufacturer and the Navy solved the difficult details posed by this problem, the new all-weather Vinylite coat on today's binoculars is as good as and, in some important respects, better than the former rubber coats. This plastic does not deteriorate in sunlight and clings more firmly to the metal body.

This superior covering material will be on the *better* Bausch & Lomb Binocular that will be available after Victory, one more reason why Bausch & Lomb Binoculars will still be known as "the world's best—by any test."

BAUSCH & LOMB
OPTICAL CO. ROCHESTER, N. Y.
ESTABLISHED 1853

*Makers of Optical Glass and a Complete Line of Optical Instruments for Military Use, Education, Research, Industry and Eyesight Correction and Conservation*

Washing-up a plastic printing plate

about tantalite is the small, though priceless, amount of product resulting from an incredible amount of work. As one operater puts it: "We're pouring out gallons to get a drop." Here are some figures which point out the complexity of the tantalite business:

An estimated 3000 tons of rock must be mined to get one ton of tantalite, and it takes one man 130 days to crush, wash, and prepare a ton of the ore for shipment. This becomes even more remarkable when it is realized that tantalite mining, despite the recent arrival of American mechanical equipment, is still basically a hand-picking and hand-washing operation.

### PRINTING PLATES

#### Made of Plastic and Paper, Used in Photo-Lithography

Out of experiments which began nine years before the war, has come an invention which today is serving many governmental agencies and may tomorrow revolutionize the mechanics of offset printing throughout the world. This invention is a flexible printing plate made of paper and Plaskon resin glue.

Paper sheets are permanently bonded together with waterproof Plaskon urea-formaldehyde resin and their outside surfaces are coated with this same material. The printing side is then coated with three layers of a special alcohol and clay emulsion and the plate is ready for the engraving process. Such plates can be manufactured with existing machinery in practically any paper mill.

Experts of the offset printing industry who have tested the new plastic plate state that it not only restores certain advantages lost when metal replaced stone as a printing base, but also adds new advantages. With copper and other standard plate materials growing more scarce because of the war, the non-metal plate is looked upon as a "life-saver" by the nation's 4000 lithographers, who are hoping it will soon be released for their use.

Costing far less to begin with, the plastic plate will bring users savings in shipping costs, since each weighs but a fraction of a comparable copper plate. The non-metal plates will require less storage space after being used and, unlike metal plates, will not have to be protected against damage from air or water, since they are impervious to both.

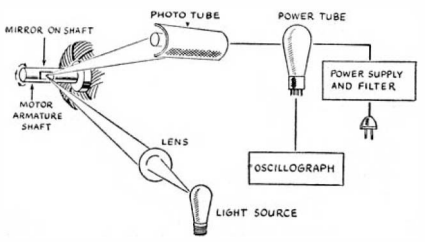
The plastic plates are used in offset printing in the same manner as metal plates. Once the plate is sensitized with a solution of albumen bichromate of ammonia, the subject to be printed is placed on it and it is inserted in a vacuum frame. On exposure to light from a carbon arc lamp, the image is transferred to the plate's alcohol-resin surface. This exposed surface is then coated with developing ink, washed until the print becomes clear, and etched with a chemical solution. When the plate is clamped to a cylinder of an offset press the image is first imprinted on a rotating rubber blanket and then transferred to paper.

Inventors of the new plastic-paper printing plate are William C. Toland and Ellis Bassist of the Plastolith Company.

### MECHANICAL MATHEMATICIAN

#### Aids in Study of Motor Deceleration

That mechanical mathematician, the phototube, went to work on another job recently when H. C. Anderson of the General Electric Company used the phototube in a set-up designed to count




Set-up for motor-deceleration study

the number of revolutions a motor armature makes after the electricity has been cut off and a brake applied to the motor.

A tiny mirror no bigger than a baby's fingernail is glued to the shaft of the motor so that it reflects a beam of light every time the armature completes one revolution. This beam of light enters the phototube which, in turn, is connected to an oscillograph galvanometer. The deflections of the galvanometer are recorded on a photographic film and, at the same time, a visual record of the current is photographed.

Thus it is possible, by examining the oscillograph's film, to count the number of revolutions the armature makes after the current has been cut off and until the motor armature comes to a complete stop.

### FLAVOR AND VITAMINS

#### Both Essential To Success of Dried-Food Industry

Dehydration is a relatively new industry with new technical problems, and the preservation of food by this process after the war will depend to a large extent on the success of research workers in developing methods which will insure palatable and nutritious dried vegetables. So says Dr. J. C. Moyer, chemist at the New York State Agricultural Experiment Station at Geneva. Doctor Moyer and his associates have been studying the effects of dehydration, and of the steps in preparing vegetables for drying, upon the flavor and vitamin content of the finished product.

"Much progress has been made in the past three years, and most dehydrated vegetables today have at least 90 percent of their original carotene, or vitamin A, and 80 percent or more of their thiamin, or vitamin B1," he says. "The destruction of ascorbic acid, or vitamin C, however, frequently amounts to one half to two thirds of the original amount."

One of the most important factors affecting the flavor and nutritive value of dehydrated vegetables is the method of blanching the fresh vegetables, says this authority. Blanching is necessary to destroy or inactivate the enzymes which would otherwise impair the flavor of the dehydrated vegetables and would also greatly reduce their vitamin content. On the whole, blanching with boiling water was found to be more efficient than blanching with steam in the Station experiments, although with certain vegetables and in large-scale operations steam blanching may be more practicable. The drying process itself causes little loss of vitamin A and vitamin B1, but vitamin C is readily destroyed at this step in the operation, depending upon the kind of vegetable.

### INSPECTION TABLES

#### For Parachute Manufacturers, Would be Useful Elsewhere

Illuminated tables designed especially for parachute inspection have now become fixtures in plants producing escape and aerial delivery parachutes for the armed services.

Designed and perfected by the Reliance Manufacturing Company, the tables are 14 feet long and have glass-paneled top surfaces, 8 inches wide and 12 feet in length. Lighted from below

Illuminated tables speed inspection

with three 30-inch blue-white fluorescent tubes, the tables now are government-required equipment for all parachute manufacturers.

The lighted panel facilitates the careful examinations of parachute stitching. If one of the estimated 250,000 stitches fails to catch the edge of the material, it is quickly detected by the inspector and the entire section of the canopy is rejected. Similar types of tables could be used to speed up inspection and assembly jobs in other industries.

### MOTOR SPEEDS

#### Recorded Automatically in Wind Tunnel Tests

ELECTRONIC robots that read instruments far more accurately than a man can, and which automatically print their readings on a strip of paper, are used to measure with high precision the speed of motors used in airplane wind-tunnel tests, according to Everett S. Lee, engineer in charge of the General Engineering Laboratory of the General Electric Company.

Models of newly designed airplanes, being tested in wind tunnels, are powered with small electric motors, corresponding to the gasoline engines of full-sized planes. In order that information about the performance of these motors may be extended accurately to the big airplanes, data about their operation must be determined with great precision.

The indications picked up by electronic tubes, Mr. Lee explains, cause the rotation of a tiny thyratron motor, which in turn drives wheels carrying type numbers. When the operator wants to take a reading he presses a button, and the type wheels print their setting at that moment.

### ROT-PROOFING

#### Research With Copper Soaps Gives Promising Results

COPPER soaps are employed as rot-proofing agents in intensified methods developed to prevent rotting and mildewing of fabrics, particularly under conditions of military service, according to a report to the American Chemical Society. That copper naphthenate leads other copper soaps in efficiency in the battle against rot is indicated by research conducted by Paul B. Marsh, Glenn A. Greathouse. Katharina Bollenbacher, and Mary L. Butler of the U. S. Department of Agriculture.

"From the standpoint of rotting, one of the most severe conditions to which a fabric may be exposed is contact with moist soil," the report declares. "Sandbags are often placed in direct contact with the ground and may contain soil as well as other filling materials. Many other mildew-coated fabrics may be expected to come in contact with soil for longer or shorter periods during storage or use.

"Cotton duck strips treated with copper naphthenate, copper oleate, copper tallate, and copper hydrogenated resinate were placed in moist soils at 85 degrees, Fahrenheit, and the strengths of the fabrics at the end of a nine-day period were recorded. Under the conditions of this experiment, copper naphthenate provided effective protection at lower copper concentrations on the fabric than did any of the other three copper soaps.

"Similar burial tests were made in soil with fabric treated with copper naphthenates made from naphthenic acids from different original sources. Fabric treated with a copper naphthenate made from a naphthenic acid of West Coast origin retained the following percentages of the original strength after the burial test in four different soils: 36, 76, 83, and 85 percent.

"Fabric treated with copper napthenate made from naphthenic acid of Mexican origin retained 19, 76, 85, and 94 percent of the original strengths for the same copper concentrations on the fabric; fabric similarly treated with copper naphthenate made from a naphthenic acid of South American origin retained 40, 71, 85, and 86 percent of the original strength. Since this superiority of copper naphthenate was so clear-cut and could be demonstrated repeatedly in the soil burial test, experiments were devised to determine its cause.

"Investigating further into the fungicidal capacity of copper naphthenate, it was found that the material had good protective power against growth of the copper-tolerant fungus, 'aspergillus niger.'

"The tests indicated that the superiority of copper naphthenate over other



## Center Scope Brings Optical Precision to Machine Shop Operations

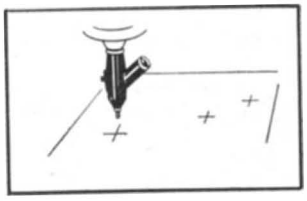
**The** Center Scope is an optical centering and locating tool that can be easily and quickly used on any machine to center work reference lines to a spindle axis. It permits accuracy to a degree never before obtainable, as the optical beam or line of sight is absolutely inflexible and cannot be distorted.

**The** Center Scope's easy accuracy eliminates many human errors, as the operator can see just what the cutting tool will do before it is actually fed into the work. It increases production, improves efficiency and prevents spoilage. There is no pressure on the work piece nor is it subject to wear or changes in temperature—for the Center Scope never touches the layout.

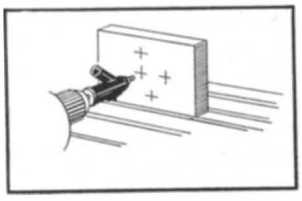
**The** Center Scope enables the operator to easily and quickly locate edges to a spindle axis, set-up faster and compensate for run-out. It saves vital hours in checking, inspecting and measuring when mechanical methods and tools are impossible to use. Its 45 x magnification allows operator to see ".001" and requires no technical knowledge or training to operate.

**While** there is nothing particularly new or ingenious about Wrigley's Spearmint gum, it is proving useful to millions of people in many new ways. Workers in war plants everywhere have found it helps keep them alert and relieves nervous tension and dry mouth while they are on the job.

*You can get complete information from the Center Scope Instrument Company, 351 S. LaBrea Ave., Los Angeles, Calif., or Kearney & Trecker Products Corporation, Milwaukee, Wis.*



**ON A VERTICAL MILL—locating and centering height gauge or size block layouts. Permits jig borer accuracy on more machines.**



**ON A HORIZONTAL MILL—the ability to center a layout, edge block or rotary table plug while spindle is running. Permits quick and easy set-up for high precision work.**

Y-109

soaps in soil contact tests is attributable, at least in part, to the fungicidal properties of naphthenic acid.

"The relative protective values of different copper soaps may be expected to vary with the conditions of exposure of the treated fabrics. It seems possible that, for above-ground exposures, copper hydrogenated resinate might release sufficient soluble copper to provide good protection. In the case of above-ground exposures with conditions of heavy rainfall, the relatively low solubility and consequent slow rate of loss of total copper from the fabric might be a distinct advantage.

"The length of the service life of a treated fabric exposed to attack by micro-organisms may also be influenced by mechanical stresses, by photochemical deterioration, by direct chemical reactions between the preservative and the fabric or between the preservative and other finishing agents, and by other factors.

"In warm humid climates or in such cases as fabric tests in contact with soil, decay by micro-organisms may often be the most important deteriorative influence."

## RAYON FIBER

### Now Available in Finer Size

SUCCESSFUL development into commercial application of a "fine-as-silk" viscose rayon staple fiber of the "Avisco" or extra-strength type, is of immediate interest to a large part of the textile industry.

The new fiber is described by the American Viscose Corporation as 1.0 denier "Avisco" and is produced in appropriate standard lengths suitable for the different spinning systems on which it is used. Basically, it is said to permit spinning yarns of far finer sizes than heretofore possible with standard type rayon staple fibers. In addition, it materially increases the strength of spun rayon yarns and fabrics as compared with the yarns and fabrics made with standard type viscose rayon staple fibers.

Commercial applications already reported include flat knit fabrics, simplex glove fabrics, tricot knit dress goods, fine broadcloths, foundation fabrics, and various types of sheer handkerchief, dress, and shirting materials.

As a result of the availability of the new fiber in commercial quantities, it is predicted that the use of spun rayon in new fields, in new types of fabrics and new products, will be considerably broadened.

## MACHINING CERAMICS

### Speeded by Use of Cemented Carbides

OVERSHADOWED perhaps by the phenomenal increase in use and performance of cemented carbide tipped tools in the machining of steel for war equipment, little has been known of the growing use of this material in the machining of ceramics.

Typical of some of the developments along this line are applications now accepted as standard in the Porcelain Department of the General Electric Company. Here tools tipped with Carboloy cemented carbide are used for three different classes of work: For turning unfired insulators on lathes; for drilling and counterboring unfired insulators on drill presses; for dies for

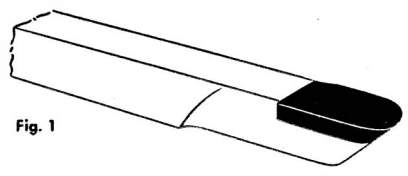


Fig. 1

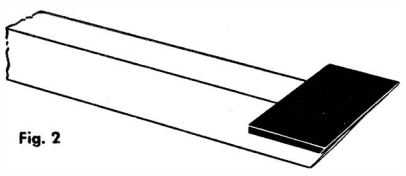


Fig. 2

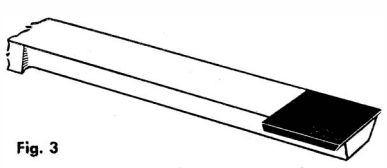
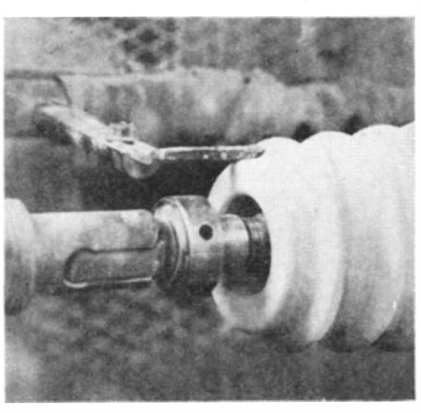


Fig. 3

**Above: Caroboly tools for machining ceramics; (1) for grooving, (2) for counterboring, and (3) another type for use on semi-automatic lathes. Below: Turning a porcelain insulator**



pressing insulators made of highly abrasive materials.

The first application is by far the most common. Formerly, with steel tools, it was necessary to take the tools out of the semi-automatic lathes every half hour for sharpening them. With the adoption of carbide tipped tools, the life between sharpening was increased to eight hours.

About the same ratio of length of life between sharpenings has been obtained with Carboloy-tipped as against steel counterboring tools. Contrary to the practice in machining metals, it is possible to have the tips on these tools have very little support below them, and the tips actually extend well beyond the "holder" each side of center.

Recently, Carboloy cemented carbide dies have been employed for pressing insulators used in the manufacture of vacuum tubes. While experience is not quite as broad on this type of service, over 75,000 insulators have been pressed with no signs of appreciable wear on either the pins or die cases. When steel pins and dies were employed it was usually found necessary to replace the dies after about 20,000 insulators.

Prime reason for the growth in popularity of carbides in the processing of ceramics is its tremendous resistance to abrasion. In this respect it departs somewhat from experience with this material in metal-cutting, where extreme hardness is probably its most important attribute.

## MATERIALS BATTLE

### Plastics and Light Metals Not Serious Menace to Steel

THE POST-WAR steel industry will not be seriously menaced by the light metals—aluminum and magnesium—or by plastics, Dr. John M. Weiss, New York industrial chemist, says in a report to the American Chemical Society. Nor will the very substantial percentage growth in the use of plastics be a marked hindrance to light metal development, he holds. Progress in the full utilization of light-metal production will, however, be slow, he warns.

The estimated capacity figures for aluminum and magnesium are 1,500,000 short tons of aluminum and 300,000 tons of magnesium, or only somewhat less than 2 percent of the projected yearly steel capacity of 100,000,000 tons, Dr. Weiss points out.

"The impact of the light metals on the steel industry can hardly be expected to be as great as the usual effects of the rise and fall of the tide of business activity," he declares. "Competition and new needs may so stimulate the alloy steels as actually to increase production and thereby bulwark the steel manufacturers. The steel industry cannot be expected to surrender tamely to light metals, even to the extent of 2 percent.

"Plastics will also fight for recognition. Exact estimates of production are not available, but a safe top figure of present capacity would be less than 300,000 tons of plastics per year. Tonnage-wise, the synthetic plastics represent only about 15 percent of the projected light-metal capacity. Many uses of plastics, notably the protective coating field, are not competitive with the light metals. Likewise, the transparent and colored specialty products do not fall into the competitive class, so that the extent of the impact on metal is even less than the tonnage figures indicate.

"It seems evident that the basic economic situations of plastics and light metals are quite different. The production facilities for the light metals appear far ahead of immediate post-war demand, so that a considerable time will elapse before the gap is filled. Plastics, on the other hand, with the lower tonnage base from which they start, should have an easier task and after a relatively short period of post-war recession may be expected to resume their pre-war upward trend."

New uses for aluminum and magne-

sium reaching far beyond the transportation field will be necessary if the plants are to continue to operate at capacity, according to Dr. Weiss. The light metals will have to justify their entrance into some broader line such as building and structures, where a small proportion of the total tonnage would afford substantial outlets, he says.

"The large war uses of aluminum and magnesium are in airplane construction and in incendiary bombs," Dr. Weiss points out. "The latter will disappear with peace and the former will undoubtedly be sharply reduced.

"Offhand, it might seem easy for the light metals to develop by intensive effort to a tonnage of only 2 percent of that of steel. Many statements have been published suggesting that the transportation industry could easily absorb it, based on the economy of low weight in such use. Transportation includes airplanes, autos, and trains.

"Airplane use will undoubtedly continue, but the scale will inevitably be far less, at least for an extended period, than during wartime, and hence can hardly be expected to take more than a fraction of the available capacity. With automobiles, trucks, and the railroads, post-war expansion seems reasonable, owing to wear and tear on equipment and to pent-up replacement demand.

"A goal of an average of 300 pounds of light metal per car or truck would appear optimistically ambitious. Even with a 5,000,000 unit market, this would only take 750,000 tons of light metals or a little more than one third of the projected producing capacity—a substantial bit, if it could be obtained, but a considerable period of time and trial will be needed to see the real extent of the possibility.

"The railroads have less than 2,000,000 freight and passenger cars in service, according to recent statistics. The replacement demand for equipment can hardly be expected to afford as large a potential use of light metals as the automobile industry. It has been stated that the projected aluminum capacity would give sufficient metal in four months to build replacements for all passenger cars now in use on the United States railroads.

"Light metals will, therefore, have to reach far beyond the transportation field to utilize the available production capacity. The road is not easy. Progress appears necessarily slow."

### TOOLING METHODS

#### Speed Up Work, Reduce Scrap

MARKED acceleration of automotive assembly-line production, in response to war needs of recent months, has pointed up the value of the continuous application of the industry's tooling techniques to the big job ahead.

Developed and refined over 40 years of peacetime manufacture, these methods—now applied to fighters and bombers, shell and shot, tanks and cannon, and hundreds of other war products—are proving just as sound an investment for the nation today as they were in the mass production of automobiles and trucks.

The Automotive Council for War Production cites several recent statements revealing a vast step-up in production, based on the solid groundwork of tooling needed for straight-line production.

One company, for example, was producing its third thousand bombers within eight weeks after production of the first thousand bombers had been announced.

Another company's production of 22,925 engines for Flying Fortresses in 1943 was nearly four times greater than the output of the previous year.

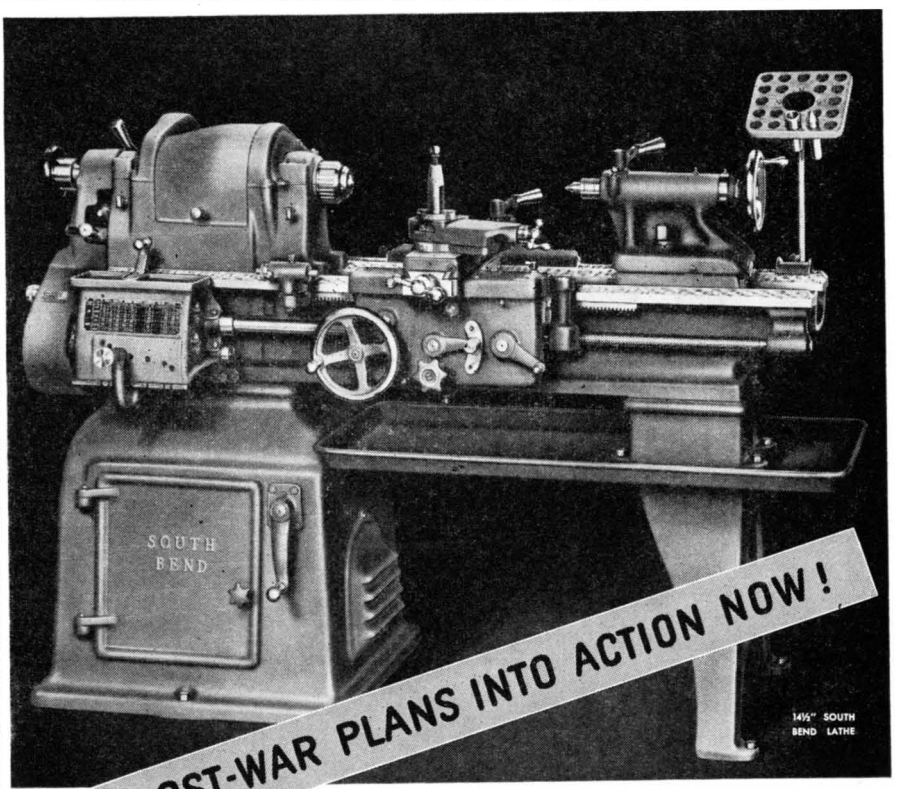
Thirty-three thousand engines for Liberator bombers have been turned out by another company, with 75 percent of these produced in the past 12 months.

Constant expansion and refinement of machine tools, jigs, and fixtures is one of basic reasons for such increased productivity, the Automotive Council says. It is a continuation of the peacetime practice to "do it better—do it quicker—do it oftener."

An instance of tooling up, and how it contributes to faster and more efficient production, is shown in the case example of the crankcase for one company's aircraft engine, whose output schedule was revised upwards three times. The original small daily output schedule was met with a minimum of tooling, although each crankcase required 230 hours of work, and spoilage averaged 47 percent.

With the first big increase in production—an order that nearly tripled the daily output—the company quickly mechanized the crankcase operation. Thirty-two new machines were purchased, along with their accompanying jigs and fixtures. Instead of 230 hours manufacturing time, only 125 hours were required for each crankcase, while scrappage was reduced to less than 7 percent.

Tooling refinements and expansion kept pace as production schedules were later doubled and then doubled again. Efficiency, too, continued to increase.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War production is still urgent — still our No. 1 job. But alert executives are now making plans that will permit a quick change-over to peace-time production. Many are already putting their post-war plans into action by placing orders for machinery to be delivered after the war is won. To help you order South Bend Lathes for post-war delivery, we have developed a practical post-war priority plan.

It is only necessary that you place your order now—and in good faith. No deposit or down payment is required. Each order will be acknowledged by a numbered Post-War Priority Certificate. When civilian production is resumed, lathe orders will be filled as nearly as possible in the order established by the certificate numbers. The order may be cancelled at any time.

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# What Strange Powers Did the Ancients Possess?

EVERY important discovery relating to mind power, sound thinking and cause and effect, as applied to self-advancement, was known centuries ago, before the masses could read and write.

Much has been written about the wise men of old. A popular fallacy has it that their secrets of personal power and successful living were lost to the world. Knowledge of nature's laws, accumulated through the ages, is never lost. At times the great truths possessed by the sages were hidden from unscrupulous men in high places, but never destroyed.

## Why Were Their Secrets Closely Guarded?

Only recently, as time is measured; not more than twenty generations ago, less than 1/100th of 1% of the earth's people were thought capable of receiving basic knowledge about the laws of life, for it is an elementary truism that knowledge is power and that power cannot be entrusted to the ignorant and the unworthy.

Wisdom is not readily attainable by the general public; nor recognized when right within reach. The average person absorbs a multitude of details about things, but goes through life without ever knowing where and how to acquire mastery of the fundamentals of the inner mind—that mysterious silent something which "whispers" to you from within.

## Fundamental Laws of Nature

Your habits, accomplishments and weaknesses are the effects of causes. Your thoughts and actions are governed by fundamental laws. Example: The law of compensation is as fundamental as the laws of breathing, eating and sleeping. All fixed laws of nature are as fascinating to study as they are vital to understand for success in life.

You can learn to find and follow every basic law of life. You can begin at any time to discover a whole new world of interesting truths. You can start at once to awaken your inner powers of self-understanding and self-advancement. You can learn from one of the world's oldest institutions, first known in America in 1694. Enjoying the high regard of hundreds of leaders, thinkers and teachers, the organization is known as the Rosicrucion Order. Its complete name is the "Ancient and Mystical Order Rosae Crucis," abbreviated by the initials "AMORC." The teachings of the Order are not sold, for it is not a commercial organization, nor is it a religious sect. It is a non-profit fraternity, a brotherhood in the true sense.

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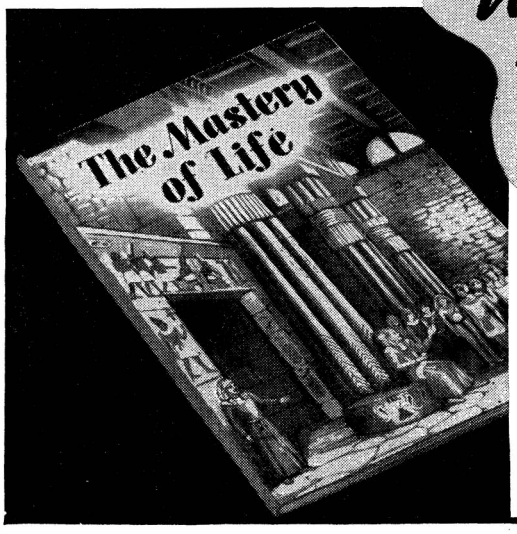
Sincere men and women, in search of the truth—those who wish to fit in with the ways of the world—are invited to write for a complimentary copy of the booklet, "The Mastery of Life." It tells how to contact the librarian of the archives of AMORC for this rare knowledge. This booklet is not intended for general distribution; nor is it sent without request. It is therefore suggested that you write for your copy to the Scribe whose address is given in the coupon. The initial step is for you to take.

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Machine time dropped first to 40, and finally to 32 hours, while scrap eventually reached the low point of less than 4 percent.

Meanwhile, the application of automotive mass production methods caused similar changes to be made throughout the entire plant.

Two especially designed boring mills were installed to accomplish simultaneously 18 operations formerly done individually. Production was increased 92 percent; nine regular boring mills were made available for other work. Total production time for a complete engine eventually was cut in half, and scrap declined 80 percent.

### FIRE EXTINGUISHERS

#### Must Suit the Class of Fire to be Fought

EFFECTIVE "first aid" fire fighting requires the use of a suitable extinguisher on each different class of fire, of which there are three.

Fires in ordinary combustible materials, such as wood, paper, textiles, rubbish, and so on are known as Class A fires. They are best put out with water, which has a cooling and quenching effect. Extinguishers which contain water or chemicals and water are the soda-acid, foam, pump tank, gas cartridge, and loaded stream types.

Vaporizing liquid and carbon dioxide extinguishers also are effective for controlling small Class A fires, if the fires are not deep-seated and if there are no strong air currents to dissipate the vapor or gas.

Fires in flammable liquids, grease, and so on, are known as Class B fires. Here a blanketing effect is essential, to cut off the oxygen supply. Suitable extinguishers are foam, vaporizing liquid, carbon dioxide, and loaded stream.

Fires in electrical equipment, Class C fires, require the use of extinguishants that will neither damage equipment nor convey an electrical charge along the hose stream to the operator. Vaporizing liquid and carbon dioxide extinguishers are suitable for use on fires of this class. However, in some cases, fires in electrical equipment may be such that the quenching and cooling effect of large quantities of water is necessary. In such cases, the equipment should be made electrically dead before water or water solution is applied.

The Underwriters' Laboratories label on every approved fire extinguisher indicates the class or classes of fire for which that extinguisher is considered suitable and the number of such extinguishers considered necessary to comprise one unit of protection. Thus, a 2½-gallon foam extinguisher is designated "A-1; B-1," meaning that it is approved for use on both Class A and Class B fires, and that one such extinguisher is required to make one unit of protection.

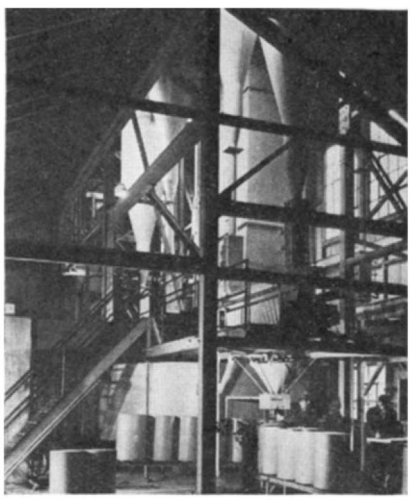
The number of units of protection required in any given location depends upon the relative severity of the incipient fire to be anticipated. The National Fire Protection Association recognizes three general classes of occupancies—light hazard, ordinary combustible,

and extra hazardous. A guide for determining the number of units of protection required for each class of occupancy has been worked out. For example, a place where fires of average intensity may be anticipated should have units so located that a person will not have to travel more than 50 feet from any point to reach the nearest unit, but at least one unit will be required for each 2500 square feet of floor area.

### RESIN DRIER

**Produces Powdered Adhesive for Easy Storage and Shipping**

LARGER shipments of synthetic resin plywood adhesives to overseas points for on-the-scene assembly of barges and landing boats, and an ever-increasing domestic need for these adhesives for production and assembly of gliders, airplanes, torpedo boats, landing barges, pontoons, barracks, military truck bodies, skis, and snowshoes, account in part for the development by Resinous



**Interior of the resin drier, showing the powdered material being packed**

Products and Chemical Company of one of the world's largest resin driers.

This mammoth installation converts liquid urea-formaldehyde and phenol-formaldehyde resins by a new process into weight and space-saving powders that flow like water. Whether used here or abroad, the powder resins are permitting the use of lighter shipping containers constructed of non-critical materials, and this circumstance has resulted in great savings in shipping space. Most important of all, the powder resins have a storage life twice as long as liquid resins, a major consideration both in logistics planning and storage in plywood plants in this country.

### POLISHING BOBS

**Play Large Part in Engine Life**

THE AUTOMOBILE industry's success in building aircraft engines on a mass-production basis is due in a large measure to skill of workers long accustomed to engineering tolerances of high accuracy.

An example of this may be found in the polishing departments of the Ford Motor Company's Highland Park plant and Rouge aircraft plant, where the scores of gears and rods used in 2000-horsepower Pratt and Whitney aircraft engines are finished to microscopic dimensions.

Due to the relatively high stresses to which aircraft gears are subjected, polishing to a microfinish is vital, since tests have proved that gear failures invariably occur where cutting-tool marks or scratches exist.

In view of the exactness and quantity of polishing necessary for the mass production of aircraft parts, Ford has expanded facilities for the manufacture and reconditioning of tens of thousands of polishing bobs used in this task. At the present time 139 different sizes of polishing bobs, ranging in diameter from one half to four inches, are manufactured and resurfaced.

Approximately 80 women are employed daily in this work at the Rouge aircraft plant, while half that number are similarly occupied at the Highland Park plant. Their combined output averages about 24,000 polishing bobs daily. All the polishing bobs are made of pressed felt. The women work in pairs, and while one holds the bob on a wooden mandrel, the other applies a quick-drying cement to the proper surface. Then the woman holding the mandrel agitates the bob in a tray of special abrasive. The bob is then placed in a medium oven, baked for four hours, removed, and a second coat applied. It is baked a second time and is then ready for use.

The abrasive used is made from slag and is purchased in great quantities, as much as 11 tons per month being used on one grinding job. Artificial abrasive has replaced emery dust because of its greater all-round utility. The rapid drying cement used by Ford is made by a secret formula developed by an outside company. Unlike the hot glue formerly used for this purpose, it does not melt under heat of friction; the abrasive life of the bobs is thereby extended.

### PIG DE-HAIRING

**Now Accomplished by Chemical Means**

A PLASTIC covering that removes all the hairs from a pig when it is peeled off has given the housewife more high-grade pork cuts, ham, bacon, lard, and other pork products, according to Hercules Powder Company.

The chemical shaving method, which has been adopted by meat packers, also saves processing time and reduces dehairing costs.

Coating the pork carcass with a resin called Brisgo, packers now get rid of the toughest whiskers and stubble in a simple stripping operation. The pig is dipped into a tank containing the chemical and is then carried on the dressing conveyor to an operator who slits the warm plastic suit and unrolls it. In another method, the chemical is brushed on and scraped off. The removed plastic goes back to a remelting tank and is used over and over again.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Here is probably the lowest price at which achromatic lenses have ever been offered. These were manufactured for use as telescope eye-pieces, but the edges were chipped and we can now offer to you at only 50¢ each. Minimum order $1.00. Come uncemented and you may either cement them or mount them in contact when mounting.

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*By* **CHARLES B. NORRIS**

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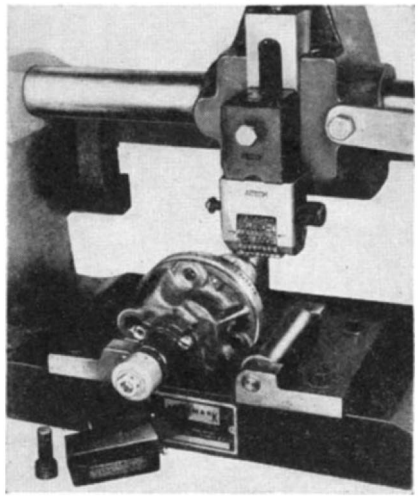
# New Products

### CURVED-SURFACE MARKER

COMBINING of standard fixtures in a regular No. 9A Acromark machine enabled a large manufacturer of aircraft equipment to speed up the marking production of curved parts without increasing personnel. By installing a set of standard non-adjustable cradle rolls and a socket-type mandrel fixture to



**A mark for every stroke**

support and locate the part in the proper marking position, the marking of a peculiarly shaped unit was accomplished as the last operation after the unit was completely assembled and inspected.

When a numbering machine with a sight index control was placed in the marking head of this machine and adjusted to the proper marking depth, a part was easily marked at every forward stroke and one at every return stroke of the machine.

### PLATING ON PLASTICS

IN A new process for metal plating on plastics, glass, and so on, it is claimed that stronger unity of bond between metal and base is obtained. The plating withstands impact, vibration, and extreme temperatures without peeling or blistering, to the limits of the dielectric itself, which is greatly strengthened by the plating.

### VIBRATION FATIGUE TESTER

AUTOMATIC cycling is obtained with a new vibration fatigue testing machine made by the All American Tool and Manufacturing Company. This new unit handles parts or assemblies up to 10 pounds in weight on a table eight inches square with holes drilled and tapped for attaching work to undergo test. The vibration mechanism runs in an oil bath.

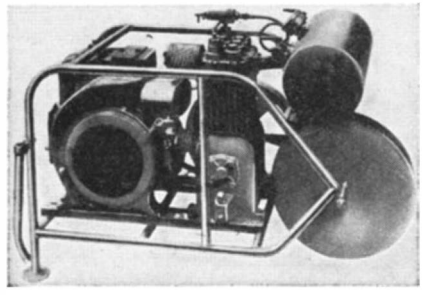
Vibration, in simple harmonic motion, is produced vertically. Acceleration, or rate of change of velocity, is controlled automatically by a device which changes the frequency from 10 cycles per second to 55 cycles per second and back to 10 cycles per second continuously and uniformly, the complete cycle requiring one minute. Acceleration can also be adjusted manually. Frequencies are accurately recorded on a sensitive electric tachometer.

Use of this device simulates vibration conditions actually encountered by parts in service and points out defects in design and construction materials.

### WHEELBARROW TYPE COMPRESSOR

DESIGNED originally for the armed forces, many post-war uses are possible for a new, compact, wheelbarrow type air-compressor unit being manufactured by the Quincy Compressor Company. Weighing only 225 pounds, the unit is easily wheeled by one man. Despite its small size, it incorporates a powerful, single-stage, air-cooled compressor with air delivery in excess of 16 cubic feet a minute at 80 pounds pressure.

Since this type of unit is primarily used at locations inaccessible to stationary or truck-mounted units, a number of features have been incorporated to overcome unfavorable outdoor conditions. Among these are the steel front wheel that is mud and water-proof and a belt tension adjusting device for easy starting of the gasoline motor in



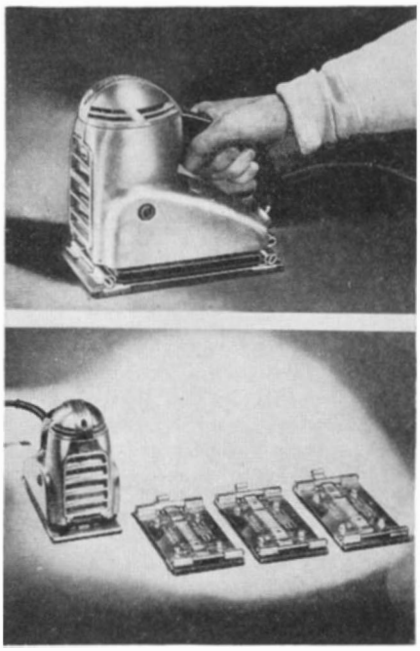
**Easily handled by one man**

cold weather. By means of a hand crank, the compressor load is taken from the motor during starting and the belt then tightened again for operation.

Among applications thus far found for the unit are exterior and interior paint spraying, camouflage work, emergency service to motorized units or airplanes, and in numerous construction operations.

### DETACHABLE SANDING PAD

OUTSTANDING feature of a new Sterling electric portable sander is the flexible sanding pad which detaches from the machine by simply pulling out a latch. Several pads loaded with abrasives



New sander (top) operates easily with no pressure exerted by the operator. Detachable pads (bottom) make possible fast and easy exchange of various grades of paper

can be kept near work for quick exchange. When different grades of abrasives are used on a job, additional pads loaded with coarse and fine grits can be switched when necessary, thus avoiding the necessity for operator to stop work and reload.

The Sterling sander is especially designed to cover the entire range of abrading from coarse sanding to lapping and finishing. It provides fast and uniform cutting on wood, metal, and plastic. The sanding pad is flexible and will conform to convex or concave surfaces of moderate curvature. Special pads for unusual contour sanding or rubbing are also available. The tumbler action locks on the sanding pad can be easily operated by a key that is furnished with the machine, or by a screwdriver. As tumblers are turned to lockup position, they draw in slack, pulling the sheet of abrasive taut on the pad.

Another feature is the non-vibrating action of the sander while the pad is moving at a speed of 4500 oscillations per minute. In fact, the vibration is so negligible that all the lettering on the nameplate (which is small) can be easily read when the sander is in operation. This smooth performance permits the operator to use it constantly with maximum comfort and to hold it with one hand from any position.

### CHROMIUM DEVELOPMENT

TRIVALENT chromium, a long sought goal in the field of electroplating, has now become an established fact. By means of a new process, developed by Warner Laboratories, and a new chromium salt known as "Skalite," procedure for both hard and decorative chromium has been simplified. Plant investment is immeasurably less; the need for special chrome plating equipment has been eliminated. It is claimed that the Warner method is simple and automatic, not greatly different from copper plating.

Time, electrical energy, and salts required are only 20 percent of those for the old process. Due to the bath's non-gassing characteristics and substantially increased throwing power, there is no need for special contour anodes on intricate objects. Also, the bath is non-corrosive and non-poisonous.

### SYNTHETIC-RUBBER GLOVES

TWO STYLES of industrial gloves made from synthetic rubber, now being manufactured by The B. F. Goodrich Company, can be sold to anyone who can qualify for such items under Rubber Order R-1.

One of the gloves is a light-weight type, 10½ inches in length. The second glove is of heavier construction, 14 inches in length. The heavier glove is available only in the straight-finger style.

Sizes and weights of the two types were carefully worked out to meet the greatest average demand, the company's announcement says. It also declares that the synthetic rubber gloves are equal in most respects to those made from natural rubber. They are as good as natural rubber gloves in resistance to acids, and at the same time are grease and oil-resistant.

The company offers a tip on synthetic rubber gloves which have been packed for a long time and which look wrinkled and stiff when unpacked. All their normal snap and life will reappear if they are held under warm water for a few minutes.

### SELF-POWERED VENTILATOR

A PORTABLE self-powered ventilator, developed by The Herman Nelson Corporation, is primarily designed for use in cooling the interior of aircraft during repair work in hot climates; several other applications have been evolved by the necessities of war, and many civilian uses are anticipated.

The unit consists of a pressure-type fan, driven by a small gasoline engine or electric motor connected to a collapsible canvas duct through which the air is propelled to the area to be ventilated. Air delivery at 3400 revolutions


Exact Weight Scales

take the Hidden Ounces Out of Your Packaging...

Many an eyebrow would be raised if the eyes under them were centered upon the huge pile of free goods which daily goes into individual small packages. These eyes would see pounds, plenty of them . . . feel the actual weight of them too. But this sight is never seen. Overweight per container is small and in fraction ounces, scattered and hidden, but it is there . . . thousands of ounces and in turn hundreds of pounds. This creates "PROFITLESS PACKAGING" . . . severely affects profits. EXACT WEIGHT Scales catch profitless packages on the production line . . . ferret out these ounces, one by one. They cut packaging costs . . . insure profitable operation. Whatever you package in small containers there is an EXACT WEIGHT Scale for the operation — Write for the details!

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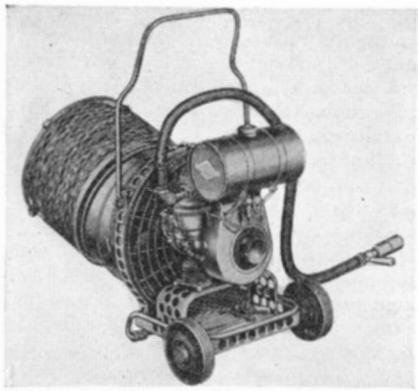

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In addition to its use on aircraft, where it either blows outdoor air into the plane or exhausts hot air from the interior, the unit has been found useful for drying out the bilges, engine rooms, and double bottoms on boats, for driving out gases and fumes from confined spaces and, without the duct, as a man-cooler and repellent of winged insects.

### HYDRAULIC PULLER

RECENTLY introduced by Templeton, Kenly and Company, the Simplex Jenny center-hole hydraulic puller was designed to accomplish in minutes many production, maintenance, and repair jobs which normally require hours.

This unit is being used for many tasks in general industry, construction, shipbuilding, mines, railroad shops, and in the oil fields. It has also been used for pulling in utility service pipe. Applications include pulling bushings, cylinder liners, cutless bearings, pistons, wrist pins, valve seats, keys, wheels, sprockets, gears, boiler tubes, and pipes, and pulling structural members together for welding or riveting.

The Simplex Jenny pulls, pushes, or lifts; and can also be readily rigged up as a portable press. This self-contained unit operates vertically or horizontally without the need for heavy auxiliary equipment, and without side thrust or friction. The Jenny is its own back-up and is self-supporting because of its center-hole construction.

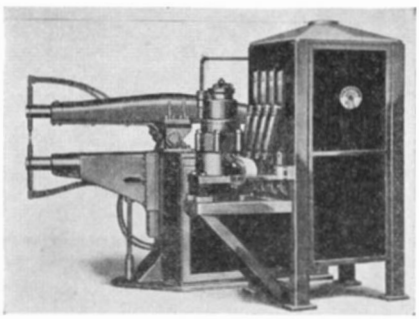
New hydraulic puller at work

Five models are available, of 30 to 100 tons capacity, all of them light in weight in proportion to capacity. Three models have single pumps and two have high- and low-speed pumps which may be operated separately, alternately, or together.

### STORAGE-BATTERY WELDERS

WHAT IS believed to be the first practical direct-current resistance welder using storage batteries as a source of welding current has been announced by Progressive Welder Company, and is now in use for welding aluminum in aircraft assemblies.

Actually, the use of batteries as a source of "stored energy" for resistance welding involves no radical re-design of already available welding machines, since modified types of welding machines or guns may be used in combination with the storage-battery power



Batteries furnish the power

unit. The only requirement is sufficient power to operate a battery charger.

Development of storage-battery operated welders has been predicated on two new developments: The creation of a special battery design which will withstand high repeated discharge rates and the development of a contactor-controller which will control and interrupt enormous amounts of current, if required, without arcing.

Power to keep the batteries charged is supplied from a normal power line, either single- or three-phase A.C. The charger is of the dry-disk rectifier type, provided with automatic controls, and normally requires no attention. At the welder itself only a simple (non-synchronous) sequence welding control is needed. This, together with an automatic pressure switch on the welder and a "starting" pedal-operated switch, controls the weld cycle. Control of the actual amount of welding current is furnished by the contactor-controller. The latter is capable of making and breaking tens of thousands of D.C. amperes at low voltage without arcing, and of controlling the current with but one single adjustment—that of pressure. Its principle is that of the well-known carbon pile, although pressures in the contactor may be as high as 25 tons when welding aluminum, for example. Usual factory air-line pressure is sufficient to provide this pressure.

# Metals in Industry

(*Continued from page* 201)

tolerances. For the closest tolerances, screw machine parts are best and you may be sure the post-war engineer, intent on reducing vibration and noise and on guaranteeing perfect interchangeability on a million-part basis, is going to insist on ±0.001 inch or better in many engine, transmission, and general machinery components.

Where loads are heavy or dynamic stresses severe, forgings will be favored. Forgings may have tough post-war competition with die castings or plastic moldings for non-structural consumer-goods parts but their use should increase in the industrial machinery and vehicular fields. Sand castings, too, are better engineering materials than formerly and will be employed for load-bearing jobs more than in the past.

Precision casting and powder metallurgy are still more specialized in their applications than most persons realize. The former is ideal for making small parts of metals with very high melting points, complex shapes, and narrow dimensional tolerances. Powder metallurgy excels chiefly for very close-tolerance work on a reasonably large-production basis, where considerable machining would be involved in making the part by conventional methods. On the other hand, recent improvements in powders, press sizes and speeds, coining practices, and so on, continually permit the attainment of closer tolerances or higher production rates or better mechanical quality than was considered feasible for a given part a while ago.

The pressure of supply on the aluminum and magnesium market is certain to result in an increasing use of die castings made of the light metals, while the use of zinc die castings should resume the steady growth it consistently enjoyed in the ten years before the war. One can see nothing but cheer ahead for those interested in die casting.

As a matter of fact, all the forms discussed here, plus a few others (magnesium extrusions, for example, and metal spinnings) would have bright futures if their present performances are any criteria. The important thing to remember is that war throws our economics all out of gear and that no 100 percent accurate appraisal of the rival methods will be possible until a more competitive era re-focusses our attention on such things as prices, material costs, labor charges, and so on.

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### POWDER METALLURGY

#### Expansion Must Come from Unexpected Fields

THE POWDER metallurgy field has reached (probably passed) the peak of its war-time development and any future expansion of the industry must come from directions as yet unexplored. That is the basic conclusions to be drawn from a review of recent developments in powder metallurgy written by Frances H. Clark of the Western Union Telegraph Company for *Mining and Metallurgy.*

After an astonishing flurry of interest in it one or two years ago, the process has found its place on a somewhat smaller scale than many expected. Ordnance methods are now established and the Government's insistence on thorough testing and certification of new designs and processes for reasons of military safety has tended to bring the "ordnance expansion" phase of powder metallurgy's development to a close. Cost factors limited this expansion, too—for example, although high quality rotating bands for projectiles have been successfully made from sintered copper or brass powder, tubing manufacturers could still produce the bands more cheaply by sectioning copper or brass tubing, and the latter method continues to be the one used.

On the other hand, powder metallurgy parts of high density (that is, of low porosity), where machining costs are sizeable by ordinary production methods, have shown a moderate but steady increase in use. Iron parts for an automatic weapon, carburized iron gears for an aerial camera, and bronze or iron bombsight parts are in production and have performed satisfactorily. The sole supplier for an iron pole piece used by the Signal Corps in a field telephone is using powder metallurgy methods.

### HIGH ALLOY STEELS

#### Can Stand Competition With Light Metals

THE HIGH alloy steels (steels with more than 4 percent alloying elements) have a much brighter future than one might suppose after reading some current prophecies of a "light metal age" to come. So one concludes on reading a paper recently presented by S. M. Norwood of Electro Metallurgical Company before a meeting of the American Society for Metals.

Basic compositions of high alloys and stainless steel will remain much as at present, but small variations will be developed to have profound effects on properties. The greatest development in the near future will probably be with the high alloy steels of the heat resistant type, particularly those which are not only resistant to deterioration at elevated temperatures but which have mechanical properties surpassing anything available in the past, so far as stress rupture and creep resistance are concerned. The development of alloys for power units in the gas turbine is a trend of this type.

High-manganese stainless steels, which have mechanical properties comparable to, and corrosion resistance inferior to, ordinary (chromium-nickel) stainless steels, but which cost less than the latter, may be widely used for structural applications. As a matter of fact, a much wider use of high alloy and stainless steels may be expected primarily because of their high strength rather than their corrosion resistance.


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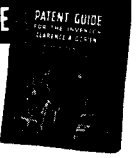


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(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

SELF-LOCKING NUTS FOR AIRCRAFT is a 12-page compilation of tables showing comparative weights between various types of self-locking nuts manufactured by one organization and those of different design produced by others. The data are particularly important to the aircraft industry and will be helpful to other industries as well. *Boots Aircraft Nut Corporation, Dept. SA, New Canaan, Connecticut.—Gratis.*

OCCUPATIONS IN ELECTRONICS, by Forrest H. Kirkpatrick and John E. Crawford, is a six-page leaflet describing post-war opportunities in the field of electronics. The text covers the nature of the work, training required, probable earnings, distribution of employment, and other advantages and disadvantages. *Occupational Index, Inc., New York University, New York 3, New York.—25 cents.*

CHEMICAL NAMES AND TERMS is an eight-page pamphlet giving pronunciations and meanings of words peculiar to and frequently encountered in the synthetic rubber industry. *Hycar Chemical Company, 335 South Main Street, Akron, Ohio.—Gratis.*

WHAT YOUR TOWN NEEDS FOR THE COMING AIR AGE is a 36-page booklet directed to all civic-minded citizens and officials of municipalities in the United States. It discusses in a sane, practical manner the problems of aircraft landing facilities which will be so important in the post-war era. *Piper Aircraft Corporation, Lock Haven, Pennsylvania.—Gratis.*

FACTS ABOUT PLASTICS is a 24-page non-technical booklet covering all types of plastics, their properties and uses, and general information on the plastics industry as a whole. *The Richardson Company, Department 100, Melrose Park, Illinois.—Gratis.*

PLATE SET SYSTEM is a large eight-page folder describing the use of the latest development in industrial hole-punching technique. Through the use of this system it is possible to produce rapidly a punching set-up for any specific purpose. Brochure PS. *Wales-Strippit Corporation, 345 Payne Avenue, North Tonawanda, New York.—Gratis.*

ETCHED STEM THERMOMETERS is a 52-page, lavishly illustrated catalog showing and describing a complete line of laboratory thermometers which are available in types and ranges for almost every conceivable purpose. Included is a comprehensive temperature conversion table. Request Catalog Number 44. *Faichney Instrument Corporation, Watertown, New York.—Gratis.*

WELDING INSPECTION CHART is a 23- by 35-inch wall chart designed so that operators and inspectors can tell at a glance whether welds are being properly made. Pictures show actual specimens of various results. *Lincoln Electric Company, Cleveland, Ohio.—Gratis.*

SEQUEL TO MAKING DEMOCRACY AND THE WORLD MUTUALLY SAFE is a 14-page pamphlet supplementing one recently described in this column. It is a continuation of the original plea for a better democratic government as the only road to a better world. *Arthur Graham Glasgow, 1900 Monticello Avenue, Norfolk 10, Virginia.—Gratis.*

FLUXING CHART presents a list of the common metals and alloys and recommends the most satisfactory flux for use in welding, brazing, or soldering them. Available to men engaged in metal working who make their request on their company letterhead. *Krembs and Company, 676 West Ohio Street, Chicago 10, Illinois.—Gratis.*

"DIE-LESS" DUPLICATING is a 40-page comprehensive catalog summarizing the origin and development of a system of metal duplication without dies, plus illustrations and descriptions of the newest equipment which has been designed for this purpose. *O'Neil-Irwin Manufacturing Company, Minneapolis 15, Minnesota.—Gratis.*

THREADED INSERTS AND LOCKED-IN STUDS is a 20-page, brightly illustrated instruction manual showing the methods of using Rosan locking units. *Bardwell and McAlister, Inc., Post Office Box 1310, Hollywood 28, California.—Gratis.*

SPRINGTITE SEMBLY is a six-page folder which contains complete data on an engineered preassembled lock washer and screw and bolt combination. This all-in-one fastener unit cannot come apart while it is being put in place. Request folder No. 101. *Eaton Manufacturing Company, Massillon, Ohio.—Gratis.*

DELTA GRINDERS is a four-page folder describing a new type of half-horsepower industrial grinder and attachments which may be used with it. *The Delta Manufacturing Company, 600-634 East Vienna Avenue, Milwaukee 1, Wisconsin—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"

NOVELTY for novelty's sake can easily be argued down by cold logic but, who wants to be too logical when a hobby is involved? Recently your scribe, in mining down through the Archeozoic strata of a desk filled with many years' accumulations of telescoptical lore, in search of an elusive file of papers, hauled out the following item dated 1939. No apology is offered for its age; some ageless and fascinating items lurk in the same place.

The present little item came from C. H. Helm, an electrical engineer, Blidahlund 1, Chrl., Copenhagen, Denmark. He says he bought "A.T.M." in 1928, when living in the U. S., made a 10″ Cass, returned to Denmark, forgot optics for 9 years, then made five concave grating mirrors for the Academy of Science at Stockholm, made a Fabry-Pérot interferometer for the University of Lund, with mirrors worked to 1/50 wavelength (and sends a ronchigram to prove it), also made two mirrors to 1/50 wavelength for the famous Danish physicist Bohr.

The idea offered by Helm is shown in the figure—a modified Gregorian for terrestial use. *A* is the usual paraboloidal primary. *B* is a secondary, also paraboloidal and adjusted to return the rays as parallel light. *CD* is a small telescope, like field glasses, adjusted to infinity. The parallel lines represent a tube to exclude extraneous light. "It works all right," Helm reports. He reports also that "A.T.M." is "the best book ever published on any one subject," which may be slightly hyperbolic but is pleasant to hear.

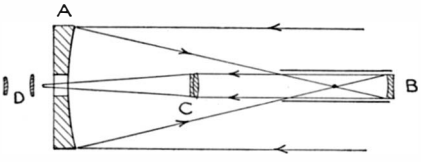
Commenting on Helm's ideas, N. J. Schell, Beaver Falls, Pa., says: "Have never seen just this before, but the secondary acts similar to an erecting lens if used in this fashion. The rays would be parallel to the axis only on an object in line with the axis, all others being inclined from the axis at angles corresponding to the entrance (or incoming) angles. This would tend to limit the extent of the field to the proportions of the secondary. The arrangement would serve somewhat along the lines of Dall's 16″ spherical Cass, which has the secondary focus between the mirrors, but since Dall's is á-la-Cass, the size of the field available would be larger with a given size of secondary. Dall's also gives an erect image.

"Two or three years ago, at the request of the late Dr. Palmer of Pittsburgh," Schell continues, "I suggested to him a Cass with secondary designed and figured to have a secondary focus at infinity, for a special purpose he had in mind. This has no bearing on Helm's design, except to indicate that the idea of infinity secondary focus, having occurred to me, probably has occurred to many others as well.

"However, if this has any advantage not readily apparent, it might be worth developing further."

One function of this department being to put ideas on public record, the above idea is hereby put on public record. In fact, not enough of those proposed to this department have been similarly put on such record—they hide in special files of old letters in the above-mentioned desk, and every now and then some new worker rediscovers them and proposes them, which then sets in motion a search. The variety of telescoptical ideas hit on by amateurs during the past 10 years has been astonishing.

IN A TINY NOTE in this department in July, 1942, mention was made of the death of J. H. Hindle, co-author of "A.T.M." and of "A.T.M.A.," and promise of further facts was made. At long last, and despite the complications of




Modified Gregorian

the war, data have now come to light in the form of an obituary contributed by William Porthouse, of England, to the famous "M.N.," or *Monthly Notices*, of the Royal Astronomical Society, principal organ of British professional astronomers. Hindle was an amateur but, just as several amateurs enjoy membership in the professionals' American Astronomical Society, so was Hindle regarded by British professionals as properly belonging to both groups. The *Monthly Notices* is a magazine of scope, solid substance, abstruse depth and height, similar to our American professional astronomers' magazine, *The Astrophysical Journal*. The obituary:

"John Henry Hindle was born at Edenfield, in the Rossendale valley of Lancashire, of Scottish stock, on 1869 November 2, and was elected to Fellowship of the Society on 1922 June 22.

"He was a shrewd Lancashire ironmaster, generous of heart and hand, with all the many virtues of his race: a man of robust intelligence, inexhaustible patience and infinite resource. At the date of his death he was the governing director of the firm of Hindle, Son & Co., Ltd., Engineers, of Witton, Blackburn, where he produced, based on his own and his son's patents, electric and other baling presses, and powerful wide looms for the weaving of cotton and woolen dryer felts for use in the paper-making industry. He was indeed the first person directly to apply electrical power to the generation of mechanical pressure for baling loose materials, and the convenience of this machine has been widely recognized.

"Apart from elementary education at the local school at Edenfield, Hindle was practically self-taught. At the age of 12 years he commenced work as a 'half-timer' in the textile industry, and upon leaving school at the age of 13 went into the mill office where his father was secretary and cashier. During this period he worked in an iron foundry and workshop in his spare time and developed very early his interest in engineering, particularly on the electrical side. About 1895 he had attained the position of electrical consultant on hoisting machinery and electrical motors and dynamos. He developed and patented automatic control gear, an electro-magnetic brake and an emergency safety mechanism for use in electric passenger and goods lifts.

"In 1910 he courageously started in business for himself as a practical engineer in Manchester, removing in 1918 to Haslingden and afterwards to the present Union Engineering Works, Blackburn, where, with the assistance of his only son Thomas, who survives him, he built up a considerable business in textile engineering.

"As his major hobby the production of telescope mirrors appealed to him because of his love of the delicate and precise in science and art. Although not physically a big man he had a wonderful facility in the handling of large specula. Some years ago he was described in the *Manchester Guardian* as 'one of the leading optical experts of the time.' He produced and mounted many Newtonian and kindred mirrors of all sizes, the largest being the 20½″ made for Dr. W. H. Steavenson, the 25″ which he used himself for the delight of his friends, and the 30″ which is being mounted at the Cambridge University Observatory by arrangement with Sir Arthur Eddington. This instrument is to be available for the Observatory staff until such time as Dr. Steavenson is free to put it to full use. It is described in detail by Hindle himself in *Scientific American* for 1939 September. Notwithstanding the magnitude of these instruments Hindle always considered himself a 'pure' amateur, never profiting financially by his hobby, but always shrewdly placing his telescopes where he knew they would do the best work.

"His principal contributions to the craft were:—(a) 'The Compound Telescope—Cassegrainian and Gregorian Types.' (b) 'The Mechanical Flotation of Mirrors.' (c) 'How to Make a Diagonal for a Newtonian Reflector.' (All appearing in permanent form in 'Amateur Telescope Making' and 'Ama-

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Harvard Observatory, Cambridge 38, Mass.


teur Telescope Making—Advanced.') (d) 'A New Test for Cassegrainian and Gregorian Secondary Mirrors.' (*M.N., 91,* 592, 1931.)

"This new test was considered by Professor Sampson to be a great improvement on other practice, and led to Hindle's being commissioned to make a new 19½" convex secondary for the 72" reflector at the Dominion Observatory, B. C., to be subjected to the new test. I cannot find, however, that this convex was actually completed.

"Hindle designed his own 'ovoid stroke' grinding and polishing machine but refused to patent it. It is described in 'Amateur Telescope Making' and has become justly popular in the United States of America. A machine of its type is installed at the Kyoto Imperial Observatory, Japan.

"Hindle was a world-wide traveler. His unique business took him constantly to the Continent. He visited South Africa, the United States, and Canada, the last two on many occasions. At such times he always made it convenient to visit the great observatories, where his acquaintance with the optics of reflection made him persona grata with those in control. He was present at the pouring of the 200" disk for the Mount Palomar reflector, an experience which he afterwards described to the present writer in vivid phrases and good Lancashire accent.

"Hindle died at his home in Blackburn on 1942, May 17, at the age of 72. He is buried with his wife (who predeceased him by 22 years) in Helmshore churchyard and his memorial bears the simple inscription of his devoted daughter, who survives him: 'He helped them to look at the stars.'"

Your scribe recalls several protracted visits made by Hindle in New York for business purposes. The "good Lancashire accent" is closer to American than the so-called "standard" English.

He was a thick-set man who, despite his descent from Scottish stock, reminded one of the chunky, substantial John Bull of the familiar sketches, and he was a bit "set." His Scottish stock came to the surface in a long but exceedingly lively argument which he conducted with Ellison in *English Mechanics* in 1926, regarding the effects of changing temperature in telescope mirrors. In issue after issue the Englishman of Scottish descent and the sometimes peppery Irishman of Scottish-English descent did major combat, barring no holds. Your scribe still has most of these serial communications—a dozen rounds of pitched battle, each provocative of many a chuckle—preserved in a treasured file clipped from *English Mechanics.* Few of us are wholly logical when it comes to higher authorities. We incline to place them beneath the haloes of saints. Most of them would prefer to be regarded only as people, and these two were very human.

CYRIL G. WATES, 7718 Jasper Ave., Edmonton, Alberta, Canada, writes:

"With reference to J. R. Haviland's note on the Barlow lens in the September, 1943, issue, the following points may be of interest. The amplifying power of any Barlow is given by the formula $A = F\text{-}d/f_1\text{-}d$, using the same notation as in Haviland's equations. The focal length of the lens is the principal factor in determining the amplifying power.

"While it is true that the position of the lens has some bearing upon the magnification, the result of moving the lens within reasonable limits is very small. In the example given the lens is placed 2" inside the prime focus, giving an amplification of 4. With the lens 1" inside prime focus, $A$ is 3.8; with the lens 6" from prime focus, $A$ is 5.

"As a rough method of determining the correct focal length of the Barlow lens and its position in relation to the prime focus, the following formulas are approximately correct. No exact formula is possible, since each factor depends upon the other.

$$f_2 = 3f_1/2A$$
$$d = f_1\text{-}f_1/6A$$

"The 'power' of spectacle lenses is given in diopters, and the amateur who wishes to experiment with a Barlow lens purchased from his local optician should ask for a negative lens of 39.4 divided by $f_2$ in inches."

READERS of this department have inquired about the cause of rough, porous, or flaky aluminum coatings that have sometimes been found on telescope mirrors. The question was submitted to an outstanding authority on aluminizing and he replied that this is often a case of what he called "measles," due to faulty cleaning of the mirror before it is put into the jar for coating, or to greasing up in the "evaporatus" after the mirror is put in before mirroring.

An independent means by which the recipient of an aluminized mirror may evaluate the job done consists, as described in a private communication from the authority just mentioned, in pressing a little strip of scotch tape onto the edge of the aluminized surface. If the latter is correctly mirrored the scotch tape will not, when pulled off, remove any of the aluminum film.

On the other side of the question, some who have aluminized mirrors have been blamed unjustly for imperfect coatings of another type, that were caused by pits left in the polishing by the mirror maker himself. Many mirrors—a very great many—especially first ones but sometimes subsequent ones, are not polished out. No aluminizer can be even remotely expected to cover over these faults; in fact, the coating will make them appear to be much more prominent than they appeared before.

Those, also, who hurry the aluminizer, asking immediate return of the mirror sent him, run risk of receiving a case of measles, especially if the job has been done in damp weather, when there is a tendency for oil to creep into the chamber. The disease does not always appear at once but may have a gestation period of a few days. If, therefore, the aluminizer is given a few days to age the mirror before he ships it back, the latent measles, if any, may show up and be cured by recoating.


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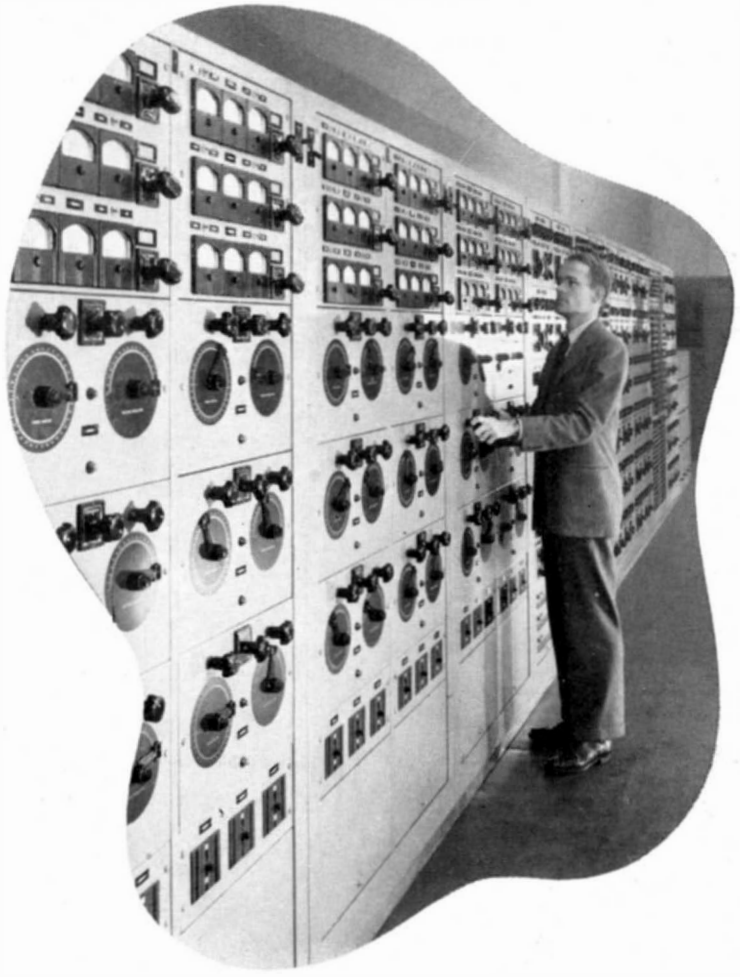

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