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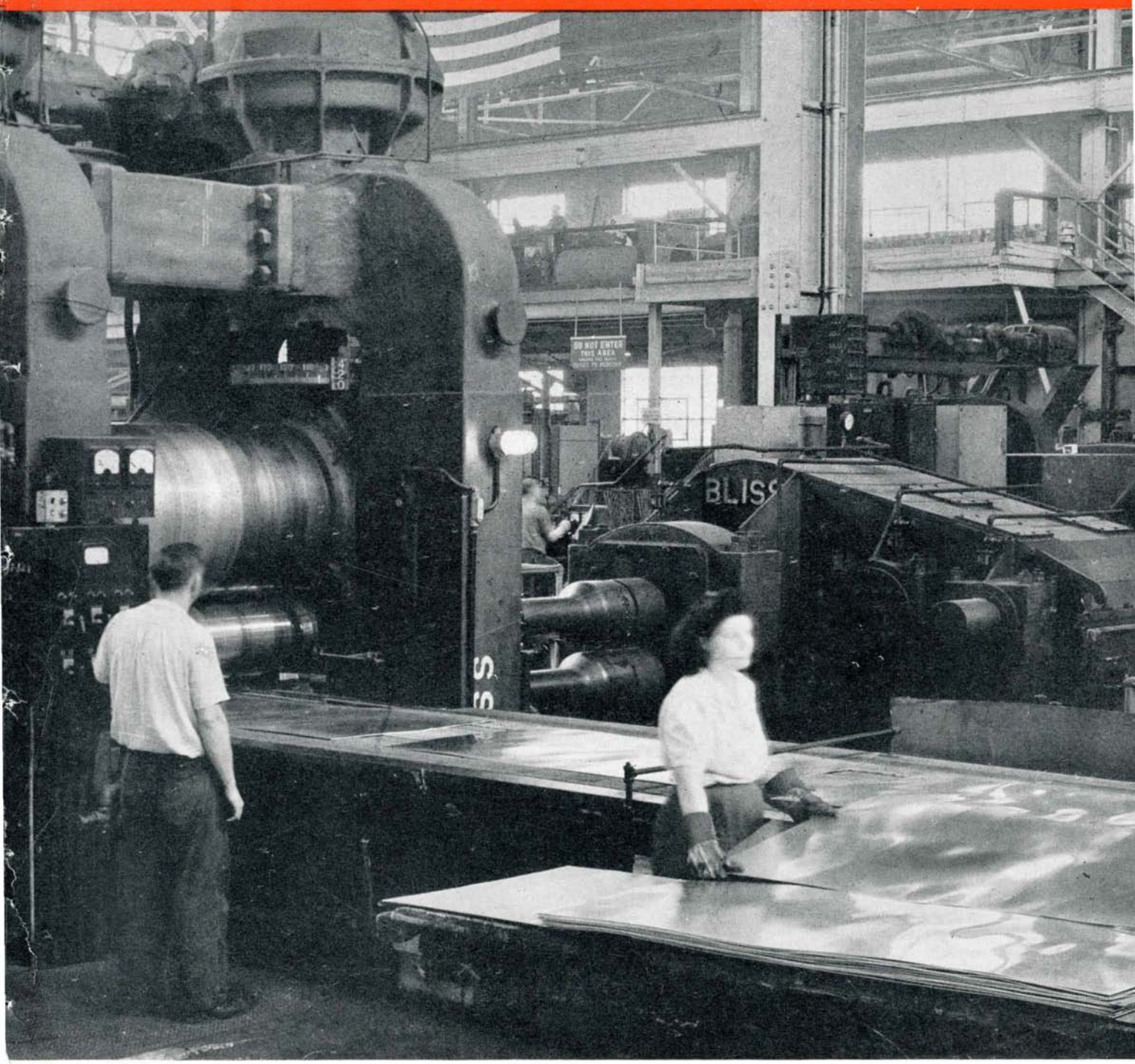
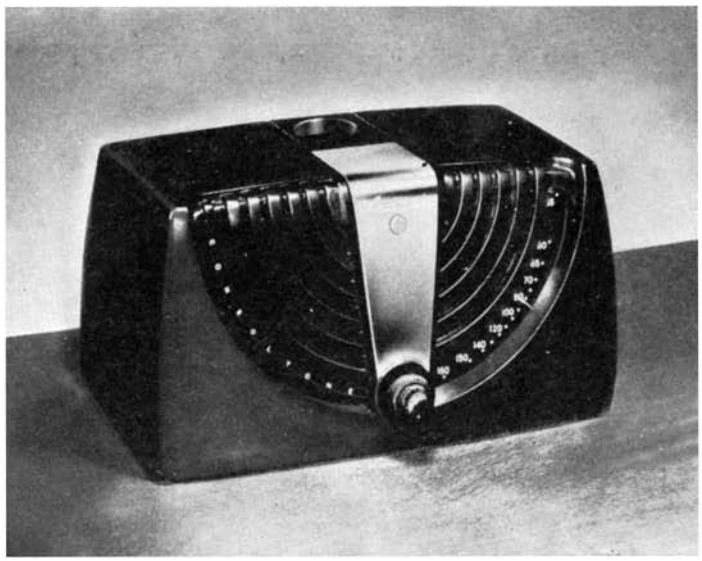
REPORTING THE PROGRESS OF SCIENCE AND INDUSTRY



Successor to Iron and Steel? . . . See pages 49 and 53

DUREZ PHENOLIC PLASTICS... INSIDE AND OUT



Style and performance make this new Zenith radio. The wide traverse dial and the excellent, rich tone quality that make this 1946 model outstanding are recent developments of Zenith engineers.

Durez phenolic plastics permit its attractive cabinet design...contribute to its physical and electrical qualities.

Why Plastics?

In addition to...and more important than...the tuning knobs and cabinets which are quite often molded of plastics, are the vital but "hidden" operating parts of radios.

These unseen items make the difference between good and bad performance. Many of them are constructed in whole or in part of plastics because plastics are better suited for these important jobs than any other material.

Why Phenolic Plastics?

Excellent moldability, heat resistance, diversity of finish, moisture resistance, good dielectric properties...all are inherent characteristics of phenolic plastics. Add to these their practicability for economical mass production, their long-wearing, non-warping qualities, and you have the ideal material for the radio field, where versatility is the prime requisite.

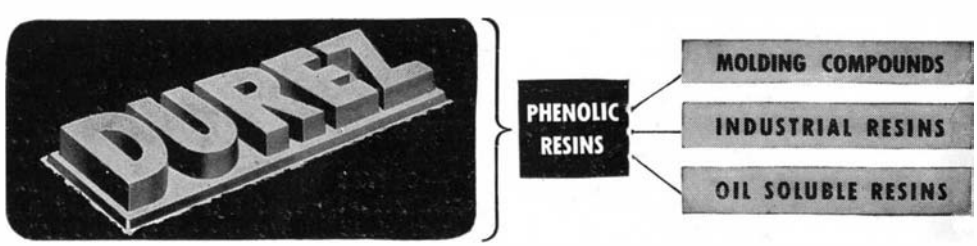
Why Durez Phenolic Plastics?

As specialists in the production of these most-versatile-of-all-plastics, Durez technicians, backed by more than a quarter century's successful product development experience, are equipped to counsel the design engineer wisely on all phases of the molded phenolic picture.

Add to this rich background the more than 300 Durez phenolic molding compounds ... each carefully developed for a specific purpose...and you can readily understand why custom molders and radio manufacturers everywhere look to Durez for the plastics which fit their jobs.

Experienced Assistance Available

Any aid which the Durez staff can give towards solving your plastic material problems is available to you and your custom molder for the asking. Durez Plastics & Chemicals, Inc., 18 Walck Road, North Tonawanda, N.Y. *Export Agents: Omni Products Corporation 40 East 34th St., New York, N. Y.*



PLASTICS THAT FIT THE JOB

INDUSTRIAL DRAMA: Magnesium, available in unlimited quantities from the sea, may someday occupy the place among metals that is now held by iron and steel. Why and how this may come about will be found in the article starting on page 53. Our cover photograph shows the rolling of magnesium sheet in a plant of Revere Copper and Brass Incorporated.

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In This Issue • August 1946

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of August, 1896)

STILL NOT METRIC — "The arguments in favor of the metric system for England are equally strong, or soon will be, as applied to the United States; for although our foreign trade does not approach the volume of British foreign trade, it is likely that in the course of time it will do so, and even exceed it. Prudence would suggest that we should avoid the dilemma in which the English manufacturers find themselves, by making an early change to the metric system. . . Any temporary inconvenience which might be experienced in making the change would be amply compensated by the subsequent saving in time and trouble."

ROTATING SHAFTS — "Some of the results arrived at by recent tests made at the Watertown Arsenal are regarded as of special importance in relation to the endurance of rotating shafts. While it has been found that great improvements in tensile strength and elastic limit have been obtained, it has not been shown whether the limit of endurance under repeated strains has been increased. In the rotating tests of cylindrical shafts, alternate tensile and compressive strains are successively applied, and under these conditions of loading no steel has yet been experimented with which will endure a continuous fiber stress of 40,000 pounds per square inch without rupturing."

SPECTROGRAPHIC ANALYSIS — "W. N. Hartley has determined the composition of a coin by an ingenious adaptation of the methods of spectrographic analysis. The spectrum of the coin was photographed and the metals present first ascertained, after which their relative proportions were arrived at by comparing the photograph with a series of quantitative spectra, in which solutions of known strengths yielded spectra with a certain number of lines of definite length and strength."

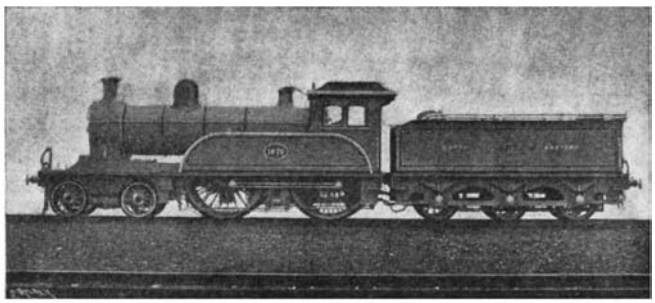
LIGHTNING PROTECTION — "The problem of protecting electric apparatus against lightning has not been altogether one of invention; it has been quite as much one of careful and patient observation. Four years ago it was customary to place a single lightning arrester at the point where protection was desired. Today the same point is protected by distributing line arresters at frequent intervals over the system."

INDUSTRIAL EDUCATION — "We are confronted with the curious spectacle of employers with vacancies which they cannot fill, and an army of unemployed clamoring for work which they cannot get. Our progress in the appliances of the mechanical acts has outstripped our present methods of turning out workmen competent to handle those appliances. This growing scarcity of the skilled mechanic is undoubtedly due to the decadence of the apprenticeship system and the inadequacy of our present industrial and trade schools, excellent as they are, to meet the growing necessities of the case."

OCEAN LINER — "The largest ship in the world is building at the Vulcan shipyard in Bredon, near Stettin, Germany, for the Hamburg-American line. . . The new monster steamer has a length of 625 feet on the waterline, and is therefore considerably larger than the Campania, which is 600 feet in length between perpendiculars. The engines will have 27,000 horse power and a speed of 22 knots is expected."

FLIGHT — "If man does learn to fly by mechanical means, or even to float for an indefinite period by a balloon, then Lilienthal's death, the flight of Langley's machine and the other achievements will be a group of notable occurrences. Slowly a tangible theory of soaring has been evolved. The support given to an aeroplane in horizontal motion through air has been experimentally tested and has proved surprisingly great."

LOCOMOTIVE — "Northeastern Railways (England) No. 1870 is the second locomotive of its class to be turned out. . . It must be admitted that within the limitations imposed by the English custom of placing the cylinders inside the frame, and hiding the working parts from view, which to American eyes always appears to rob a locomotive of much



of its charm, this is a very handsome and well-proportioned machine. . . The driving wheels, 7 feet 7 inches in diameter, are the largest set of four coupled wheels in the world, and were only exceeded by some 8 foot 3 inch six-coupled wheels tried on the Continent some years ago."

LOCKS — "The Yale lock manufacturers have proved that in a patent lock having six 'steps,' each capable of being reduced in height twenty times, the number of changes or combinations will be 86,400. Further, that as the drill pin and the pipes of the keys may be made of three different sizes, the total number of changes will be 2,592,600."

EXPORT — "An entire locomotive making plant will be taken soon to St. Petersburg from Philadelphia on the British steamship Laleham."

100 Years Ago in . . .

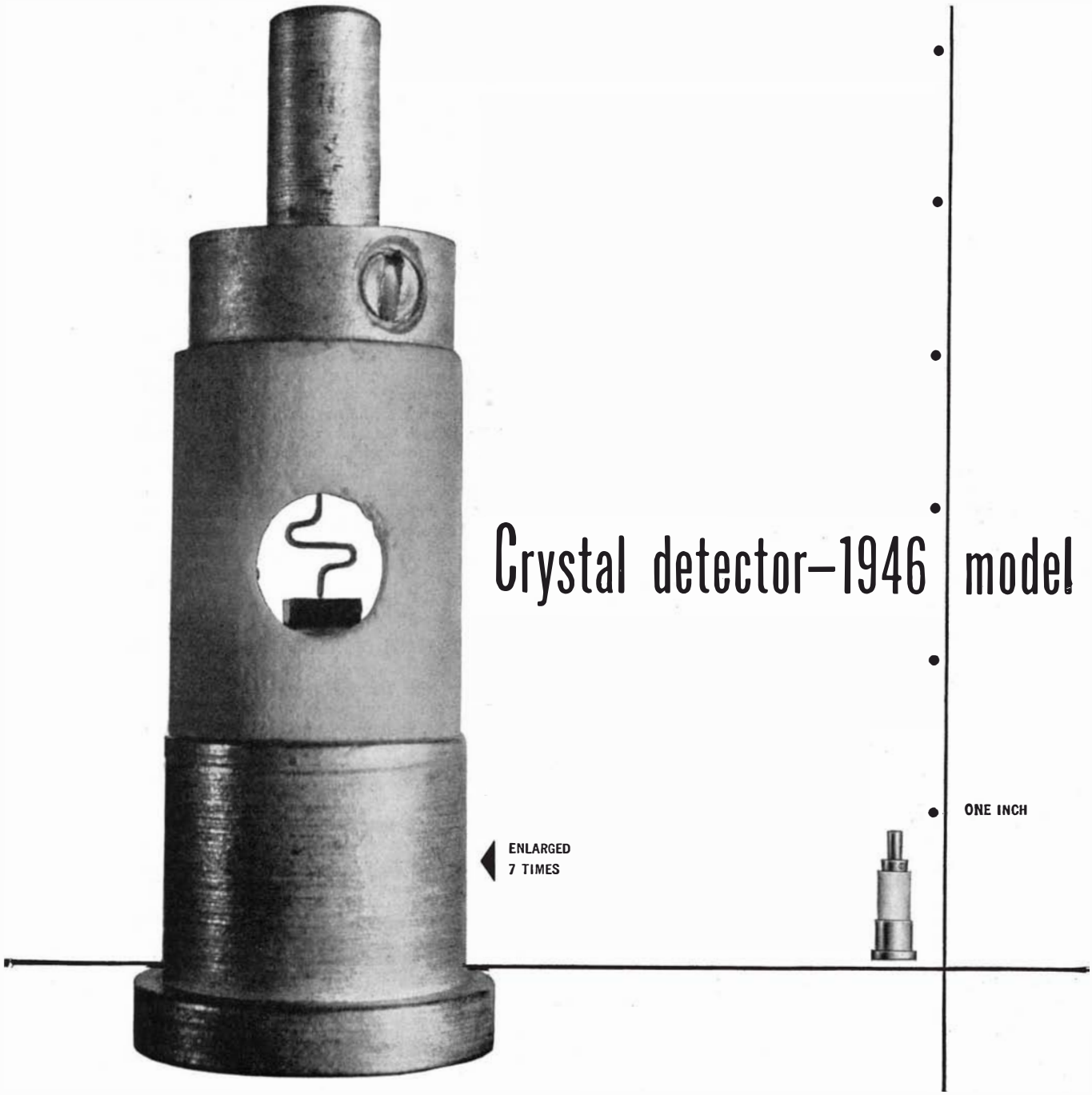
SCIENTIFIC AMERICAN

(Condensed from Issues of August, 1846)

IRON — "The new furnace at St. Clair will produce 80 tons of iron a week, or 4,000 tons a year, which, manufactured into bar or railway iron, will give 3,200 tons, worth at $75 per ton, $240,000."

WAGON BRAKE — "A patent has been recently granted for an invention that consists of a simple arrangement by which the rear end of the pole of a wagon or stage coach, by being permitted to slide back two or three inches through a groove, by this motion, operates a pair of brake-blocks against the rear side of the forward wheels; thus impending the wheels by the action of the horses in holding back the pole."

PAVING — "The new pavement of granite blocks in State Street, Boston, is much admired and approved, and appears likely to prove much cheaper eventually than the uncouth old fashioned pebbles. The blocks are judiciously arranged so that all the seams or interstices run diagonally across the street, thus evading the danger of having the seams worn much faster than the faces of the blocks."



Crystal detector—1946 model

Remember the crystal detector in the first radios — hunting for the right spot with a cat's whisker? For years the detector lay discarded in favor of the vacuum tube. But when microwaves came, and with them the need to convert minute energy to amplifiable frequencies, a Bell Laboratories' scientist thought back to the old crystal.

Silicon of controlled composition, he discovered, excelled as a microwave detector. Unlike the old-style natural crystals, it was predictable in performance, stable in service. From 1934 to Pearl Harbor, the Laboratories developed silicon units to serve microwave research wherever needed.

Then Radar arrived. The silicon crystal came into its own, and found application in long-distance microwave Radar. Working with American and British colleagues, the Laboratories rapidly perfected a unit which the Western Electric Company produced in thousands. It became the standard microwave detector.

Crystal detectors are destined to play a big role in electric circuits of the future. They will have an important part in Bell System microwave radio relay systems. In various forms, they may reappear in radio sets. Here again Bell Laboratories' research has furthered the communication art.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED ECONOMIES AND IMPROVEMENTS IN TELEPHONE SERVICE

Previews of the Industrial Horizon

By A. P. Peck

WHAT'S IN A NAME?

If anyone ever doubts the value of brand names in a competitive market, let him take heed of the present situation in the retail radio-receiver field. Production has been pushed to nearly record heights by "quickie" manufacturers. Would-be purchasers of radio sets have the money to buy. Retailers, at least in large cities and surrounding areas, have plenty of sets on their shelves. But, despite the demand for receivers, sales are slow. Unknown brand names—let's coin a few, such as Ethermaster, Tonamatic, and Electromystic—just don't move. Unknown, unadvertised, unsung in every respect, these receivers are being severely left alone by the buying public.

Some pinkish students of economics might ascribe this situation to defects in our system of production, advertising, and distribution. Actually, it finds its basis in a solid foundation of public faith in proved materials. When such firms as RCA, Westinghouse, Zenith, General Electric, and Emerson—to name but a few—are in a position to place radio receivers on the market, and to back them with their advertising and their reputations, the public will receive their products with open arms. In the meantime, that same public will sit on their pocketbooks and await the time when they can spend their money for radio sets which they know by name.

All of this lends added force to the overall subject of free enterprise and competition. Produce a better mousetrap, prove its ability, tell people about it, and the path will be beaten to the door. But try to crash even a seller's market with an unproved mousetrap and the path will be overgrown with weeds. In the long run, industry can deal best on integrity which backs brand names, rather than on opportunism that takes momentary advantage of circumstances.

RAMIE—WONDER FIBER, OR . . .

For thousands of years the fibers of the ramie plant have been known as a fabulous material with about the same strength as mild steel for the same weight. These fibers can be made up into durable and attractive clothing. They resist deterioration by moisture and have high wet strength. Fishing lines and nets of ramie fiber are strong and long wearing. Further, ramie fibers can be stapled and spun on either cotton or woolen systems. They are also valuable industrially in heavy belting, packing, filter cloth, upholstery, carpets, draperies, and blended fabrics of many kinds.

Wherein, then, lies the answer to the ramie problem that has cropped up perennially for many years? Known as the Oriental wonder fiber because of its use in the Orient for many hundreds of years before Christ, there is still all too little knowledge of the best ways of growing and handling it by modern industrial methods.

Now, it appears, the whole problem of ramie is being attacked in a rational manner. Probably ramie will never compete commercially with cotton and wool because the ramie plant is subtropical in nature and cannot be produced over as wide an area as competitive fibers. Yet, because of its outstanding advantages, it will have a real place of its own when commercially produced in this country.

Foremost among the problems of ramie is the matter of decorticating—stripping the useful fiber from the surrounding plant bark and skin and from an obstinate gum seemingly placed as an obstacle to the desired imbedded threads. In the Orient, where hand labor is the cheapest part of a production program, a Chinese laborer can strip or decorticate a few pounds of fiber for an equally few cents a day. The product is excellent, but production is low. This, then, is the problem that American producers of ramie must face.

Today, several millions of dollars are being invested in Florida in ramie projects. Prominent in the work are the powerful United States Sugar Corporation interests, coupled with Newport Industries, Inc., and the Sea Island Mills, all of which are intent on working the Everglades area for all it is worth. Here the soil is composed of decomposed vegetation, ideal for propagation of ramie, and thousands of acres are planted to ramie, with processing plants completed or under construction.

Still experimental work continues. While an acre of Florida Everglades soil will produce 30 tons of ramie plants, these 30 tons will yield only one ton of fiber. Thus the transportation problem enters the picture. Newest technological possibility is in the form of portable decorticating plants which will work right in the field. And when the problem is finally licked, American science will have another commercial fiber into which to sink its teeth.

In the meantime, Florida has no monopoly on the growing of ramie, although the Everglades area appears to hold advantages. Acreages are being planted in Louisiana, Mississippi, Texas, and California. It appears that a new textile-fiber race is on, backed by a few thousand years of hand labor.

DEPRECIATION VERSUS OBSOLESCENCE

So sound and sane is the philosophy propounded by a brochure from an industrial company which recently came across our desk that we cannot resist the temptation to quote:

"Economics teaches us and industrial history shows that when a company cuts the cost of a product, it can offer that product at a lower price. As the price goes down its potential market increases. As its market increases, its volume goes up. As its volume goes up—it can hire more men. One of the fundamental principles of our competitive economy is that jobs are created by increasing the productivity of the worker.

"The modern machine tool is an important factor in this cycle of events. It is industry's instrument for reducing costs, and it reduces costs by increasing output, by doubling and redoubling the productivity of the individual worker."

This leads up to a question: Should this instrument, then, be subjected to yardsticks of obsolescence, rather than to demands of depreciation? Forward-looking executives are minimizing obsolescence in their plants; are measuring machine-tool usefulness in terms of production efficiency rather than in arbitrary years of tool life. They view these tools in the light of what they can do and not of their age.

More thinking of this kind is necessary to the American way; references will be given on request.

FOR FUTURE REFERENCE

Heat sealing of plastics sheeting, promoted by RCA, is being used in production of dress shields, bathing caps, raincoats, shower curtains, and the like; many such products can be made faster, better, and more economically through the use of electronic heating . . . Another plastics item: These materials are notoriously sensitive to heat and cold, but now Du Pont reports Teflon, an electrical insulating material that will withstand heat up to 600 degrees above zero, Fahrenheit, and down to 75 degrees below zero, with resistance to effects by ordinary chemicals . . . Men who work with machine tools should be taught the *why* of things as well as the *how;* Shell Oil Company is advocating this procedure with new literature on lathe operation principles.

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METALS IN INDUSTRY

Magnesium: Inexhaustible Metal

When Other Metals Reach the Economic Vanishing Point, the Seas Will Still Hold Unlimited Quantities of Magnesium. Today, this Remarkable Metal is Slowly Gaining in a Competitive Market. Its Strength, Machinability, and Lightness are Important Benefits

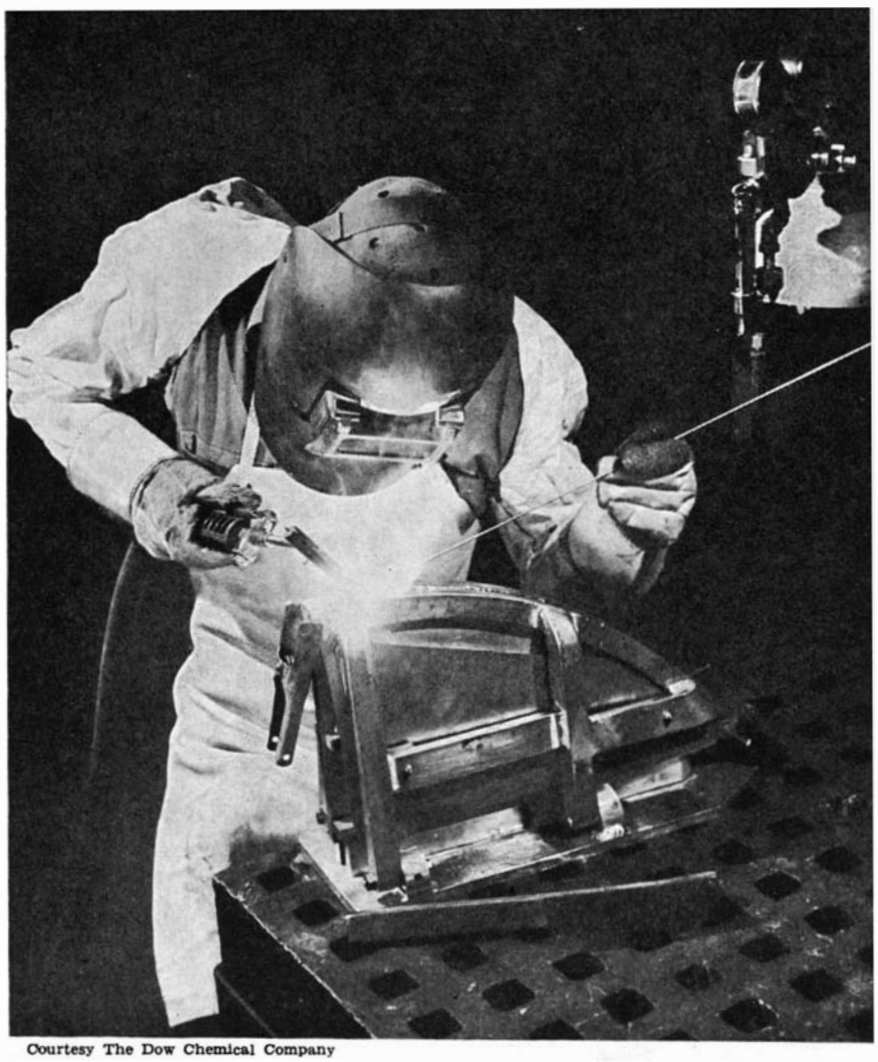
By FRED P. PETERS
Editor-in-Chief, *Materials & Methods*

TECHNICALLY this is still the "iron age" of man's development, but this era or the period immediately ahead is also called, with varying degrees of accuracy or optimism, the chemical age, the plastics age, the air age, the atomic age, or the light-metal age. The latter, and one of the most plausible of the so-called ages, is partially based on the contention that magnesium will eventually replace iron as the world's basic constructional raw material. Hence, it might be feasible to call the next age of man the "magnesium age."

This implies, however, that the total American production of magnesium would probably have to reach more than 25 million tons per year, as compared with an optimistically estimated 1946 production of 25 to 38 thousand tons. This, in turn, would mean that magnesium as an industry would have to grow to about a thousand times its present size. Moreover, before this could happen magnesium's present and potential chief competitors—iron and steel, aluminum, structural plastics, copper, and so on—would have to have reached a state of depleted or vanished supply, prohibitively high prices, and technical inferiority to magnesium in the tonnage markets.

Actually, the production of some of these competitive materials is steadily rising or their prices are falling, while among all the engineering metals technical quality is steadily being improved. It is evident, therefore, that if magnesium is to become the prime raw material it is not likely to do so for scores of years or perhaps centuries.

But it is also evident that magnesium does stand a good chance of achieving this ultimate goal on some distant day, and that in the much nearer future it will grow rapidly



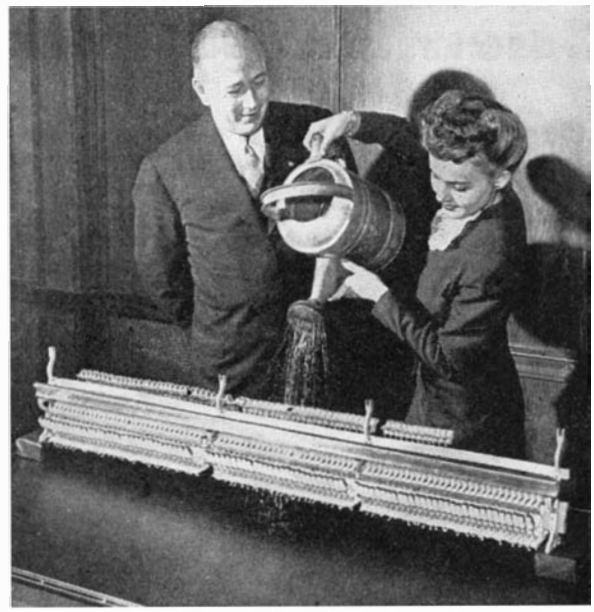
Courtesy The Dow Chemical Company

Welding magnesium alloy with a helium-shielded electric arc; a tungsten, rather than carbon, electrode is used. Magnesium alloys are also weldable with gas

to become a major competitor of the heavier basic metals for hundreds of uses as yet unimagined.

MAGNESIUM TODAY—At present, the going is not too easy for magnesium. It is still young as an engineering metal and its established uses have been predominantly military in nature. The number of plants and engineers familiar with magnesium, and the number of peace-time product applications that can serve as stimulating examples, are still relatively small—too small at this moment to occupy fully the war-expanded production capacity of the industry. Also, magnesium has cost problems. It is competitively at an original-price disadvantage with respect to aluminum, steel, cast iron, and other common engineering materials. And its acceptance is hindered by certain prejudices and misconceptions that only persistent and aggressive education can eradicate.

But producers and fabricators of magnesium are anything but pessimistic, and they are on sound ground. Magnesium's position from now on will continually improve. Several factors favor a steady—perhaps, eventually, an accelerating—growth for magnesium. These factors include: extractability from an inexhaustible raw material—sea water—at a reasonable and steadily decreasing cost; and technical superiority over all other metals with respect to lightness and machinability. The last points are important in a world that places increasing value on mobility, comfort, and mass-production manufacturing.



Extruded magnesium parts combine with plastics to replace wood and make this piano action virtually waterproof. New uses for the light and workable metal will appear as more engineers come to know its advantages

If the eventual thousand-fold growth of an industry seems fantastic, it should be considered that magnesium's annual production volume expanded 100-fold in just the five-year war period. In 1939 the American magnesium output was six million pounds; by 1944 the capacity of the industry had reached 580 million pounds. The "magnesium industry," which previously comprised one primary producer and a mere handful of fabricators, now is banded into a trade organization, the Magnesium Association, whose members include four or five producers and more than 45 fabricators of the light metal.

One of the outstanding characteristics of this still-infant industry is the strength and stability of its leading members. Such companies as Dow Chemical Company, American Magnesium Corporation, and Revere Copper and Brass are enthusiastically and effectively sharing the technology with the rest of the industry and intelligently educating their markets on the advantages and limitations of magnesium.

The war's end left the industry with an enormous immediate task of finding markets for most of its capacity where virtually no markets existed before. Yet, more new uses for magnesium have been contemplated and started since V-J day than in the five-year period before the war, and users are now climbing on the bandwagon at an accelerating rate.

PRICE FAVORS USE—Future price trends are going to increase further the rate of application for magnesium. Since 1915 the price of magnesium ingot has fallen from $5 per pound to about 20 cents per pound. At its present price, magnesium is more expensive on a unit-weight basis than aluminum, but is somewhat less expensive on a unit-volume basis. It is reliably predicted within the industry that the price of magnesium will be lowered 25 percent in the next five years, and that its fabricating costs will also be significantly reduced by virtue of technological improvements.

These forthcoming price changes are closely related to the development and increasing importance of the Dow process using sea water as the source of the magnesium chloride from which the magnesium metal is eventually electrolyzed. Built in 1940 and 1941, the sea-water plants and processes have demonstrated their ability to produce magnesium at lower costs than other

Light enough for one man to handle, magnesium aircraft wheels carry heavy loads

• LOOKING AHEAD •

Advantages of magnesium—other than lightness—will be exploited... Production of raw metal will increase and price will decrease... Cost will become a less-important factor... Engineering and design will welcome easy fabrication... Early-birds in applications of magnesium as a structural metal will gain a desirable marketing edge... Predictions of a bright future based on sound logic.

methods, and will probably soon become the major production processes for the metal.

Because of the sea-water process —and to a lesser extent because of the undiminishing availability of the workable magnesium minerals in the earth—magnesium appears to be the only potentially "basic" material of which the supply is actually unlimited or inexhaustible. One cubic mile of sea water, for example, contains the equivalent of 9.2 billion pounds of magnesium metal.

At the present time, no other engineering material, including plastics produced from agricultural raw materials, offers this same possibility of a continuing supply without a necessary rise in extraction cost. And while this may be of little economic importance from the standpoint of today's or 2046's materials engineering, it will be the consideration that will have overweighed all others in that dimly distant future when readily extractable high-grade deposits of iron, aluminum, zinc, lead and copper ores, and of coal and oil, have reached exhaustion.

LIGHT BUT STRONG—From the engineering point of view, as well, magnesium's position may be expected to become steadily stronger relative to its competitors. Today, it is the lightest of the structural metals, with a specific gravity one quarter that of steel and two thirds that of aluminum. Its alloys are sufficiently strong that many products will be both stronger and lighter when made of magnesium than when made of aluminum or steel.

On the basis of equal strength, for example, a magnesium part may save 70 percent of the weight of a similar steel part. Once it becomes generally appreciated that the use of magnesium not only can permit weight saving without sacrifice of structural strength but also can simplify design by allowing the use of thicker and therefore stiffer sections without adding to weight, the conquests of magnesium will start to add up. Lightness will be particularly important as man takes increasingly to the air and to higher-speed land vehicles and sea-going vessels, all of which place a premium on light weight. Further, most people favor those aids to daily living that are lighter to lift or less heavy to push around.

The damping capacity—ability to absorb vibrations—of magnesium alloys is now known to be higher than that of aluminum alloys and many other metals, and to approach that of cast steel. This means that magnesium parts run quieter, are less likely to transmit vibratory stresses to adjacent parts, and are less subject to fatigue failure than if they were made of other metals.

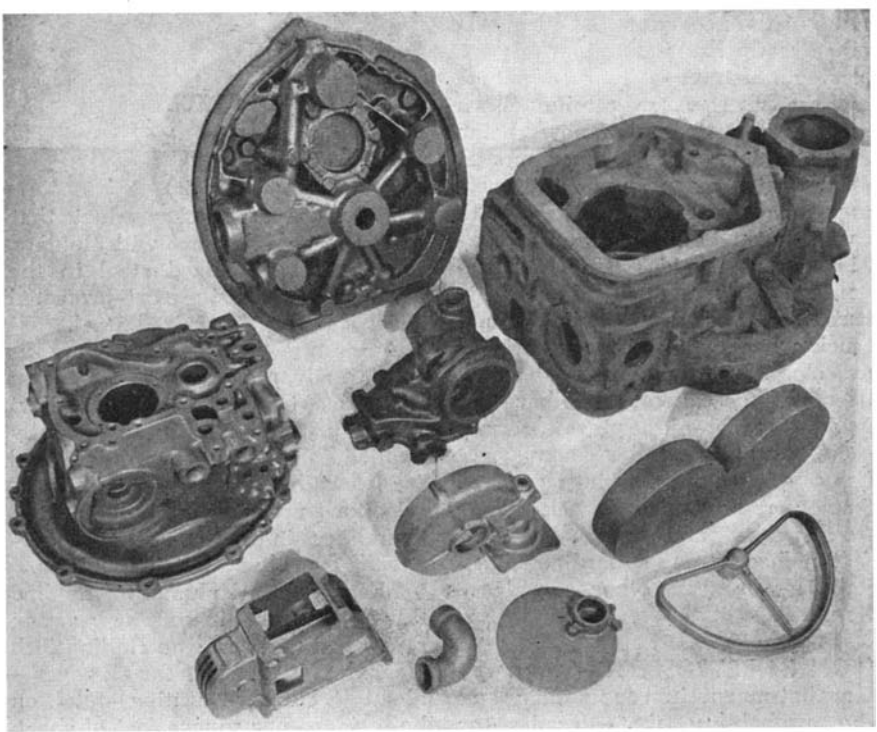
Another discovery that some 30,000 new magnesium-fabricating plant employees made during the war, but which thousands of others in industry have yet to learn, is that magnesium is one of the easiest to work of modern materials. It is beyond dispute the most machinable engineering metal, requiring only from one sixth to three fifths the power needed to machine most of its important competitors. It is also among the most weldable of metals and one of the few, along with aluminum, on which deep draws can be made from hot sheet metal in one operation.

Where corrosion-protection is needed, and this is required less often than was formerly supposed, a large number of chemical finishes and paint treatments—simple, quick, and inexpensive—are available. And magnesium's so-called "fire hazard" is now widely understood for what it actually is: a hazard only when handling fine magnesium powders or the molten metal. Solid pieces and parts made of magnesium alloys are no more flammable than they would be if made of aluminum, steel, zinc, or copper.

Technical developments now available or in the making presage a steady rise in the product appeal, processing efficiency, and ultimate consumption of magnesium. "Superstrength" magnesium alloys are heralded as a challenge to structural steels and heat-treated aluminum alloys. A series of highly pure magnesium alloys have exceptionally good corrosion resistance. Giant forgings soon to be available in magnesium alloys provide, in effect, a new type of engineering material. The rapid development of shielded arc welding; of cerium-bearing alloys for high temperatures; of new, strong die casting alloys; of castings that are free of micro-porosity; and of magnesium sheet for stressed-skin aircraft structures are only a few of the technical foundation stones in magnesium's future.

WEIGHT OR COST?—The cost factor is still a sharply restricting agent in expanding uses of magnesium. This situation will improve as the raw material price goes down and as still more efficient fabricating methods are developed—the latter being one of the goals the industry has specially set for itself.

The design economies achieved in the aircraft industry through the



Magnesium-alloy sand castings for aircraft use; intricate shapes are possible

All-metal magnesium skis do not warp, are lighter, faster than wooden

use of magnesium floor beams for cargo ships and of stabilizers with magnesium shells are familiar to many. This couples neatly with the fact that a light-weight design may be initially more expensive but return much more than this extra cost to transportation equipment operators in increased payload or reduced power charges during the service life of the equipment.

Thus in many cases and with certain forms of alloys, the use of magnesium may be more economical, one way or another, than some other material. However, although lightness is still the dominant factor leading to the choice of magnesium in most present-day applications, some of the new uses that magnesium already has found in post-war products involve a cost advantage for the user. A magnesium lawn mower, for example, now being made in lots of 50,000 per month, incorporates magnesium-alloy castings in successful competition with cast iron on both a cost and durability basis—besides the chief advantage of "less push." For furniture, too, and even for auto and truck wheels, the cost comparisons are close. But for most of the new uses such as canoes, wheelbarrows, griddles, skis, auto pistons, crank cases, gravity roller conveyors, baby carriages, sleeping-car bed frames, radio towers, truck structural beams, and so on, the cost factor has been subordinated to lightness or some other consideration.

IRON IN RETROSPECT—The problem that magnesium faces today and the probability that—decades or centuries from now but nevertheless eventually—it will replace steel as a basic material has been intriguingly presented by one of the industry's leaders. Iron and steel, he reminds us, were not always as cheap as they are now, and their production a century ago was measured in thousands rather than millions of tons. There is no evidence that the problems in the magnesium industry are any greater than those faced and overcome by steel.

Suppose, to continue the analogy, that the positions of steel and magnesium had been reversed, with magnesium the beneficiary of 50 years of commercial development and use and steel a brash newcomer. Suggestions that steel products could compete in cost with magnesium would be considered highly optimistic, and as barriers to such a situation would be mentioned the excessively high melting temperatures needed for steel, the expensive refractories necessary, the heaviness of the material, and of course its devastating and expensive propensity to rust.

One would most probably compare these qualities with the low-melting, light-weight magnesium alloys and conclude that steel could never be cheap enough to compete for the uses that magnesium had so firmly established for itself.

Which is another way of saying that if steel could achieve its present economic position in such a short period, magnesium should certainly be able to match that position eventually.

ALUMINIZED STEEL

Resistant to Corrosion, Reflects Heat Well

A DIP-COATED steel product that will soon take its place with tinplate, terne, and galvanized steel in the array of inexpensive rust-protected sheet steel is Aluminized steel.

Aluminum-coated steel has, as special advantages, good corrosion resistance, heat resistance, and heat reflectivity. It has been successfully applied in automobile mufflers and for firewalls in airplanes. Other applications now under study include oven liners in domestic ranges, heat-exchanger tubes, and similar uses.

The weight of aluminum applied during the hot-dip-coating process, developed by American Rolling Mill Company, is the same for all gages—about ½ ounce of coating—total, on both sides—per square foot of sheet. The actual thickness of aluminum film is 0.001 inch on each side—much thicker than tin-plate coatings of the same weight, because of the lighter specific gravity of aluminum.

COPPER-BEARING

Iron and Steel Have High Strength and Corrosion Resistance

GREATLY increased use of copper-bearing cast irons and steels—from 2000 tons to 13,000 tons in ten years—stems from the much improved characteristics obtained from the addition of small percentages of copper. For example, addition of 0.15 to 0.20 percent copper cuts corrosion of plain carbon sheet steel exposed to atmosphere by 50 percent. Higher amounts of copper contribute strength. Resistance of 18:8 stainless steel to boiling dilute sulfuric acid is increased 90 percent with 2 percent copper added. The use of copper, molybdenum, and chromium in gray cast iron is said to develop a tensile strength of over 60,000 pounds per square inch.

EXTRUDED WELD-ROD

Alloys Iron Base and Powdered Coating in Use

WELDING rod made by extruding a combination of powdered metals and ingot-iron wire is arousing interest in both the welding and the powder metallurgy fields.

In making the stainless steel weld-rod, base wire (ingot iron) is clad with enough powdered chromium, nickel, manganese, and silicon to produce under the welding arc a weld deposit of standard stainless steel. The clad wire is extruded just as fluxes are now extruded on drawn welding wire; the extruded product is then sintered.

Close control of powder analysis, particle size, mixing, and extruding pressures is said to result in a composite welding wire that yields consistently good deposits and at lower cost than conventional wire.

ENGINE BLOCK

Die-Cast In One Piece at Three-Per-Shot Rate

LATEST development in large die castings is the production as a one-piece die casting of a combined engine cylinder block and crankcase. The castings, made of aluminum alloy, weigh about 15 pounds each and can be produced at the rate of 40 per hour. The machines cast up to 65 pounds of aluminum—three of the engine castings—in each shot. Westfield Manufacturing Company is casting the units for Jack and Heintz Company.

Conducted by D. H. KILLEFFER

Is Soap Slipping?

Aided by the Fats Shortages of Two World Wars, "Soapless" Soaps are Moving in Rapidly on Tasks Long Regarded as Soap's Own Province: More than 300 Wetting Agents, Detergents, and Emulsifiers are Now Made. Many are Specialized; Others, General Purpose

By HOWARD C. E. JOHNSON, Ph.D.
Chemical Editor, *Chemical Industries*

• LOOKING AHEAD •

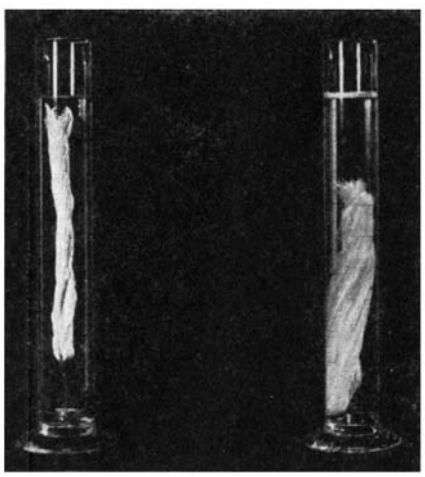
Foods, cosmetics, and toothpastes will feel the impacts of "soapless" soaps . . . Water-base paints, sprays for agriculture, industrial "soluble" oils will benefit . . . Surface active agents can make "impossible" processing methods work . . . Can be production "catalysts."

SYNTHETIC detergents, made either from petroleum products or from less fats than a comparable quantity of soap, can do most of the things that soap can do and many things that soap cannot. Moreover, they can be tailor-made for a particular use.

Soap has long been almost unique, among thousands of materials, in its characteristic properties.

Of these properties, soap has, first of all, a detergent or cleaning action. Every day advantage is taken of the fact that soap and water remove dirt much more easily and effectively than water alone. Secondly, soap has a wetting action. Pure water will often collect in little droplets on a surface, such as glass, while a soap solution will spread out over and wet the surface. Also, fabrics will "soak" faster in a soap solution since they are more easily penetrated by the solution than by plain water. Still a third characteristic of soap is its ability to disperse solids, liquids, and gases so intimately in water that they are not easily separated. Suds and lather are simply dispersions of small air bubbles in soap solution.

SURFACE ACTIVITY—These characteristics—detergency, wetting and penetration, and emulsification and dispersion—are all manifestations of what the physical chemists call "surface activity" because they involve the surfaces of the soap solution and the textile fiber, the oil droplet, the particle of dirt, or the sheet of glass. Of chief importance is the fact that soap lowers the interfacial tension—the barriers between the separate substances are broken down, enabling them to mix and, what is more important, to stay mixed, more readily.

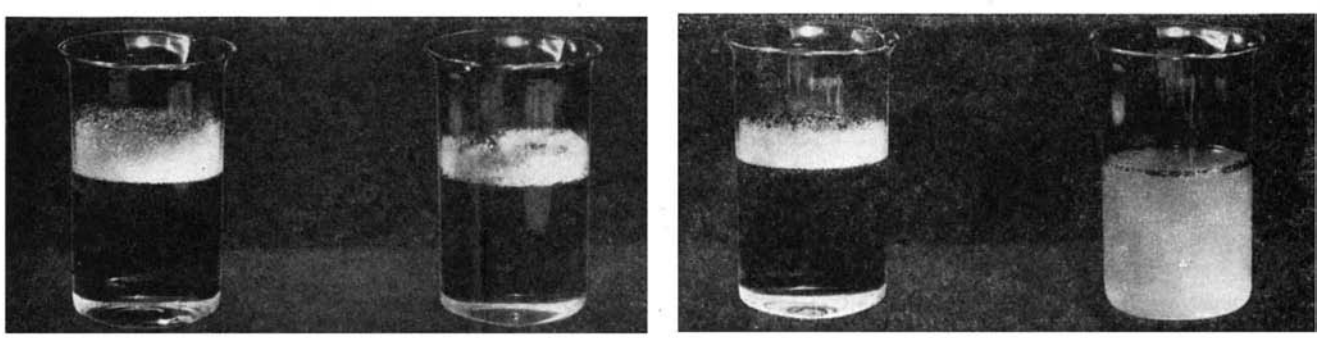


Sinking of yarn skein illustrates the wetting action of ordinary detergent (left) and synthetic detergent (right)

This concept explains in a limited way the action of soap. Wetting and penetrating ability are exhibited when soap reduces the disinclination of two dissimilar substances—the water solution and the textile fiber, for example—to mix. Its function might be likened to that of a hostess at a meeting of strangers.

In detergency, the soap solution wets both the surface of the material being cleaned and the particles of dirt and oil adhering to it. It interposes a thin wedge of water between the two and prevents them from adhering to each other. Emulsification is essentially the same—the oil droplets or air bubbles are kept from rejoining by the thin film of soap solution surrounding them.

It should not be inferred from this oversimplified explanation that surface activity is completely under-

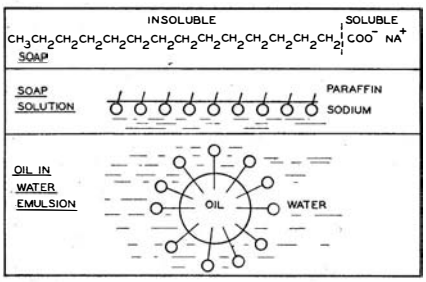


Acid, added to right-hand beaker of detergent (left) has little effect on suds as compared with acid-free beaker at left. Soap solutions (right) show suds in acid-free beaker at left but no suds and floating fatty matter when acid is added as at right

stood. Detergency, especially, is an exceedingly complex phenomenon, and many phases of it are still defying analysis by and and all available techniques.

SOAP AT WORK—Certain characteristics of chemical structure are shared by soap and all the newer materials possessing surface activity. The molecules of these substances all have a water-soluble portion attached to a water-insoluble portion. In ordinary soap, the insoluble part resembles paraffin and is a fatty acid of from 12 to 18 carbon atoms.

The water-soluble portion is the sodium or potassium salt of the oxygen-containing, acidic end of the fatty acid, as shown in the accompanying diagram. In solution the dissolved soap orients itself at the surface with the sodium "head" in the water and the paraffin-like "tail" sticking out. The "tails" are soluble



Diagramatic concept of soap action

in oil, grease, and so on; hence the soap acts as a bridge between the two unlike materials. A magnified section of an oil-in-water emulsion might look something like the sketch in the diagram.

In the synthetic detergents, the water-soluble portion may be a sulfate, sulfonate, or chloride ion, or sufficient hydroxyl or ether groups to confer solubility. The insoluble part may be a paraffinc chain, such as in soap, or an alkylated aromatic hydrocarbon nucleus.

Soaps, as well as most of the synthetic detergents, are salts; and as such they exist in solution as ions. Each molecule breaks up into a positively charged ion—cation—and one of a negative charge—anion.

Where the water-insoluble portion is in the anion—as in soap, the sulfates, and sulfonates—the material is called anion-active. A rather novel type is the cation-active synthetic surface-active agent, in which the hydrocarbon portion is found in the cation. An example of these is cetyl dimethyl benzyl ammonium chloride, known commercially as Triton X-400.

Still other types are non-ionic; that is, they are not salts. The solubility of the water-soluble portion depends on a grouping of several hydroxyl or ether linkages. Examples of these are the Spans, which are fatty acid esters of sorbitol anhydride. Sorbitol is an acid derived from sorbose—a sugar—and contains six hydroxyl groups.

SOAP VS SYNTHETICS — Soap is excellent for many uses, but it also suffers from many limitations. The calcium and magnesium salts in hard water, for example, form insoluble curds with ordinary soap. These curds are responsible for the familiar "bathtub ring" and for the dingy appearance of hair, clothes, or glassware washed in hard water. Not only do these greasy, insoluble curds make cleaning more difficult, but they also waste a good deal of soap. For example, the inhabitants of a northern Illinois city where the water hardness is 555 parts per million, use almost twice as much soap per capita as the people of a comparable city in northern Wisconsin, where the total hardness of the water supply is only 45 parts per million. The water can, of course, be softened or otherwise chemically treated to make it acceptable for use with soap, but such treatment is an additional expense and often an inconvenience.

Also, soap is practically insoluble in cold water and precipitates as a greasy, insoluble fatty acid in the presence of mineral acids. Many industrial processes, such as metal cleaning, textile dyeing, and the like —or even domestic tasks such as the washing of delicate fabrics— might be more advantageously carried out at room temperature or in an acid medium where soap is useless.

It is generally conceded that soap is the best known cleansing agent in soft, warm, alkaline water. It is where these conditions cannot be met that synthetic detergents are finding daily increasing use.

In the other manifestations of surface activity—wetting, penetrating, dispersing, and emulsifying— the synthetics have proved superior to soap. The history of synthetics starts with Turkey Red oil, developed almost a 100 years ago to assist in the dyeing of cloth with Turkey Red dye. This oil, which is sulfated castor oil, proved superior to soap and is still being produced in quantities of 30,000,000 pounds a year.

In foods, cosmetics, toothpaste, and the like, soap has drawbacks as an emulsifying agent. Its alkalinity not only causes soap to be incompatible with neutral or acidic materials, but it also gives it a bitter taste, and an irritant action on sensitive skins. In contrast, synthetic emulsifiers of the non-ionic type are stable in any range of acidity and alkalinity, are much more blander, and are soluble in oils.

DETERGENTS EXPAND—In view of soap's limitations, it is not surprising that the synthetic detergents industry has experienced a phenomenal growth. Not a pound was produced in this country in 1928, but by 1945 production had skyrocketed to 125,000,000 pounds annually. Stimulated by the fat shortage of World War I, the Germans developed soap substitutes at that time. Research progressed after the war, and in the early 1920's were introduced the fatty alcohol sulfates, later to become familiar in this

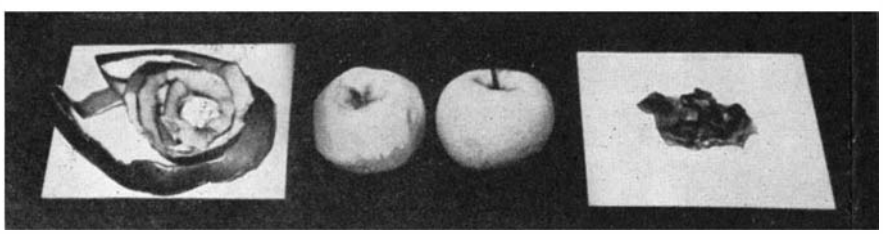
Some of the Ways in Which Synthetic Detergents will Find Increasingly Wide Applications

DOMESTIC USES

Glassware	Rugs
Dishes	Woolens
Colored fabrics	Shampoos
Upholstery	Bubble Baths
Walls and woodwork	Windows

INDUSTRIAL USES

- Textile scouring, dyeing, and finishing
- Leather and paper processing
- Acid pickling of steel
- Metal cleaning and degreasing
- Etching and electroplating of metals
- Cosmetics and pharmaceuticals
- Industrial emulsions
- Water-base paints and coatings
- Sanitary and insecticidal sprays and dusts
- Bottle and container cleaning
- Printing pastes and inks
- Shoe, metal, furniture, and floor polishes
- Fruit and vegetable peeling
- Lubricant additives



Manually peeled apple (left) is 10 percent waste. Chemical peeling (right) was done with lye and alkyl aryl sulfonate; the waste was reduced to about 4 percent

country as Dreft and Gardinols. Manufacture of these was undertaken in the United States in 1929, and shortly thereafter a new type of detergent, the alkylated benzenesulfonates, were developed under the trade name Nacconol. During the intervening years about 300 commercial products have been introduced, and new variations are continually being discovered.

Just as World War I and its aftermath saw the birth of these new materials, the present period will undoubtedly see a huge expansion of manufacturing facilities and partly for the same reason—the fats and oils shortage.

Many of the synthetics are petroleum-based products, and of that raw material there is at present a comparative abundance. Many of them, on the other hand, use natural fats and oils just as does soap. But even here, the same quantity of fat or oil will give more synthetic detergent, pound for pound, than soap. Couple this with the fact that synthetic detergents are often equally effective at one third to one fifth the concentration of soap and it becomes apparent that a great saving can be made of the seriously curtailed fats and oils supply.

It is largely for this reason that synthetic detergent manufacturers have hinted at immediate plant expansions up to a total capacity of 400,000,000 pounds per year.

Mass production and improved processes have brought the price of the synthetics within shooting distance of soap prices. One product, for example, has been reduced to 13 cents per pound in industrial quantities—very little higher than comparable soap prices. Considering the higher efficiency of synthetics, the cost of using them is at least on a level with if not lower than the cost of using soap. For many purposes, too, the synthetics are so far superior that price is a secondary factor.

SYNTHETICS IN USE—A consumer survey of a large mid-western city, made early this year, showed that over a quarter of the families in the area buy synthetic detergents. Such a record by products introduced just a few years ago, and against the stiff competition of packaged soap goods, is proof of the eventual popularity of the synthetics.

Not only for general domestic laundering and cleaning do they find wide use in the home. Synthetics are incorporated in dentifrices because they taste better than soap, are widely sold as shampoos, and are being increasingly made into bar form as toilet soap for people who are allergic or sensitive to ordinary soap.

As industrial detergents the synthetics find wide use in bottle washing in dairies and breweries. Many of the synthetics have been found to have a greater bacteriostatic action than soap, and an added bonus is the greater ease with which they soak off labels. They are also useful as metal cleaners, both with alkalies and with acids. Being stable to acid, they are uniquely useful in the pickling of steel, where they not only cleanse the metal of grease and carbon but also inhibit attack by the acid. In electroplating baths, where acids and heavy metal salts are present, the synthetics keep the metal surfaces clean and help avoid pitting, pinholes, and other plating difficulties. Moreover, they are being added to lubricating oils to keep sludge from depositing, and to photographic developing solutions to keep air bubbles from adhering to the film.

As wetting agents the synthetics find their largest industrial application in the textile field. Here they are used for scouring, dyeing, finishing, softening—any application, in fact, where the fibers must be treated with a water dispersion, emulsion, or solution. They are especially desirable for wool, which is sensitive to alkali, and for rayon, which does not stand high water temperature.

In addition, synthetics are now entering the paper and leather industries, where they speed the processing of the raw materials. Added to paper, synthetics increase absorbency; used in leather-dyeing baths, they afford greater penetration of the dye.

WIDE HORIZONS—One large use of these versatile materials is the wetting of dusts. They are used in air-conditioning equipment to wash dust out of the air, and in the formulation of wettable insecticidal dusts, such as lime-sulfur mixtures and DDT concentrates.

A novel agricultural application of the synthetic wetting agents is in conjunction with either caustic or strong acid in the chemical "peeling" of fruit. The most careful knife peeling of apples wastes at least twice as much fruit as chemical removal of the peel. A usual method is a short treatment with hot caustic to which a synthetic wetting agent has been added, followed by a wash with cold water and acidification with citric acid to remove the last traces of caustic.

The synthetics are also being formulated into a number of specialties, such as windshield cleaners; metal polishes; scouring powders; mechanics' hand soaps; shoe, automobile, and furniture polishes; printing inks; and special industrial soaps.

The non-ionic agents are widely used as emulsifiers and dispersing agents. To discuss these alone would require a separate article, but some of the most important fields are water-base paints and other coating compositions; cutting and other "soluble" oils; paper, leather, and textile finishes; foods and beverages; cosmetics and pharmaceuticals; agricultural and sanitary sprays.

The list of specific applications of these materials is endless. In summing them all up, one manufacturer states: "Surface-active agents save money and time by decreasing the natural reluctance of dissimilar materials to mix. They can reduce the mechanical energy required and improve the performance and permanence of the final result by bringing surfaces closer together faster."

BUCKWHEAT DRUG

May Help Prevent Weakness of Blood Vessels

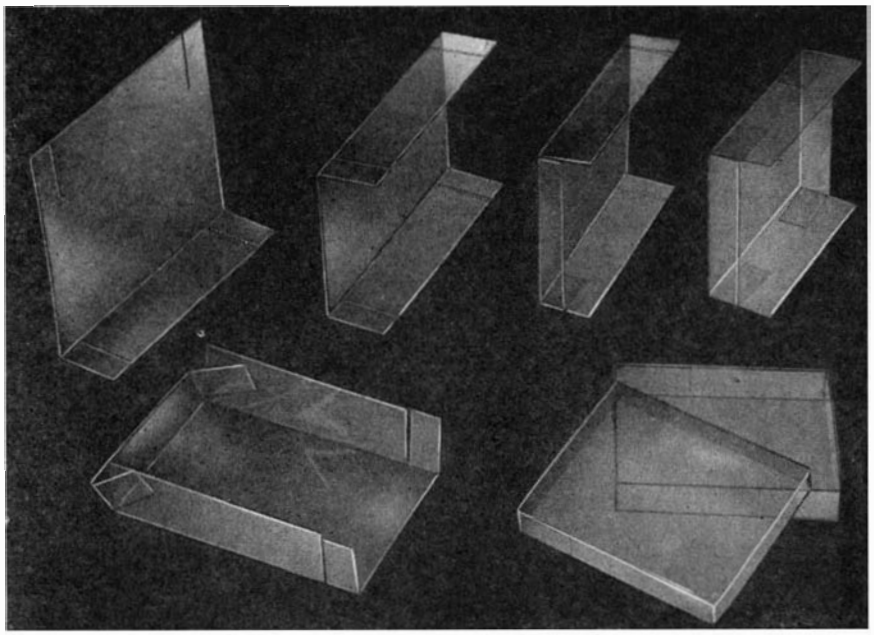
A DRUG, rutin, previously derived from tobacco by a laborious series of operations, has lately been found to be more plentifully and cheaply available from buckwheat. Rutin is reported to have an important effect in strengthening the walls of the tiny capillary blood vessels, thus lessening the possibility of their bursting should the blood pressure rise unduly.

Rutin, it is explained, is a preventive and not a curative. The yield of the drug from $10 worth of green buckwheat is said to be as much as that from $1000 worth of tobacco. Clinical tests are planned to supply the basis for licensing the product by the Food and Drug Administration, a necessary preliminary to its general use.

RAYON FABRICS

May See Wider Use as Result of Shrink-Proofing

GLYOXAL is a recent development that is said to offer a successful shrink-proofing treatment for spun rayon. According to Dr. R. L. Bateman of Carbide and Carbon Chemicals Corporation, the process "will lead to a greater acceptance and use of spun rayon as a clothing fabric, for the disadvantage of rayon shrinkage is thus controlled chemically."



Plastics boxes are simply fabricated, have both display and re-use values

PLASTICS

Pack It In Plastics

Packaging, the Last Step in Production, is Often the All-Important First Step in Merchandising. Whether Precision Parts Need Protection, Or Elegant Dainties Call for Plus-Feature Packages, Plastics are Available in More than 30 Basic Types and Many Colors to Aid the Sale

By CHARLES A. BRESKIN
Editor, *Modern Plastics*

• LOOKING AHEAD •

Re-usable containers that are more than just trinket boxes . . . Really fresh merchandise . . . Greater public demand for "smart" packaging will follow packers' recognition of plastics . . . From merchants' viewpoint, storage problems will ease . . . No rust or damage to displayed articles . . . Increased impulse buying because transparent containers "show" goods better. . . Better looking stores because packages themselves may be colorful.

It is up to the package to attract the eye and induce the purchase. Thus has been described the key function of the package in today's merchandising picture. And thus is explained, in great part, the expanding use of plastics as a packaging medium. For these materials, in at least one of the 30 or more different basic types, possess every quality calculated to catch the eye —crystal-clear transparency, unlimited color range, formability, and light weight. These characteristics not only fit plastics to meet the requirements of eye appeal but they also adapt them to protection and convenience, factors of almost equal importance to packagers.

While appearance may always be an element to consider in the designing of a package, the requirements of protection for the merchandise or, on the other hand, convenience for the purchaser, may at times take prior place. Moreover, the designer may be asked to strike a balance between any two of these three packaging requirements, or to give heed to the entire trio.

Just how plastics' varying qualities of transparency, unlimited color, formability, light weight, and resistance to many acids, alkalis, and other agents, and to varying climatic conditions, fit them to packaging's need for eye appeal, protection, and convenience can perhaps best be illustrated by describing a number of new plastics packaging applications. Some of these feature display, some protection, and some convenience.

EYE APPEAL — Display, pure and simple, was the goal of J. P. Sawyer of Morse International, Inc. when designing the acrylic package for Prince Matchabelli's gold-encrusted crown perfume bottle. The effect of a bottle of perfume frozen inside a block of ice and tied with a golden cord is an immediate eye catcher. Yet, had plastics not been used, it is doubtful whether the container would have been practicable. Although glass could have been employed, the fragility and the weight of this material might have proved serious handicaps. Plexiglas and Lucite, however, offered all the ad-

Courtesy Cudahy Packing Company

Mixing envelope of plastics typifies consumer-convenience packaging ideas

vantages of glass, transparency in particular, but did not possess its limitations.

In appearance, it seems as though the perfume bottle is cast in a solid block of plastics; actually the transparent cube is made in two identical sections. Each half has a cavity on the inside that conforms to the outlines of one side of a crown bottle. Molding, rather than fabricating, was selected as the most practicable and economical method of producing this package. Still further to speed production, both sections are made the same size so there is no need for balancing the production of two different dies so as to give an even number of halves. Any two parts can be fitted together to form one cube-packages.

CONVENIENCE—A new flexible thermoplastic inner envelope for oleomargarine exemplifies the utility of plastics from the standpoint of convenience. Messy mixing dishes are eliminated since the yellow coloring can be kneaded evenly into the margarine while it is still tightly sealed within the plastics container. And there should be a saving in oleomargarine, too, since estimates indicate that every year 2½ percent of the total margarine production is lost through coloring waste.

Cudahy Packing Company is the first manufacturer to take advantage of this new container, developed by Leo Peters of Harris Hall and Company, and now being manufactured in experimental quantities by Visking Corporation, producer of the thermoplastic film itself.

This plastics film is factory-filled with oleomargarine, and a capsule containing the yellow dye suspended in edible oils is attached to the inside surface of the envelope. The film is then heat-sealed. The purchaser when ready to color the product, pinches the capsule to force the dye out into the oleomargarine so it can be diffused by kneading.

The coloring operation with this new inner container requires only two minutes or less of kneading. Still sealed inside the envelope, the colored margarine may be put back in the paper carton in which the product is sold and blocked back into shape. The carton may then be placed in the refrigerator to allow the oleo to harden after which it may be easily cut in neat quarters or in fancy patties.

Courtesy Celluplastic Corporation

Storage, without rust or damage, is advantage to dealer and buyer alike

This package promises to eliminate returns due to leakage during hot weather; seal dirt out of the package completely; permit display on unrefrigerated counters; eliminate the use of dishes and pans formerly required in coloring; keep grease and hard-to-remove color stain off hands and clothing; and prevent margarine from picking up refrigeration odors.

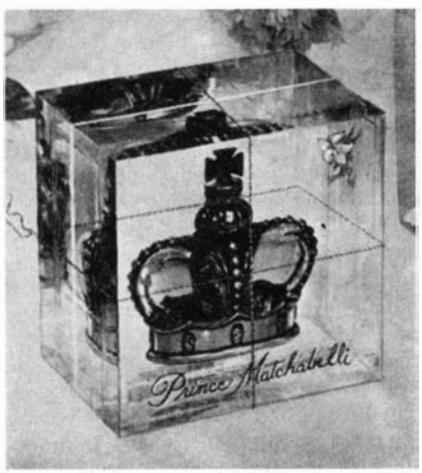
The strength of plastics film plus its transparency and flexibility are essential to the success of this packaging idea. But equally vital are the thermoplastic's non-toxic qualities, its chemical stability in the presence of fatty acids and brine, its lack of color, and its low cost. Since the film can be made without a plasticizer, it imparts no odor or taste to the margarine.

As in all plastics applications, whether they are in the field of packaging or in totally unrelated industries, the choice of the correct plastics is even more important than the decision to use them. How free a hand this leaves the designer or engineer is evidenced by the fact that, taking the 30 basic plastics materials, thousands of special formulations can be made up to meet as widely varying demands as were made by the producers of the two packages just described.

PROTECTION—Today, the Navy is putting many units of the fleet and all types of armament and equipment in long-term storage—packaging them in plastics to protect them against time and the elements, yet keeping them ready for almost instant active duty.

The requirements for such "packaging" are economy, maximum moisture protection, and quick and easy removal. The answer, developed by Dr. William H. Holst and G. Russell Hersam of Butler and Company, and manufactured by R. M. Hollingshead Corporation, was a strippable coating based on Vinylite resins. Only compressed air and spray guns are needed for application.

The system begins with a frame-



Eye-appeal of plastics is apparent in this acrylic "ice-cube" perfume pack

work of pressure-sensitive tape built up around the object to be sealed. The spraying operation then applied to this skeletal frame consists of four steps. First the webbing solution is applied. This consists of a vinyl-resin solution to which a webbing agent, Saran, has been added to produce filaments. when emitted from a standard spray gun. These filaments, extruded in a cobweb-like form, bridge over but do not adhere to the surfaces with which they come into contact. The web is built up to a point where sufficient strength is obtained to permit the application of the second coating.

The second coating, the moisture barrier, is a solution of Vinylite resins with the webbing agent omitted. This cover is built up to a

film thickness that will give the desired strength plus low moisture vapor transmission. Then a pigmented vinyl-resin top coating is added, the pigmentation being designed to resist the effects of the sun's rays as well as protect against general weathering conditions. This step is needed only for long-term outdoor storage.

Finally, regardless of whether a top coating is added, the protective package is evacuated of air and solvent fumes by the use of a hot-air blower.

It is conceivable that this processing will find wide application in the shipment of such equipment as refrigerators, washing machines, tractors, outboard motors, and other types of household and industrial units. Storage and shipment under any climatic condition will then hold no dangers for the manufacturer.

STRIP COATINGS—A different approach to the packaging of metal parts is to be found in the strip coatings. Rather than covering entire units of mechanical equipment, these coatings are best used for component metal pieces such as gears, bearings, and so on.

Ethyl-cellulose stripping was introduced to the packaging field during the war; since then a new type of coating based on cellulose acetate butyrate has made its appearance. This new material, with special characteristics of its own, is complementary rather than competitive to the ethyl cellulose compound. For example, it has lower tensile strength, higher elongation, and greater strippability. Hence it can be applied to and stripped from parts of greater intricacy. In addition, this cellulose acetate butyrate coating deteriorates less due to aging in the melting tank. It has approximately twice the load-carrying capacity of the ethyl cellulose compound and therefore can be applied to heavier parts without danger of "squeeze-out." With these advantages, however, it costs approximately twice as much as the ethyl cellulose compound; both the higher cost and the more versatile properties are due to the fact that it contains about 50 percent of plastics in the formula as contrasted to 25 percent of plastics in the corresponding ethyl cellulose formula.

TRIPLE-PLAY PACKAGES—Perhaps the more usual packaging application is one in which some of all the three factors—display, convenience, and protection—are needed. A new development of this type is found in the rigid, folded vinyl and acetate boxes of the John H. Oxley Company, licenser of the process and builder of the equipment. Solid corners, reinforced sides and ends if desired, and absence of any cement or solvent, are features of these packages which can be produced in sizes varying from a ring box to a container large enough to hold a blanket.

The folds in the plastics sheet and the equipment that makes these folds are the heart of this new boxing method. Almost as important is the die which permits the stamping out of almost knife-edge thin slots from the flat cellulose acetate or vinyl sheeting comprising the blanks for the boxes. After the flat vinyl or acetate sheets are die stamped, they are fed into a semi-automatic forming machine containing a knife-edge heater. With this equipment it is not necessary to heat the entire sheet of plastics; only thin lines need to be heated where the material will be folded.

Just as there is almost no limit on the size of boxes made by this method, so it is with the color and rigidity. Governed by the use to which the box is to be put, a customer may use 0.0075 to 0.040-gage plastics sheet. Material of 0.015 gage is, however, recommended for most applications. And the boxes can be made in any color in which the plastics is available. This selection is further augmented by the fact that the top and bottom of a box can be of differently colored material. Thus, a clear, transparent bottom may have either a clear top, a red top, or one in any of a multitude of colors. Or the top may be clear and used with variously colored bottoms.

The protection offered by these boxes is excellent. Their convenience lies in the fact that a product may be viewed by the public through the transparent top, yet be guarded from the soiling usually attendant upon repeated handling by either the public or the sales force. Eye appeal is there, of course, and the boxes have the added advantage of re-use possibilities. After the original contents have been removed the container may be used to hold gloves, handkerchiefs, or other articles.

There are endless other types of plastics packages, but these examples show how the materials, if properly selected, can meet the demands for display, protection, and convenience demanded by packaging designers, product manufacturers, and the consumer.

COSMETIC BAG

Prevents Leakage, is Light and Flexible

As PROTECTION against leaky cosmetic bottles in traveling bags, a zippered vinyl case large enough to hold a number of bottles and boxes, as well as wash-cloths and soap, has been recently introduced. Stitched with nylon thread, the case is fashioned of an unsupported vinyl co-polymer film which is both flexible and strong. The material is called Elasti-Glass and S. Buschsbaum Company manufactures the bag.

Vinyl is well suited to travel accessories as it is light in weight, water-proof, and resistant to oils and greases. It will stand up under packing, and will give good service in all climates, being impervious to fungi, mildew, extreme heat, or cold.

PLASTICS HORSE

Weighs 15 Pounds, Supports 400 Pounds

A NEW toy comprises a phenolic-laminate rocking-horse body, a mane and tail made from vinyl monofilaments, and eyes molded from cellulose acetate. Realism is achieved through the application of actual ponyhide skin to the outside of the laminated body. No stitching is required for this work, casein adhesives being used instead.

The method of producing the body is an adaptation of the methods used in the fabrication of laminated helmets used for head protection by industrial workers. The hobby-horse body is first built up from phenolic-impregnated canvas sections in a criss-crossed pattern. This lay-up is placed in a cast-phenolic mold where air pressure of about 30 pounds forces the impregnated canvas outward against the forming die. Curing is accomplished by baking the parts for from six to eight hours under pressure.

Mounted on aluminum rockers, the horse stands 34 inches high and weighs about 15 pounds; it is said to support 400 pounds.

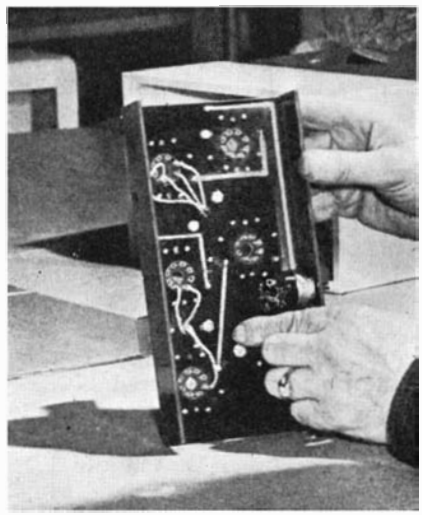
AUTO DOOR AND SEATS

Now Formed of Laminated Plastics

AMONG the newer applications of plastics in the automotive field are taxi doors and folding seat backs constructed from Melmac resin impregnated barrier and Kraft cores. The laminating of these coverings, presently available in a mottled white, is the work of the Formica Insulation Company.

Conducted by KEITH HENNEY

Mechanized Wiring



Plastics chassis having sprayed metal circuits in sandblasted channels is neat, simple to inspect and service

Many Hand Operations in Wiring Various Electrical and Electronic Mechanisms Can be Eliminated by the Use of Sprayed Metal Coatings, Pre-Formed and Welded Harnesses, and Metallic Paints Applied Through Silk Screens. Costs Can be Reduced and Efficiency Increased

By JOHN MARKUS
Associate Editor, *Electronics*

• LOOKING AHEAD •

High cost of many electrical units can be reduced through use of new processes. . . Radio industry will make greatest gains but other electronic manufacturers will profit in proportion. . . What has been done with motor drives, radio receivers, loop antennas, and resistances, can be extended to other fields.

SEEKING means of offsetting skyrocketing labor costs, electrical, radio, and electronic equipment manufacturers are seriously considering mechanization of the wiring required in their products. To this end, many different wiring shortcuts are being tested in the development laboratories of alert manufacturers. As a result, new techniques are already in use as heralds of a trend toward speeding up the biggest hand-work operation involved in the production of electrical equipment having complicated wiring.

Miniature tube leads are soldered to printed circuit; wires are eliminated

Elimination of soldering operations is one goal. The latest electronic adjustable-speed motor drives, made by General Electric Company for industrial applications, have all resistors, capacitors, transformers, and other components connected together by the use of screw-type lugs and terminals. Punch presses crimp the lugs over the ends of the connecting leads and long rows of terminal screws on insulating panels are provided for making connections between parts. Only the tube sockets and certain small rheostats and potentiometers have soldered connections, because these parts are commercially available only with soldering lugs as terminals. The labor saving occurs here not only in assembly but in maintenance of the equipment during use; the technician in an industrial plant can replace a defective part in a jiffy with a screw driver as his only tool. Faulty soldered connections both during manufacture and repair are thus eliminated, making for greater reliability of industrial electronic equipment. This same technique is also used extensively for other electrical equipment.

As conventionally done by hand, wiring is the most expensive part of the work involved in radio receiver production. It involves cutting wires to length, stripping insulation from ends, bending wires to shape, connecting the ends of the wire to the proper points, and then soldering each end of each wire in turn. For an average five-tube radio receiver this involves handling and soldering two or more wires or leads for some 40 different parts, often in a crowded under-chassis space which gives a result that looks much like a rat's nest—and often is equally frail.

AUTOMATIC WIRING—To overcome such difficulties, a method of applying all wiring to a chassis automatically in one operation with a spray of molten metal has been developed by Promenette Radio and Television Corporation. An all-plastics chassis is covered with a mask having cut-out lines where connections are to be made, and shallow grooves are sandblasted into the plastics. The process may in some cases be repeated with another mask on the other side of the chassis so that crossovers of connecting paths are separated by the insulating chassis.

The chassis is placed in a metallizing machine and molten metal is sprayed into the sand-blasted grooves through another mask. The molten metal hardens to provide the required connections between parts. Mounting of the parts in

drilled holes, with nuts and bolts or with rivets, serves to clamp terminals against the metal-filled grooves, achieving wiring without wires. Some soldering of external leads is still required, such as antenna and loudspeaker leads, but the process may eventually be further developed to make all connections at once.

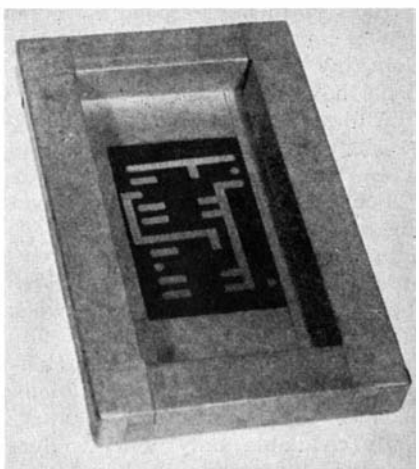
Mechanization of wiring by this molten-spray process offers a number of advantages. Circuit and equipment design changes can be made as often as desired because masks are cheap and simple to make. Uniformity of production is assured because, if the mask is right, all connections must be correct. Performance is improved and the number of final alinement adjustments and tests is minimized since all wiring in critical circuits is precisely and uniformly positioned on all sets.

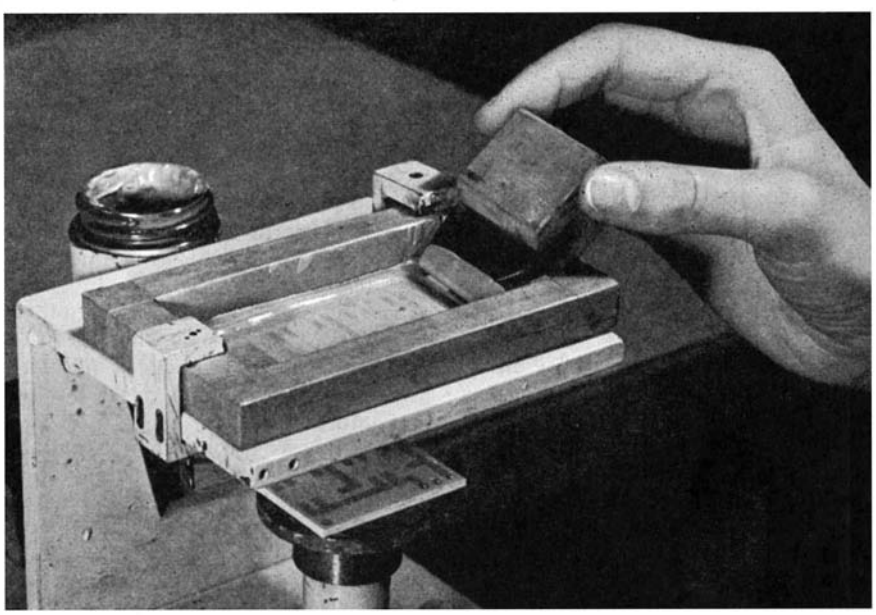
Another proposal for eliminating soldering operations involves forming stiff hookup wires to shape in punch presses, letting them slide down hoppers to correct positions in a jig on which tube sockets, resistors, capacitors, and coils have been previously placed either by hand or by other hoppers, then lowering a multi-electrode welding head over the assembly and electronically spot-welding all connections in one operation.

Instead of using bent-to-shape wires, narrow strips of copper can be punched out with all the required curves and right-angle bends taken by ordinary wiring, then welded to the terminals. Insulating buttons would be used here to support the strips in as many planes as are required to prevent short-circuits where strips cross.

PRINTED WIRING — Development of the radio proximity fuze for mortar and anti-aircraft shells during the war resulted in perfection of a new technique for printing wiring directly on a ceramic surface with a silver solution by a silk-screen process that makes possible the mass production of ultra-compact amplifiers, pocket radios, personal telephones, miniature hearing aids, meteorological instruments, and electronic control units. In addition, the process permits applying resistors directly to the ceramic to give any desired resistance value, by applying a carbon solution with the silk screen or spraying it on through a mask.

The process, as developed by Globe-Union, Inc., consists essentially of the following four steps: (1) Circuit wiring is printed or stencilled (using silver paint) onto a suitable chassis or base material, such as a plate of steatite; (2) resistors in the form of a carbon and resin mixture are sprayed through positioning masks that locate them between appropriate silvered end tabs; (3) small disk-type capacitors, consisting of a high-dielectric-constant ceramic with both faces silvered, are attached directly to the silvered wiring on the plate; (4) terminals of other components such as tubes (or tube sockets for standard replaceable tubes) are soldered into appropriately located and silvered holes in the ceramic. Used with the newly developed subminiature tubes, the electronic circuit assembly made possible by this process is extremely compact.





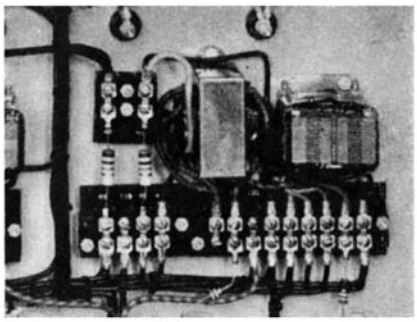
Simple silk-screen stencil (right) is used with applicator (below) to apply silver paste to ceramic plate. Part of printed circuit is seen under jig

Although the compactness of the method was the most important factor in its military application, other equally important and desirable characteristics are the uniformity of finished assemblies both in appearance and performance, high production speed, and ease of circuit checking. Uniformity is obtained since each circuit is an exact reproduction of the master pattern. High production speed is gained by the screening and spraying operations, which combine in a few fast mechanical operations the slower operations of cutting wires to length and soldering wires and resistors into place.

REPAIRS FACILITATED — Because of its two-dimensional nature and the open method of construction, circuits constructed by this new process lend themselves to rapid circuit tracing and repair. Faulty components such as resistors and capacitors which are on the chassis can be repaired, if necessary, by soldering a conventional component of equivalent value across each faulty part and opening the circuit leading to the fault.

The leads between components are applied by a process in which the silver is intimately bonded to the ceramic. The metal is in the form of finely divided silver or silver oxide uniformly dispersed in a suitable vehicle. The consistency is adjusted with solvents to meet requirements for the specific type of application.

The method most commonly used for circuit reproduction is a screening process in which the silver paint is dispersed through the open mesh of a silk screen arranged as a mask to define the circuit. This makes it possible to print circuits of any degree of complexity. Complicated designs can be held to very close tolerances. The deposited or printed film thickness is very uniform and but little silver paint is wasted. The silk is stretched tightly on a wooden frame and



Screw driver is only tool needed for replacing wiring on this equipment

coated with gelatin or polyvinyl alcohol, which is made photosensitive with potassium dichromate. A photographic positive of the circuit is held tightly against the sensitized silk screen and exposed to light. The portions of the sensitized coating exposed to light become insoluble in water. Those portions which are not exposed to light are water soluble and can be washed out. The parts that wash out from the design are to be printed.

The next step is to place the silver paint, in paste form, on one end of the top surface of the screen. The ceramic chassis or other surface to be painted is brought into contact with the bottom of the screen. A neoprene bar is moved across the top surface of the silk, pushing the paste ahead of it and through the open mesh of the screen pattern. The paint forced through the open mesh is deposited on the ceramic plate in a design which conforms identically to that of the screen pattern.

After applying the silver to the ceramic, the parts are placed in a furnace and heated to a temperature between 1300 and 1500 degrees, Fahrenheit. This temperature removes the vehicle and solvents, and intimately bonds the silver to the ceramic.

When making resistors, the process involves the application of an accurately controlled amount of resistance paint to the ceramic surface. The paint consists of a conducting material, a filler or inert material, and a vehicle or binder. By varying the quantities of these ingredients, paints may be obtained covering a resistance range from three ohms to 200 megohms per unit length.

The resistor paint is usually applied through masks by a spray. After air drying, the masks are removed and the paint is cured in an oven at 300 degrees, Fahrenheit, for several hours to produce stable resistors. A special resin coating is applied to the resistors to protect them against humidity and temperature effects.

Where necessary, amplifier, filter, or other control circuit assemblies may be printed on small ceramic blocks and plugged into a main chassis. Replacements can then be made just as easily as changing a tube. Furthermore, any tampering with a circuit by inexperienced personnel is immediately apparent, as ordinary resistors or capacitors soldered across the printed components will be clearly visible.

STAMPED LOOPS — Built-in loop antennas for table-model radio sets are being stamped out in a single operation by a variation of the printed-wiring technique. In this method, used by A. W. Franklin Company, a sheet of copper foil and an adhesive-covered insulating panel are placed in a special punch press that stamps out the rectangular spiral turns of the antenna coil and attaches them to the supporting panel in one operation. To get spacing between turns, the die forces the cut edges of each turn into the panel so that each turn is V-shaped and hence narrower than a flat strip.

Compared to the conventional wound loop mounted on the back of the cabinet, the new Airloop is lower in price and itself provides a back for the set. Accurate stamping of the turns means that no adjustment of the turns is necessary by the set manufacturer in final assembly to compensate for variations in winding. Over a million of these loops have already been turned out.

Thus is the highly competitive radio and electronic industry seeking, by mechanization of wiring, the answer to rising labor costs and shorter working hours. Whether any or all of these techniques will become standard practice depends upon the great host of human and economic factors that are governing the growth of the electronics industry itself.

GAS-STOVE GENERATOR

Charges Batteries or Operates Radio Equipment

HEAT from a gasoline burner is converted directly into electricity in a modern industrial application of the thermoelectric principle. The new thermoelectric generator provides a small, noiseless source of power for charging storage batteries and operating radio equipment. Three sizes have been developed; one generates 2½ volts at two amperes D.C. for charging the new two-volt storage batteries used in portable radio equipment, and runs for eight hours on a gallon of fuel; another gives 10 watts at six volts for charging standard auto storage batteries; the third has an output of 20 watts at 12 volts, enough to operate a 14-tube F-M combination transmitter and receiver such as might be used in cars for highway radiophone service.

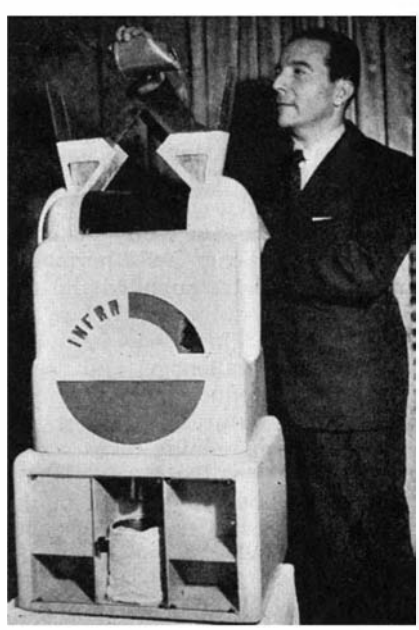
In addition, heat is available for cooking or for warming up a room, even while electricity is being generated by application of the 1100 degree, Fahrenheit, flame to the banks of thermocouple units.

COFFEE

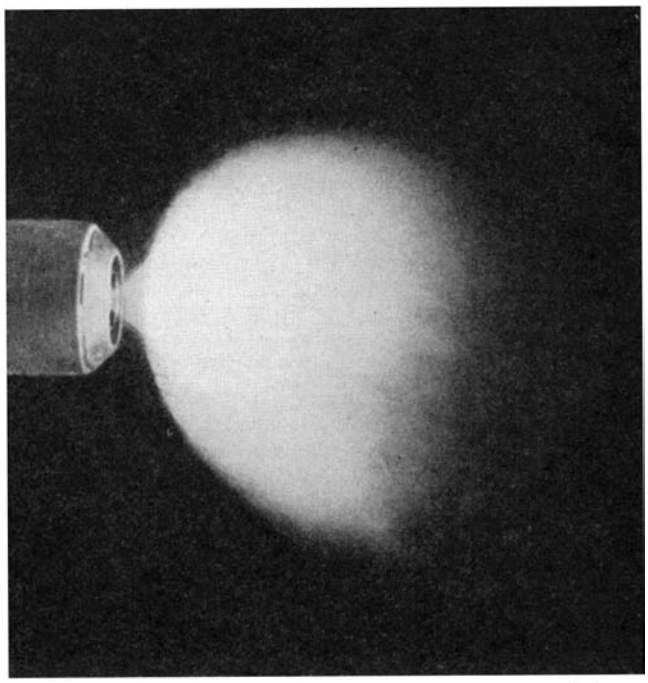
Roasted Electronically at Retail Market

FOR ROASTING coffee on the spot in grocery stores and restaurants, an electronic coffee roaster approximately the size of a cash register has been developed by A. S. Torres, Colombian inventor. Green coffee, dumped into a hopper, is pre-heated to 900 degrees, Fahrenheit, then roasted by a combination of coils and infra-red lamps at the rate of a pound in about two minutes. The roasting is ended automatically by a photo-electric device that measures reflected radiations from the coffee beans—green coffee beans are good reflectors, roasted beans very poor ones.

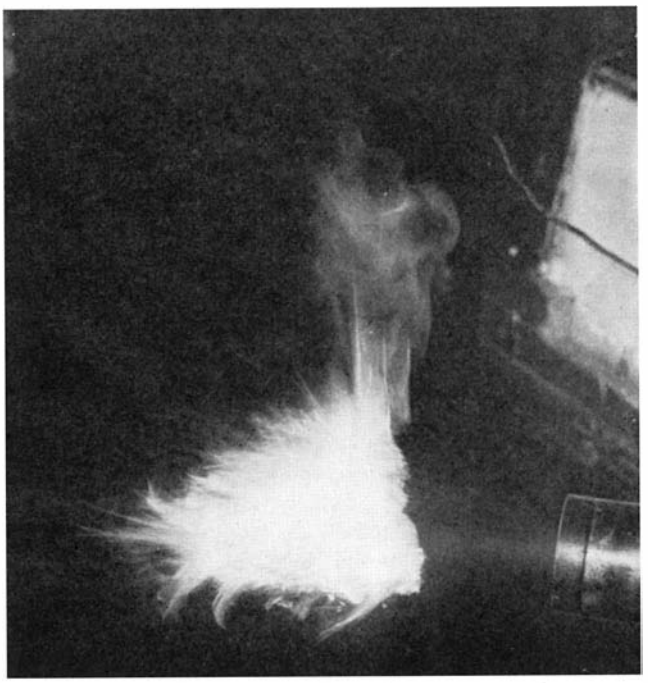
Advantages claimed are that by buying blended green coffee and roasting it himself, the grocer can lower current retail coffee prices, consumers will get fresher coffee, and they will buy more of it at the lower price.



Two minutes average roasting time



Uniform flame mass shows efficient combustion with new head



Old type combustion head gives ragged flame, is inefficient

PETROLEUM

Conducted by E. F. LINDSLEY

Fuel Oils Have Changed

Not so Dramatic as Some Petroleum Developments, but Holding a Vital Interest for Oil Heat Users, is the Current Transition to Better and Somewhat Different "Cat-Cracked" Fuel Oils. Efficient Heating Will Depend on Proper Adaptations of Present Burners to a New Oil "Diet"

By WILLIAM A. SULLIVAN

Senior Applications and Development Engineer, Manufacturing Department, Shell Oil Company, Inc.

CATALYTIC cracking, a comparatively new development in oil refining, has caused a minor revolution in the fuel-oil business. While straight-run and thermally-cracked distillates supplied the entire fuel-oil requirement before the war, "cat-cracking" now provides much of this gallonage, and seems destined to produce an ever larger share in the future.

Straight-run refining takes out of crude oil, by distillation, only those chemical compounds present in the oil when it came from the ground. Thermal cracking is an improvement on this. By subjecting crude oil to intense heat or to combined heat and pressure, it breaks down the more complex molecules originally present into simpler ones; in other words, it re-forms the original chemical compounds into new compounds to get a larger yield of the products most desired.

"Cat-cracking" is an elaboration of thermal cracking. Oil is cracked in the presence of a catalyst—such as certain compounds of manganese, iron, aluminum, and silica—to produce either different arrangements of molecules than can be had by thermal cracking, or to produce the same arrangements at different temperatures and pressures. The process reached a high stage of development during the war when it was responsible for turning out enormous quantities of high-octane aviation gasoline, and for every gallon of "cat-cracked" gasoline produced, an approximately equal volume of fuel-oil distillate was turned out.

To answer the questions regarding this war-time fuel oil with respect to the operation of both pre-war and future oil burners, extensive investigations have been carried out at Shell's Sewaren Fuel Oil Laboratory.

BURNER TESTS—Here, before the development of catalytic cracking reached commercial production, engineers and petroleum chemists engaged in thorough experimentation with "cat-cracked" fuels to find the answers to these questions. Many varieties of the fuel, produced under different operating conditions in refinery pilot plants and in commercial units, were tested in the laboratory. These findings were checked against the results of a year of field experience, in

• LOOKING AHEAD •

More research on oil heating problems to come... Closer matching of burner designs and fuel characteristics... Cleaner operation at higher levels of efficiency... Lower fuel consumption with better fuels ... More general understanding of burner installation fundamentals ... Wider industrial use of oil heat.

which the marketing organizations checked the reaction of consumers to millions of barrels of "cat-cracked" fuel distributed throughout the country.

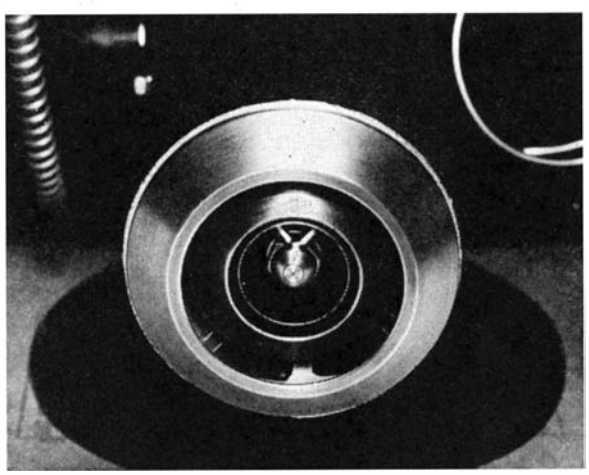
Results of these tests offered substantial evidence that "cat-cracked" fuels are superior in many respects to the thermal-cracked and straight-run distillates of which pre-war fuels were composed, and that they may actually accelerate the greater acceptance of oil as an economical and satisfactory form of heat.

One important factor is that catalytic distillates are inherently cleaner and less likely to deteriorate and form sediment in storage than many untreated straight-run distillates and the average thermally-cracked distillate. This is because catalytic cracking produces a relatively high percentage of aromatic compounds, considered the most stable of the four hydro-carbon groups. The small percentage of remaining unstable constituents responds quite readily to removal by acid treatment. When the increasing industrial and domestic use of oil burners is considered, this factor of cleanliness becomes a particularly welcome improvement. In the case of domestic units, burners must operate at relatively low firing rates and are more susceptible to clogging of the atomizing nozzle or oil-metering valve than the larger industrial sizes.

Catalytic fuels have shown no tendencies toward corrosion of metallic oil-burner parts, such as copper lines, pump seals, and pressure-regulating valves. Their difference from many pre-war and wartime fuels in this respect is apparently due to the fact that corrosive compounds which may be present in feed stock are either removed during the cracking or subsequent treating processes, or are chemically converted to non-corrosive forms.

The impression has become rather widespread that catalytic fuels are much heavier than pre-war fuels. In weight per gallon this is true; they weigh more than straight-run distillates of comparable boiling range. But this is actually a distinct advantage because the heavier the gravity of the fuel, the higher its heat value. In viscosity, the most reliable measure of the ease with which oil can be atomized, the difference between catalytic and straight-run fuels is negligible; catalytic fuels are lighter, if anything, in this respect.

In pour point, due to their higher aromatic content and lower paraffinicity, catalytic distillates run lower than their predecessors. This is still another point in their favor, since it makes for easier handling in extremely cold weather.

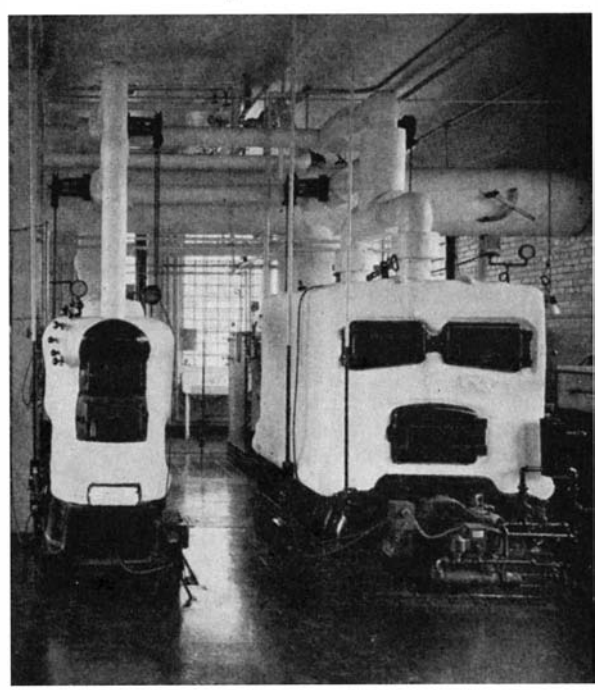


Combustion head installed in blower mouth. For best efficiency, relative positions of oil nozzle, flanges, and blower mouth are mutually adjustable

AIR-OIL MIXING—Actually, catalytic distillates rate lower than pre-war fuels in only one respect. Under adverse burning conditions, they show a somewhat greater tendency to smoke and carbonize than straight-run distillates in the same boiling range. It should be noted that this is under adverse burning conditions. In heating apparatus that provides proper burning, catalytic fuels exhibit no greater tendency to smoke than straight-run fuels.

The petroleum engineers offer the following explanation for this: Burning the high proportion of aromatics in catalytic fuels involves splitting apart the carbon and hydrogen and burning each element separately. Unless each carbon particle thus liberated is surrounded by air while still at high temperature, it escapes without being burned and appears as smoke, soot, or carbon. Catalytic fuels, hence, require more thorough mixing with air than some fuels to completely ignite all the free carbon split off during the combustion process. In general, more efficient mixing of air and oil is the basic issue around which revolve almost all adaptations of the fuel to existing burners and the design of new burners.

Tests conducted on vertical, rotary-wall flame burners, for example, have demonstrated the important role timing plays in mixing air and oil when burning catalytic



Portion of oil-heat research and testing laboratory. New fuels, new equipment, and wider use of oil heat have posed a variety of questions answerable only by service-type tests

fuels. With low-type grills clipped on the edge of the flame rim, there was a limit to the amount of catalytically-cracked fuel that could be blended with a straight-run distillate without producing excessive smoke and forming a heavy carbon build-up on heating surfaces at the base of the boiler. By simply raising grills about two inches above their normal setting, however, thus affording a slightly longer time for mixing air and oil before combustion, it was possible to burn 100 percent of catalytically cracked fuel without a trace of smoke and without objectionable carbon formation, over a prolonged period of operation.

Increasing the diameter of the fan also gave marked improvement in performance of vertical, rotary burners on catalytic fuels. This produced a higher velocity air stream, which provided greater turbulence and more intimate mixing of air and oil in the early combustion stages.

In both cases, these were relatively simple changes, but still sufficient to bring burning conditions in line with fuel requirements, just as retarding the spark timing in an automobile engine suppresses the tendency of gasoline to knock. Indeed, the two phenomena appear to be closely related.

Improved performance of both catalytic and pre-war fuels can be obtained from the gun-type burner by closer control of the air-fuel mixture. The largest percentage of all smaller burners are of this type, and, taken as a whole, they are less critical to the composition of the fuel than any other burner.

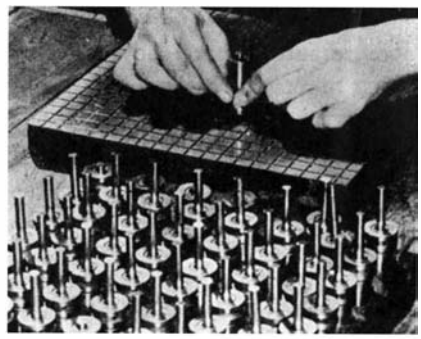
In most cases, the tendency of catalytic fuels to smoke can be overcome in gun-type burners by simply opening the fan shutter and supplying more air. This is the easy way out, however, and not necessarily the most desirable. While the oil will burn completely this way, the heat produced is wasted in heating excess air. Thus gains that should be realized from the higher heat content of the catalytic fuel are nullified.

COMBUSTION HEADS—In making a special study of the problem, it was found that the design of the combustion head or air turbulator was the most important single factor influencing gun-type burner efficiency. By designing the mixing head so as to maintain high velocity air at a point where it enters the oil spray, an intimate air-oil mixture could be obtained without greatly increasing the volume of air beyond the theoretical amount required to burn the oil. By this means, it was possible to burn a 100 percent catalytically-cracked fuel with no smoke whatever, and with a practically negligible loss of heat through excess air.

This new combustion head, designed at the Sewaren laboratories, is now being licensed to burner manufacturers who wish to incorporate it into their own design, and, in addition, research is underway to investigate the possibilities of adapting it to existing gun-type burners already installed.

Fifteen years ago, the petroleum industry thought of sales chiefly in terms of gasoline. Fuel oil was a minor by-product that received scant attention. Today the demand for fuel oil has skyrocketed to such proportions that it has taken its place along with gasoline as a major product of refining. Annual consumption in the United States is in the billions of gallons, and is constantly on the increase.

Although straight-run and thermal-cracked distillates, each with their own special merits, will continue to supply much of this demand, there is little doubt but that the trend is in the direction of more and more catalytically cracked fuels. As time goes by, adaptations to existing burner installations, and completely new designs in burners, will enable the industrial and domestic consumer alike to obtain the maximum benefits from it.



Diesel fuel injector bodies and stems must be precisely lapped or polished

FUEL CONTROL

Gives Improved Diesel Performance

IMPROVEMENT and refinements in the fuel injection system of the modern Diesel engine are responsible for its versatility, according to Ralph L. Boyer, chief engineer of The Cooper-Bessemer Corporation.

In the Cooper-Bessemer fuel injection system, component parts are lapped and fitted to within 25 millionths of an inch. One such part is a plunger that fits into a small cylinder through which fuel oil is pumped into the engine cylinder for combustion. The reason for such precision is that this heavy fuel oil is pumped at a pressure of from 7000 to 10,000 pounds per square inch, and any appreciable leakage would be greatly magnified by the terrific force.

The oil is pumped through the system to an injection spray nozzle about the thickness of a lead pencil. At the tip of the nozzle there is a ring of from six to ten holes, each one drilled individually to a diameter of .008 inch, and each one drilled at precisely the same angle to assure uniform injection. On this exact uniformity depends the efficiency of the entire power plant, for if the fuel oil does not enter the cylinder as a fine fog which can be completely burned, power is lost and "knocking" can be expected.

POUR POINT

Depressed, Viscosity Index Raised by Oil Additive

INTENDED for wax-base lubricating oils, a new material not only lowers the pour point of many oils effectively but also retains the reduced pour point under cyclic temperature changes. Paraffin-base motor oils in the SAE-10 and SAE-20 range which show a tendency to revert to their original pour points with some additives, are reported to be effectively stabilized with Acryloid 150. Stable pour points as much as 40 or 50 degrees, Fahrenheit, below the original pour point are claimed to be obtainable.

In addition to its characteristics as a pour-point depressant, Acryloid 150 is also described as an effective viscosity-index improver. Thus it is possible to raise the viscosity index appreciably and at the same time lower the pour point with the addition of this material. It is suggested that a refiner might, therefore, cross-brand oils, producing an oil which will meet both SAE 10-W and SAE-20 specifications.

The developers, Rohm and Haas Company advise that Acryloid 150 be used in quantities of about 1 percent and that it is readily blended with mineral oils by any of the commonly used methods. Since the material is supplied as a fairly viscous product it is desirable either to heat the Acryloid to about 150 degrees, Fahrenheit, before adding, or to heat the entire blend after the addition of the depressant. Mixing is ordinarily accomplished by circulating pumps or paddle stirrers.

Machine Tools For Heating

To Apply Heat Where and When Wanted, and in Exactly the Right Amount, Has Long Been a Dream of Metal-Working Industries. Now, Contoured Ceramics, High-Frequency Currents, Controlled-Atmosphere Furnaces, and Molten-Salt Baths Give Precision to Heating Processes

By EDWIN LAIRD CADY

• LOOKING AHEAD •

An increasing number of "punched-out and brazed-together" articles ... Fewer fatigue failures with selective-area heat treating ... Faster machining with heated metal will be a boon to cost-conscious industry ... Longer wear from bearing surfaces ... Less internal-strain distortion of precision parts ... Automatic controls will eliminate variations between heat-treat batches.

IN PLANTS all over the country several different types of machine tools are starting all-out races for the right to perform industrial heating jobs.

The competing machines are being mounted beside each other, sometimes on a winner-take-all basis, more often with the idea that each shall take over such tasks on the production line as it proves itself best able to perform.

Guiding every move on each machine are staffs of the keenest brained application engineers that industry can produce. College professors are being lured from their lecture platforms to get out into the factories for a few days at a time and apply the latest heating theories. Technical and business men are watching every improvement in their own and competitors' machines, working intensively, seven days a week to apply new equipment, thinking and experimenting.

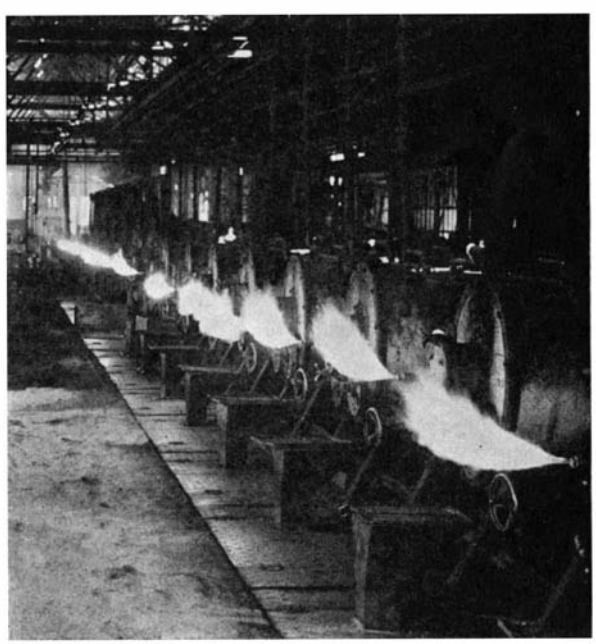
The stakes are big. Winners will make huge installation sales right now. And they will have the right to go out and use every success as a sales argument all over the world.

Sitting on the benches and waiting to get into the game in some cases, carrying the ball and playing a stellar role in others, are the makers of chemicals and of equipment for de-scaling, the designers of all kinds of production tools and equipment, the makers of every kind of metal and other raw material. This is a contest the like of which has not been seen since the days nearly 40 years ago when high-speed steels and production-grinding machines almost simultaneously made their first major impacts on the production lines. No one knows what the ultimate effects upon all kinds of industry will be.

CERAMIC HEATING—One of the entries is so wholly new to most production men that very few other than its own engineers have any clear idea of what it can do. It works by first pre-mixing air and combustible gas, putting this mixture under carefully controlled pressure, then feeding the mixture to specially shaped ceramic surfaces.

Once they are warmed up, the ceramic surfaces supply radiant heat which not only helps to heat the work but also promotes combustion of the gas and air mixture and makes it easier to keep the amount of combustion heat under exact control. The contours of these ceramics are shaped as accurately as those of precision dies. They direct the heat so that it follows the contours of the work pieces and is applied, heavily in one spot, more lightly in another, just as it is wanted along the work surface.

These machines can heat selected areas of pieces, or whole pieces, as desired. They use automatic timing devices, materials-handling mechanisms, and quenching means as needed. In operation, the work piece advances to the heating zone, is positioned at an exact distance from the ceramic surfaces, turned if necessary, then with split-second timing is moved to the quench tank



A battery of gas-fired heat-treat furnaces. Here low cost, long-known practices, and wide acceptance have combined with modern de-scaling techniques to give the simple type furnace a fighting position among newer heating tools

or other cooling zone. Ceramic heating saw extensive application during the war and is currently invading many fresh fields.

H-F HEATING—Induction-heating machines are racing for the same controlled-area heating market, and have a long head start for it. These devices take alternating current—direct current may also be used—at the standard 60 or other cycles used in the plant, employ rotary converters or various kinds of electronic circuits to step up the frequency to anything from 3000 to 50,000,000 cycles, and pass these high-frequency currents through "inductors" or work coils. The work goes within the coil but is carefully kept from touching it. Magnetic flux from the work coil passes across the narrow air gap to the work itself and sets up eddy currents which reverse their directions within the work piece twice as many times a second as the current has cycles. These eddy currents or circuit "losses" cause the work to heat up.

Induction heating engineers design and shape the work coils as carefully as the gas-ceramic machine manufacturers do their ceramics. The timing, positioning, work handling are just as exact. Between these two it is a tool-makers' contest. Both methods really proved themselves for the first time during the war. Induction heating was 10 years old when the war began, but with the exception of a few automobile and other large plants very few engineers knew much about it. Installations were few and on many war jobs induction heating was able to perform its production miracles only after application engineers had sweated over it for a year or more. But it came out of the war a proved production tool with capabilities and techniques so well known that now single installations costing as much as $500,000 are being made. Its peace-time market is at least 20 times as large as its war-time one.

FURNACES FIGHT BACK—The induction-heating and the gas-ceramic machines use high heating speeds, especially for local-area heating, to avoid scaling the metal. They move their work pieces into and out of the heating zones with a series of quick movements interspersed with carefully timed pauses for heating.

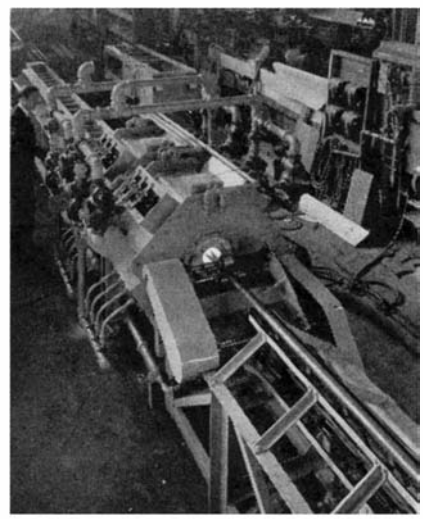
Working right beside them are controlled-atmosphere furnaces. Through these the work pieces move in steady streams. Timing is exact, work-handling mechanisms are well thought out, but selected-area heating is difficult if not impossible. Thus the contest between a furnace with the work moving slowly and steadily and two machines in which the work jumps quickly and then pauses becomes that of a tortoise *versus* two hares of different breeds.

The older style furnaces which use atmospheres that are controlled very little, or not controlled at all, are by no means out of the running. They can set up scale losses which amount to as much as 3 percent of the metal heated. But they are by far the least expensive to operate. They cost less per ton of heating capacity to install. And with such processes as sodium-hydride de-scaling available, the amount of loss to scaling is reduced to the actual scale produced in the furnace; there is practically no additional loss of metal to pickle baths.

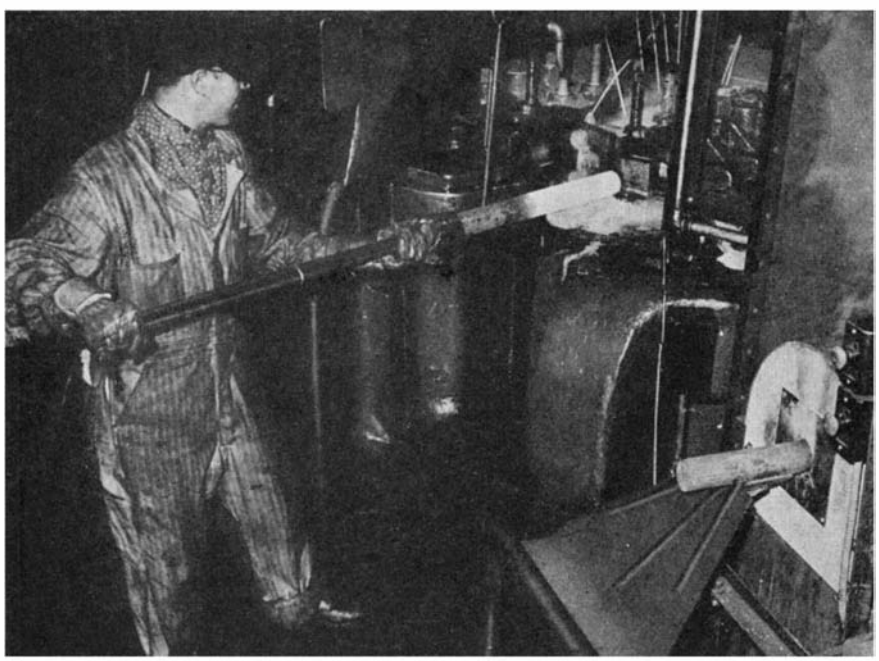
Makers of metals-cleaning compounds are bolstering the case of the open-muffle furnace and all kinds of open-fire heating. Their products can take off the scale from most metals, and leave clean and corrosion-resistant coatings behind them. And the open-muffle furnace has the advantage of years of use in factories. Everyone knows how to use it.

MORE TO COME—Just nosing its way into this contest is the modern salt bath. Here, the temperature can be controlled with greater accuracy than in any other device. No one can even guess what salt baths will be accomplishing when the chemists have developed the salts a little further. Right now, the most exactly controlled hardening, much de-scaling, and even some soldering and brazing in which the pieces are heat treated while being fastened together, all are being done in salt baths.

The production manager, then, has a great deal to watch as these gas-ceramic, induction-heating, controlled-atmosphere furnace, open-muffle furnace backed by modern de-scaling, modern salt bath, and many other heat-treating machine tools compete for places on his production line. Some of the things that will happen are sure to be almost revolutionary.

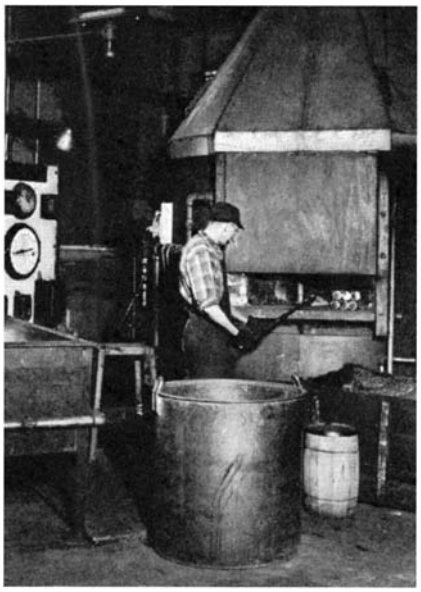


Ceramic-furnace unit is a product of exact design for exacting heating jobs



Induction heating, one of the foremost contenders for selective-area assignments

Soldering and brazing operations will become fully mechanized as never before, and more of them will be performed than ever before. Dozens of new silver solder, braze, and soft-solder alloys, and better fluxes, will be worked out to fit the new mechanical techniques. All such jointing alloys will be cut to size and perhaps stamped to shape, or



Controlled atmosphere furnaces demand precision controls. Note panel

will be in liquid or plastic forms but be fed in exactly controlled amounts to exactly designated areas. The forming and placing of solder and braze alloys will become a new mechanical art with specially developed equipment. The contours and tolerances of the parts to be joined will be maintained far more exactly than they are now, with operations of punch presses and other machine tools affected accordingly. Another brand new mechanical art will be developed for rapid positioning of the parts to be joined and for holding them in position during the heating operation. Most of the new equipment for soldering and brazing has not yet reached the drafting-board stage.

SELECTIVE-AREA HEAT—As a result of these developments, there will be much swapping of positions between high-alloy and low-alloy metals.

Low-alloy steels and other metals can be so hardened on selective areas that they have the wear resistance of present high-alloy counterparts. The savings by substituting the low alloys will be in metals and in machining costs.

By contrast, selective-area hardening often can save enough on the heat treating, the straightening, the secondary grinding, and other production costs so that it pays to use higher-alloy metals.

In between the high and the low are wide ranges of medium-alloy metals. These will take over assignments from both ends of the range.

Selective-area hardening and annealing, and far wider selectivity of what may be brazed or soldered, are resources which the stress engineer has long awaited. With them, machine parts can be so designed that the stresses concentrate in the places where they can do the least damage. Sprocket and clutch teeth, for example, can be so hardened that most of the tensile and shearing stresses are transferred by the stiffened teeth to the resilient and unhardened masses of metal below the teeth. When this happens, a highly stressed part can be made 20 percent or more lighter and still have far more durability than the original.

By annealing selected areas of parts and leaving the remainders hard, the parts can be straightened far more rapidly. Some areas can be stiff to withstand chuck-jaw pressures while others are softened for machining. All sorts of new parts can be made by simple twisting or bending of pre-formed shapes; the areas from and to which metal will flow in drawing-press dies can be so controlled that stronger and better parts are made with lower die and fabrication costs.

MAGIC TEMPERATURES—Carbon steels are much stronger at about 600 degrees, Fahrenheit, than at room temperature. Many machining operations, especially on bars of less than a half-inch diameter, now have to be slowed down to prevent the steel from springing away from the tool, from tearing, or from twisting off. The attachment of selective-area heating devices directly to machine tools will permit the machining of this steel at a temperature which gives the greatest mechanical strength, with machining speeds which are undreamed of today.

Various alloys of copper, magnesium, aluminum, and other metals have their individual "magic temperatures" at which they can be machined, drawn, spun, stamped, or cold forged far more easily than at any other temperatures. At present, these temperatures are listed among the known facts which are impractical of application. The modern machine tools for heating will change all that.

The race is on, then, to see which machine tools for heating will be quickest and best in the business of bringing hundreds of benefits to industry. And the integrating and mechanizing of heating devices to the point where they can be regarded only as machine tools is the most promising as well as dramatic fact in the mechanical engineering world today.

STEEL WOOL

Now Made from Stainless To Gain in Quality

IN MODERN industrial processes, steel wool is clamped between disks to form buffing and scouring wheels, is formed into balls and cones which can be mounted in drill chucks, and is used by many another power driven method.

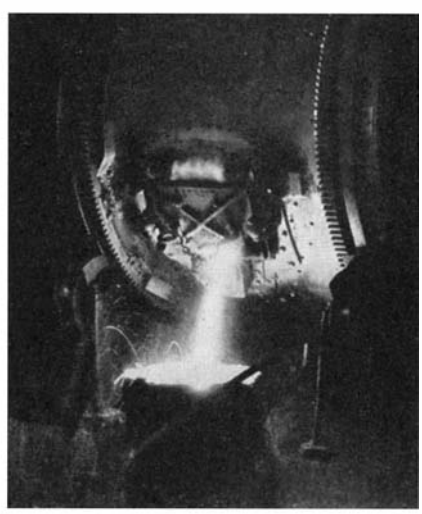
Industrial steel wool needs several controlled qualities. Sharpness of the edges of individual strands, freedom from saw teeth on those edges, controlled amounts of resiliency, and resistance to damage by fatigue failures of the strands and by corrosion, are among them.

To obtain increased amounts of these qualities, industry is turning to steel wools made of alloy steels. Stainless steels are increasing in use for this purpose. The stainless steels are strong, take edges which are sharp and durable, and, of course, are highly resistant to corrosion.

MACHINE SCRAPS

Melt Without Burning In Electric Furnaces

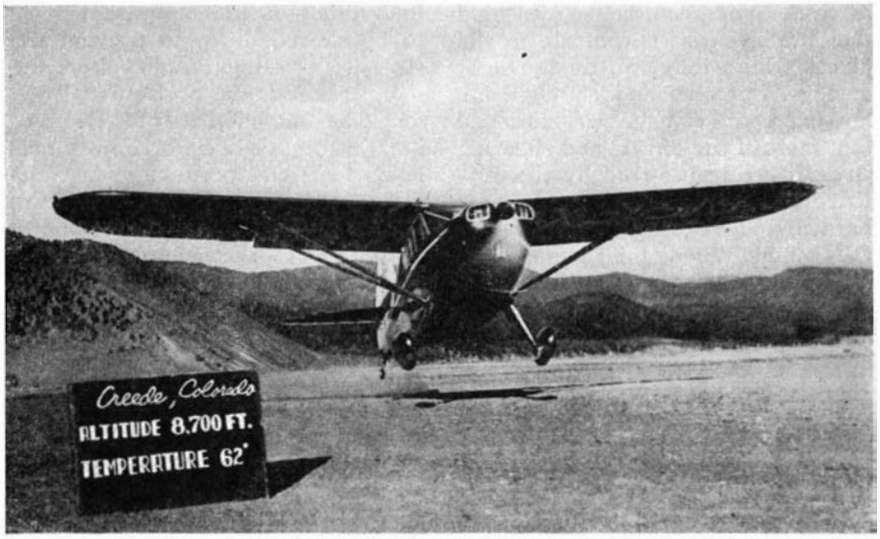
THE OLD-TIME foundryman's dream was to melt scrap chips taken direct from the machine shop. Unfortunately, chips burn up in ordinary cupolas.



Foundry furnace salvages scrap

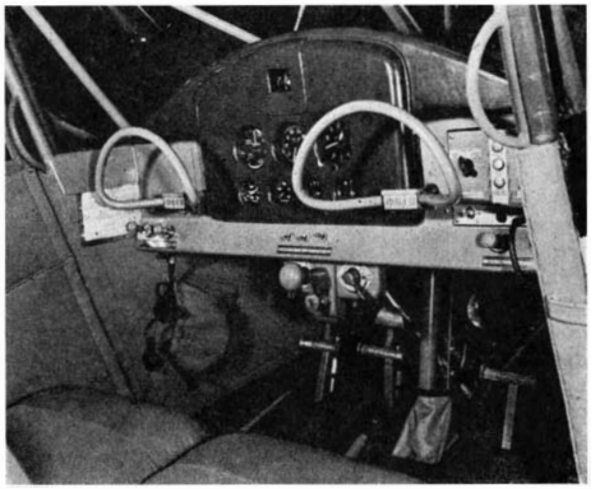
Modern electric furnaces protect the chips against excess air, can melt the chips in inert-gas atmospheres if necessary. In them, the scrap can be carefully mixed to control the alloy ingredients.

Often the presence of such a furnace in a foundry connected with a machine shop can melt scrap at high enough savings to mean difference between profit and loss on the machining of alloy steels.



Courtesy Stinson

Rapid take-off, fast climb are vital to safety; make smaller fields practical



Convenient and correctly designed control handles contribute to comfort and security of private pilots. Also shown in the photograph below is the clean, smooth instrument panel in a Stinson Voyager 150. Such panels are not only attractive in appearance but are an added safety feature in case of an accident

AVIATION

Plane Sense and Safety

Analyzed in Terms of Accident Causes, Private Flying's Safety Record Clearly Shows the High Price of Recklessness. Sane Flight, However, is Relatively Safe. In a Determined Effort to Cut the Toll, Government and Industry Now Combine in an All-Out, Safe-Flying Campaign

By ALEXANDER KLEMIN

Aeronautical Consultant; Research Associate, Daniel Guggenheim School of Aeronautics, New York University

THE future of private flying seems assured. Plane designs are excellent; manufacturers have thousands of orders on the books; learning to fly is easy; aviation is expensive but not too expensive; and great numbers of people have both the money and the desire to engage in private flight. One less sanguine factor remains—the poor safety record of private aviation.

Mr. Jerome Lederer, Chief Engineer of Aero Insurance Underwriters and a recognized authority on aviation safety, takes a frankly pessimistic view. In a speech before the Private Flying Conference of the National Aeronautic Association, Mr. Lederer said: "In the past 15 years I have tried every means . . . to get pilots, mechanics, airport operators, and other aviation enthusiasts to adopt safe practices. The figures show that my efforts and those of others have failed miserably. Before the war, in the worst year, about 40,000 people were killed on the highways. If there were as many aircraft as automobiles, the yearly aviation death rate would not be a mere 40,000 per year but 250,000!"

Unfortunately, sound statistics support Mr. Lederer's comments. An accompanying table offers the comparative safety record, as presented by the National Safety Council, based on the average figures for 1939 and 1940; the last two years for which valid aviation records are available. In this analysis, drivers of passenger automobiles and pilots of private planes are considered passengers.

Regular transport flying is safer than the automobile, though it does not make quite as good a showing as the railroads. But the figures for private flying are deplorable! Actually, private flying should be nearly as safe as transport flying. It is not the intrinsic character of private flying which makes it hazardous. It is a neglect of safe practices, plus low stunting and reckless flying, which mar the situation.

In one week, the Civil Aeronautics Safety Board reported five light-plane accidents in various parts of the country. Each of the five accidents was due to reckless flying or poor piloting. Some of the CAB reports read: "Poor piloting;

• LOOKING AHEAD •

For a while, a continuance of private aviation accidents as more and more people fly. . . Later, a growth of public indignation, even more strenuous safety campaigns by all concerned . . . Eventually, general realization that flying is not quite so simple as motoring. . . This, followed by better safety records as air lore becomes common knowledge to new generations.

pilot stalled out of the turn at low altitude." . . . another "probable cause of the accident was the pilot's maneuvering of the aircraft at a recklessly low altitude." . . . and yet another "pilot failed to keep the engine warm in a long gliding descent."

Another tabulation of statistics on fatalities, printed here, confirms the view that with reckless flying eliminated, the safety of private flying would be immeasurably improved.

ACTION DUE—In an effort to eliminate reckless flying, an energetic educational campaign is being conducted under the joint auspices of the National Aeronautics Association and of the Aero Insurance Underwriters. As a beginning, an advisory council of 17 interested national organizations has drafted the minimum standards to determine the eligibility of airports for certificates of good safety practice.

The second part of the safety campaign will comprise a series of monthly educational drives, each directed at one phase of the safety problem such as reckless flying, collision hazards, inadequate flight planning for cross-country trips, accident prevention, and the like. Piper Aircraft Corporation is also sponsoring a nation-wide contest to encourage safe flying by students, pilots, and plane owners, with a flying log and freedom from accidents as the basis of awards.

Although the exact details of the NAA Educational Campaign are not yet available, there are some things at which it will certainly be directed. One is the pilot who is a public nuisance and disturbs people by low flying, with or without acrobatics. Such pilots should be reported. Fire hazards such as arise when pilots throw burning cigarets out of a ship; low stunting; spectacular takeoffs; inaccessible fuel strainers; dirty fuel; and improper cockpit vision are other dangers whose miscellaneous natures are in themselves indicative of the problem's magnitude. Airport managers as well as pilots bear a heavy responsibility and among other things should make provision against trespassing by people who may damage airplanes with the damage remaining unnoticed until too late.

Private flying safety is not a matter of one device or one outstanding invention. It is a combination of safe practices in the air and on the ground.

REGULATIONS—The Civil Aeronautics Board quite rightly believes that safety observance in general lies well beyond the imposition of regulatory requirements. W. E. Koneczy of the CAB Safety Bureau concurs fully with the views of NAA and does not believe that Civil Air Regulations should try to cover all safety problems. "There remains unregulated by CAB a broad field dealing with safety which can be dealt with more efficiently by other than regulatory means." There are many practices to this end which should be observed by pilots; other which should be followed by manufacturers and ground personnel.

Passenger Deaths in 100,000,000 Passenger Miles

Automobiles and Taxis	3.2
Buses	0.22
Railroad Passenger Trains	0.24
Scheduled Air Transport Planes	2.4
Privately Operated Planes	76.8

Pilots, to get a private flying certificate, need only 30 hours solo, three hours cross-country experience, 10 hours dual instruction, and a written examination in Air Regulations. Safe pilots, however, recognize the limitations of this rudimentary knowledge; they study meterology, acquire some knowledge of cross-country navigation and gain some grasp of maps and topography. Above all, pilots should know when *not* to fly. According to Mr. Koneczy: "The experienced pilot who might be able to cope with an emergency under adverse conditions is the one who usually has learned by that very experience when to stay on the ground."

SAFE PLANES—The designer and manufacturer of the airplane itself also play a part in the safety picture. The importance of stall- and spin-proof planes, of planes provided with a nose wheel, of simplified two-control designs cannot be overestimated. But there are many other more prosaic features that the designer must keep in mind. Private airplanes need a rate of climb well over 300 feet per minute, a climbing angle of at least 1 in 12. If the ship is to be used for cross-country work, then the fuel tanks should have at least one gallon capacity for every seven horsepower of the engine. The recommended cruising speed should be low enough that the engine is not pushed too hard on prolonged trips.

Statistics of Fatalities in 1941

Cause	Number of Accidents	Fatal
Low Acrobatics	20	16
Circling Houses, etc.	6	5
Stalls Near Ground	20	17
Others	6	6
Total	52	44

Low landing speed is important, but it is even more important that the pilot have ample control at the slowest flight speed. Here the airplane must be both stable and easily controlled. Windshields of the non-

Range of 600 miles and wing slots are Skyranger safety features

splintering type—proof against the impact of a bird—are as vital in planes as they are in automobiles. Furthermore, windshield defrosters, and wing de-icers have a definite role in safe flight.

A wide variety of minor details enter into design considerations of safety. For example, door handles should be jam-proof, control handles ought to be of distinctive shape so that in an emergency the pilot can pick out the correct handle by feel, and protruding objects within the cockpit should be avoided. An instrument panel with many knobs protruding from it may cause serious injury in a crash landing whereas a flat instrument panel may act as a shock absorber.

All of the foregoing factors—government and industry campaigns, better plane designs, and a sounder grasp of flying fundamentals by pilots—will ultimately aid the cause of private aviation safety. As with most problems where the public safety is involved, however, a purposeful action by the general public will be required if a level of adequate safety is to be reached. Purchasers and users of private planes can accomplish a substantial amount along these lines by abstaining from foolish practices themselves and upholding the Civil Air Regulations. Even non-flyers may do their share by promoting the construction of air facilities in their home communities; and, equally important, by exercising their rights as citizens in seeing that such publicly sponsored facilities are well managed by sensible and competent personnel.

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WIND TUNNEL

Provides Test Conditions For Engines and Propellers

PERHAPS the most versatile wind tunnel ever built is that recently announced by United Aircraft Corporation. While many industrial wind tunnels have been built for general aerodynamic testing, this industrial laboratory is the first to be built solely for power-plant and propeller testing. The east leg of the tunnel has a closed-circuit length of 634 feet, with fan-motor foundation and maintenance hoisting equipment on one side and air exchanger towers on the other.

Two alternate test sections can be put to work. One has a throat diameter of 18 feet, in which speeds up to 200 miles per hour can be obtained; the other with a throat diameter of only eight feet, with available air speeds up to 800 miles per hour. It is this interchangeability of throat sections that accounts for the versatility of the new piece of equipment.

The propeller, 26 feet in diameter, has 20 blades and is variable in pitch. Back of the propeller are air-straightening vanes.

Wind tunnels have now reached a high degree of complexity and need many auxiliary devices. In the United Aircraft tunnel, models can be mounted on a turn-table for obtaining data on yawing and pitching. Test models are supported on a six-component balance frame which measures thrust up to 20,000 pounds.

Since the laboratory is designed to function at constant temperatures, two air-exchanger towers are provided, each 66½ feet high, through which warm air is exhausted and fresh air is inducted. A large air-exchanger capacity is indispensable because a powerful engine under full load must dissipate a tremendous amount of heat energy, and to this has to be added the 7000 horsepower of the ventilating fan.

Special equipment is available for testing small propellers, fans, and helicopter rotors.

AIRCRAFT SOUND-PROOFING

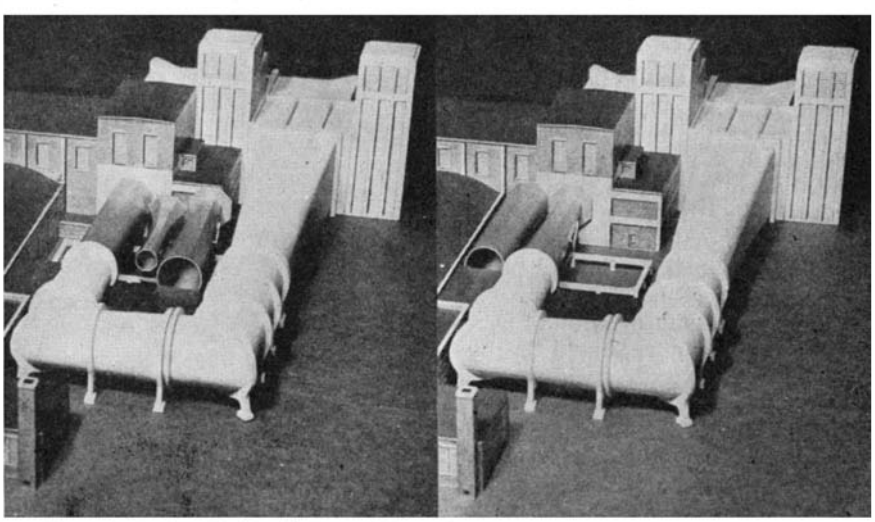
Improved by Newly Developed Material

SPEED and power of aircraft have greatly increased in recent years, and noise has increased accordingly. But noise reduction within the airplane usually involves some loss of performance, either from the additional weight of sound-proofing material or from the loss in engine efficiency due to an exhaust collector system.

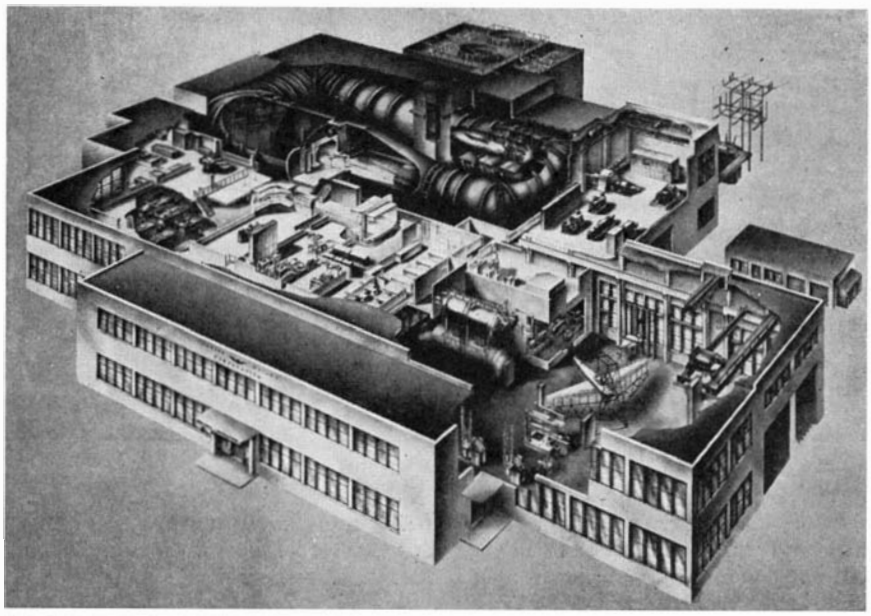
Now that emphasis has shifted once again to civil aircraft, greater efforts are being made both in reducing the noise at the source and in sound-proofing. Moreover, a new problem arises as the jet engine appears likely to be employed in commercial aircraft. In the jet engine the main sources of noise are the whistle from the impeller and the roar of the jet. The use of the jet engine avoids the use of a propeller, but, of course, the jet cannot be muffled. Some authorities are of the opinion that, for the same performance, aircraft powered with jet engines may be less noisy than those powered with piston engines with open stub exhausts, but the exhaust noise of the piston engine may be reduced by manifolds; thus the question remains to be answered and further research is necessary.

In the meantime, one of the most important things is to give the greatest attention to sound-proofing materials. It is possible to secure sound-proofing from non-porous solid slabs or panels simply by the sheer-bulk method of increasing their thickness and weight, but that is an unsatisfactory solution to the airplane problem. Better sound insulation for a given weight is obtained by inserting a layer of light, porous, sound absorbing material in the space between the outer skin and the lining. Double windows also help.

The Electro-Acoustic Laboratory at Harvard University, which has done much research for the AAF to reduce noise inside long-range bombing planes, has tested many materials and now announces as a proved fact that an acoustical material for aircraft use should have a large surface area of the fibers in proportion to their weight. Owens-Corning Fiberglas Corporation has developed a material in accord with this finding. Called Fiberglas insulation, it is composed of glass fibers with an average diameter of 0.00005 inch, which are



Wind tunnel model shows method of alternating test sections by moving throats to side. (Left): Large section in position. (Right): Eight-foot throat installed



Cutaway view of aviation research laboratory indicates the wealth of complex equipment involved. Wind tunnel, model shop, and altitude chamber are visible

treated with a thermosetting binder and shaped into resilient, flexible, half-inch-thick sheets. The density is only 0.6 pounds per cubic foot, while that of water is 62½ pounds per cubic foot. The approximate weight of the sheets per square foot is 0.025 of a pound. Put more graphically, a thousand square feet of the material, as produced in half-inch thickness, weigh no more than a suitcase packed for a week-end trip.

Thermal conductivity is also low so that thermal as well as acoustical insulation is obtained. Tests made with two half-inch layers of the material with an asbestos septum between them, and faced on one side with trim cloth, have shown that the material is very much better proportionately to its weight than the ordinary weight-law of acoustical insulation would indicate. Applications of the new material are possible not only in airplanes but also in automobiles and trains.

AVIATION LABORATORY

Is Turned to Academic Uses When Plane Company Moves

WHEN Curtiss-Wright moved its airplane plant to Columbus, Ohio, it transferred its aeronautical research laboratory at Buffalo to Cornell University. Finances and research problems for the laboratory are supplied by a group of eastern aircraft manufacturers. Fully available to graduate students will be a new 600 mile-per-hour wind tunnel, of the return or closed circuit type; a model shop; chemical and metallurgical laboratories; and an altitude pressure chamber. In the latter, altitudes up to 80,000 feet and temperatures as low as minus 85 degrees, Fahrenheit, can be simulated. Another fine piece of equipment is a system whereby an airplane instrument panel can be observed by television at a ground station. Particularly important, many of the laboratory personnel, including its Director, Doctor C. C. Furnas, will remain.

PRODUCTION "PACKAGE"

Speeds Construction of New Aircraft

MANY war-learned lessons in the mass production of aircraft are now finding application both in peacetime aviation and in planning a system of production-preparedness for the future. When early hand-methods of aircraft construction gave over to mass production, it was considered necessary for an airplane to pass through multiple stages before quantity production. First, the plane had to be designed on an experimental basis; next, two or three were built for service testing; and finally it was necessary to redesign before it was safe to tool up for mass production.

Richard S. Boutelle, Vice President and General Manager of Fairchild Aircraft, writing on a "Key to Preparedness for Mass Production" in *Pegasus,* summarizes a great deal of the aircraft industry's cumulative production thinking in terming a new principle—that eliminates the multi-stage development engineering—"packaging" mass production knowledge. In his discussion of the "packaging" principle, as applied to the building of the Fairchild Cargo Packet, Mr. Boutelle tells of collecting all production knowledge, investigating tooling, and formulating jig designs while the plane was still in the design stage. Under this plan, successful prototype tests were not the signal to start production thinking, but were, instead, the authority to speed the "package" of production knowledge to the production-lines. Hence, construction in mass quantities got under way many months earlier than it would have under previous procedures.

LABORATORY PLANE

Carried Researchers to Pacific Islands

DURING the war in the Southwest Pacific, the Army's Tropical Science Mission converted a Douglas C-54, four-engined transport, into a flying laboratory. The C-54 laboratory carried electric sterilizers—with current supplied by a gasoline-engine driven 110-volt generator—standard size refrigerators, and supply shelves located in the space ordinarily used for litters. Also provided in the plane were work tables and benches where 17 scientists could work at one time, effectively, but not in great comfort!

Flying laboratory in operation

AIRPORT MAINTENANCE

May be Improved by Inspection from Helicopters

HELICOPTERS are now suggested for use in servicing large airports. They could be used for such everyday work as daily inspection of runways and approaches, checks on possible damage to boundary lights, conditions of painted numerals or guide lines and so on. It appears that the overall coverage of the helicopter is such that these tasks could be done much better from a helicopter than by automobile.

Conducted by The Staff

Powdered Coal

Vital Technical and Economic Significance Attaches to New Power Plant that Will First Challenge Diesel and Steam Power on the Rails. Of Prime Importance is the Promise of Saving Dwindling Oil Reserves. Further, it Will Eliminate Water Supply and Boiler Problems

FOR 50 years some of the world's leading inventors have been dreaming of feeding an internal combustion engine with cheap and abundant coal instead of gasoline or oil. Rudolph Diesel planned to run his now famous engine on powdered coal. He couldn't make it work and a number of later attempts, aimed at the same end, were abandoned. The coal was hard to feed and the gritty ash damaged the engines. Still it remained a shining hope for ambitious engineers, who foresaw an industrial revolution if they could wrest power directly from inexpensive coal instead of burning it less efficiently beneath a boiler to make steam.

Now it has been done. In the basement of a laboratory at Johns Hopkins University in Baltimore the world's first successful powdered-coal turbine has been whirring away since last December. Cheap bituminous coal goes in at one end. It is reduced to the fineness of confectioner's sugar by an ingenious but simple mechanism and shot directly into a roaring combustion chamber. Purged of the abrasive ash particles by a man-made whirlwind, the super-hot gases of combustion spin the blades of a turbine.

This pioneer machine is a sprawling affair. It was not built for beauty, but to prove a principle. That principle has now been proved, and work has already begun on a compact, streamlined successor to be mounted in a locomotive. Half a dozen of the country's leading railroads and three major coal companies are gambling on its future, and it now appears that the coal-burning gas turbine will soon be challenging Diesel and steam power not only on the rails but in ships and stationary power-plants as well.

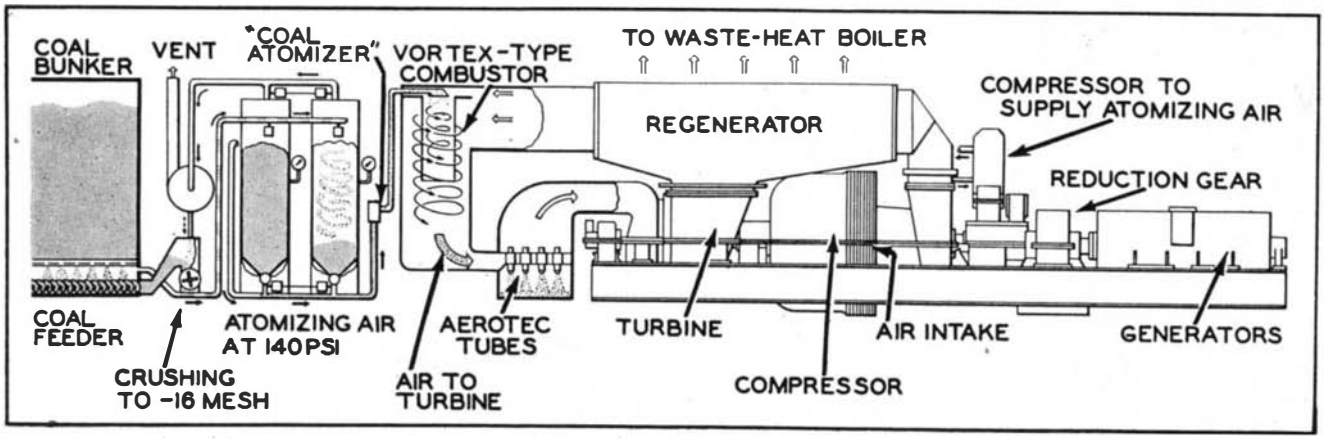
The ultimate importance of an engine that will take coal and make it perform like oil can hardly be over-estimated. It is an accepted fact that our oil reserves are vanishing; the price of oil seems certain to rise over the years as wells go deeper and oil searching goes farther afield. Eventual exhaustion of our oil reserves is inevitable. But we have plenty of coal—enough to last 3000 years at least. Gasoline and Diesel oil can be made from it by costly chemical processes, but it is obviously cheaper to burn the coal directly.

STEAM ENGINES INEFFICIENT — Only 18 months ago, the coal-burning gas turbine—or something like it—was a mere gleam in the eyes of a group of railroad and coal company executives, spark-plugged by Roy B. White, president of the Baltimore and Ohio. The group met to consider a common problem. Railroads get an important slice of their income from carrying coal, so it is to their interest to promote its use. But most coal-burning steam locomotives are inefficient in many respects. They convert less than 8 percent of the coal's heat units into power, they waste time taking on water, they jerk passengers when they start, they pound the roadbeds, and they spray the countryside with smoke and cinders. The highly efficient, smooth-starting, oil-burning Diesel has for several years been pushing the old iron horse out of the picture.

"What this country needs," said Mr. White, "is a better coal-burning locomotive, but it will take plenty of money and one of the best men in the country to build it." So they passed the hat.

The presidents of the Baltimore and Ohio, the Chesapeake and Ohio, the Louisville and Nashville, the New York Central, the Pennsylvania, the Norfolk and Western railroads and of the M. A. Hanna, Island Creek, and Sinclair coal mining companies, joined with Bituminous Coal Research, Inc., to raise a million dollars and to form the Locomotive Development Committee. Mr. White was selected as chairman and he set out to find the man to do the job.

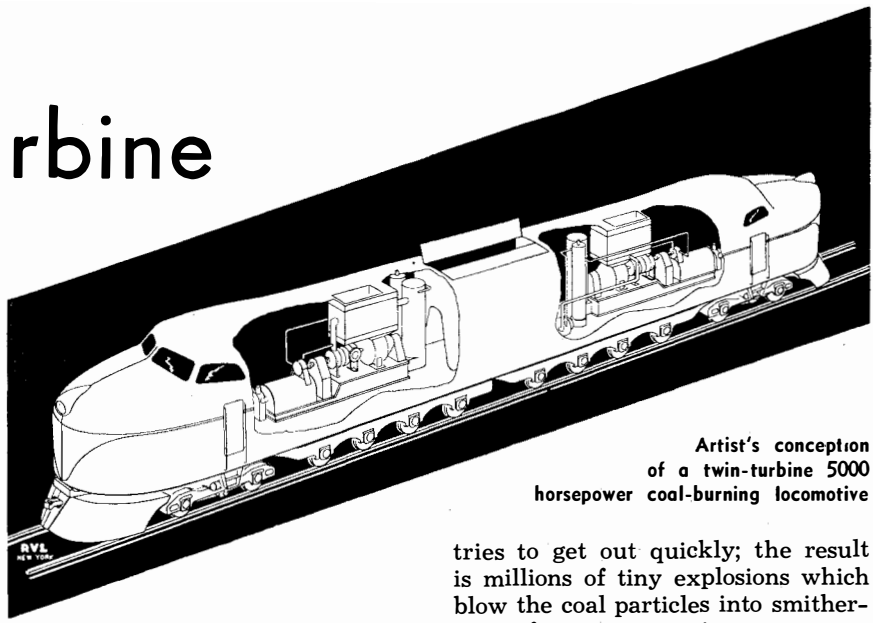
The man was found in John I. Yellott, brilliant Johns Hopkins



How the coal-burning gas turbine will be set up for locomotive service

Feeds A Turbine

By HARLAND MANCHESTER



Artist's conception of a twin-turbine 5000 horsepower coal-burning locomotive

• LOOKING AHEAD •

Applications of the efficient gas turbine will be vastly broadened. . . Rail use initially. . . Then in ships and stationary power plants. . . Even home-heating problems may bow to new powdered coal technology. . . Diesels may yet operate on solid fuel.

graduate who at 32 became head of the department of mechanical engineering at Illinois Institute of Technology, and who in 1939 was be-medaled by the American Society of Mechanical Engineers as the outstanding young man in his field. Later he became chief of the noted Institute of Gas Technology in Chicago. There he plunged into experiments with gas turbines, and also directed the war training of 55,000 technicians in the fields of explosives, ordnance, aircraft engines, and radar.

MAN WITH IDEAS — Yellott jumped at the exciting new commission, and left for Baltimore about a year ago to begin work. He knew about where he was headed, for he had already designed one of the most important parts for such an engine and applied for patents. He was prepared to spend five years translating his ideas into metal and fire, but he had his turbine running before Christmas.

Yellott's coal-burning gas turbine is a close relative of the jet-propulsion plane which has been shattering speed records for the last three years, and of the turbo-supercharger which enables bomber engines to breathe at high altitudes by using the power of the exhaust gases to pack more air into their carburetors.

In the jet plane, a fanlike compressor forces air through a combustion chamber where fuel is burned. The flaming hurricane turns a turbine—a super windmill—which runs the compressor, and with its remaining power streaks out through the jet and drives the plane forward. In the gas turbine—as contrasted with the jet—all the hurricane's strength is expended upon the turbine, which, after running the compressor, delivers a husky dividend of useful power for driving generators or turning wheels. The hot gases which do the work don't care what fuel heats them, as long as it has enough energy in it.

Various grades of gasoline and kerosine have been used as fuel for the gas turbine, but many engineers have been lured by the goal of cheap coal. Experiments to this end are being quietly conducted both here and abroad. But Yellott is the first to solve enough of the problems to produce a turbine that really works and can be put into production.

At Johns Hopkins, where the new engine stands in a rectangular space about the size of a locomotive, Yellott traced its operation for me all the way from the coal bunker to the spinning turbine. It is not so much an invention, he says, as a putting together of devices already invented to create something new.

"ATOMIZED" COAL—Soft coal in the bunker is slowly fed into a preliminary crusher which reduces it to the size of percolator coffee. This is still too coarse for the turbine, so it is "atomized" in a cylindrical device invented by Mr. Yellott while he was still teaching in Chicago. This atomizer works something like the machine used by cereal manufacturers to make "food shot from guns." The "percolator-size" coal is blown at high pressure through a nozzle, where the air pressure is suddenly released. The air trapped in the pores of the coal tries to get out quickly; the result is millions of tiny explosions which blow the coal particles into smithereens of microscopic size.

"Atomized" coal is a soft, fluffy powder which feels like lamp-black or instant coffee when you rub it between your fingers. It is now so fine that it will burn like fuel oil, when blown into the combustion chamber, creating the raging inferno which a gas turbine demands. This powdering of the coal, by the way, uses up only about 2 percent of the power produced.

Ever since the first inventor thought of feeding fine coal to an engine in place of oil, the big question has been: How do you get rid of the ashes? If the "fly-ash"—the tiny cinders which remain when powdered coal is burned—were allowed to pelt the whirling turbine blades, the resulting abrasion would cut through them the way a sand-blasting machine cuts stone or brick. In the many attempts to run a Diesel on powdered coal, the ash has always scored the cylinders; even the hardest metals were unable to resist the harsh particles.

ASH PRECIPITATED—Yellott solved the fly-ash problem by removing the dust particles before they hit the blades. The Aerotec dust precipitator, a war-time invention used in tanks, trucks, and airplanes, does the job. During the early fighting in Libya, engines wore out rapidly because fine particles of sand were pulled into them through the air intakes. The problem was turned over to the Prat-Daniel Corporation of Connecticut, which for years had been making cinder-catchers for factory smokestacks. From this device, the Aerotec Company, a firm created for the job, developed a small centrifugal dust precipitator which was an immediate success, cleaning air as no filter could.

In these precipitators, dust-laden

air is whirled around inside a tube at high speeds. Centrifugal force throws the solid particles out to the wall of the tube, where they fall downward and are trapped for future removal.

Yellott installed a battery of these precipitators between the combustion chamber and the turbine and the problem that had baffled inventors for half a century was licked. The precipitators take out 95 percent of the fly-ash, and the remaining dust, says Yellott, you could put in your eye without noticing it. The air which his locomotive will exhaust, he states, may actually be cleaner than the air it takes in. And if experiments now under way in another laboratory at Purdue University are successful, the ash salvaged by the precipitators will be used for sanding the rails, supplanting the two tons or so of sand now carried by locomotives.

The advantages offered by the new coal-burning turbine sound like a railroad man's dream. Calculations indicate that Yellott's blue-print locomotive, soon to be built, will be three or four times as efficient as today's coal-burning steam locomotive. It will use no water—a great advantage everywhere and especially in arid sections. With no boilers to inspect and clean and few moving parts, it will be far cheaper to maintain. It is so compact that a locomotive half the length of a Diesel-electric will deliver an equal amount of power. It will use any kind of coal, even the cheap lignite variety found in abundance in Texas, Montana, North Dakota, and parts of Canada.

Thermal Efficiencies of Locomotive Power Plants		Average Fuel Costs per Million Btu (December 1945)	
Diesel	36 percent	Diesel Oil	39.0 cents
Gas Turbine	24 percent	Fuel Oil	17.3 cents
Reiprocating Steam Engine	8 percent	Coal	13.1 cents

Turbine efficiency is only two thirds that of a Diesel; now low cost powdered coal, burned directly in a turbine unit, more than offsets lower efficiency

LOW FUEL COST—Coal to run it will cost about one half as much per ton mile as fuel for a Diesel, and will probably cost relatively less in the future. It is certain that Diesel oil will never be any cheaper, and Yellott has plans that may make the powdered-coal gas turbine even more economical. For example, he hopes to eliminate the electric drive which will serve as a gearshift in the first coal burning "turbomotive" as it does in the Diesels now on the rails. Gearing the turbine directly to the wheels by means of an automobile-type gearshift would cut the fuel bill still more as well as reduce initial and maintenance costs.

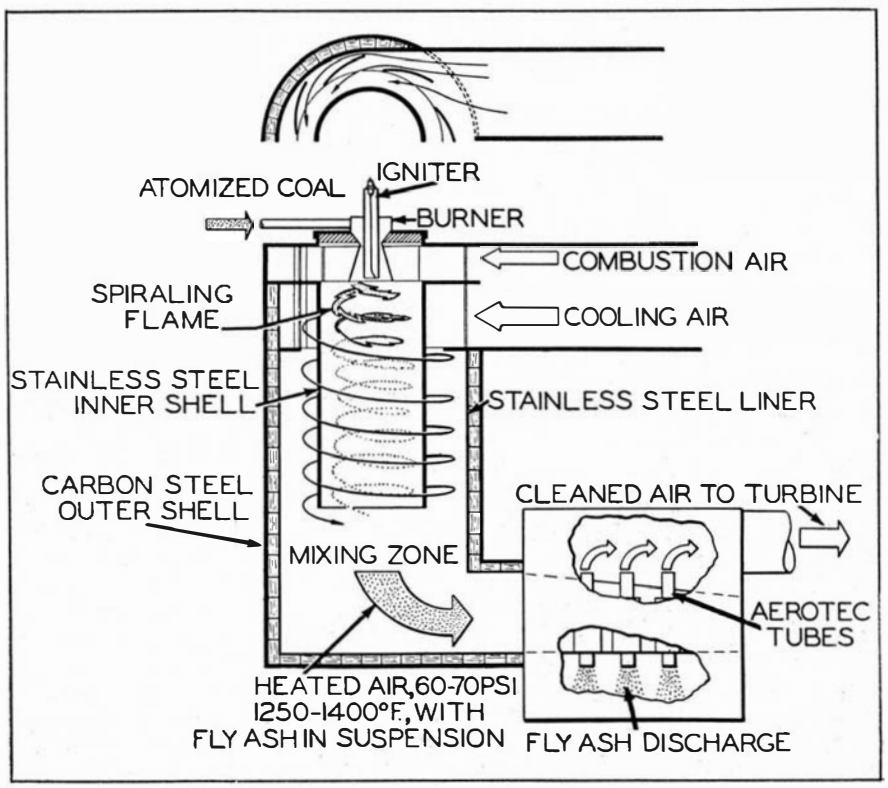
Oil-burning gas turbine locomotives will be only two thirds as efficient as Diesels. The Diesel is still the most efficient internal-combustion engine in the world, delivering as high as 36 percent of the power potential of its fuel as against the gas turbine's 24 percent, the central station steam turbine's 30 percent, and the steam locomotive's 8 percent. But the gas turbine can now burn coal which costs only one-third as much per heat unit as Diesel fuel, thus more than canceling out the Diesel's efficiency advantage.

The turbine locomotive will not pound the rails because it has no reciprocating piston action. Still another virtue of the turbine which appeals to railroad men has been noted by jet-plane pilots in cold northern climates. When a gas turbine draws in cold air, its power goes up by as much as 50 percent. This is because cold air is denser, and much more of it can be driven through the compressor with the expenditure of less power. This fits neatly with the fact that it takes more power to pull a train in winter, when grease congeals and the wheels of a standing train often freeze to the rails. The exhaust from the turbine can also supply the comfort-heat requirements of the train

Many other possibilities lie ahead. Convertible gas turbine locomotives which will burn either coal or oil are being considered. Thus a train leaving the oil-rich West Coast could switch to coal east of the Rockies. The coal-burning gas turbine should be ideal for stationary power plants in regions which have plenty of coal and a limited water supply. Suitable for loads all the way from 500 to 10,000 horsepower, it may once more make coal supreme on the seven seas. Oil-burning gas turbines are now being built for ships, and a shift to coal would be a big money-saver. Yellott has his eyes on harbor tugboats, which he thinks may well be marine pioneers in the new power.

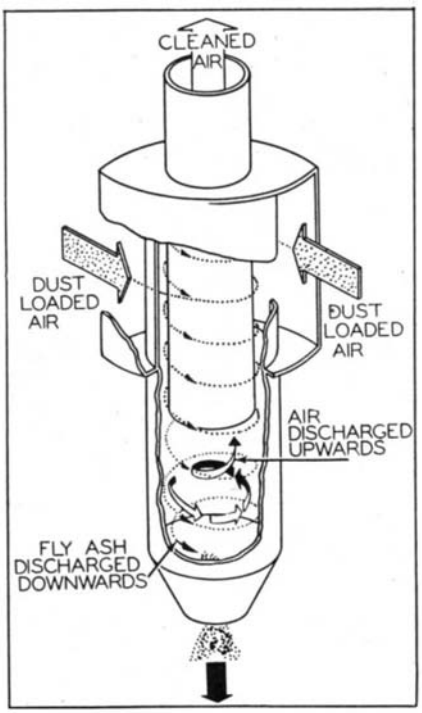
Bituminous Coal Research, Inc., which sponsors the present work, through its Locomotive Development Committee, is taking out patents only to keep the development from being bottled up, and will license all firms which want to build the new engine. The Committee's major interest is in promoting the use of coal.

OTHER USES—Important offshoots are being explored. As a long-range project, Yellott plans to bring to fruition Diesel's old scheme of feeding his internal-combustion re-



Details of the coal-burning turbine's combustor and fly ash eliminator

ciprocating engine on coal. He has in mind an attachment for the engine to pulverize the coal, turn it into gas, and inject the gas into the cylinders. Meanwhile work is progressing on a home furnace to be fed automatically with an air-driven stream of powdered coal. The "face-powder" fuel would be delivered in dust-tight containers. Combustion



Principle of operation of the Aerotec tube as applied to removal of fly ash from hot air that operates the new coal-burning turbine rotor

would be practically complete and smokeless, the remaining cinders would be removed by adapted Aerotec tubes, and houses would have exhaust pipes instead of chimneys.

Next to atomic energy possibilities yet unrealized, the gas turbine ranks as the most important power development of the 20th Century. The new engine in Baltimore, designed to conserve vanishing oil and to use abundant coal, promises to complete the power revolution which the gas turbine has started.

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ACCIDENT COSTS

Magnified Four Times by Indirect Losses

THE HIGH indirect cost of industrial accidents—four times as great as the direct cost—should be regarded by management as an important factor when determining cost-control policies, George K. McKenzie, vice president and secretary of the Flintkote Company, told the safety division of The American Society of Mechanical Engineers at a recent meeting.

Authorities agree that the indirect cost of industrial accidents involving injuries to persons is four times greater on the average than the direct cost of the medical payments and the disability benefits. Some examples of indirect costs are: cost of time lost by other employees who stop work out of curiosity, out of sympathy, or to assist the injured employee; cost due to the damage to the machine, tools, or to the spoilage of material; incidental costs due to interference with production, failure to fill orders on time, payments of forfeits, and similar causes.

In other cases, loss of profit on the injured worker's productivity and on idle machines is a substantial cost factor, while supervisory time losses in selecting and training a new worker, preparing accident reports and investigating the cause of the accident are almost always present.

GAP-FILLING GLUE

Holds Well in Imperfectly Fitted Wood Joints

A MODIFIED and improved version of the resin adhesive known as Beetle cement, which was used by the British in aircraft construction during the war, is now being manufactured by the American Cyanamid Company under the name Urac 185. The essential difference between this and other resin glues is the fact that it can be used successfully for glue lines up to .020 inch in thickness without danger of cracking or crazing and ultimate structural failure. Because of these non-crazing properties, it is not necessary for the joints or surfaces to be perfectly machined. It is said that they can be glued just as the wood comes from the saw. The urea-formaldehyde resin provides a water-resistant glue line and is also resistant to attack by fungus.

An example of the applications to which the glue is suited—in addition to many industrial uses—is found in the repair of small boats. Here, such structural repairs as the replacement of broken ribs, often a difficult job requiring steaming equipment, may be simplified by the use of Urac 185 and glued laminations which do not require heat or pressure to set. The gap-filling and craze resistant properties are helpful in avoiding the problems involved in matching imperfect surface contours.

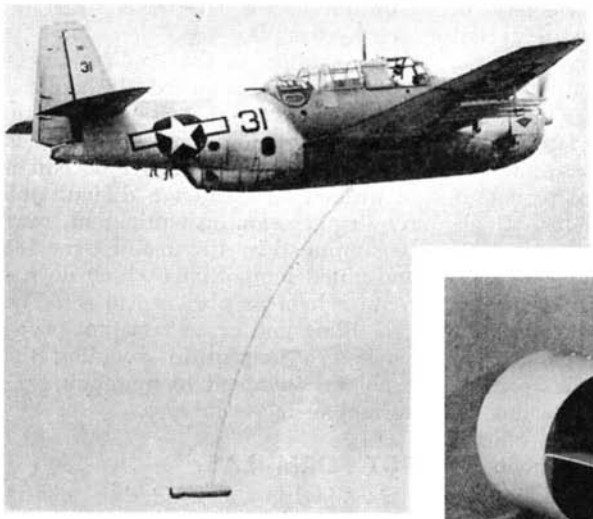
DDT FORMULAS

Matched to Uses, Aided by New Vehicle, Bug "Flusher"

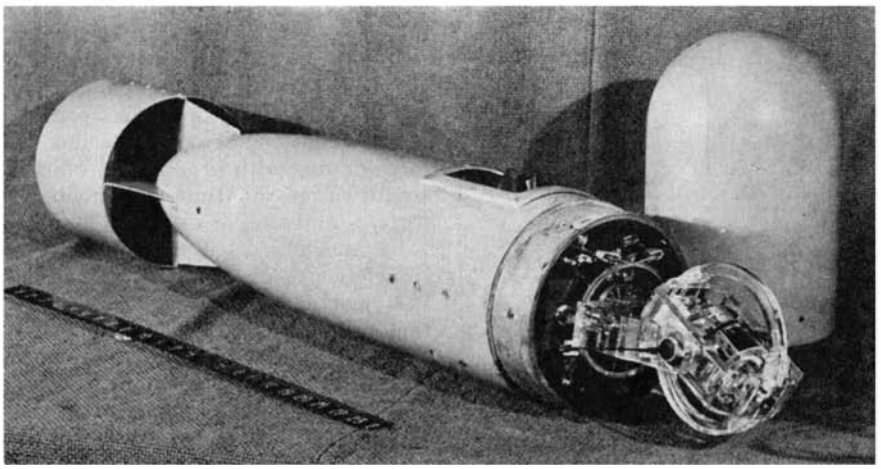
ANNOUNCEMENT of a colorless synthetic resin liquid which promises to make use of DDT safer, faster, more permanent, and practically fool-proof is coupled with the statement that no one DDT formula can solve all insecticide needs. The manufacturer, the Sherwin-Williams Company feels that much confusion stems from various attempts to make an all-purpose DDT. Hence the development of a DDT powder to accompany the resin-liquid—and still another formula for farms and business places.

Since DDT consists of microscopic crystals, which the insect's foot need only touch lightly to cause death in a matter of minutes, it was necessary to find a resin-coating which would hold the crystals on the surface, and permit lower layers of crystals to "migrate" to the surface at a controlled rate for months to keep the DDT.

Repairing a boat by use of gap-filling glue and laminated ribs. Left: The glue is applied to the surface of the first ply, which was cold-bent to shape and screwed in place. Above: The second ply is bent and fastened



Left: How the aerial "doodle bug" is trailed from an airplane. Below: The airborne magnetometer with nose cap removed, compared with two-foot scale



coating lethal. Brushed onto screens, porch ceilings, floors, light fixtures, stairs, and so on, the new resin-coating, called "Pestroy," quickly dries, leaving an almost invisible, non-shiny film. Flies, mosquitoes, fleas, ants, moths, roaches, and bed-bugs are said to be almost instantly paralyzed as the "lipoids" of their feet touch the exposed crystals. Complete safety, however, is claimed for humans, particularly children, who may touch the coated surface, since the crystals do not rub off easily. Inside, the coating is said to remain effective at least three months; outside, at least a month.

Companion to the resin-coating is a powder containing 10 percent DDT and a chemical "bug-flusher" known as pipernylcyclohexanone, which makes it more effective. The chemical causes bugs to leave their cracks and thus come into contact with the deadly powder.

Pestroy powder is marketed in an applicator-top container which squirts a stream of powder into cracks and hard-to-reach places where roaches, moths, and bed-bugs lurk. Dogs may also be dusted to kill fleas and lice.

TIN FOR CARS

Replaced by Newer Materials, Better Techniques

DUE TO a continued scarcity, at least 50 percent less tin is being used in 1946 passenger cars than in pre-war models. In 1942, the average automobile contained 3.72 pounds of tin, mostly used in solder, or to prevent corrosion, or as a finishing material for moving parts such as pistons. Today, the average amount of tin going into cars is 1.73 pounds.

Alternate materials and manufacturing methods developed to meet heavy-duty, military vehicle needs now help to accomplish the tin saving without any diminishing of automobile quality. Examples of such changes include a new "tinless" body solder, and chemical and brass coatings to replace the formerly used tin "lubrication" surfacing for aluminum pistons.

AERIAL DOODLE BUG

Speeds Surveys of Earth's Geophysical Structures

PROSPECTING by air for potential oil and mineral producing areas is possible with a new device developed as an outgrowth of a hitherto secret means of magnetically finding and tracking submerged enemy submarines. Termed the magnetic airborne detector, and familiarly known as "the aerial doodle bug," the device provides a means for a quick, large scale survey of those geological structures which may include valuable natural resources. It is expected to be especially valuable in such now inaccessible areas as polar regions, jungles, and offshore tidewaters.

The device was developed by Bell Telephone Laboratories in co-operation with the Naval Ordnance Laboratory under the auspices of the Navy's Bureau of Ordnance and Bureau of Aeronautics. Another magnetometer was developed by Gulf Research and Development Company, working independently and later under contract with the National Defense Research Committee.

Engineers associated with the development emphasized the reconnaissance nature of the device and pointed out that its chief value lay in its capacity to outline rapidly those areas which are promising, and which should be more intensively investigated by ground parties. In this connection, it was noted that the aerial doodle bug does not actually detect oil deposits but, by mapping geological structures, indicates those peculiar areas in which oil is usually found.

The principal feature of the new system is an airborne magnetometer —measurer of magnetism—which for peace-time use, has been revised somewhat and combined with Shoran, a radar-mapping device, and with special mapping cameras. Thus, in addition to being a speedy preliminary survey tool, the new device also gives a more accurate appraisal of the geological structure of an area than that obtained by ground parties using conventional methods of magnetic exploration. Further, the airborne detector draws a continuous magnetic record of the terrain over which it is flown and in so doing disregards small and relatively unimportant magnetic irregularities.

The new instrument may also be used by oceanographers and geologists in the study of offshore geological conditions.

MORE ABOUT SILICONES

High Temperature Lubricants and Heat Resisting Paints

BALL BEARINGS permanently lubricated, paints that will protect hot engine mufflers and furnace fronts, motor oils and lubricating greases that will not fail under continued high temperatures, are all possible through the use of silicones, according to W. R. Collings, vice president and general manager of Dow Corning Corporation. These new products have properties which "will simplify the problems of the chemical engineer," said Mr. Collings, who spoke on silicones as new engineering materials at a recent meeting of the American Institute of Chemical Engineers. He revealed

that one of the simplest silicones, Hexamethyldisiloxane, was valuable as a compass fluid during the war because its viscosity changes only slightly with variations in temperature.

Regarding motor oils, he said that "for general high temperature lubricating purposes it was necessary to develop a fluid of a different type than the straight chain silicones." He also revealed that a silicone fluid is now in production that is equal to ordinary motor oil in lubricity at normal temperatures, is non volatile, and it has no tendency to gum at operating temperatures as high as 400 degrees, Fahrenheit.

Mr. Collings also pointed out that new silicone greases would be ideal for permanent lubrication of ball bearings since they exhibit the lowest volatility and the greatest heat and oxidation resistance of any known greases. Tests conducted in ball bearings indicate that the silicone greases now available will operate successfully at temperatures of 300 to 320 degrees.

Resins made from silicones have excellent protective properties. Mr. Collings stated that pigmented varnishes using aluminum powder have been used successfully for protective coatings on furnace fronts, stacks, Diesel engine mufflers, and on many other steel surfaces at temperatures up to 600 degrees, Fahrenheit. Heat resistant mineral pigments can be used also but they will not withstand as high temperatures as aluminum. The greatest volume of so-called silicone paints has been used in the middle west on hot equipment around oil refineries.

TURBINE SIZES

Fixed by New Standards as Production and Service Aid

THE FIRST "standardized" steam turbine built for electric power generation is now in production. The unit is the result of a long-felt need to remove the "custom-made" label from such machines and introduce certain standard sizes and operating conditions.

According to Westinghouse Electric Corporation, steam turbines, the source of much of the nation's mass-production power, have always been tailor-made. Thus, this recent development, brought about by a committee organized by the American Institute of Electrical Engineers and the American Society of Mechanical Engineers, can be described as a definite step toward improving the power facilities of the country and at the same time giving more satisfactory service to the public in general.

The six sizes of turbines, decided upon by the committee as within the range of the most common of the larger power-plant sizes and therefore the most suitable for standardization, run from 11,500 to 60,000 kilowatts in productive capacity. This is sufficient range to provide power for cities from 10,000 to 50,000 population. With a plant's productive facilities geared to a definite number of turbine sizes, many types of stock parts—such as blades—can be turned out in quantity for use in future orders or to be kept in reserve as replacements.

It is expected that eventually this standardization will have a two-fold result. First, it will speed up production and facilitate quicker delivery of equipment, and secondly it will be much easier to provide repairs and to service machinery than before. The standardization program will not hinder production of any size of steam turbine-generator needed for purposes for which the standard specifications might not be suited. Neither will it prevent building duplicates of machines already installed and for which designs and patterns are available. Further benefits are anticipated in that the amount of effort formerly devoted to custom designing may now be turned to research.

New Products and Processes

PORTABLE LIGHT

Is Fluorescent Type, Operates on Battery

INTENDED for use wherever a portable, self-powered light is needed, a new flood-light incorporates a six-watt fluorescent tube and uses a standard B-battery as the power supply. With continuous use, the battery will provide light for about 30 hours.

Known as the "Totelite," the unit is contained in a single 24-gage steel case finished in crackle-type enamel. Its lens shield, described as non-breakable, is transparent Lumarith. The plastics carrying handle is located just above the convenient one-hand control.

Dimensions of the light are 11 by 8¼ by 4½ inches, and the weight is seven pounds with battery installed. The makers, Paramount Industries, Inc., call attention to the fact that the light

Light is completely self-contained

is not a spot-type but has a full 180 degree light spread.

Suggested applications for the portable unit range from industrial and domestic emergency illumination to routine uses by electrical, plumbing, and maintenance employees. Motorists, sportsmen, and farmers are also expected to find the light convenient and practical.

AUTO LACQUER

Offers New Effects in Translucent Colors

JUST introduced to the automobile industry is a new lacquer said to be the most durable ever developed, with colors and color effects never before produced. Utilizing a new pigment technique and manufacturing process, "Duco" Metalli-Chrome nitrocellulose lacquer, as the new finish is called, is produced in more than 200 grays, greens, and browns.

It is explained that the deep-glowing luster effect results from the high degree of translucency of the lacquer films. Light penetrates and is reflected back to the eye from within instead of from the outer surface of the film as it does when it strikes a conventional coating. The glowing effect is enhanced by small particles of aluminum flake which serve as tiny mirrors, diffusing and reflecting light from within the film.

Moreover, the translucent metallics afford a color variation as the lighting alters or the angle of vision shifts. Burnished gold and shades of bronze are also available.

The new finishes differ considerably from the so-called metallic finishes used before the war, and it is said that the majority of the colors are made possible by a new pigment material—ferric hydroxide. The reason the lacquers are translucent, it is explained, is because of the extremely fine particle size of the pigments employed. Du Pont chemists say the durability of Metalli-Chrome is based on a different principle than the durability of conventional lacquers which are dependent to a large degree on the opacity of standard pigments which prevent destructive ultra-violet light rays from entering the film.

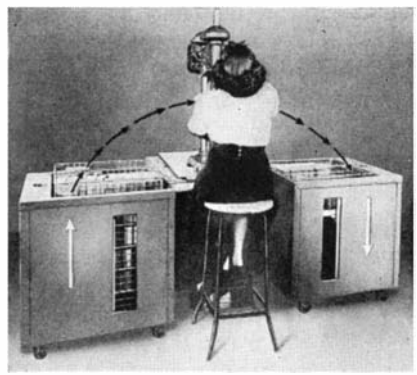
INDUSTRIAL RACK

Feeds Material to Hand Level, Stores, and Transports

A THREE-IN-ONE unit that combines automatic material handling with storage and transporting, features speedier production and elimination of psychological slow down, physical back strain, and accident factors involved in manual lifting of loaded tote boxes or in lifting materials to working levels. The automatic, spring-powered racks hold a visible bank of material and bring each piece to the operator's hand level as soon as the preceding piece has been removed. Production benefits because the same working level is constantly maintained and flow of parts or material is continuously timed to the worker's capacity.

Reloading is accomplished by placing material on the platform where it automatically finds its proper level. Activated by self-contained springs, the rack requires no outside power source and is smooth and noiseless in action. Parts may be placed in tote boxes or the material may be placed directly on the platform.

Made by American Machine and



Constant material supply speeds work

Foundry Company, the units are designed to handle any weight. Load changes can be made by unhooking one end of the springs, accessible through a hinged door. The units, mounted on ball-bearing casters, can readily be moved from one department to another while the filled rack can be used as a storage unit.

FOIL LAMINANT

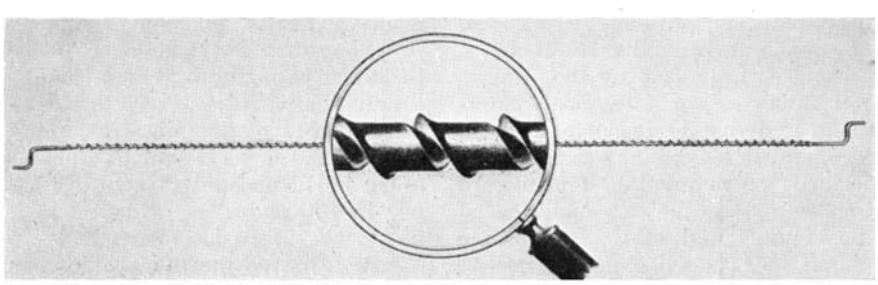
Bonds Aluminum to Other Materials with Synthetic Resin

RECOMMENDED primarily for roll-applicator machines, a new thermo-plastic resin emulsion adhesive is described as able to bond all grades of aluminum foil to cellophane, acetate, glassine, bond, kraft, sulfite, chip-board, and other materials. The manufacturer, Paisley Products, Inc., maintains a technical service department to assist users in adapting this product to their specific requirements.

"BARBER-POLE" TEETH

Provide Jig-Saw Control Without Turning Work

SPIRAL teeth, running the full length of the blade body, are employed in new saw blades for hand coping saws or power-operated jig saws. On the



Enlarged view of saw teeth shows spiral that provides omni-directional cutting

Tylor "Allways" blade, the teeth cut in any direction without requiring the operator to turn the saw frame or the work to change the direction of cut. This stems from the fact that the blade is circular in section, hence its normal stock removal in one stationary stroke leaves a circle and a cut may be made in any line or arc from this circle without blade-binding or breakage.

It is said that nothing is lost in starting facility or cutting accuracy but that the new blade greatly simplifies intricate work such as scroll or fret cutting. Made of oil tempered spring steel and designed to cut all woods, light metals, and plastics, the blades are claimed to be unusually durable. Also, the peculiar spiral cut teeth make for safer use. Industrial applications—for carpenters, mechanics, repairmen, model makers, and cabinet and pattern makers—are anticipated.

SMOKE AND GAS DETECTORS

Possess Surprising Sensitivity, Promise Wide Industrial Use

Two new instruments for detecting the presence of gas or smoke are said by the developers, Northwestern University, to be the most sensitive ever devised. One, the Northwestern Ultra-Violet Photometer, is a rugged, portable instrument for detecting the presence of gases by means of ultraviolet light. It can discover as little as one part of gas in a million parts of air.

With an automatic recording attachment it is expected to find considerable use in providing continuous measurement of toxic vapors in factories and mines. It may replace chemical analysis of gases in closed systems, it is explained, because it does not affect the substances analyzed.

Another instrument is so sensitive it can detect 1/100,000th of an ounce of smoke in a room 30 feet square, and is called the "Northwestern Photoelectric Smoke Penetrometer." The device gives instantaneous readings on the amount of dust in the air and a puff of cigarette smoke diffused in a huge auditorium will deflect its indicator. Its delicate electronic circuits must be hermetically sealed to insure accuracy.

The instrument can be used in studies of industrial plants, smoke elimination, and air purification and conditioning systems. It will also be employed in studying the concentration of various colloidal systems in the field of pure chemical research.

HIGH-DUTY BEARINGS

Resist Foreign Particles, Use Aluminum Base Metal

Aluminum alloys containing tin, nickel, silicon, and copper were recommended at a recent meeting of the Society of Automotive Engineers as new materials for bearings which promise to accelerate progress in designing internal combustion engines.

Reports claim that the results of extensive experiments and tests revealed these bearing materials to be superior for high-duty service in the engines both of land vehicles and aircraft. Other advantages appear to be abilities to resist wear, as well as damage by foreign partieles, and to support much greater loads for prolonged operating periods.

ALUMINUM PANELS

With "Sandwich" Center Now Made for Buildings

Lightweight, high-strength, economical aluminum building material which can be produced in large quantities has recently been announced. Known as "Reynalite," the product combines two sheets of aluminum bonded with a plastics adhesive to a cellulosic core to form an attractive panel which possesses permanent rigidity, resists harmful elements, is easily worked, and is said to be adaptable to many major uses in building construction and related fields. It is described as impervious to moisture and to temperature changes.

Wood-veneer surface can be bonded to either of the metal surfaces, or both. In addition to building construction uses, the aluminum panels appear applicable to railroads cars, buses, trucks, and trailers. Adaptations are also reported in the furniture industry for use as table tops on occasional tables, coffee tables, and end tables. The heat-

conductive property of aluminum reduces to a minimum, and, in many cases eliminates—according to the Reynolds Metals Company—the danger of scorch or burn marks caused by matches or ashes falling onto a table top.

Further features are high insulating value, resistance to lightning and fire, and insect-proof properties.

For fabrication, the panels can be fastened with ordinary nails or screws and worked with common carpenter tools.

CONTACT-FACE ALLOY

Resists Pitting, Welding, Under Heavy Currents

DEVELOPMENT of a new silver-molybdenum alloy that is particularly suitable for facing of contact surfaces in switch gear designed to handle heavy currents has recently been announced. Called Callinite Type SM alloy, the metal is described as a high conductivity facing material suitable for applications where high currents may cause pitting, sticking, or welding of other contacts.

The alloy, produced by Callite Tungsten Corporation, is made in standard and special shapes.

SIGHT EFFICIENCY

In Terms of Job, Checked for Individual Employees

AN AID in assisting employees to do a better job with greater comfort, the Ortho-Rater, a vision-performance tester, helps to assure selection and placement of individuals whose visual capacities fall within pre-determined requirements for each type of job. Developed in co-operation with Purdue University's Division of Education and Applied Psychology, the Bausch and Lomb instrument is now being used in many major industrial plants.

Testing is performed in a few minutes time, in most cases at or near employees' working station. Intended solely for the measurement of visual

Proper vision contributes to success

performance and not for refraction or diagnosis, the Ortho-Rater tests at far and near distances of 26 feet and 13 inches respectively.

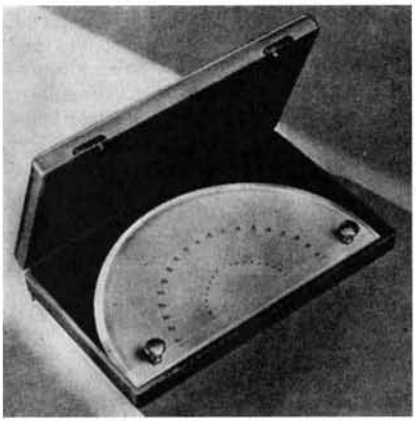
Studies are reported to prove conclusively that persons with high visual efficiency in their specific jobs, other factors being equal, are more likely to attain success.

Eye care is recommended to those whose vision is not right for the requirements of the job. It has been found that proper eye care will, in most cases, sufficiently improve eye skills to meet job requirements.

PROTRACTOR

Precision Made on Plate Glass for Fine Layouts

WHERE requirements demand extremely accurate layouts for use on optical projectors and form grinders, a new layout protractor made of ¼ inch, beveled plate glass should prove valuable. The ruling is on the under side of the glass and, as a consequence, the operator is assured accuracy of measurement since the ruled lines of the protractor are in actual contact



Rulings are on under side of glass

with the layout being produced or checked. The same feature is said to assure exactness of measurement on the screens of optical comparators.

The circular edge of the glass is beveled to a thin outer edge through which the divisions are viewed. This contributes to the ease of accurately marking measurements with a very hard sharp pencil or scriber, or the reading of fine rulings so closely spaced that they designate intervals of but 10 minutes of arc. The layout protractor has cushioned metal handles, and is manufactured by the Engineers Specialties Division, The Universal Engraving and Colorplate Company, Inc.

HEARING AIDS

Powered by Flashlight Cells with Adapter Unit

STANDARD flashlight-type cells, in place of special socket-type cells, may be adapted to hearing aids by a new battery-holding device. Greater economy and added convenience, plus service equal to many of the more expensive socket-type cells, are advantages

claimed for the unit. In addition, standard cells are available almost anywhere at any time.

This offers greater convenience to traveling men, farmers, sportsmen, or others who are not always conveniently able to secure the socket-type hearing aid cells. The resultant savings in battery costs over a period of time is said to be considerable.

Called the Spitfire Battery Holder for "A" batteries, the retainer attaches to the "B" battery with a piece of adhesive tape and holds a flashlight cell firmly in place, making a compact unit

Economy, convenience are advantages

requiring no special carrying case. A socket on the holder contains two terminals, into which the plug of the hearing aid cord is inserted. Insulating plastics surround the contact terminals, providing positive assurance against short circuiting.

INSECT REPELLENT

Retains Power for Long Periods, is Non-Toxic

COLORLESS, stainless, and relatively odorless a new insect repellent is reported to have repelled insects for as long as 36 hours in temperate climates and for as long as 10 hours under tropical conditions. The repellent, to be marketed under the name "d-Ter," is described as having been thoroughly tested with no incidents of toxic reactions to it.

Features of "d-Ter," made by Chandler Chemical Corporation, are that it will not harm any fabric, including nylon, or such things as nail polish and cosmetics. In diluted form, it is said that "d-Ter" can be sprayed on dogs to protect them from fleas and ticks, and on horses, sheep, cattle, and other live-stock, without ill effects. In this form it can also be used to keep flies, mosquitoes, midges, and gnats, away from screens and screen doors.

PHOTOCOPY EXPOSURE

Quickly Determined with "Simple-To-Operate" Slide

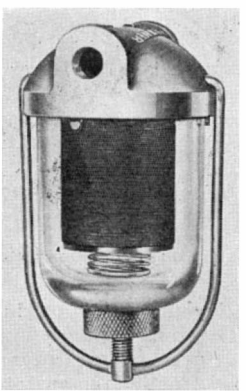
EVEN though photocopying units are quite easily handled by unskilled help, a new and simple exposure slide has been developed to give instantaneous calculation of exposure time, thus bringing added speed to photocopying operations. The slide, which is now being distributed, is made of high quality varnished cardboard, measures approximately six inches long and three inches wide, and holds a movable chart whose figures appear through slots on the front face of the rule. Exposure time is given for five types of reproduction: positive; and reflex, reverse, alternate, and readable negative.

These exposures apply to documents ranging all the way from original tracings on very thin paper to newspapers, photographs and blueprints, and so on. Development of the slide is credited to American Photocopy Equipment Company.

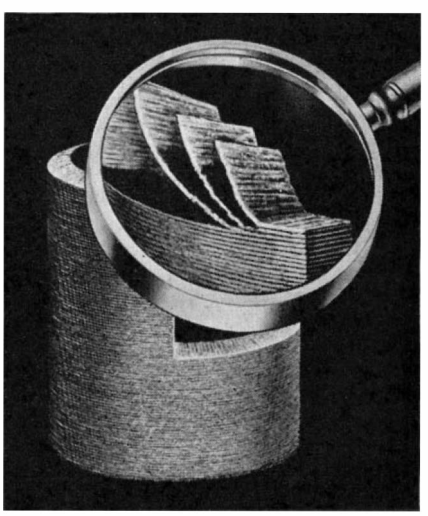
FUEL PURIFIER

Removes Foreign Bodies and Water from Gasoline

MADE in one model to fit most applications—cars, trucks, buses, tractors, and stationary engines—a new fuel purifier passes gasoline or other fuel between layers of helically wound ribbons made from impervious material. Dirt and other impurities are stopped at the outer edges of these ribbons and fall into the sediment chamber. Any accumulations on the outer surface of the cylinder of helically wound ribbons occurring after long use can



Filter, installed in sediment bowl (above), has multi-ribbon structure (below). Fuel passes between ribbons



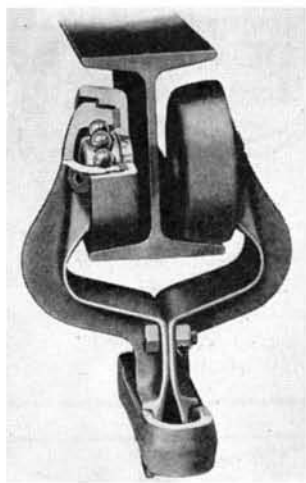
be cleaned off by blowing compressed air, or the breath, into the cylinder. The cylindrical element is known as the Kwick Klean Kartridge.

Called the Skinner Purifier, the unit is claimed to separate free water from gasoline as the result of a laminated construction with almost innumerable orifices of a few microns in size, and the differences in surface tension and specific gravity of the two liquids. It is said that the purifier can be installed in a few minutes and that the flow rate capacity is enough for practically any automotive application.

CONVEYOR TROLLEY

Simplified by Unusual Ball-Bearing Construction

CONTRARY to the design of conventional I-beam trolleys, a new free-rolling conveyor trolley has no wheel shafts, or spindles, and does not require separate retainers for its full complement of hardened alloy-steel balls. Two


Even wear-distribution and greater bearing-area increase conveyor life

basic elements—wheel and one-piece bracket—themselves form the deep inner and outer races of the bearing. The inner-bearing race, being a part of the wheel forging, revolves within the outer race formed by the head of the trolley bracket.

The revolving inner race is said to distribute wear completely around the ball-path. All fixed points of pressure are on the outer race, where the larger diameter provides a greater area of distribution and, consequently, greater resistance to wear. The bearings are assembled by holding the wheel in position on the head of the bracket and then dropping the balls into race-groove through a ball-loading hole at the back of the bracket.

Protective felt seals and lubrication reservoirs are features of the design. Wheels and brackets are drop-forged steel, with ball races accurately machined and hardened. Another feature is the inclusion of both the outer-bearing race and the carrying attachment in a single bracket, resulting in fewer parts and a more pleasing appearance. The lower ends of the two brackets are connected by two bolts, and have horizontal flanges between which the

trolley is joined with conveyor chain link. In addition, the distance from centerline of the conveyor chain to attachment pin has been held to a minimum, thus reducing the resultant action when traveling in an inclined position.

The advantages claimed for the new Link-Belt trolley are smoother operation, higher efficiency, and long life.

REAMING

Upped in Precision with Rigid Tool

AN EXPANSION reamer with a solid one-piece body all the way from the driving end to the lower lock nut is offered under the name Dual Spiral and is said to have great rigidity. In

Solid body gives minimum runout

addition, according to Lempco Products, Inc., the cutting blades spiral more concentrically than previously, and runout is held to an absolute minimum, insuring accuracy to extremely close tolerances.

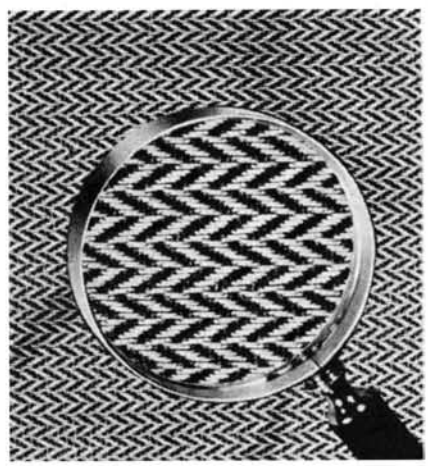
MONOFILAMENT FABRICS

Have "Built In" Color, Take Heavy Wear

TOUGH, water-resistant fabrics are now woven of Saran monofilaments in a variety of patterns and colors and ranging from finer weaves for interiors to those woven of the larger monofilaments for playroom, porch, and sunroom upholstery where harder wear is expected. With these new fabrics the furniture manufacturer has distinctively different fabrics to work with which combine practicability and beauty.

It is reported that Saran fabrics are being specified for shipboard, automobile, and plane upholstery in addition to uses in shoes, and luggage. The materials feature "built in" color and the monofilaments are extruded in both transparent and opaque types. The pigments and dyes may be added to the molding powder before extrusion.

Other properties of Saran are its re-



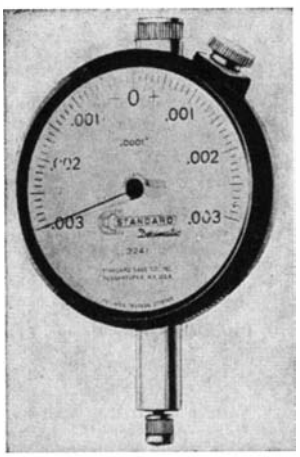
Extruded single filaments make stiff, smooth fabrics that will clean easily

sistance to chemicals, acids, and water; toughness; and no staining or fading under ordinary usage. Monofilaments are extruded in sizes ranging from .003 to .053 inches in diameter. Compared with fine multifilaments, the monofilaments produce a strong, smooth-surfaced, rather stiff fabric.

DIAL GAGES

Calibrated in Decimals, Have Hand-Range Limits

FOR FINE-TOLERANCE checking, Decimatic indicators, characterized by dial markings in decimals—directly comparable to blueprint tolerances—are now being made. Working advantages are described as including a modified range, from approximately "20 minutes of" to "20 minutes past" on the dial. This range, adequate for all but coarse tolerance checking, is said to



Numerals match blueprint tolerances

eliminate the possibility of failure to notice a complete revolution of the indicator hand.

Mounting dimensions are in accordance with American Gage Design standards and consequently standard Gage Company's Decimatic models may be used in AGD type fixtures.

CHLORINE DISINFECTANT

Had Broad Application in Food Industries

HIGH-TEST calcium hypochlorite, containing a minimum of 70 percent available chlorine, is now available for civilian industrial uses, according to an announcement by the Columbia Chemical Division of the Pittsburgh Plate Glass Company. Marketed under the trade name "Pittchlor," the product is a bleach, germicide, and disinfectant.

Calcium hypochlorite solutions are also valuable in the food industry as efficient agents for preventing food contamination by micro-organisms on equipment and around preparation areas. Sanitary uses of the solutions include disinfecting such equipment as coolers, bottles and bottle fillers, pasteurizers, churns, separators, tanks, and tank cars. In addition, spray or rinse applications can be used in the brewing and distilling industries on beer and condensing coils, and the like.

The Editors Recommend

Best Sellers In Science

PROCEDURES IN EXPERIMENTAL PHYSICS — *By John Strong, Ph.D.* A wealth of useful data of a practical kind for the constructor, experimenter, and skilled craftsman. **7.10**

HIGH FREQUENCY INDUCTION HEATING — *By Frank W. Curtis.* Answers many questions concerning induction heating and its utility in industrial processes. Thoroughly practical in scope. **$2.85**

TOOL MAKING — *By C. M. Cole.* Instructions for making and using all kinds, from personal tools to arbor presses, lathes, planers, etc., in different metals. **$3.60**

THE PSYCHOLOGY OF SEEING — *By Herman F. Brandt.* From motion-picture data of eye movements and use the author has revised many concepts of seeing. His interpretations will be of value to everyone—editors, advertising men, product designers, safety engineers, and so on—whose living depends on the use which people make of their eyes. **$3.85**

YOUR HAIR AND ITS CARE — *By Oscar L. Levin, M.D., and Howard T. Behrman, M.D.* Scientific facts about hair—how to save and beautify it, treat infections, and so one. Real facts — not a "cure-for-baldness" screed. **$2.10**

EXPERIMENTAL SPECTROSCOPY — *By Ralph A. Sawyer.* Covers theory and types of spectroscopes and spectrographs, mounting and use of gratings, determination of wavelengths, infra-red spectroscopy, spectrochemical analysis, and so on. Somewhat elementary but requires knowledge of physics and some physical optics. **$5.10**

ATOMIC ENERGY FOR MILITARY PURPOSES— A General Account of its Development Under the Auspices of the United States Government, 1940-1945. The famous Smythe report, telling in relatively non-technical language of the developments in nuclear physics that lead to the manufacture of the atomic bomb. **Paper cover, $1.35; cloth $2.10**

PLASTICS — *By J. H. Dubois.* Third edition, again revised and enlarged, with two four-color plates. This is an important book on the whole general subject of plastics, plus much brand new material on synthetic rubber, manufacturing processes, and plastics moldings. **$4.10**

PLANNING TO BUILD — *By Thomas H. Creighton.* Answers many of the questions asked by prospective home builders. Planning, design, and construction are fully covered. **$2.60**

EXPERIMENTAL ELECTRONICS — *By Ralph H. Muller, R. L. Garman, and M. E. Droz.* A solid book of eminently practical information on the characteristics and non-communication applications of electron tubes. The text describes experiments and presents results. For students, radio engineers, communications experts, and the serious general reader. **$5.10**

THE MEANING OF RELATIVITY — *By Albert Einstein.* Second edition with added chapter describing advances since publication of first edition some 25 years ago. Requires knowledge of advanced mathematics and physics; not a popular exposition. **$2.10**

A SMALL BUSINESS OF YOUR OWN — *By Harold S. Kahm.* Simplified, compact, paper-covered book that sets out to tell persons with capital ranging from $10 to $2000 how they can get started in the right direction. **$1.10**

A PRACTICAL COURSE IN HOROLOGY — *By Harold C. Kelly.* Definite, outright, practical instructions on watch making, repairs, and adjustment. **$2.85**

SLIDE RULE SIMPLIFIED — *By C. O. Harris.* How to use a slide rule, without any of the mystification that often surrounds this important tool of the engineer. Excellent illustrations make everything clear. **$3.60** including a slide rule; for book alone, **$2.60**

HOW TO SOLVE IT — *By G. Polya.* The text deals with the general method of solving problems. It will be of value to teachers but will also find wide use by those who have to solve problems requiring scientific reasoning. **$2.60**

MACHINERY'S HANDBOOK — *13th Edition.* "Bible of the mechanical industry." 1911 pages of latest standards, data and information required daily in shop and drafting room. **$6.10**

BUILDING INSULATION — *By Paul D. Close.* When, how, and where to use thermal and sound insulation. Fundamentals as well as practical aspects, with many typical examples and their solutions. **$4.60**

ATOMIC ARTILLERY AND THE ATOMIC BOMB — *By John Kellock Robertson.* Standard best seller for years, describing electrons, protons, positrons, photons, cosmic rays and the manufacture of artificial radioactivity—now with a chapter added on the bomb and the difficulties of its production. **$2.60**

PRINCIPLES OF PHYSICS, VOL. III — OPTICS — *By Francis Weston Sears.* One of the most modern works on physical optics available today. At college level, it covers the subject with emphasis on physical principles rather than practical applications. **$4.10**

ELECTRONIC PHYSICS — *By Hector, Lein and Sconton.* A simplified text for those who desire to acquire a sound basis for following the advance of applied electronics. **$3.85**

ASTRONOMY, VOL. 1 — THE SOLAR SYSTEM — *By Russell, Dugan, and Stewart.* Revised edition of the first volume of a 19-year old standard textbook. Deals with the solar system alone, not the stars. **$3.50**

FUNDAMENTAL OF OPTICAL ENGINEERING — *By Donald H. Jacobs.* This new work starts out at the very beginning, is mainly non-mathematical, and is probably the best suited of all existing books as an introduction to optical design. Author is a physicist at Bureau of Standards. **$5.10**

WITH THE WATCHMAKER AT THE BENCH — *By Donald DeCarle.* Simple, practical, straightforward instructions on the repair of timepieces, with direct implications to the manufacture and repair of delicate instruments of all kinds. **$3.10**

ELEMENTARY STATISTICS — *By Levy and Preidel.* A readable and understandable book on statistics that can pay big dividends to business men by re-alining their conceptions of the subject. **$2.35**

ARCHITECTURAL DRAWING AND DETAILING — *By Dalzell and McKinney.* Reasonably complete coverage of fundamentals for students or others who need a working knowledge of architectural representations and terminology. **$2.60**

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(All prices subject to change without notice.)

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CURRENT BULLETIN BRIEFS

Conducted by K. M. CANAVAN

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

THE ATOMIC BOMB, prepared by the Atomic Scientists of Chicago for the information of Congressmen, is a 64-page pamphlet rated as one of the best brief introductions to the problems of the "atomic age." It discusses the bomb and how it works, problems of control, and peace-time uses, and clarifies the vocabulary which has grown up around atomic power. *National Committee on Atomic Information, 1621 K Street, N.W., Washington 6, D. C.—20 cents.*

DEPRECIATION VERSUS OBSOLESCENCE is a 12-page pamphlet which takes a new view of one of industry's most important machine tool problems. It clearly outlines the factors which must be considered in determining the economic life of machine tools in terms of years. *National Machine Tool Builders' Association, 10525 Carnegie Avenue, Cleveland 6, Ohio.—Gratis.*

THE TOOL STEELS OF ALLEGHENY LUDLUM. This 168-page, wire bound, pocket-size booklet sums up the five tool-steel groups—high speed, hot work, shock resisting, cold work, and carbon and low alloy steels—and then gives factual data on their various industrial applications. Included is a tabulation of steels which presents type analysis and working characteristics of the principal grades. *Allegheny Ludlum Steel Corporation, 2332 Oliver Building, Pittsburgh 22, Pennsylvania.—Gratis.*

CHANGING THE SHAPE OF METALS WITH AN ENGINE LATHE. This 160-page book, containing over 500 charts, photographs, and drawings, is a comprehensive industrial-training tool explaining the "why" rather than the "how" of lathe operation. Intent is to stimulate workman initiative and pride of craftsmanship. Extremely readable. Available at special rates for industrial training programs. *Shell Oil Company, Inc., 50 West 50th Street, New York 20, New York.—Individual copies $7.50.*

PLASTICS FOR LIGHT CONDITIONING, a 12-page booklet, describes the uses of plastics in reflectors and shades. All available models of reflectors and shades are illustrated and the characteristics of each are given. *General Electric Company, Plastics Divisions, Chemistry Department, Pittsfield, Massachusetts.—Gratis.*

PERMANENT MAGNETS MAY DO IT BETTER. This well-illustrated, 32-page manual outlines the ways in which permanent magnets can serve industry, illustrates and describes the basic types, presents information on commercial magnetic materials, and shows how

good engineering design is applied to produce maximum utility from such magnets. Request Permanent Magnet Manual Number 3. *The Indiana Steel Products Company, Six North Michigan Avenue, Chicago 2, Illinois.—Gratis.*

SAFE PRACTICES IN WOODWORKING is a kit-set of 22 discussional type teaching and training slide films totaling 1129 individual slides. Fourteen of the groups give instruction in safety with woodworking machinery and eight on basic safety shop practices. Each lesson concludes with a review and a series of test questions. *The Jam Handy Organization, 2900 East Grand Boulevard, Detroit 11, Michigan.—$81.60.*

"SURFACE" RADIANT TUBE HEATING. Used in both ferrous and non-ferrous metal processing, this four-page bulletin points out the advantages of this method of heating when applied to carburizing, carbon restoration, hardening, and annealing. A chart giving the available heat of artificial, natural, propane, and butane gases is included. Request bulletin SC-128. *Surface Combustion Corporation, Toledo 1, Ohio.—Gratis.*

MATHEMATICIAN'S DELIGHT is a pocket size, 215-page book explaining arithmetic, calculus, trigonometry, and other parts of mathematics. *Penguin Books, Inc., 245 Fifth Avenue, New York 16, New York.—25 cents.*

WESTON ENGINEERING NOTES is a new publication designed to serve for the dissemination of engineering information regarding electrical indicating instruments. It is planned for bi-monthly publication. *John Parker, Editor, Weston Electrical Instrument Corporation, Newark 5, New Jersey.—Request this publication on your business letterhead.*

SELECTING THE RIGHT THERMOSETTING MOLDING MATERIALS. This new booklet, designed for workers and executives in the plastics field, as well as for students of plastics, packs into 36 pages, with illustrations, a complete view of this one phase of plastics. A special comparison chart shows the complex relative values of the various phenolic and urea molding plastics. *Bakelite Corporation, 30 East 42nd Street, New York 17, New York.—Gratis.*

DISTRIBUTION TRENDS is a selected bibliography, with brief descriptions, of literature covering the broad aspects of industrial distribution. *Business Information Bureau, Cleveland Public Library, Cleveland 14, Ohio.—10 cents.*

YOUR POST-WAR PLACE IN AVIATION, by Russ Brinkley, with an introduction by Eddie Rickenbacker. Subtitled "A Civil Aviation Guide for Ex-Service Men, Student Pilots, High School Students, Civil Air Patrol Cadets," this 96-page book presents fairly and without exaggeration the opportunities offered for civil aviation. It covers not only airlines but private flying, operation of airports, and so on. *Aviation Press, Tenafly, New Jersey.—50 cents.*

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the cooperation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want, and you will be furnished with the names of available books, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for. Books listed in these columns may be ordered from our Book Department. Add 25 cents per book for mailing outside U. S. All remittances are to be made in U. S. funds. Prices given are subject to change without notice.

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SCIENCE YEAR BOOK OF 1946

Edited by J. D. Ratcliff

OUTSTANDING science articles of the year are here presented as an overall survey of the progress of science as it relates to everyday life. Articles cover the fields of physics and chemistry, medicine, agriculture, and aviation and other sciences. This is the fifth annual volume of its kind. (245 pages, 5½ by 8 inches, unillustrated.)—$2.60 postpaid.—*A.P.P.*

CAMPS AND COTTAGES HOW TO BUILD THEM

By Charles D. White

PRACTICAL in every aspect is this well organized volume which discusses not one camp and cottage but a number of them. The method of treatment is unusual. First a number of general types are discussed and illustrated. Then considerable details are given which can be applied directly to the specific type of building which the reader selects. Ample space is devoted to methods and to tools and their uses. Even paints and painting are dealth with in sufficient detail. A careful perusal of this book would be the next best thing to working side by side with an experienced builder. (260 pages, 6 by 9½ inches, 116 detailed drawings.)—$2.85 postpaid.—*A.P.P.*

PHOTOSYNTHESIS AND RELATED PROCESSES

By Eugene I. Rabinowitch

FIRST of two volumes on this basic process of life, the present one deals primarily with chemical aspects of the subject in two principal parts: the chemistry of photosynthesis and related processes, and the structure and chemistry of the photosynthetic apparatus. The second volume, expected to be issued soon, will treat of the physical aspects of both processes and apparatus. The two volumes will constitute an exhaustive monograph on this fundamental life process in its various ramifications and will summarize what is now known of it. An excellent index and a bibliography make the vast amount of information in the present volume readily available. (599 pages, 6 by 9 inches.)—$8.60 postpaid.—*D.H.K.*

THE FUNDAMENTALS OF AVIATION

By Henry Lionel Williams

A REMARKABLY sound book, prepared and illustrated in a way that makes the price appear remarkably low. This is not just another popular book on aviation, but a sound, elementary text, giving a scholarly yet simple treatment to every phase of aviation—History, Mechanics of Flight, Aircraft Structure, Modern Developments—Rockets, Meteorology, and the like. It is an outstanding contribution to the literature. (282 pages, illustrations.)—$1.10 postpaid.—*A.K.*

VITAL PROBLEMS OF AIR COMMERCE

Edited by Lucien Zacharoff

THIS book is not the work of one man. It represents the thoughts of over 30 individuals each of whom is well-qualified to talk on a specialized phase of aviation. The subject matter does not, for the most part, deal with engineering but rather with the economic-political-social impact of worldwide aviation as it even now is being felt. The material in the book was obtained from both formal papers and extemporaneous speeches given at various gatherings of the Aviation Section-New York Board of Trade. Hence, the literary tone of the work smacks of the speakers' table and little effort has been made to change it because of a desire for accuracy rather than editorial perfection. The subjects discussed are thoroughly interesting and give a wealth of interesting sidelights on the real reasons for various political, diplo-

matic, and commercial maneuvers involving both continental and international air commerce. Recommended for the reader who is cognizant of aviation's power to alter the business scene. (338 pages, 6 by 8 inches.)—$3.10 postpaid.—*E.F.L.*

REVISED LAPIDARY HANDBOOK

By J. Harry Howard

TEN years ago Howard published his "Handbook for the Amateur Lapidary." This has become the recognized bible of the widespread gemstone cutting and polishing hobby. It now has been rewritten to such a major extent, and added to, that it rates a new title and dress. This book tells the beginner how to begin, what to get (mostly medium-priced stones or even pick-me-ups), where to get it (addresses stated), and takes him up to advanced hobby work, always in a practical manner since the author is himself an old hand at this fascinating pastime. (220 pages, 5 by 7¾ inches, 50 illustrations.) —$3.10 postpaid.—*A.G.I.*

CONDUCTORS AND WIRING LAYOUTS

By E. S. Lincoln

ESSENTIALLY practical, this book packs a tremendous amount of reference material between its covers. Nearly every type of conductor material, conductor fabrication, and insulating medium that can be conceived for use on modern electrical installations has been discussed or tabulated. The text is not confined to any particular field of wiring, but gives attention to the problems of appliance wiring, underground power circuits, control, signal, and communications lines, industrial hookups, and so on. Instructional data on splicing and other techniques is well presented, and the book should, because of its size and content, be a handy pocket manual for engineer and technician alike. (342 pages, 5½ by 8½ inches, 85 tables, over 100 diagrams and illustrations.)—$3.10 postpaid.—*E.F.L.*

VOLCANOES NEW AND OLD

By Satis N. Coleman

POPULAR description of all the earth's great volcanoes, written by an eyewitness of the birth of the newest volcano Paracutin in a Mexican field in 1943 who thus became volcano-minded. It is excellently presented, readable, scientifically worthy, and dramatic, a rare combination. (222 pages, 6 by 9½ inches, 97 illustrations.)—$3.85 postpaid.—*A.G.I.*

TWO-WAY RADIO

By Samuel Freedman

COMING rapidly to the fore in the communications field is the whole subject of two-way radio for a number of purposes ranging from train dispatching to personal equipment which can be carried in a motor car or on the person. It is this section of the field which the author has adequately covered in a style of presentation equally usable for the layman or engineer. The result is an excellent text marking a milestone in radio progress and definitely filling a need in radio literature. Necessary equipment for various applications of two-way radio is discussed in some detail and its possibilities and limitations are dealt with. A few typical circuit diagrams are included. (506 pages, 6 by 9½ inches, well illustrated, completely indexed.) —$5.10 postpaid.—*A.P.P.*

THE CAVENDISH LABORATORY

By Alexander Wood

COMPACT history of the most noted physical laboratory in the world. (59 pages, 4 by 6¾ inches, 8 illustrations.)—$1.10 postpaid.—*A.G.I.*

TESTING PRECIOUS METALS

By C. M. Hoke

AN INTENSELY practical guide for those who buy and sell precious metals, this little book describes the time-honored touchstone method and the standard needles used to determine the fineness of gold in the field quickly and accurately enough to serve the buyer of scrap gold. Furthermore, the various methods used to stretch gold and the makers' marks that tell the cautious buyer important facts about scrap offered him are described for the tester's guidance. The author's long experience in this field of precious metals makes this fully authoritative. (92 pages, 5½ by 8 inches, illustrated.) —$2.10 postpaid.—*D.H.K.*

TECHNIQUES OF GLASS MANIPULATION IN SCIENTIFIC RESEARCH

By Julius D. Heldman, Ph.D.

REPAIR of glass apparatus or the fabrication of relatively simple glass equipment can be learned by a careful study of this compact book. Every effort has been made by the author to present the subject of glass working in an understandable manner and from the practical standpoint of the laboratory technician. The text covers the properties of glass, glass-working equipment, basic operations, seals (including glass-to-metal), and exercises aimed at perfecting technique. (132 pages, 6 by 9 inches, 56 illustrations including excellent step-by-step photos and drawings.)—$3.70 postpaid.—*A.P.P.*

NEW HOMES FOR TODAY

By Paul R. Williams

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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"

DALL of England was the first to make the special type of Cassegrainian telescope having a spherical secondary mirror instead of the usual hyperboloid, with the primary figured to fit it. He made several, the first in 1931. But he did not stop to publish the design details. Independently, the late Alan R. Kirkham in 1938 published the design data in these columns. George P. Arnold, 519 Holmes St., State College, Pa., now contributes the following article on the testing and performance of this type.

THOSE desiring to study the Moon and planets from a comfortable and safe position would do well to consider the Cassegrainian. Properly constructed, it is the equal of any ordinary refractor of the same aperture, and is practically as good as the equivalent Newtonian. Despite its desirable features, many may have hesitated to make Cassegrainians after reading the warnings by various authorities on the difficulties involved, which are probably real enough with the conventional type. By modifying the design, however, construction is greatly simplified and testing becomes much easier.

The biggest step toward simplifying the Cassegrainian was made by Dall and Kirkham, who made practical the substitution of a spherical secondary for the customary hyperboloid, thus eliminating the need for another large

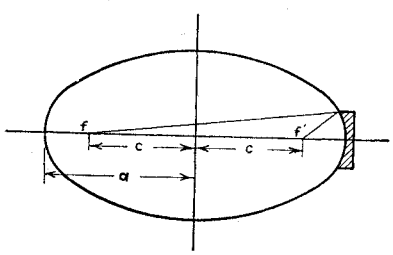


Figure 1: Kirkham's ellipse test

optical surface for testing, and at the same time avoiding the difficult task of figuring the hyperboloid. To compensate for the aberration introduced by the secondary mirror, the primary is left undercorrected by an amount depending on the dimensions of the system, in accordance with the equations given by Kirkham (Sci. Am., June 1938). These equations may be combined and rearranged into a form possibly more suitable for calculation:

$$N = 1 - \frac{4p^2}{RR'}\left(\frac{p' + p}{p'}\right)^2 \quad (1)$$

where N is the fractional correction, R the radius of curvature of the primary, R' the radius of curvature of the secondary, p and p' the lengths from the secondary mirror to the primary and secondary foci, respectively. *All quantities in the above and following equations are to be considered positive.*

The primary is thus figured to an amount $N\ r^2/R$ instead of the usual r^2/R. With mirrors of short f-ratio, testing in the usual way is still rather difficult, as small zonal irregularities may easily be overlooked and the knife-edge must be set and read with considerable accuracy. Kirkham suggested that the undercorrected primary could be considered to be an ellipse, in which case the source is at one focus, and the mirror, with the knife-edge at the other focus, should present the appearance of a sphere at the center of curvature. Dall mentioned (Sci. Am., May 1939) that he tested his 15" primary with the knife-edge at the remote focus some 120' from the mirror. Neither, however, gave a formula for finding the position of the foci. Referring to Figure 1, f and f' are the foci of the ellipse, and it can be shown that the distances a and c are very nearly

$$a = R/(1 - N),\ c = a\sqrt{N} \quad (2)$$

where R is the radius of curvature of the primary, N the fractional correction given by Kirkham's formula.

In practice, the source may be placed either at f, at a distance of $a + c$ from the mirror, or at f', distant $a - c$ from it; the image will be found at the other focus. As an example, consider a 10" $f/5$ primary, to be 73 percent corrected:

$$R = 100",$$
$$a = 100/(1 - .73) = 370",$$
$$c = 370\sqrt{.73} = 316".$$

Then f is $370 + 316 = 686"$ from the mirror, and f' is $370 - 316 = 54"$ from the mirror, which will appear flat under the knife-edge only if it is corrected to $0.73\ r^2/R$. Actually, however, f can be moved several feet in either direction before a lack of flatness is perceptible, as this corresponds to only a very slight change in N. If the source is at f, a small flat must be used to place the image where it can be knife-edged; this complicates collimation, but adjustment can be made by one person, as the mirror is only a few feet away. Any lack of collimation is easily detected by the appearance of the knife-edge inside focus or, better, by the distortion of the Ronchi bands. The mirror appears much larger at the near focus, and the effect of a very narrow source is obtained. It is not too difficult to make a slit finer (at the distance it is placed) than the resolving power of the mirror; when this has been done, a Ronchi wire one or two thousandths of an inch in diameter may be conveniently used, and the test becomes unusually sensitive. On the other hand, with the knife-edge at f, no flat is necessary. The aberrations are greatly magnified, but the depth of focus is also magnified the same amount, so that it seems reasonable to suppose that the test is no more sensitive with this arrangement, even with a fine enough source.

The correction of an under-corrected mirror can be found by measuring the distances of f and f' at which the mirror appears flat, and using the first of equations (2):

$$N = 1 - \frac{2R}{(a + c) + (a - c)} \quad (3)$$

Equations (2) can also be used to find the minimum distance of an artificial star for testing a Newtonian primary, by letting $100(1 - N)$ equal the maximum percentage tolerance of figure. For example, a 6" $f/8$ could be figured flat to the knife-edge with the source as close as 30' from the mirror, and would still give excellent performance.

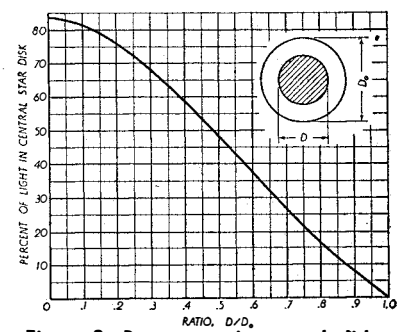


Figure 2: Percentage in central disk

A word should be said about the accuracy of equations (1) and (2), and the tolerances in figuring the mirrors. Kirkham's equation (1) is probably accurate enough for any system of reasonable dimensions. Trigonometrical ray tracing shows it to be correct to less than 1 percent of N for an 8" $f/12$ system with an $f/3$ primary, and again for a 10" $f/19$ with an $f/5$ primary. Equations (2), also owing their simplicity to binomial expansions, hold to the same order of precision. The tolerance of figure for a Cassegrainian primary is the same as if it were to be used for a Newtonian, and can be found from the table given by Wright in "A.T.M."; that is, the correction N, expressed in percent, may vary by the amount given in the table. The secondary may deviate from a true sphere by a quarter of a wavelength or half a fringe, provided the primary is perfectly figured, and should be tested by interference against its polished and figured tool*, or by the King test if optical glass is used. The above tolerances are for half of the Rayleigh quarter-wave limit, since the optical path error can be reduced to a quarter of its extreme value by proper focusing. Even the keenest observer can detect no departure from perfection of the image produced by a system corrected to within half of the Rayleigh limit.

If the optical parts have been fig-

* A fluorescent lamp makes a fairly satisfactory light source for interference testing, although the fringes are not so dark as those from a sodium or mercury lamp.

ured correctly, and the system properly collimated, the only reason for any relatively inferior performance is the diffraction effect produced by the secondary. Many writers have expressed alarm at the amount of light thrown by such obstructions into the diffraction rings surrounding the central disk. Few have considered the quantitative aspect of the situation.

Two important effects are produced by the obstruction from the secondary. The most noticeable, of course, is the loss of light from the central disk and the enhancement of the first few bright rings. Assuming perfect optics, no spider diffraction (which is negligible, anyway), and that the obstruction is centered and circular, Figure 2 shows the amount of the total image light remaining in the central disk for various sizes of obstruction. (Strictly speaking this holds only when the obstruction is directly over the objective, but the effect of placing it several feet in front of the objective is practically the same.) Note that, with no obstruction, about 84 percent of the light is in the central disk. Now Conrady ("Applied Optics and Optical Design") has pointed out that, in the average case, at the Rayleigh limit this figure drops to about 68 percent. At double the limit, only about 40 percent of the light remains, but up to this point the size of the disk has not increased appreciably. Thus, considering Figure 2, a good reflector with a 25-percent-diameter obstruction would be at least as good as a refractor corrected to the Rayleigh limit. However, beyond apertures of about 5", the secondary spectrum of the ordinary *f*/15 refractor exceeds the Rayleigh limit for chromatic aberration. Even allowing for the decreased sensitivity of the eye for the scattered

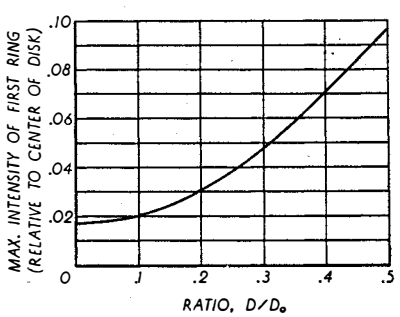


Figure 3: Intensity comparison

colors, it is hard to see how a large refractor could perform as well as any reflector of the same aperture; a long-focus Newtonian with its very small flat should be far superior.

The second effect is a favorable one. As the size of the obstruction increases, the actual diameter of the central disk decreases, becoming about 80 percent of the normal size for a half-diameter obstruction, and about 75 percent normal size for a three-quarter obstruction. This effect serves to compensate for the increased brightness of the rings by increasing the resolving power of the instrument. In fact, with a three-quarter-diameter disk over the center of the objective, it is quite possible that the Dawes limit could be exceeded.

The net result of the diffraction is, of course, to obscure detail of very low contrast which is near the limit of resolution of the telescope, the bright rings from points at the edge of a bright area overlapping the disks from a relatively darker area. Since, for moderate sizes of obstruction, it is the first bright ring which will cause trouble, a rough indication of its effect may be obtained by considering the intensity of the brightest part of the

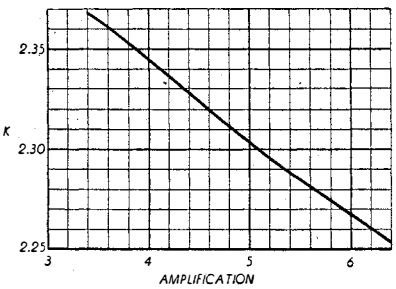
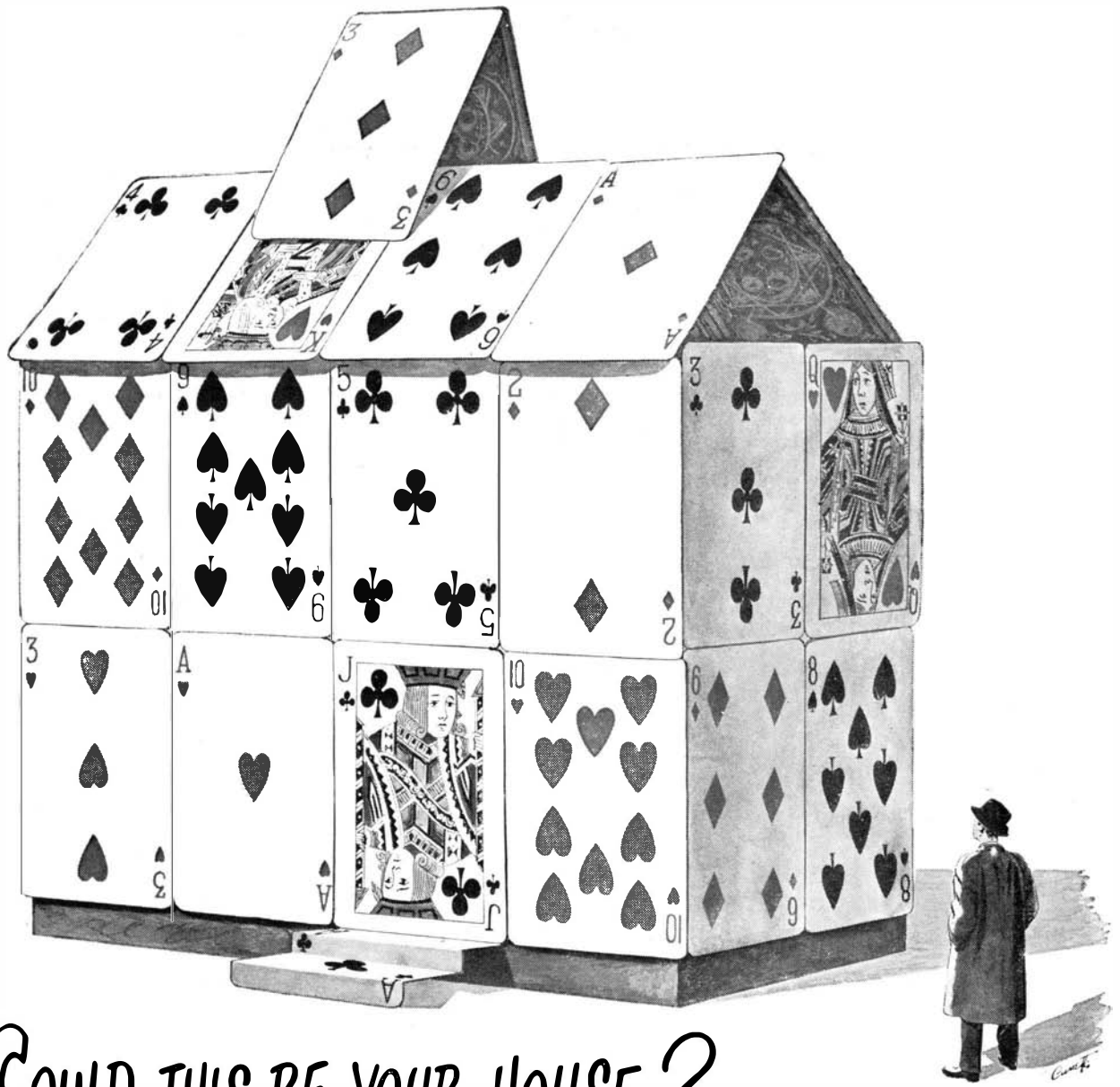


Figure 4: To find N, first choose or calculate the amplification, which is given by p'/p. From the graph, find the corresponding value of K. Multiply this K by p/R, and subtract the result from 1. That is, N = 1-Kp/R. As an example, take the system given by Hindle in "A.T.M." Here R = 120, p = 15, p' = 60, and the amplification is thus 4. Hence N = 1-2.345x15/120, or about .71. Of course, the system could no longer be used as a Newtonian or Gregorian in the usual way.

ring as compared to the intensity at the center of the disk. This is shown in Figure 3. It is seen that the secondary may be almost a third of the diameter of the primary before the ring has more than 5 percent of the intensity of the disk. At this point in the discussion physiological factors enter, but it would seem unlikely that the average person could detect any difference, in changing to a perfect refractor where the ring is about 2 percent as bright as the disk. All in all, one may conclude that the diffraction rings, so noticeable around bright stars, are not nearly so harmful as they would appear.

Thus the modified Cassegrainian, while admittedly somewhat harder to make than a long-focus Newtonian, is not a very formidable project. The secondary involves only a sphere, the easiest of optical surfaces to make; the primary, since testing involves no zonal measurements, should be actually easier than the common Newtonian primary. Combined, the two make a compact and powerful instrument whose performance will leave little to be desired.

GARAGE door becomes an alt-azimuth mounting for a Newtonian reflecting telescope in the yard of F. L. Frazine, 1016 Seventeenth Avenue North, St. Petersburg, Fla. Through the door, near the outer edge, is a horizontal axle, the telescope's horizontal axis. Vertical axis then is the hinges of the door, which may be swung as a door usually is swung.



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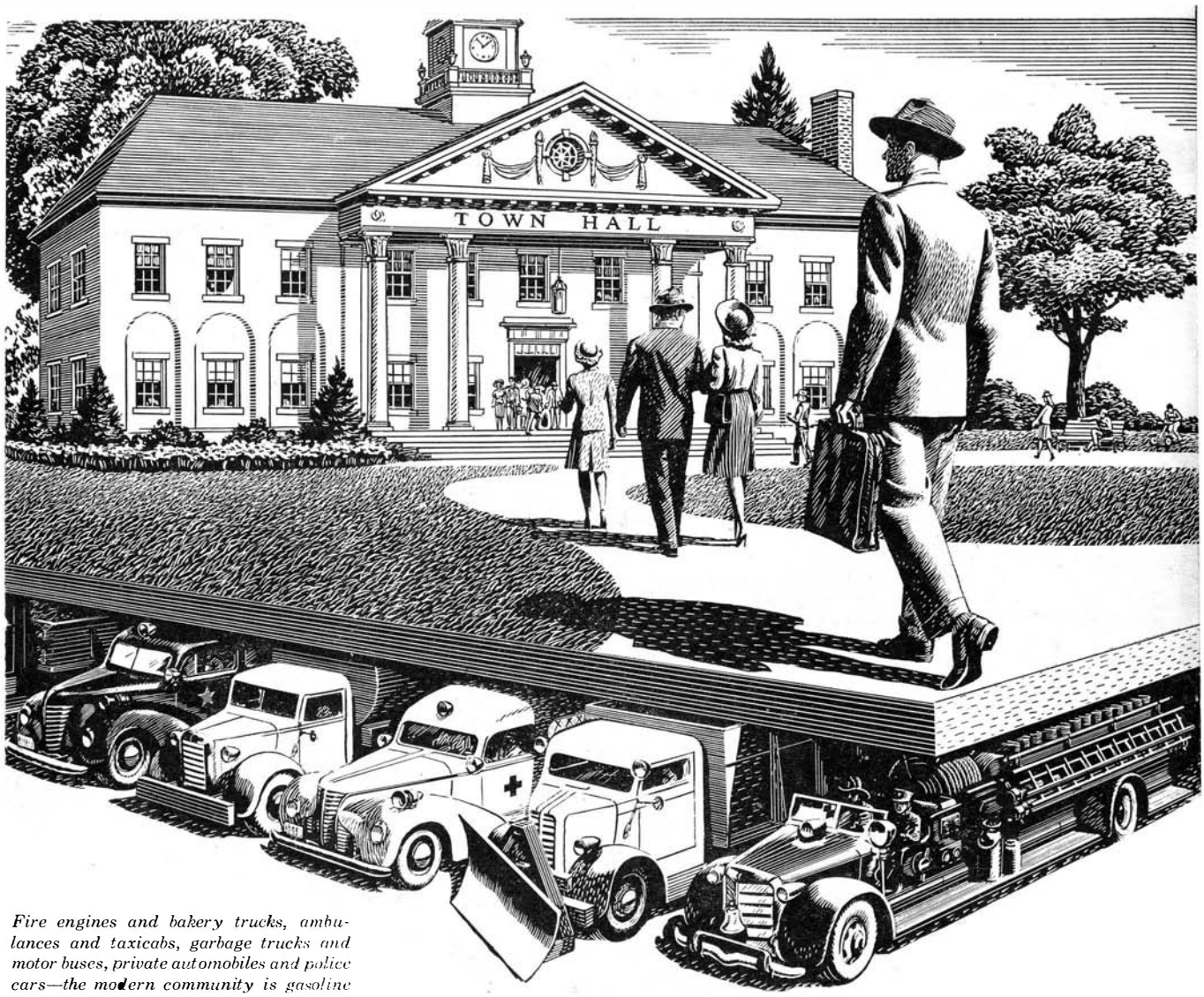

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