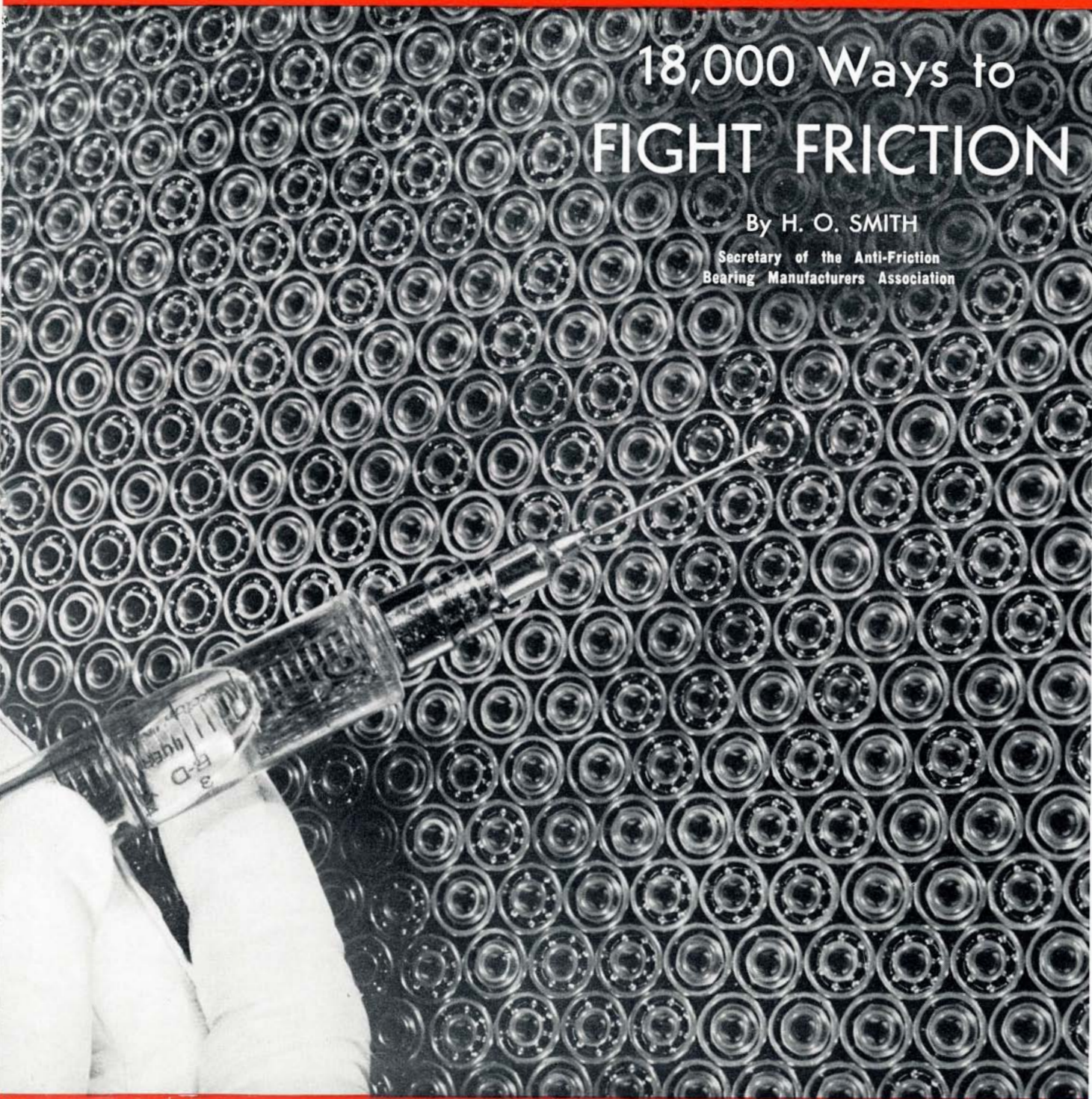
Scientific American

— FOUNDED 1845 —

OCTOBER
1947

50 cents
a copy

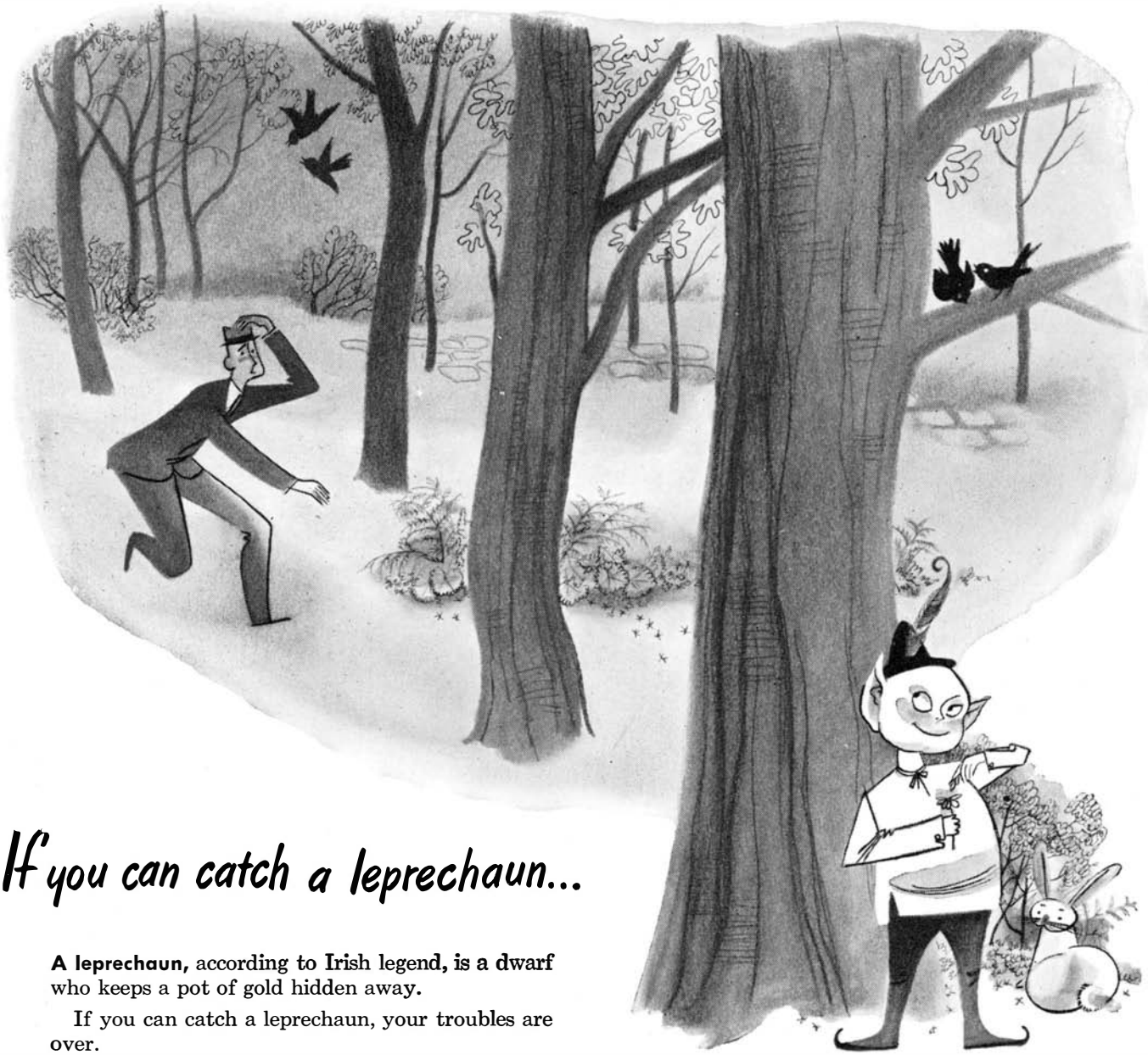
PROGRESS IN INDUSTRY



18,000 Ways to FIGHT FRICTION

By H. O. SMITH

Secretary of the Anti-Friction Bearing Manufacturers Association



If you can catch a leprechaun...

A leprechaun, according to Irish legend, **is a dwarf** who keeps a pot of gold hidden away.

If you can catch a leprechaun, your troubles are over.

Because he keeps his gold just for ransom money. If you catch him, he'll quickly tell you where his gold is, so you let him go.

The best place to look for a leprechaun is in the woods. They're green, and only about nine inches tall, so you'll have to—

Or maybe you don't believe in leprechauns.

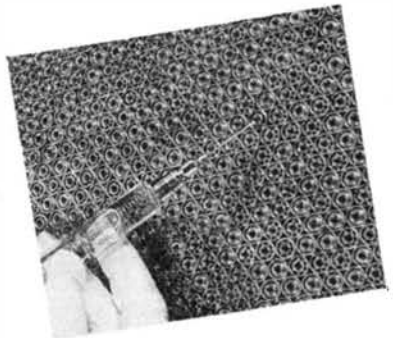
Maybe it would be more practical to just keep working for your money. But you can learn one good lesson from these little fellows. A small pot of gold put to one side is a great help when trouble catches *you*.

And there's a much faster and easier way to get your pot of gold than by catching leprechauns. You can buy U. S. Savings Bonds through an *automatic* purchase plan.

If you're employed you can sign up for the Payroll Savings Plan. If you have a bank account you can sign up for the Bond-A-Month Plan. Either way, your pot of gold just saves itself, painlessly and automatically.

And your money increases one third every ten years. That would make a leprechaun turn even greener with envy.

Save the easy, automatic way—with U.S. Savings Bonds



INDUSTRIAL DRAMA: Ball bearings so small that their lubricant is applied through a hypodermic needle are only one group in the "18,000 ways to fight friction." See page 149.

ORSON D. MUNN, Editor

A. P. PECK, Managing Editor

ALBERT G. INGALLS, A. M. TILNEY, JOHN P. DAVIS, K. M. CANAVAN, NEIL H. UPTEGROVE, Associate Editors

CONTRIBUTING EDITORS: CHARLES A. BRESKIN, Editor of "Modern Plastics." EDWIN LAIRD CADY, Contributing Editor to "Mill and Factory." KEITH HENNEY, Consulting Editor of "Electronics." D. H. KILLEFFER, Chemical Engineer. ALEXANDER KLEMIN, Aeronautical Consultant; Research Associate, Daniel Guggenheim School of Aeronautics, New York University. FRED P. PETERS, Editor-in-Chief of "Materials & Methods."

CORRESPONDING EDITORS: A. E. BUCHANAN, JR., Manager, Technical Division, Rayon Department, E. I. du Pont de Nemours and Company, Inc. L. WARRINGTON CHUBB, Director of Research Laboratories, Westinghouse Electric Corporation. MORRIS FISHBEIN, M.D., Editor of "The Journal of the American Medical Association" and of "Hygeia." IRVING LANGMUIR, Associate Director, Research Laboratory of the General Electric Company, Schenectady. M. LUCKIESH, Director, Lighting Research Laboratory, Lamp Department of General Electric Company, Nela Park, Cleveland. RUSSELL W. PORTER, Associate in Optics and Instrument Design, California Institute of Technology. VLADIMIR K. ZWORYKIN, Associate Director of RCA Laboratories, Princeton.

ADVERTISING STAFF: F. CLEMENT SCOTT, Eastern Advertising Manager. Western Advertising Representatives, HARLEY L. WARD, INC., 360 North Michigan Ave., Chicago 1, Ill., JOSEPH W. CONROW, 1175 Woodbury Rd., Pasadena 6, Calif.

Subscription Rates:

ONE YEAR—$5

TWO YEARS—$9

THREE YEARS—$12.50

Canada 50¢, foreign $1 per year additional.

WHEN you change your address, please notify us immediately, giving your OLD as well as your NEW address. Postal requirements are such that our subscription files are arranged geographically, not alphabetically. Because of this, failure to give your old address may result in delaying receipt of copies.

Scientific American

Founded 1845

In This Issue • October 1947

SCIENTIFIC AMERICAN, October, 1947. Vol. 177, No. 4. Owned and published by Munn & Co., Inc. Orson D. Munn, President; I. Sheldon Tilney, Vice-president; John P. Davis, Secretary-Treasurer; A. P. Peck, Assistant Secretary; all at 24 West 40th Street, New York 18, N. Y. Entered at the New York, New York, Post Office as second-class matter June 28, 1879, under act of March 3, 1879. Additional entry at Orange, Connecticut. Published monthly by Munn & Co., Inc., 24 West 40th Street, New York 18, N. Y. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage. Files in all large libraries; articles are indexed in all leading indices.

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of October, 1897)

STILL IS — "It is characteristic of the times that there should be a growing disposition, just now, to inquire into the working of the patent laws of the country. The progressive spirit which prompts the inquiry is, on general principles, commendable. At the same time it should be borne in mind that the question of a change in existing laws should always be approached in a guarded and conservative spirit, especially when it affects a branch of our laws like that relating to patents, under which such splendid results have been achieved."

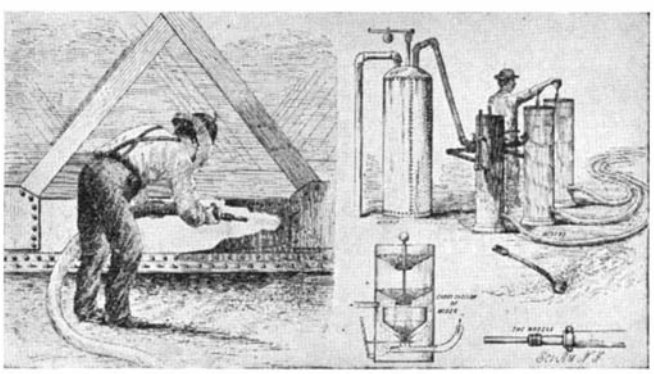
LIGHTING PLANT — "The Westinghouse Electric and Manufacturing Company has received from its European company notice of the award to it by the Metropolitan Electrical Supply Company of the contract for a large electric lighting plant to be installed in London. The apparatus will be of the multiphase type, involving the use of the Tesla patents."

PAVING — "Since the asphalt street has come to be generally acknowledged superior, in essentials, to all others, the adoption of asphalt for paving purposes has become the rule in all of the more important cities of the United States."

HATTERAS LIGHT — "The Lighthouse Board has sent out a notice that the dangerous Diamond Shoal off Cape Hatteras will soon be marked by a first class vessel, bearing two powerful electric masthead lights and a fog siren that will blow a blast audible twelve miles in the heaviest weather."

PNEUMATIC TUBES — "Shortly after noon on the 7th instant the first section of the pneumatic postal tube service, which is now being installed in this city, was opened for regular service. . . There are two tubes, each 8⅛ inches in diameter, the bends being made of brass and the straight sections of cast iron. The interior surface is smoothly finished off to assist the passage of the carriers. The air-compressing plant is located at the General Post Office, and a pressure of 6 pounds to the square inch is employed for the present, though pressure and speed may be increased if desired."

SAND BLASTING — "The massive steel viaduct which carries 155th Street across the terminal station of the Manhattan Elevated Railway has suffered very serious corrosion, as the result of the gases which are continually playing upon it from the locomotives of the road. . . It has been decided to first thoroughly clean the steelwork by the sand blast and then paint it with eighteen different varieties of paint. As times goes on, a careful record will be made of the behavior of each variety of paint. . . It was necessary to get rid, not merely of the old paint, but also of rust and scale, and the consulting engineer of the board decided this result could only be secured by the use of the sand blast. . .The air is compressed by two Ingersoll-Sergeant machines, which deliver to a receiver which has a capacity of 30 cubic feet. . . The nozzle is 8 inches in length with a 9/16 inch opening, and is made of chilled iron, with a view to resisting the abrasion of the sand. . . The speed of the mixture of sand and air is about 300 feet per second."



Sand blasting and equipment

GOLD VERSUS COTTON — "While the few lucky miners who have reached the Klondike are digging for the gold in the frozen ground of their Arctic homes, and stories of the wonderful richness of the mines are published to agitate a world of readers, a different kind of a gold mine is being worked in another fairer and warmer part of our country, where the sun shines eternally and the conditions of life are all that one could desire for comfort and pleasure. The great cotton crop of the Southern States is worth several Klondikes; it yields profits to hundreds of thousands of toilers, and enriches our country by many millions of dollars. Our exports of cotton alone amount to more than the output of all the gold mines of the world."

EXPLOSIVES — "The ingenuity that has been exhibited of late years in the discovery and application of explosives for mining purposes has really been remarkable. . . Not only has the number of factories more than doubled in 20 years, but the number of persons employed in them is now over 10,000, which shows an increase of nearly 3,000 even during the last ten years."

CABLE — "At its last session, the Icelandic Parliament decided to accept the offer of the Great Northern Telegraph Company in Copenhagen to lay a submarine cable to Iceland from the north of Scotland via the Faröe Islands."

100 Years Ago in . . .

SCIENTIFIC AMERICAN

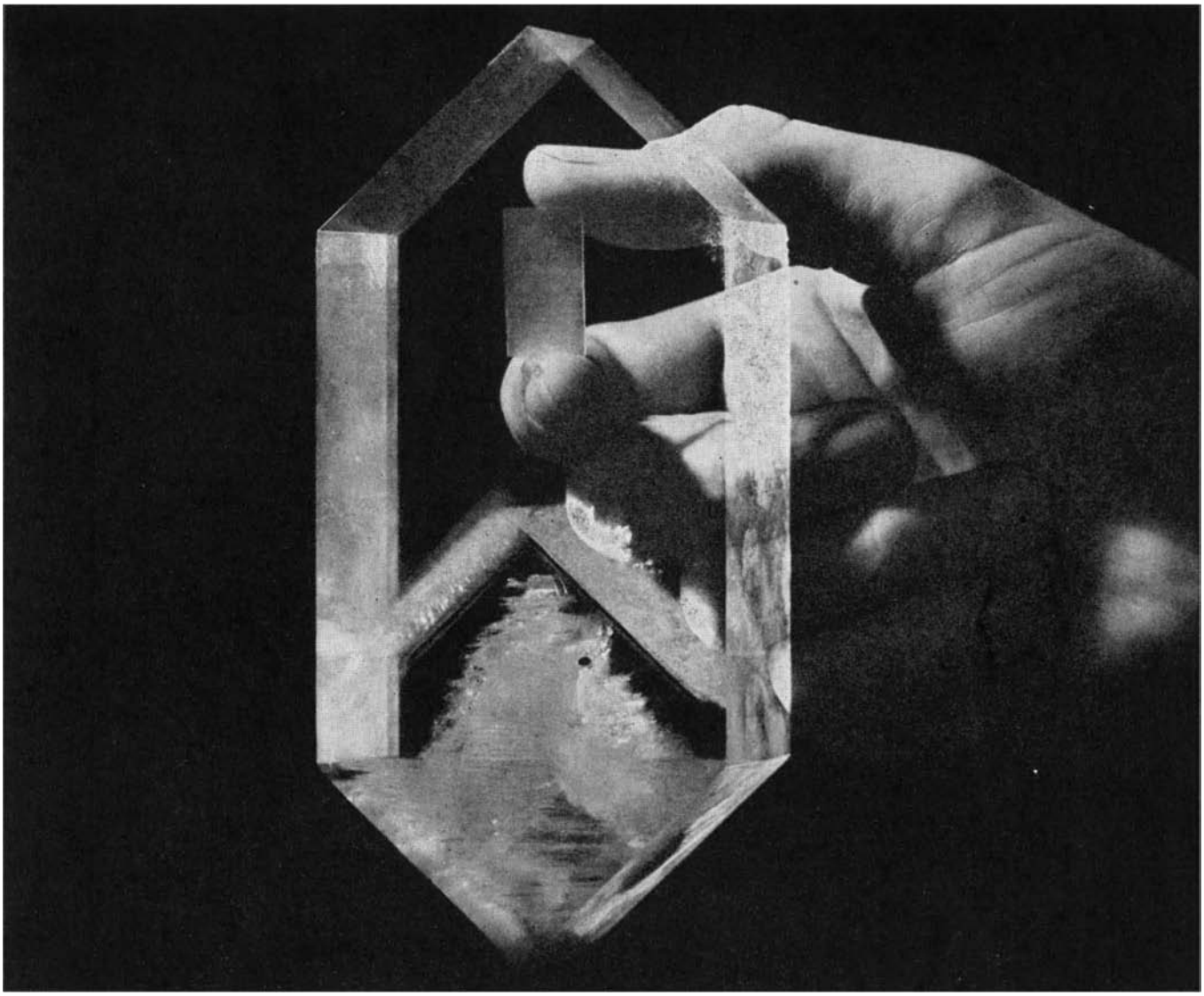
(Condensed from Issues of October, 1847)

TELEGRAPH NEWS — "The Louisville Journal is informed that House's printing apparatus is to be attached to the battery of the electric telegraph in that city. By this arrangement, the managers expect that they will be able to furnish copies of the President's message for the newspaper offices in that city within five minutes after the reading of it by the clerk of the House of Representatives!"

LABOR COMPETITION — "The employing and employed mechanics are making active war upon the employment of convicts, in the county penitentiary, in shoe making, and other business, at rates which defeat the fair competition of trade, and to take legal means to prevent it."

WATER PIPE — "The extent of water pipes now laid in the city of Boston is about sixteen miles, of which nearly a mile is pipe of 30 inches in diameter and more than half a mile including the main pipe laid in Washington street is of 24 inches. The greater part of the residue is of 12 and 6 inches."

RAILROAD IRON — "There will be sixty thousand tons of railroad iron manufactured in this country during the present year, which will be equal in quality to any imported iron. The value of this quantity, at present selling prices, will be upward of four millions of dollars."



A CRYSTAL THAT GREW FROM A SEED . . . *The large crystal in the foreground is an EDT (Ethylene Diamine Tartrate) crystal. It started from a seed (a piece of mother crystal) and in three months grew in a slowly cooling solution to the size shown. The small plate is cut from a large crystal, then gold-plated for electrical connection and mounted in vacuum. Cultivated EDT crystals can do the same job as quartz in separating the nearly 500 conversations carried by a coaxial circuit.*

Crystals for Conversations

AT WAR'S END, the Bell System began to build many more Long Distance coaxial circuits. Hundreds of telephone calls can be carried by each of these because of electric wave filters, which guide each conversation along its assigned frequency channel. Key to these filters was their frequency-sensitive plates of quartz.

But there was not enough suitable quartz available to build all the filters needed. Bell Telephone Laboratories scientists met the emergency with cultivated crystals. Years of research enabled them to write the prescription at once—a crystal which is grown in a laboratory, and which replaces quartz in these channel filters.

Now Western Electric, manufacturing unit of the Bell System, is growing crystals by the thousands. Many more Long Distance telephone circuits, in urgent demand, can be built, because the scientists of Bell Telephone Laboratories had studied the physics and chemistry of artificial crystals.

By A. P. Peck

MORE ON NUCLEONICS

RECENT ground-breaking for new buildings at the Brookhaven National Laboratory (Long Island, New York), marked the beginning of construction of the first peace-time atomic pile. Here work will be pressed on fundamental research in engineering, chemistry, physics, biology, and medicine. This newest pile, while not the largest, will be extremely flexible and well adapted to the experimental and research work for which it was designed.

Scientists at the ground-breaking ceremonies spoke at some length on "tracer" uses of the radio-active isotopes which they plan to produce. Most widely publicized of such uses thus far are in the study of human-body processes, where radio-active isotopes are introduced into the system, and in the investigation of the arrangement of atoms in metals by adding tracers to the ingredients of an alloy while it is being made. Just as fascinating—and perhaps even broader in scope—are the possibilities of adding tracers to fertilizers and thus gaining invaluable information on the effect of various fertilizer ingredients on plant growth; tremendously increased productivity of cultivated areas are a prospect. Closely allied are the projected uses of tracers in determining the diets which will produce the most beef and pork from cows and pigs in the shortest space of time.

On other aspects of nucleonics, Dr. Arthur H. Compton, Chancellor of Washington University and noted physicist, has this to say about the enormous importance of electrical power production through utilization of nuclear energy: "It will make possible the spreading of industry into regions far from any supply of fuel . . . New territories will be opened . . . New areas will be made available for growing population. . . How soon will this come? My own estimate is that it will be hardly ten years . . . before those responsible for establishing new power installations will, in some cases, consider uranium as a serious competitor with coal. It may be a generation hence before the total uranium power production will compare in magnitude with that from coal."

SOLID FLUIDS

FLUID-CATALYTIC cracking of petroleum has become of vital importance to the production of gasoline. Essentially the process depends upon the use of catalysts reduced to such a state of fineness that, suspended in a stream of gas flowing upward, the solid catalysts behave like fluids and can be controlled in the same manner as if they actually were fluids. The flexibility of the fluid-catalyst process gives excellent temperature control and intimate contact between the catalyst and the material being processed. An added advantage is the ease with which the catalyst can be revived.

Now the fluid-powder technique is being expanded. It is being applied to the burning of limestone to make lime, to the manufacture of fuel gas from coal, to the production of coke from powdered coal, and to similar operations. The characteristics of the process are such, and its advantages are so great, that it is certain to find broad applications throughout the chemical industry.

GLUE REPLACES RIVETS

INDICATIVE of the almost unbelievable advances in adhesives is the recent announcement by The B. F. Goodrich Company that a cement has been perfected which can be used instead of brass rivets to fasten lining to automobile brake shoes. Further, it is claimed that this new cement (the formula is still secret) has more than twice the shear-resistance of conventional rivets. Still further, it permits use of the lining right down to the shoe instead of only to the tops of the rivets, which practically doubles the service life of the lining.

When an adhesive can do a job like this, it really opens cement horizons unlimited!

LIGHT-WEIGHT WOOL

AUSTRALIA, land of the kangaroo (for mammilian curosia) and of the sheep (for crass export commercialism), is experimenting with spider-web-light woolen fabrics as possible commercial competitors with silk, rayon, and nylon. These feather-weight cloths are reported as being woven from woolen thread so thin that it cannot be handled alone; it must be combined with a material that gives enough strength to withstand the weaving process and which can later be dissolved, leaving a wool structure claimed to be softer, warmer, and more sanitary than silk. Those who have a leaning toward fine wool in clothing will see here a brilliant spot on the textile industry horizon.

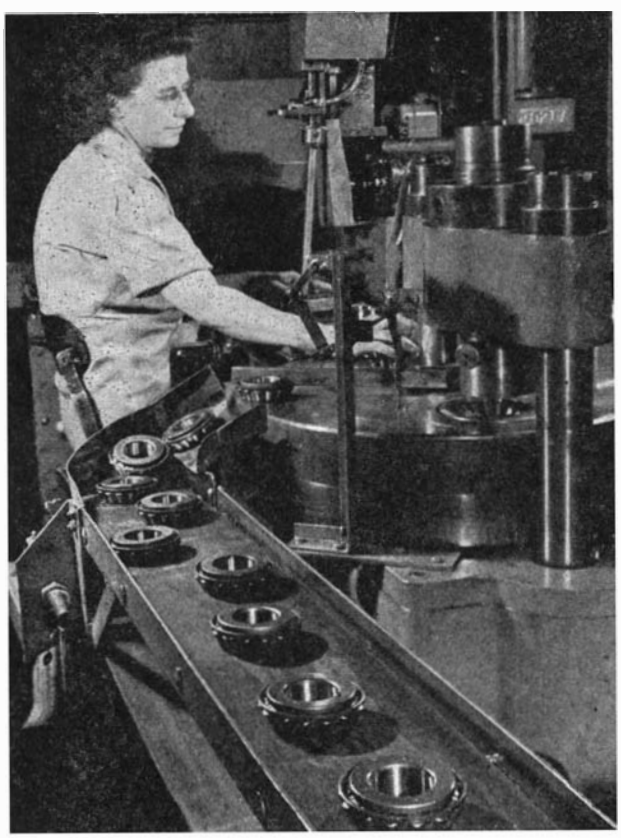
STRAWS IN THE WIND

THAT more efficient tools can lead the way to a sounder national economy, through a high level of productivity, will be amply demonstrated at the Boston convention of the American Society of Tool Engineers to be held late in October. . . Commercial possibilities of obtaining oil from shale are being proved in a Colorado pilot plant. . . Electrical utilities will spend a billion dollars a year for the next five years for plant additions. . . High-grade castor oil for industrial uses is being produced from Oklahoma castor beans.

18,000 Ways to FIGHT FRICTION

By H. O. Smith
Secretary of the Anti-Friction Bearing Manufacturers Association

Reducing to a Minimum the Friction With Which Our Entire Civilization Moves, Ball and Roller Bearings of All Types and Sizes are Major Contributing Factors to the Super Speeds Which Characterize This Age. Continuing Research is Yielding Better Materials and Better Lubrication



Assembling parts which make up a tapered roller bearing

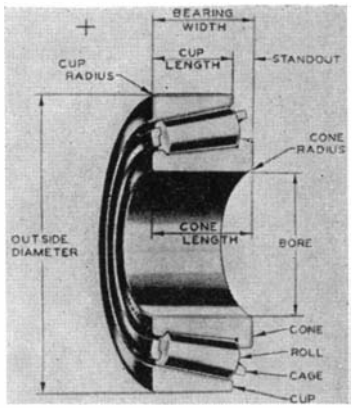
APPROXIMATELY 250 million ball and roller bearings were produced in the United States last year to carry on a war that never ends.

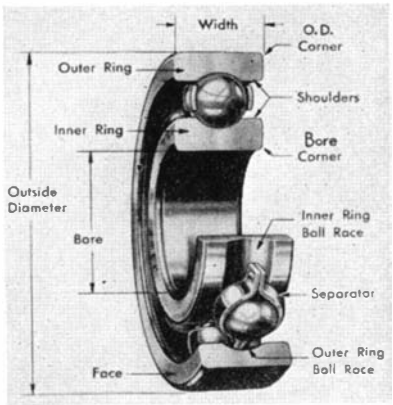
This is the war against friction, the deadly enemy of all movement, and it has been in full swing ever since that day when some forgotten man of antiquity first hacked out a crude wheel and attached it to an axle.

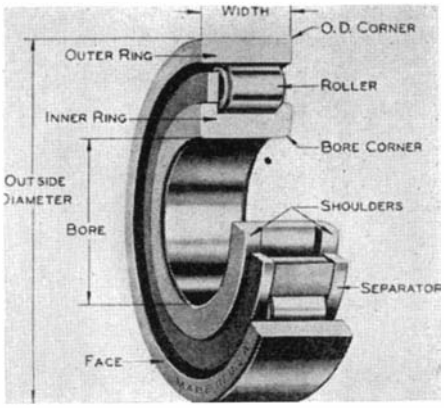
Some idea of the importance of the modern anti-friction bearing can be gained from this fact: If all the ball and roller bearings were suddenly removed from every kind of machinery, life in big cities would be reduced to the level of a medieval fortress town. Famine, plague, and complete isolation would result because virtually all forms of power transmission, communication, sanitation, and transportation would cease. Throughout the world, modern civilization itself would come to a grinding halt.

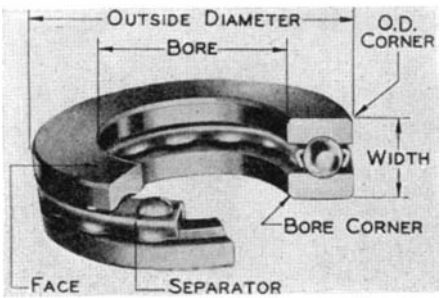
The science of fighting friction can be reduced to a simple fundamental. It is the job of changing sliding friction to rolling friction. Pushing a heavy book across a table illustrates the principle of sliding friction. If marbles are put under the book, sliding friction has been converted to rolling friction. A feather touch will then start the book moving.

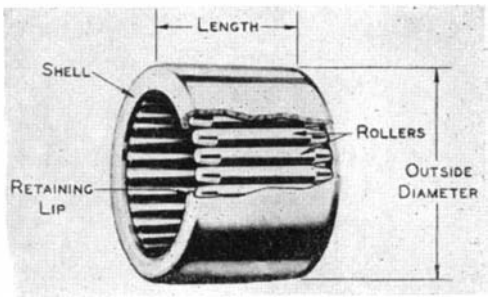
In the early stages of the industrial revolution, the plain bearing or stationary bushing met the needs of higher speed and longer life in turning parts—up to a point. The point was that speeds of things could be increased only in direct ratio to improvements in bearing metallurgy and lubrication. Modern technology and the present age of super speeds waited on the development of bearings that would eliminate the rubbing friction of a moving part against a stationary one and substitute rolling friction. The solution came less than a century ago and at once removed many of the barriers to high speed, at least











A few of the most commonly employed anti-friction bearing types. Upper left: Tapered roller bearing assembly. Above: Ball bearing assembly. Upper right: Straight roller bearing assembly. Left: Ball-thrust bearing assembly. Right: A needle bearing assembly

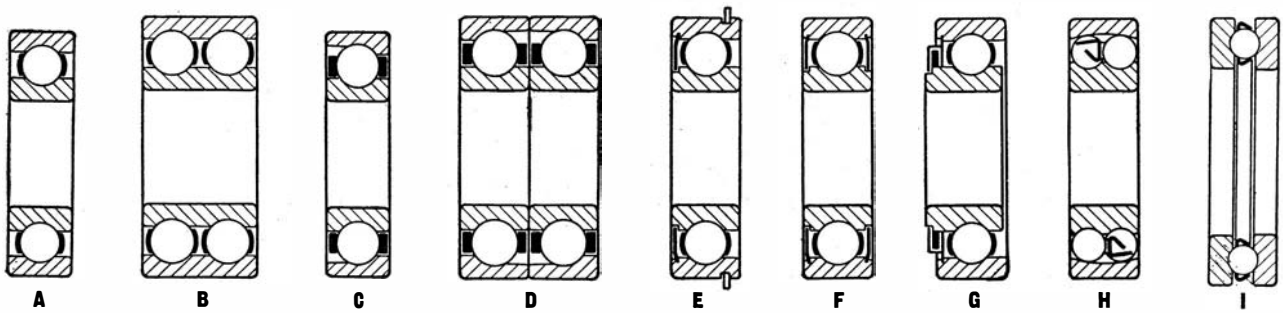
as far as the revolving parts of machinery were concerned.

Today, most machinery which must carry heavy weight or travel at high speeds depends on rolling friction, which is the closet man can come to no friction at all. Shafts, pulleys, pivots, axles, wheels —vital turning points—are protected by a ring of steel rollers or balls. No matter how complicated, no matter what technical refinements have been added, the anti-friction bearing is basically this: an outer ring or race in which a specified number of balls or rollers ride; a retainer or cage to keep the balls or rollers from falling out; and an inner ring to hold the shaft.

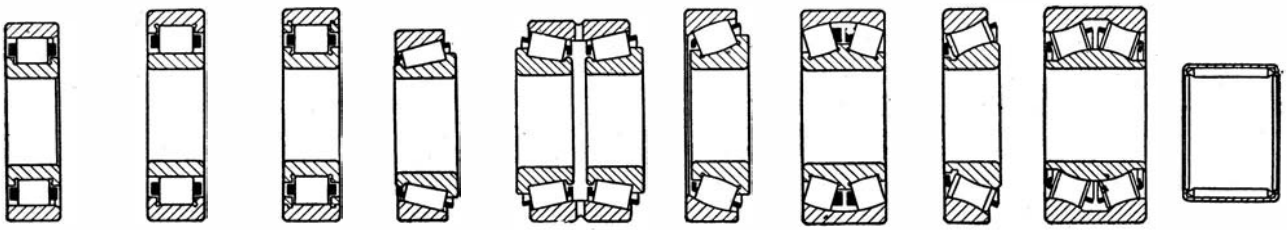
Most of the high speeds of the 20th Century are taken for granted. For example, the average vacuum-cleaner rotor spins at about 3000 revolutions per minute, a speed that would have been impossible on the plain bearings of 100 years ago and impractical even with many of today's plain bearings. The difference between the demands for speed and precision in the first and second world wars alone gave the makers of anti-friction bearings top priority in 1941 —the enemy's plants as targets, our own as mainsprings of production. Thus the two most historic air raids, first Schweinfurt and then Hiroshima, were aimed at the heart of enemy bearing centers.

18,000 TYPES AND SIZES — Because there is such a great variety of anti-friction bearing from which to choose (18,000 types and sizes), the basis for bearing selection is often difficult for industrial executives and engineers as well as for students to understand. And because the application of anti-friction bearings is expanding at an enormous rate in all industries, a basic understanding of the various types and their functions becomes increasingly important.

Consider, for example, the choice which confronts the designer or draftsman with a bearing problem. He can have angular contact bearings for thrust or combined thrust and radial loads; double row ball



Types of anti-friction ball bearings. A, single row; B, double row; C, radial thrust; D, duplex with faces ground for use in pairs; E, snap ring (used both with and without shields); F, shielded (shields may be on either one or both sides); G, single seal (sealed bearings may have seals on both sides, in which case they are wider); H, self alining; I, ball thrust



Types of anti-friction roller bearings. J, straight, separable outer ring; K, straight roller, separable inner ring; L, straight roller, non-separable; M, tapered roller; N, tapered roller, double row, adjustable through cones or cups; O, barrel roller; P, barrel roller, double row; Q, concave roller; R, concave roller, double row; S, needle, sometimes with separable inner rings

Roller bearings so large that a crane is used in assembling them

bearings, Conrad, or maximum type; roller bearings or roller needle bearings with or without self-alining features; and so on.

In unraveling these seeming mysteries, it should be understood that there are relatively few instances in which basic anti-friction bearing types are not interchangeable. Thousands of borderline cases exist in industry where conditions of load and speed, and other factors, permit a choice between ball or roller bearings. And even where one bearing type seems clearly indicated, special designs or additions may make substitution possible. Three different makes of machine tools of similar design may each respectively use a ball bearing, a straight roller bearing, and a tapered bearing in the same function.

Railroad journal boxes are an exception. All use roller bearings, although one type incorporates a ball bearing, too, to take up thrust. The largest steel mill bearings for presses are invariably roller types. On the other hand, in instruments which must function at high speeds and have room for only the smallest type of anti-friction bearing, ball bearings are the single choice.

BALL-BEARING TYPES — Ball bearings are generally divided into three basic groups: (1) deep groove bearings, used chiefly to support radial loads in a direction normal to the shaft axis, (2) angular contact bearings which are employed to sustain combined radial and thrust loads, and (3) thrust bearings which carry purely end-thrust loads. In the first two types, the component parts consist of an inner ring, an outer ring, and a retainer (sometimes called a separator or cage) which is used to space the balls apart. Where the bearing is called upon to sustain extremely heavy loads at very slow speeds, a full row of balls without retainers is occasionally used. The

Air conditioning protects tiny bearings during assembly and inspection

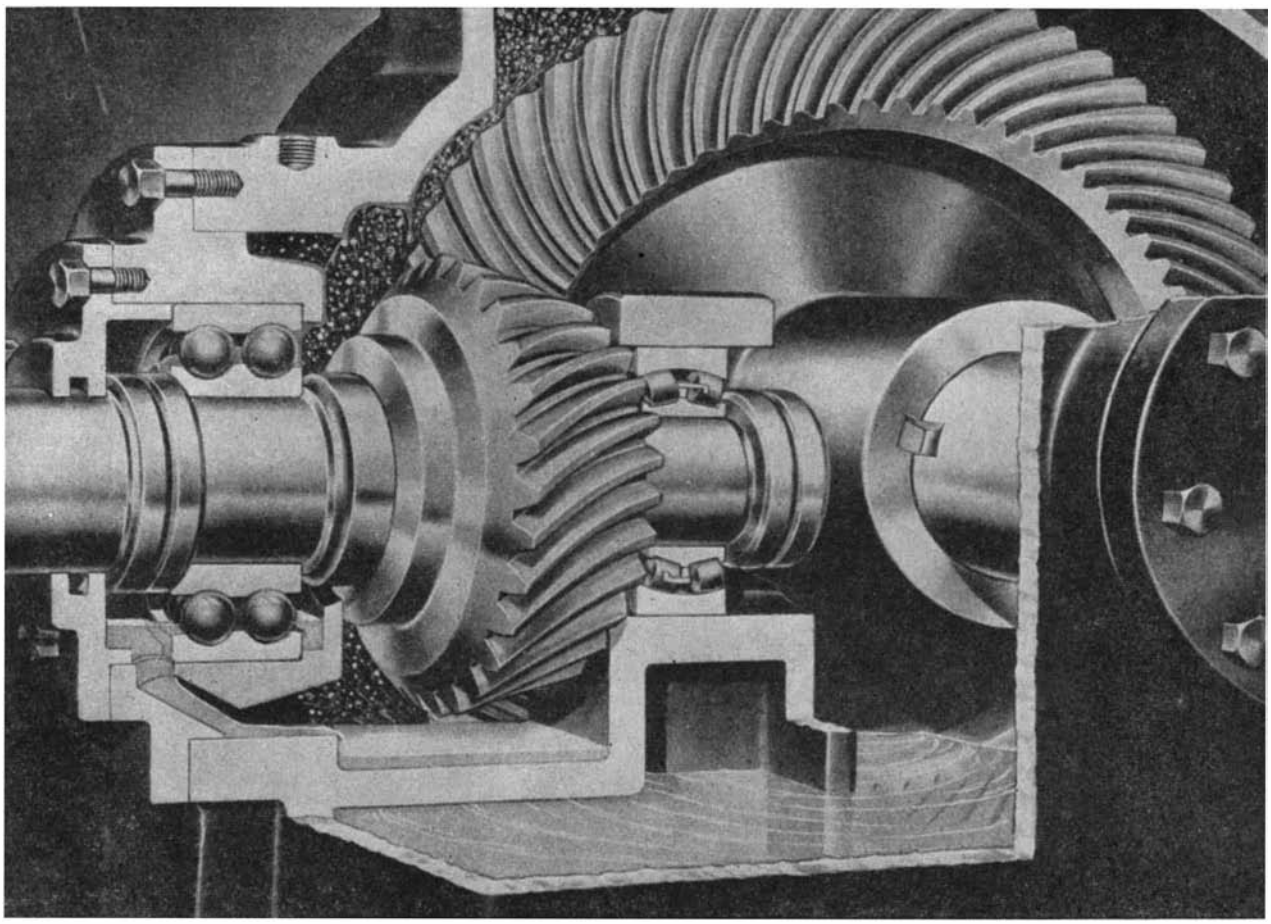
raceways of the inner and outer rings have curvatures which conform closely to the curvature of the balls, so as to provide the maximum load carrying capacity. However, the raceway curvature is slightly greater than the ball curvature to reduce the friction between the ball and the sides of the raceway.

For increased radial load capacity, ball bearings are sometimes made with two rows of balls, each row having its own retainer. Another type of ball bearing designed to compensate for misalinement of the shaft with the housing has two deep raceways in the inner ring with the outer raceway of spherical form, the center of the sphere coinciding with the shaft axis. The outer ring is therefore free to aline itself as required, without binding the balls in any way. The load carrying capacity of such a bearing, however, is limited due to the small contact between the balls and the outer raceway.

The range of speed at which ball bearings rotate varies from an almost imperceptible movement as in instrument gimbals to speeds of 100,000 revolutions per minute when used in small grinders employed in making dies. In both extremes of speed, the highest degree of precision and smoothness of the raceways and balls is required. For continuous high-speed operation, retainers are frequently made of phenol-impregnated composition, accurately machined for good balance. This material is light in weight and requires little lubrication, although it cannot be used at temperatures higher than 250 degrees, Fahrenheit. For moderate speeds, steel retainers formed in two halves and riveted together are satisfactory, and the majority of bearing retainers are of this type. However, retainers are sometimes machined from bronze or aluminum tubing, the latter material being desirable for aircraft bearings because of its light weight.

Thrust ball bearings are usually made up of two plates or washers between which the balls rotate. The washers ordinarily have grooved raceways, although flat ungrooved washers are sometimes employed for light loads. One washer is mounted so as to rotate with the shaft while the other is stationary. Retainers of machined brass or pressed steel are generally used to separate the balls. The speed at which thrust ball bearings may be rotated is limited because of the centrifugal action which tends to force the balls outward, causing wedging.

ROLLERS AND THEIR USES — Cylindrical roller bearings are designed mainly to carry radial loads, while tapered roller bearings and those of barrel and hour-glass form will withstand end-thrust as well as radial loading. For low speeds, cylindrical roller bearings having rollers of a length several times their diameter may be used, but where speeds are higher, bearings having rollers of the same length as diameter give the best results. When made to extreme precision, such roller bearings may be operated at speeds which approach those obtainable with ball bearings. Another form of cylindrical roller bearing employs a full row of rollers of exceedingly small di-



ameter, the roller diameter being about one eighth the length. These are called "needle" roller bearings and they are used chiefly for slow speed or oscillating applications. In many cases they run directly upon a hardened and ground shaft, thereby dispensing with the usual inner ring.

Tapered roller bearings are made up of tapered rollers with a length about twice their mean diameter. The elements of the cone of each roller, when extended, meet at one point on the axis of the shaft so that true rolling is obtained without slippage. The rollers are restrained from moving outward by a flange with which the outer ends of the rollers are in contact. The angle of the cone through the axis of the rollers varies in degree, being larger for applications where extra heavy loads are to be carried.

Self-alining roller bearings, designed to operate under conditions of misalinement, have one raceway, either the inner or outer, which is spherical in form and which conforms to the shape of the rollers. Bearings employing rollers of barrel shape have the outer raceway spherical while those using hour-glass shaped rollers have the inner raceway spherical. In both types the center of the sphere lies in the shaft axis. Flanges on either outer or inner ring are used to guide the rollers.

LONG SERVICE, LITTLE WEAR — Anti-friction bearings, properly lubricated and adequately protected against dirt and foreign matter, will show no appreciable wear even after long periods of service. On the other hand, plain or sleeve-type bearings usually are shorter lived. Anti-friction bearings can be replaced as complete units, ready for immediate service, requiring no special filing, scraping, or fitting operations. Ball bearings in particular and also many types of roller bearings are made to established standards of exterior dimensions which are in use in Continental Europe and in the Western Hemisphere, so that bearing units are obtainable almost anywhere throughout the world, should replacements be needed.

In recent years there has been an increased use of completely sealed anti-friction bearings, particularly in units where low manufacturing cost is essential. These have flexible leather or felt seals or closely fitting, non-rubbing metal seals at each side of the bearing. The seals retain the grease as originally packed into the bearings, and keep out dirt and foreign matter. With the highly developed bearing greases now available, pre-packed bearings have been known to operate under normal conditions for three years or more without requiring re-lubrication.

Over the years, the industry has added many new types, shapes, and forms to the original straight roller and standard ball bearing to answer specific needs. Stack bearings in which several rows of ball bearings are merged together were an outgrowth of World War II and the needs of the aircraft industry. The needle roller bearing is likewise a comparatively recent development in which slender rollers of unusual length are used for various types of shafts. From the original roller bearings have also come barrel roller bearings—all of them tending to give the industry greater versatility.

At present, the major research in the anti-friction bearing industry centers around four major goals: Better lubrication, improved steels, increased straight-line precision, greater standardization. In production of quality steel, the industry's record is so outstanding that it has given to jet plane research one of the few steels suitable to withstand the blast-furnace temperatures of jet engines. Likewise, its research in lubrication has gone beyond its own problem and contributed knowledge and know-how to better greases for other moving parts.

Anti-friction bearing manufacturers believe that the field of expansion for their products is virtually unlimited—that the saturation point is nowhere in sight and that it will not be reached until there is no longer a need for high-speed turning parts, durability, and trouble-free maintenance in machinery of all kinds.

Opposite page:
Anti-friction bearings in the differential of an automobile. To the left of the pinion gear the drive shaft is supported by a double-row ball bearing; to the right of the same gear a double-row thrust roller bearing is used

Right:
In a sound-proofed room, a trained tester listens to bearings which he places, one at a time, on a rapidly revolving shaft. The slightest "foreign" noise is instantly detected and the offending bearing is discarded, even though the noise may be caused by only a fleck of rust or other minor defect

Sleeping Beauty of Industry

Silver, Long Tied to Currency Values, Can Become the Fair-Haired Boy of Industrial Engineering Metals. Its Mettle Has Already Been Proved in the Brazing, Electrical, and Chemical Fields. Future Expansion Will Depend Upon Price and Industry's Attitude

By Edwin Laird Cady

WHEN FINE silver got down to 60 cents a fine ounce (about $9.00 an avoirdupois pound), dozens of engineers rubbed their eyes, reached up on their shelves for the blue-prints of plans which had been gathering dust for years.

At this price silver could be fabricated into many products at prices competitive with the high-alloy types of stainless steel. If the price were to go still lower then any number of industrial uses of silver might become commercially practical. And since there are some industrial uses for which silver is nearly indispensable, no matter what its price, quite a few industrialists could see money which had gone for high priced silver made available for higher wages to labor.

Thus was resumed an engineering struggle which has been going on for centuries excepting when interrupted by wars.

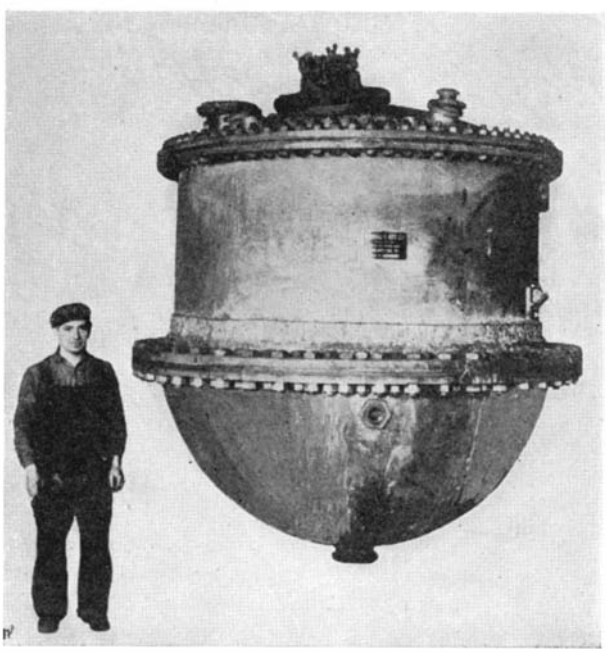
Mankind always has taken an ambivalent (cock-eyed) view of silver. Seen out of one eye, silver is a basis of coinage, an article of costly table-ware and of jewelry, a by-product of copper and other mining; therefore, its price must be kept artificially high. Glimpsed from an eye which the actions of governments have kept blackened for centuries, silver is a metal which has more on the ball than any other with the possible exceptions of iron and copper and therefore ought to be priced as low as the law of supply and demand will permit. Up until now, mankind has been unable to make up its mind. But industrialists are hoping.

Weather making is one of the uses for which the silver price would make no difference. There has been plenty of publicity about dropping dry ice into clouds to cause snow or rain storms but not so much about the fact that silver iodide undoubtedly would do the job much better.

FLOOD CONTROL — Scientists have calculated that, if the entire United States could be found blanketed by clouds at the same time, then only 200 pounds of silver iodide blown into the air from selected points on the terrain could cause simultaneous rain over every square foot of our nation. With silver iodide dispersed from airplanes, heavy storms might be broken up before they got well started, flood waters might be made to deposit themselves on arid desert regions before they got a chance to concentrate and swell the rivers.

Silver brazing ("hard soldering") is another use which will find some employment almost regardless of silver price. A silver brazed joint between most metals is second only to 100 percent welding in strength, and between some metals is stronger than welding. The juncture is corrosion resistant and a good conductor of heat and electricity. To counterbalance the high cost of the silver in the braze alloy there are such savings as the avoidance of the cost of machining fillets and grooves ahead of the braze, the elimination of final or "clean up" machining after brazing, the extreme ease of handling which lends itself ideally to induction heating or automatic gas torch heating or furnace or even salt bath brazing, and the low temperature (as low as 1140 degrees, Fahrenheit) at which the work may be done. But wide spread as the possibilities of production-

The silver lining has an immediate cash value when the equipment is scrapped

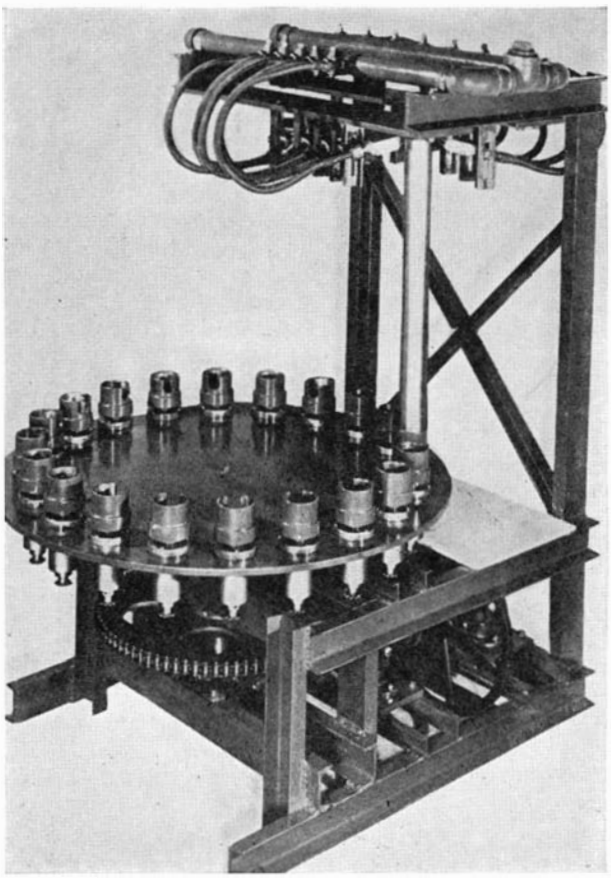


line savings may be, there still are thousands of uses of silver solder which will become economical only when the price of silver goes still lower.

SILVER LININGS — On the fence in the price matter is the use of silver linings for chemicals and foods processing equipment.

Such silver linings have a great deal to offer. Anyone can find as many chemist's opinions as he wishes regarding the question of whether or not silver ever oxidizes at temperatures below its molten state, but certainly it does not oxidize very much and if at all then only at very narrow ranges of temperature. It is not dependent, as are the stainless steels, upon a thin layer of oxidation to inhibit further oxidation, and so it does not present an oxidized surface to liquids with which it is in contact.

There are other advantages of silver linings. Silver



Equipment for silver brazing with gas

is the number one metal as a conductor of heat and electricity; it thus can contribute much to heating, cooling, and electrical processing. Silver is one of the most readily self-healing of metals if attacked chemically at porous areas. It can be electroplated on a surface, rolled to a highly homogeneous wrought metallurgical structure, and thus used as a thinner protective cladding than almost any other metal. And it is highly resistant to most acids and a long list of other corrosive chemicals.

A price-wise argument concerns the value of the silver lining as an investment. Many a chemicals house has bought huge silver-lined kettles and vats, extensive installations of silver-lined faucets and

Parts set up for mass fluxing and silver brazing

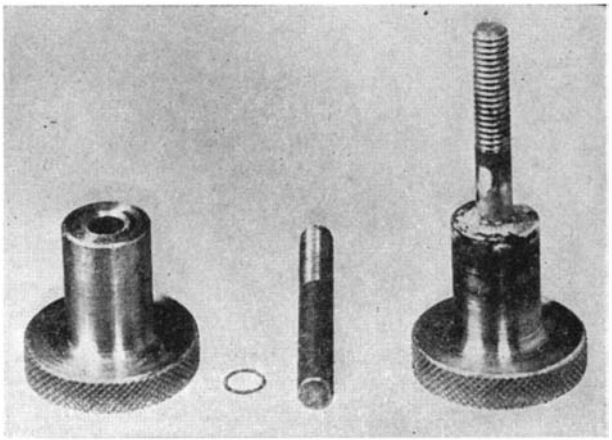
pipes, with the idea that when the equipment wore out the silver linings would be money in the bank. On such a financial basis depreciation need be charged only on the iron or other common metal parts of the equipment, only interest on the investment being charged against the silver. More than one company bought silver-lined equipment during the depression, scrapped it during the war, and got more for the silver linings than the complete equipment had cost.

Let the price of silver go down severely, and many a brand new depreciation entry will appear on capital equipment books.

And yet, as always, there is the opposite picture of highly valuable contributions of silver if the price goes down. The oligodynamic use is an example.

IONS HUNT MICROBES — "Oligodynamic" means, in simplicity, that a silver lining on a vessel has the ability to shoot silver ions into the liquid within the vessel, and these ions will go hunting for microbes the way old-time privateers used to hunt down enemy merchant ships.

Industry does not know as much as it would like to about this oligodynamic business. The price of silver never has been low enough to warrant much commercial development. Research has indicated that the ions may not be too effective against the



A micrometer screw costs less to make in two pieces and silver braze than to machine from the solid

kinds of microbes which are high in protein or are protected by devices which under the microscope look like long hair. But research also shows that plenty of other kinds will be reduced to the minimum in the liquid contained in a silver-lined vessel. And if the action is effective it keeps on being effective for a long time. A water glass which has had only a tiny bit of silver in it can be refilled again and again and enough of the silver will cling to the glass walls so the ions will continue to shoot out, killing the microbes at each refilling.

Cans for orange juice, for malt beverages, and other liquids have been given extremely thin silver linings and found effective for long period storing and shipping. Pasteurization, which reduces the palatability of some liquids, may some day be eliminated in this way. But these benefits will be commercially rare unless reduced prices of silver make them practical.

The electrical uses of silver offer another cost dilemma. Silver contacts are highest in electrical conductivity, conduct heat away from contact surfaces and thus tend to prevent troubles from overheating, are not oxidized by the ozone which so often is present within electrical equipment. If corroded they are likely to form compounds which are high in electrical conductivity and therefore the corrosion damage is slight. In many cases, no substitute for silver contacts is considered, almost regardless of price.

Silver brushes in electric motors, even when the silver be mixed with carbon, have an ability to impart an extremely thin silver coating to rotating parts against which they bear. This coating has virtually the same conductivity as silver, of course, and therefore the voltage drop between the brush and the mating surface is very little. Aside from other advantages, this property al has caused wide-spread use of silver in brushes.

SILVER OFTEN LESS COSTLY — Many an engineer has been astounded to learn that, kilowatt for kilowatt of capacity, silver often is a less costly form of electrical wiring than is aluminum. And the fact that silver can be fastened to spring steel parts without drawing their spring tempers, and hard or soft soldered to almost any metal, offers advantages of fabrication costs which electrical device makers

• LOOKING AHEAD •

New views of silver as an industrial metal . . . Expansion of silver brazing . . . Silver-plated vessels replacing pasteurization process . . . More uses in electrical industry . . . Better magnets . . . A changing attitude toward quoting silver's price.

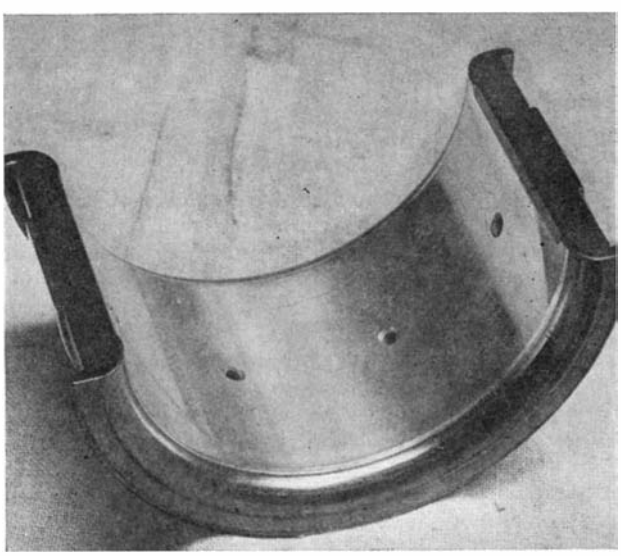
cannot ignore. But with all this there is many an electrical need which silver cannot meet unless price goes down.

Magnets are an example. An alloy which contains about 85 percent of silver can be made into a permanent magnet which can be much shorter in length than any other magnet alloy for the same flux. But in spite of the obvious savings in space and weight to be obtained with this alloy it is recommended only for "special" uses, the other alloys being more economical for the majority of purposes.

Silver as a lining for bearings is high in lubricity and embeddability, does not melt readily, can conduct away the heat of friction. Silver as a catalyst is highly valuable to the chemical industries. Silver as an alloying ingredient in metals can promote machinability and add to corrosion-resistant qualities. Silver is the most weldable of metals; when methods are perfected for welding at room temperature and by means of pressure and time alone, the first metal to be used will undoubtedly be silver. Silver as a chemical ingredient is irreplaceable for many uses.

In the face of all these advantages mankind has to make up its mind whether to turn silver loose on the open market or keep it tied to currency values. But in the present industrial picture perhaps the greatest need is to quit quoting silver on the basis of ounces. "Nine dollars a pound" sounds like an industrial metal; "sixty cents a fine ounce" has the ring of a jewelry or drug store purchase.

Silver lined bearings are high in lubricity and embeddability



PARADOXICAL Paints

Surface Coatings With Bases of Silicone Resins Possess Many Seemingly Impossible Combinations of Opposing Qualities

By James R. Patterson
Engineering Section, Resin and Insulation Materials Division, Chemical Department, General Electric Company

A SINGLE silicone paint may resist both high and low temperatures; may withstand exposure to both acids and alkalies; and may be hard as well as flexible. And it is this combining of such apparently opposite characteristics in a single paint that holds the secret of the growing importance of silicone paints.

The silicones are characterized by an unusual inertness to physical and chemical change over a wide range of conditions. This inertness can be attributed to a basic chemical structure of recurrent alternating atoms of silicon and oxygen, a structure similar to that existing in glass and quartz. The flexibility, toughness, and workability of the silicones come from built-on groups of carbon and hydrogen atoms. All of this is in marked contrast to the less inert but more familiar hydrocarbon structure based on chains of carbon atoms.

Today's silicone products range from gases and volatile liquids through oily fluids and greases to plastic resins and elastomers. And it is these resins and elastomers that are attracting great interest as bases for paints, lacquers, enamels, and similar types of surface coatings.

In making finishes and coatings with these silicone resins, the same equipment and techniques as used with other binders may be employed. Pigments are dispersed in them with ball or roller mills; metal salts such as those of cobalt, iron, or zinc are added to catalyze curing; and common aromatic and aliphatic solvents thin the resulting mixtures for more convenient application.

The coatings may be applied by spraying, rolling, dipping, or knifing. Then for the most satisfactory results they should be baked or cured at 400 degrees, Fahrenheit, for 30 to 60 minutes. As yet no entirely satisfactory air-drying silicone paints have been designed; unless baked, they are lacking in toughness, adhesion, and weather resistance.

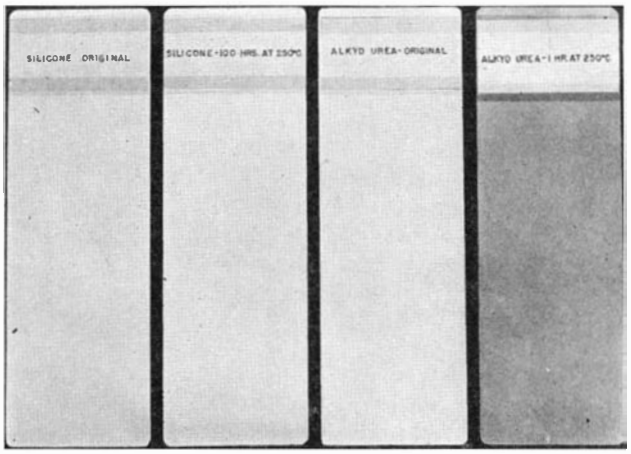
It might be said that the finishes made with silicone resins possess many of the desirable characteristics of both vitreous or porcelain enamels and organic polymers. Fortunately, this end result is accomplished without an outcropping of the undesirable characteristics of the individual members, as so often happens with blends of other resins.

RESISTS HEAT, KEEPS FLEXIBILITY — While silicone enamels will not withstand as high temperatures nor provide as much abrasion-resistance as porcelain enamels, they do permit the attainment of new levels of heat-resistance along with flexibility. They may be exposed to 500 degrees, Fahrenheit, for months will little or no change in color and gloss, and with only a negligible loss of flexibility and adhesion. Some types may be held at temperatures of 600 to 700 degrees, Fahrenheit, for several hours, but at these temperatures there is a gradual loss of the resin through volatilization. Beyond a certain point in this loss, the film has lost enough binder to be brittle, and may crack from shrinkage. Color change does not accompany this film failure.

Thermoplasticity, or softness when hot, is an objectional trait of the more heat-resistant organic finishes. Thermo-cured silicone enamels are markedly superior in this respect, even though they do not have the abrasion resistance at high temperatures that porcelain enamels possess. And these same silicone enamels retain their flexibility and adhesion at temperatures as low as 60 degrees below zero, Fahrenheit. To attain this with other types of materials, usually a sacrifice in hardness at normal temperatures must be accepted.

The semi-inorganic nature of silicone resins would be expected to display itself in low flammability and resistance to burning. This is so, but to varying degrees, depending on the content of organic modifier. Generally they will burn when in contact with a hot flame, leaving a residue of silica, but it is difficult to set them aflre with a lighted match.

RESISTS ACIDS, ALKALIES — General chemical resistance constitutes another silicone plus-value. This is evaluated by applying films on the outside of large glass test tubes which are then immersed in baths of various reagents at set temperatures. Silicone finishes are not affected by exposure for several hundred hours in 5 percent solutions of



Coated test panels before and after exposure to heat. Left to right: Silicone painted panel before test; silicone painted panel after 100 hours at 250 degrees, Centigrade; alkyd-urea coated panel before test; alkyd-urea coated panel after exposure for only one hour at 250 degrees, Centigrade

caustic soda, or of acids such as hydrochloric, sulfuric, or nitric, at 100 degrees, Fahrenheit, but at their present stage of development they fail in a few hours in concentrated solutions. Also, they strongly resist materials that they might encounter in kitchens, laundries, creameries, bakeries, breweries, and hospials—for example, such materials as fruit and vegetable juices, mayonnaise, mustard, vinegar, cooking fats, soap, alcohol, lactic acid, iodine, and mercurochrome. Another factor which cannot be overlooked in finishing equipment for many of these uses is whether the coating will support mildew and other fungoid growth. Alone, silicones will not support such growth. When mildew grows on them, it is being supported by foreign material.

This brings cleanliness and its maintenance to mind. The silicone paints can be formulated to have a very smooth, slick surface to which foreign matter does not readily adhere, and which can be easily wiped clean.

One practical application of this slickness is in coating molds to prevent molded articles from sticking. For instance, bread pans coated with silicone varnish never need greasing to prevent the bread from sticking; these pans can be used for several hundred bakings before they need re-coating. Apparently this coating has no deleterious effect. Its adherence to the pans is sufficient to avoid contamination of the bread; also, while the non-toxicity of silicone coatings has not been entirely established, there is much evidence of their being physiologically inert.

In the food canning industry there has long been a need for an improved coating which will withstand exposure to the boiling water and wet steam used for sterilization. It is believed that silicone coatings will stand up well under these conditions. Laboratory tests with samples suspended in the steam and partially immersed in the boiling water have been run for as long as one hundred hours without failure.

RESISTS WEATHER — Resistance to weather is not one of the least important assets of silicone paints.

• LOOKING AHEAD •

Exterior surface coatings which are virtually unaffected by weather. . . Easily cleaned heat-resistant surfaces resisting chipping throughout a wide range of temperatures. . . Automobile paints far outlasting those in present use. . . Direct competition with conventional paints.

Determining weather resistance is a long-time affair, but preliminary evidence again attests to unusual inertness, and indicates a long life span graced with a lasting appearance of newness. Several accelerated exposures of silicone paints have gone four years and more with no apparent deterioration. Control exposures of other durable coatings available at the time the tests were started already show considerable failure. Depending on the color, they have either chalked and faded or cracked and checked. The silicone paints containing durable pigments still maintain their original gloss, color, and film integrity. Some of the softer types exposed in industrial areas have collected an adherent coating of atmospheric dirt and dust; harder types seem to have shed this dirt readily. Many pigments which are considered unsuitable for outside use in other binders stand up very well in silicone resins.

The method of accelerated testing used for the above weather-resistance observations is as follows: Steel or other metal panels are thoroughly protected with a corrosion-inhibitive primer. Then the paint to be evaluated is coated over the primer; usually two coats are applied. These finished panels are placed in specially designed outdoor racks so that the panels are at an angle of 45 degrees from vertical, and facing southward. This position insures that a maximum of direct sunlight reaches the coating. Exposures are made in various geographic localities to ascertain the effects of cold winters, hot summers, sudden drenching rains, seaside salt air, and industrially contaminated atmospheres. These particular tests are being made in Florida and New York. In addition, tests are being run in weather-simulating devices. Results here are unusually good, too.

Weather resistance as shown by silicone paints immediately suggests their use on automobiles. Until recently their tendency to re-dissolve in high-test gasoline was much against this application; a careless service station attendant might overflow or spill gasoline and badly damage an automobile's finish. Now silicone paints can be designed to be suitable in this respect. Also, these same paints will safely resist radiator anti-freeze mixtures, hydraulic fluids, and lubricants.

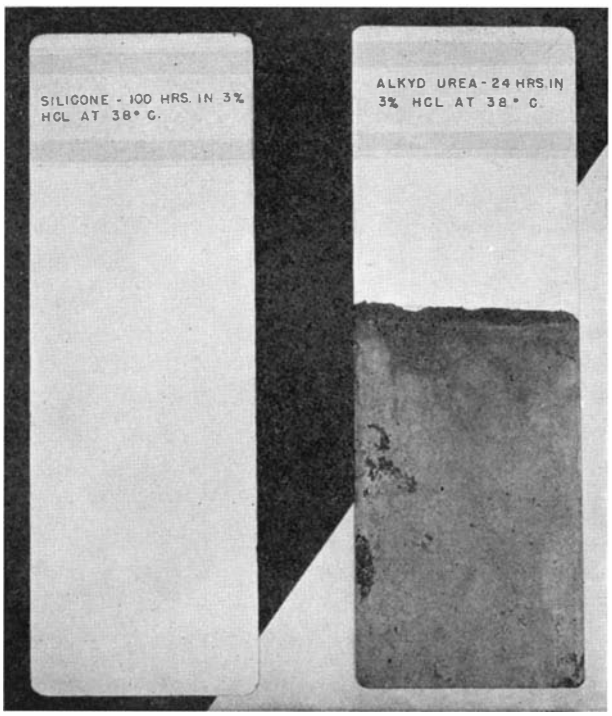
CURING IS PROBLEM — However, one of the important requirements for finishing such products as automobiles has not been fully met by silicone paints so far. This is the ability of the finish to be air-dried or baked rapidly at moderate temperatures. For refinishing used automobiles, an air-drying coating is desirable. For production-line finishing of new

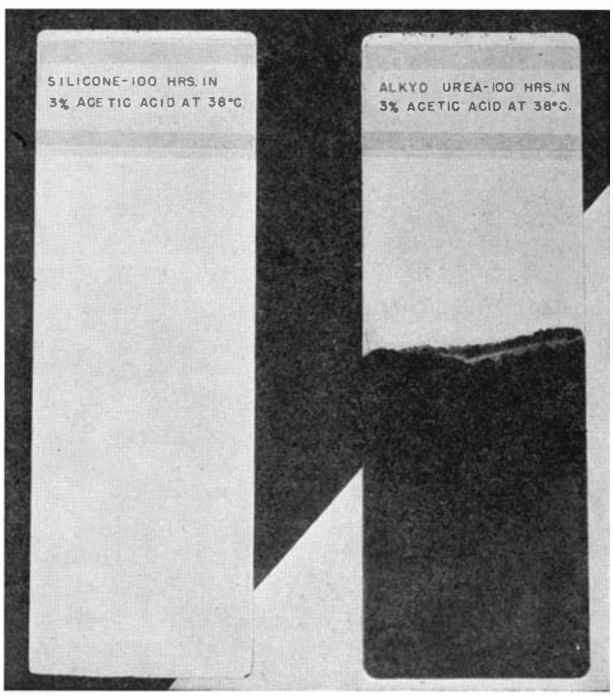
models, speed is essential, and some parts should not be subjected to temperatures above 250 degrees, Fahrenheit. As mentioned above, air-dried silicone paints are not durable and relatively high baking temperatures must be used to bring out their superior qualities. Some success has been obtained with curing at 300 degrees, Fahrenheit; but this requires the rather impractical time of two to three hours. A temperature of 400 degrees, Fahrenheit, is much more suitable for producing hardness and general resistance characteristics; at this temperature 30 to 60 minutes is required. Fifteen to 30 minutes at 500 degrees, Fahrenheit, produces equivalent results.

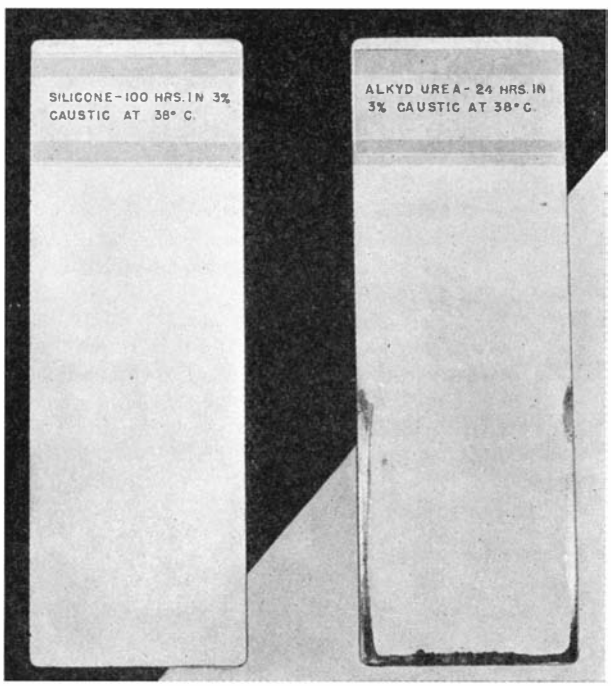
With the advances that have already been made in speeding up the curing of silicone paints, further improvements will not be surprising. It may be that even before this is published, modified resins will be designed and new catalysts discovered to decrease making temperatures and times by as much as one half, and air-drying types are theoretically possible.

PRICE LIMITS USES — As for most new chemical products, cost and limited production capacity are the main factors restraining silicone paints from wide general use today. But there are many special applications where their present high cost of as much as 20 to 25 dollars per gallon is no barrier. For example, in finishing stove, heater, and kitchen-range parts where heat-resistance is essential, and no other finish except porcelain enamel is satisfactory, it is economically desirable to use silicones. The high application cost, the necessity of using special steel, the high rejection of imperfect pieces, and the difficulty of repairing damage with porcelain make silicone enamels more than competitive.

There are many other uses where the characteristics of silicone paints are desirable, but their present price is too high. However, the additional manufacturing facilities which will be completed this year should bring the cost to the level demanded for these uses. Then there is also the type of use where other paints are satisfactory, or nearly so. Here price is all-important, and possibly as long as ten years will pass before silicone paints can be used economically. However the time is not too distant when production experience and quantity production should aline these new paints competitively with all others of good quality.







Panels coated with silicone and alkyd-urea paints, as they appeared after being subjected to tests indicated by lettering at tops of the panels

SEEING is Believing

Industry Is Turning More and More to Motion Pictures to Solve Tough Sales Problems. Here Is How One Manufacturer Used This Graphic Medium to Break Down Consumer Incredulity in the Capabilities of His Products, and also to Present Instructions For Their Use

By Carl Toll
General Advertising Director,
The Sherwin-Williams Company

FROM the very beginning, when we began to market Pestroy DDT and Weed-No-More 2,4-D on a national scale, we realized our biggest single job was to educate our dealers and the consumer to the advantages and uses of these new scientific achievements.

Last year millions of Americans laughed when they saw their neighbors walking around their yards spraying weed-killers on the lawn. It seemed too fantastic to be true that you could spray weeds away. It was this kind of resistance we faced when we marketed Weed-No-More. No one could blame the consumer for his attitude. Even many of our dealers doubted the claims we made for the product. They were just as skeptical about our claims for DDT when we announced that we had a DDT product which would stay lethal for a period of 60 to 90 days. Our dealers wanted proof—and so did the consumer.

We decided the best way to prove our story was to produce a movie for each product, in which we could visually show the actual results of the products in action. Movies, we felt, had additional advantages. We could actually show our dealers and the consumer how and where to use the products, and we knew from Army reports that the retentive value of movies was far greater than that of the printed word.

Once this was decided, our next step was to select a studio. Since the products dealt with new scientific developments which were comparatively unknown, we felt the studio which did our job should have had previous experience in this type of work. The studio we selected (Jerry Fairbanks, Inc.) had a fine record in turning out two-reelers on scientific subjects which met with popular acceptance.

In presenting the story of the development of Weed-No-More we wished to make clear several important facts: 1. That 2,4-D was the first positive advance in the killing of weeds since the beginning of time. 2. That 2,4-D actually killed weeds—roots and all. 3. That it was effective on hundreds of varieties of weeds.

TECHNIQUE USED — We solved the first problem by using cartoon strips which graphically portrayed man's battle with weeds through the ages until the present day. Proof of the actual killing power of 2,4-D was achieved by making delayed-action pho-

Scenes from two motion pictures, made to present facts about consumer goods and to tell how to use them. ABOVE: From the movie on a weed-killer. RIGHT: From one on a new DDT product. In both, cartoons combined with "live" shots give emphasis and dramatic appeal

tographs at 15-minute intervals over a period of three weeks of a weed that had been treated with Weed-No-More. The process was repeated several times to show the action on the most common weeds.

To give the story popular appeal, the whole film was woven around a family situation where the man in the house was delegated to weed his lawn by hand on a Saturday afternoon. In disgust with the slow progress of the job, the husband, (Donald Woods) storms into the house and protests to his wife (Wanda McKay) that on Saturday afternoons "I play golf." On the golf course, Woods learns about Weed-No-More from the groundskeeper who is using it on the fairway. At this point, the technical pictures were stripped into the film. The movie ends after Woods uses the product on his own lawn and is amazed with the results.

The film on DDT, called "Doomsday for Pests" is principally a cartoon-type feature with real models coming on the scene when the many uses of the product are shown. In dealing with insects, it was felt the cartoon-type lent itself to much better treatment of the subject. Close-up photographs which give actual proof of the lethal effects of DDT were also employed. The scene is set in "Bugville" where it has just been announced that millions of insects have been wiped out by a Pestroy attack. The bugs then rush to Bugville's theater where they see a newsreel on Pestroy DDT. The newsreel traces the development of DDT, its uses in the war, and shows with micrographic photographs exactly how it works.

CONCRETE RESULTS — Dealers throughout the nation were contacted upon completion of the films and told how to order prints for showing at their stores, or at clubs and fraternal groups in their community. The response to the films has been so great and the word-of-mouth advertising so effective that today we have 350 prints in continuous use from coast to coast. Our best estimate is that more than 1,000,000 have seen the films since their release eight months ago. The real proof of their effectiveness can be judged in two ways: Did they make our dealers better salesmen for the products, and did they produce sales? Evidence from all sections of the nation confirms our belief that these films were worth every penny of the investment. For example, on the Pacific coast, a showing in Santa Rosa, California, netted $550 in sales on the spot, another in San Jose resulted in the sale of 45 gallons of Weed-No-More for use on neighboring golf courses.

In the East one dealer wrote: "These are excellent pictures. I wish to compliment your company on the type of picture and production. They are instructive and educational as well as interesting, and I know were much enjoyed by all."

The Michigan Extension News reports the following concerning the films: "These films which describe the use of DDT and 2,4-D in an entertaining and story-like manner have been previewed and approved by Michigan State College."

In May our Southwestern District alone reported that the film had been shown 739 times. At that time it was reported these showings resulted in $19,936 in on-the-spot business.

In general, the results from these movies, which are the first full-color movies we have ever used in this manner, have been gratifying.

FUELS OF THE FUTURE

By Robert P. Russell
President, Standard Oil Development Company

The Petroleum Industry Looks to Atomic Power for Valuable Assistance in Supplying Fuel Demands in the Years to Come. Liquid Fuels in Improved Forms, Obtained From Crude Oil and Synthesized from Coal, Vegetable Matter, and So On, Are Expected to Furnish Power for Still More Efficient Transportation Units

Editor's Note: **The accompanying article is the last of a series of four, adapted by permission from papers presented at a recent Standard Oil Company (N. J.) seminar on Fuels of the Future. Each paper deals with different phases of fuels for engines of types now in use, under development, or projected. Together they summarize the general subject and furnish a glimpse of the fuels and engines which technology will be offering to transportation in the years to come.**

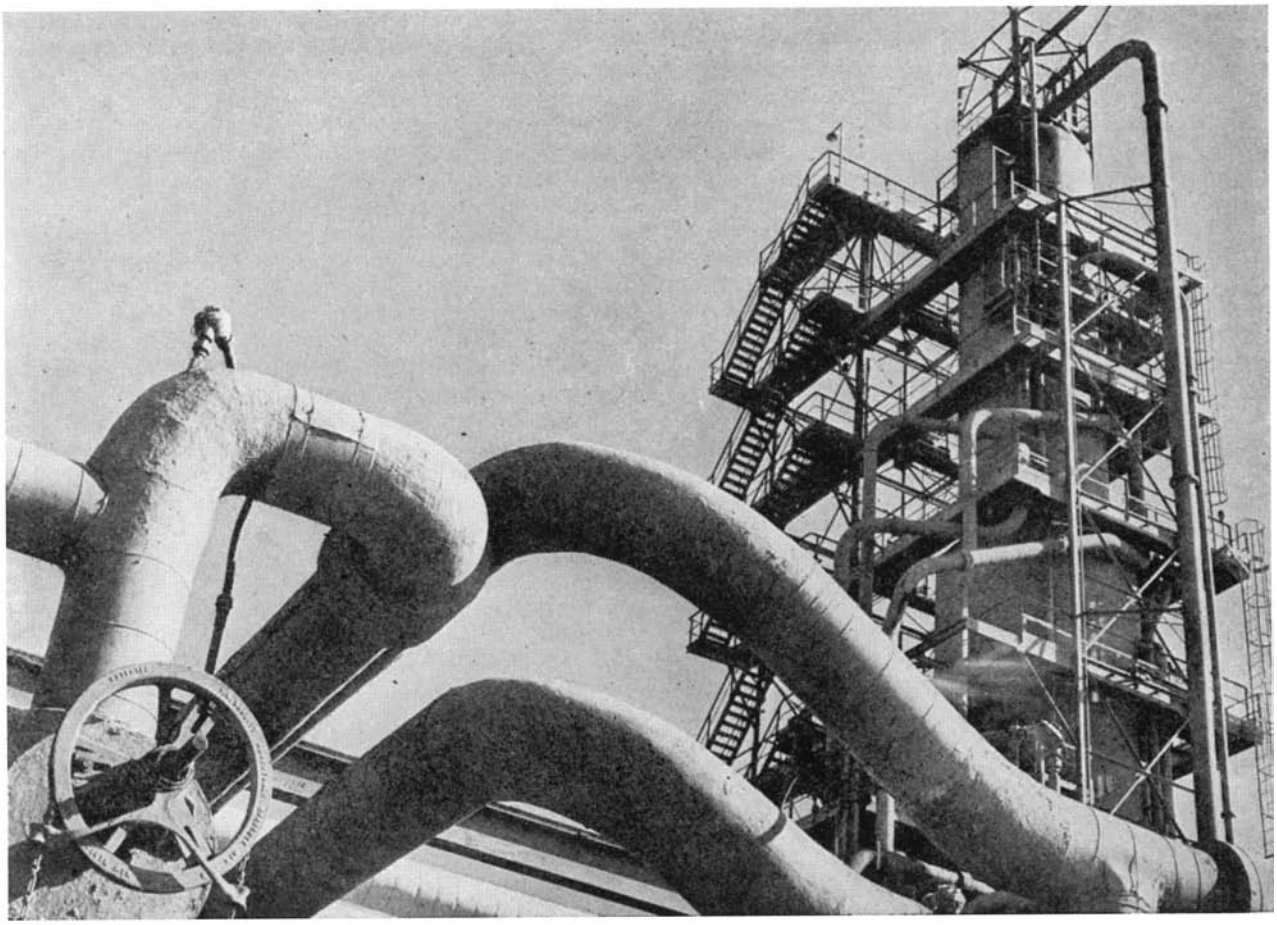
As THE future is viewed through the eyes of the petroleum research scientist, certain trends are seen which will undoubtedly influence our activities for at least the next decade. Foremost among these trends is the growth in world demand for liquid fuels. The percentage of total world energy supplied by petroleum has jumped from 16 percent in 1925 to about 30 percent today. A few figures illustrate this trend. In 1914 only 4 percent of the world's merchant fleet tonnage ran on oil. In 1945 over 75 percent was oil-burning. The horsepower from petroleum installed in the United States increased from 5½ million in 1935 to 45 million at the end of 1945. The war provided a striking example of our dependence on oil for energy. A typical military division in 1918 had 4000 horsepower behind it, but in 1945 the horsepower of a mechanized division exceeded 187,000.

Or the world picture may be scanned from the point of view of oil consumption prospects. The per capita consumption of oil in the United States is 9.35 barrels per year. World consumption per capita is 0.33 barrel. The difference is tremendous. If the rest of the world were to attain the same consumption rate as the United States, the petroleum industry would have to produce almost 19 billion barrels of oil per year to meet demand. Or take gasoline: Per capita consumption in the United States is 3.97 barrels, whereas the world per capita figure is only 0.12 barrel. To bring world consumption to the same relative position as the United States would require over 8 billion barrels of gasoline per year, or roughly 15 times this country's present production.

Of course, the rest of the world will not attain the level of consumption in the United States for many years—if ever. But as industrialization proceeds throughout the world, consumption will increase in proportion. The demand for oil products today is unprecedented, surpassing even the peak war year. And all our estimates foresee further pronounced increases.

ATOMIC ENERGY A HELP — These figures have extreme significance to those of us engaged in petroleum research. They mean that our efforts will be directed toward achieving economy through efficiency in use, and toward development of synthetic substitutes. We also assume that other energy sources will come along from time to time to take some of the load off the oil industry. Atomic energy is a promising source, but it seems most unlikely that atomic energy will be used for powering automobiles or aircraft. However, there is no reason why it should not eventually find application in large stationary power and heating units, and possibly even in large ships. Atomic energy would remove much of the current strain on oil, and the oil industry looks to atomic power for welcome assistance.

Our liquid fuel research has made us consider not only new engines and new materials, but even new concepts of combustion itself. The combustion problem is almost entirely mechanical. In other words, if satisfactory mechanical means for mixing the air and fuel at or before the point of combustion are provided, then there seems to be no limiting restriction on how much fuel can be burned in a given space or on how well it will burn. Therefore, the mechanical construction of burners plays an important part, and burners, whether for an ordinary household lamp or heating furnace or for a modern jet propulsion engine, must be adequately designed. Nevertheless, the basic phenomenon of combustion is fundamental, and knowledge of the mechanism of combustion is essential. Knock in the automobile engine, roughness in the Diesel, and carbon deposition and other objectionable features in household



Typical of the progress made in oil refining equipment is this set-up of pipe lines and fractionation tower of the most modern still at the Baton Rouge refinery of the Standard Oil Company (N. J.). This still refines more crude per day than any other unit at the refinery

heaters and gas turbines are the results of poor or uncontrolled combustion. Our laboratories, therefore, have under way as a continuing project fundamental studies on the nature of combustion.

Much of our fuel research is tied in with developments in the automotive field. We think that here the trend will be in the direction of smaller, lighter, reciprocating engines of higher compression ratio. Trends in aircraft engine design are already pointed strongly in the direction of turbo-jet propulsion.

Higher compression ratios in automotive engines will naturally require higher quality fuels. The oil industry can produce these higher quality fuels today, and will be ready when the automobile industry designs and sells cars capable of taking full advantage of them. Gasolines can be made today, with existing equipment and by processes already fully developed, to operate in cars with engines of 10 to 1 to 12 to 1 compression ratio, as against the present average compression ratio of slightly over 6 to 1.

MORE MILES PER GALLON — From the standpoint of John Q. Public's pocketbook, these figures have a very real significance. A car giving performance equal to the best obtainable from present-day models, but designed to take full advantage of these new high anti-knock gasolines, would show a real gain in miles per gallon. For example, today's 6.5 to 1 compression ratio car will make, let us say, 16 miles per gallon at 40 miles per hour on a level road. A car fully designed for a 12 to 1 compression ratio engine would make 24 miles per gallon. This is an improvement in mileage of 50 percent. The motoring public may, therefore, look to a saving in its annual gasoline bill and the oil industry to a conservation of supplies. Experts in the automotive industry have stated that new cars with such high-compression engines can be built for no more than the cost of present-day cars.

The introduction of the turbo-jet engine for aircraft might pose a problem of fuel supply, particularly in the event of a national emergency, when upwards of 1,000,000 barrels per day, or roughly one fifth of this country's present total refining capacity might be required. However, a review of one of Jersey's refinery facilities has indicated that, if specifications were adjusted to permit the inclusion of certain gasoline fractions, a yield of over 50 percent on crude could be realized. This would provide almost three times the amount needed to meet any emergency volume requirement and, accordingly, fairly liberal protection would thereby be afforded to the manufacture of needed quantities of refined oil, Diesel fuel, and motor gasoline of satisfactory quality. Engine builders are being encouraged to design

future turbo-jet engines around such a prototype fuel, and it is expected that tentative procurement specifications encompassing fuels of this broad type will soon issue from the military.

It is interesing to contemplate the other changes that gas turbines may cause in refining. At the present time we generally assume that, speaking in round numbers, 43 percent of a barrel of crude will go into gasoline, 6 percent into kerosine, 14 percent into gas oil and distillate fuel, 24 percent into residual fuel, 3 percent into lubricating, and 10 percent into heavy products such as tar and asphalt. Obviously, turbo-jet fuel demand will increase the need for middle distillates, probably at the expense of heavy oils, for there is little doubt that the demand for gasoline will remain high, and most of the additional requirements for jet fuel will have to be converted from other parts of the crude.

This will not be a difficult technical problem for the oil industry, for over the past 15 years or so we have learned so much about hydrocarbon chemistry, and our refining processes have become so flexible, that we can produce almost any proportion of any oil fuel we choose from a barrel of crude—provided always that the necessary refining equipment is installed. We could turn the whole crude into gasoline if we wanted to. In fact, we can perform the modern miracle of producing a barrel plus two gallons of gasoline from one barrel of crude oil. The additional volume is made up of the hydrogen added to the crude in converting it into gasoline. We can even take a barrel of asphalt from the street and turn that into gasoline, too. At present, of course, these processes are uneconomical, but they are possible.

LIQUID FUEL SYNTHESIS — In looking to sources for the fuels of the future, we no longer confine our search to petroleum alone. We know how to make liquid fuels from coal or gas just as readily as from oil. For that matter, we know how to make liquid fuels from potatoes, sawdust, cabbages, and grain. Most of these synthesis processes are not economical today, but in effect we have taken out scientific insurance against any reduction of our crude oil supply in the future. I can definitely say that the United States need never be without liquid fuels—and at reasonable prices.

A considerable part of the present research and development effort in our Company—nearly one third, in fact—is directed to obtaining liquid fuels from sources other than petroleum. The emphasis being placed on this field is not due basically to any fear of future oil shortage. Competent oil geologists have estimated that proved reserves of crude oil will be as great 20 years from now as they are today, or even greater. But the cost of finding and producing petroleum is increasing, and this has already imposed on the industry the need for more efficient refining methods. It has also brought us within sight of the point where liquid fuels from gas, coal, and other products will be directly competitive with petroleum products.

COAL GREATEST POTENTIAL SOURCE — Our very greatest potential source of liquid fuels today is coal. And research results to date make at least rough estimates of costs possible, even though no plants have yet been built. Largely because of the large plant facilities required, the estimated cost of synthetic gasoline from coal is today higher than the cost of gasoline from crude oil. For example, a plant to produce about 9000 barrels of gasoline per day from coal, together with about 1800 barrels of Diesel fuel or gas oil, would, we believe, cost about 60 million dollars. In addition to high octane motor gasoline and Diesel fuel products, this plant would also yield nearly 40 million cubic feet a day of high-heating-value gas, which in Eastern industrial areas and some parts of the South sells for about 35 cents per thousand cubic feet. At this figure, and allowing suitable credit for the Diesel oil and certain chemicals produced, the cost of gasoline from this plant, with coal at $2.50 a ton, comes to approximately 10 cents a gallon. This does not greatly exceed the cost of producing similar quality gasoline from crude oil at present crude prices. The plant investment, however, is several times as much, and the figure of 10 cents a gallon does not include any return on the added investment. But even with a fair return on the greater investment, American motorists could operate their cars on synthetic gasoline from coal at an average additional cost of not more than 10 cents a day.

We are much closer to producing liquid fuels from natural gas on a commercial scale. Two natural gas conversion plants are under construction right now, one in Texas and the other in Oklahoma. According to our most recent estimates, a hydrocarbon synthesis plant erected in the United States to produce 10,000 barrels per day of hydrocarbon liquid products from natural gas, although costing less than a plant designed to make the same amount of liquids from coal, will still cost over twice as much as a complete refinery capable of producing the same products from crude oil. Of the 10,000 barrels per day of hydrocarbon synthesis products, roughly 9200 barrels per day will be gasoline and 800 barrels per day will be gas oil. There will also be produced about 845 barrels per day of oxygenated water-soluble products consisting largely of alcohols. By assigning reasonable values to the by-products, and charging natural gas at 5 cents per 1000 cubic feet, the cost for gasoline from natural gas becomes somewhat less than the present cost of gasoline from petroleum.

New engine developments and better fuels will, in effect, add extra billions of crude to our petroleum reserves by enabling us to save and conserve our oil resources. Future developments in hydrocarbon synthesis, already under way in pilot plant stages, will enable us to extract liquid fuels from natural gas and coal to meet the ever-increasing world demand for sources of energy and industrial power. And if the need for gasoline and fuel oil is ever great enough, and petroleum and natural gas and coal cannot supply it, we can make those fuels from potatoes, sawdust, cabbages, and grain.

We expect that atomic energy for ships and stationary power plants will be developed in time to take its share of the energy-supplying load from oil fuels, allowing the oil industry to concentrate on products for automobiles, airplanes, and other small, compact power units.

We believe that the fuels for these future transportation units will be liquid fuels. We are ready to make those fuels today, and we will be ready, with new processes and new equipment, to make other fuels tomorrow. They will be better fuels for better engines, and I hope they will contribute their share to a better world than we have ever known before.

SARAN... For Short

A Wide Range of Consumer, Commercial, and Industrial Applications Lie Open to Polyvinylidene Chloride, a Plastics Material Whose Unusual Versatility Marks It for A Position of Ever-Increasing Importance

Courtesy Firestone Industrial Products Company

Railway coach seats covered with Saran fabric resist stains and wear

By Charles A. Breskin
Editor, MODERN PLASTICS

ONE OF the versatile plastics materials which made notable war contributions and now offers important peace-time opportunities is Saran. This Dow Chemical Company resin, known to the chemist as polyvinylidene chloride, is marketed under a number of different trade names by various processors.*

The civilian manufacturer saw little of this material during the war for two reasons: first, because of comparatively limited production facilities; second, because of the immense popularity of Saran for screening to keep the malarial mosquito away from troops fighting in the tropics, for inner soles to protect their feet from fungus and jungle rot, and for tubing, pipe coating, and other chemical-resistant applications in vital scientific laboratories and industries.

Saran compels widespread attention today because of its unusual versatility. It can be used for extrusion, injection, or compression molding, and produced as monofilaments, multifilaments, film, or latex. The range of products extend from fine fibers to heavy-duty extruded pipe and tubing, from small molded vials and ladles to electro-plating masks, and from colorful monofilaments for slip covers to moisture-proof wrapping films. It is serving such diversified industries as footwear, petroleum, chemical and pharmaceutical, textile, and packaging. In industry, it serves in such heavy-duty applications as spinning buckets, tank lining, pipe, and filter cloth. In the consumer field it is to be found in furniture, millinery, shoes, and food packaging.

There are many other uses in the experimental stage. A lady's gown made of Saran fabric plus rayon and acetate was exhibited recently, though up until now little of this type product has come to market because it is believed that at the present stage of development the filament is too stiff. This stiffness, however, presents no insurmountable obstacle to the material's use for draperies and institutional or commercial applications. There are those who conjecture that the day may not be far off when a much smaller monofilament will be successfully extruded. At present the smallest size for commercial application is about 4 or 5 mils (0.004 to 0.005 inch).

OUTSTANDING QUALITIES — Saran is highly resistant to chemicals, possesses great strength and brilliant color, is practically unaffected by acids, soap, salt solutions, most solvents and alkalis.

Saran has an extremely low water-absorption and vapor-transmission rate—less than 0.1 percent after 24 hours at room temperature in the case of molded and extruded products, including monofilaments. There is no accompanying shrinkage or elongation; nor is the tenacity or extensibility of the material affected. Saran also is unaffected by mildew, rot, or mold. It is practically stain-proof and persistently refuses to be associated with such contaminating agents as chewing gum, lipstick, blood, ink, fruit juices, and the like.

The material's strength and toughness varies considerably according to the method by which it is processed. Molded, its tensile strength is from 4000 to 8000 pounds per square inch. When extruded and oriented, experimental filaments of approximately

*Companies processing or using Saran and merchandising it under other names are: National Plastic Products Company, "Saran by National"; Chicopee Manufacturing Corporation, "Lumite"; Firestone Industrial Products Company, "Velon"; Visking Corporation, "Viskord"; Concordia-Gallia Corporation, "Cogon"; Elmer E. Mills Corporation, "Mills Plastic."

one mil diameter have shown tensile strength up to 100,000 pounds per square inch though the usual filaments of from 8 to 20 mils exhibit strengths of from 30,000 to 50,000 pounds per square inch.

One of the brightest characteristics of the material is its color. From the original 20 standard colors offered by Dow, the number has grown until today, by combining the standards, almost any desired shade may be obtained. For the past two years, efforts have been directed toward the production of pastel colors.

Fading is a problem in virtually all materials, and has been met more successfully here than in most other cases. The solution is due partly to the recognition by the materials manufacturer that different formulations react differently to the same pigment. A pigment that may be fast in a formulation for tape is not necessarily fast in a monofilament, due to extrusion difficulties. By varying the formulation according to its intended end use, color fastness can be improved. For this reason the producer recommends that customers consult its experts concerning the type of material they want and the contemplated processing method on the theory that color considerations may be involved in making up the raw material. As a result of this far-sighted planning, Saran colors show up very well in rating tests, wherein polyvinylidene chloride is placed alongside a standard dye of the same color and with which it is compared after weathering. In this test, the ratings are from 0 (poorest) to 8 (the best) and most of the Saran colors used rate between 6 and 8.

DISADVANTAGES — With all its manifold advantages, why haven't manufacturers discarded all other plastics and used Saran exclusively? First of all, there are economic considerations. With colored resin or powder at around 40 cents a pound, Saran rates among the moderately priced plastics, but not among the cheapest.

Also, its processing presents certain difficulties. For example, because the difference between its decomposition and processing temperatures is very small, special equipment is often needed for controlling heat applications. Further, only such metals or alloys as Hastalloy A, Hastalloy B, Stellite 19, nickel, z-nickel, and magnesium are recommended for use in those portions of the heating cylinder that come in contact with the material at molding temperatures. This is necessary because metals normally employed in such machinery speed the heat decomposition of the plastics at temperatures above 200 degrees, Fahrenheit.

Another problem attendent upon the use of polyvinylidene chloride concerns the difficulty involved in obtaining adhesion between it and other materials. One user asserts that the most successful adhesives are those containing rubber. Even this adhesive, however, leaves something to be desired, and all the companies working with Saran—including Dow—are still seeking the real solution.

The growing use of Saran make it clear that in many fields the special virtues of the material far outweigh the disadvantages. Why this is so can be gleaned from the following brief summary of major successful applications:

Screening. One of the greatest single outlets for the material is the war-tested application of screening. Perhaps the best testimonial to its worth is a statement issued recently by the Materials Branch of the United States Army's Engineer Board which, after a thorough test of all possible materials for screening, reported:

"Of the screens tested, Saran and phenolic-coated glass cloth screening were the most durable. . . If metal screening must be used, bronze screening coated with two coats of paint is recommended."

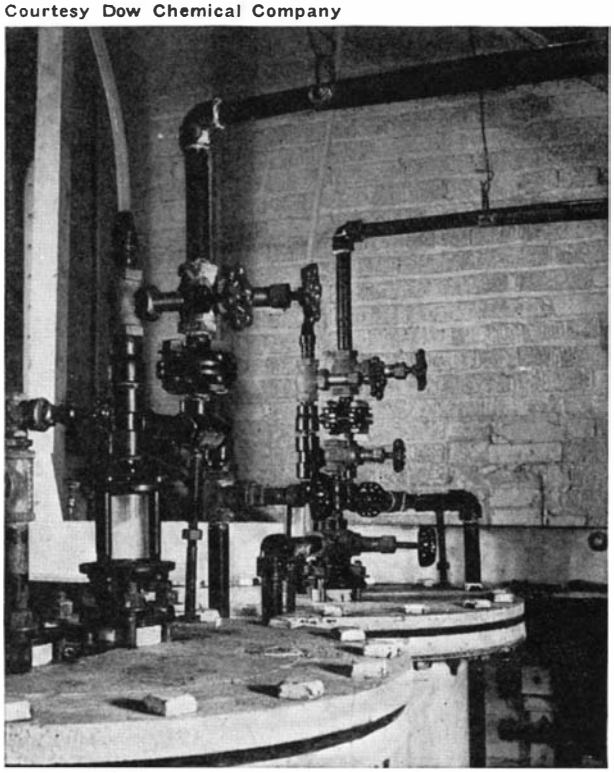
Only the Saran type of the two plastics screenings mentioned above is commercially available, and this the Army found more durable than metal when subjected to weathering, salt water, salt spray, heat, humidity, and attack by fungus. Little wonder then that the quantity of Saran screening sold in the year ending June 1, 1947 is estimated by a principal producer as not less than 120,000,000 square feet. Before the war, when plastics screening was not yet in evidence, the market for metal screen averaged about 500,000,000 square feet a year.

Woven monofilaments. Not only can Saran fabric be produced in varying weights achieved by varying the diameter of monofilaments (8, 10, 12 mil diameters being the most common) but it can be turned out in almost any type weave. At present, herringbone, twill, broken twill, and honeycomb weaves are most generally employed. A big advantage so far as the producer is concerned lies in the fact that any textile mill can, with only minor changes, switch from cotton, woolens, or rayon to this synthetic textile.

As for the outlets for this material, auto seat covers rate high. One reason for its popularity in this application is that the open weave permits breathing (in contrast to solid type upholstery), which makes the covers cooler in summer and warmer in winter.

Piping and fittings of Saran are combined with metal parts in this water purificaton unit

Courtesy Dow Chemical Company



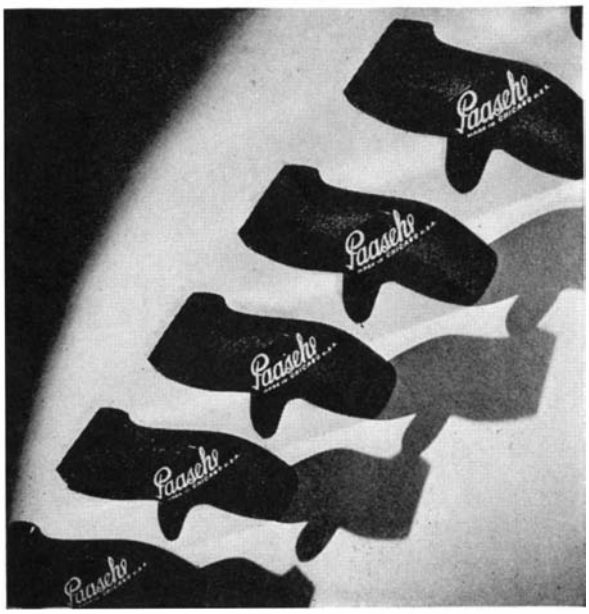
Then too, if properly woven for the application, this Saran material makes it easier for passengers and driver to slip in and out of the seats. Seat manufacturers like this material because it can be sewed on the same heavy-duty machines used for other materials, and with the same needles. Nylon thread is recommended. The way in which woven polyvinylidene chloride will give under pressure, but come back immediately when the pressure is removed, is good insurance against cupping and sagging auto seats.

Upholstery for railroad and bus seats, office furniture, auditorium and theater seats, and for hospitals is another important outlet for the Saran woven fabric—one demanding much the same characteristics needed in auto seat covers.

Less obvious, but even more important perhaps, is the use of woven Saran in the heavy-duty commercial field. Here it is to be found in filter cloth where its commercial resistance is of importance. Then there is the use of the fabric for dippers for use in recovering items from strong acids. And also in conveyor belts there is an important potential application.

Saran is used in paint spray gun handles for its light weight and chemical resistance

Courtesy Dow Chemical Company



Courtesy Chicopee Manufacturing Corporation

Screening made of polyvinylidene chloride is durable and needs practically no maintenance

Rope. While the market for Saran rope is still somewhat of a conjecture, the material possesses a number of interesting and potentially important properties. When compared with manila rope the weight of Saran rope in corresponding sizes is from 35 to 60 percent greater. Exposure to weather, winter or summer, does not reduce its strength nor does alternate drying and wetting change its properties. Wet strength is the same as dry strength. Further, Saran rope does not rot. Under repeated loading it has a working stretch from three to four times greater than manila rope, making it considerably more resistant to shock loading.

Moldings. Saran can be injection or compression molded—each process imparting special advantages to the finished product. For example, compression moldings have improved chemical and mechanical properties, are stronger and tougher and have increased impact and tensile strength as compared to injection moldings. In addition, larger parts can be made by compression molding. However, compression molding requires greater care and presents more processing problems.

Examples of compression molded applications include spinning buckets and dipping baskets for textile processing. Here the material's toughness, durability, rubber-like consistency, chemical resistance, and resistance to water absorption stand it in good stead. Dipping baskets that are generally used today are either nickel plated or made of pottery, and must be replaced frequently due to chemical corrosion or breakage. Saran baskets, not suffering from either failing, thus mean less frequent replacement.

Other compression-molded Saran parts include rollers for textile and chemical plants, valves, pipe joints, and flat sheets for use as metal tank linings in chemical and electroplating plants.

As for injection moldings, the field has only been touched. However, handles for paint spray guns are a typical application which makes use of the material's chemical resistance and lightness. Small spinnerette couplings, gasket holders and valve seats for water chlorinators, pipe elbows, and tubing for a spray are other injection-molded Saran parts that indicate the wide field of application for this process and this material.

CONCRETE AGAINST X-Rays

From the National Bureau of Standards

Protection of Personnel in the Vicinity of High-Voltage Industrial X-Ray Equipment Becomes a Greater Problem as Voltages Go Up and Uses of X-Rays Broaden. Studies Now Underway are Aimed at Replacing Guess-Work With Facts Which Can be Fitted to Individual Installations

EFFECTIVENESS of concrete barriers against multi-million volt X-rays, whose use is increasing in industry and medicine is the subject of an extensive program being conducted at the National Bureau of Standards. At the present time, exact wall thicknesses and most desirable types of construction necessary for maximum X-ray protection are not definitely known. One of the basic aims of the new project is to collect data from which the highest degree of protection with the lowest possible cost of installation can be calculated.

Industrial uses for million volt X-ray equipment were greatly increased during World War II when industrial engineers turned to it as a device for detecting flaws in all types of metal. In particular, broad beam X-rays, which permit simultaneous examination of wide areas, came into extensive use. While broad-beam X-rays, ranging in diameter up to four or five feet, are not essentially different (except for the amount of surface covered) from narrower-beam radiation, they pose a special protection problem.

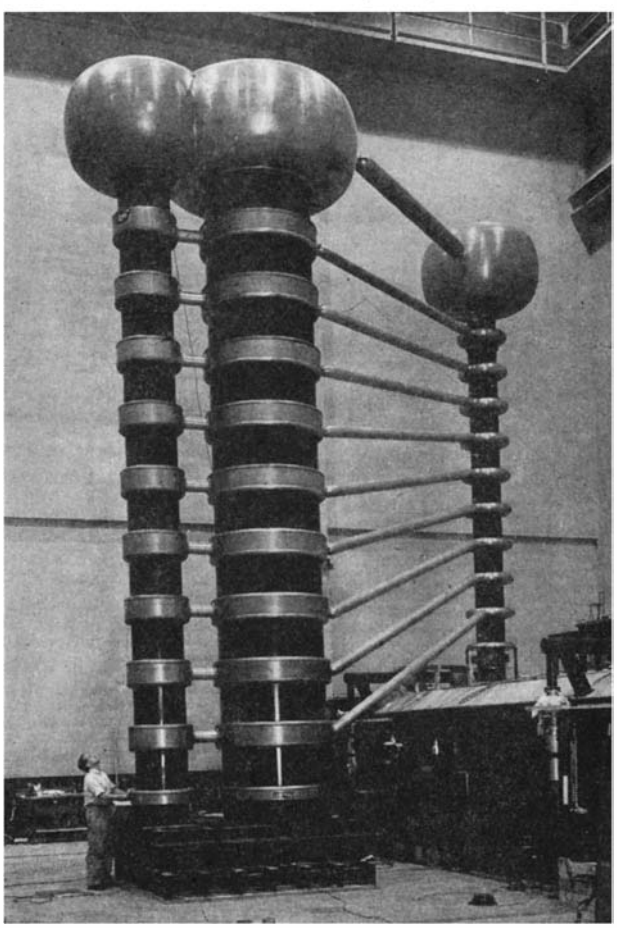
When a broad X-ray beam enters a thick concrete wall, it is scattered and rescattered many times with the result that a considerable fraction of the beam emerges on the other side, endangering near-by personnel. Quantitative information on the amount of this scattering is not yet available.

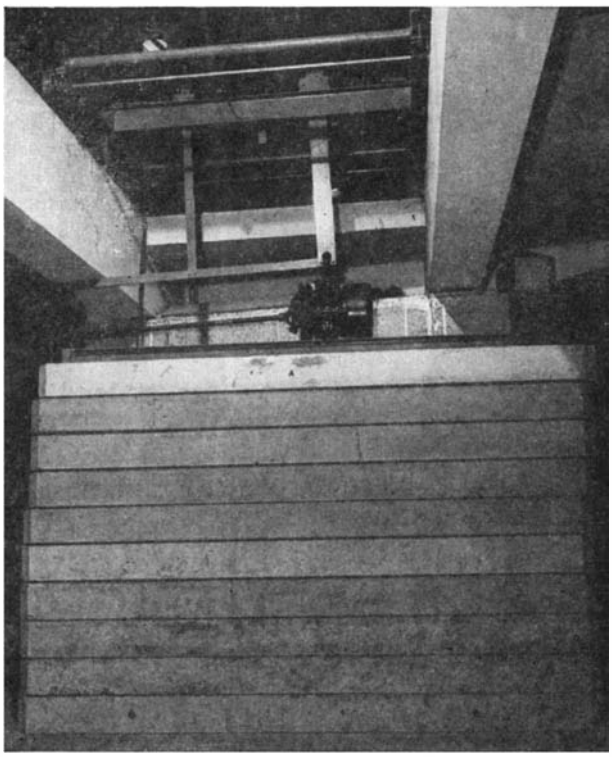
Users of million-volt equipment have been seriously concerned with this phenomena and in order to assure a wide margin of safety have constructed barrier walls of exceptional thickness. Field attempts to make measurements establishing optimum thicknesses and construction characteristics involve so many variables that it has been decided that the entire project, except for final testing, must be carried out in the laboratory, where the variables effecting radiation hazards can be simulated, controlled, and analyzed.

Industrial X-rays are used in three ways for metal examination: Radiographs are obtained by directing beams of X-rays through a metal object and recording the shadow lines on photographic plates. Many examinations of small parts are made by a fluoroscopic screen. X-ray diffraction, a relatively new technique, is a method for studying crystalline structure, where the X-rays are diffracted by the crystals within the metal and are recorded photographically or by means of a Geiger counter.

To determine protection standards, a 1,500,000

The National Bureau of Standards' X-ray generator delivers 25 milliamperes at 1,500,000 volts





To determine the protective value of concrete, slabs of accurately formulated cement mix, six inches thick and weighing 2½ tons, are placed one by one over the mouth of the radiation pit

• LOOKING AHEAD •

Safer use of industrial X-ray equipment . . . Reduction in installation costs . . Massive concrete walls used only where needed, not indiscriminately . . . Concrete-lead sandwiches reducing bulk of X-ray protective barriers.

volt X-ray machine in the Bureau's laboratories has been converted so that it will produce beams of varying widths. It is mounted so that it can be directed downward into a "radiation pit" about 6 feet square and 20 feet below the target of the X-ray tube. Special instruments, designed to explore the strength of the radiation in the pit, can be shifted to various positions by remote control.

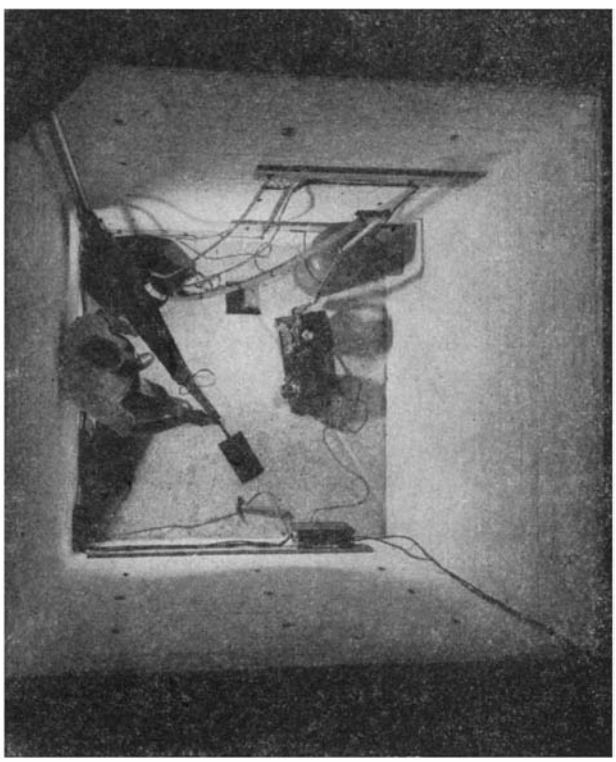
LEAD-CONCRETE SANDWICHES — During the investigations, test slabs of concrete each weighing two and one-half tons and measuring six inches in thickness are used. These slabs, when placed over the mouth of the pit one at a time, enable investigators to vary the protective barrier from six inches to five feet in thickness. Since space and weight are of critical importance in many installations, arrangements have also been made for producing sandwiches of lead and concrete in alternate layers. At present, the best proportions between these two materials are entirely unknown.

Studies of radiation hazards have been carried on continuously at the National Bureau of Standards since 1913. At that time the early type of gas-filled X-ray tube was used. Though voltages were low, long exposures may have been responsible for the many cases of serious burns on record for that period. About the time of World War I, the new high-vacuum Coolidge X-ray tube came into use, operating at higher voltages, with radiations of correspondingly greater powers of penetration. Exposure times were reduced, eliminating some of the hazard to the operator. But accompanying this was the increased penetration of the X-ray due to higher voltages and the greatly extended use of X-rays with the increased versatility of the equipment.

For equipment operating up to 200,000 volts, lead afforded the best means of protection. A room used for diagnostic purposes, for example, has to be lined with 1/16 inch of lead to prevent the escape of rays to surrounding rooms with consequent danger to the occupants. Correspondingly, in deep therapy installations, the room must be surrounded with 3/16 to ¼ inch of lead. Because ¼-inch lead weighs 16 pounds per square foot, the installation of such protective shields becomes a very massive and costly project. In the early days, such protection had to be provided around the entire X-ray room, since the X-ray tubes were operated in the open and the penetrating X-rays were emitted in every direction.

One of the Bureau's first problems was to study ways and means for improving protection in the im-

Radiation pit in which penetration measurements are made is about six feet square and is located 20 feet below the target of the X-ray tube. Measuring instrument (at man's right hand) can be moved to any part of the pit by remote control



mediate vicinity of the X-ray tubes in such a way as to reduce the protection necessary in the room walls. As a result of these early studies, it was found that a relatively small weight of lead could be placed closely around the X-ray tube, allowing the rays to escape only in the direction in which they would be utilized. By doing this, lead protection in the remaining walls of the room could be reduced 50 to 75 percent except for that small portion of the walls or floors in the path of the main beam. This meant immense savings in the initial cost of X-ray installations.

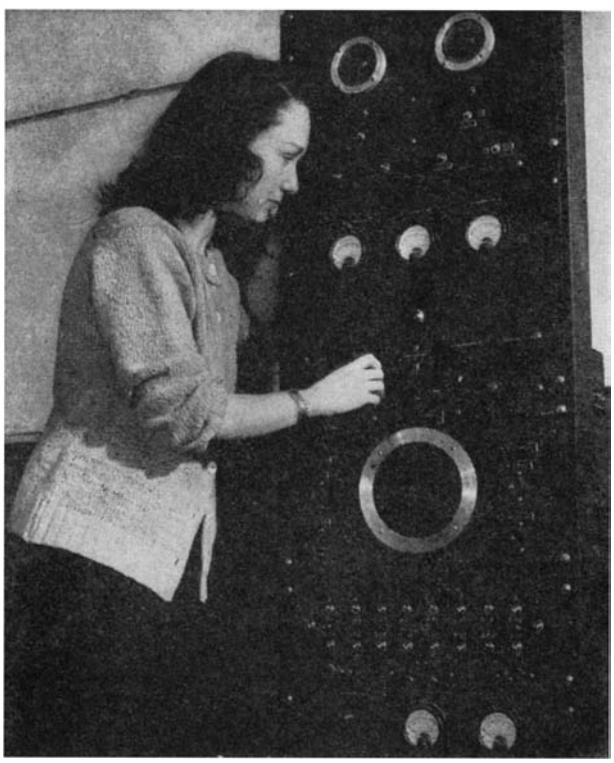
AUXILIARY PROTECTION — At about the same time, studies were undertaken to determine the efficiency of such auxiliary protective devices as lead aprons, lead rubber gloves, lead glass windows, and wall plasters made of material loaded with lead or barium. Some of these devices were found to be effective while others were not. For example, lead glass goggles for the protection of the eyes were found to offer little or no protection. In fact, they proved to be more of a hazard than a protection because they gave the user a false sense of security.

Lead glass has always been a necessary adjunct to an X-ray protective installation. This is particularly true in therapy work where the operator of the machine must remain outside the treatment room and yet have a good view of the room through a window or some other device. Such windows were made of glass loaded with lead. Many of the glasses sold for protective purposes were found to contain so little lead as to be of negligible value. Others have adequate quantities of lead but were so discolored by the addition of the metal that they are unsuitable for window purposes. Up to about 1930 practically all of these glasses were imported from Europe. Under the impetus of a broad study of X-ray protective glasses by the Bureau, American industry was encouraged to undertake the development and production of such materials. As a result, this country now produces the finest grades of lead protective glasses obtainable anywhere in the world.

Beginning about 1930, X-ray tubes for operation up to 400,000 volts and higher were developed and began to come into use for both industrial and medical purposes. The thickness of lead necessary to shield a 400,000-volt X-ray tube adequately is of the order of ⅝ inch in thickness. It is obvious that the weight and cost of such a room assumed prohibitive proportions. Massive walls of concrete were suggested as a substitute for lead. While these had the advantage of being part of the building structure, concrete nevertheless introduced serious engineering problems because of its weight.

It was not until the Bureau undertook a comprehensive study of concrete for protection that the economics of such protection could be reduced to a reasonable scale. Prior to this, concrete walls were simply installed by guess methods. As a result of studies, it was possible to decrease the requisite wall thickness substantially and still maintain a high level of safety.

All measuring and auxiliary equipment in target room is controlled from panel in a well protected room



BEAM DIRECTION RESTRICTED — By the time X-ray voltages had gone up to one million and two million volts, the protection problem again became critical. Studies were undertaken along the same line as for 400,000 volts, and it was determined that in most cases all secondary X-rays could be satisfactorily stopped by an ordinary reinforced concrete wall, varying in thickness from 8 to 12 inches. To cut off the direct beam would require from 12 to 18 inches of concrete, but it was usually possible to minimize this extra thickness of protective concrete by restricting the direction of the beam.

With the advent of the betatron operating at from 50 million to 300 million volts, scientists are confronted with a new series of X-ray problems. While protection from the direct beam of X-rays at 50 million volts is very important, there are other simplifying factors in the problem. For example, as higher and higher voltages are used in the production of X-rays, the rays themselves tend more and more to emerge in a single direction from the target. Thus the X-ray beam from a 50 million volt betatron covers an angle of only six or eight degrees. For protection from this beam alone, very great thicknesses of concrete may be required. On the other hand, X-rays which are scattered sideways out of this beam are of low penetrating character, and as a consequence it may be found that the protection problem to the side of the beam may not be seriously different from that at one or two million volts.

The exact answers to these important problems, however, are uncertain at the present time and it is the responsibility of the National Bureau of Standards to set up the necessary experimental arrangements to properly evaluate them. Again, solutions must be found which are safe and yet provide the maximum economy, since the cost of protection alone in a 50 million-volt installation may represent half to three quarters of the total cost.

SCIENTIFIC AMERICAN'S Industrial Digest

VISCOSIMETER

Assures Proper Thickness of Spraying Enamel

THE VISCOSITY of the enamel sprayed on metal shipping containers manufactured by the Cleveland Steel Barrel Company is now accurately controlled by the use of the General Electric Company's Zahn viscosimeter. This instrument is designed to simplify the otherwise difficult task of making viscosity measurements.

Until the Cleveland company began to regulate the viscosity of their enamels with the viscosimeter, the containers often came from the drying oven still sticky because the enamel sprayed on them was too thick to dry properly. In other instances, it was found that the coating was too thin, thus necessitating respraying many of the containers. Consequently, the efficiency of this operation was decreased.

Now the previous trial-and-error method of thinning enamels to the proper consistency for satisfactory spraying is no longer relied on. Instead, use of the viscosimeter has resulted in the establishment of a set of standard viscosities for various types of enamel, regardless of color. In addition, the instrument is also used to facilitate determining the correct quantities of thinner and dryer to be added to the enamels in order to obtain a durable and attractive baked finish.

Measuring enamel's viscosity

This company uses approximately 5000 gallons of paint and enamel monthly for spraying about 200,000 of these resistance welded steel containers, which range from 2½ to 65 gallons in capacity.

RIGID TESTING MACHINE

Exerts 2,000,000 Pounds For Tension, Compression, or Transverse Tests

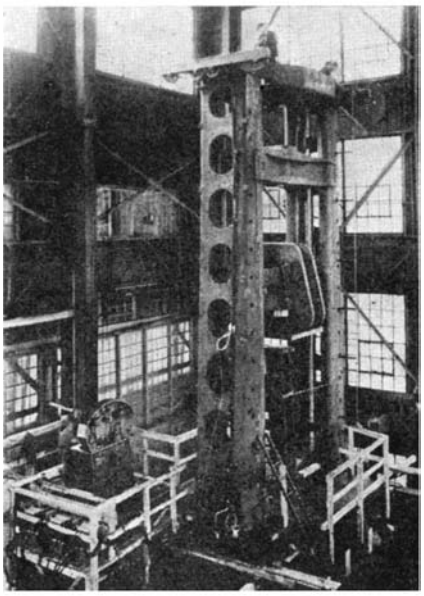
ENTIRELY new construction principles are embodied in the University of Washington's new 2,000,000-pound testing machine, designed and built by The Baldwin Locomotive Works.

According to Professor F. B. Farquharson, in charge of the University's testing research, the machine, while not the largest in use by industry, incorporates several new features in design which make its steel columns more rigid than has heretofore been possible, give the machine greater accuracy, and make it more versatile.

Special flex-plate construction ties the sensitive yoke to the transverse rigid beam. Another feature involves adjustable guides, made triangular in shape, making it possible not only to keep horizontal movement to a minimum but also to lock the crosshead in position when required.

A third feature, which makes it possible to maintain the minimum tolerance against horizontal deflections under load, to prevent premature buckling of compression specimens, and to neutralize horizontal components of force, is the flaring of the steel columns from a point about one third of the way from the top to the base of the machine. This affords maximum rigidity or minimum deflection when testing specimens so long that their height forces the columns to function as cantilever beams. It is asserted the machine will have from 300 to 400 percent greater rigidity than machines of earlier design.

The University plans to devote the machine to special testing research on materials for Boeing, including aircraft wing panels; to various tests for the timber industry; to testing concrete culverts for the state highway department; and to other work for industries of the Northwest, according to Professor Farquharson.



Versatile testing machine as it appeared with scaffold during erection

The machine is to be used for tension and compression testing, as well as transverse testing. It will take specimens up to 10 feet wide, 20 feet high, and (for transverse testing) 80 feet long. Its versatility is shown by the fact that it will enable the research man to test materials for all six forces and six moments.

ELECTRONIC MICROMETER

Highly Sensitive, Gives Readings On Oscilloscope or Meter

AN ELECTRONIC micrometer used to measure the displacement of a six-inch turbine shaft in its journal is so sensitive that a deflection of 0.01 inch of the center of the shaft provides a two-inch movement of the center spot on a cathode-ray tube. Readings to 0.001 inch are easily obtained, and the indication on a meter

is linear to within a fraction of 1 percent.

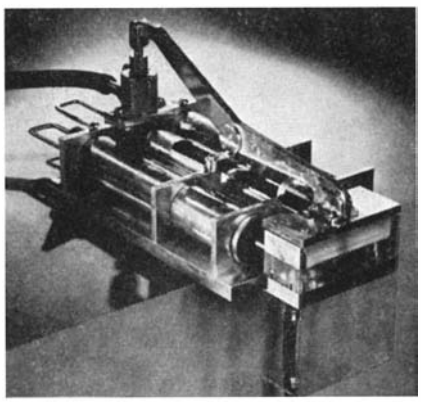
Developed by M. L. Greenough of the National Bureau of Standards, the instrument was primarily designed to afford a means for measuring thickness of the oil film in the bearings of a large Navy turbine shaft.

In operation, radio-frequency current is applied to a radiating coil; when the unit is held at some distance from a metallic object, the field from the radiating coil induces voltage in the pickup coil, which is measured on either an oscilloscope or a meter.—*K.H.*

SEALING PLASTICS BOXES

With High-Frequency Generator Reduces Waste

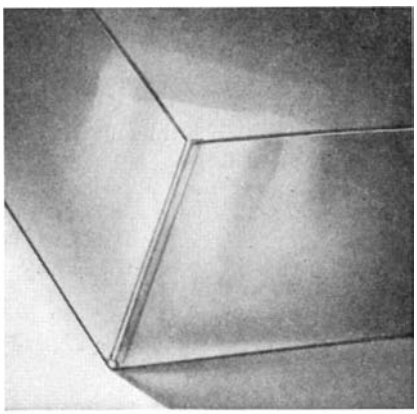
A NEW APPLICATION of electronic sealing to transparent box manufacture, which promises, among other things, to speed up production, was developed by the Eastman Kodak Company. This method is expected also to reduce waste, improve box appearance, lead to greater uniformity of product, and eliminate the distortion sometimes caused by the cementing operation usually employed in transparent box manufacture. It is applicable to acetate sheet with thicknesses of .005 inch and heavier.



Heater, clamping overlapping box corners, seals them in a quarter second

No cement is used in sealing transparent boxes with this method. The technique consists merely of firmly clamping overlapping portions of the box ends and sides between two electrodes of the heater. The "deep-heat" thus produced fuses the two pieces of acetate in as little as one quarter of a second. In spite of the high temperature developed within the acetate sheet, the outer surfaces remain cool, and the electrodes never heat up. Box seams produced by this method are only 1/16-inch wide and almost invisible. Large "ears" are unnecessary on box blanks since the seams practically coincide with the corner crease.

Many of the standard high-frequency generators now on the market can be used to produce the power required for this purpose. Interchangeable electrodes or sealing heads to accommodate boxes of various sizes may be made in any machine shop.



Box corner sealed without cement

DYEING GLASS YARN

With Ordinary Dyes Possible if Fibres First Have Gelatin Coat

DEVELOPMENT of a new process of filament coating, whereby a thin protein film (gelatin-type) is applied to Fiberglas yarns as they are formed, has made it possible to dye the yarns with ordinary dyes and by commonly used methods. The protein film represents only 1 to 2 percent, by weight, of the finished yarn, but with this small amount of film, improved depth of color has been achieved, due to absorption of the dyes by the film on the large surface area presented by the multiple-filament yarn.

ELECTROLESS PLATING

Of Nickel, Cobalt on Metals by Chemical Reduction

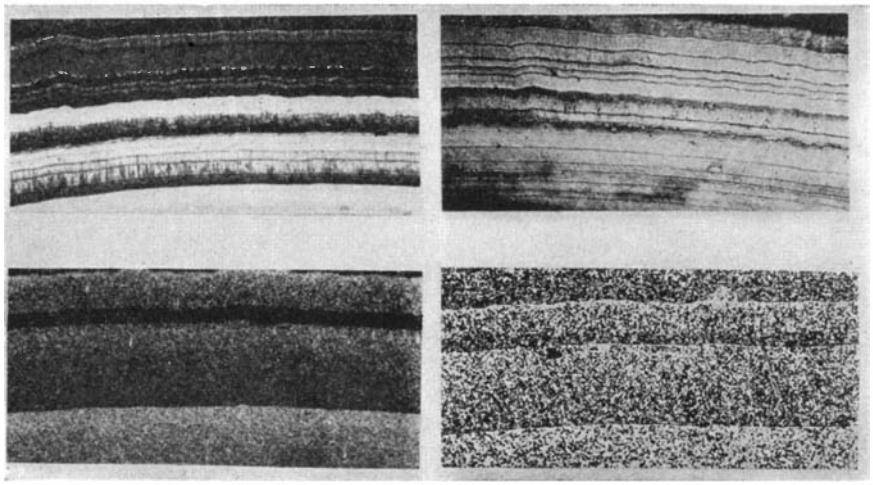
PLATING nickel and cobalt on metal surfaces without the use of electric current, a new process known as electroless plating, is brought about by chemical reduction of a nickel or cobalt salt with hypophosphite in hot solution. The reaction is catalytic, and under the prescribed conditions of concentration and pH, no plating occurs unless certain metals, such as steel or nickel, are introduced in the bath. The reduction then occurs only on the surface of the immersed metal with the production of an adherent coating of 93 to 97 percent purity.

Photomicrographs of deposits obtained in this way show both a laminar and a columnar structure, similar to bright nickel electrodeposits. The electroless deposits are of good quality—sound though brittle—and unusually bright. Since they can be made as hard as tool steel, the method may prove useful where hard, wear-resistant surfaces are required, as in bearings. The process is particularly applicable to plating recesses, irregular-shaped objects, and enclosed areas such as tubes, where a centered internal electrode with special current leads would be needed in electroplating.

The equipment is simple and more easily assembled than that required for electroplating. No generators, rheostats, special racks, or contacts are necessary. Small parts which cannot be barrel-plated economically are readily plated by the electroless process if suspended by a string or in a bag affording ample exposure of the metal surface to the solution. There is no need of constant motion, as in barrel plating, since current distribution is not involved. The reactions require a temperature above 90 degrees, Centigrade.

A unique feature of the electroless process, developed by the National Bureau of Standards, is the catalytic initiation of the reaction by the following metals: Iron or steel, nickel, gold, cobalt, palladium, and aluminum. Unless one of these metals is introduced into the solution, no reaction takes place. Once started, the

Equipment for electroless plating includes only vessel, solution, and immersion heater (projecting from bath)



Photomicrographs of electroless nickel deposits. Upper left: Nickel as deposited. Upper right: After annealing at 400 degrees, Centigrade, for 30 minutes for maximum hardness. Lower left: After annealing for 30 minutes at 600 degrees, showing precipitation. Lower right: After annealing for 30 minutes at 800 degrees, showing excessive precipitation.

reaction continues at the metallic surface, and only rarely occurs in other parts of the bath. For this reason, the containing vessel should be of glass, plastics, or other non-catalytic material.

Electroless plating on non-catalytic metal surfaces may be accomplished in two ways. If a film of palladium or rhodium of nearly monatomic thickness is first applied by chemical replacement on a non-catalytic metal, deposition of nickel or cobalt will occur on the activated surface. Electroless plating of copper may be carried out in this way. A second method of initiating the reduction is to bring a less noble metal, such as iron or aluminum, in contact with the non-catalytic metal while it is immersed in the hot electroless solution. Once the process has been started, it continues because of the catalytic action of the initial deposit.

ELECTRONIC SOLDERING

Applied on Production Basis To Increase Output

A SIGNIFICANT practical application of high-frequency induction heating to the soldering of conductors to end rings in small squirrel-cage motors rotors has been accomplished by an Illinois manufacturer. The rotors are ¾ inch in length and one inch in diameter. The process is continuous with a production rate of 600 per hour.

Using the former conventional process, consisting of jigging the assembly and then dipping each end into molten solder, production rates in the neighborhood of only 150 per hour were obtained. In addition, the hot dip method is cumbersome, wasteful of solder, and somewhat messy. In the new process, the end rings are tinned with solder prior to assembly; the assembled rotors are rolled down an inclined track and through an electromagnetic field established by a work coil. The currents induced in the ends of the rotors melt the solder and "sweat" the conductors on to the end rings.

The high frequency power equipment is an RCA two kilowatt electronic power generator, which converts the 60-cycle power supply to a frequency of about 400,000 cycles. Not only has production been increased, but results are more uniform and costs have declined in proportion to the increase in output. —*F.P.P.*

FIRE HAZARD REDUCED

By Drawing Off Dangerous Charges of Static Electricity

ELIMINATION of a fire hazard common to many coating operations has been accomplished at the plant of the Pantasote Company in a simple and effective way. In this operation, static electricity is a constant and dangerous problem, as the product moves through the machines, for a spark can ignite vapors of the volatile solvents used.

Static charges in this plant are now safely drawn off by application of an Ionotron static eliminator. [See also Scientific American, July 1946, page 30.—*Ed.*] This device consists of a shielded bar supporting a strip of radioactive alloy at the point on the machine where the static charges tend to build up. The air at this point is ionized by the alpha rays from the radioactive source, and acts as a conductor to draw off the charges as they are generated.

The Ionotron, a product of the

Radioactive strip (arrow) locally ionizes air, providing a path of escape for static charges as they build up, eliminating possibility of sparks

United States Radium Corporation, is said to be the only type of static eliminator suitable for this application, as it involves no electrical power source or other possible ignition danger, and is not in physical contact with the coated surface.

SYNTHETIC QUARTZ

Grown in Silica-Sodium Solution For Electronic, Optical Uses

QUARTZ crystals, required in optical and electronic devices, and hitherto available only from scattered natural deposits, will be produced by the Naval Research Laboratories, Washington, D. C., as soon as equipment is installed for the operation of a new process of growing them. The method is based on techniques developed in Germany, and depends on the growth of a crystal from a seed placed in a solution of silica, sodium hydroxide or carbonate, and water, heated to 350 to 400 degrees, Centigrade, in a steel bomb. Pressures generated may reach 2000 to 3000 pounds per square inch. The new method is reported to yield crystals satisfactory for present known uses, and is expected to make the United States independent of the foreign sources from which these essential crystals hitherto have come.—*D.H.K.*

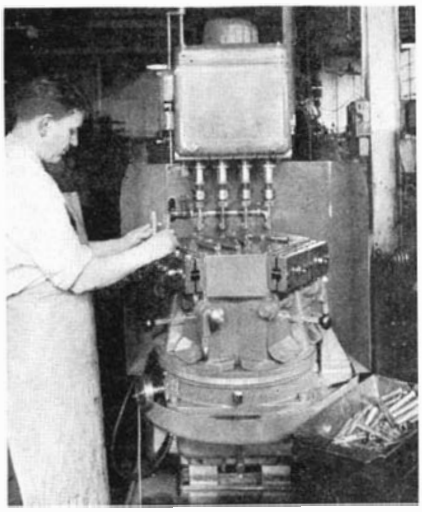
TURNBUCKLES TAPPED

In Specially Designed Multiple Tapping Head

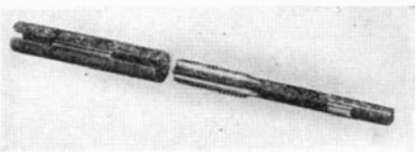
TAPPING 2¼ inch deep un-drilled holes in cold rolled turnbuckles at a speed of 12,000 pieces per machine per 24-hour day is one way in which one manufacturer is meeting a demand for greatly stepped-up production without any increase in operator effort.

The particular job involves tapping a hole 2¼ inches deep in each end of a turnbuckle for automotive tie rods. The turnbuckle is formed by rolling 0.125 inch flat stock. The edges of the finished part are left open. Thus the inside diameter which is to be tapped is neither a machined surface nor a drilled hole. Due to the method of making the turnbuckle, rather generous tolerances are allowed, the inside diameter being held to .626-.633 inch and the outside diameter to .870-.880 inch.

A specially designed multiple tapping head accommodating four taps and fixtures which permit fast manual loading, automatic clamping, and automatic unloading at the end



The four tapping heads turn out 12,000 threaded turnbuckles per 24-hour day



Turnbuckle (left) and tap (right)

of the tapping cycle is used. Taps made of a special chrome-cobalt high-speed steel, developed by the Detroit Tap and Tool Company, were adopted as standard on the basis of production records. The manufacturer of the turnbuckle, the Thompson Products Company, reports that these taps turned out 500 finish tapped turnbuckles before regrinding became necessary, as against 175 for the average straight high-speed steel tap. The M-11 taps, as they are called, also permitted a total of eight re-grinds before the tool had to be scrapped, instead of six re-grinds averaged by other tools.

DISTORTION OF METAL

In Arc-Weld Build-Up Can Be Minimized, Say Engineers

THE PROBLEM of distortion in metal, frequently met when building up worn surfaces with arc welding where the amount of weld metal to be deposited is large in proportion to the parent metal, can be minimized if certain precautions are taken, according to welding engineers of General Electric.

If the surface to be built up is not already worn smooth, it should be ground smooth. Pre-heating to unlock stresses is helpful, if permissible. Electrode size should be small, and the current kept in the mid-range to prevent excessive heating. Beads should be kept thin and should be well peened. Only small areas should be covered between peenings. Alternate layers should be laid at right angles. Plenty of pressure on the wire brush between welds will aid sound metal build-up.

CARD TABLE TOP

Molded From Phenolic, Is Stronger, Costs Less

MOLDED in one piece of general-purpose phenolic, all plastics card table tops weighing from 10 to 12 pounds are believed to be the largest-area parts thus far developed in the American plastics industry.

The phenolic tops, molded by the Goodchild Plastics Company, are credited not only with being as light as other tops of comparable size and strength, but also with being stronger than tops constructed from laminations of wood or paper. More important, perhaps, is the fact that these plastics tops cost 17 to 21 percent less than a comparable quality part made from other materials, and that they have no dust-collecting joints or seams, no corner laps, wrinkles, or folds.

These tops, for which Durez, Bakelite, and Makalot general-purpose phenolic compounds are used, have a uniform finished thickness of a quarter inch. For greater rigidity, the tops are reinforced by 1¾ inch sides, ¼ inch thick, and by six ribs, ⅞ inch high, arranged in waffle design and molded into the under side. Also molded into the under side, adjacent to the inside faces of the outer ribs, are four leg attachment anchors.—*C.A.B.*

SPINDLE LOCK SYSTEMS

Prevent Motors From Starting Till Locks Are Released

LOCKING machine spindles so that tools or work may be changed without damage to bearings, or without the need to hold the spindles with wrenches, is an ancient trick of the machinist. And in the old days when the starting of a machine with its spindle locked meant only the squealing of a slipping belt, these locks were fairly proof against carelessness.

With electrically motorized machines, however, it is a different story. With several motors there are several possible sources of delay or damage. Locks therefore are being so placed that it is impossible to start a motor unless all of the spindles have been released.—*E.L.C.*

New Products

HEAVY-DUTY CLEANER

Vacuums, Blows, Dries, And Sprays

BLOWING air at a velocity of 25,500 feet per minute, a new heavy-duty industrial cleaner is powered with a 1 1/3 horsepower motor and weighs only 14½ pounds. It has precision-type sealed ball bearings and air stream cooling scrolls which permit continuous operation without overheating. It is claimed that the blower is able to run continuously for 24 hours a day, if necessary.

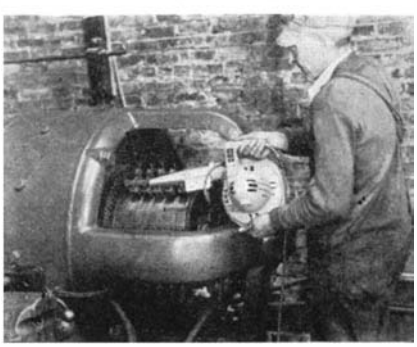
This new cleaner, manufactured by Ideal Industries, Inc., serves a multitude of industrial and commercial uses. It vacuums, blows, sprays, and dries, and is quickly and easily converted to any of its functions.

With powerful suction force, it cleans away dirt, dust, and grime which accumulates on and around machinery, motors, generators, and so on.

In some instances, where the parts to be cleaned are encased or otherwise inaccessible, such as in air conditioning, refrigeration, and heating units, the dirt to be removed has become oil-soaked and heavy, and must be blown out. The blower does the job easily and safely. While blowing velocity is high, the pressure is low, eliminating the possibility of damage from blasting.

The unit may also be used as a sprayer for deodorants, insecticides, paint, varnish, and so on. And if drying action is desired, a heater nozzle is attached to the blower, which raises the temperature of the blown air to a minimum of 85 degrees, Fahrenheit. This is useful in drying motor windings and electrical equipment, and also for drying paints, inks, and so on.

In addition to this heavy-duty blower, there is also available a medium-duty model with a 2/3 horsepower motor, which displaces air at 19,000 feet per minute. This model weighs 9½ pounds.



Spraying, blowing, and vacuuming with same basic blower unit

STUD WELDING

Results in New Blind-Fastening Method of High Strength

THREE out of every ten cars coming off the 1947 automobile production lines are minus the bolt heads that have always marred the streamlined surfaces of bumpers. The secret of this construction lies in the fact that leading motor manufacturers are now attaching bumpers to their frames by the new blind-fastening method of stud welding.

Bolt holes, which reduce the basic strength of these parts and provide an inevitable starting place for corrosion, are eliminated by the use of stud welding in which headless bolts are welded directly to the interior surface of the parts.

DYNAMOMETER SCALE

Eliminates Double Handling by Weighing At Stock Pile

SAVING considerable time and labor while taking inventories, a portable dynamometer scale eliminates the necessity of moving stocks to a platform scale, usually some distance from the stock piles, and then moving them back again. The scale which does away with this double handling fits the crane or hoist hook and reads instaneously in pounds on the face of the dial. With this scale, made by W. C. Dillon and Company, on the hook the load can be lifted right at the stock pile and immediately replaced without further handling. Dillon dynamometer scale capacities are from 0 to 500 pounds to 0 to 20,000 pounds. Scales are all the same size and same weight regardless of capacity.

Scale is between load and hoist hook

RUBBER-BASE PAINT

Resists Moisture and Abrasion, Gives Long-Lasting Protection

FORMING a tough, hard, elastic coating which is highly moisture-proof and resistant to acids, alkalis, and abrasion, a rubber-base paint may be used on wood, metal, plaster, cement, and many other surfaces.

The coat is smooth and velvety to the touch, with a high gloss, and may be applied by brush or spray. A product of Foundry Rubber, Inc., the paint

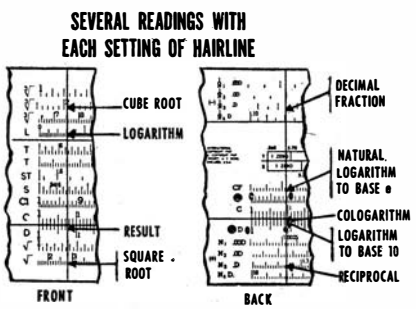
dries sufficiently in 10 or 15 minutes to receive a second coat, and in four to eight hours, depending on temperature and humidity, it is fully hard and dry.

Particularly well suited to use in foundries for the protection of wood patterns subjected to severe ramming of hot moist sand, this paint, called Paracoat, is said to resist sand abrasion and outlast shellac, lacquer, and other finishes by four to eight or more times. Foundries report that Paracoat does not become tacky or sticky as shellac does, and the patterns draw clean and clear of sand. Also, the moisture-proofing qualities of the paint stabilize the moisture content of the wood, thus eliminating warping.

SCHOLASTIC SLIDE RULE

Has New Slide Arrangement To Simplify Computations

WITH SCALES on the front of the rule so arranged that only one setting of the hairline gives with each result its square root, cube root, and logarithm, a new deci. log log slide rule, greatly simplifies computations. The log log scale on the back is expanded for greater accuracy, and arranged to give these five readings with each setting



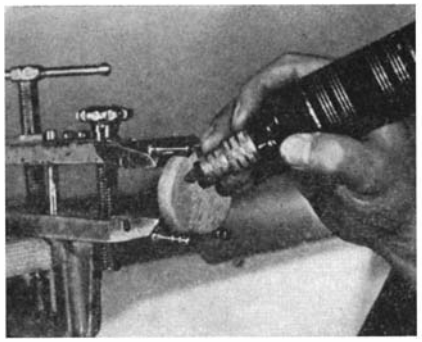
Detail of students' slide rule

of the hairline: 1) decimal fraction to four and five figures, 2) its reciprocal to four and five figures, 3) logarithm, 4) cologarithm, and 5) natural logarithm to base. The scales read from one ten billionth to ten billion, and give decimal point location. A simple legend tells which scale to read when raising to powers. The slide rule, produced by Pickett and Eckel, Inc., is made of magnesium alloy with a plastics surface bearing permanent, expanded, easy-to-read washable scales. The size is 12⅛ by 2⅛ by 3/16 inches.

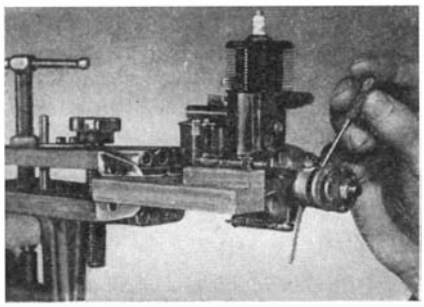
VISE WITH FINGERS

Grips Difficult Shapes Surely Without Marring Work

GRASPING firmly regular as well as irregular shapes which could not be held in conventional vises, a new bench vise has fingers which give the user the advantage of having a third hand. This novel vise, made of solid bronze, will hold disks, rings, spheres, hemispheres, tubes, and almost any



Vise fingers hold disk firmly



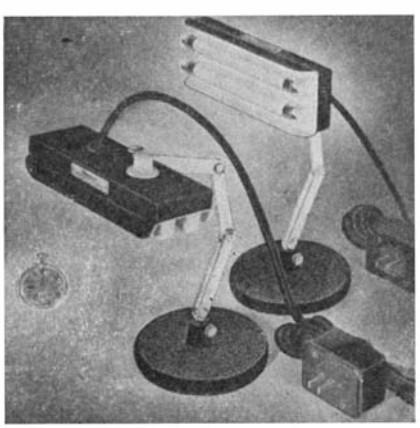
Vise in use without accessories

irregular shape without marring, denting, or scratching the work. The vise, called Bench King, will hold work from 0.001 inch thick to two and one half inches thick with equal strength and positional convenience. The four fingers supplied as accessories with the vise fit into sockets in the two jaws. The vise, made by Benjamin Uydess and Sons, Inc., may be used with these fingers, with tube and ring arbors (also supplied with the vise), or it may be used alone for holding flat work.

SMALL FLUORESCENT LAMP

Is Cool, High-Intensity Light Source for Close Work

DESIGNED for use on standard or special-purpose machines or for close bench work, a miniature fluorescent lamp produces a light intensity of 550 foot-candles at three inches working distance, and a color temperature of 3500 degrees, Kelvin. This intense illumination, converging on the subject



Standard four-watt tubes are used

from widely divergent angles, floodlights the subject, thereby minimizing objectional bright spots and reflections.

A normal operating temperature of 115 degrees, Fahrenheit, allows close work without appreciable radiant heat or hot surfaces. The lamp, a product of Stocker and Yale, is designed for use on 115 volts, 60 cycle A.C. Starting is accomplished by twisting the starter knob on the lamp after the plug-in-type ballast reactor is plugged into a standard electrical outlet.

Twin four-watt bulbs of standard manufacture are rated at 2500 hours normal life, and may be obtained at any electrical supply store.

The lamp is finished with a baked black wrinkle exterior and a baked white enamel reflector. Although normally supplied with supporting bracket and cast base, it may be obtained less these supports where direct attachment to machines is desired.

MAGNETIC PROBE

Extends, Retracts Magnet To Vary Field Strength

COMPRISING a powerful permanent magnet housed in a plastics tube, a new magnetic probe finds many applications in industry and in the shop. The magnetic bar can be extended from the

Pocket-size probe with magnet extended

housing or retracted by turning a plastics knob at one end; by doing this, the probe's magnetic field strength may be varied—the greatest strength being reached when the magnet is fully extended. Called Magicbar by its manufacturer, Eljay Enterprises, the probe resembles a fountain pen, and can be carried by means of a pocket clip.

The probe is well suited to such uses as removing magnetic particles from the operating areas of machines; picking up hard-to-grasp articles such as small screws, tacks, and so on; and removing small sharp magnetic objects from storage bins. Plant first-aid stations should find the probe helpful in removing steel splinters. The adjustable magnetic strength feature makes it possible for the doctor or nurse to properly orient the splinter for extraction without painful rupture of the tissues.

POWER-FACTOR CAPACITOR

With Glass Bushings Will Not Puncture With Overload

USING cast glass bushings made of exceptionally stable low-expansion glass in which are cast metal inserts of a special nickel-steel alloy, new power-factor capacitors are hermetically sealed units. The thermal expansion characteristics of the alloy are coördinated

Glass bushings at final inspection

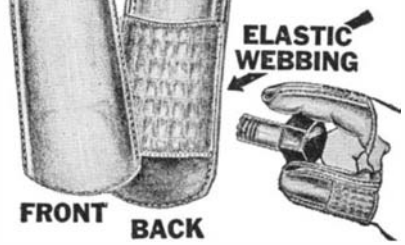
with those of the glass. A metal mounting flange cap is fused directly to the glass and the flange is in turn welded and soldered to the capacitor case, forming a hermetic seal that is permanently moisture-tight.

According to the manufacturer, the General Electric Company, these glass bushings are practically unaffected by weathering, micro-organisms, and thermal shock. When excess potential is applied, the bushings will flash over externally rather than puncture or shatter. The bushings are equipped with a split-type solderless connector, assembled after completion of the capacitor.

FINGER GUARD

Without Seam on Wearing Surface, Offers Over-End Protection

PROTECTING the thumb and fingers not only on the face and sides, new finger guards extend the leather protection over the ends of the fingers. There are no seams or joints at the finger tips, affording comfortable handling of even the smallest parts during buffing, grinding, polishing, and similar operations. The seams on the sides are well out of the wearing zone; the elastic webbing assures comfortable wearing without annoying slipping. These new finger guards are made by the Industrial Gloves Company in three weights of leather: light, medium, and heavy. Four sizes are available: small, medium, and large for the fingers, and one thumb size.

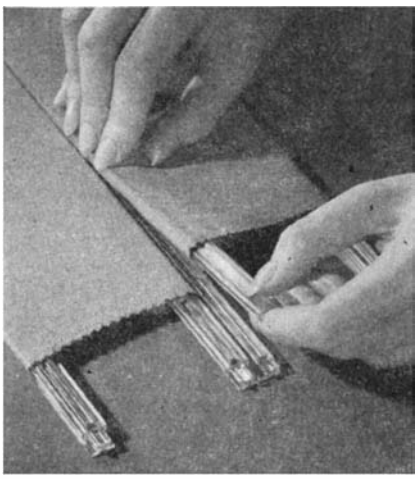


Guards are comfortable, will not slip

CLOTH PANEL INSTALLATION

By Locking Fabric With Plastics Strip Saves Time, Labor

FABRIC for the cloth-paneled interior of the Boeing "Stratocruiser" need no longer be hemmed or cut to exact shape; a new method of installation uses strips of Tennessee Eastman Corporation's Tenite to lock the fabric in place. One plastics strip is fastened to the airplane structure; a locking strip, about which the fabric to be installed is wrapped, snaps into place over the first strip, automatically tightening the fabric panel.



Locking strips hold fabric tightly

ELECTRONIC SORTER

Inspects, Classifies, Counts at Rate of One Per Second

INSPECTING for accuracy of both diameter and length, an automatic sorting gage can check up to 3600 plastics fountain barrels per hour. An electronic system is used to make the actual measurements and to control the mechanical devices which sort the barrels. The device, which sorts acceptable barrels into four size catagories, rejecting over- and under-sized pieces, was made for the Esterbrook Pen Company by the Federal Products Corporation.

As the pen barrels pass through the gage, they are inspected in the following sequence:

1. Acceptance or rejection for length. Over- and under-size parts fall into a reject tote box. Satisfactory parts continue through the gage.
2. Acceptance or rejection for diameter. Unsatisfactory parts fall into another reject box.

Sorting device and time cycle

3. Satisfactory parts sorted into four usable diameter groups, each tolerance equaling 0.001 inch.

Both rejects and acceptable parts are counted.

Greater accuracy, simultaneous control of two dimensions, and greater speed of work handling and inspection are counted among the advantages of this system over manual inspection methods. Labor savings alone, it is estimated, will pay for the gage in little more than a year.

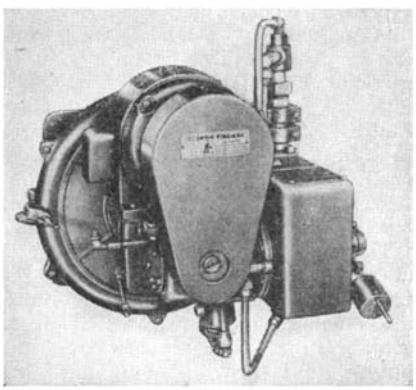
The Federal-Foote, Pierson Electronic Comparator, upon which this gage is based, is adaptable to a great many such inspection applications. Already similar devices are in use for the inspection of such articles as piston pins, bearing balls, and rollers.

STABILIZED FEED BURNERS

Deliver Constant Amount of Fuel In Spite of Viscosity Changes

IN A NEW series of industrial heavy fuel oil burners, means are used to stabilize the feeding rate of fuel, regardless of changes in fuel oil temperature or viscosity. These new Iron Fireman burners have capacities from 8 to 125 gallons per hour.

Even though the fluidity of the fuel may vary widely with changes in temperature, it is claimed that these Iron



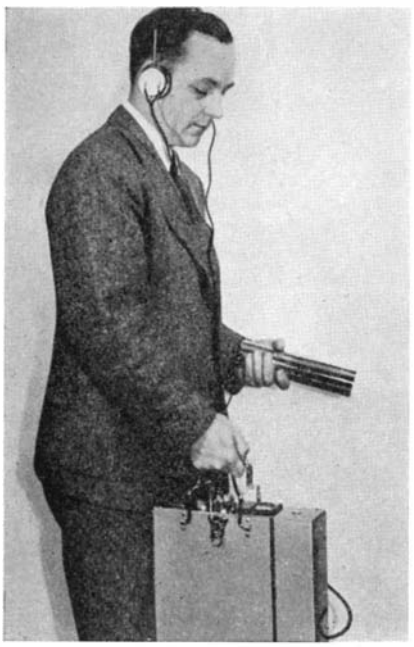
Capacities—8 to 125 gallons per hour

Firemen burners will deliver the same quantity of oil, no matter how thick or thin, and will feed evenly whether at the maximum burning rate or throttled down to low capacity. It is reported that no regulating valve or viscosity compensating device is required.

RADIATION DETECTOR

For Use in Field or Laboratory Is Light and Portable

BATTERY powered to adapt it for field survey work, a new and compact Geiger counter is suitable also for use in the laboratory or plant for radioactivity determinations. It is carried by hand



Detector unit weighs 17 pounds

or by means of a shoulder strap when employed in such work.

The Geiger tube is enclosed in a housing which permits differential detection of hard and soft radiation components and is connected by a flexible cord to the internal circuits. It may be employed either within the cabinet, where it is mounted in clips, or it can be removed for hand use in scanning areas where radioactivity is to be investigated.

Controls and indicators are conveniently located on a top panel so that adjustments and measurements can be made while the unit is being carried. For laboratory work, the counter, produced by North American Philips Company, Inc., may be mounted so that the instrument panel is in a vertical position, which facilitates observation of the radiation indicators from a distance.

The indicating meter shows the rate at which radioactive pulses are received and also is used to determine the potential applied to the Geiger-counter tube. Visual indication of the pulse rate is provided by the flasher which is mounted on the panel. If head phones are connected to the jack terminals, audible signals can be received.

Geiger-counter voltage is adjusted by means of a convenient rotary control. High- and low-voltage supplies are controlled by a master switch which is interlocked with the cover. This shuts off the power automatically when the instrument is closed. All components are mounted in a metal cabinet measuring 12¼ by 11¾ by 4¼ inches. The instrument complete with batteries weighs 17 pounds.

ASBESTOS-COTTON TOWEL

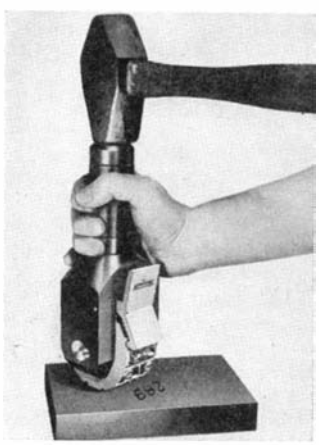
Has Good Water Absorption and Polishing Properties

SAID TO wipe dishes faster and dryer than conventional towels, a new dish towel contains 20 percent asbestos, a material long noted for its ability to resist fire, and recently discovered to have excellent water absorption and polishing properties. The towel, known as Carosel, is produced by the textile division of United States Rubber Company, and is made in a range of six colors—red, green, yellow, rose, blue, and burgundy. The ability of asbestos to soak up water and impart a polish to china and glass was discovered by textile engineers testing asbestos fabric for fireproof ironing board covers. Asbestos combined with 80 percent cotton produces a fabric similar to linen in appearance. When dyed the cotton absorbs color but the asbestos remains white, resulting in a mottled fabric. While the asbestos content is sufficient to provide maximum polishing and wiping efficiency, it is not sufficient to make the fabric fireproof.

NUMBERING TOOL

Built Especially For Heavy Work

PERMITTING unusually heavy stamping, a simplified numbering machine features solid wheels and a one-piece solid bar stock alloy tool-steel holder. The machine numbers from one to 999. The wheel locking is accomplished by a solid lock that fits into a depression between the characters, or separate locks for each wheel may be constructed. The numbering machine, a product of the Acromark Company, is especially well suited to field work, where it eliminates the necessity of carrying easily lost individual numbering stamps.

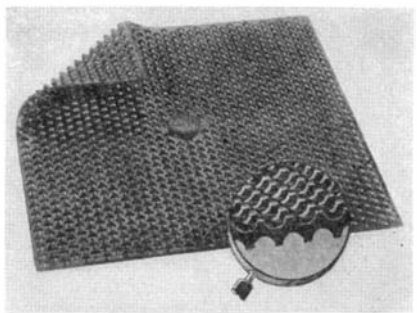


From one to 999

FLOOR MAT

With Rubber Cone Construction Reduces Workers' Fatigue

PROMOTING safety and comfort in factory and office, a rubber floor mat, 21¼ inches square, is made with some 2000 rubber cones, a quarter inch in height, on its upper and lower surfaces. This black, non-skidding, non-marking mat



Magnified section shows rubber cones

not only cushions the feet of those who must work standing for long periods of time, but also protects them from possible electrical shocks. An interesting feature of the mat, called Magic Mat by its producer, Avenue Manufacturing and Sales Company, is the method by which it is cleaned. The mat is simply dropped onto a hard floor, and, due to the rubber-cone construction, the dirt just falls off.

WATER-SHEDDING LIQUID

Dries Metal Surfaces and Helps Inhibit Rust

HAVING VERY high penetrating power to enable it to displace water from blind holes and crevices, a new product in the form of a thin mobile liquid sheds water from the surfaces of metals. After the water has been displaced, the work is removed from the liquid and the solvent evaporates, leaving a water-free surface with some rust-inhibiting properties.

The liquid is recommended for drying of plated work to prevent staining; spots that normally remain on the work from solids dissolved in the water, such as chromic acid, or from the normal solids present in hard water, are removed. The water separates to the bottom of the liquid and can be drawn off periodically.

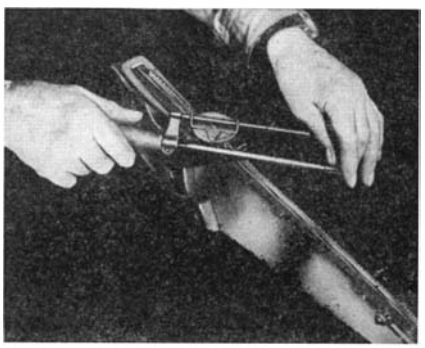
The liquid, known as Hydrex, is being used for drying of jewelry which contain many recesses that formerly required alcohol, distilled water, or sawdust drying. Silver plated work is being dried without spotting, using this

water displacing liquid followed by a vapor degreaser. This liquid, manufactured by Enthone, Inc., can be used for drying of steel after pickling and is particularly valuable for drying in the presence of high humidity when rusting occurs. The liquid displaces the water from the surface of the steel and the thin film of material remaining acts as a rust-inhibitor without detracting from the appearance of the work.

SAW FILER

Clamps Onto Hand Saw, Insures Proper Filing Angle

ENABLING even the most inexperienced hand to sharpen a hand saw swiftly and correctly, a new tool clamps onto the saw to guide the operation. Two simple adjustments set the correct pitch



Two adjustments set pitch and angle

and angle to sharpen any type of hand saw. Called the Speed Saw filer, it is made by the Speed Corporation, and is reported to have been thoroughly tested by both amateur and professional wood workers.

THERMOPLASTIC POLYBLEND

Unites Qualities of Polyvinyl Chloride, Nitrile Rubber

COMBINING the toughness and chemical resistance of polyvinyl chloride with the solvent resistance and flexibility of nitrile rubber, a new thermoplastic material is also unusual in that the valuable characteristics of vinyl elastomers are achieved with no liquid plasticizer. The nitrile component of the material serves as a non-extractable, non-migrating, polymeric plasticizer. If desired, conventional liquid plasticizers may also be added.

Designated Geon polyblend 500 x 503, the new material has been espepecially designed for extruding and calendering, and is unusually well adapted to embossing and press-polishing operations. This should be of extreme value to the upholstery, shoe, electrical, and packaging industries. In the electrical industry, polyblend will serve as an excellent covering for cables containing vinyl insulated wires since there is no danger of plasticizer migration. This elimination of plasticizer transfer is also important to food packaging and adhesive applications.

The compounding, processing, and fabrication of polyblend, developed by the B. F. Goodrich Chemical Company, have characteristics peculiar to both vinyl plastics and nitrile rubber. The stock can be easily processed either on a hot or a cold mill where it forms a smooth sheet after only one "pass," and, unlike rubber, does not require a "breakdown" period.

Stocks to be press-polished after calendering may be processed like rubber at low calendering temperatures of 150 to 250 degrees, Fahrenheit. If maximum physical properties are desired at the calendering operation, for such applications as films for packaging, the stock should be calendered like a vinyl plastics at temperatures of 300 to 330 degrees, Fahrenheit. It is interesting to note that at temperatures between 310 and 330 degrees, Fahrenheit, the transition of polyblend from a rubber-like polymer to a vinyl plastics becomes complete.

SPARK-GUARD

Prevents Accidental Sparking In Electrostatic Painting

AN ELECTRONIC safety device so sensitive that it can be set to anticipate an accidental short, and de-energize the electrostatic field before a spark-over develops in electrostatic spray-coating and dip-detearing processes, will automatically stop the equipment should a piece accidentally approach the discharge electrode.

In electrostatic spraying, special discharge electrodes are energized to bombard atomized paint with a negative charge as the particles enter the coating zone. The product being painted passes through this zone on a conveyor, which, being electrically grounded, also serves to keep the piece at the opposite polarity to the electrodes. This polarity differential creates a flow of charges and attracts the paint to the product with a "wrap-around" action characteristic of the process. So powerful is the attraction of the field within the coating zone that some paint particles make 180 degree turns and "paint around a curve" so that paint which otherwise would become overspray contributes to the coating of the product.

In normal operation of this Ransburg process, the likelihood of any spark occurring is minimized by installing the electrostatic equipment in accordance with rules established by the National Fire Protection Association. Under these rules, the electrostatic installation is engineered so that any part of the equipment which transmits electric current is separated from the products being painted or parts of opposite polarity by at least twice the possible spark-over distance.

The new "spark-guard" is designed to further minimize sparking possibilities which would result from any abnormal accidental reduction of this

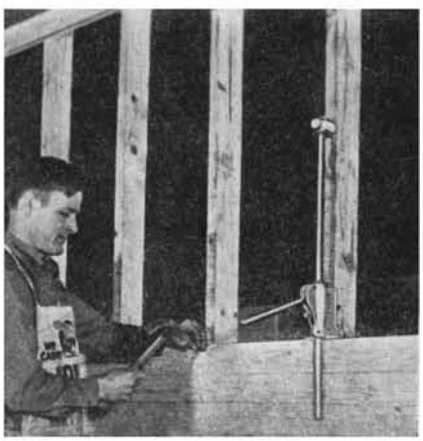
separation. It consists essentially of a self-contained control cabinet, power pack, and electronic relays arranged to de-energize the field when accidental dislocation of a part reduces the separation below safe limits. The device also activates a bell and lamp to signal the operator, and can be wired to stop the conveyor or other equipment as desired.

BOARD JACK

Assures Tight-Fitting Joints in Flooring or Siding

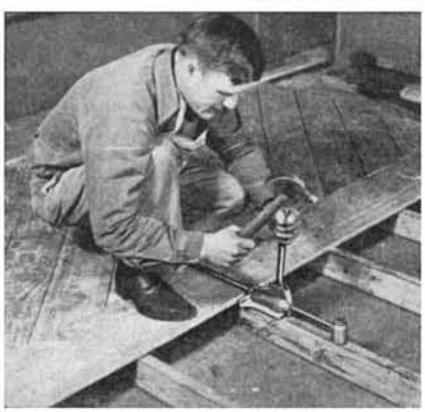
OF PARTICULAR interest to building contractors, carpenters, and home-builders is a new tool operating on the lever principle which was especially designed for quick application of flooring, siding, and sheathing with the tightest possible joints. With this tool, called Bord-Jak, even badly warped boards can be forced into line and held in position for easy and accurate nailing. Tongue-and-groove or square-edge flooring or siding can be brought into perfect tight-fitting alinement without hammering or battering the lumber—all with substantial savings in time, labor, and cost.

It is not necessary to hammer, block, and set boards in order to obtain close-fitting joints. A quick tap of the hammer against the anchor head sets it into position on the joists. Lever action against the broad pressure plates



For siding, tool is used vertically

Floor-laying tool in use



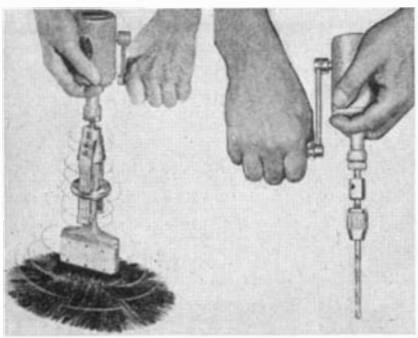
squeezes the boards tightly together, and holds them in position, leaving the hands free for nailing.

Spreading and squeezing joists or studs that bow too closely together can be accomplished with ease by using accessory feet which are a part of each tool, product of the Maco Corporation. After true alinement has been made, studs or joists are held in accurate position until nailed or anchored to hold permanently. In applying sheathing or siding, the tool is used vertically rather than horizontally.

DUAL PURPOSE TOOL

Combines Hand Drill and Paint Brush Cleaner

COMBINING in a single unit a paint brush cleaner and a hand drill, a new device is easily converted from one application to the other by replacing the drill chuck with the brush-clamp attachment, or vice-versa. The gear ratio is eight to one; as a drill, the unit, produced by Home Utilities, Inc., will bore holes up to a quarter inch in diameter.



As drill (right)—brush cleaner (left)

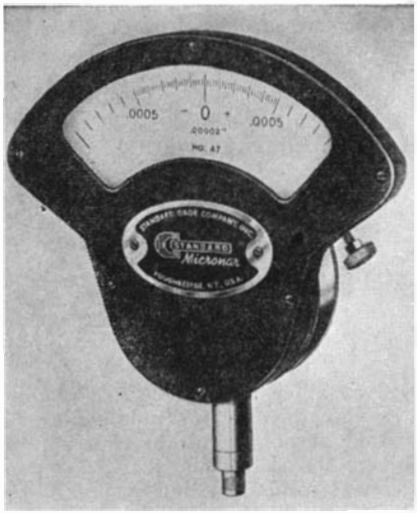
DIAL INDICATOR

Has High Amplification Ratio For Greater Accuracy

SAID to extend the field of accuracy which can be covered by a wholly mechanical dial indicator, a quadrant-type dial indicator which has standard mounting dimensions is suited for use on comparators and on fixtures for controlling especially close tolerances.

The indicator, called Micronar, has an unusually high amplification ratio for an instrument of the dial indicator type. The scale of the English unit model is divided into .0001 inch steps and in the central portion these intervals have been subdivided to .00002 inch. Consistent repeatability and accuracy in keeping with these fine divisions is claimed. The effective range is .0018 inch, considered adequate for the fine checking for which this instrument is intended.

The working advantages of Micronar, made by the Standard Gage Company, Inc., include a light-weight hand which is instantly responsive and reaches its final position without noticeable fluttering. The dial is rotatable over a small angle by means of a fine adjusting screw which facilitates setting the instrument to a standard. The Micronar is regularly furnished with a sapphire tipped contact point for wear resistance. In addition to the English model there is available a metric model graduated in .001mm and having a range of .04mm.



Indicates without noticeable flutter

ALUMINUM PAINT

Dries Fast, Resists Attack By Most Chemicals

MADE WITH a corrosion-proof, synthetic resin vehicle and a special aluminum powder that leafs well, an aluminum protective coat offers advantages not obtainable with ordinary aluminum paints. Since aluminum is acted upon by both acids and alkalis, and since there are nearly always at least some traces of chemicals in the atmosphere of every industrial plant area, the encasing of the aluminum particles in an acid-, alkali-, and waterproof synthetic resin vehicle protects the leafed aluminum from any dulling corrosive effect. Further, since the synthetic resin vehicle transmits approximately 95 percent of the visible light (in contrast to the dark amber color and lower light transmission of conventional aluminum vehicles), this coating, called Prufcoat Aluminum, actually is brighter in the first place.

The leafed aluminum particles plus the polymerized Prufcoat vehicle not only provide protection against acids, alkalis, and water, but also seal in all average surface conditions. Thus, Prufcoat Aluminum can be satisfactorily applied to any general maintenance surface that is dry and reasonably free of rust and foreign material (oil, grease, tar, and asphalt). The resultant coating also keeps moisture and other corrosive agents from reaching the surface.

The volatile solvents in Prufcoat Aluminum evaporate sufficiently within a few minutes after application to leave the coating dry to the touch. It can rain within a matter of minutes

after the paint has been applied with no adverse effect upon the finished job. This fast air-drying characteristic also makes the coating unusually interesting for production line painting where it is desired to paint sheet metal products, and either keep a production line moving or to handle the painted product within a matter of minutes.

SOLIDS-HANDLING PUMP

Designed For Minimum Dilution, Has Longer Service Life

INTENDED for applications where dilution must be kept to a minimum, even though it may result in reducing the life of the sleeve and packing, a new type of solids-handling pump with a special back cover allowing for two rings of packing between the seal cage and the area of the casing in back of the impeller has no stuffing box wear plate. This solids-handling pump, produced by the Allis-Chalmers Manufacturing Company, is an addition to the line of pumps produced by that company for several years, which has its seal cage immediately adjacent to the area of the casing in back of the impeller. This latter unit has been used in pumping such solids as slurries, tailings, pulps, sludges, and so on, where materials must be kept out of the stuffing box, regardless of dilution, or where dilution is not considered to be a disadvantage.

Combining a special design plus a new, highly abrasive-resistant alloy this solids-handling pump is said to outlast ordinary pumps two to four times, and is available in capacities from 175 to 7000 gallons per minute at heads through 100 feet.

DEHUMIDIFYING AGENT

Supplied in Cloth Bag To Be Hung Wherever Needed

DESIGNED for use wherever air dampness should be removed or reduced, a new dehumidifier effectively aids in the prevention of mold and mildew. During the war, this material, called De-Moist, was used as a dehydrating agent for the prevention of damage by rust in shipment of equipment overseas. It is claimed to be superior to many other air-drying agents because it not only attracts moisture—up to 100 percent of its weight—but completely absorbs this moisture like a sponge. It does not drip. When this material, made by the G. N. Coughlan Company, has absorbed its full capacity of moisture, it can be regenerated as often as desired, simply by baking for an hour or two in an oven.

It is available now in 12-ounce packages, one package being adequate for an average room. This package consists of a cloth sack containing the product, and an outside container made with a vapor-proof aluminum foil lining. The user simply removes the outer container and hangs the cloth sack wherever needed.

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.)

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.*

TEXTOLITE LAMINATED PLASTICS. This 64-page booklet lists 44 different grades of this sheet material with their electrical, physical, and mechanical properties as well as information on the manufacture, application engineering, and properties of each type. *General Electric Company, Chemical News Bureau, Pittsfield, Massachusetts.—Gratis.*

PEDESTAL SPOT WELDERS. Describing a line of welders built on heavy duty principles and equally adaptable for miscellaneous spot welding and for high production work, this bulletin presents specifications, drawings, and details of the available types and sizes. Request Bulletin No. 503. *Progressive Welder Company, 3050 East Outer Drive, Detroit 12, Michigan.—Gratis.*

DRESINAL, a chemical selective plugging agent for use in secondary recovery of oil from oil wells by water flooding, is described in a 12-page booklet. Pointing out how Dresinal can be economically effective in reducing excessive water consumption by sealing off the more permeable, non-productive sands, and directing the water flow into oil-containing sands, the booklet also gives information on how it is applied and the results obtained. *Hercules Powder Company, Wilmington 99, Delaware.—Gratis.*

INVESTIGATION OF THE STRENGTH OF RIVETED JOINTS IN COPPER SHEETS, by W. M. Wilson and A. M. Ozelsel, is a bulletin based on the findings of tests conducted by the Engineering Experiment Station of the University of Illinois. Request Bulletin No. 360. *University of Illinois, Engineering Experiment Station, Urbana, Illinois.—Gratis.*

GE LAMP BULLETIN. This 76-page bulletin, prepared by C. E. Weitz, has been called the lamp users' "bible." It contains technical data on lamp design and operation, gathered from a wide range of bulletins and articles, and covers incandescent, mercury, and fluorescent lamps. Included are: photographs, diagrams, and charts; informa-

tion on lamp economics, temperatures, voltages, auxiliary equipment; and discussions of germicidal, infra-red, sunlamps, and glow lamps. Request Bulletin LD-1. *General Electric Company, Lamp Department, Nela Park, Cleveland 12, Ohio.—40 cents.*

SIDE SUCTION CENTRIFUGAL PUMPS is an eight-page catalog presenting information and illustrations on three types of belt or direct-drive pumps; single ball bearing with open type impeller, two ball bearing with open type impeller, and two ball bearing with semi-enclosed impeller. Sizes include ½, ¾, 1, 1½, and 2 inch side suction, and capacities range from 2 to 200 gallons per minute. *The Deming Company, Salem, Ohio.—Gratis.*

A REPORT ON HOW TO SELECT POWER BRUSHES FOR MANUFACTURING OPERATIONS, a 24-page booklet, was designed as an encyclopedia of power-brush usage. The factors entering into brush selection are given and illustrations show actual power-brushing operations. *The Osborn Manufacturing Company, 5401 Hamilton Avenue, Cleveland 14, Ohio.—Gratis.*

FLOOR CLEANING EQUIPMENT is a 16-page catalog of commercial equipment including wringers, tanks, mopsticks, and so on. *Geerpres Wringer, Inc. Muskegon, Michigan.—Gratis.*

STOKES FREEZE-DRYING EQUIPMENT, a 20-page catalog, describes and illustrates equipment and procedures which were developed for this method of preserving without refrigeration and of promoting complete and rapid solubility of difficult-to-dissolve materials. *F. J. Stokes Machine Company, Tabor Road, Philadelphia 20, Pennsylvania.—Gratis.*

"CONTROLLED-AIR" POWERED DEVICES. In 16 pages this bulletin illustrates how almost any repetitive manual operation involving push, pull, lift, or turn can be performed faster and with cost reduction by the use of the powered devices described. *The Bellows Company, 798 North Main Street, Akron, Ohio.—Gratis.*

MAGNETIC TAPE RECORDING HANDBOOK. In 28 pages this booklet describes the tape, which is made of paper coated with a special material which permits high-energy saturation of fine magnetic particles. Also included are: design principles, mechanical requirements, and engineering details of recording and playback equipment. *The Indiana Steel Products Company, Six North Michigan Avenue, Chicago 2, Illinois.—Gratis.*

HANDBOOK OF ANAYLITICAL METHODS FOR SOYBEANS AND SOYBEAN PRDDUCTS. In 40 pages this booklet prepared for the convenience of oil, food, and agricultural chemists, gives details on methods of analyses, including certain official methods and adaptations. *National Soybean Processors Association, 3818 Board of Trade Building, Chicago 4, Illinois.—$1.00.*

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.

TO MAKE CERTAIN that books ordered by or for men in the Army, located in the United States, or men in the Navy, Marines, or Coast Guard, located anywhere, will be delivered, insurance fees should be sent with orders, as follows: To $5 in value, 3¢ additional; from $5 to $25, 10¢; from $25 to $50, 15¢.

HEAT PUMPS

By Sporn, Ambrose, and Baumeister

READER interest in the article "Fireless Heat for the Home," published in our May, 1947 issue, indicates that the present book will find wide interest and acceptance. Its treatment of the subject of heating and cooling by this old yet new method is technical, the work being designed to present basic facts about principles, equipment, maintenance, operating, and installation problems. Further, heat pumps are not only considered for heating and cooling of buildings, but also for their equally important applications in the industrial field for evaporation and purification of liquids, for drying of solids, and for the simultaneous chilling and heating of process fluids. (188 pages, 6 by 9 inches, well illustrated with drawings and photographs of existing installations.)—$3.85 postpaid.—*A.P.P.*

STUDIES IN GENIUS

By Walter G. Bowerman

STATISTICAL, mainly, but with accompanying discussion. Study of eminent deceased Americans on basis of place or origin; occupations; heredity and parentage; childhood and youth; marriage and family; duration of life; pathologies; height and weight; pigmentation. Conclusions drawn are of interest to those trying to find basis of genius. Part II (85 pages) treats worldwide genius similarly. (343 pages, 6 by 9 inches, 7 charts.)—$4.85 postpaid.—*A.G.I.*

ORGANIC CHEMISTRY

By Paul Karrer

SECOND English edition of a well known and authoritative book brought up to date by the inclusion of amendments and additions to agree with the eighth German edition published in Leipzig in 1942. The present English edition has been published under the copyright vested by the Alien Property Custodian from its former German owners. While organic chemists commonly possess adequate reading knowledge of the German language, the appearance in English of a new edition of this work by Prof. Karrer of the University of Zurich, Switzerland, makes its contents more easily available to Americans for ready reference. Prof. Karrer was awarded the Nobel prize in chemistry in 1937. (973 pages, 6½ by 10 inches, 6 illustrations.)—$7.60 postpaid.—*D.H.K.*

PUBLIC RELATIONS IN ACTION

Edited by Philip Lesly

THIRTY case histories of successful public relation programs are described in full, with the problem faced, the method of handling, and the results obtained concisely presented. A clear, easily read book of decided value to anyone interested in or concerned with this rapidly growing field. (280 pages, 6½ by 9½ inches, illustrated.)—$4.60 —*N.H.U.*

NEW COLLEGE STANDARD DICTIONARY

By Funk & Wagnalls

REVIEWING a dictionary may seem offhand to be a dull and thankless chore. However, here's a dictionary that warrants more than mere passing attention. First and foremost is the use of an entirely new procedure for showing accent and pronunciation, using what the publisher has dubbed "Em-Pha-Type." No cabalistic symbols must be interpreted before you can be sure of pronunciation. The type and underlining does the job for you. Then, pronunciation is indicated in simple spelling so that no further interpretation or guess work is required. Even a cursory glance through the entirely readable pages of this volume shows

that the illustrations have been selected for the information which they provide, rather than as mere decorations. Without a doubt, this is the easiest-to-use dictionary thus far available. (1404 pages, 6½ by 9½ inches, 1000 illustrations, 145,000 entries.)—$5.65 plain, $6.15 with thumb index, postpaid.—*A.P.P.*

Because of increased production costs of books, publishers' retail prices today are subject to constant change. It may be necessary, therefore, for our Book Department to advise book purchasers of increased costs, even when orders sent are based on current quotations.

The Editor

MAKING YOUR OWN TELESCOPE

By Allyn J. Thompson

EXCELLENT practical instructions which take the tyro by the hand and lead him, with little chance of straying afield, through the construction of his first telescope, and then discuss second telescopes. Chapters on telescope history; materials and equipment; mirror grinding; pitch lap; polishing, testing, correcting; the paraboloid; diagonals; tube parts, alinement, and the finder; eyepieces; mounting; aluminizing; setting circles and adjustment; optical principles; second telescopes; flats; miscellany; bibliography. The methods selected are more standardized, precooked, and confined than in "Amateur Telescope Making," thus containing advantage and debatable philosophical disadvantage, but all are sound, being based on the author's years of experience as instructor in telescope making in the American Astronomical Association's sub-planetarium optical shops. (211 pages, 5½ by 8½ inches, 98 illustrations.)—$3.60 postpaid.—*A.G.I.*

PRINCIPLES OF ELECTRICAL ENGINEERING

By T. F. Wall

COMPREHENSIVE and compact, this text stresses the identity of the principles relating to both heavy-current and light-current engineering practices. New developments in applications, testing, and materials are fully covered, and the whole is clearly presented. (563 pages, 5½ by 9 inches, with many diagrams and 20 pages of problems.)—$8.60 postpaid.—*N.H.U.*

ATOMICS FOR THE MILLIONS

By Dr. Maxwell Leigh Eidinoff and Hyman Ruchlis

A CHEMIST and a physicist have collaborated in the production of this book which makes a valiant and successful attempt at bringing into focus the whole subject of atomic energy. Unfortunately, from this reviewer's standpoint, too much emphasis is placed upon the atomic bomb itself, but the text is so extensive—for a book designed for popular consumption—that the bomb does not completely overpower other aspects of atomic potentialities. The authors' handling of the subject is excellent, and their attempts at popularization have not been carried too far. A large number of excellent line drawings—mostly humorous in treatment—serve to balance some of the heavier parts of the text. A bit of philosophy concludes the book in a chapter entitled "Atomic War—World Suicide?" (281 pages, 6 by 9 inches, numerous drawings, well indexed.)——$3.60 postpaid.—*A.P.P.*

AIRPORT OPERATION AND MANAGEMENT

By Charles A. Zweng

AN EXCELLENT treatise on the subject, containing a wealth of solid, accurate information on the design and construction of an airport; on the daily problems of operation, aircraft, maintenance, control, safety, and so on; the problems of management, personnel, and financing; and financial aspects. There are some useful appendices. This book will be of practical help to anyone at all concerned with airport problems. (312 pages, illustrated.)—$4.60 postpaid.—*A.K.*

RUSSIAN-ENGLISH TECHNICAL AND CHEMICAL DICTIONARY

By Ludmilla I. Callaham

SCIENTIFIC and engineering relations between ourselves and the Russians continue to grow to greater importance in spite of political differences. Thus it is vital to all concerned to build an effective bridge over the language difference. Mrs. Callaham has provided a vital part of that language bridge in her new dictionary. It is a workmanlike job presented in an effective manner. Without doubt it will prove invaluable in helping to open the works of Soviet scientists and engineers to their English-speaking colleagues. (794 pages, 5½ by 8 inches.)—$10.10 postpaid.—*D.H.K.*

GENERAL BIOLOGY

By Strausbaugh and Weimer

COLLEGE textbooks in biology (and numerous other subjects) start exactly where high-school textbooks do—at the very beginning—assuming no previous knowledge. They are broader in scope, deeper, more mature—about right for independent older readers wishing general coverage of subjects never studied. This one is even broader (not deeper) than most college texts in biology, swinging through a wide arc of related sciences. While textbooks, which carry schoolish earmarks, repel some readers they do have the ad-

vantage of systematic completeness. Modern ones are far more interesting, less formal, than the old-timers this reviewer recalls. (718 pages, 5½ by 8½ inches, 350 illustrations.)—$4.85 postpaid.—*A.G.I.*

PETROLEUM PRODUCTION In Three Volumes

By Park J. Jones

AN EXHAUSTIVE text dealing with various aspects of petroleum production. Divided into three parts, Volume I treats the mechanics of oil production prior to the breakthrough of displacing fluids into producing wells; Volume II, the optimum rates of production; and Volume III, oil production by water, neither gas nor production by gas being considered. An excellent, detailed presentation, and a thoroughly technical one. (Vol. I, Mechanics of Production, 228 pages, 6½ by 9½ inches, unillustrated. $4.60 postpaid. Vol. II, Optimum Rate of Production, 293 pages, 6½ by 9½ inches, unillustrated. $4.60 postpaid. Vol. III, Oil Production by Water, 271 pages, 6½ by 9½ inches, unillustrated. $5.10 postpaid.)—*N.H.U.*

MODERN POLISHES AND SPECIALTIES

By W. D. John

COVERING raw materials and manufacturing methods for producing a wide variety of polishes, this text is essentially a compilation of precise formulas, coupled with instructions for procedures. The groups covered include: vegetable and mineral waxes; floor polishes; floor oils and sweeping compounds; floor and furniture polishes; shoe cleaners, polishes, and dyes; motor car polishes and cleaners; metal polishes; household cleaners; and miscellaneous formulas ranging from aluminum paint through red marking ink to white line road paint. (313 pages, 6 by 9 inches, unillustrated, well indexed.)—$7.60 postpaid.—*A.P.P.*

ANCIENT PLANTS AND THE WORLD THEY LIVED IN

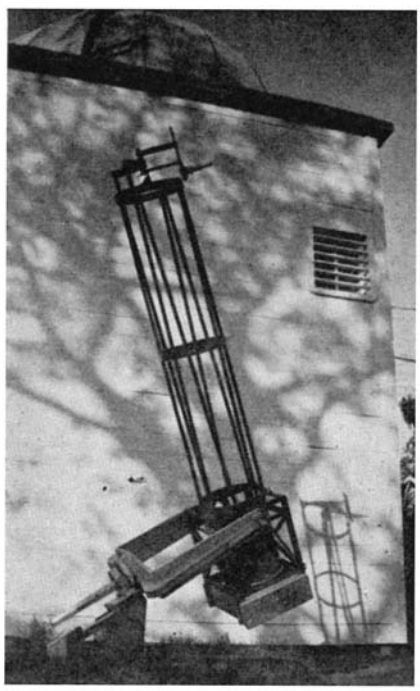
By Henry N. Andrews, Jr.

PALEOBOTANY, the science of the past evolution of the vegetable kingdom, is a fascinating study but unfortunately most technical. This book by a paleobotanist, weeds out the technicalities. As paleobotany it would rate as decidedly light but as popular writing it would rate average. Suitable for readers having serious interest in pure science and for the "rock hounds" (amateur mineral collectors) who now abound. It is of interest to find that so many modern plants—the pines, for example—remain essentially unchanged since 60,000,000 or more years ago, as proved by perfectly preserved fossils. (279 pages, 6 by 9¼ inches, 166 illustrations.)—$4.60 postpaid.—*A.G.I.*

A MERE MAN'S RETREAT

Is a Combined Back Yard Shop, Den, and Observatory

AN ATTRACTIVE thought for any man who would enjoy a private retreat from strict standards of feminine housekeeping is that of being the possessor of a combined work shop, den, and personal hobby place with a lock on the door and the key in his pocket. Such an escape place is shown in the illustration: a ground-level garage; a second-story shop and den; and on top of these



Homemade reflecting telescope

a hemispherical dome for housing a homemade telescope like the one shown temporarily set up outside to be photographed.

All this was built by H. D. Stanhope, Texarkana, Arkansas, one of a minority of amateur telescope making hobbyists who are able to skip the customary six-inch diameter telescope of the beginner and start with a 12½-inch instrument without getting into too much trouble.

Even a six-inch telescope will magnify 100 diameters, this 12½-inch diameter about 240. The Moon's distance being 240,000 miles, this brings its silvery surface, a maze of fascinating individual features affording endless close observation, down to only 1000 miles. Mars, Venus, Jupiter, Saturn's rings, nebulae—all provide varied subjects.

Nearly all the parts of this telescope were homemade or home-town-made.

Readers who are not initiates of the telescope making hobby usually inquire: "Isn't it pretty mathematical?" In the whole job there's just one little mathematical formula, r^2/R. "A lot of special tools?" Your two hands, and patience. "Do you actually make the optical parts?" That's the heart of the fun. It's a tussle but thousands have won it.

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"

MAKSUTOV, pronounced Mack's-suit-off, is the name given to a new type of telescope originated by the Russian of that name. As soon as Maksutov published basic data for the design, this department facilitated the construction of Maksutov telescopes by inviting N. J. Schell, Beaver Falls, Pa., experienced amateur telscope maker, to interpret Maksutov's abstruse original article for other amateurs and by arranging with the Corning Glass Works to mold 24 of the special blanks needed for the construction, all of which are now in various amateur's hands.

First to furnish a description of a finished Maksutov telescope is G. Camilli, 155 Dawes Ave., Pittsfield, Mass., who enthusiastically reports the "Mak" a success. Some are still having difficulties with the extremely sensitive alinement after nearly finishing their Maks. Camilli writes:

"The optical system developed by D. D. Maksutov of the State Optical Institute, Moscow, U.S.S.R., is similar to the Schmidt camera and combines the action of a single meniscus lens with that of concave spherical mirror. The role of the meniscus is identical to that of the correcting plate of the Schmidt camera—the correction of spherical aberration and coma of the spherical mirror without introducing a noticeable chromatism.

"The meniscus shuts the tube and makes possible a sealed instrument

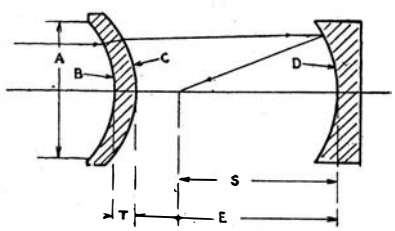


Figure 1. Maksutov system, Camilli. A = 8". B = 12.224". C = 12.668". D = 65.856". E = 43.128". T = .800". S = 33.6"

free from convection currents and a mirror protected from dust and dew; in addition, secondary mirrors may be fastened to the meniscus to reduce their diffraction effects.

"The Maksutov system was described first by Maksutov in the *Journal of the Optical Society of America*, 1944, May, and subsequently by N. J. Schell in Scientific American, 1944, October and December.

"The optical system of the Mak completed by the writer is shown in Figure 1. In common with other members of the Mak group, the telescope has an aperture-focal ratio of 1:4. It can

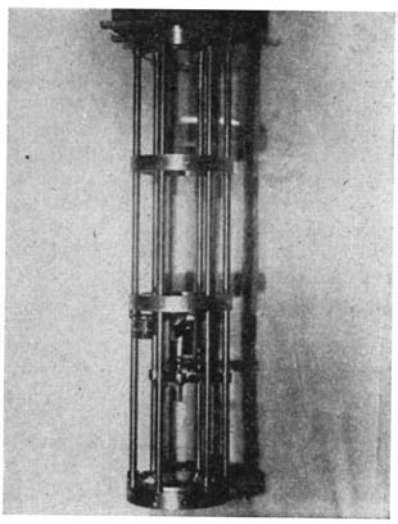


Figure 2: Camilli's solution of the supersensitive alinement problem

be used for visual and photographic purposes.

"The meniscus is made of crown glass ($n_D = 1.5170 \pm 0.0010$; $V = 64.5 \pm 0.5$) and was ground, polished, and figured against a tool of the same dimensions. Both surfaces of the meniscus are spherical. The convex surface of the meniscus needs no accurate figuring since the curve is very deep. This is one of the attractive features of the Mak design. Deep curves of this kind can be held truly spherical with reasonable care in the grinding and polishing; especially when it is known that a sphere is aimed for. A light polishing action has been found to be best.

"The spherical mirror is made with radius of curvature held as closely as possible to the dimensions shown in Figure 1. The success of this job depends very much upon holding radii very close to those called by the design theory. Unlike our ordinary telescope mirror jobs, where we get a certain radius and then correct to the extent called for by the actual radii obtained, this work is more like that of refractors where close adherence to radii as computed must be had if correct results are to be attained. For the above purpose a spherometer ('A.T.M.A.,' 242) is almost a necessity. The meniscus must be optically centered by edge grinding.

"In the writer's optical assembly shown in Figure 2, the meniscus and the mirror are rigidly mounted in an aluminum frame. This method affords great simplicity in the mounting and adjustments of all the parts. Thus the cells for the meniscus and the mirror, as well as the spider that supports the

diagonal, can be slid up and down on the rods of the frame. The frame will be found very useful during the final phase of the assembly. To obtain the best performance from the Mak system it is imperative that the optical axis of the meniscus and of the mirror coincide. This adjustment is of course done with the spider and the diagonal removed from the assembly. By providing three small bushings which are held against the cell of the meniscus, this and the spider can be removed and returned exactly to the original ac-

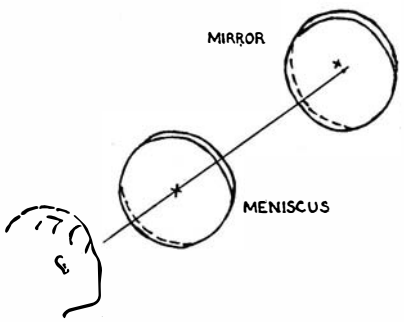


Figure 3: Getting axis alinement

curate position without injuring the optical alinement of the parts.

"A method of obtaining the alinement of the two optical axes (mirror and meniscus) is shown in Figure 3. Using a wax-pencil, a cross is marked on the convex (back) surface of the meniscus. Likewise a small round dot is marked on the exact center of the mirror. A light held slightly on side of the operator illuminates the front of the meniscus. Looking at the system from the meniscus and keeping his right eye in line with the center of the cross and the dot on the mirror, the operator will see also the reflection of the cross on the surface of the mirror. By careful adjustment of the mirror, the reflection of the cross can be made to coincide with both the original cross and the dot of the mirror. In making this adjustment it is of course assumed that the meniscus is squared on the mechanical axis of the frame.

"After this adjustment has been completed, the spider is returned to place and the assembly is inserted in a protecting tube as shown in Figure 4. The adjustment of the diagonal with respect to the mirror is done in accordance with one of the schemes described in 'A.T.M.A.,' 272.

"The performance of the Mak well repays all the work which the writer has put into it—the definition is much superior to that obtained by a simple reflector. The images of stars are very small and sharp, free from coma and color. The writer expects to run a series of comparative tests between the Mak and an *f*/17, 6½" reflector, the mirror of which is made of fused quartz, mounted in tandem with the Mak.

"The mounting for this telescope (Figures 4 and 5) is similar to Everest's 'Old Town Pump' described in 'A.T.M.A.,' 514. An Alnico motor (75 r.p.m.), through an additional gear-reduction, drives the final worm gear of the telescope (Figure 5). The same

worm gear can be driven at very high speed by a capacitor type reversible motor. Ordinarily the Alnico motor drives the right ascension shaft at sidereal time. When it is necessary to advance or retard on the normal speed, a push button arrangement brings the capacitor motor into operation. After the correction has been made the Alnico motor immediately goes back into service without the mediation of any mechanical clutch."

Figure 4: Tube protects assembly

CONFUSION exists in some minds regarding the type of Pyrex Brand glass in standard molded telescope blanks. Are these regular products or some "off" variety?

Such a rumor probably started from the fact that Corning developed for the 200" mirror a special glass having only two thirds the expansion coefficient of the standard Pyrex. While this special glass is available for to-order jobs, it is much more expensive. The regular type in standard molded mirror blanks, 4¼" to 12½", also the 16" blanks recently made for special price club groups, is the same as used in Corning's huge annual tonnage of Pyrex Brand laboratory glass, cooking ware, insulators, and other industrial and consumer ware. It is drawn from the same tank furnaces and from the same melts in them. If a farmer, milk-

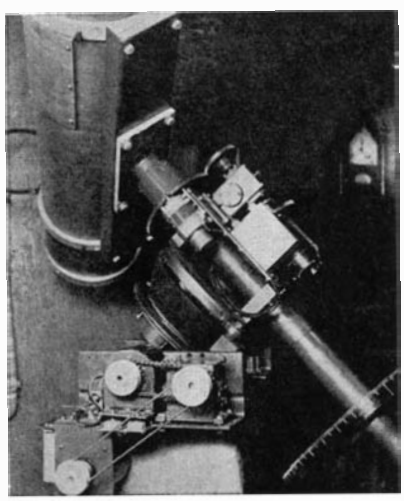


Figure 5: Detail of the mounting

ing a cow, directs a squirt into a cat's mouth, the milk is from the same cow, same bag, same batch, and has same composition, and Corning mirror blanks are as completely regular material as the milk squirt is the cow's regular product. This also explains why Corning molded telescope blanks can be as inexpensive as they are, since the regular glass used in immense quantities for products having large sale, is *always in continuous melt.*

Not all may even yet know how large an industry Corning Glass Works is. They have 10 plants, make more than 37,000 different items of glass including 45 percent of all the glass bulbs for incandescent lamps made by others in the United States, and do a $50,000,000 annual business of which telescope blanks is fractional.

Let's look at the two kinds of Pyrex Brand glass mentioned above. Wide awake telescope makers will learn their numbers.

	Brand 774 (Consumer ware and telescope blanks 4¼"—16")	*Brand 716* (200" and to-order telescope blanks)
Softening point	820°C	832°C
Annealing point	555°	535°
Strain point	515°	493°
Expansion	32.5×10^{-7}	23×10^{-7}
Density	2.23	2.16
N_D	1.474	1.464

The ratio of linear coefficients of expansion is seen to be as .00000325 is to .0000023, or as 33 is to 23—about as 3 is to 2. In ordinary conversation glass technologists say merely "expansion 33" or "expansion 23," and on the same scale fused quartz (silica) has expansion 5 and plate glass 90.

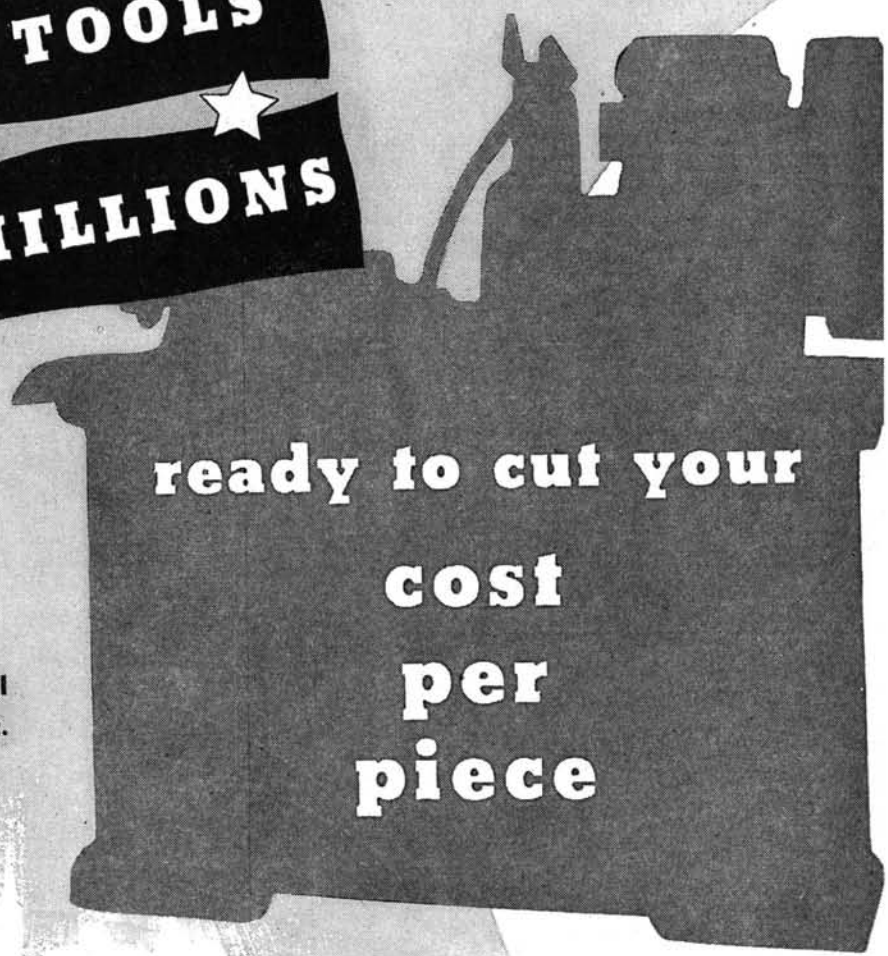
Why, you may now wish to ask, couldn't Pyrex Brand No. 716, the lower expansion brand, be just as easily used in telescope blanks as the 774? Because it isn't in continuous melt. Much of it is in stock but it is cold. Obviously the telescope demand wouldn't begin to justify keeping it in continuous melt, and melting it is expensive in more practical ways than the one that is most obvious from the table—that is, higher softening point (more fuel). This softening point is only 12°, Centigrade, above that for Pyrex 774 but at the top temperatures involved this increment is appreciable. It took five weeks to melt 60 tons of 716 from which to dip enough to fill the mold for the 200" mirror.

When an order for a blank of Brand 716 is filled, a special ceramic mold is built up, large irregular pieces of 716 are laid in it, cold, and melted down to shape of mold. In practical ways this is expensive. For example, a single blank of 716, 16" by 3 1/3", was priced as of last spring, $198, and a 20" by 3 1/3" was priced $306. In a club group of 24 blanks molded at one time the 16" blanks of 774 sell for $37.50 net.

This department has now been urged to start a club of purchasers of 20" mirror blanks, as it did with 16" blanks. Investigation revealed that the economics in the two cases were dissimilar, with heavy accent on the dis, and no such club is in the offing.

Printed in the U. S. A. Press of Wilson H. Lee Company, Orange, Connecticut

BARGAINS IN SURPLUS TOOLS WORTH MILLIONS



GRINDER, Plain External Cylindrical
Norton Model C Plain. 6" Swing, 18" cc.
Sales Price: $986.00.
Location: Detroit, New York, Kansas City Regions.

War Assets Administration has the machine tools you need to cut costs—to modernize—to set up a new shop. Look at the big bargains shown. They are typical of scores of types, hundreds of models that must be sold at rock bottom prices—at least 25% BELOW USED MARKET.

Listings of available machine tools are on file in all WAA Customer Service Centers. They include the major makes and types manufactured by the American Tool Industry. Plenty of models for both large and small shops. Initial payment as low as 15% when you use WAA's Deferred Payment Plan.

Get in touch with your nearest WAA Customer Service Center for details of current offerings. Bargains like this won't last—so act today!

ALL TOOLS SUBJECT TO PRIOR SALE

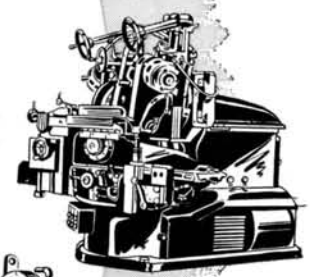
THESE ARE TYPICAL OF CURRENT OFFERINGS

BORING MACHINE, Horizontal, Precision, Bridge Type
Ex-cell-o Model 2112-A, Single End, 5" Diameter Bore, 12" Table Travel.
Sales Price: $720.00.
Location: New York, Detroit Regions.

MILLING MACHINE, Bed Type, Horizontal Spindle
Cincinnati Model 08, Plain Automatic (Not Rise and Fall), 8" Table Travel, 6½" Width.
Sale Price: $459.00.
Location: Detroit Region.

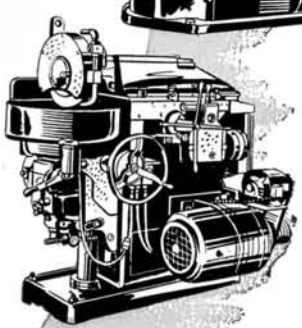
HAMMER, Air Drop
Chambersburg, Cecostamp Model ELPLANK. Bed Area 66" x 48"
Sales Price: $3684.00.
Location: Los Angeles, Grand Prairie, Kansas City Regions.

GRINDER, External Thread
Ex-cell-o Model 33, Plain, Automatic. 6" Diameter, 18" cc.
Sales Price: $1929.00.
Location: Detroit, New York, Kansas City Regions.

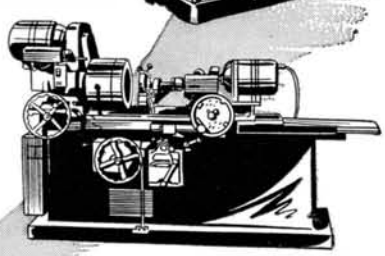


GRINDER, Gear Tooth
Pratt & Whitney Model 1679, Two Wheel Helical Gear, 10 11/16" Dia. 1¼" Face.
Sales Price: $3300.00.
Location: Kansas City Region.

CHECK THE COMPLETE LISTINGS AT ANY CUSTOMER SERVICE CENTER



GRINDER, Rotary Surface
Arter Models A1-8", A3-12", A3-16" Horizontal Wheel Spindles.
8½", 12" and 17" Table Diameters.
Sales Prices: $1022.00, $1380.00, $1494.00.
Location: Cincinnati Region.



GRINDER, Internal Cylindrical
Heald Model 72A3 Plain Hydraulic Feed. 11½" Swing, 12" Stroke.
Sales Price: $1327.00.
Location: Detroit, New York, Cincinnati Regions.

OFFICE OF GENERAL DISPOSAL

WAR ASSETS ADMINISTRATION

GOVERNMENT WAA SURPLUS

Offices located at: Atlanta • Birmingham • Boston • Charlotte • Chicago • Cincinnati • Cleveland • Denver Detroit • Grand Prairie, Tex. • Helena • Houston • Jacksonville • Kansas City, Mo. • Little Rock • Los Angeles • Louisville Minneapolis • Nashville • New Orleans • New York • Omaha • Philadelphia • Portland, Ore. • Richmond • Salt Lake City St. Louis • San Antonio • San Francisco • Seattle • Spokane • Tulsa • CUSTOMER SERVICE CENTERS IN THESE AND MANY OTHER CITIES

686-4

if gasoline were sold in cakes...

all the information you'd like to know about the ingredients it contained could be printed right on the wrapper. However, gasoline is usually piped directly into your car from a pump—so it isn't practical to label each gallon. Instead, oil companies put "Ethyl" trade-marks on their pumps to show you at a glance that their best gasoline contains "Ethyl" antiknock fluid. This important ingredient, which is made by the Ethyl Corporation, is mixed with gasoline to step up power and performance. To get more out of your car, buy *your* gasoline from pumps marked with the familiar yellow-and-black "Ethyl" emblem.

Ethyl Corporation, New York.

look for the **"ETHYL"** trade-mark