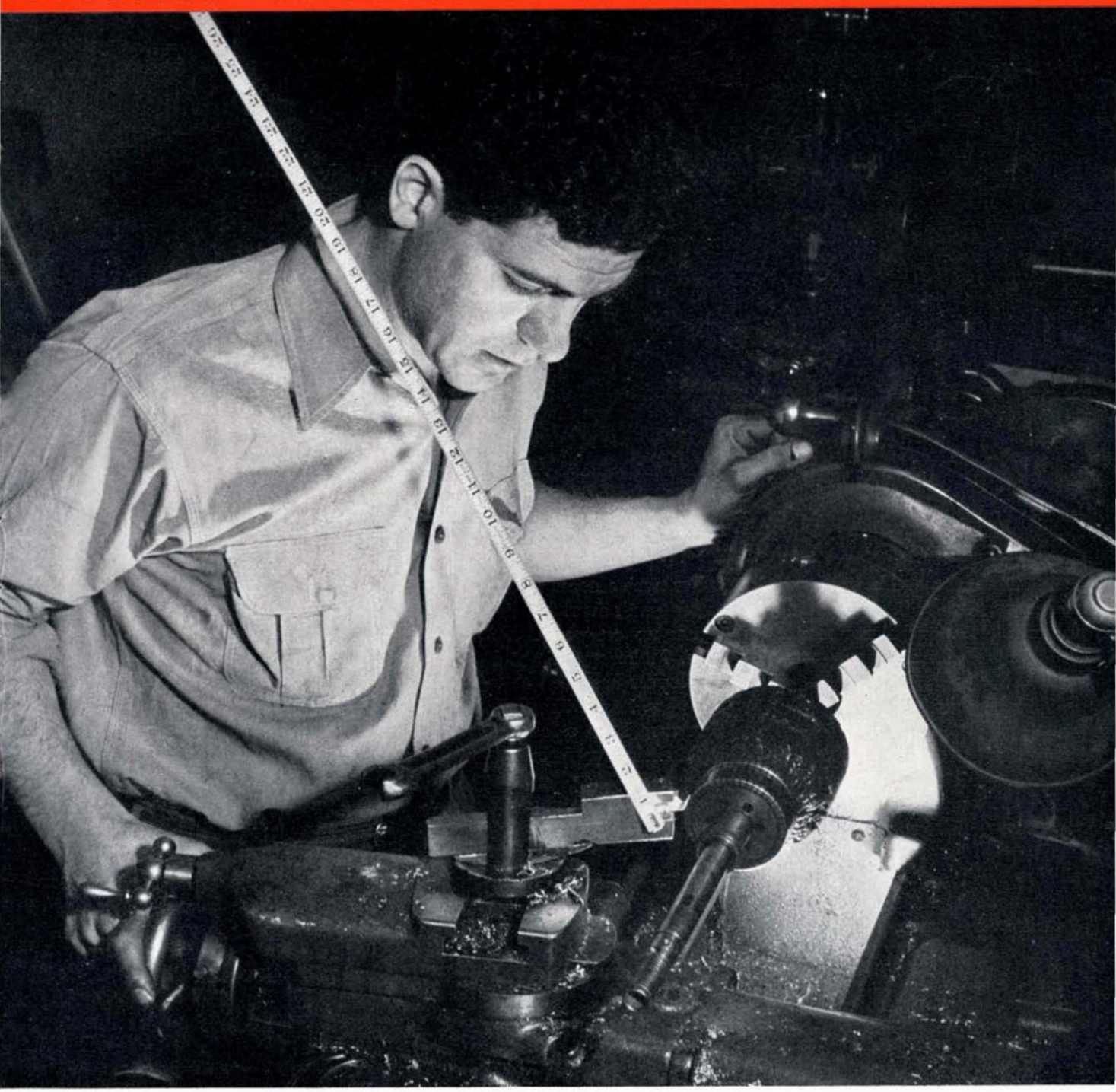
Scientific American

—FOUNDED 1845—

JUNE
1947

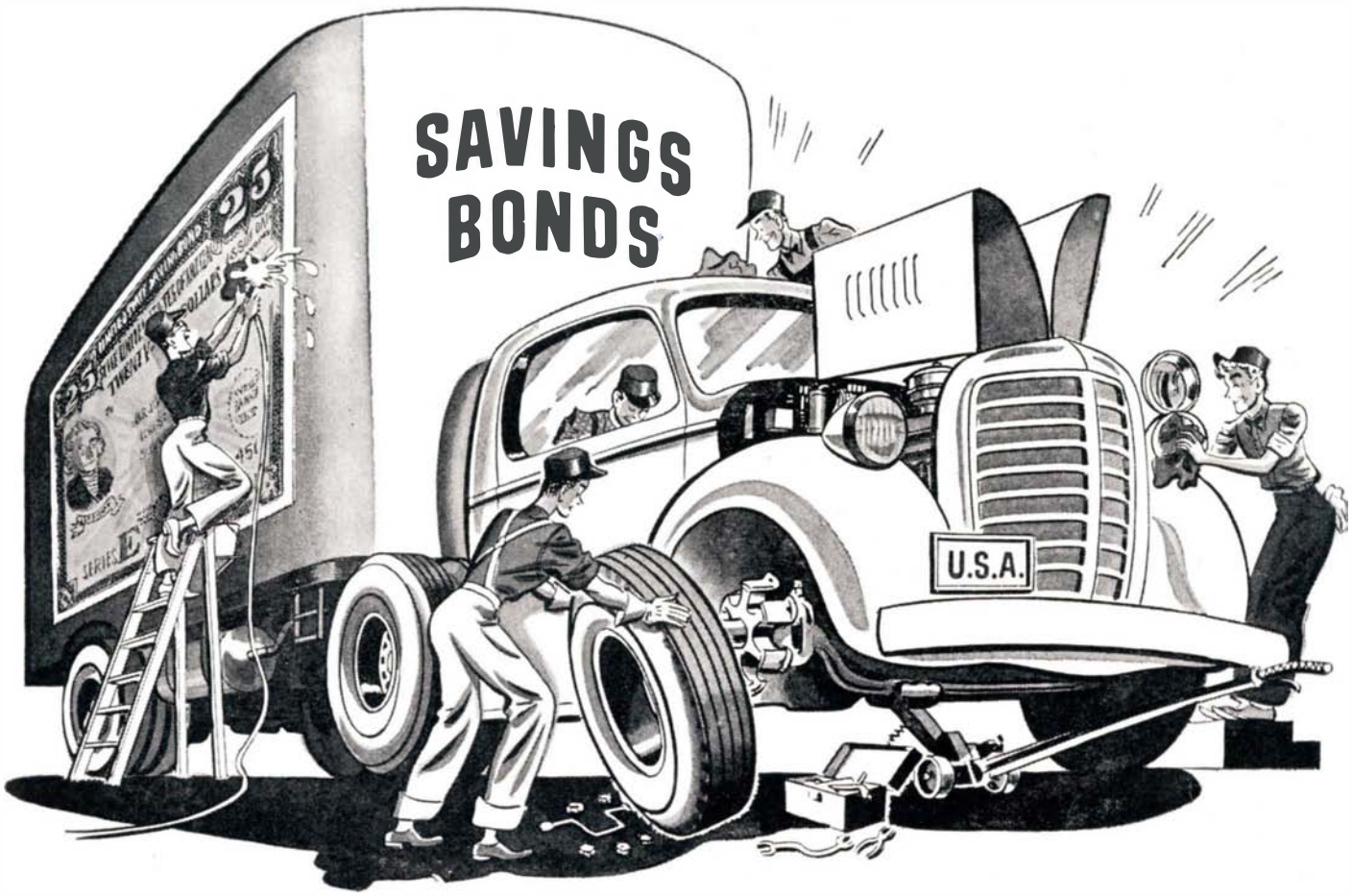
35 Cents
a Copy

REPORTING THE PROGRESS OF SCIENCE AND INDUSTR



Vision Checks Match Men and Jobs . . . See page 241

Time for a **Spring Check-up . . .**



on the plan that delivers Peace of Mind

THANKS to the work of patriotic volunteers, the U. S. Savings Bonds program has carried America a long way up the road to economic security.

During 1946, in spite of all the problems and uncertainties the nation faced, sales of Savings Bonds *exceeded redemptions* by $1,389,216,000. The success of this great sales operation has helped stem the tide of inflation, has reduced public debt holdings of the banking system, and has given millions of citizens a stake in their country and a profitable investment in their own futures.

Yes, we've come a long way—but the trip isn't over! Now is the time to check up on your Payroll Savings Plan. Make sure that all your new employees are familiar with its advantages. Remind *all* your employees that there's no easier, surer way to build their own futures—and America's—than by buying Bonds regularly through the Payroll Savings Plan. Every $3 invested pays $4 at maturity!

For any help you need in conducting the Payroll Plan, call on your State Director of the Treasury Department's Savings Bonds Division.

New Savings Bonds Plan won't affect the P.S.P.

SOON the Treasury Department and the banks of America will make it possible for farmers, doctors, and other self-employed people to participate in "automatic" Bond buying by special arrangement with their banks. This extension of the Savings Bonds program is not a partial payment plan and is intended *only* for people who are not in a position to take advantage of the Payroll Savings Plan.

The Treasury Department acknowledges with appreciation the publication of this message by

Scientific American

This is an official U.S. Treasury advertisement prepared under the auspices of the Treasury Department and The Advertising Council.

Scientific American

Founded 1845

INDUSTRIAL DRAMA: Essential to profitable production processes of all kinds is accurate fitting of workers' vision to the tasks. Details and case histories on page 245.

Subscription Rates:
ONE YEAR—$4
TWO YEARS—$7
THREE YEARS—$10
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.

In This Issue • June 1947

50 and 100 Years Ago in Scientific American 242
Previews of the Industrial Horizon ..... A. P. Peck 244

ENGINEERING

Better Vision Boosts Production ..... Allen C. Holland, O.D. 245
Processes Have Families ..... Edwin Laird Cady 249
Hydraulic Accumulators 251

ELECTRONICS

Demobilized Microwaves ..... Vin Zeluff 252
Electronic Drive 255
See-Saw Bed 255
Talking Letters 255
Metal Identifier 255
River-Boat Radar 255

PLASTICS

Coats Make the Product ..... Charles A. Breskin 256
Polyethylene Bags 258
Resin Adhesive 258
Coated Yarn 258

CHEMISTRY IN INDUSTRY

Glycerine and Glycols Gain Ground .. Howard C. E. Johnson, Ph.D. 259
Agricultural Fungicide 261
Vinyl Ethers 261

METALS IN INDUSTRY

Deep Draws with Hot Magnesium ..... Fred P. Peters 262
Aluminum Welded 264
Printed Silver 264
Non-Corrosive Coat 264

IN OTHER FIELDS

Micro-Hardness Testing 265
Artificial Legs 266
Lightweight Motors 266
Home Sound System 267
Powder Metal Bearings 268
Gasoline From Gas 268
Electronic Annealing 268
Runabout Body 268
Mineral Deposits 269
Color Television 269
Highway Standards 269

NEW PRODUCTS AND PROCESSES

Self-Soldering Tape 270
Shrinkproof Rayons 270
Magnetic Comparator 270
Finish Grinding 270
Insecticide Sprayer 271
Spirit Level 271
Knurling Tool 271
Precision Plumb Bob 271
Vulcanized Starches 271
Post Turret 272
Wing Nuts 272
Oxidizing Compound 272
Portable Power Burner 272
Signaling Timer 272
Smokeless Heaters 273
Plastics Gear Housing 274
Kink-Free Cord 274
Commercial Wire Recorder 274
Better Synthetic Rubber 275
Simplified Solenoid 275
Illuminated Clipboard 276
Smoke Tester 276
High-Pressure Hose 277
Protective Pigment 277
Light-Weight Pump 277

Current Bulletin Briefs 278
Our Book Corner 280
Telescoptics 283

SCIENTIFIC AMERICAN, June, 1947. Vol. 176, No. 6. 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.

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of June, 1897)

TESLA'S WIRELESS—"Very recently Nikola Tesla has announced that he has completed his wireless telegraph to such an extent as to permit of telegraphy through the earth for a distance of 20 miles or more, and his experiments satisfy him of the feasibility of wireless telegraphy on a much more extended scale. In fact, he aims at nothing less that the establishment of a system of telegraphy that shall include the whole earth, and by which items of news may be distributed from one political or commercial center to every other such center throughout the world. This, Mr. Tesla claims, is possible without the interference of one set of signals with another. . . While Mr. Tesla has been wrestling with this great problem in this country, Mr. Marconi, a young Anglo-Italian, has been working on the same line in England under the direction of Mr. Preece."

GAS ENGINES — "It is a noticeable fact that although the gas engine industry has been advancing with rapid strides in England and on the Continent, it has made comparatively slow progress in this country. . . The causes are various. They are chiefly to be found in the cheapness of steam coal and the high cost of gas in the United States. . . . It is reasonable to suppose that when this industry, which in respect of its proportions is yet in its infancy, has attained the importance which it has in Europe, it will tend to reduce the price of gas, especially such gas as is used for cooking and power purposes; and the gas companies, themselves, will undoubtedly benefit."

POPULATION — "Now that the city of Brooklyn and other suburban districts have been incorporated with the city of New York, the latter in point of population easily takes rank as the second greatest city of the world. London, of course, comes first with its great total of 5,600,000 souls."

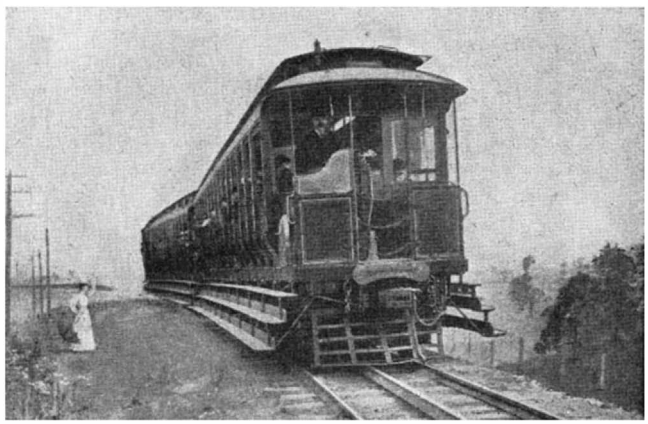
WOOD PULP—"While most branches of business have been languishing, the wood pulp manufacturers have had an unprecedented year of success, and, if the consumption of white paper is any indication of the true literary tendencies of the age, we have reason to congratulate ourselves upon the growth and spread of general education."

X RAYS — "To determine the nature of the X rays has, from the beginning, been a great problem for all investigators, and it still perplexes and baffles all. Are they, in reality, light rays or rays analogous to light, but of much shorter wave length, or are they projected matter? Both theories have advocates?"

FLIGHT — "Scientific experiment has been carried on by many able inventors in working on what may be called the true flying machine. . . This line of experiment has resulted in such great progress in the last few years (and especially so in the last six months) that the attainment of long, free flight for man, which not long ago seemed an invention for the far distant future, is a thing now near, if not quite at hand."

ALUMINUM — "In 1896 there were imported into Germany 591,500 kilos of crude aluminum. Of these, 467,600 came from Switzerland, 55,000 from France and 8,400 from Austria. In the first two months of the current year 138,900 kilos were imported, as against 65,900 for the corresponding month of the previous year."

THIRD RAIL SYSTEM — "The third rail system of electric traction is now in permanent operation on an important section of a leading steam railroad. The recent opening of the line from Berlin to New Britain and from New Britain to Hartford, while it is by no means the first successful operation of third rail traction, is notable as being its first application in a permanent way to the lines of a standard steam railroad. . . The third rail conductor is of a special section rolled for this purpose. . . The ends of the rail are bonded by sheet copper plates ⅛ inch thick, 4½ inches wide and 12 inches long, which are held against the under side of the flanges at the rail ends by iron plates. . . The current is taken from the third rail by means of a sliding contact shoe, which



consists of a simple cast iron plate. . . Each train is made up of a motor car and a trailer. Each motor car has two 125 horse power motors. . . The danger to the public from the use of the third rail is considerably less than is popularly supposed, and in view of the precautions which have been taken to safeguard the ignorant or unwary, the chance of accident is very small."

100 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of June, 1847)

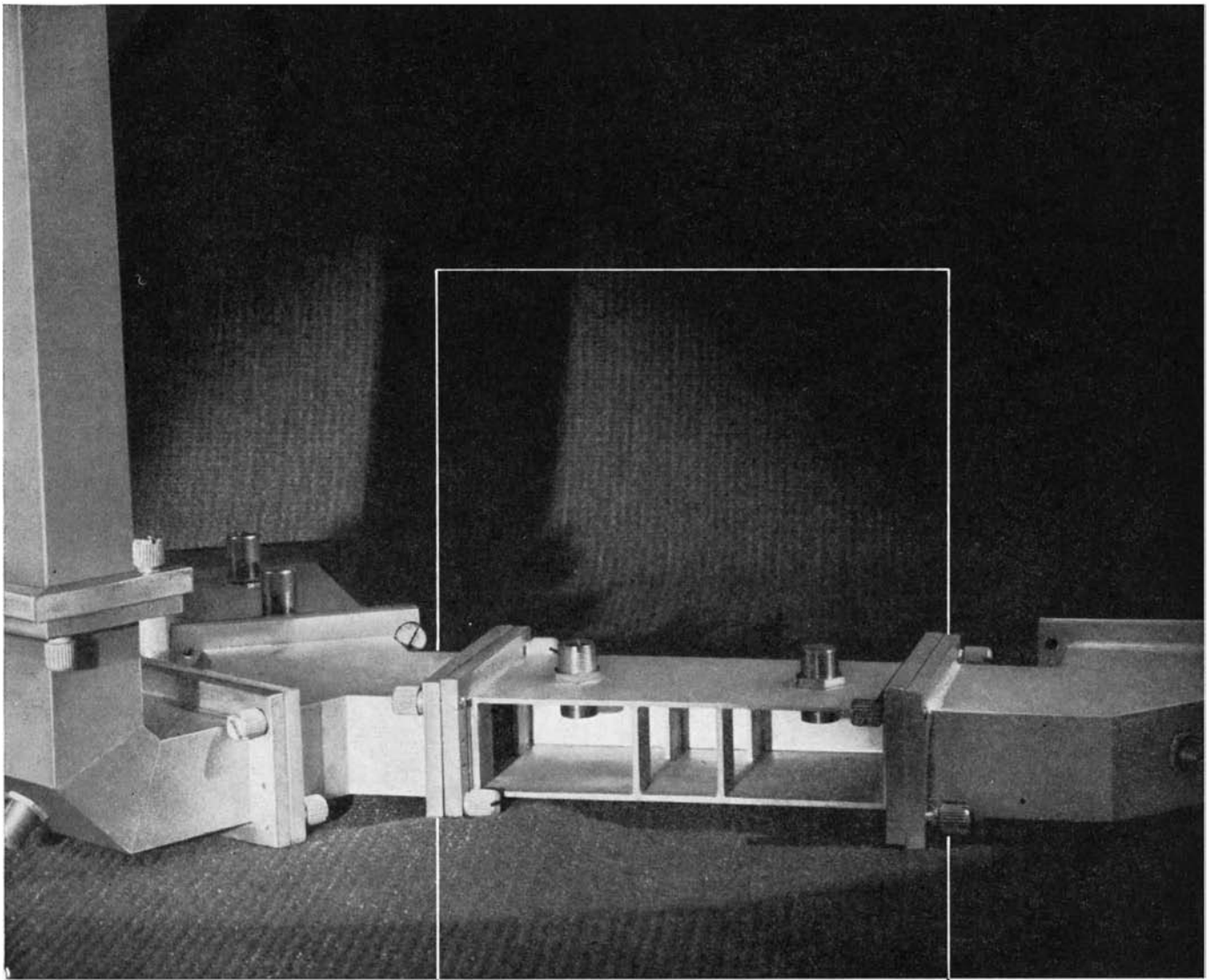
CASTING — "On last Saturday afternoon the 14th, Messrs. T. F. Secor & Company, of this city moulded the Bed plates for the engine of the new Steam Ship United States, one of the four packets to run between New Orleans and Liverpool. The casting weighed over 24 tons."

PRINTING PRESSES — "Messrs. Hoe & Company are making two huge Printing Presses for the New York Sun. . . All the motion is rotary, and it is calculated that in the saving of friction, and wear and tear by such means, the great amount of from five to twenty thousand dollars expense per annum will be avoided. It is calculated that these presses will be able to throw off 30,000 copies per hour."

CANAL BOATS — "About 1000 new canal boats are estimated to have been added to the New York Canals the present season, making with those previously registered, say 3,500. These at 80 feet in length to each, would make a line of boats over 53 miles in length!"

ASTRO-PHOTOGRAPHY — "To apply the telescope with the Daguerreotype in astronomical observations, has lately occupied the attention of the Royal Society of Bohemia. Professor Doppler says, that notwithstanding the extreme susceptibility of the human eye, it is surpassed many thousand times by an iodized silver plate."

CASEIN PAINT — "A foreign correspondent says that a paint has been used on the Continent with success, made from milk and lime, that dries quicker than oil paint, and has no smell."



The two filters in the picture (one with side cut away) are used to separate two radio channels coming in on the same antenna but on different frequencies. At the end of the connecting waveguide, the channels are made to part company, each going to a different circuit through its assigned filter.

SEPARATION CENTER

FOR RADIO WAVES

Thirty years ago, when all telephone service went by wire, Bell scientists developed means of sending dozens of conversations over the same line.

This they did by giving to each conversation a different *carrier frequency;* then to separate it from the others, they used a device which they had invented and named—the *electric wave filter.*

Today, in microwave telephone systems, the message-bearing waves pass to and from the antenna in pipes called waveguides. So scientists in Bell Laboratories devised a different kind of filter — a filter in a waveguide. This filter is a system of electrically resonant cavities formed by walls and partitions. Waves that set up sympathetic vibrations in the cavities pass through; others are reflected.

In the Bell System, now, single circuits are carrying many conversations at the same time through precision wave-filtering.

BELL TELEPHONE LABORATORIES

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

By A. P. Peck

NUCLEAR ENERGY . . . AND COST

WITHIN the next 18 months or so, industry will come one step nearer to a realization of the comic-strip artists' and Sunday-supplement writers' dreamy-eyed views of atomic energy utilization. No, there won't be magic pills to run automobiles, or 'round-the-world airplanes with a fuel tank the size of a fist, or home heating plants with a life-time supply of heat in a capsule. But there will be in operation at least one pilot powerplant generating electricity from a source of nuclear energy.

Big question whenever power generation from nuclear fission is seriously discussed usually is: How much will it cost? Most accurate answer to date is: No one really knows. But other answers loom on the horizon. Pilot-plant tests will reveal a lot. In the meantime, here is a statement from A. L. Baker, vice president of The Kellex Corporation, who has played a leading role in the development of atomic power:

"In evaluating the place of atomic power in industry," Mr. Baker says, "we must keep in mind that the high costs, such as were involved in the war-time program for the separation of fissionable isotopes, are not involved in industrial applications. People are too apt to think of atomic power in terms of hundreds of millions of dollars. The fact is . . . that the cost of an atomic power plant for industrial use is not greatly in excess of present costs of standard types of power plants. We have to dismiss from our minds the idea that great sums are involved. Even tens of millions are out of the picture. Actually, an atomic power plant could possibly be built for a few million dollars."

That's one view of costs. Technical bugs there will be aplenty. That these can be solved goes without saying, because the means of solving them are within reach. Practical applications of atomic power in the near or more distant future revolve around the cost factor, the technological factor—both largely predictable—and the completely unpredictable factor of international politics.

INDUSTRIAL TELEVISION

WHERE there is an advantage of watching a process or operation from a distance, television furnishes a means. One such use in boiler rooms was described on page 126, March 1947 Scientific American. Still newer equipment broadens the horizon: Time and motion studies, viewing processes that go on in closed vessels or in toxic atmospheres, removing operating personnel from hazardous to safe positions, are only a few of the ways in which industrial television is being put to work.

DUAL-PURPOSE PACKAGING

PRODUCERS of consumer goods can boost public acceptance by giving more attention to packaging. This has been amply proved by attractive packages, but there is a lot more that can be done. Belts in plastics cases that can later be used as cigarette boxes are one of the oldest examples of practical dual-purpose packaging. Now comes cereal in a box that later becomes a child's toy. Then there is the insecticide packed in a dispensing container, a whiskey bottle whose plastics case finds favor with the distaff side of the family, and a window cleaning fluid in a bottle from which the fluid is sprayed as needed.

There is an endless variety of products whose manufacturers can profit by these few examples. They range from face power through carpet tacks to machine tools. Remember the old story of Ford's specifications for packing cases? As we recall it, parts purchased by the Ford Company had to be delivered in wooden cases of such size and material that, when taken apart, the boards could be used in the bodies of Model T's.

Dual-purpose packaging can take one of at least three forms: The package can dispense the product, can be put to other uses after the product is removed, or can serve (in the case of durable goods) as a permanent storage container.

COMPETITION FOR LEAD

NOW selling for more than double its war-held price of 6.5 cents a pound, scarce lead is once more coming into plentiful supply. In the days of lead scarcity, however, other materials encroached on fields where the soft metal formerly held full sway. Aluminum, for example, started into the foil market in a modest way; now it is bidding for the lion's share. In collapsible-tube manufacture also, aluminum has obtained a good foothold which present-day costly lead will have to fight hard to dislodge.

Plastics, too, are eating their way into former lead applications. They can replace lead in tank linings and pipes in chemical industry and in cable sheathing in the electrical industry. Substitute pigments are being developed for paints, to take the place of time-honored white lead. Glass and rubber offer many of the inert advantages of lead and are being used for jobs where lead was formerly the only material considered.

STRAWS IN THE WIND

A "JET PROPULSION" heater for orchard protection against frost burns oil fuel without smoke, circulates warm air more efficiently than smudge pots; applications of the principle to industrial dehydrating and drying operations, where flame noise is not objectionable, are predicted . . . Dreams of a helicopter in every backyard still seem far off; two-place flying "egg-beaters" are on the market—at $25,000 each. . . . All-natural rubber tires, when they again reach the market, will probably demand premium prices; tire manufacturers favor a blend of natural and synthetic.

BETTER VISION Boosts Production

By Adopting Plant-Wide Vision-Testing Programs, and by Applying Corrective Aids Wherever They Are Found to Be Necessary, the Vision of Workers Can Be Brought to the Optimum. Results Will Include Better Quality Output, Greater Worker Comfort, Reduction of Accidents

By ALLEN C. HOLLAND, O.D.
Chairman Occupational Vision Committee, American Optometric Association

AN INCREASE of 20 to 25 percent in production can be achieved in the average industrial plant by the application of tried and proved rules for better vision.

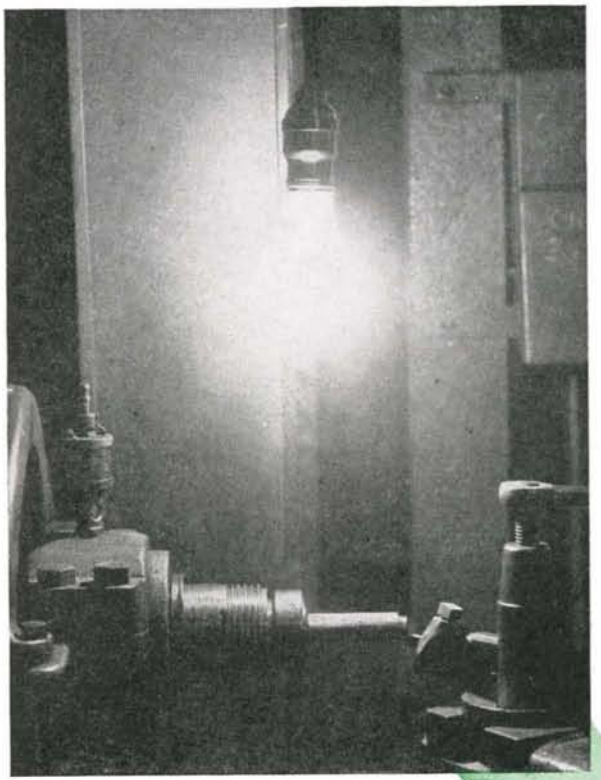
This statement is based on the experience of hundreds of companies which are offering dramatic proof of the value of systematic better-vision programs. For example, one survey indicates that 37 percent of all spoiled work in industry is traceable to visual inefficiency.

Good vision pays dividends to both employer and employee. In one plant a group of solderers on piecework earned 14 cents an hour more than another with inefficient vision, largely because their work was of better quality, measured in fewer rejects. A company reported that it earned 5 percent more on capital invested in equipment used by employees with efficient vision compared to those who rated substandard.

An employer who instituted a visual corrective program and established better lighting, raised production 19 percent and improved quality 16 percent.

Industry is just beginning to recognize the part vision plays in safety. Every ten seconds a worker is injured, the financial loss being about 2.5 billion dollars a year, and many accidents are due to inefficient vision. The worker who does not see

Courtesy National Better Light Better Sight Bureau
Planning that avoids glare and shadows also reduces accidents and spoiled work



Courtesy Better Vision Institute, Inc.

Open lights, improperly placed, produce uncomfortable glare and cast deep shadows on work. Results: Inferior workmanship, high accident rates, increased spoilage

properly is dangerous both to himself and his fellow workers.

Establishment of good vision is not a panacea for industrial inefficiencies, nor for high accident rates, and there is no single secret to good vision. However, experience in industry has made it possible to lay down some specific principles which, if followed, are likely to prove profitable for any company.

An encouraging fact is that more than 90 percent of industry's vision problem can be solved by the simple procedure of bringing each employee's vision up to its highest possible level through professional attention.

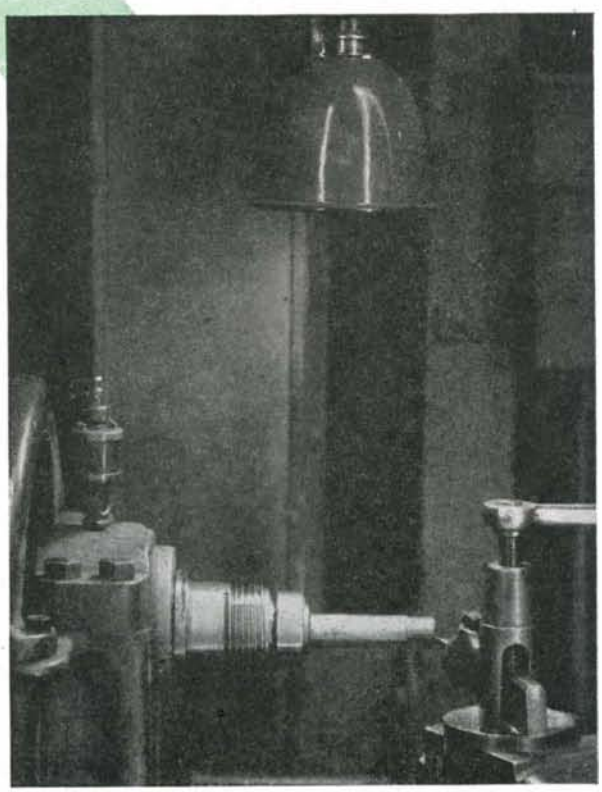
The objective of a better-vision program is not to screen employees out of industry, but to improve visual efficiency and to help match the employee or prospective employee to the job for which he is best fitted.

MOST TESTS INADEQUATE—Today only one company in seven has anything like an adequate vision program. In many companies there are no vision tests, and in hundreds there is nothing but the common Snellen test in which one reads letters on a chart at a distance of 20 feet. This is of little value in the scientific program which industry needs. A person with normal vision rates 20/20 in this test, but "normal vision" as measured on a distance chart may not be satisfactory for near work. A job may require good vision at 14 inches if the work is done at a bench, or at 60 feet if it involves operating a crane. The Snellen test gives little indication of one's suitability to a particular job. It is necessary to go far beyond it in matching workers and jobs.

In a group of about 200 workers who performed an intricate looping operation at very close range in hosiery production, it was found that those who had "poor vision" by the 20-foot visual discrimination test were consistently better producers. In other words, those who were below normal by the common standard were superior for this particular job. If workers had been picked for this job by the Snellen test alone, the best operators would probably have been rejected.

Through hundreds of generations man was an outdoor animal requiring eyes that focused best at a distance—on the animal he stalked or on the enemy on the far horizon. It is only in the last few generations that so many millions have become dependent on occupations that require near-point vision, and much must yet be done to make our vision what it should be at the working point.

SPECIALISTS NEEDED — When a company decides to institute a better-vision program, one of the first requirements is to realize the importance of a vision specialist. The optometrist is such a specialist. He makes a complete visual analysis and prescribes and adapts opthalmic aids, or administers visual training where necessary. He is trained to recognize disease in the eyes and when such is found to be present he refers the patient for other pro-



Properly shaded lighting eliminates glare and reduces shadows. The workman can see his job better, is less prone to accidents, and will spoil less material under these better lighting conditions

Jobs throughout industry analyzed from the standpoint of vision requirements . . . Minimum visual standards for each job established, meeting which will become as important a consideration as aptitude, experience, and training . . . Company-supervised vision programs aiding safety and efficiency.

fessional care. The opthalmologist and oculist are physicians specializing in the pathology and surgery of the eyes.

Professional services may be obtained either by maintaining complete facilities and personnel within the company, or through outside practitioners.

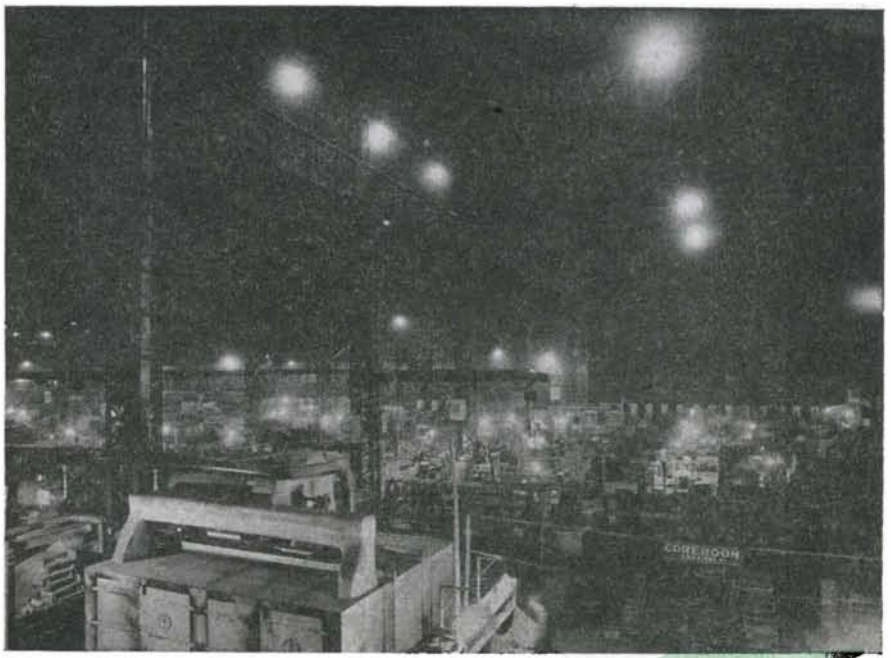
A better-vision program must be a co-operative project involving teamwork, particularly of the vision specialist, foremen, and engineers who together can determine the visual requirements for each job and the visual standards which the employee should meet for adequate job performance.

There should also be teamwork in seeing that lighting and painting make maximum contribution to visual efficiency. Some of the questions to consider are:

Is there adequate lighting, particularly in critical work areas?

Is maximum use made of light and paint to make the environment pleasant?

Are contrasts used to aid discrimination?



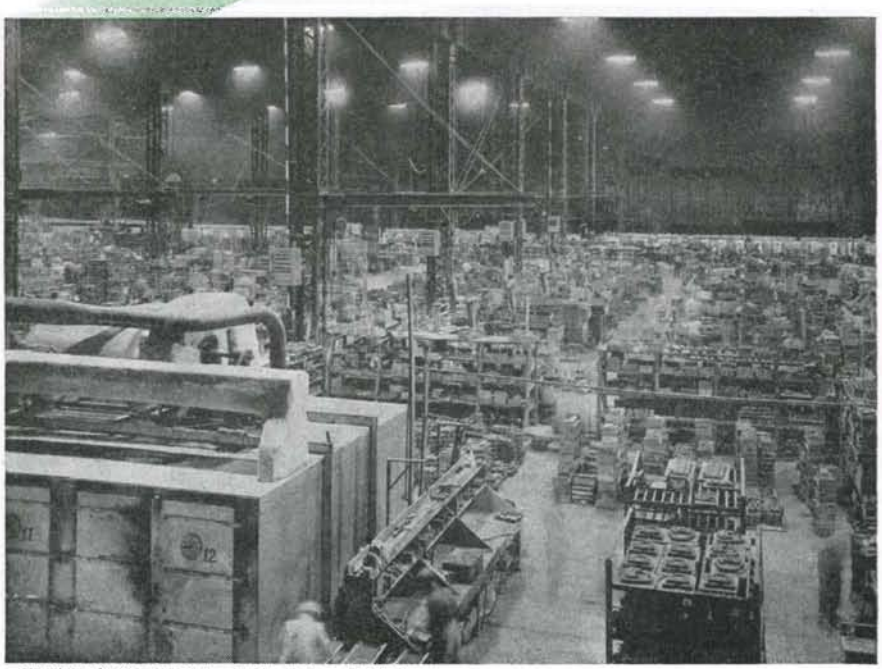
"Before" and "after" (above and below) adequate lighting for good vision was installed in a foundry

Is there a minimum of glare?

Illuminating engineers have done a great deal of research in this field, and advantage should be taken of the service they can give.

A VISION PROGRAM — The major steps in a better-vision program for an industrial company are:

1. Sell the program to employees by explaining it fully.



Courtesy National Better Light Better Sight Bureau

2. Analyze each job to determine its visual requirements, hazards, and so on.

3. Test vision of employees and prospective employees by methods which determine suitability of the individual to his particular job requirements.

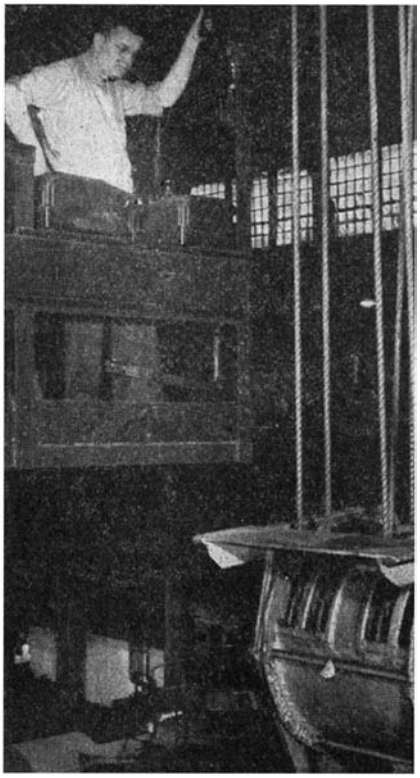
4. See to it the necessary corrections are not only prescribed but actually made—proper lenses, proper fitting, eye training, and so on.

5. Make sure that protective-corrective eyewear is used where needed.

6. Re-check periodically, particularly employees who are accident-prone or who have unusual visual problems.

Selling the program to employees is an industrial relations job, the importance of which cannot be overemphasized. Unless the program is frankly and thoroughly explained, over and over, there will be rumors that it is a scheme to screen out workers. An early step should be to make the program clear to union leaders. When they are convinced that it is beneficial to all they will help sell it. Employee meetings and the company house organ may be used in an intensive educational program. Supervisory employees should be thoroughly informed so that they can answer questions and allay fears.

JOBS ANALYZED — Job analysis from the standpoint of visual requirements is a comparatively new subject, but it is not as difficult as it may seem. As has been said, visual acuity at 20 feet does not tell much about one's suitability for a



Courtesy Better Vision Institute, Inc.

Although near-point vision is usually one of the biggest problems in industrial sight, some jobs also require good vision at a distance. An example of this requirement is found in the case of the overhead crane operator

particular job. Some of the more common requirements in typical industrial jobs are:

Near point vision. Work point for the hosiery mill operators who made loops with fine thread was about eight inches from the eyes. Most bench and desk work is done with greatest comfort when the eyes focus and see properly at a distance of about 14 inches. Near point vision is one of the most important factors in an industrial program. Although some jobs require both near point and distant vision, few require distant vision only.

Depth perception. Most skilled industrial jobs require ability to judge relative distances. In assembly of small parts, or in adjusting work in a machine, good depth perception is essential. It is also an essential to the automobile and truck driver.

Field of vision. In most jobs one must be able to see to the sides as well as straight ahead and, where work moves, one must be able to follow it comfortably with his eyes. Too small an arc of vision makes one especially prone to accidents because he fails to see danger approaching from the side and, equally important, he is dangerous to his fellow workers.

Color discrimination. About 8 percent of all men and ½ of 1 percent of all women are color blind, and there are wide variations in ability to discriminate between colors by others who are not rated as color blind. Color discrimination is essential only in some jobs.

It is not difficult for a vision specialist and a foreman or engineer to check each job on such major points as these. A tabulation can be made of whether the worker in a job must, or need not, be normal or above on each point. Often slight changes can be made in lighting, placement of work, location or adjustment of machines, and the like to make the visual requirements simpler.

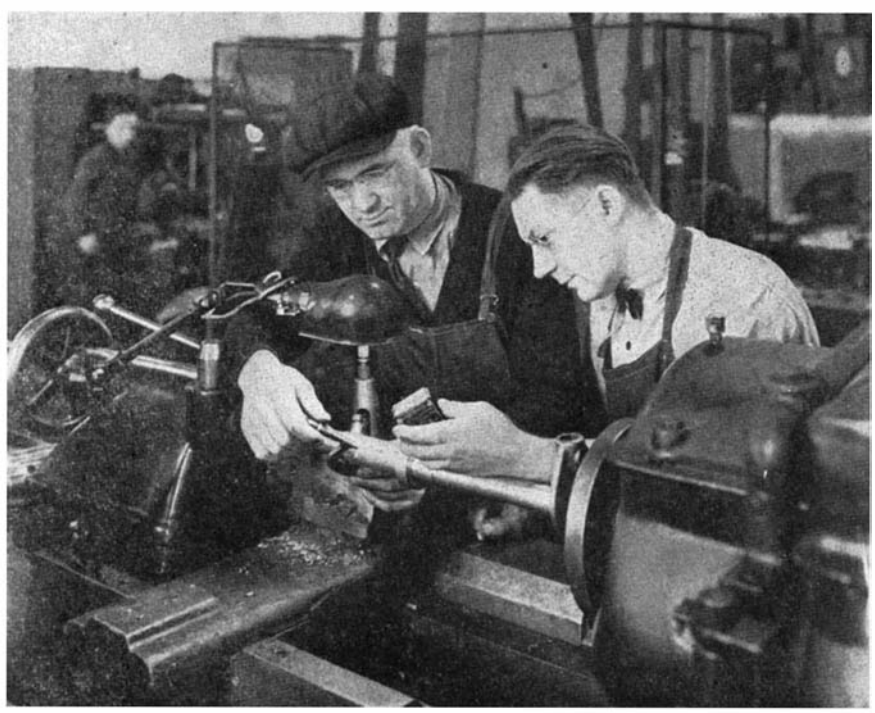
MATCH MEN AND JOBS — When the job requirements are tabulated, each employee and prospective employee should be given visual tests to determine whether his visual skills match the requirements set up for his job. Here, again, it should be stressed that if his visual skills do not match the job he has or wants, there are more than 90 chances in 100 that they will match that job or one equally good in the same plant when the usual corrections have been made. Visually as in every other way there are wide individual differences, but job requirements fortunately vary just as widely. Industry can accommodate even the blind.

The most common corrective measure is fitting proper lenses, although in many instances visual training to improve visual facility brings about corrections which cannot be achieved by spectacles.

When lenses are prescribed there should be careful re-evaluation to see that the prescription is properly filled and the spectacles properly fitted. Sight is not a simple mechanical process, like a camera recording a picture. It involves mind, muscles, and nerves, and one of the principal objectives in a better-vision program is to help each employee to see comfortably. The worker who sees without undue effort is less subject to fatigue and its attendant psychological and physiological disorders, and is likely to be a higher producer and a safer worker.

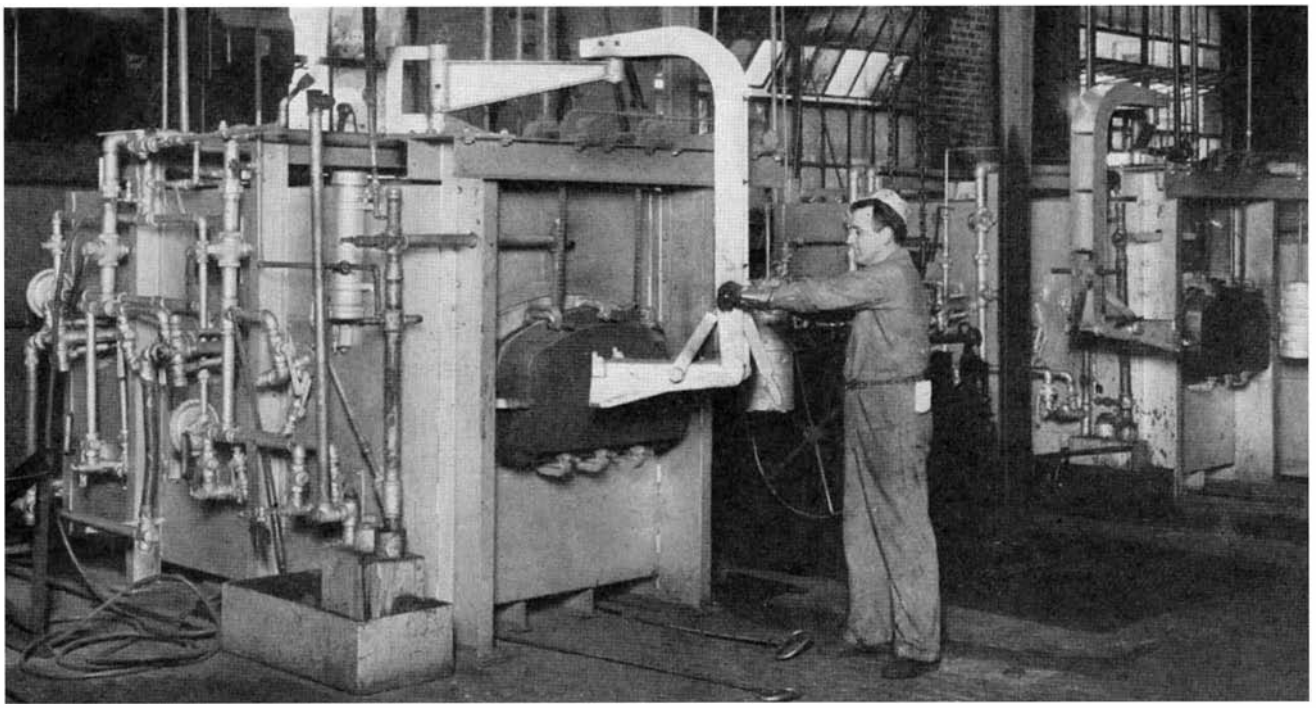
If you go out into your plant you may find many employees with their spectacles or safety goggles in their pockets. Something is wrong with a vision program when this is too common. One of the preventives is to have frequent re-checks. This is especially important for employees known to have out-of-the-ordinary inefficiencies or those who are accident-prone. Visual capacity changes with age and under strenuous working conditions; lighting and other factors also change. The spectacles which are right today may be unsuitable in a few months.

Asking the question, "Do you see comfortably?" is a good test of a company's vision program. If there are only a few negative answers, the chances are that insofar as vision is a contributing factor the production per worker is high and the accident rate is low.



Courtesy Better Light Better Sight Bureau

A light-meter removes guess-work from the job of determining whether adequate standards of lighting for near-point vision are being met at this lathe



Clad steels lead to new heat-treating methods

Processes have Families

By EDWIN LAIRD CADY

Significant Industrial Developments Invariably Initiate Great Series of Inventions, Refinements, and Modifications. So Broad May be the Scope That Ultimately Not a Corner of Industry is Unaffected

BEFORE this year is over, the Lukens Steel Company will have announced new kinds of stainless clad steels. In the making are new and dramatic studies of the sciences of stress relieving, as worked out by scientists of that company. Competitors Allegheny Ludlum, Republic Steel, and the others are hot on the same trail, will have announcements and papers of their own.

Products of those kinds are not created over night, and neither are the scientific papers that go with them. The two are counterparts of each other. Every new product or process brings whole tribes of machines and other products into the world. The speed with which these grow depends upon the scientific papers. And as the tribes grow so do the new developments themselves become strong and healthy.

Clad steels, for example, lead to welding. They lead also to brand new heat treatments, and to new metals-cutting processes. All of these new processes or variants of old processes need either new equipment or adaptations of old equipment, much of which has yet to receive its first pencil marks on the draftsman's schematic sketch pad.

There are reasons for putting stainless steel cladding on ordinary carbon steels. Stainless steel is resistant to corrosion, is highly resistant to wear, and has high ratio of strength for a given weight. But the carbon steel averages less than one sixth the cost of the stainless, is much higher in its ability to conduct heat, has plenty of strength in its own right, and is much easier to fabricate by welding, machining, forming, or any other process.

Put the two together and a great many problems are solved—and a great many new difficulties are created.

CLADS WILL GROW — Many a product needs to be corrosion- and wear-resistant on its surface only. Make that product entirely of stainless, and its cost is higher than for the clad. Many another product has to be corrosion-resistant and at the same time has to conduct heat. Make that one entirely of stainless and

• LOOKING AHEAD •

New tools and techniques making stainless clads as workable as carbon steel . . . Methods and equipment thus born aiding all branches of metal working . . . The end result—more efficient handling of a great variety of materials, many of which are in no way related to the stainless clads.

the heat conduction goes down so that the heat is localized. It is much easier to burn food in an all-stainless pan than in a carbon steel one. But make the pan of clad steel and the corrosion resistance of stainless is combined with the high ability of carbon steel to spread the same temperature to all parts of the pan.

The same difference of qualities cause the troubles. Try to roll, stamp, or swage a clad sheet and the carbon steel flows easily beneath the pressure while the stainless portion holds back. Try to machine it and the two alloys need entirely different tool angles, cutting speeds, and feeds. Try to weld it and the stainless needs different rods, electrical currents for flash or resistance welding, stress-relieving treatment after welding.

Industry never is defeated by such difficulties. Stemming from the scientific papers and bearing their real fruit in the more direct and diversified articles in the technical magazines will be the answers.

Equipment makers will put these answers to work. There will be hundreds of new furnaces and clamps for taking the residual stresses of welding out of clad steel products without allowing the carbon and stainless steels to distort each other. New salt-bath techniques will attack the same problem. New welding machines, welding rods, punch presses, bending rolls and brakes, metals spinning machines, cutting oils, flame machining equipments, will come along. Many a product will be designed to have the stainless-steel component flat or otherwise contoured as received from the steel mill, the machining and other forming to be applied to the carbon steel component only. This technique will bring greatly increased use of shapers, planers, and milling machines.

The changes will not stop with their applications to clad steels. Other products, such as castings, forgings, and extrusions, also need better stress relieving and better all around processing techniques. The developments created by problems of clad metals will improve dozens of products which compete against clad metals.

TOOL PROPAGATION — On the subject of newly developed clad steels it is necessary to look prophetically. Industry can see much, but by no means all, that is going to happen. Tungsten and other sintered carbide tools, however, are older and better developed. Industry can look at their effects historically.

Without stampings, there might be no electron tubes

Sintered carbide tools were first developed in Europe. The Germans hoped to win World War I with them. Such tools could machine steel at rates as high as five times those possible for high-speed steel tools. The man power thus freed from the factories could be put into the trenches.

Machine-shop operators in the United States soon found that the material had a handicap. Carbide was somewhat brittle. This had meant little to the Germans who believed in manual controls for machine tools. A skilled man who operated a lathe could change his feeds and speeds and make other adjustments when the cutting conditions threatened to break the tool. But our practice was to use automatic, semi-automatic, and integrated controls. Our labor could run machine tools after a few months of training, whereas the German mechanic was trained for years. If we wanted to use the carbides, we had to improve the machines. There followed 20 years of intensive development. It is still going on.

Lathes and other machine tools were completely redesigned to make them stiffer. Many of the deflections which had permitted the tools to get slightly out of line had come from the actual bending of machine members under working stresses. Now the members must not bend, and the stresses might be as much as 50 times higher.

New and stiffer cast irons, such as the Meehanite types, were put into machine tools. Preloaded ball- and roller-bearings, bearings which retained all of their anti-friction characteristics, but had heavy initial loads on their rolling members to take out the initial elasticity, were put into the mountings of machine-tools spindles and other important members. Elasticity at the bearings could mean deflection at the tools, and deflection meant broken carbide.

NEW SCIENCE BORN — Vibration would break carbide tools. Stiffening the machines did not seem to take the vibration out. A special science of finding the causes and cures of machine vibrations was born. Pads of rubber and cork, sometimes weighing several tons, were put under heavy presses and other percussion machines so the heavy hammer blows at those machines would not appear as vibrations at nearby lathes. Vibration usually appeared at the sonic frequency, or a harmonic of the frequency, of some members of the tool mounting. All parts of machine tools were tested for their sonic frequencies, and redesigned so that the frequency of

Carbide tools, when first developed, were easy to use with manual control. But the carbide family had to multiply before the tools could be successfully applied to automatic and integrated machine control

one member would dampen that of its neighbor. Special metallurgical structures were developed in cast metals. Those structures were dampening to vibrations.

Slowing downs of machine speeds under heavy cutting loads had been taken for granted. But the slightest variation of this kind could break a carbide tool. New electric motors were designed, and with them better V-belt drives and flat belt drives and chains and gearing. The positive actions of clutches took on new meanings. Machine-tool spindles no longer slowed down when the cuts became heavy.

Cutting oils were improved. The carbide tools did not need them so much, but the heat of higher cutting speeds tended to expand the work pieces and lose the accuracies unless cutting oils kept them under better control. Every device which held, controlled, or guided a tool came in for its share of attention.

On some tools and applications, carbides simply could not be used—lathe tools making heavily interrupted cuts, for example, and drills which were apt to release their cutting pressures suddenly when they encountered porous shrink areas within sand castings. But all the improvements for the sake of carbide tools had been improvements for high-speed tools too. Every operation which could not be performed by carbide now could be handled to immensely better advantage than ever before by high speed steels. But the development was not finished. Carbide tools were saving money. That money could be spent on higher accuracies, better heat treatments, higher strengths in machinery for the same weights.

More and better grinding machines came into use. Lapping, honing, super finishing so that the variations from true flatness or other contours of surfaces could be held to less than one-millionth of an inch, all became commercial processes. Intensely close control of heat treatments so that the strength and hardness of a machine part could be predicted within very fine limits was also developed by spending the money saved by carbide tools. As one process promoted another, the modern automobile, airplane, and television set became possible.

MATERIALS MULTIPLY — While all this was going on, the raw materials makers were not idle. If not uniform in their constituents, hardnesses, toughnesses, and machinabilities, alloys also can set up shock and vibrational loads which will break carbide tools. The steels were made more uniform, more dependable. Uniformity had to be even better for grinding, lapping, and heat treating. The steel metallurgical laboratory formerly had been a quiet corner where long-haired metallurgical scientists could draw their salaries provided they did nothing to disturb the production line. The production line now has become a body of which the metallurgical department is the brains.

There is not a chemical process, power plant, production textile machine, mechanical refrigerator, engine of war, nor any other product which has not changed, and changed radically, because of the improvements in machine tools which carbide tools instigated.

Metal stamping is in similar case. The continuous steel strip mills with their hundreds of electronic tubes and thousands of miles of electrical wiring are but servants created by a stamping industry which needed their products. Electronic tubes themselves might be impossible to make at commercial prices if there were no stampings.

Dozens of other materials and processes are coming along. Their children and tribes will change the trends of history just as surely as did the abrupt and unforseen hordes of Ghenghis Kahn.

Precision investment-casting is a process to watch, and powder metallurgy, and argon gas as a servant of welding, and of every metal process which needs controlled atmospheres.

The greatest industrialist of all time would be a man who could watch the scientific papers for basic principles of such developments, watch the technical and scientific magazines for down to earth factual reports on progress, and then predict what families of materials and processes were going to be born, and how soon they would become strong.

HYDRAULIC ACCUMULATORS

Designed for Aircraft, Find Wide Industrial Uses

AIRPLANE accumulators, used to actuate the hydraulic landing gears and other mechanisms of airplanes, are simple, light-weight devices consisting generally of cylinders having opposed pistons or other moving members to accomplish the same purposes. At one end of a piston will be air, and at the other, the hydraulic fluid. Applying force on the hydraulic fluid drives the piston, compressing the air. Releasing the hydraulic fluid valve permits the compressed air to expand, moving the fluid which in turn actuates the mechanism. If the actuation is wanted only at reasonable intervals then the fluid can be pumped very slowly into the accumulator, thus securing plenty of quick power at low power cost.

Machinery makers have been grabbing the war surpluses of these accumulators as fast as they can find them, using them to actuate mechanisms of welding machines, plastics presses, paper making machines, or booster mechanisms for conveyors. The industrial market for airplane accumulators threatens to outstrip the aircraft one.

Demobilized Microwaves

Microwaves, Having Long Been Publicized as One of Our Greatest Military Tools, Are Now Finding Their Place in Civilian Industry. Here They Are Adding New Techniques to Established Electrostatic Heating Methods, Lending New Speed and Efficiency, Opening New Uses

By VIN ZELUFF
Associate Editor, *Electronics*

DEVELOPMENTS and applications of electronics in recent years, replacing older methods of doing certain jobs, are rapidly being expanded into still wider fields, and even are themselves being replaced by newer electronic techniques that can do a faster, cleaner, more efficient, and more economical job.

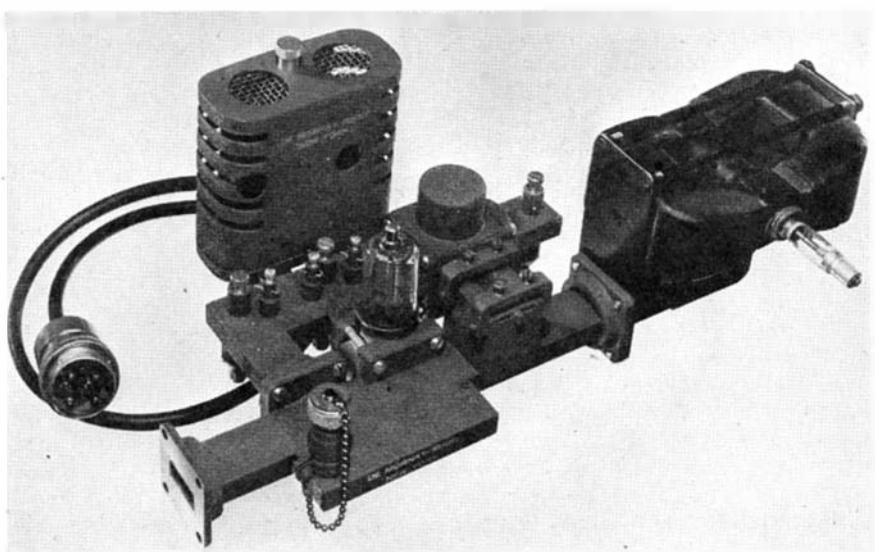
One expanding technique is that of dielectric heating. For many industrial applications it has done work that no other method has ever done before, yet even these methods may be relegated to the limbo of forgotten processes as tubes and circuits for microwave generation—of frequencies greater than 300,000,000 cycles—are further developed and applied.

Almost all of the microwave tubes that have been built in mass production for war use operate to supply radio-frequency power for only a small fraction of a second at a time. Although the peak power produced during that short interval of time is on the order of a few million watts, the average continuous power is seldom over one thousand watts. This amount of average power is useful for heating a small batch of material, about the size of a man's fist, for example, but for many industrial applications several thousand watts are required to do a good heating job quickly on the area, mass, or quantity of object that is to be heated.

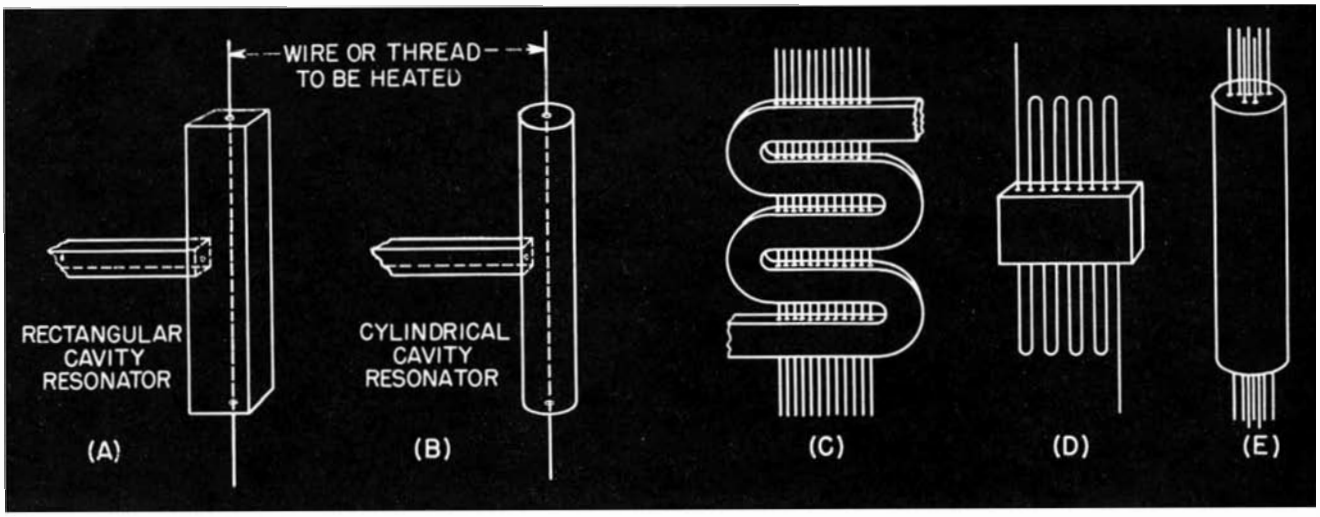
Even if the extremely high power that is developed by microwave tubes during the extremely short interval is fed to the conventional type of electrodes used in dielectric heating, the work piece would be subjected to tremendously high voltages momentarily, and a considerable number of precautions would need to be observed to prevent damage due to arcs flashing between the electrodes and through the material being treated, causing searing and burning.

Now, however, two tube types are available for continuous microwave heating—the resnatron and the split-anode magnetron. The latter develops ten kilowatts of radio-frequency power continuously at an efficiency of 50 percent. This power is produced at wavelengths between 0.4 and 0.9 meter. The resnatron, a higher-power type of beam tetrode (big brother of the beam-power 6L6 output tube used in radio sets) can be used at wavelengths between 0.1 and 1.0 meter as either an amplifier or an oscillator. Under continuous operation, it is capable of handling about 50 kilowatts of radio-frequency power at an efficiency ranging up to 60 percent. In other words, it draws about as much from the power line as 850 hundred-watt lamps wou'd take.

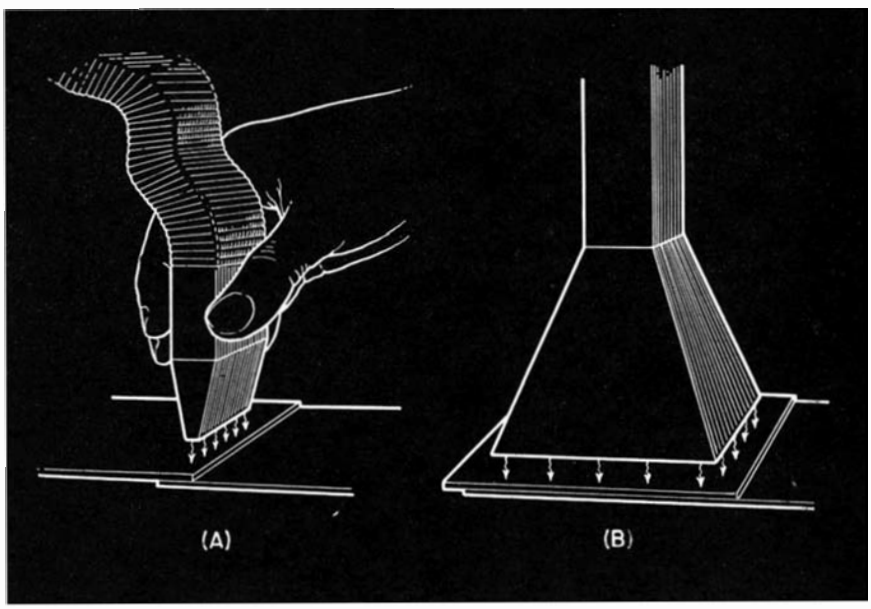
WAVEGUIDES — One of the characteristic peculiarities of microwaves is that ordinary types of electrical transmission lines cannot be used. Such lines act very efficiently as antennas, and radiate the electromagnetic power into space, instead of conducting it to the work. Ordinary insulated wire leads connected to electrodes in a dielectric heating installation are useless at the microwave frequencies. "Waveguides" must be used for conducting the microwave electromagnetic power. These consist of actual copper pipes, highly refined it is true, but nevertheless pipes. With silver-plated interiors, special gas-filled affairs in



The oscillator tube of this packaged microwave generator is the magnetron, shown at the extreme right surrounded by its two powerful permanent magnets. The output waveguide connection is made to the rectangular flange at left



Various methods for applying microwave energy to threads and wires (above), and also to sheet materials (right)



• LOOKING AHEAD •

Continuous, high-speed production of such thin materials as printed cloth and paper, sheet plastics, and plywood . . . Rubber, nylon, and rayon thread materials produced at a greatly increased rate . . . Cooking of hot dogs, cakes, and even complete meals accomplished in a matter of seconds.

some instances, these hollow pipes act as conductors of electromagnetic waves or project them from an open end.

Another important microwave accessory that is difficult to visualize is called a resonant cavity. This consists essentially of a specially dimensioned section of waveguide in which electromagnetic oscillations can be made to occur, just as sounds of a certain frequency are produced in the cavity of a whistle or organ pipe. Electrically the function of such a cavity is similar to that of the tank circuits in conventional radio sets.

A cavity resonator can be used for heating rapidly moving thin sheet material. An electromagnetic field of uniform character is created which is maximum at the center of the cavity or guide. By passing strip material through slots at the top and bottom of the cavity it is subjected to the strong field. Because standing waves are formed along the length of the cavity, however, the material would be heated unevenly if passed straight through the cavity. (Electrical standing waves are alternating points of high and low electrical intensity along the path, just as waves on water are alternate high and low points on the water's surface.) Making the entry and exit points a half-wavelength apart, and passing the material through the cavity at an angle, insures uniform heating.

USES OF HEAT — Many industries now use dielectric heating for drying, curing, or setting resins or glues in continuous processes. Cloth is dried after dyeing, printed cloth requires rapid drying of the inks, and paper is often dried by this process. Some of this work is done in bulk, with the material being placed between the electrodes of a dielectric heating generator. In other cases, the material is passed in strip form between the electrodes, which are then necessarily placed close together. This latter condition causes some difficulty, however, as the voltage produced between the electrodes at conventional frequencies is quite high, and there is the danger of flash-over through the material.

For thin materials such as paper and cloth, it is difficult to apply sufficient voltage to the electrodes without flash-over, and still obtain enough heat in the material. Use of microwave energy from waveguides eliminates the electrodes and their attendant high potentials and should allow high-speed automatic heating of the thinnest materials.

Many commercial heating jobs can be done by this method of sending radio waves through pipes. Bonding and drying of wallboard materials, floor covering materials such as linoleum, and plastics-bonded cork materials are only a few applications. Continuous curing of sheet rubber, plastics, and synthetic materials, and production of plywood on a continuous basis are still other likely applications.

In some cases it may be desirable to heat sheet material with a microwave antenna similar to that used last year in sending radar signals

to the moon. The antenna is put to work as a means of coupling energy into the material to be heated. Such a "bedspring" antenna is designed to have uniform distribution of field and can be used to heat a large sheet of material. The shape of the antenna is somewhat flexible and can be modified for efficient heating of various widths and shapes of material.

HIGH-SPEED HEAT—Thread materials such as rayon and nylon must be cured, dried, and the twist set during manufacture. Rubber thread material, both synthetic and natural, must be cured. Many insulating coatings on wire, either rubber, synthetic, or enamel, must be dried or cured. For all of these operations, heat must be applied to the material at high speed. With conventional heating frequencies it has been impossible to couple energy into such materials at a rate suitable for mass-production requirements.

Microwave energy can be applied to these materials in a long cavity through the center of which is passed the wire or thread that is to be heated. For efficient production a number of wires or threads can be passed through at once lengthwise or through holes in a folded section. These same means of increasing coupling efficiency could be applied to sheet material.

In the lumber industry, many problems of gluing await solution by dielectric heating. Spot gluing and edge gluing could be accomplished by the concentrated field made possible through the use of openings in waveguide structures. Holes in folded sections of waveguide structures would apply concentrated fields to the glue line.

Continuous bonding of plywood by passing it through a slot in a cavity would make possible a process which has not yet been tackled because of the major difficulties encountered by conventional press designs and curing methods.

In the plastics industry, radio-frequency energy is widely used for preheating material prior to molding. Conventional frequencies used in dielectric heating adequately supply the heating rates normally used for hand-fed press operation. High-speed automatic operation could now use radio-frequency energy to advantage, however, if sufficiently fast heating rates can be obtained by microwave energy. Jet molding on an automatic basis could easily become one of the faster means of molding thermosetting material.

Microwave energy piped to numerous press positions from one central generator may be the future answer to many a molder's present problems. Central generators supplying many operating positions have not proved too satisfactory at conventional frequencies because of the many electrical problems encountered.

Courtesy Raytheon Manufacturing Company

Microwaves cooked this steak dinner in just 35 seconds

For plastics and synthetic materials there is a rapidly growing demand for bonding or sewing of sheet material such as the vinylidene chloride materials. Here again conventional dielectric heating at low frequencies is relatively slow and microwave energy properly applied may be the answer. It may be possible to bond such sheet materials at a high rate with simple handling equipment. Using presently available flexible waveguides, such a bonding operation could result in a flexible hose from whose open end microwave power would emerge like water from a garden hose, and be equally controllable.

MICROWAVE STOVE — Similarly, a divergent taper at the end of the hose could be attached to provide a horn-shaped affair that would spray microwave energy over a larger area. Fittings of this latter type are already in use. The Radarange made by Raytheon utilizes this type of construction. The flared portion forms a "horn" antenna fed by a magnetron tube mounted above the apex of the horn. Microwave energy radiates downward, out of the flared portion, and into the food below.

The commercial model Radarange was engineered and designed primarily for extremely rapid cooking of foods served by the quick-lunch counter and the drive-in type of restaurant.

Use of Radarange results in a reduction of food handling, elimination of waste, and increase of overall economy. It cooks a hot dog in roll in 15 seconds, pre-cooked beef steak in roll in 15 seconds, grilled ham and cheese in 18 seconds, raw hamburger with onion in roll in 35 seconds, and it bakes gingerbread from batter in 26 seconds, corn muffins and other types of cupcakes in 26 seconds.

The sandwiches can be at refrigerated temperature going into the machine and at approximately 200 degrees, Fahrenheit, coming out. Most meats and vegetables can be

cooked in approximately two minutes.

Input power requirement is 4½ kilowatts, this power being supplied at 115 volts, 60 cycles, A.C. at 40 to 45 amperes current consumption or 230 volts, 60 cycles A.C. at 20 to 22½ amperes current consumption. Basically, the input line voltage is stepped up by a transformer to 4000 volts, rectified, and fed to the magnetron oscillator.

Radio-frequency energy output of this tube is oscillating at a frequency of 3,000,000,000 cycles per second, a microwave wavelength of 0.1 meter. No heat whatsoever is generated until the energy is transmitted into the food, whereupon the molecules of the food itself rotate in synchronism with the radio-frequency energy. The friction caused by the agitation of the molecules generates the heat internally in the food itself just as is done in conventional dielectric heating.

Factories and other industrial plants that maintain lunchrooms for employees could use this type of quick cooking service and save on kitchen space and preparation time in the handling of food. Hot meals in aircraft may soon be commonplace using a lightweight version of the Radarange. This model is designed to defrost and heat a pre-cooked eight-ounce meal, consisting of four ounces of meat, two ounces of potatoes, and two ounces of a vegetable, in approximately one minute. The temperature of the food in the frozen state is 10 degrees, Fahrenheit, and is 170 degrees, Fahrenheit, at the end of the time interval. The input power requirement is 5000 watts per minute per meal.

With actual microwave heating equipment now on the market for the restaurant trade and with engineers seriously considering the industrial possibilities of this unique method wherein the radio waves themselves produce heat, it can safely be said that the microwaves of war-time radar fame are definitely finding their place in industry.

ELECTRONIC DRIVE

Provides Stepless Speed Control for Printing Presses

MAKING its debut at the *Philadelphia Inquirer,* an electronic drive is being put on 61 rotogravure presses and 44 newspaper press units at the new plant of the newspaper.

Except for the D.C. drive motors, the control equipment has no moving parts. All the current for controlling the speed of these motors is handled by huge all-metal electronic tubes called ignitrons, that can be turned on and off gradually with a variable resistor no larger than the volume control on a radio set.

With this new General Electric drive, especially adapted for use with high-speed rotary web presses, adjustable voltage is supplied to adjustable-speed D.C. drive motors which may be mounted coaxially with the main shaft of the press. Stepless speed control—including jogging, slow threading speed, acceleration, deceleration, and dynamic braking—can be achieved from conventional push-button stations on the presses.

SEE-SAW BED

Electric Drive Aids Polio Victims' Respiration

TO HELP in treating the after-effects of polio, a bed which is mounted on a pivoted frame, driven by a General Electric Thymo-trol drive, see-saws in rhythm with the patient's normal breathing. By turning a small knob an attendant can regulate the speed of the driving motor. In addition to aiding polio victim's respiration, the bed has other uses in treating respiratory and circulatory diseases.

TALKING LETTERS

Recorded on Coated Paper Disks

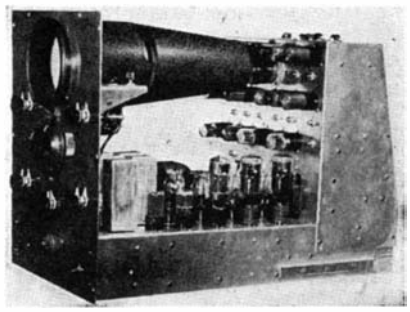
DISKS of paper coated with a magnetic material serve as the recording blanks for a new Mail-A-Voice sound recorder and reproducer. There are no grooves on the paper, but when a record is made or played back a grooved spiral plate is placed on the turntable to guide the magnetic tone arm. This electronic recorder-reproducer, made by The Brush Development Company, uses paper disks coated with a magnetic material. During recording, the coating on a disk is magnetized to varying strengths proportional to the sound signals fed in, and during playback the magnetic variations cause sound signal voltages to be induced in the tone arm.

Magnetic disk coating records sound

METAL IDENTIFIER

Unit Operated by Unskilled Personnel

CALLED the Ferrograph, a new electronic instrument provides a simple means for relatively unskilled personnel to identify or compare iron and steel rods or bars at a rapid rate. The sample is made the core of a two-winding transformer. The voltages across the windings are amplified and applied to a cathode-ray tube used for direct indication of the results. Patterns obtained on the screen for samples of unknown composition are compared with patterns for known samples to obtain positive identification.



Electronic "brain" identifies metals

RIVER-BOAT RADAR

Permits Shipping Movement In Fog-Bound Waters

RADAR for river towboat traffic has been given winter tests jointly by the Ashland Oil and Refining Company, the United States Coast Guard, and the Sperry Gyroscope Company. For years, heavy fogs on the Ohio and Mississippi Rivers have forced river pilots to stay tied to the bank awaiting clearing weather. Now, with the aid of radar, these long and expensive delays can be eliminated. Even though the visibility be reduced to 20 or 30 feet, a thousand-foot barge-string may now proceed on its way in safety.

Captain Kent Booth, master of the Tri-State towboat used in the tests, said the Sperry radar showed clearly the shore line of the river, approaching craft which were beyond view, boats tied to the bank, bridges and power lines crossing the river, locks and dams, and other objects.

Coats Make

In a Great Many Instances, the Qualities of the Plastics Coating, Rather Than Those of the Base Material, Are Responsible for a Product's Serviceability

By CHARLES A. BRESKIN
Editor, *Modern Plastics*

• LOOKING AHEAD •

Service life of many metal parts greatly extended by corrosion-preventive plastics finishes . . . Grease-, oil-, and water-resistant papers in specialized packaging jobs . . . More durable, more sanitary finishes for kitchen, laboratory, and hospital furniture and fixtures . . . Safer food handling with tanks, boilers, and cans lined with tasteless, odorless plastics.

To THE layman, the word "coating" connotes a superficial finish which, at best, enhances the appearance of a product and protects the material of which it is fabricated. The modern manufacturer, however, has proved that the correct plastics coat can have equal or greater importance than the cloth, paper, leather, or metal base which it covers. In some instances, it is the coating that imparts to the product the qualities that make it usable and salable, while the structural material serves merely as a frame or base for the surface.

Cited here are some case histories of coats that make the product. A Canadian manufacturer is marketing an attractive table with a durable top resistant to heat, moisture, and stains—a table designed for rough restaurant service. Basically, the laminated lignin material, derived from paper mill waste, would not be suitable for this application, but a thin coating of melamine provides the necessary surface characteristics. Thus it is possible to capitalize on the structural strength of the economical lignin in a field it could not otherwise reach.

The average paper loses its strength when wet, and in some applications this is a fatal weakness. Obviously, it is imperative that toweling, frozen food packages, blueprint paper, paper diapers, bags, and wrapping paper retain their strength when subjected to moisture. Without some means of imparting this resistance to paper, all the uses mentioned would be difficult or impossible, and markets would be lost to competing materials. An effective answer to the problem was the use of urea and melamine resins. These resins either can be incorporated into the beater stock in the manufacture of the paper, or can be used to impregnate the paper after its manufacture. In either case, the result is a high wet-strength paper. Again the coat made the product.

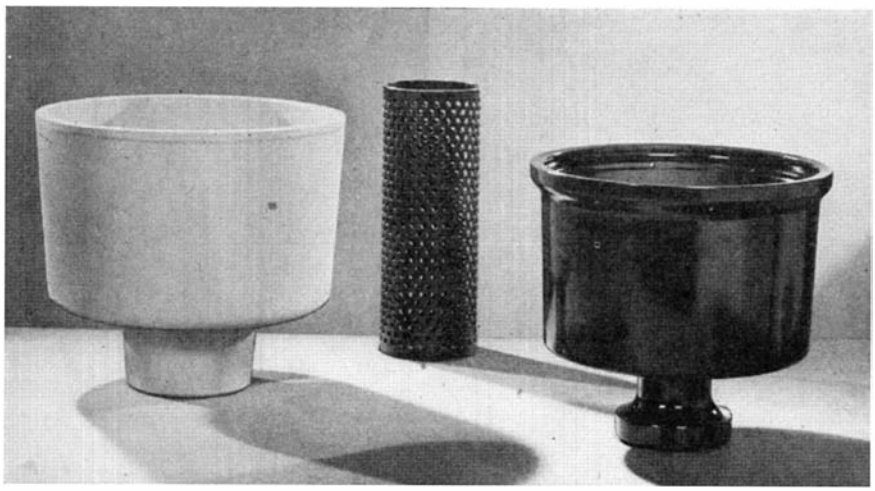
Courtesy Bakelite Corporation

Vinyl coat on metal foil insures against odor transference, renders packages resistant to chemicals present in dairy products, and adds flexibility, permitting packages to retain protective qualities through many unwrappings

When available supplies of leather began to fall behind consumer demand, manufacturers of shoes, luggage, handbags, and similar products found it necessary to utilize every scrap of material they could obtain. The difficulty was that much of this leather was inferior in quality to the grades commonly used for these purposes. Surface blemishes are major handicaps in the fashion field, and the manufacturer had to find some way to give imperfect leather the flawless appearance his customers demand. He found that acrylic resin coatings level the surface and minimize surface defects. The acrylic film forms by coagulation and the deposit is heavier in the lower spots of the leather. The result is a smooth, even surface and a ready entry to the fashion market which otherwise would be closed to these marred materials.

Technical advancement in coat-

The Product



Courtesy Aluminum Company of America

These aluminum spinning buckets, designed for use by the rayon industry, are made corrosion-resistant by the application of a phenol-formaldehyde coating

ings during the past ten years can be attributed both to the extreme severity of the conditions to which many finished articles were subjected during World War II, and to the critical condition or actual unavailability of a great many of the raw materials required to produce most of the durable finishes then in use. Knowledge and experience acquired in development of protective coatings to meet these conditions are being applied toward production of similar coatings for industrial, commercial, and domestic applications. The technical background thus gained has been an asset in the development of decorative as well as functional coatings of all types.

HOW COATS ARE APPLIED — Coatings are applied in four ways: in solution, as melts, as pastes, or as films.

Coatings in solution: These can be applied by simple brush, dip, or spray processes, and depend either upon evaporation of the solvent to leave the required deposit of resin, or upon cure of the resin by heat.

Coatings as hot melts: Hot melts are applied by dipping or spraying. These coatings are thermoplastic (can be re-softened by the application of heat) and require only cooling to harden.

Coatings as paste: Pastes are spread by means of a doctor blade and subsequently calendered (run between two rollers that squeeze out the excess coating material.)

Coatings as films: In this form coatings are applied by calendering, frequently in the machinery in which they are produced. In some cases, films are first cast on paper or other receiving medium and subsequently transferred to their final backing.

In discussing the various important coatings applications, this article will be confined to metals, paper, and leather, leaving the fields of fabric and wood coatings for separate attention in a later article.

In no other application has coating won more complete acceptance than in metals for home use. A refrigerator or stove without the customary durable, sanitary, attractive coating probably would be unacceptable to the housewife. Less publicized, but equally important, is a wide range of industrial uses.

The type of surface coating to be used on metal is determined not only by the type of metal, but also by service conditions to be encountered. For metal furniture and fixtures, instruments, and machinery which are to be used where there are no serious corrosion problems, surface coatings may be comparatively simple one- or two-coat systems. Most of these are baked or are fast-drying lacquers. Many special finishes, such as wrinkle coatings, may be used for decorative effects.

When metals are to be used under more corrosive atmospheric conditions, subjected to galvanic or electrolytic corrosion, or brought into contact with foods, drugs, or chemicals, more elaborate finishing systems are necessary. Such systems usually include: 1) passivation of the surface by chemical pretreatment; 2) use of primers containing inhibitive pigments; and 3) sealing the surface with an impervious coating.

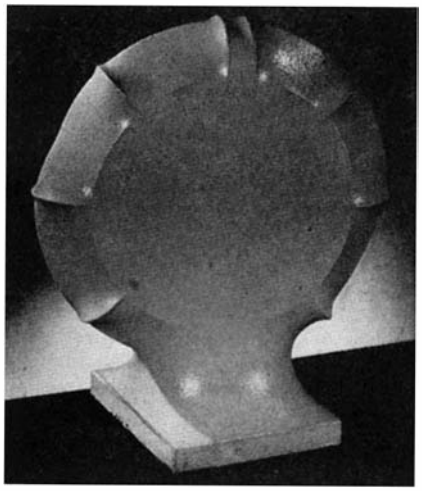
The familiar refrigerator coating is likely to be melamine resin coating which has superior resistance to abrasion, water, and chemicals, and to discoloration on exposure to light. This last property makes it particularly valuable as a finish for automobiles. Another plastics which lends itself to refrigerator coatings is silicone resin but, at present, cost considerations limit its use in household equipment. Instead, it is being used in products that require its excellent electrical insulation properties—on ceramic insulators and in conjunction with glass fabric.

The electrical insulation qualities of several plastics coatings open a broad field for industrial uses. For example, all types of coils are coated with phenolic oil-soluble resins. Ethyl cellulose is used to protect cables. Polyethylene also has good electrical properties.

AIDS FOOD HANDLING—Coatings make another valuable contribution in food handling and packaging. For example, phenolic baking resins are used to protect tanks and other food and beverage equipment. The chemical inertness, non-toxicity, and lack of odor and taste make vinyl resins ideal coatings for interiors of containers for beer, other beverages, and foods. The acrylic resins also have high resistance to water, alcohol, vegetable acids, mineral oils, and chemical fumes.

To protect the finish of a product during plant handling and processing, manufacturers frequently apply a temporary coating which can be stripped off either when the finished product comes off the assembly line or when it is taken out of stock for delivery to dealer or customer. This protection is afforded by ethyl cellulose, acrylic, polyvinylidene chloride, or vinyl chloride.

The shipbuilder, concerned with protecting metal surfaces against the corrosive effects of salt water, finds



Courtesy Bakelite Corporation

A vinyl strip coating, applied with an ordinary spray gun, provides excellent packaging for the electric fan

a valuable aid in dispersion-type phenolic coating resins with their high resistance to the passage of water and their remarkable exterior durability, and in coumorone-indene resins. The high heat-resistance of these last finishes makes them suitable also for the coating of steam pipes and flues.

ON PAPER — In the past, coating of paper has been achieved mainly with the aid of clays, asphalts, waxes, and natural resins. Synthetic materials have been introduced largely as modifying agents to improve the properties of these cheap basic materials. Since price considerations are exceedingly important in the paper industry, however, the application of many otherwise desirable plastics is limited.

In general, resinous coatings can be formulated to give gloss, scuff-proofness, tear-resistance, improved packing, and heat-sealing properties. With the aid of pigments, dyes or other additives, or by means of embossing rolls or dies, novel and decorative effects may be obtained. Plastics coatings have greatly improved this quality of paper. Some of the widely used resin coatings and the properties they impart to the paper are described in the following paragraphs.

Polyvinyl alcohol has a high resistance to oil, gasoline, and certain other solvents, and gives a grease-proof coating. Since it is water-soluble, however, it cannot be used for applications that are intended for wet and humid climates.

Vinyl esters and vinyl acetal resins, with a ready resistance to oils and chemicals, are used in grease-proof paper for food wrapping and in liners for bottle caps and gaskets.

Polyvinyl chloride as a coating for paper imparts water- and grease-resistance and is much used as a coating for shipping containers.

Cellulose nitrate improves the durability and appearance of paper, but has the disadvantage of flammability.

Ethyl cellulose is used to coat the insides of food and medicinal packages, because of its resistance to alkalis and also for its non-toxic properties.

Polyethylene is also used as a coating for paper that comes in contact with foods and medicinals. It gives toughness, good impact resistance, low water vapor transmission, low water absorption, chemical inertness, and non-toxicity.

Coumorone-indene resins are used to impregnate or laminate heavy paper for use as building paper. It is also used for bags holding chemicals and fertilizers.

COATING LEATHER — A coating for leather must possess special characteristics. It must be adhesive—able to cling tenaciously to the fibers of the leather in spite of changes in moisture content or temperature. It must be flexible—as pliable as leather itself—so that it can bend and stretch with the leather without cracking or losing adhesion. It must be durable—able to hold up throughout the severe conditions of use to which leather is often subjected. Finally, it must be attractive in appearance.

Two of the newest plastics coatings for leather are the silicones and emulsions of thermoplastic resins. The two silicone fluid preparations used in dressing leather not only keep the leather soft and flexible, but provide a water-repellent finish for the skins. The emulsions of thermoplastic resins provide an attractive sheen on the leather and form a continuous surface film which is tough and water-resistant. They are capable of binding pigments securely to the leather.

Among the materials used for sizing and bonding leather are vinyl resins, combinations of vinyls and phenolics, formulations of butadiene-acrylonitrile and phenolic resins, and liquid organic polysulfides. Urea resins in conjunction with treated oils have also been used to coat leathers.

The soft and tacky types of resin are utilized for binding the major portion of the pigments to leather in the bottom or lower coat. Dryer and harder types are used in the upper or top coats.

Plastics also form the basis for artificial leathers—but that is another story.

POLYETHYLENE BAGS

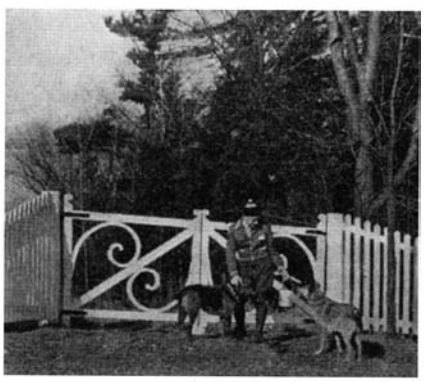
Insure Maximum Freshness For Frozen Foods

WHAT MAY prove to be an important use for polyethylene is as a packaging material for foods. Traver Corporation is now fabricating Bakelite polyethylene into bags for use in packing quick-frozen fowl, fish, and meat so that the food can go from packer to consumer without being exposed to the air. The advantage of polyethylene for this application is that it is odorless, tasteless, non-toxic, and resistant to fats and brines.

RESIN ADHESIVE

Makes Laminating Complex Patterns Easy, Inexpensive

WOODWORKERS were once restrained in their creatings by the limitations of their medium. Many scrolls and curves were too wasteful of time and effort when cut from solid blocks or timbers. But there



Waste-less curves in a wooden gate

are no such limitations when fabricators take advantage of the possibilities of laying up of thin strips of wood over light, inexpensive forms and laminating the strips with Urac 185 resin adhesive.

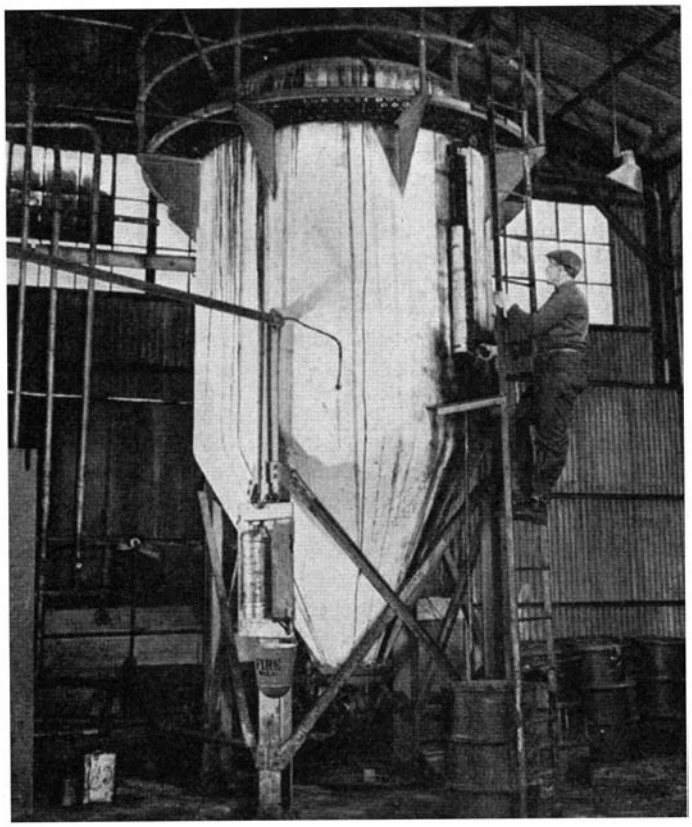
COATED YARN

Makes Easily Cleaned Nurses' Caps

PLASTICS coated yarn in nurses' caps facilitates neatness and cleanliness when time is at a premium. When Plexon coated yarn is used as the material in nurses' caps, it is necessary only to wipe the cap with a damp cloth to remove all dirt and stain. Furthermore, this fabric is impervious to most acids in addition to dirt and grease. Merland Manufacturing Company is now making these caps for Angelica Jacket Company.

• LOOKING AHEAD •

Harder, more resistant paints and varnishes made from less expensive materials . . . Bacteria-killing air conditioning system to reduce industrial absenteeism . . . Commercially practical production of synthetic rubber from agricultural wastes.



Courtesy Woburn Degreasing Company of New Jersey

Huge pressure-splitter, using chemicals and heat, separates glycerine from oils and fats

Glycerine and Glycols Gain Ground

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

Polyhydric Alcohols, Soon to Be Made Greatly More Abundant by the Construction of New Manufacturing Facilities, Are Rapidly Increasing in Industrial Importance. They are Used in Such Diversified Products as Dehumidification Agents, Resins, and Insect Repellents

VERSATILE glycerine, familiar to the average man only as an ingredient of cough syrup and as an anti-freeze for his automobile, is an important raw material to the industrial chemist. He sees in it the basis for a score or more of useful products.

Called the "sweet principle of oils" by Karl Wilhelm Scheele who discovered it in 1779, glycerine has since that time been obtained as a by-product of soap manufacture. Now, however, the Shell Chemical Company is erecting a $10,000,000 plant to make it from propylene, a constituent of natural gas.

In this process, propylene, which occurs to some extent in natural gas, or can be obtained by cracking petroleum, is treated with chlorine at a high temperature to form allyl chloride. This, in turn, can be treated with chlorine in water-solution to form the chlorhydrin. The latter material is hydrolyzed to allyl alcohol, which can then be transformed into glycerine by the same procedure. Perhaps the most important feature of this process is that the raw materials—petroleum, salt, and water—are abundant.

Another synthetic process, patented by E. I. du Pont de Nemours and Company but reported to be not yet in operation, involves the reaction of carbon monoxide with formaldehyde to produce glycolic acid. This in turn is used in another reaction to produce a formaldehyde derivative of glycerine from which glycerine itself is readily produced. The only raw materials necessary are carbon monoxide and hydrogen, a mixture readily obtained by passing steam over red-hot coke.

MEET THE FAMILY — Glycerine, a chemical compound which contains three hydroxyl groups, is the foremost member of the glycol or polyhydric alcohol family which consists of those compounds made up of two or more hydroxyl groups. A

great many of these compounds have become exceedingly important in recent years in a large number of industries. Glycerine, for example, is a chief constituent of alkyd resins, made by the reaction of glycerine with phthalic anhydride, maleic anhydride, and other dibasic acids. In 1944, production of these resins exceeded 100,000,000 pounds.

The second most important member of this family is ethylene glycol. The Carbide and Carbon Chemicals Corporation makes this material by oxidizing ethylene with air. The Dow Chemical Company makes it by a different process involving the use of chlorine and ethylene. Ethylene glycol has now largely replaced glycerine as an anti-freeze for automobile radiators and in many pursuit planes, engines are cooled by glycol rather than water or air. Certain types of dynamite are made with glycol dinitrate instead of nitroglycerine.

Among the foremost derivatives of ethylene glycol are the so-called Cellosolves and Carbitols. These ethers of ethylene glycol and diethylene glycol, respectively, are valuable because they are excellent solvents for cellulose esters and have thereby contributed to the growth of the lacquer industry. Since they can be used with both water and organic solvents, they are widely employed for coupling immiscible liquids in preparing soluble oils, cutting oils, insecticides, dry-cleaning fluids, soaps, and the like. They are also used in shock absorbers, brakes, aircraft landing gears, and other hydraulic systems.

Other glycols similar to ethylene glycol are propylene glycol, dipropylene glycol, and diethylene glycol. The latter is widely used in the textile industry in dyeing and printing operations, and one cigarette company exploits the fact that its product is kept moist with diethylene glycol instead of glycerine, claiming that it does not give the irritating material, acrolein, upon burning.

REDUCES ABSENTEEISM—A more complicated glycol, triethylene glycol, is helping to cut down colds and other infectious diseases. It has been discovered that small amounts dispersed in the air kill air-borne bacteria. The material is used as a dehumidifying agent in air-conditioning systems, and the small amount of the glycol vaporized during operation is reported to knock out cold germs. In two identical buildings at the Lockheed Aircraft Corporation, operated during a complete winter, one with and one without glycol vaporization, absenteeism in the glycol-treated plant was only half that of the other.

Ethylene glycol is another one of the materials which has been found to be an excellent insect repellent. Either in liquid form or incorporated in a cosmetic cream, it repels mosquitoes, biting flies, gnats, chiggers, and fleas, and can be produced as a dual purpose sun-tan and repellent cream for beach use.

Diethylene and triethylene glycols might be considered the dimer and trimer, respectively of ethylene glycol. Higher polymers of ethylene glycol, ranging in molecular weight from 200 to several thousand, are also manufactured for industrial purposes. Those with average molecular weights ranging from 200 to 700 are liquids; those above 1000 are wax-like solids, some like petroleum jelly, others like paraffin. One of their many uses is a water-soluble base for cosmetic creams.

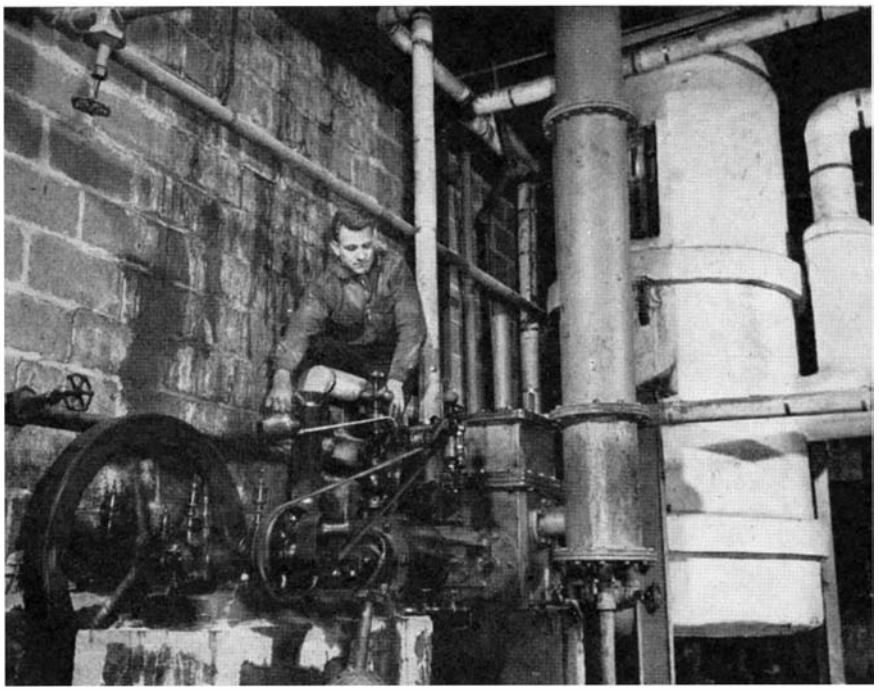
The liquid polymers are good plasticizers and dispersants for casein and gelatin compositions, glues, cork, and special printing inks. The textile industry uses them as water-soluble lubricants in warp sizes, conditioners, and finishing agents for textile yarns. Esterification with dibasic acids gives alkyd-type resins; with fatty acids, emulsifying agents and detergents are produced.

ALCOHOLS FROM GLUCOSE — Ordinary glucose can be converted into sugar alcohols by an electrolytic process currently used by the Atlas Powder Company. By changing the reaction conditions, either sorbitol or mannitol may be obtained, which have the same chemical formula as the sugar alcohols, but differ slightly in their structure and properties. They are really double molecules of glycerine, and indeed may be used as replacements for glycerine in many formulations. Sorbitol, like glycerine, absorbs moisture from the air. It is used as a softener, therefore, in such diverse products as candy and glue. Reaction with fatty acids gives excellent emulsifying agents which are unaffected by the salts present in hard water. Sorbitol is also used in the paint and varnish industry to prepare drying oils and synthetic resins.

The jaw-breaking name of pentaerythritol is given to an interesting polyhydric compound made from acetaldehyde and formaldehyde. Tons of this material were produced during the war as the starting material for pentaerythritol tetranitrate, a superior explosive. Although this application is minor now, large amounts are still being made by Hercules Powder Company, Heyden Chemical Corporation, and Trojan Powder Company as a raw material for synthetic resins. Production of these in 1944 exceeded 12,000,000 pounds.

Varnish resins made by Hercules from rosin and pentaerythritol, called Pentalyns, are claimed to be superior to rosin-glycerine resins in that they have a higher melting point and are more resistant to heat and oxidation. These improved properties are ascribed to the symmetry

Wiping finished rubber tubing with glycerine helps prevent drying out



Courtesy Woburn Chemical Company of New Jersey

Pump of a vacuum evaporator where glycerine and water are separated

of the pentaerythritol molecule. It is a general rule that the more symmetrical a molecule is, the higher is its melting point and the greater its stability. It is claimed that pentaerythritol resins permit the use of the cheaper linseed and dehydrated castor oils rather than the expensive tung oil in varnishes.

FARM WASTE TO RUBBER — A special kind of fermentation that transforms carbohydrates into butylene glycol has been reported by the National Research Council of Canada. It is believed that the process has not yet been worked out on a commercial scale, but agriculturists are showing great interest. The glycol can be converted with ease into butadiene, major constituent of synthetic rubber, and this process would provide a route to synthetic rubber from agricultural wastes.

It is hard to imagine an industry untouched by the variegated products into which the glycols and polyhydric compounds enter. If industry had to depend upon the glycerin present in natural fats and oils, scarce the world over, prospects for a wide extension of its uses would be dim indeed. Fortunately, processes based on petroleum hydrocarbons are getting under way. There are enough glycerin and glycols potentially available from petroleum, air, and salt to give us varnish resins, synthetic detergents, antifreeze compounds, insect repellents, and cosmetic bases, for some time to come.

VINYL ETHERS

Serve as Plasticizers, Adhesives, and Pharmaceuticals

LATEST additions to the vinyl family —of which vinyl acetate and vinyl chloride are the most illustrious to date—are the vinyl ethers, six of which have already appeared: methyl, ethyl, isopropyl, *n*-butyl, isobutyl, and 2-ethylhexyl.

Like other vinyl compounds, these ethers can be polymerized to useful resins. The characteristics of the polymers may be varied at will, depending on which ether is used and the conditions of reaction, giving a range from liquids to rubbery solids to waxlike balsams. The polyvinyl ethers are useful as adhesives, plasticizers, coatings, and lubricants.

As adhesives they are more stable to light and storage than rubber, and they have been used for surgical tapes, envelope seals, laminating glass, sealing cellophane and metal foils, and cementing other materials to glass.

The new vinyls have been used as plasticizers for nitrocellulose, synthetic rubbers and other resins, in synthetic polishing waxes, and for impregnating textiles and paper.

The monomers are interesting, too, as possible intermediates for pharmaceuticals, rubber chemicals, lubricating oil additives, and a host of other synthetic organic materials. Ethyl vinyl ether is an anesthetic similar to ordinary ether.

General Aniline and Film Corporation is manufacturing methyl, ethyl, *n*-butyl, and isobutyl vinyl ethers by processes based on acetylene.

Carbide and Carbon Chemicals Corporation are offering the isopropyl and 2-ethylhexyl vinyl ethers, as well as the ethyl, produced by presumably different methods.

AGRICULTURAL FUNGICIDE

Forms Rubber-Like Film, Does Not Wash Off Plants

POTENTIALLY important, a new agricultural chemical which has polyethylene polysulfide, derived from petroleum and sulfur, as a basic material has been developed by the B. F. Goodrich Chemical Company. It is one of a group known by the trade name Good-Rite and is now ready for commercial application following several years of research development and testing.

This latex-like material (see also page 3, January 1947 Scientific American) is not only an effective fungicide when used alone, but an outstanding assistant to insecticides and other fungicides. Its adhesive quality holds the chemicals so that they cannot be washed away after application by rain, dew, or other moisture, thus providing maximum killing action against blights, diseases, insects, and pests of various kinds.

Supplied as a latex closely resembling dispersions of many synthetic rubbers now on the market, both in appearance and physical characteristics, the chemical solution, when diluted with water, can be used with standard spraying equipment and by conventional methods. After drying the material forms a microscopic web that can be removed only by scraping, decomposition of the chemical materials, or expansion by growth. The film stretches to accommodate some growth after it has dried. With applications discontinued six weeks before harvest, no odor, taste, or other undesirable evidence of the spray remains on fruit or vegetable to create any problem in the preparation of the foods for market.

Used alone as a fungicide the new chemical has proved capable of controlling most of the fungi which cause extensive losses on fruit trees, including apple scab. Employed in conjunction with other fungicides, pesticides, and insecticides, as a carrier and adhesive, the Good-Rite product has shown excellent results.

Deep Draws with HOT MAGNESIUM

When Raised to the Proper Temperature, Magnesium Develops Singular Workability. With it, a Fabricator is Able to Accomplish in One Draw What Would Require a Series of Operations With Many Other Metals

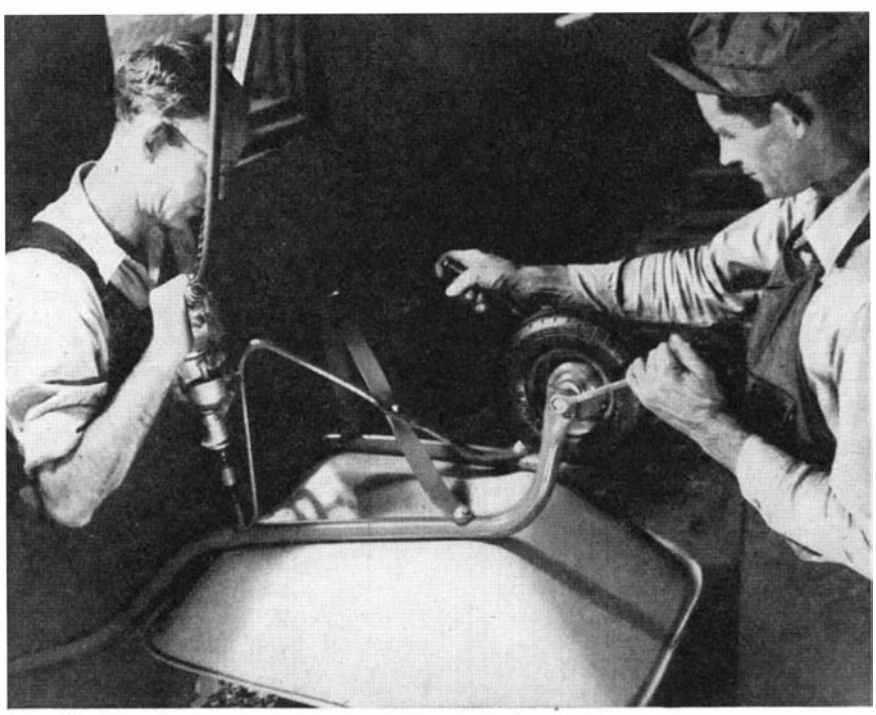
By FRED P. PETERS
Editor-in-Chief, *Materials & Methods*

ALTHOUGH magnesium is known to be the easiest of the commercial metals to machine, the readiness with which it can be hot-drawn is not so generally understood. A few fabricators, however, have taken advantage of magnesium's hot workability, developed techniques to suit the process to the mass production of normally "difficult" shapes, and are capitalizing on the demand for light-weight products of rather large size.

The Brooks and Perkins company has been one of the pioneers in production of deep-drawn parts of magnesium alloys, and the information in this article is based on their experience. During the war this company cut its deep-drawing eyeteeth on radar housings, aircraft dorsal fins, supercharger oxygen bottles, and so on—all hot-drawn in magnesium alloy. Since the war, the company has been one of the chief fabricators of the ubiquitous magnesium griddle, which not only aids the housewife and amateur chef in whipping up a quick and evenly cooked batch of wheatcakes or fried eggs, but also effectively demonstrates the non-flammability of solid magnesium. Others among their post-war products are discussed below.

The factor that in the past had retarded the commercial development of deep-drawn magnesium products was the difficulty in cold-drawing magnesium and its alloys—forming or stamping them at room temperatures. The crystal structure of magnesium makes it one of those metals that are prone to crack or break under working stresses at temperatures up to, say, 400 degrees, Fahrenheit. But at temperatures between 450 degrees, Fahrenheit, and 600 degrees, Fahrenheit, it is possible to do with magnesium in a single draw what would require up to three drawing operations in steel, brass, or aluminum.

Deep-drawing of magnesium, of course, does have its technical problems, which such fabricators as Brooks and Perkins have learned to control within economic limits. The drawing dies are heated, using either electric strip heaters or open gas flames; die, punch, and the work to be drawn must be heated to the proper temperatures. In designing both the part and the steel dies to form it, allowance must be made for thermal expansion effects, and for distortion during heating. Suitable lubricants must be used on



Courtesy Brooks and Perkins

Pan of the magnesium wheelbarrow was formed in a single draw

More and more manufacturers realizing the advantages of magnesium's workability . . . An avalanche of new products.

blanks and dies. Press pressures and speeds must be closely regulated.

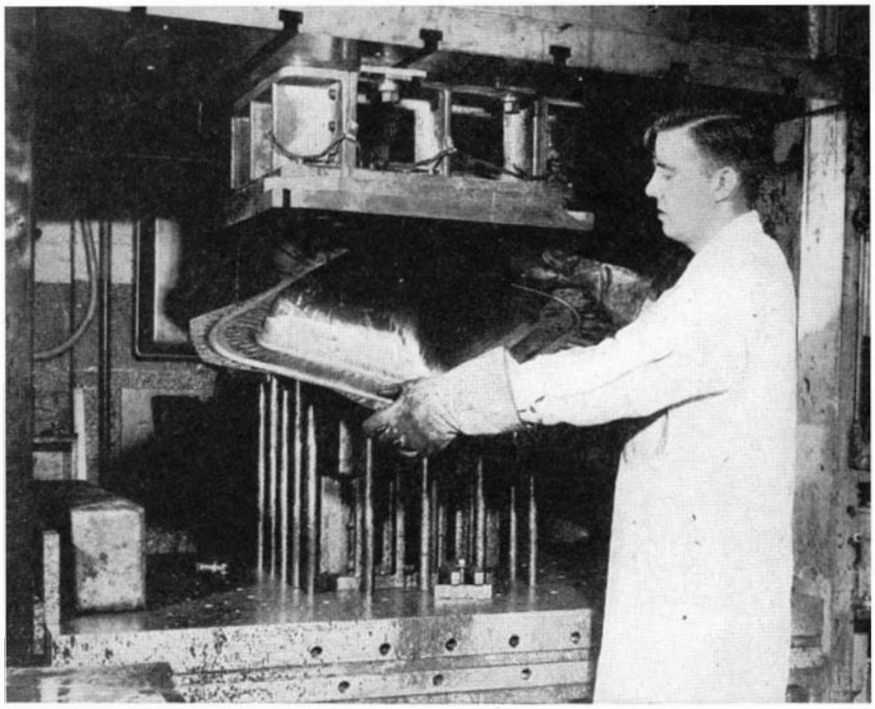
PRICE COMPARISONS — With all this—and despite the somewhat higher price per pound of rolled sheet magnesium alloys in comparison with other metals—their difference in weight and their lower fabrication costs (only one draw, with elimination of intermediate anneals) are enough to make deep-drawn magnesium parts comparable in price to the same products made of other metals.

In general, any design which can be drawn from sheet steel, aluminum, copper, or brass can be successfully drawn from magnesium. Indeed, some parts that are difficult or impossible to draw in other metals are readily formed out of magnesium. A good example are the top corners (roof corners) of large buses, which in the past have been partly drawn from sheet steel and then finished by power hammering to shape. They are now completely drawn in one operation from magnesium alloy, with a noticeable saving in labor cost.

Amenable designs are numerous. Hemispherical or cylindrical shapes have been drawn to a depth of about twice their diameters, in one draw. Rectangular box shapes have been drawn to a maximum depth of 1½ to 1¾ times the narrower width in a single draw. These are at present the approximate limits that are commercially feasible, using a single draw.

The magnesium alloys most commonly used are Dow M or American Magnesium Corporation 3S, containing 1.5 percent manganese; Dow FS-1 or AMC 52S, containing 3 percent aluminum and 1 percent zinc; and Dow JS-1 or AMC 54S, containing 5 percent aluminum and 1 percent zinc. Alloy M (AMC 3S) is lowest in price, with the best deep-drawing characteristics. If higher strength and not much weldability are needed, FS-1 (AMC 52S) is used. For highest mechanical properties and good weldability, JS-1 (AMC 54S) is the usual choice.

SPECIFIC APPLICATIONS — Aside from the established uses of deep-drawn magnesium parts for aircraft components, a number of other applications have been developed in the past two years. The best-known are the magnesium griddle, the magnesium wheelbarrow, and the magnesium canoe; other important applications include radio and radar cases, portable tool housings, business machine cases, vacuum cleaner parts, camera and projector housings, and, most recently, an oil filter for an aircraft de-icing system.



Courtesy Warren McArthur Corporation

Magnesium pans for aircraft seats are deep-drawn in electrically heated dies

In one instance, a radar computor case, the case and cover were each made as a single draw, after which the holes were blanked. A strip of thin sheet magnesium was spot welded at the top of the box to form the flange for the cover. Threaded tubes and clips were welded in by argon-shielded arc welding. A black crackle finish, baked on, is used for this product. In general, there is no limit to the number and types of paint, enamel, and lacquer finishes that are successful on magnesium alloys.

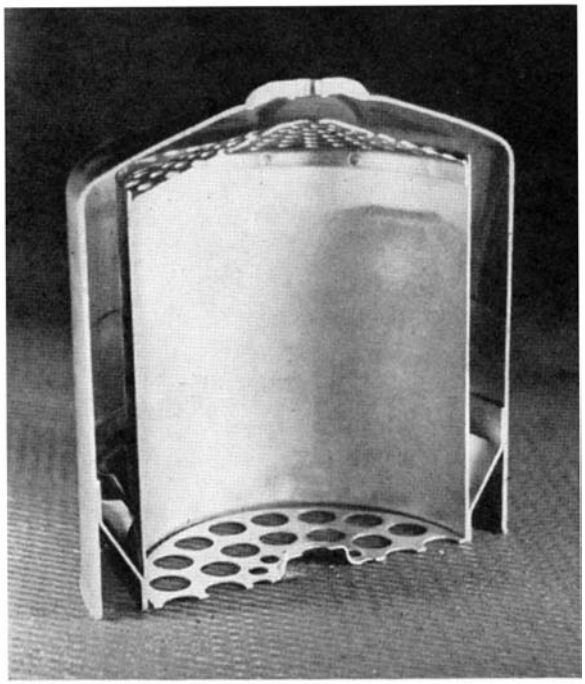
For the dorsal fin on the Republic P-47 Thunderbolt, previously mentioned, 0.040-inch thick sheet was used, with the radius at the bottom of the drawn crease only ⅛ inch. Although the fin is about five feet long, it is so light that a girl can hold it without effort.

The oil filter case was formerly produced from aluminum sheet with several components made by spinning: The product was redesigned and made as a drawn-magnesium part not only to save weight but also to reduce production cost. When made of aluminum spinnings the case weighed three and one half pounds; as now produced the case weighs only two pounds, six ounces, a weight saving of 32 percent.

There are several parts to this "case," which really functions as a combined housing and oil separator, the main ones (all of deep-drawn magnesium) being an outside container, an inner shell and a combined spacer and perforated inner section. The outside container, 8-3/16 inches in outer diameter, is made in one draw, which includes the forming of 12 stiffening ribs on the bottom and the punching of a hole for a through-bolt. The inner shell, also drawn to a 10-inch depth in one operation, is formed as a can; the bottom is later cut off and the extra material at the top removed to give the desired cylinder. The piece from which the spacer and inner section are formed also involves a single draw, to a depth of six inches.

Other items, now being produced as magnesium drawings for weight-saving purposes, are even more dramatic. A 16-foot canoe, full-size in every respect, has been produced with a weight of slightly under 55 pounds. It comprises four deep-drawn magnesium sections, each eight feet long, drawn in a hydraulic press of 950 tons capacity at 625 degrees, Fahrenheit. The sheet used is alloy M, 0.051 inch thick.

WELDED AND RIVETED — After drawing, the pieces are trimmed, and the sections welded together to form two longitudinal half-sections. These are then riveted to an



Courtesy Brooks and Perkins

Cutaway view shows the deep-drawn magnesium parts which comprise an oil separator assembly

extruded magnesium keel strip. Other parts—gunwhales, thwarts, and so forth—are also made of magnesium.

Like the canoe, the magnesium wheelbarrow is an interesting example of a large size press-formed magnesium product and shares with it all the problems of special shape and irregular (not rectangular or cylindrical) contour. The sloping sides of the wheelbarrow are difficult to draw without wrinkling, and the variation in slope for the different sides presented extra problems.

The wheelbarrow pan is formed from 0.072-inch alloy M sheet, held at 650 degrees, Fahrenheit, during drawing. After trimming, the pan is beaded around the upper edge, and the result is a full-size piece of extreme lightness and with ample strength and rigidity for this service. The handles of the wheelbarrow are made of magnesium alloy tubing and the legs of extruded flat bar stock. The wheelbarrow is very simply assembled by bolting.

The total weight of the completed wheelbarrow is only 12 pounds, achieved through the use of magnesium alloys in virtually the entire construction. The axle bolt, rubber-tired wheel, rivets, and assembly bolts are the only important exceptions.

For these and many other products, the use of magnesium alloys, deep-drawn in one operation at elevated temperatures, has produced noteworthy benefits in lightness of the finished product, mass-producibility and, in some cases, lowered cost. It is true that the need to carry out the drawing at elevated temperatures does introduce additional complications, but it should also be remembered that at those temperatures more can be accomplished with magnesium in one operation than with other metals in several operations at room temperatures.

One manufacturer has stated flatly that those who have become familiar with the deep drawing of magnesium alloys would rather work them than other metals. Once this state of mind becomes wide-spread, watch for an avalanche of products like the magnesium griddle, wheelbarrow, and canoe.

⊕ ⊕ ⊕

ALUMINUM WELDED

By Processes Using Air, Heat, and Dies

WELDING and forming aluminum sheet by a novel method was accomplished by the Germans during the war in the manufacture of aircraft radiators. In this operation, sheets of aluminum are virtually melted together between gas heated dies that are closed under pressure. When the dies are nearly closed, compressed air is injected between the sheets to blow open the areas between the rows of welds, in order to form passageways conforming to the design of the dies.

The working temperature of the press welder is 842 degrees, Fahrenheit. The pressure of the air cushion in the machine table is 36.8 to 51.5 pounds per square inch, and the pressure of air used to blow open the sheets is 265 to 350 pounds per square inch. The air pressures selected depend upon the physical properties of the material, and only after experimentation can another material be employed.

PRINTED SILVER

Replaces Copper Wire In Electrical Circuits

RELATIVELY large volumes of copper have been replaced with infinitesimal amounts of printed silver in the circuits of the VT fuse. And the same process is now being applied in several other products.

The silver is laid down on a steatite base as a paste of either powdered silver or silver oxides, with appropriate binders and solvents to hold the conductor in suspension. The binder is burned off in a furnace at 1300 to 1500 degrees, Fahrenheit, following the printing of the circuit, and the silver conductor is left adhering to the plate, just as the pigment in ordinary printing ink remains after its vehicle is removed by drying.

NON-CORROSIVE COAT

With Zinc Base Found Superior to Tin

DEVELOPED as an answer to the shortage of tin, a zinc-base finish for metal parts has a bright luster resembling that of chromium and corrosion resistance claimed to be greater than that of conventional tin coatings.

Known as Anozinc, and developed by United Chromium, Inc., the new electrodeposited coating is now being used on refrigerator shelves. Before adopting it, the refrigerator manufacturers investigated at least 100 different metallic and synthetic coatings, finally settling on Anozinc as providing the desired combination of corrosion resistance, bright metallic appearance, non-toxicity, and hardness.

Several variations of the process are available. In general, it comprises electroplating a zinc coating on the steel, then anodizing to produce a zinc chromate product on the surface, and finishing with a special clear synthetic lacquer.

At least 75 percent of the refrigerator shelves processed in the last year have been finished with this treatment. Black Anozinc finishes have also been used on zinc plated aircraft propeller blades, while the yellow coating has been used very successfully on zinc-plated wire screen cloth.

Micro-Hardness Testing

New Knowledge of Steels of Definite Hardness and Toughness is Being Gained Through the Application of Techniques Which Measure Characteristics of a Single Grain of Metal

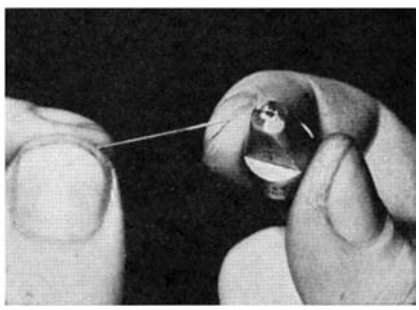
THE HARDNESS, not only of a piece of steel you can feel in your hand and examine with your naked eye, but also of microscopic grains of the steel itself, can be measured accurately by a new device designed at the Research Laboratory of United States Steel Corporation. Still more minutely, the micro-hardness tester can gage the hardness of a single steel grain at as many as three points within the breadth of a human hair.

By no means an instrument of abstract research alone, this tester is in continuous laboratory use, perfecting studies of the microscopic constituents of steel. The results of these studies are coördinated to develop steels of definite hardness and toughness for specific applications in the home and factory, and on railroads, ships, planes, and automobiles.

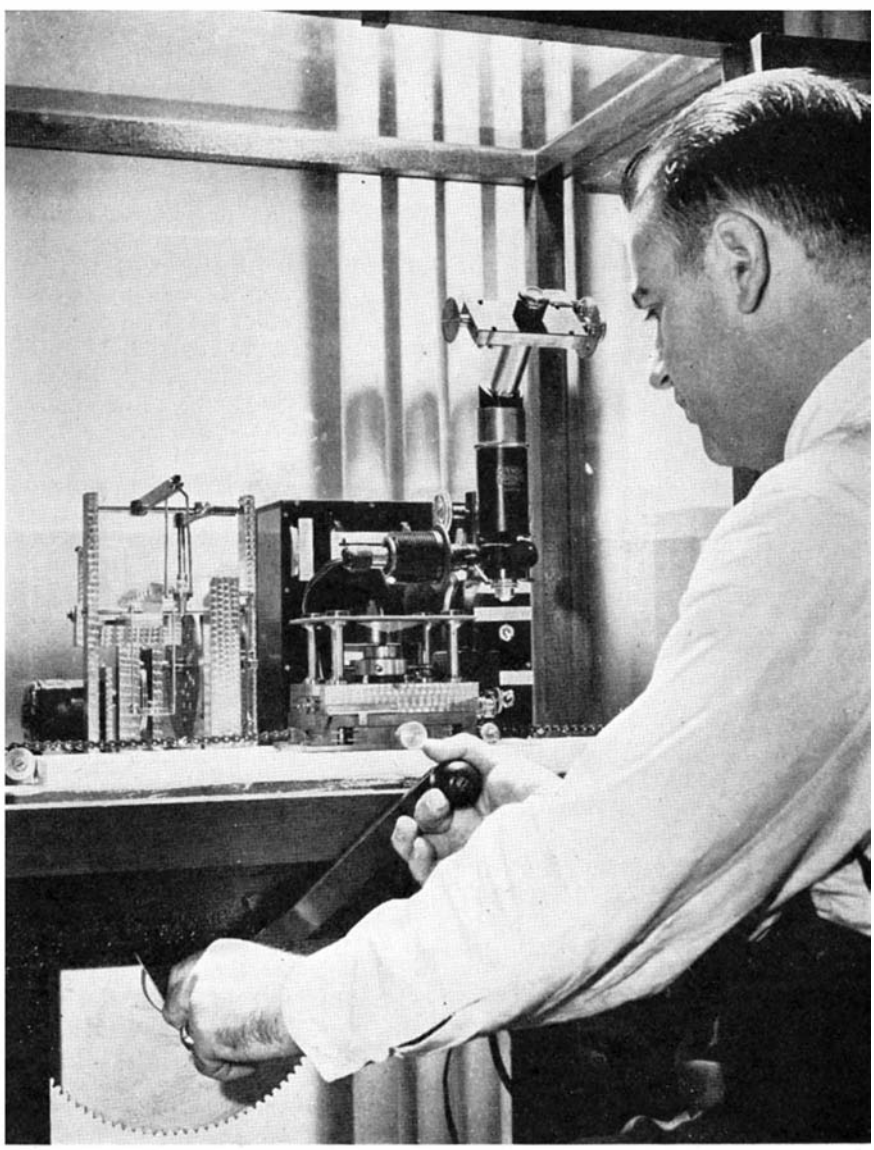
Like the Brinell, Rockwell, Vickers, and other traditional hardness testers, but on a much finer scale, this device operates by indenting the polished surface of a steel sample. Its diamond-point penetrator under a load of a very few grams leaves a square mark which can rarely be seen by the naked eye. The diagonals of this tiny square indentation are measured in microns, or thousandths of a millimeter, and this reading related to the load placed on the penetrator so that hardness may be computed.

Preparation of the sample of steel whose hardness is to be measured requires elaborate care. A small sample, which may be mounted in plastics, is ground and finished with polishing paper, care being exercised so the grinding effect does not extend below the surface. Then it is polished on wet lead laps. Alternately, the sample is polished to a mirror finish with a soft abrasive so finely divided that when shaken in water it will take a half hour to settle, and then lightly etched with acid to bring out the grain boundaries. This dual process is continued until no disturbed metal is observed under the microscope.

The operator of the micro-hardness tester places the prepared sample under the microscope on a



Pyramidal diamond point of penetrator is cut to an angle of 136 degrees



Illustrations courtesy United States Steel Corporation

After steel grain to be tested has been selected under the microscope (right), specimen on movable bed-plate is transferred to penetrator mechanism (left)

movable bed-plate and selects the grain or area to be tested. When this is determined, the sample is transferred to the penetrator mechanism. The penetrator arm, balanced with its adjustable weight suspend on knife edges, slowly bears down its weight to make the indentation.

After the indentation has been made, the sample is moved back under the microscope and examined. Depending on the hardness of the sample, indentations may range upwards of two microns in depth, which is proportional to the diagonal of the square indentation. This too is measured in microns, one micron equalling roughly forty millionths of an inch. The device makes possible the measurement of hardness gradients within areas too small to permit satisfactory exploration with any of the usual testers.

The micro-hardness tester measures with amazing accuracy the hardness of the hardest steel constituents. This is necessary to know the degree of hardness of steel grains themselves, and of the iron and other alloy carbides. The mechanism consists of the indenter with a square-base, 136-degree diamond pyramid penetrator, the mechanical stage for holding the specimen, a microscope capable of magnifying the test field 500 to 1500 times, and a control box. All parts are assembled on a heavy cast-iron plate supported by steel legs which rest on insulated wooden blocks to minimize effects of vibration present in the building. As many as 60 indentations may be made automatically at predetermined time intervals for surveying tiny gradients, which may have an important influence on the behavior of a fabricated product such as a weld.

Fatigue tester, shown at left, compresses three years' walking into ten days

ARTIFICIAL LEGS

Tested Under Accelerated Conditions

MAKING an artificial leg "walk" at the rate of 3,000,000 steps in ten days —the equivalent of three years of normal wear, a fatigue tester will permit faster testing and development of improved artificial limbs for this country's 20,000 veterans and 65,000 war workers who have had amputations.

A 300-pound load, over one and a half times that of the average man, is shifted continually from heel to toe of the foot of the artificial leg at a rate of four complete cycles a second, which means that the leg actually is "running" as fast as the swiftest athlete. Thus the amount of punishment it would take over a period of years is concentrated into a few days or weeks.

The machine was designed by William E. Dunshee, John F. Hopp, and LeRoy Barnes, research associates in mechanical engineering. Their work was done under a Northwestern University program of research in artificial limbs for war veterans.

The research in which the fatigue tester will be used includes study of the strength and durability of ankle and knee mechanisms, plastics shanks, and plastics cement used to join the parts.

In one test, the durability of artificial leg fittings used at Army amputation centers was demonstrated when a leg with the fittings completed 7,190,000 steps without failing, or the equivalent of seven years of normal wear.

Knee and ankle mechanisms of light metal alloys may be the parts most susceptible to wear, as evidenced by tests of another model in which the plastics shank remained intact after 4,800,000 steps, but the metal knee cracked after 600,000 steps and metal bearings in the ankle after 410,000 steps. An experimental plastics limb now under test has undergone 5,300,000 steps without failure.

Strain gages that translate pressure into measurable electric current are attached to various parts of the limb to record the exact pressure and tension in each part. Although the over-all load is 200 to 300 pounds, some parts of the knee and ankle mechanisms are so small that pressure concentrated on them is sometimes as high as 9500 pounds per square inch. The load on other parts, tests showed, are as low as four pounds per square inch. A major problem is to design the limbs so that pressure is more equalized.

Preliminary tests indicate that a combination of riveting and bonding (plastics cementing) is the strongest means of connecting joints and that new plastics parts show promise of great strength. No plastics part of any limb has failed yet in the fatigue testing machine.

LIGHTWEIGHT MOTORS

Made Possible by New Magnetic Alloy

CARRYING more magnetism than any other alloy practical for use in motors and generators and tough enough to withstand intense vibration, a 35 percent cobalt, 64 percent iron, 1 percent chromium alloy will make possible compact electric motors and generators an estimated 10 percent smaller and lighter than those of equal power now built for aircraft. This is so, because the high magnetic saturation point of the alloy, called Hiperco, will permit the design of motors with less metal for the same power, or more power from the same amount of metal.

The combination of 35 percent cobalt with iron gives the highest magnetic saturation point of any known metallic material, and the 1 percent chromium is added to make the alloy workable.

The new alloy is the result of 20 years' research by Westinghouse research engineers, with the final diffi-

culty of brittleness being overcome only recently. Earlier samples of Hiperco were too brittle to be of great use. However, a method of rolling was devised which enables production of a tissue-thin strip of metal tough enough to withstand intense vibration and yet ductile enough to be bent double without breaking.

Formerly the metal was "hot-rolled" and allowed to cool slowly but, unlike ordinary iron and steel, cobalt-iron becomes brittle when it cools in this manner. It has been found that brittleness can be avoided either by quenching the alloy in cool water, or by continuous rolling while the hot metal cools.

Now, with the quenching method in use, Hiperco ingots are rolled into slabs two to three inches thick, reheated to a high temperature, and rolled again to a thickness of one tenth of an inch. As the strip emerges from the last set of rolls, it plunges into a trough of cooling water.

The sudden cooling makes the metal so strong and workable it can be coiled like wire, whereas formerly it could not be bent at all. The cool metal then goes through a "cold rolling" process which can further reduce its thickness to as little as one two-thousandth of an inch. For most motor and generator applications, however, a thickness of approximately one two-hundredth of an inch is sufficiently thin.

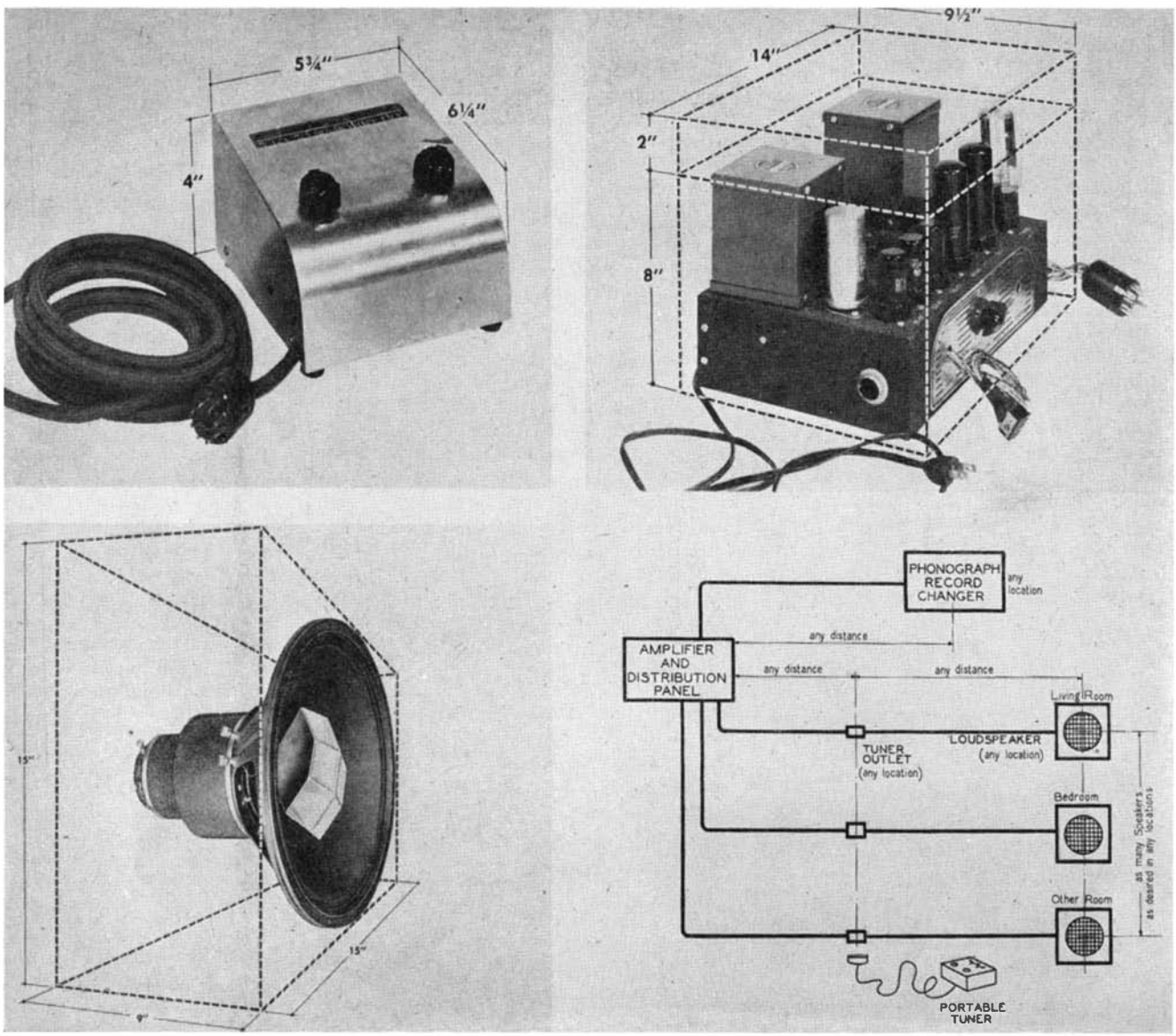
Even though cobalt is a high-cost material, most of which must be imported from Africa, Hiperco will be of value wherever smaller and lighter motors and generators are economically important.

Mineralogists now are searching for new supplies of cobalt in the United States, Canada, and China. If they should find a sufficient supply, Hiperco might replace other metals in many types of motors and generators. Today, however, its cost limits its use to such applications as aircraft where savings in weight and size are important from an operating cost standpoint.

HOME SOUND SYSTEM

Serves as Radio and Record Player, Is Built into Walls

ENGINEERED to be a functional part of a home, a built-in radio and sound system consists of four major parts: a portable tuner, an amplifier, a record player, and one or more speakers, plus an antenna and the necessary wiring to connect the various units. The portable tuner, about the size of a cradle telephone, is the only part of the system which appears in the room. All other units are concealed in the walls or other



Tuning unit of new sound system (upper left) can be used in any room having a speaker and tuner outlet. Amplifier unit, with an output of 15 watts (upper right) can be located in any out-of-the-way place. The high-fidelity speakers (lower left) are concealed in recesses in the wall, and cover the entire range from 30 to 15,000 cycles. Block diagram (lower right) shows system's flexibility

suitable space. The amplifier unit can be placed in a closet, the basement, or the attic. By eliminating the costly cabinet, a considerable saving is achieved.

Simplification of both the wiring and installation requirements for the Reeves Soundcraft Radio system makes it possible for the builder and a competent electrician to incorporate the various units into any home. The speakers and their connections are mounted on a panel for easy installation, while special outlets to receive the plug-in jack of the tuner can be provided, where desired, in rooms that have speakers. For each speaker location, an on-off switch is available for listening to a program that is tuned in by the portable station selector in another room. The record player plays through the radio amplifier but is controlled at its location independent of the radio tuner.

POWDER METAL BEARINGS

Wear Long Without Additional Lubrication

DESPITE severe usage, Americans may expect a great increase in the useful life of home appliances, farm machines, automobiles, airplanes, and factory machinery as the result of new developments and improvements of self-lubricating bearings which in tests have completed the equivalent of 14 years of continuous operation with no perceptible diminution of oil supply and a minimum of wear on the bearing metal made from powdered metals.

Oilite bronze precision bearings, made by The Chrysler Corporation, permit use of lower bearing clearances than is possible with solid cast bronze thereby assuring quiet operation and greater bearing life.

These bearings can be made to many desired specifications as to physical properties and chemical composition. With proper design, Oilite bearings have carried loads exceeding those under which cast bronze and hardened steel have failed.

Other advantages of the self-lubricating bearings include elimination of oil drippage and the fact that there is now a large supply of the metal powders from which they are made.

GASOLINE FROM GAS

Seen Economically Possible, With Fluid Cat-Cracking

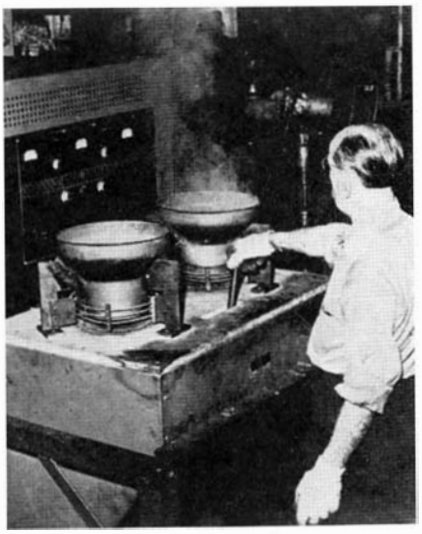
DUE to the utilization of certain principles developed in the fluid catalytic-cracking process, conversion of natural gas into gasoline is now economically competitive with production of gasoline from petroleum, it was reported at a recent American Gas Association meeting. Also, it was declared that production of gasoline from coal is practical but not now, in general, competitive with production from crude oil. The development of coal conversion processes, however, is continuing.

ELECTRONIC ANNEALING

Increases Speeds and Lowers Costs in Milk-Can Fabrication

ADOPTION of electronic heating in the manufacture of milk cans at the Buhl Manufacturing Company, has resulted in increased production of cans, lower manufacturing costs, and a more durable finished product.

Prior to the installation of two five-kilowatt General Electric electronic heaters, the entire breast of a milk can had to be annealed in a gas-fired furnace, although only the neck of the can needed to be heated. Then the can had to be pickled to remove the scale before finishing.



Courtesy General Electric Company

In 12 seconds the milk can's neck is brought to a red-hot temperature

With the new method, it is possible to anneal as little as an inch of the neck of the can. The piece can be brought up to a red temperature in 12 seconds. Since the heater has a two-position transfer switch, one piece can be heated in one heating position while the other position is being unloaded and reloaded. At the end of the heating cycle, the power is transferred from one heating position to the other by the throw-over switch.

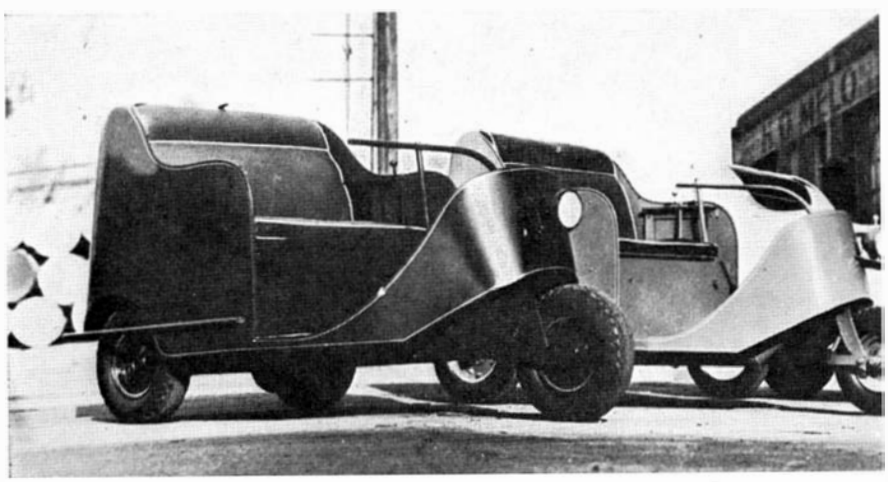
The electronic heater is located directly in the production line. As a result, one operator can anneal more cans with the present system than two men using the former method, which necessitated removing the cans from the production line, moving them to the annealing furnace, pickling them, and returning them to the line.

RUNABOUT BODY

Easily Formed of Durable Laminate

OF SPECIAL interest to automotive and aircraft manufacturers and other industries using semi-structural parts, is a new application for plastics—the body of an electric runabout, called the Autoette. The body section for this vehicle, with an area of approximately 20 square feet, is laminated Fiberglas which has been impregnated with American Cyanamid's Laminac resin. The one-piece structure is molded into complicated, curved forms.

The Autoette body, manufactured by the Triangle Boat Company, is adaptable to use in industrial plants as well as for local, personal traveling. The original design called for an all steel frame, but the manufacturers of the Autoette have



The wear-resistant body is formed in a single piece

recently switched to laminated plastics. The fact that a large section can be molded over an inexpensive form, plus the weather resistance and general durability of this type of construction, were largely responsible for the change.

Actual technique of manufacture of the laminated plastics body consists of laying up Laminac resin impregnated Fiberglas over a male mandrel which has previously been covered with cellophane, curing, and then repeating the process with additional layers. The finished body is painted and is said by the manufacturer to be durable and resistant to weathering and denting.

MINERAL DEPOSITS

Located By Analysis of Clay

A TECHNIQUE for discovering mineral deposits which has given early evidence of being able to add substantially to the nation's dwindling mineral resources has been reported by Paul F. Kerr, professor of mineralogy at Columbia University and president of the Mineralogical Society of America.

The technique is known as "alteration study" and involves the careful study of the clays found in the vicinity of mineral deposits. Particular attention, according to Professor Kerr, is paid to the processes of nature that have destroyed original rocks and left in their place clay and various other types of alteration minerals. These alteration minerals constitute the clue that leads to the mineral deposit.

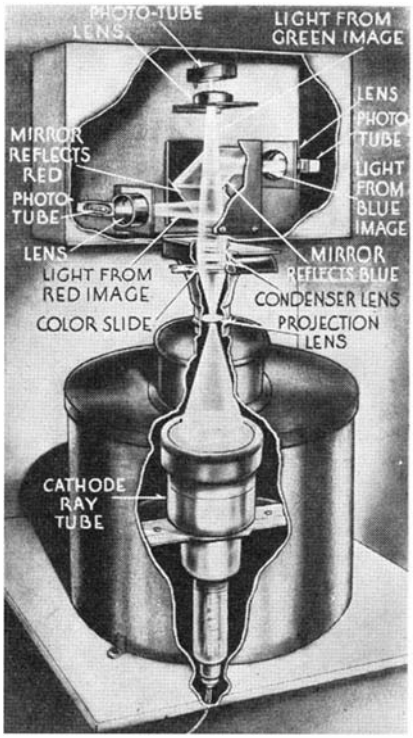
The alteration study method has been in use by Professor Kerr and others in the southwestern states for the past five years. As a result of work with Columbia geology students in co-operation with various mining firms, considerable success has resulted from the method.

When the alteration study technique is developed to its expected possibilities, it will give the mining industry a valuable weapon in the fight to increase the rate of mineral discovery.

COLOR TELEVISION

Electronically Produced By Splitting Light Beams

WITHOUT rotating disks or other moving parts, a new color-slide television camera produces full-color television pictures by all electronic means. This camera, recently demonstrated by its developers, the Radio Corporation of America, produces signals from 35-mm Kodachrome slides. Transmission of the picture on the slide is achieved in natural colors when a light beam from a kinescope is focused through the slide and separated into component colors by a system of mirrors and photoelectric cells.



At the camera, light from cathode ray tube passes through color slide. The resulting image is separated into its component colors, and each color is then reflected to a photo-electrc tube where it is changed to electrical signals

Each of the three resulting images —red, blue, and green—is of the same number of transmission lines, that is, 525; also, the horizontal scanning rate and the picture repetition rate of 30 pictures per second is the same as in present commercial television broadcasting.

The receiving set is equipped with three three-inch kinescopes, which separately receive the signals representing red, blue, and green. This trio of kinescopes is called a Trinoscope. From it the three color images are optically projected into a composite picture which appears on a 15 by 20-inch screen in natural color, free from flicker, color fringes, or break-up of color.

By this new advance in television, simultaneous color transmission, instead of sequential transmission, color by color, is achieved.

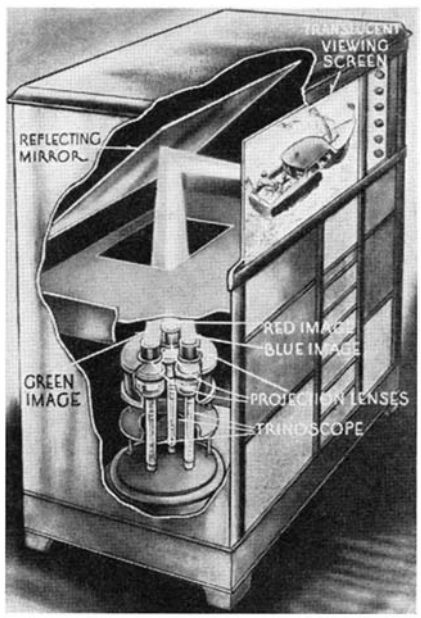
HIGHWAY STANDARDS

Probably Will Change Little During the Coming Year

DESPITE accelerated repair and new construction activities in every state, the nation's 300,000 miles of paved highway will incorporate few engineering changes this year, in the opinion of T. R. Johnson, general manager of the American-Marietta Company's Keystone Asphalt division.

Releasing a summary of highway pavement specifications obtained in co-operation with state highway officials, Mr. Johnson revealed that only ten states contemplate any changes in highway standards during 1947.

Amplifying information secured in the nation-wide survey, he declared: "In the move toward national engineering standards for State and Federal sponsored highways, only the expansion joint has made appreciable progress, with 38 states accepting the principle that expansion joints are essential." Expansion joint spacing ranges from 60 to 600 feet, with contiguous New Mexico and Arizona representing the extremes. The average spacing for highway expansion joints is approximately 200 feet.



At receiver, images from the three kinescopes are cast onto mirror and reflected to screen where they superimpose, reproducing scene in color

Preformed mastic board and poured rubber asphalt contraction joints at spacings of 15 to 20 feet are specified in 90 percent of the states reporting definite standards. Asphalt and fiber are the preferred expansion joint materials, with cork, steel, wood, sponge rubber, and cottonseed hulls being used in a few regions.

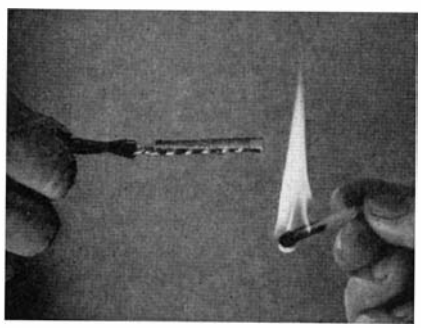
Curing processes also are approaching national standardization, with 33 states approving the membrane cure techniques.

New Products and Processes

SELF-SOLDERING TAPE

Supplies Own Heat, Needs Neither Torch Nor Iron

SOLDERING splices in electrical wiring, and similar small soldering jobs, can be accomplished without the use of either an iron or torch with a recently developed self-soldering tape. Made with a strip of regular solder on one side and a strip of flexible, flammable plastics on the other, the tape assures



Tape is ignited with match or lighter

a perfect soldering job, greatly speeding and simplifying the usual process. To use, a piece of the tape is pressed firmly around the entire length of a flux-coated splice. Then the plastics strip is ignited with a match or cigarette lighter. The intense heat from the burning plastics not only melts the solder, but also thoroughly heats the work, allowing the solder to flow freely into the joint. When the flame burns out, the soldering is completed. Even in the most inexperienced hands, there is absolutely no danger of a cold-solder joint. The tape, called Neat-N-Nifty Self-Soldering Tape, is offered by the W. B. Franklin Company in a kit containing also a supply of flux and full instructions.

SHRINKPROOF RAYONS

Withstand Heat and Are Easily Handled

ASSURING no more than 2 percent shrinkage or stretching, a newly developed process permanently stabilizes viscose rayons. Commercial finishers licensed to use the process have already begun turning out stabilized rayons and, bearing the trade mark Sanforset, the treated fabrics are expected to be available in the fall.

The process, called BR-I Stabilizing Process by its developers, Cluett, Peabody and Company, eliminates many of rayon's most serious disadvantages. Permitting the fabric to be washed without special handling, the expense and bother of dry-cleaning are avoided. Ironing the treated rayons is also greatly simplified.

The results achieved by the BR-I process of stabilization are permanent, it is claimed, because there is nothing introduced into the fabric to wash out. The "hand" of the fabric is not changed and any desired finish may be obtained. It also is easier to handle on the cutting table.

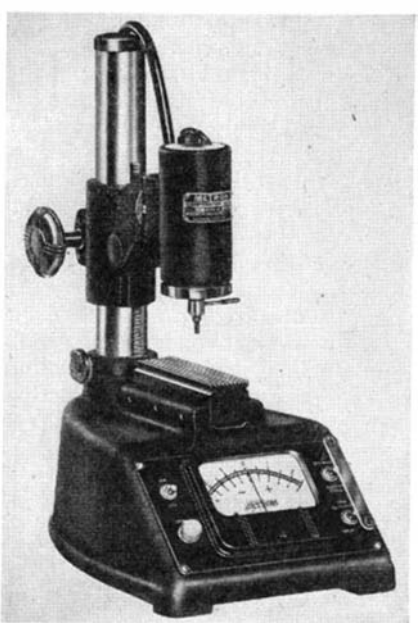
Multiple laundering tests indicate that the wash durability of the stabilized fabrics was actually greater than that of untreated fabrics. There is no need to "baby" the treated garment in washing and it will retain its original fit whether washed at 100 or 212 degrees, Fahrenheit.

MAGNETIC COMPARATOR

Has Four Ranges, Uses No Vacuum Tubes

A COMPARATOR gage, which is of the electromagnetic type, having no vacuum tubes or other components of limited life, has four ranges of magnification (selected by means of range switches) so that a single gage is suitable for a wide range of gaging applications from checking gage blocks to production inspection of machined parts. Three models of the gage, a product of the Merton Instrument Company, are available, calibrated in either English or metric units. Model 10 has a gaging range from 0.000001 to 0.0004 inch. Model 20 has a range from 0.000010 to 0.005 inch. Model 30 has a range from 0.00005 to 0.020 inch. The spindle pressure is adjustable and calibrated from 4 ounces to 2½ pounds and the head can be rotated at any angle about the column or in the vertical plane. The head can be removed for special setups if desired. The gage has only two moving parts: the spindle, which is supported in flexure, and the pointer, which is mounted on jewel pivots. This assures millions of gaging operations and years of service without maintenance.

A complete line of accessories is available such as large anvils, stops, flat tips, over-hang supports, V-anvils, and so forth, for accurate measurements of parts of all shapes and materials.



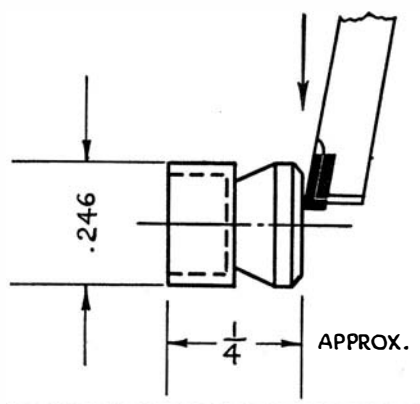
Fits wide range of gaging applications

FINISH GRINDING

Operation Eliminated by Carbide Tool

ELIMINATION of the need for a final grinding operation together with increased production speed and a tenfold increase in life between grinds of tools, has been achieved through the use of standard Carboloy turning tools in place of high-speed steel tools on a facing operation in a large manufacturing plant.

The operation consisted of facing plunger pins of S.A.E. 1035 bar stock. The manufacturer reports that, with high-speed steel tools, some 1000 pieces were faced between grinds. Moreover,



Sketch of facing tool in use

the end of each plunger pin had to be ground in order to obtain a satisfactory finish.

When standard Carboloy T-41 tools were installed in an effort to speed production, the tool life between resharpenings jumped to 10,000 pieces. Furthermore, the new tools produced a degree of finish on the pins which made the final grinding operation unnecessary. The tools were tipped with Carboloy Grade 78, a type of carbide

possessing high wear resistance. The only special tool grinding required to fit the standard tools to this job was to increase the front relief angle from 7 degrees to between 25 and 30 degrees in order to clear the work.

Facing was perfomed on a Brown and Sharpe Automatic Number 00. Feed was .0018 inch. Depth of cut varied from .002 to .005 inch. The machine speed was raised to 3300 revolutions per minute—which was maximum for the machine—giving a cutting speed of approximately 200 surface feet per minute.

INSECTICIDE SPRAYER

Electrically Operated, Has No Moving Parts

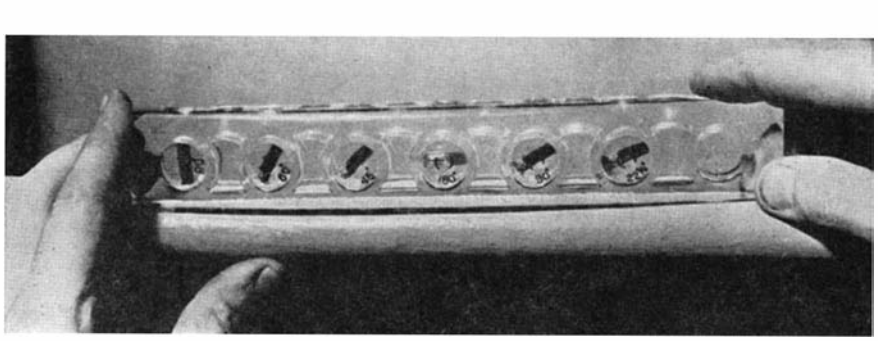
REPRESENTING a new principle of insect control, an Aerosol gun's operation is unusual in that it has no moving parts and does not employ steam. The gun automatically converts Aerosol concentrate to gas by means of a thermostatically controlled heating process. Electrically operated (115 volt A.C.-D.C.), it weighs but 6 pounds, is 12 inches long and 9 inches high. The case is of molded plastics and all parts are entirely self-contained. To operate, the filler cap is removed from the back plate and a charge of concentrate poured in. A few minutes of heat are required to change the liquid to a gas after which the Commando Aerosol Gun, a product of Mayfair Industries, is ready for several hours of operation. Sufficient pump pressure results to discharge the dry gas eight to ten feet with a fog that is not readily dissipated.

The dry gas is deadly to cockroaches, mosquitoes, flies, bedbugs, spiders, moths, fleas, ants, silverfish, weevils, and many other insects. Reported as non-toxic by the American Research and Testing Laboratories, it leaves no oily film or unpleasant odor and will not contaminate food products.

SPIRIT LEVEL

Of Acrylic Plastics, Indicates Six Angles

POCKET-SIZED, a new spirit level, molded from transparent Plexiglas, is light-weight, sturdy, and shock resistant. A result of the combined engineering efforts of Lawco Plastic Products Company and Sobenite, Inc., the spirit level indicates six different angles: 22½, 30, 45, 60, 90, and 180 degrees. To simplify the identification of these angles, the degree of each angle is molded into the plastics, and different colored fluids are employed for each indicator. The close tolerances used in the molding process eliminate the need for adhesives to hold the dime-sized indicators in place. All parts of the level are molded simultaneously in a seven-cavity mold.

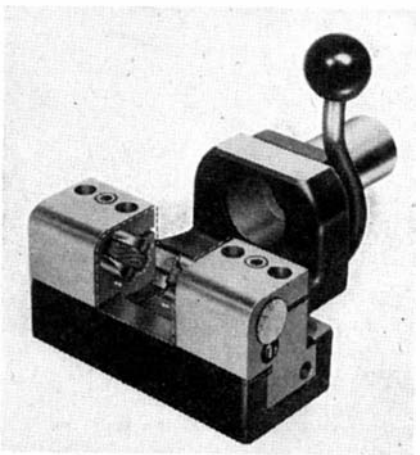


Each angle is clearly marked

KNURLING TOOL

Produces Various Patterns Without Changing Knurls

ADAPTABLE to any engine or turret lathe, a cam-action retractable knurling tool will rapidly knurl long, thin work and will clear threads, pilots, and other sections of the same diameter as the portion to be knurled. Made by the Universal Vise and Tool Company, it can be instantly adjusted to any diameter up to two inches; the cam-action retracting mechanism is self-locking to free the operator's hands while the tool is feeding. Formation of different knurl-patterns without changing the knurls is possible and the use of standard knurls permits easy replacement.

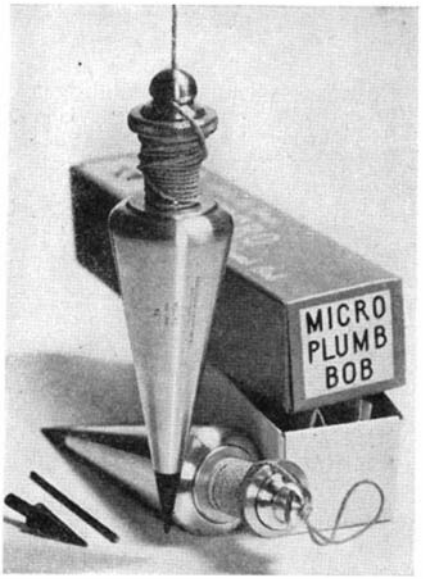


Takes work up to two-inch diameter

PRECISION PLUMB BOB

With Minute Adjustment Promotes Speed and Accuracy

A QUICK-ACTING, precise plumb bob for use by carpenters, mechanics, construction men, surveyors, and so on, has a rotatable reel at the neck. Cord is reeled off to the approximate length wanted, and then slipped into a hook on top of the neck, which holds bob exactly centered anywhere on the cord. The bob can then be minutely adjusted up and down simply by rotating the spool. When not in use, the spool and hook hold the cord neatly and securely in place, even with the bob carried loose in a tool box. Rugged and simple in construction, there is nothing to get out of order, even when working in wet mines.



Forged brass, steel tipped

Carefully engineered and thoroughly field-tested, this Micro Plumb Bob is constructed of dense, forged brass, with a steel point, heat treated for toughness and hardness. The popular 10, 12, 14, and 16 ounce sizes are available, and each bob is supplied with tool-steel pin, cord, and an additional precision point.

VULCANIZED STARCHES

Resist Swelling Action Of Heat and Chemicals

HAVING countless potential applications in industrial fields, "vulcanized" starches are resistant to the swelling action of heat and chemicals and are available with various degrees of non-swelling and non-gelatinizing characteristics. Wide-spread use of the partially treated starches, produced by National Starch Products, Inc., is suggested by a number of possible applications such as in printing thickeners in textile operations, certain creams in cosmetic fields, electrolyte carriers in dry-cell batteries, or as ingredients for canned soups. In the printing and paper trades, these materials, known as Vulca starches, are adaptable as dusting powders, beater sizings, or as additives to tub sizings.

The completely vulcanized starch, known as Vulca-100 answers industrial requirements for an inert, non-toxic organic filler or ingredient. It can be cooked in boiling water or a 5 percent alkaline solution without increasing its average granule size more than five

microns. Approximately neutral in water suspension, the starch settles after cooking, because the granules are not appreciably swollen or ruptured.

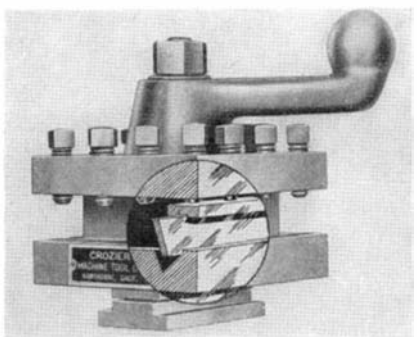
The product is non-toxic and is not rapidly hydrolized by acids or enzymes. Steam sterilization makes no essential change in any of the properties of Vulca-100.

POST TURRET

Eliminates Resetting by Holding Four Tools Simultaneously

COSTLY set-up time and down time in general tool room lathe work is virtually eliminated through use of a new tool post turret. Bolted firmly in place on the lathe, this tool post turret, produced by the Crozier Machine Tool Company, holds any four tools simultaneously, thereby doing away with resetting and recentering of tools in 90 percent of work operations.

Indexing is accomplished simply by "opening" the handle and revolving the turret manually. The pre-location is determined automatically by a powerful detent mechanism without the operator having to feel for the correct position.



No need to feel for correct position

When the turret has been revolved to the desired tool, the handle is "closed." No auxiliary operations are necessary —no pins to pull or levers to throw. Close indexing is maintained by hardened pins closely fitted into holes in the hardened body.

WING NUTS

Made Self-Locking With Nylon Inserts

FEATURING an elastic nylon locking collar, a self-locking wing nut has been developed to answer design requirements calling for the convenience of a wing nut, plus the ability to lock in position anywhere on a bolt or stud. Potential applications of the self-locking wing nut exist on household appliances, children's toys, garden equipment, folding chairs, furniture, office equipment, automobiles and trucks, industrial equipment and special machinery of all kinds.

The wing nuts, produced by the Elastic Stop Nut Corporation of America, are available in four diameters with both fine and coarse threads. Machine screw sizes, in fine threads, are 8/32, 10/32, and 12/28, with the fractional size of 1/4-28. Coarse thread sizes are 8/32, 10/24, and 12/24, in addition to 1/4-20.

The locking torque characteristics of these wing nuts have been tested under severe conditions and they have shown retention of locking effectiveness through 200 applications and removals. The wing nuts are made of die-cast zinc, with all nuts in regular production supplied in plain finish. Nickel plating can be furnished on special order.

OXIDIZING COMPOUND

Gives Silverware Antique Appearance

PRODUCING a black to gray oxidized finish on sterling silver, silver-plated flat ware, or hollow ware, a compound known as Platin-Nig, product of the Hanson-Van Winkle-Munning Company, gives that antique look to the treated pieces. No electric current is required for the process. The work is simply dipped into the easily prepared solution, and then high-lighted for the desired light and shadow relief.

PORTABLE POWER BURNER

Can Produce 15-Foot Flame of 2000 Degrees

ANSWERNG the need for a large, portable, self-contained piece of equipment to provide a high-temperature flame for industrial work is a power-driven burner which is self-starting and has no chains, belts, or gears.

The burners used on this unit make possible working in a vertical as well as a horizontal position without affecting the volume or density of the flame. By regulating the air and fuel valves, any type and length of flame can be produced from six inches up to 15 feet, with temperatures up to 2000 degrees, Fahrenheit. The burner, produced by Aeroil Products Company and Schramm, Inc., operates on kerosine or any oil up to Number 3 fuel oil.

Although this model was originally designed as a weed burner for agriculturalists, high-way engineers, and railroads, it has many uses in industry, for such work as straightening, bending, shrinking, and expanding; skin drying foundry molds; heating plates, ribs, and girders; and for general repair work.

SIGNALING TIMER

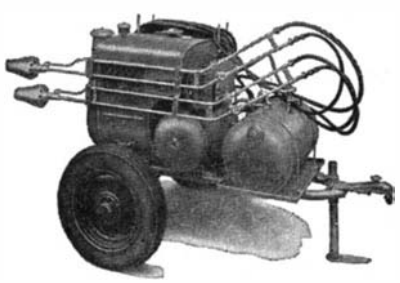
Opens or Closes Control Circuits

COMMANDING visual and audible attention the instant a pre-selected time interval is completed, a signaling timer provides for automatic closing or opening of a circuit at the end of elapsed time, and operates additional buzzers, bells, or lights at remote locations.

A buzzer sounds and pilot light goes out when time interval is completed

When the pointer on the timer is manually set to the required interval shown on the dial, a circuit is closed which operates a pilot light indicating that the time interval has started. The moving pointer revolves counter-clockwise toward zero; at any second during the interval the exact time elapsed is shown on the dial. When the interval is completed, an audible alarm sounds and the pilot light goes out. The buzzer continues to sound until the toggle switch on the timer is snapped to "off" position or the timing interval is again started by moving the pointer knob.

Two sockets are provided on the



Above: Close-up of the power burner with two torches in brackets on the side. Left: The burner in use, operating three four-gallon-per-hour torches. Note length of flames and large working radius possible

Editorial purpose of Scientific American is to provide its readers with thought-provoking feature articles and shorter items on all phases of industrial technology. In every case the material is drawn directly from industry itself. The Editor will be glad to refer interested readers to original sources and, when available, to additional literature, giving further details of a more specialized nature.

side of the case, one for normally open, and the other for normally closed circuit control. They provide for connection of additional lights or alarms. Rapid resetting of the pointer knob, when the same time interval is to be repeated indefinitely, is afforded by a quickly adjustable back stop.

This timer, a product of the Industrial Timer Corporation, is enclosed in a metallic grey case, 5 by 5 by 3½ inches deep and is readily attachable to any wall or panel or standard switch box. It operates on alternating current, 115 or 230 volts; 25, 50, or 60 cycles, voltage and frequency to be specified. The motor is slow speed, self-starting synchronous type. Pure silver contacts are used throughout. Connection to the line is made with line cord. Voltage, frequency, and switch rating are plainly indicated on the name plate.

SMOKELESS HEATERS

Prove Efficient In Field Tests

COMMERCIAL models of a smokeless heater have undergone practical field tests in four major cities—Chicago, Cincinnati, Indianapolis, and Pittsburgh.

Early reports indicate that these

These heaters require less manual attention than do conventional models

heaters are giving smokeless performance with high-volatile coals, and trouble-free operation. Also, they require less manual attention than conventional heaters.

In its present size, the Smokeless Heater, developed by the Bituminous Coal Research, Inc., is designed to operate for a 12-hour period without attention, yielding an average of 35,000 B.T.U.'s an hour. For shorter periods it will burn up to six pounds of coal per hour with corresponding increase in heat output.

Laboratory burning tests in the latest model, using high-volatile coals, are giving excellent performance with smokeless operation, it is reported. The self-feeding principle operates well, and "puffing," a troublesome drawback with some magazine-feed designs, has been eliminated.

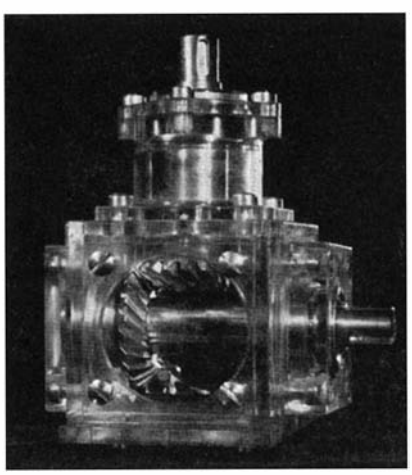
Having emerged from the research stage with design principles well established, the BCR Smokeless Heater is expected to be produced in quantity prior to the 1947-48 heating season. It is believed that these heaters will offer a considerable selection in price range, capacity, and exterior finish. Some combine the radiant and circulating principles of heat transfer while others are strictly circulators. They are of the magazine type with easily operated and precise controls, and employ fundamental principles of smokeless combustion. These combustion principles can likewise be applied to warm-air furnaces, ranges, and boilers.

Development of the space heater was given priority over other type of heating equipment because of the vast number of them required in cities enacting smoke control legislation. In Pittsburgh alone, it is estimated that 53,000 units will be required to replace heaters that cannot burn high-volatile coal smokelessly.

PLASTICS GEAR HOUSING

Permits Close Observation Of Moving Parts

A DEMONSTRATION model of a spiral bevel gear has been created by enclosing all working parts of the gear in acrylic plastics so that the operation of the various parts may be observed to determine how the gear functions. In the actual assembly, constructed by M. L. Bayard and Company, Inc., all moving parts are made of steel. For any one predetermined gear ratio, the mounting flange and distance from the flange to the center of the assembly remains constant.



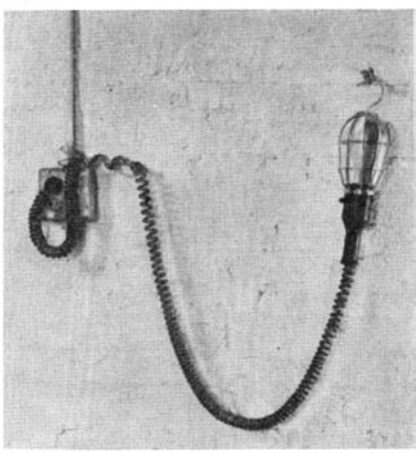
Spiral bevel gear demonstrator

The gear is enclosed in its transparent housing by bolting thick machined pieces of Plexiglas together to form the box-like case. Space between sections prevents interference with the mechanism, and the gear is operated by revolving either one of two exterior rods connected to the mechanism.

KINK-FREE CORD

On Trouble Lamp Recoils Automatically

EQUIPPED with a 25-foot self-recoiling cord, a new trouble lamp is completely free from the kinks and snarls that plague conventional models. With its cord jacketed in neoprene and therefore impervious to steam, water, oil, grease, and most acids, the lamp, known as Recoilo-Lite, is moveable to any outlet and adjustable to any length by means of a safety clamp which also guards against accidental pulling from the socket. The cord's retractibility insures its long life by preventing the cord from dragging on garage or service department floors or from becoming caught in industrial plant motors or machinery. The cord extends from a 43-inch retracted length to 25 feet. It is also available in 35-foot lengths. Recoilo-Lite, produced by the Kellogg Switchboard and Supply Company, will be sold through mill supply distributors and through automotive jobbers.

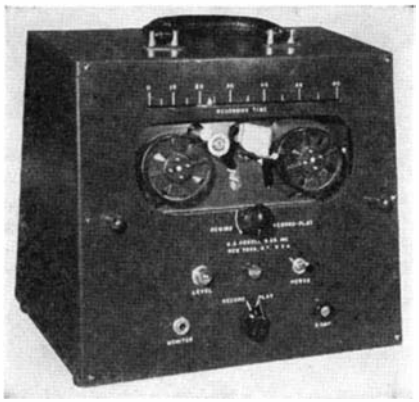


Impervious to water, oil, most acids

COMMERCIAL WIRE RECORDER

Can Be Used With Existing Amplifying Equipment

BEING turned out on a mass-production basis, a new magnetic wire recorder has been developed jointly by The WiRecording Corporation and the Armour Research Foundation. This recorder is designed for general com-



Sound-on-wire unit

mercial use by recording studios, radio stations, schools, theaters, industrial plants, and other companies operating public address and recording systems. Known as the Model B sound-on-wire recorder, it is interchangeable with most sound-on-disk and sound-on-film recording equipment. It can be used with any suitable amplifying system already in operation, and does not duplicate any of the parts of such a system. It makes available to an established sound system the advantages of high quality, low-cost wire recording, by the simple interchange of the recording unit. Installation is easily made with cables with which the recorder is equipped, and operation requires no technical knowledge.

The recorder utilizes a fine, stainless steel wire, a mile and a half of which winds on a spool 2½ inches in diameter and ¾ inch thick, which will record continuously for one hour.

Wire recordings are permanent. A spool may be played hundreds of times, or stored indefinitely. However, if one wishes to use the wire again, as for office dictation, the recording on the wire is automatically erased as the wire passes through the machine for new recording. This feature reduces the cost of using the machine to an absolute minimum wherever re-use is a factor. Recordings may be edited by cutting out the unwanted wire with household scissors, and tying the ends with a square knot. The knot will pass through the machine without perceptible noise.

Mechanical features of the Model B Wire Recorder include: a capstan drive which keeps wire speed constant, thus preventing flutter and changes in pitch; magnetic clutches which keep wire tension constant during recording; a cam-operated recording head which winds the wire in even layers on the take-up spool; and safety switches which stop the motor when a spool is almost entirely unwound, thereby eliminating re-threading.

BETTER SYNTHETIC RUBBER

Obtained by Addition of Cross-Linking Agent

IMPROVING the appearance and production efficiency of many rubber products, a "super-processing" synthetic rubber makes possible rubber boots and shoes, bathing caps, and other articles with a bright, shiny appearance produced in any color. It also improves the finish of tire sidewalls by reducing molding blemishes.

This new super-processing member of the rubber family is closely related to the general-purpose synthetic rubber, GR-S. The product obtains its unusual properties from the addition of a "dash"—about 0.5 percent—of a special chemical known as a cross-linking agent. After initial trials of the new product, fabricating plants announced that it is remarkably easy to handle; in some applications it is easier to process than the natural product. For example, tire makers report that less tearing and smoother and better molding are encountered in forming tire sidewalls with the special rubber, developed by the United States Rubber Company.

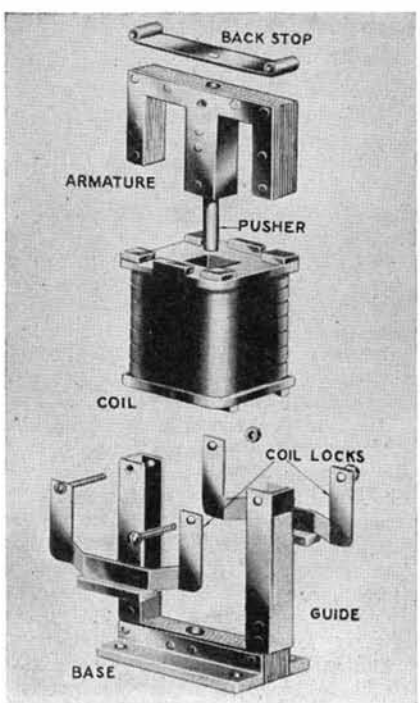
Producers of rubber shoes, boots, bathing caps, and hot water bottles said they favor it for two reasons. It gives better retention of embossed design, resulting in a smoother finish. Also, pieces of rubber sheet cut from patterns shrink much less during fabrication, causing fewer rejects. When using regular GR-S in making footwear, pieces have to be cut a size larger than desired because they would shrink before being built into the shoe.

The super processing synthetic will be made in two types, regular and non-staining. The latter can be used in white or light colored articles, since it contains a non-staining anti-oxidant, or preservative.

SIMPLIFIED SOLENOID

Has Built-In Pusher To Broaden Application

OF GREATLY simplified construction is a solenoid which consists of only five component parts: base, armature, coil,



Exploded view of solenoid

coil locks, and back-stop. The armature is designed with a built-in pusher, enabling the solenoid to do both pushing and pulling, greatly extending its adaptability. The T-shaped armature of the solenoid, a product of the Practical Electric Company, produces a very effective magnetic circuit, providing a high rating. The base is equipped with an accurately formed seat to receive the armature, thus preventing chattering.

ILLUMINATED CLIPBOARD

Permits Writing In Poor Light

CONVENIENT wherever writing or checking must be done in poorly lighted areas is a self-illuminating clipboard.

Standard flashlight bulb is used

A flashlight bulb in a reflector, set into the clip and powered by two standard flashlight cells, supplies the illumination. Backboards of either aluminum or masonite are available in two sizes —seven by twelve inches, and nine by fourteen inches. The clipboard known as Ray-Rite, is a product of Lennan Lights, Inc. A convenient switch controls the light.

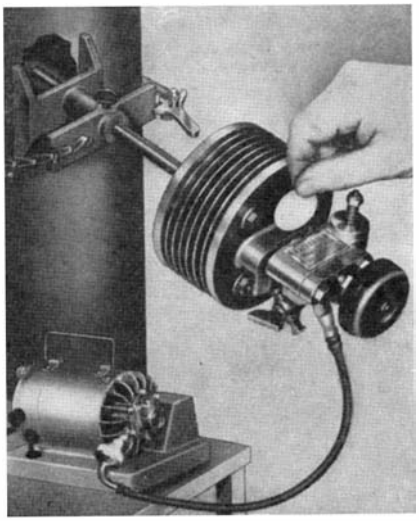
SMOKE TESTER

Measures Density By Visual Comparison

DESIGNED primarily for measuring density of smoke from oil-burning furnaces, a smoke tester consists of a sampling unit, which is attached to the smoke pipe of the furnace, and a motor-driven vacuum pump which may be set at any convenient place near the furnace. A time switch mounted on the motor base automatically stops the operation of the 110-volt A.C. motor after a one-minute interval.

The flue gas sampling tube of the sampling unit is inserted into the flue pipe through a 7/16 inch hole located between the furnace outlet and the barometric draft regulator. The sampling unit is then attached to the flue pipe by means of an adjustable strap. A small filter disk is inserted into the filter holder of the sampling unit. A turn of the handwheel at the end of the sampling unit closes the filter holder and holds the filter disk firmly in position.

When the lever of the time switch



Inserting filter in smoke sampler

is pushed against its stop, the vacuum pump starts, drawing flue gas through the filter disk for one minute at controlled vacuum. The smoke is carried along in the flue gases and is evenly deposited on the filter disk, thus producing a visual indication of the smokiness of the flame. The exposed area of the fllter disk will vary in shade from light gray to black, depending upon the extent to which the flame is smoking.

Immediately after the pump stops, the filter disk is removed from the holder and then compared with the smoke disks on a comparator scale furnished with this product of the Bacharach Industrial Instrument Company. By this matching procedure it is a simple matter to adjust an oil burner to give its highest efficiency.

HIGH-PRESSURE HOSE

Resists Soaps, Hot Water, And Strong Chemicals

FLEXIBLE hose reinforced to withstand a pressure of 800 pounds per square inch has been developed for use on high-pressure auto washer equipment. The hose, developed by the United States Rubber Company, is constructed with a synthetic rubber tube specially compounded to resist hot water, soapy solutions, and chemicals used to clean cars, and is reinforced with two plies of Ustex, a chemically-treated, high-strength textile. The cover is made of synthetic rubber to resist oil and grease encountered on garage floors. The hose will be made in three sizes—⅜, ½, and ¾ inch inside diameter.

PROTECTIVE PIGMENT

Inhibits Corrosion on Iron, Steel, and Light Alloys

PALE yellow in color, barium potassium chromate has been developed as a pigment which possesses a desirable combination of properties, most important of which is its ready release of a corrosion-inhibitive ion in the presence of water. That water soluble sulfates and chlorides are detrimental to the corrosion-inhibitive properties of metal primer pigments is now a recognized fact. The new Pigment E is singularly low in these impurities. Paint primers formulated with this product produce coatings which have shown outstanding performance in protecting iron, steel, and the light-metal alloys.

The concentration at which Pigment E is used in paint composition varies, depending on such factors as intended service, cost, and so on.

Paints containing Pigment E may be made with vehicles containing resins such as the alkyds, phenolics, polymerized terpenes, resins derived from modified rosin, coumarone-indene, natural resins, chlorinated rubber, and other vehicles in current use. Paints made with this pigment have excellent package stability.

While Pigment E has low tinting strength and low hiding power, neither of these properties is important in the formulation of metal paint primers since top coat paints are invariably applied over them. Where hiding is important, other pigments possessing hiding power are usually included, and in such instances the low tinting power of Pigment E permits a wider range of shade.

Pigment E, developed by the National Lead Company, is available, for the present, in sample amounts and in quantities sufficient for small plant development purposes.

LIGHT-WEIGHT PUMP

Handles Wide Range of Viscosities

STURDY, though it weighs only 14 ounces, a low-cost rotary-vane type non-pulsating pump is designed to handle all types of clear non-corrosive liquids. The unit is so designed that by varying materials and accessories, it can be used to pump fluids from a watery viscosity up to No. 60 S.A.E. oil. Patterned after heavy-duty aviation pumps, this new unit is expected to see wide use in lubrication systems, as well as being incorporated into industrial machinery in manufacturing and processing plants. It is available with by-pass and relief valves for fuel delivery, as well as being built with various drive couplings and mounting flanges for either engines or electric motors. The pump, manufactured by The Romec Pump Company, has a capacity of 75 gallons per hour, a speed range to 4000 revolutions per minute and operates at pressures up to 60 pounds per square inch.

The Editors Recommend

PROCEDURES IN EXPERIMENTAL PHYSICS— *By John Strong, Ph.D.* A wealth of useful data of a practical kind for the constructor, experimenter, and skilled craftsman. **$7.45**

HIGH FREQUENCY INDUCTION HEATING — *By Frank W. Curtis.* Answers many questions concerning induction heating and its utility in industrial processes. Thoroughly practical in scope. **$3.10**

TOOL MAKING — *By C. M. Cole.* Instructions for making and using all kinds, from personal tools to arbor presses, lathes, planers, etc., in different metals. **$4.10**

POTTERY PRODUCTION PROCESSES—*Edited by J. J. Svec.* For amateur and professional alike, this compact volume gives specific instructions. Particular attention is called to troubles most likely to develop. **$2.10**

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

NORTON'S STAR ATLAS AND TELESCOPIC HANDBOOK — *By Norton and Inglis.* Tenth edition of a standard work, with main charts redrawn for epoch of 1950. Standby for amateurs past the cradle roll. **$5.10**

PLASTICS — *By J. H. DuBois.* Third edition, again revised and enlarged, with two four-color plates. This is an important book on the whole general subject of plastics, plus much brand new material on synthetic rubber, manufacturing processes, and plastics moldings. **$5.10**

REVISED LAPIDARY HANDBOOK — *By J. Harry Howard.* Practical instructions in gemstone cutting and polishing, for both beginner and the advanced hobbyist. **$3.10**

SIMPLIFIED PUNCH AND DIE MAKING — *By Walker and Taylor.* Comprehensive reference book for tool engineers as well as those just getting started. Emphasis is on what-to-do and how-to-do-it, from the simplest to the most complex dies. **$5.10**

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

TECHNIQUE OF GLASS MANIPULATION IN SCIENTIFIC RESEARCH — *By Julius D. Heldman, Ph.D.* Text covers properties of glass, glass-working equipment, basic operations, seals (including metal-to-glass), and exercises aimed at perfecting technique. **$3.70**

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

SLIDE RULE SIMPLIFIIED — *By C. O. Harris.* How to use a slide rule, without any of the mystification that often surrounds this important tool of the engineer. Excellent illustrations make everything olear. **$4.10** including a slide rule; for book alone. **$2.85**

Best Sellers In Science

ELECTRIC MOTOR REPAIR — *By Robert Rosenberg.* Practical instructions, with excellent drawings and text separately bound so that book can be left open to a certain drawing while following the printed instructions. **$5.10**

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

THE EINSTEIN THEORY OF RELATIVITY — *By L. R. and H. G. Lieber.* An intermediate book from which engineers and the like can get close to an understanding of relativity. Partly in language but largely in mathematics of college grade, mainly calculus. **$3.10**

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

FINISHING METAL PRODUCTS — *By Simonds and Bregman.* Stress is directed toward commercial aspects of product finishing from the standpoint of sales, costs, and product function. Specific guidance for those faced with selecting finishing methods, materials, and equipment. **$4.10**

PRINCIPLES OF PHYSICS, VOL. III—OPTICS — *By Francis Weston Sears.* One of the most modern works on physical optics available today. At college level, it covers the subject with emphasis on physical principles rather than practical applications. **$5.10**

IF YOU MUST GAMBLE—*By Maurice Lenihan.* Statistical safety, as practiced by insurance companies, applied to bridge, dice, roulette, horses, and so on. No guarantee of successful "systems," but sound advice lightly handled. **$2.10**

EXPERIMENTAL PLASTICS AND SYNTHETIC RESINS — *By C. F. D'Alelio.* Explicit directions for making most of the well-known plastics and resins, using a minimum of laboratory equipment. Many of the processes can be translated directly into industrial applications. **$3.10**

FUNDAMENTALS OF OPTICAL ENGINEERING — *By Donald H. Jacobs.* This work starts out at the very beginning, is mainly non-mathematical, and is probably the best suited of all existing books as an introduction to optical design. Author is a physicist at Bureau of Standards. **$5.60**

PRECISION HOLE LOCATION FOR INTERCHANGEABILITY IN TOOLMAKING AND PRODUCTION — *By J. Robert Moore.* Complete and authoritative text on hole location procedures, plus 184 pages of Woodworth Hole Location Tables. **$5.00**

THE HOME FREEZER HANDBOOK — *By Gerald J. Stout.* Detailed instructions for building and operating home freezers, large and small, that are low in first cost and economical to run. Section on preparation of foods for freezing. **$4.10**

FEATURES OF THE MOON — *By J. E. Spurr.* New volume that includes all of the former "The Imbrium Plain Region of the Moon," plus an extended study of the whole Moon. 453 large pages, 14 Mt. Wilson photographs, 95 drawings. **$5.10**

(The above prices are postpaid in the United States. Add, on foreign orders, 25¢ for postage on each book, except as noted. All prices subject to change without notice. Books listed are offered for retail sale only, not to the trade.)

For Sale by: **June, 1947**

SCIENTIFIC AMERICAN, 24 West 40th Street, New York 18, N. Y.

I enclose $..... for which please forward at once the following books:

.....

.....

Name .....

Address .....

Write us for information on books of any subject. We can supply any book in print.

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.)

PEST CONTROL SIMPLIFIED. This 18-page booklet, published as an aid to home gardeners, presents an extensive list of insects and diseases, suggesting a remedy for each. Instructions are given for proper treatment of seeds, bulbs, and lawn turf, and for the spraying of vegetables, flowers, trees, and shrubs. The use of weed killers is also discussed. *United States Rubber Company, Publicity Department, Rockefeller Center, New York 20, New York.—Gratis.*

STORAGE OF MICROFILMS, SHEET FILMS, AND PRINTS. This 16-page pamphlet, designed to aid business and industrial organizations as well as photographic concerns, discusses the protection required, classification of records, short term storage, archival storage, moderate-term storage, preparation for storage, fire protection, storage relative humidity, storage temperature, and methods of testing the film and papers for hypo elimination. This information covers safety film base and paper base materials only. *Eastman Kodak Company, Sales Service Division, Rochester 4, New York.—Gratis.*

INDUSTRIAL MODELS CAN HELP YOUR FIRM. Illustrating four general types of industrial models, this four-page booklet describes how models can prevent costly production errors and can make possible new ideas in merchandising and advertising. *Stark Industrial Models, 95 Jane Street, New York 14, New York.—Gratis.*

CUTTING FLUIDS AND COOLANTS is a 36-page bulletin containing the following papers presented at the American Society of Tool Engineers New Era Exposition: What The Tool Engineers Should Know About Cutting Fluids; Cutting Feeds and Speeds; The Selection of Cutting Fluids; The Testing of Cutting Fluids. Request Technical Bulletin No. 5. *D. A. Stuart Oil Company, Ltd., 2729-39 South Troy Street, Chicago 23, Illinois.—Gratis.*

ATMOSPHERE GENERATORS. Describing both endothermic and exothermic types of furnace atmosphere generators, this 12-page catalog outlines their range of sizes and typical applications. *Bellevue Industrial Furnace Company, 2971 Bellevue Avenue, Detroit 7, Michigan.—Gratis.*

VISUAL AID FILMS. This new catalog lists new films released during the past year for school and industrial training purposes. There are now available 730 sound motion pictures on 16-mm film and 585 filmstrips for 35-mm

slidefilm projectors to aid in teaching a great variety of skills from nursing to shipbuilding. *United World Films, Inc., Castle Films Division, 30 Rockefeller Plaza, New York 20, New York.—Gratis.*

BALL BEARINGS FOR PRECISION INSTRUMENTS AND MECHANISMS. This four-page bulletin describes five series of ball bearings (radial, super-light radial, pivot, angular contact, and thrust) and gives their specifications, load ratings, and applications. *Miniature Precision Bearings, Inc., Keene, New Hampshire.—Gratis.*

TIME-SAVING TOOLS is a 12-page catalog outlining the features and operation of various tools, including vacuum-grip speed lathes for odd shaped parts that cannot be held by chuck or collet, tool post turrets with cutting-off holder, collet attachments, collets, and surface plates. Request Catalog No. 46-1. *Crozier Machine Tool Company, 684 North Prairie Avenue, Hawthorne, California.—Gratis.*

FOUNDRY MECHANIZATION is a 20-page bulletin describing the wide range of mechanized equipment available for the modern foundry to produce better and lower cost castings. Of particular interest is the new portable "Foundromatic" shakeout and a heavy-duty sand scrubber for use with a wet reclamation system. Request Bulletin No. 07B6092A. *Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin.—Gratis.*

INSULATING VARNISHES. In 40 pages this booklet gives complete technical and application data on 36 grades of varnishes. For each type of varnish the following information is given: Specifications, electrical properties, film properties, cure and aging, chemical properties, and baking and air drying cycles. *General Electric Company, Chemical Department, Pittsfield, Massachusetts.—Gratis.*

STURDY GAGES, TOOLS, FIXTURES is a four-page catalog illustrating and describing jigs, fixtures, and non-cutting tools of new steel, chrome plate, Stellite, tungsten carbide, and Norbide. *Sturdy Tool and Gage Company, 14520 Schaefer Highway, Detroit 27, Michigan.—Gratis.*

POINT AND CHAMFER PROFITABLY. In 10 pages this booklet describes the Cross "60" series machines which were developed for pointing and chamfering spur, helical, and bevel gears and splines. *The Cross Company, 3250 Bellevue Avenue, Detroit 7, Michigan.—Gratis.*

CENTER DRILLING MACHINE. Designed to drill concentric centers in a wide range of stock, the center drilling machine described in this four-page bulletin features a single lever control for the complete centering operation. Also described are the automatic positioning, clamping, and releasing mechanisms. *Detroit Tap and Tool Company, 8432 Butler Avenue, Detroit 11, Michigan.—Gratis.*

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¢.

SCIENCE YEAR BOOK OF 1947

Edited by J. D. Ratcliff

STORIES of outstanding achievement in branches of sciences ranging from physics and chemistry through medical research and agriculture to aviation, and so on, were culled by the editor from outstanding publications. Twenty-eight articles thus collected are here presented as a report to the general reading public of science progress. The articles were selected not only on the basis of their timeliness and accuracy, but also for their readability. (247 pages, 6 by 8 inches, unillustrated.)—$2.60 postpaid.—*A.P.P.*

MUSICAL ACOUSTICS
Second Edition

By Charles Culver

SCARCELY any books of this kind—acoustics of music—have been published at any time. This, therefore, fills a gap. It is a textbook for college students majoring in music. Without being more than arithmatically mathematical, it is essentially physics all through—about like a high school or first-year college text if wholly devoted to this one corner of that science. Interference; hearing; resonance; pitch; quality; consonance and dissonance; strings; vibrating air columns; rods and plates; stringed and wind instruments—these are typical chapter subjects. (215 pages, 5¾ by 8¼ inches, 148 illustrations.)—$3.10 postpaid.—*A.G.I.*

SOARING FLIGHT

By Terence Horsley

A BROAD revival of gliding and soaring as a fascinating sport rather than as one phase of military aviation makes this book especially appropriate. The author is a British aviator and a glider enthusiast who has put his love for the art into the book. He writes for a non-technical audience but conveys accurate and practical information on such subjects as the aircraft itself, the principles and practices of soaring, launching, cross-country soaring, the meteorology of soaring, instructing, forced landings, the selection of gliding sites, and so on. Some useful appendices end this useful and well written book. (326 pages, 5¾ by 8¾ inches, 75 drawings and photographs.)—$4.10 postpaid.—*A.K.*

CHARLES DARWIN AND THE VOYAGE OF THE BEAGLE

Edited by Nora Barlow

THIS LITTLE book is made up of hitherto unpublished letters and notebooks of the great naturalist. These have been collected and edited by his granddaughter, Lady Nora Barlow, who has also written an introduction. They provide interesting personal facts about Darwin and about his character. Neither the 36 letters written to his family during the course of the Beagle period nor his personal diaries covering the same time were intended for publication or for others than those addressed. However, they provide an interesting picture of the growth of this great man toward his period of greatest achievement. (279 pages, 5½ by 8½ inches, illustrated.)—$3.85 postpaid.—*D.H.K.*

ELECTRONS, PROTONS, PHOTONS, NEUTRONS, MESOTRONS, AND COSMIC RAYS

By Robert A. Millikan

NOTED work revised to include the advances of the past 12 years, chiefly by replacing the last 50 pages with 200 pages on nuclear energy release, geomagnetic studies of cosmic rays, mesotrons, primary rays, atom-annihilation hypothesis of the origin of cosmic rays. A physicist would find this book a simple presentation, while readers entirely unfamiliar with atomic

physics would not find it a beginner's book. Medium. (642 pages, 5 by 7¼ inches, 124 illustrations.)—$6.10 postpaid.—*A.G.I.*

CONCISE CHEMICAL AND TECHNICAL DICTIONARY

Edited by H. Bennett

CONTAINING some 50,000 definitions of terms from chemistry, physics, metallurgy, mineralogy, biology, mathematics, medicine, and nearly every other branch of modern technology, this book is accurate enough to satisfy the most exacting professional, yet simple enough to be understood by the layman with no technical background. In addition to the comprehensive collection of definitions, the book contains an up-to-date compilation of trade-named or proprietary products in the synthetic resin, plastics, metal, rubber, textile, and pharmaceutical fields, among others. Not only are the chemical and physical properties and the applications of the products listed, but also their chemical compositions. A large section has been devoted to the pronunciation of chemical terms. Also included are 36 pages of charts and conversion tables. (1055 pages, 6 by 9 inches.)—$10.25 postpaid. —*N.H.U.*

OIL FOR VICTORY

By the Editors of Look Magazine

VITAL at every point and every stage of World War II was petroleum in many forms but particularly as fuel. This book sets forth the fascinating story of oil and the people involved with its preparation and delivery to the final points of use by our military machine. The tremendous problems of logistics as well as enormous production with its innumerable subsidiary problems form part of one of the greatest of all industrial epics. The story of these events and of the people who affected the world's destiny through them is the subject of this important book. Most of the story is related through pictures and these are supplemented by pertinent text which supplies the thread of continuity which unifies this account of one major industry's contribution to victory. (287 pages, 7 by 10 inches.)—$3.60 postpaid —*D.H.K.*

GREAT ADVENTURES AND EXPLORATIONS

By Vilhjalmur Stefansson, Ed.

PLUMP BOOK of selections from original accounts of world explorers from early centuries to our own. The editor, a scholar as well as explorer, has chosen accounts few of which are available to most readers and presented them under uncommon categories such as "The Mediterranean Discovers the Arctic" (early Greek and Renaissance explorations unknown to most); "China Discovers North America"; first crossings of South and North America (probably not where you thought); Northeast and Northwest Passages; North to the Indies (early attempts to go by way of the Arctic); discovery of Australia; Antarctica; and others. The editor's scholarly notes link up the selections, which are thus made lucid. (788 pages, 5¾ by 8¼ inches, 18 small maps.)—$5.10 postpaid.—*A.G.I.*

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

PRACTICAL EMULSIONS

By H. Bennett

MUCH new text matter has been added to this completely revised and enlarged edition of a standard textbook. Included in the new material is a discussion on partial fatty acid esters of polyhydric alcohols and their applications in various food manufacturing processes. Another new section discusses the use of soap, lecithin, and pectin as emulsifying agents. Throughout the text numerous and specific examples are given so that both the layman and the professional chemist can readily grasp the possibilities of the emulsions and emulsifying agents dealt with in the text. Specific formulas are given for a wide range of emulsions, from agricultural sprays, cutting oils, paints, waterproofing, and cleaners to textile emulsions, resin and rubber emulsions, and so on. (568 pages, 6 by 9 inches, unillustrated, well indexed.) —$8.60 postpaid.—*A.P.P.*

ELEMENTARY RADIO SERVICING

By William R. Wellman

STRESSING logical and orderly procedure in locating, diagnosing, and clearing troubles in standard broadcast receivers, this manual is designed primarily for those already having a knowledge of the fundamental principles of radio receiver operation. Each stage is taken individually, with the troubles which that stage is likely to develop, along with their remedies, described in simple language. Throughout the book, all mathematics has been scrupulously avoided. Standard types of receivers, including automobile radios and FM circuits, are dealt with. (260 pages, 6 by 9 inches, illustrated.) —$3.85 postpaid.—*N.H.U.*

PHOTOELECTRIC CELLS

By A. Sommer

COMPACT yet thoroughgoing is this small volume which deals specifically with photoelectric cells of the emission type, as distinct from those of the barrier-layer and photo-con-

ducting types. Chapter heads are: Manufacture and Properties of Some Types of Photoelectric Cathodes; Matching of Light Sources and Photo-Cathodes; Vacuum Photocells; Gas-filled Photocells; Multiplier Photocells; and Applications of Photocells. The last mentioned chapter is confined mainly to problems which are purely photoelectric in nature, as distinct from circuit and mechanical design problems. (104 pages, 6 by 9 inches, 27 drawings, 5 tables, and a bibliography.)—$2.85 postpaid.—*A.P.P.*

SCIENCE AND FREEDOM

By Lyman Bryson

SOCIAL changes can and should be controlled by intelligence and experience: this is the author's thesis. He further believes that application of the scientific method to our thinking about sociological problems will lead to their most satisfactory solutions, to what he calls a "Good Society." In developing these ideas, Dr. Bryson succeeds in producing a highly stimulating essay that should have important effects on the thinking of our times. (191 pages, 5½ by 8½ inches.) —$2.85 postpaid.—*D.H.K.*

SAUDI ARABIA

By K. S. Twitchel

ANYONE planning to go to Arabia will find this book filled with the answers to the numerous questions his mind will formulate, and so will others interested in that old-new land. Written by a mining engineer, it deals with the geography, geology, topography, wealth, resources, water supply, transportation, communities, architecture, archeology, people, House of Saud, and the social and political development; also with the position of Saudi Arabia in world economy. No padding or desert hot air in this compact book. (192 pages, 5 by 7½ inches, illustrated.)—$2.60 postpaid.—*A.G.I.*

RADIANT HEATING

By T. Napier Adlam

ANSWERING the long-felt need for a truly exhaustive treatise on radiant heating in all its phases, this work gives complete information on the design, installation, and control of hot water, steam, warm air, and electric radiant heating systems. In addition, snow melting and radiant cooling, relatively new subjects, are treated in detail. All formulas have been simplified as much as accuracy will permit, and clear charts contain most of the data necessary for design, eliminating much calculation. Summarizing, step-by-step, the procedure in designing and installing all types of radiant heating systems, this book, the result of over 30 years' experience in the field, is a reliable manual for the engineer, architect, or contractor who wants accurate information on this method of heating. (472 pages, 6 by 9 inches, many illustrations.)—$6.10 postpaid.—*N.H.U.*

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"

TWO MONTHS ago in this space we described Broadhead's mirror grinding technique, last month the question of thin mirrors was discussed, and now the two are conjoined: Broadhead making a pair of thin mirrors.

Recently, Dr. John Strong, author of the widely used book "Procedures in Experimental Physics" and now professor of experimental physics at the Johns Hopkins University, asked this department whether some of the advanced amateur telescope makers could make, for non-astronomical research in the infra-red, a matched pair of 36″ spherical mirrors of 1¼″ plate glass (thickness-to-diameter ratio, 1:27), of focal length between 99′ and 101′ (*f*/33) and in focal length not more than 6″ different from each other, with a circle of confusion (pinhole image) at center of curvature not greater than ⅛″ diameter in single reflections. These mirrors were to be centrally perforated with 6″ holes, mounted in metal cells, and delivered within 90 days. Thereafter, at the Johns Hopkins University, they

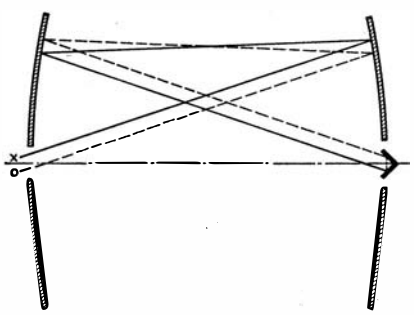


Figure 1: Set-up (diagrammatic)

were to be set in an air-tight tube 100′ long, which tube could be partly exhausted and cooled to simulate all atmospheric conditions as high as and including the stratosphere. The set-up is like that shown diagrammatically in Figure 1. (Without the small mirrors to offset it the light beam would inescapably return to the pinhole, no matter how the mirrors were tilted.)

This job went to Dave Broadhead, Wellsville, N. Y., whose precision optical background was as follows: Prewar, had made a small objective lens, a 6″ and an 8″ reflecting telescope, and in wartime 3000 roof prisms with better than 98 percent acceptance rate; postwar, two 10″ paraboloids, three 14″ flats, about 6/7 of a Maksutov telescope (now nearly finished, and so are several other "Maks"). How he went about doing the two 36″ mirrors, what methods he used, should interest all fellow amateurs, particularly those who secretly harbor hopes of someday making a larger than average mirror, which means nearly everybody. The account is especially valuable because Broadhead does not try to hide or minimize his mistakes. He delivered the mirrors, better than specifications called for and a month sooner than they called for, and these earned Professor Strong's

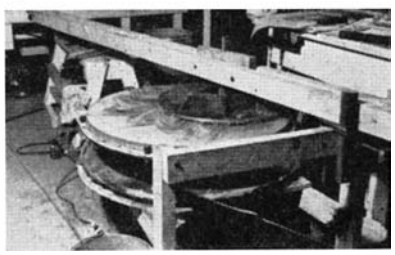


Figure 2: Rough Draper machine

comment and OK to quote: "We are just plain pleased, from the ground up."

Offhand, these looked like dead-easy mirrors. Broadhead's cellar shop, 12′ x 36′, the neatest, brightest, and cleanest we have seen, affords a lathe, drill press, metal shaper, grinder, electric welder, gas crucible furnace, and room. Most of these proved to be essential. The less than full precision tolerance did not please but disappointed Broadhead, as it would any true amateur, but there were offsetting headaches and uncertainties, also one certainty—the 90-day delivery limit. Hence, all in all, the job contained enough adventure to interest. Here are some excerpts from Broadhead's progress reports:

"Have to build a special machine (Figure 2). Vertical spindle of 2″ shafting, on top of which is a round mirror support welded up from ½″ boiler plate, with radial ribs and braces (Fig-

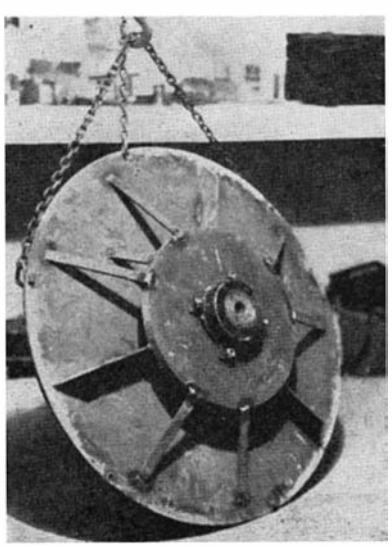


Figure 3: Welded mirror support

ure 3). Very rigid 24" grinding tool (Figure 4, left) faced with glass blocks as in Strong's book page 44, rotated by a ⅛ h.p. motor. Main oscillating arm of two-by-fours driven by a separate 1/3 h.p. motor. Tool on top. I have an ammeter in the driving motor circuit as a guide and warning to any approaching sticking of grinding tool, since a stuck 24" tool wouldn't be funny.

"Polisher (Figure 4, right) 31" diameter, made of ½" boiler plate, radial

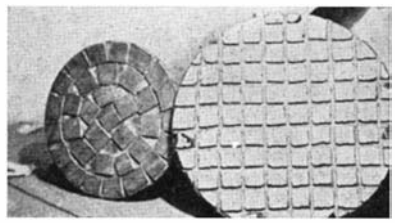


Figure 4: Grinder. Polisher

fins welded on its back side. Face has ¾" pitch layer, 2" facets. Takes 150-pound pull to budge it. Weighs 180 pounds.

"For knife-edge test on the 200' course I located image of a 1/64" pinhole with a big piece of cardboard. Found I had hit the 200' radius within specified limits first whack, using a 22" spherometer I made. (Since I didn't have a 22" flat with which to set its zero point I set it at zero on the concave mirror and then on the fitting convex tool. The difference, divided by 2, gives the desired sagitta and that with double accuracy.) But there isn't much to see at the knife-edge. Usually the convection currents make the image look like a three-alarm fire (Figure 6, right, reproduced at exact size). One night, just before a rain, the air was steady enough for me to see the figure. However, I don't try to use the knife-edge as a figuring guide. Instead, I

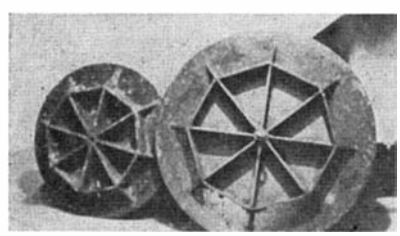


Figure 5: Welded tool backings

use an 8" test plate and study the interference fringes between it and the mirrors. I use the shape of the circle of confusion merely as a rough indication of astigmatism (Figure 6, left). Incidentally, I may bring on broken arches from lugging these 140-pound mirrors upstairs and outdoors to test them, and neurasthenia from lugging them in again for fear of dropping them.

"While grinding the 36" I gave the 8" test plate one go on it for each grade of abrasive, then polished the mirror a bit to see whether the spherometer was giving me the right answers. Then I polished the test plate, trusting to experience to get a sphere. So, actually, I got the test plate right by using the spherometer in a roundabout way. Of course, it would be practically impos-

sible to test an 8" test plate at 200' radius; at least much more difficult than the way I took.

"At present No. 1 mirror has a maximum variation from spherical of ¾ wave in any 8" area. No. 2 is ground through 400 Carbo. Had it polishing once but got a bad scratch. Mirror so light (except when you are lugging it around) that it is lifted by the grinding tool by suction when tool is lifted with a chain fall. After a lot of teasing it suddenly lets go, the mirror clumps down ½" or so, and the tool seesaws and thumps the mirror. Heart failure every wet."

THREE WEEKS later, job finished, Broadhead completes his report, and in what follows he very frankly points out the main mistake he made, and "don't we all?" (If the log book for the 200" mirror is ever published *in toto*, would you be critical if mistakes that must have been made by the human beings who made it were similarly set forth with candor, or would you expect the makers of *that* mirror to be different from other humans? If so, why?)

"Radius of mirror *A* is 198'3", that of *B* is 199'1". Circle of confusion obtained

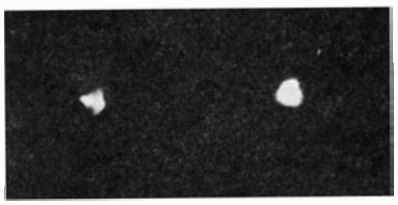


Figure 6: Astigmatism. Bonfire

by 2/3 diameter grinder and 5/6 diameter polisher and proper strokes came well within ⅛" tolerance specified for single reflections without recourse to local figuring. One modification of my previous ideas and technique that I learned—though it should have been obvious—is that my rigid tool technique is useful only up to the point where the tool is as stiff as the work. I erred by making the grinding tool probably several times as stiff as the glass, and thus unnecessarily heavy; and this in turn bent the glass and gave greater astigmatism troubles. Yet, to avoid astigmatism, I was trying to support the glass perfectly. I could have arrived at a better balance of factors. If I had it to do over again I could, if it served any purpose, make the mirrors much more easily, using the original 2/3 tool for roughing, a 5/8 tool of aluminum for fining, and a similarly light lap backing for polishing (in order that, if it became necessary to return to grinding, the glass blocks need not be re-cemented on the tool).

"Although the mirrors are well within all specifications, it is instinctive for a TN to want to continue till his best level of workmanship is reached, also until every shred of information has been wrung out of the job. In this sense, such a job as this was disappointing.

"I found that the most convenient bed for the mirrors was the long-used Brussels carpet, but that the support given by it varied considerably with

the direction of the nap. Here rotation of the mirrors at the end of each wet helped, but on the rougher grades, say 180, the variation in spherometer readings on diameters at right angles, due to the lie of the nap, was about 0.0005" in a single wet. At 600 emery this was reduced to 0.0001" and after several wets of UO10 Garnet Fines I could no longer detect this astigmatism with a spherometer. Yet, after a short polish, I could easily detect plenty of it with the 8" test plate. It slowly reduced during work with the 5/6 lap, but still was much in evidence even after the polish was complete and the circle of confusion reduced to about half the tolerance specified. The advantage of the Brussels carpet is that the variation in the support is fairly constant, whereas with a hard support the mirror touches at only three wandering places.

"Had this been an astronomical job the outstanding astigmatism would have been ratable as heavy, and would have called for slower methods and thicker blanks. The thin glass was used

Broadhead in shop togs

simply to save costs in laboratory research with these mirrors that did not call for a more expensive set-up."

COMMENTING on this job, Professor Strong stated: "The difficulty of making these thin mirrors was an unknown. I even had to make some computations before I was satisfied that such a mirror would hold a figure once it was given one; and I found that it wouldn't hold a figure unless it was used in a fixed, vertical position. Very thin mirrors can be used in a fixed vertical position if they can be given a figure. That was my joker: Who could give such thin glass a figure? I was convinced that it could be figured by someone with imagination, skill, and enterprise, but that conviction was based more on faith than on facts. Now we have the facts, and 30 days ahead of schedule. The circle of confusion for the final image, after four reflections, two from each mirror, was less than ¼" in diameter. The light in the final image of a Western Union point source, after a 600' travel and four reflections from Broadhead's two mirrors, was a hard core of about ⅛" diameter, and practically all the light fell within a 5/16" circle. For our needs this is perfect performance."

INDEX TO VOLUME 176, JANUARY — JUNE, 1947

— A —

Abrasive particles, separating ... 75
Abrasives, plastics-bonded ... 14
Acrylonitrile ... 174
ADHESIVE, bottle label ... 88
carton ... 90
holds down cargo ... 42
resin ... 258
water-resistant ... 80
AGRICULTURAL fungicide ... 3, 261
research, government ... 157
AIR cleaners, testing ... 57
drying, commercial ... 171
Air conditioning, heat pumps in ... 197
AIRCRAFT engine, in-line ... 32
wing, laminated ... 88
Airline radar ... 209
AIRPLANE cargo container ... 175
trainer, electronic ... 156
AIRPLANES, business men's ... 76
on farms ... 127
Air-water cleaning gun ... 87
Alarm, thermic fire ... 83
ALCOHOL from petroleum ... 221
plant, portable ... 26
potato ... 174
ALLOY, flexible lead ... 17
formable magnetic ... 36
high-permeability ... 266
high-temperature ... 17
steel scrap ... 75
ALLOYS, aluminum, new ... 63
chromium high-temperature ... 17
clad aluminum ... 64
electrical contact ... 107
flame-cutting tough ... 149
super ... 105
ALUMINUM alloys, new ... 63
clad ... 64
expanded production of ... 63
uses, new ... 63
welding method, German ... 264
Annealing, electronic ... 268
Apprenticeship system, value of ... 18
Artificial legs, testing ... 266
Asbestos-cement pipe ... 27
Atom-powered city ... 124
ATOMIC fission, detecting ... 53
power, cost of ... 244
power, direct ... 148
Audio filter ... 121
Autogyro glider ... 31
AUTOMOBILE oil, metered ... 136
refinishing, high-speed ... 224
springs, rubber ... 221
top, plastics ... 115
torque tests ... 220
ventilating ... 125
AUTOMOBILES for 1950 ... 76
plastics in ... 66,115, 268
Aviation fuels, cold-weather ... 23

— B —

Baseboard trim, steel ... 176
Batching by electronics ... 153
Battery, small dry ... 223
BEARINGS, metallized ... 201
powder metal ... 268
Bed, see-saw ... 255
Belt transmission, stepless ... 82
Bits, quick-change wood ... 179
Blanket, fire ... 133
Blind, electronic sight for ... 121
Boat hull, Fiberglas ... 222
Bottle carrier, acid-proof ... 183
Boxes, materials for wooden ... 3
Brake, radius ... 177
Brass-casting dies ... 17
Brazil, industrial importance of ... 3, 52, 100
Brick, better fire ... 20
Bristles, casein ... 178
Broaching tool ... 85
Buffing compound applicator ... 229
Building foundation on rollers ... 30
Burner, weed and industrial ... 272

— C —

Cable sheath, lead alloy ... 17
CARBIDE dies ... 180
grinding tool ... 270
planer tools ... 32
tool rest ... 213
tools, coolants for ... 79
development of ... 249
CARGO container, aircraft ... 175
hold-down, adhesive ... 42
Casein bristles ... 178
Casting repairs by welding ... 166
Cathode-ray spectrograph ... 220
Cell, high-capacity flashlight ... 84
Center drilling tool ... 84
Cesium lamps, infra-red ... 26
Cetane rating, importance of ... 22
Chemical plants, southern ... 196
Chromium-base alloys ... 17
Circuit tester, neon ... 85
Clamping grips ... 137
Clay analysis ... 269
Cleaners, industrial penetrating ... 34
Cleaning gun, air-water ... 87
Clipboard, illuminated ... 276
Clutch, automatic overload ... 126
COAL, burning crushed ... 173
underground ... 196
chemicals in plastics ... 214
mine hazards reduced ... 30
powdered, in locomotive ... 127
Collet fixture, lathe ... 130
Color dynamics ... 221
Colorimeter, photoelectric ... 172
Comparator gage, magnetic ... 270
Compass, electron-beam ... 156
Compounding machine, plastics ... 162
COMPRESSED AIR dehydrator ... 40
tests metals ... 174
Concrete protection, steel channels for ... 127
Conductor, aluminum ... 36
Controller, temperature ... 138
Coolants for carbide tools ... 79
Copper plating, bright ... 152
Cord, plastics coated ... 182
CORROSION inhibiting pigment ... 277
resistant zinc coating ... 264
tests, accelerated ... 49
Cotton, increased production of ... 159
Crane, portable folding ... 182

— D —

DDT on potatoes ... 174
uses of ... 157
Decimal dimensioning ... 222
Dehumidification, industrial ... 171
Dehydrator, compressed air ... 40
Diamonds, selecting industrial ... 111
Dictating machine, wire ... 223
DIES, brass-casting ... 17
carbide ... 180
DIESELS, better fuels for ... 3, 21
progress of ... 217
smoke reduction in ... 173
Drill press adapter ... 177
Drills, masonry ... 83
Dust removal equipment, testing ... 57
Dynamometer, electronic ... 59

— E —

Earthquake-proof buildings ... 30
ELECTRIC motor, light-weight ... 89, 266
motors, shortage of ... 196
typewriter ... 133
ELECTRICAL contact alloys ... 107
cord, non-kinking ... 274
outlet caps ... 42
Electroforming ... 15
Electromagnet, super ... 128
Electromagnetic vibrators test structures ... 6
ELECTRONIC annealing ... 268
batching methods ... 153
circuits, printed ... 264
color television ... 269
counting ... 121
dynamometer ... 59
eyesight for blind ... 121
machine protection ... 119
metal identifier ... 255
oil pool analyzer ... 207
testing of air cleaners ... 57
Electroplating bench ... 86
Electrostatic painting ... 213
ENAMEL, porcelain ... 52
remover ... 181
ENGINE, in-line aircraft ... 32
light two-cycle ... 39
Eraser, typewriter ... 228
Ethers, new vinyl ... 261
Eye shield, plastics ... 86

— F —

FABRICS, non-woven rayon ... 227
nylon staple in ... 219
shrinkproof rayon ... 270
starch, permanent ... 160
Farm use of airplanes ... 127
Fatigue testing ... 6, 224
FILTER, audio ... 121
pocket water ... 229
press, vertical ... 183
FIRE blanket ... 133
brick, better ... 20
FIRE ALARM, electronic ... 176
thermic ... 83
FLAME cutting tough alloys ... 149
rock drilling with ... 170
thrower, commercial ... 272
FLASHLIGHT cell, high capacity ... 84
flexible ... 178
Flexible shafts, long life ... 111
Floor polisher, low ... 81
Fluorine, industrial uses of ... 60
Flying for business ... 76
Foremen, importance of ... 52
Forest conservation ... 52
Forgings, precision ... 105
Formaldehyde polymer ... 179
Foundation on rollers, building ... 30
Foundry cores, baking ... 155
Freight cars, roller bearing ... 112
Friction sawing ... 111
FUEL, compact solid ... 179
oil, conservation of ... 3
FUELS, better Diesel ... 3, 21
cold-weather aviation ... 23
FUNGUS on optics ... 118
plants, protected from ... 3, 261
FURNACE, horizontal ... 173
scale, lithium prevents ... 36
Furnaces, fast-acting ... 166

— G —

GAGE, gas pressure ... 35
magnetic comparator ... 270
portable vacuum ... 34
GAS pressure gage ... 35
turbine locomotive ... 173
turbines, development of ... 196
Gasoline from gas ... 268
GEAR cutter, underpass ... 88
housing, plastics ... 274
Geiger counter ... 53
Germicidal lamps ... 172
GLASS, beryllium-fluoride ... 31
saws, flexible ... 135
Glass-mica plastics ... 85
Glider, autogyro ... 31
Gloves, safety rubber ... 183
GLUE, bottle label ... 88
carton ... 90
non-arcing ... 226
resin ... 258
water-resistant ... 80
Glycerine, advances in ... 259
Glycols, new sources of ... 259
Grease, heavy-duty ... 24
Grinder, manually controlled surface ... 178
GRINDING attachment, machine tool ... 226
tool, carbide ... 270

— H —

Hardenability in steel specifications ... 210
Hardness testing, micro ... 265
HEAT, expanding domestic oil ... 52
for the home, fireless ... 112, 197
induction, quenching unit for ... 86
pumps ... 112, 197
Heater, smokeless ... 273
HEATING, better home ... 112, 197
for annealing, electronic ... 268
high-frequency ... 10
system calculator ... 34
Helicopters, price of ... 244
High-frequency heating ... 10
Highway construction standards ... 269
Hose, high-pressure ... 277
Humanities, study of ... 196
HYDRAULIC accumulators ... 251
motor drive ... 134
pump, small ... 181
Hydrides, metal ... 116
Hydrogen generators ... 116

— I —

Incentive plans ... 52
Induction-heat quenching unit ... 86
INFRA-RED beam, talking on ... 156
lamps, cesium ... 26
plastics absorbs ... 89
visible ... 77
Inks, moisture-set ... 89
Insecticide sprayer, electrical ... 271
Insecticides, new ... 157
Insects, plants protected from ... 3
Instrumentation, industrial ... 122
Insulating plastics foam ... 36
INSULATION, blown rubber ... 85
fire-arresting building ... 227
IRON, electrodeposited ... 15
Mesabi range ... 32
Iso-octane solvent ... 62

— J —

Jet engines, welding in ... 137
Job rating ... 108
Jobs, machines make ... 148

— K —

Knurling tool ... 271

— L —

Labels, self-destroying ... 132
LAMINATES in runabout body ... 268
low-pressure plastics ... 161
rayon ... 132
wood-metal ... 136
LAMPS, cesium infra-red ... 26
germicidal ... 172
Land photographic process ... 167

Latch, push-pull door ... 223
LATHE turret post ... 272
turret, six-station ... 135
variable speed ... 181
Layout planning, models for ... 77
LEAD, competition for ... 244
salt lubricant ... 225
Legs, testing artificial ... 266
Letters, talking ... 255
Level, six-angle ... 271
LIGHT and industrial vision ... 112, 245
resistant paint ... 38
Lithium prevents furnace scale ... 36
LOCOMOTIVE, gas-turbine ... 173
powdered-coal burning ... 127
LUBRICANT, lead salt ... 225
metered ... 136
Lubricants, detergent marine ... 80
Lumber salvage tool ... 176
Luminescent Lucite ... 34
Luminous tubing ... 134

— M —

Machines make jobs ... 148
MAGNESIUM, deep drawing of ... 262
strip, rolling ... 107
MAGNETIC alloy, formable ... 36, 266
comparator ... 270
recording, disk ... 255
wire ... 274
sound film ... 209
Marker, inking ... 38
Masonry drills ... 83
Mesh, plastics-coated ... 163
METAL fatigue, cause of ... 175
hydrides ... 116
identifier, electronic ... 255
protective paint ... 277
tests by compressed air ... 174
wood laminates ... 136
Metallic soaps ... 24
Metallizing, uses of ... 201
Metallurgical specimens in plastics ... 115
METALS in Brazil ... 3, 52, 100
salt baths for ... 164
Micro-hardness testing ... 265
Microscopes, low-cost ... 229
Microwaves, idustrial uses of ... 252
Mine hazards reduced ... 30
Mineral deposits, locating ... 269
Mirrors, transparent ... 131
Model kit for office planning ... 77
Models, scale tool ... 137
Mold, rubber liquid ... 38
Molds, electroplated ... 15
MOLYBDENUM tubing ... 229
uses of ... 148
Monetary standard, uranium as ... 62
MOTOR drive, electronic control ... 255
drive, hydraulic ... 134
light-weight electric ... 89
transmission, electric ... 182
MOTORS, lightweight electric ... 266
shortage of electric ... 196

— N —

Names of substitute materials ... 112
NUCLEAR energy, cost of ... 244
fission, detecting ... 53
fission, energy from ... 148
Nuclei, resonating ... 222
Nuts, self-locking wing ... 272
Nylon staple, uses of ... 219

— O —

Odors, industrial importance of ... 3
OIL burner, clutch for ... 78
detergent ... 23
heat, expanding domestic ... 52
metered automobile ... 136
pool predictions, electronic ... 207
quantity computor ... 131
Oils, processing of organic ... 3
Orchard heater ... 244
Oxygen, low-cost industrial ... 175, 204

— P —

Packaging, dual-purpose ... 244
PAINT base from petroleum ... 23, 176
brush laundry ... 178
light resistant ... 38, 81
metal protective ... 277
plastics marine ... 182
Painting, electrostatic ... 213
Paper-mill slime prevented ... 206
Patent fees, increase of ... 196
Patents, Soviet buying of ... 196
Phone, portable induction ... 125
Photography, instantaneous Land process ... 167
Phototube, small ... 226
Phthalic anhydride from petroleum ... 23
Pill packing by electronics ... 153
Pilot plants, profitable ... 69
PIPE, asbestos cement ... 27
plastics coated ... 112
Plane timer, electronic ... 10
Planer tools, carbide ... 32
Planes, personal ... 76
Plant diseases, battle against ... 157
PLANTS, profitable pilot ... 69
protected from insects, fungus ... 3, 261
PLASTICS automobile top ... 115
bags, food ... 258
bonded abrasives ... 14
cabinet tops ... 216
coal-derived chemicals in ... 214
coated cord ... 182
mesh ... 163
pipe ... 112
tablecloths ... 14
yarn ... 258
coatings ... 256
compounding machine ... 162
corrugated ... 223
decorating ... 163
display bottle ... 216
eye shield ... 86
foam, insulating ... 36
gear housing ... 274
glass-mica ... 85
in automobiles ... 66, 268
in plywood ... 113
laminates, low-pressure ... 161
luminescent ... 34
machine ways ... 78
paint, marine ... 182
panels, production of ... 66
reflecting ... 14
rivets ... 176
sheeting, mottled ... 115
stress relieving ... 11
tableware ... 224
vinyl (Texflex) ... 180
visible light-transmitting ... 89
Platform, adjustable work ... 226
PLATING bench ... 86
bright copper ... 152
Plumb bob, precision ... 271
Plywood, plastics in ... 113
Polystyrene, annealing ... 11
Porcelain enamel's future ... 52
Potatoes, increased production of ... 174
Powder metal bearings ... 268
POWER, future atomic ... 124, 148, 244
transmission, belt ... 82
Precision forgings ... 105
Press guard, plastics ... 178
Printing press control ... 255
Processes, development of ... 249
Publishing costs, increasing ... 196
PUMPS, lightweight ... 277
small hydraulic ... 181
Pyrometer, water-cooled ... 76

— Q —

Quantity computer ... 131

— R —

RADAR, commercial airline ... 209
meteorological ... 175
river boat ... 255
RADIATION calculator ... 34
meter, solar ... 174
RADIO sound system, home ... 267
teletype ... 112
Radio-active materials, tracing ... 53
Radiophone, taxi ... 209
RAILROAD Diesels, progress of ... 217
induction phone ... 125
signaling, emergency ... 156
RAYON fabrics, non-woven ... 227
laminates ... 132
shrinkproof ... 270
Reamer, expanding ... 90
Refrigeration, expansion of ... 52
Research, agricultural ... 157
RESIN, heat-stable waterproof ... 130
paint, petroleum-base ... 176
Riveter, silent ... 224
Rock drilling with flame ... 170
Rocket ascent envisioned ... 203
Roller-bearing freight cars ... 112
Roughness tester, surface ... 177
RUBBER, better synthetic ... 275
insulation, blown ... 85
mold, liquid ... 38
research, synthetic ... 33
springs, automobile ... 221
tires, natural and synthetic ... 244
Rust preventives, testing ... 49

— S —

SAFETY, better vision for ... 112, 245
caps, electrical outlet ... 42
Salt baths for metals ... 164
Sawing, friction ... 111
Saws, flexible glass ... 135
Screw driver, pneumatic ... 181
Shafts, long life flexible ... 111
Shield, plastics eye ... 86
Ship bottom fouling reduced ... 26
Shipping loads, holding ... 42
SILVER, antique finish for ... 272
printed circuits of ... 264
Smells, sales appeal of ... 3
SMOKE density tester ... 276
reduction, Diesel ... 173
Soaps, metallic ... 24
Soldering tape, self ... 270
Solenoid simplified ... 275
Solvent, iso-octane ... 62
SOUND film, magnetic ... 209
on wire ... 223, 274
system, home ... 267
Spectrograph, cathode-ray ... 220
Spray-wash machine ... 87
Sprayer, electrical insecticide ... 271
Stainless steel, drawing ... 65
STARCH, permanent textile ... 160
potato ... 174
vulcanized ... 271
STEEL analysis unit, portable ... 173
drawing stainless ... 65
scrap, alloys in ... 75
specifications, hardenability in ... 210
temperature, measuring ... 76
Steels, clad ... 249
STOVE, high-frequency ... 10
smokeless ... 273
Structural defects located electromagnetically ... 6
Styrene, annealing ... 11
Substation, mobile utility ... 125
Sugar substitute ... 160
SYNTHETIC RUBBER, better ... 275
latex ... 86
research ... 33

— T —

Tablecloths, plastics coated ... 14
Tableware, plastics ... 224
Tank breather, storage ... 35
Teletype, radio ... 112
TELEVISION, color ... 10, 269
industrial ... 126, 244
Temperature controller ... 138
Tester, transverse load ... 84
TEXTILE, non-woven rayon ... 227
shrinkage, preventing ... 160, 270
starch, permanent ... 160
THERMOMETER, dial ... 82
gallium ... 152
remote reading ... 134
TIMER, electrical signaling ... 272
solar ... 137
TIRES, rubber in ... 244
tractor ... 36
TOOL, broaching ... 85
carbide grinding ... 270
center drilling ... 84
knurling ... 271
models, scale ... 137
protection, electronic ... 119
rest, carbide ... 213
TOOLS, coolants for carbide ... 79
development of carbide ... 249
Torque tests, automobile ... 220
TRACTOR scoop ... 225
tires ... 36
TRANSMISSION, electric motor ... 182
stepless belt ... 82
Trioxane, uses of ... 179
TRUCK, high-lift fork ... 226
seats, comfortable ... 83
TUBING, flexible fabric-spring ... 80
luminous ... 134
TURBINE blades, making ... 172
buckets, super alloy ... 106
development of gas ... 196
locomotive, gas ... 173
Turret post, lathe ... 272
TYPEWRITER eraser ... 228
form-letter ... 133

— U —

Ultra-violet, plastics absorbs ... 89
Uranium as monetary standard ... 62

— V —

VACUUM gage, portable ... 34
tubes, miniature ... 196
Valves, electronically controlled ... 59
Vegetables, preventing spoilage in stored ... 206
VIBRATION effects evaluated ... 6
meter ... 80
Vinyl ethers ... 261
Vision, better industrial ... 112, 245
Voltmeter, audio ... 136

— W —

Watch spring steel ... 213
WATER softener, automatic ... 41
treatment system ... 177
Waterproof bonding resin ... 130
Waveguides ... 252
WEED burner ... 272
killer, 2-4, D ... 126
Welded railroad rails ... 29
Welder, flash butt ... 37
Welders, storage-battery ... 31
WELDING aluminum, German method of ... 264
casting repairs by ... 166
electrode, new ... 178
electrode tongs ... 40
hydrogen ... 137
resistance ... 31
Wing nuts, self-locking ... 272
WIRE, aluminum ... 36
flat ... 152
measurer, continuous ... 155
recorder ... 223, 274
thin steel ... 152
WOOD beams, laminated ... 148
decay, controlling ... 221
metal laminates ... 136
salvage tool ... 176
yeast ... 160
Wooden boxes, materials for ... 3
Worker aptitude ... 108

— Y —

Yarn, plastics coated ... 258
Yeast, wood ... 160

— Z —

Zinc coating, non-corrosive ... 264

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

Out of some cold figures, came a story to warm America's heart

NOT LONG AGO, the Secretary of the United States Treasury studied a figure-covered sheet of paper.

The figures revealed a steady, powerful upswing in the sale of U. S. Savings Bonds, and an equally steady decrease in Bond Redemptions.

But to the Secretary, they revealed a good deal more than that, and Mr. Snyder spoke his mind:

"If you give them the facts," he said, "you can always depend on the common sense and long-range judgment of the American people.

"The last few months have given us heart-warming proof of that.

"After the Victory Loan, sales of U. S. Savings Bonds went down—redemptions went up. And that was only natural and human.

"It was natural and human—but it was also dangerous. For suppose this trend had continued. Suppose that, in this period of reconversion, some 80 million Americans had decided not only to stop saving, but to spend the $40 billion which they had *already* put aside in Series E, F & G Savings Bonds. The picture which *that* conjures up is not a pretty one!

"But the trend did NOT continue.

"Early last fall, the magazines of this country—nearly a thousand of them, acting together—started an advertising campaign on Bonds. This, added to the continuing support of other media and advertisers, gave the American people the facts . . . told them why it was important to buy and hold U. S. Savings Bonds.

"The figures on this sheet tell how the American people responded—and mighty good reading it makes.

"Once more, it has been clearly proved that when you give Americans the facts, you can then ask them for action—and *you'll get it!*"

What do the figures show?

On Mr. Snyder's sheet were some very interesting figures.

They showed that sales of Savings Bonds went from $494 million in last September to $519 million in October and kept climbing steadily until, in January of this year, they reached a new postwar high: **In January, 1947, Americans put nearly a billion dollars in Savings Bonds. And that trend is continuing.**

In the same way, redemptions have been going just as steadily downward. Here, too, the trend continues.

Moreover, there has been, since the first of the year, an increase not only in the volume of Bonds bought through Payroll Savings, but in the number of buyers.

How about YOU? The figures show that millions of Americans have realized this fact: there is no safer, surer way on earth to get the things you want than by buying U. S. Savings Bonds regularly.

They are the safest investment in the world. They pay you $4 for every $3 at the end of 10 years. And you can buy them automatically, almost painlessly today, through either of two plans:

If you are eligible for the Payroll Plan, for your own sake and your family's sake, get on it . . . and watch your savings mount up.

If you are not eligible for the Payroll Plan, but have a checking account, see your banker and get him to tell you about the new Bond-a-Month Plan.

Either of them will set you on the road to financial security, and the happiness that comes with it.

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

Contributed by this magazine in co-operation with the Magazine publishers of America as a public service.

A PUBLIC SERVICE PROJECT — The Advertising Council

Untangling the problems of automotive progress

THIS APPARENT TANGLE of wires, pipes, and tubes —actually an experimental engine set-up in the Ethyl laboratories—is symbolic of the complex problems faced today by forward-looking automotive and petroleum engineers.

These men are working to make your future automobile a better automobile. But their job is not a simple one. For engines, gasoline, gasoline additives and lubricating oils are like the factors in a complicated chemical equation. A change in one may affect any of the others. To make real progress, the research work of automotive and petroleum industries must be closely coordinated. Fuels and engines must progress together.

Although "Ethyl" antiknock compound, made by the Ethyl Corporation, is an ingredient added to *gasoline*, its purpose is to improve the power and performance of *engines*. Therefore, the Ethyl laboratories cooperate with the technical staffs of both the automotive and petroleum industries—working with them to untangle complicated technical problems and open the way to better and more economical motor transportation for everybody. Ethyl Corporation, New York 17, New York.

E T H Y L C O R P O R A T I O N

Service stations display this emblem *on pumps containing their best gasoline plus "Ethyl" antiknock fluid—the famous ingredient that improves power and performance.*