Scientific American

SEPTEMBER
1946

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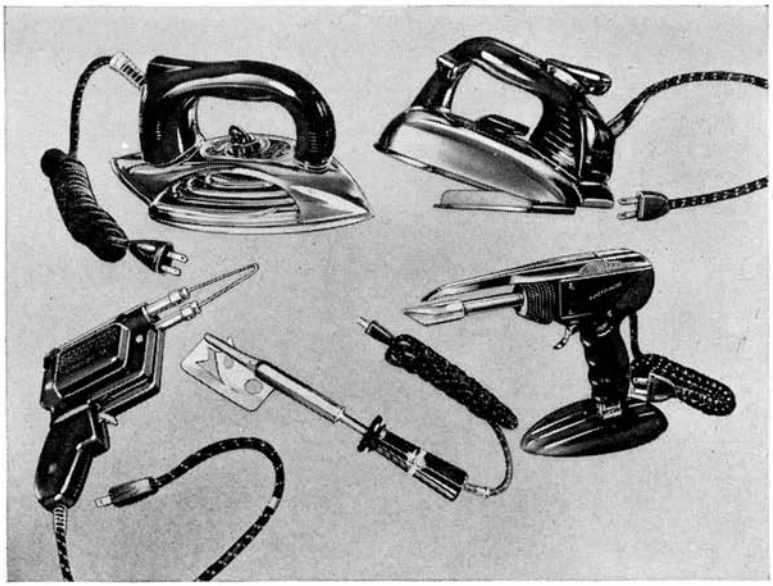
REPORTING THE PROGRESS OF SCIENCE AND INDUSTRY

Oxygen Helps Bend Pipes . . . . . See pages 97 and 101

FIVE BRANDS OF "IRONS"— ONE BRAND OF PLASTICS



These five electric irons — made by five different manufacturers — obviously differ from one another. Even the two "home" irons are dissimilar . . . each embodying its own special features.

The three soldering irons, of course, are vastly unlike, as you can easily see. However, all five have one thing in common . . . molded Durez handles. Why?

Special Properties Required

Heat resistance, of course, is absolutely essential. Dielectric strength is another property which these plastic handles must possess. Then there are several other characteristics — impact strength, pleasant "feel," and excellent moldability — which are also necessary to meet the exacting requirements of the manufacturers.

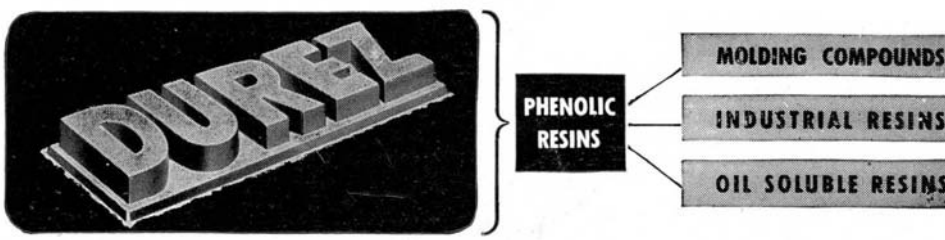
Durez Phenolics Are Versatile

All these properties . . . and many more . . . are inherent characteristics, in varying degrees, in every one of the more than 300 Durez phenolic molding compounds which have been scientifically developed during the past twenty-six years. They account for the wide use of Durez throughout the electrical manufacturing industry.

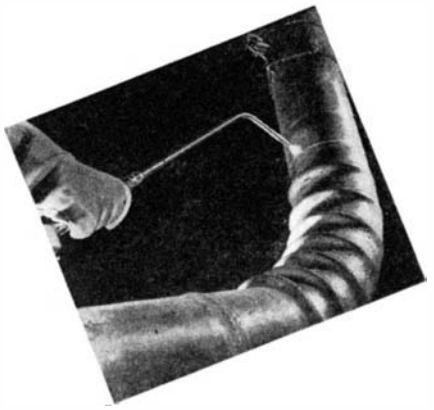
The manufacture of such products as radios, electric toasters, vacuum cleaners and telephones, for example, consumes many tons of Durez annual
Therefore, when it's a matter of ha
dles . . . or any of a thousand-and-o
other items which require a really ve
satile material . . . make it a point
look to Durez first.

Experienced Assistance Available

A staff of experienced technicians pl
a wealth of proved product develo
ment data, are available at all times
you and your custom molder. Dur
Plastics & Chemicals, Inc., 19 Wal
Rd., N. Tonawanda, N. Y. *Export Agen*
Omni Products Corporation, 40 East 34th S
New York 16, N. Y.



PLASTICS THAT FIT THE JOB



INDUSTRIAL DRAMA: Oxygen, subject-matter of the article starting on page 101, is the life breath of the ubiquitous oxy-acetylene flame. Here such a flame is being used in the "wrinkle-bending" of large pipe. The pipe wall is heated and pressure applied to make bends of any angle in pipe of almost any size. Photograph courtesy The Linde Air Products Company.

Scientific American

Founded 1845

In This Issue • September 1946

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SCIENTIFIC AMERICAN, September, 1946. Vol. 175, No. 3. 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 September, 1896)

TECHNOLOGICAL UNEMPLOYMENT—"It is, no doubt, true that when a new invention is introduced which revolutionizes some particular art or branch of business, it at first decreases the number of persons employed in that particular line; but that is only temporary, for in a short time the result is a cheapening of the product, a greatly increased demand for it, because of this cheapening, and then necessarily an increased demand for laborers in that line, and almost universally at increased wages."

BOSTON SUBWAY—"Many years ago it became apparent that Boston required additional facilities for the transportation of street car passengers through the lower parts of the city. . .In order to have the tunnel near the surface, and in order to avoid lateral pressure, the tunnel has been given a flat roof, supported by brick arches turned between heavy I beams. The sides are of similar construction, the I beans in the sides standing vertically. . .Our cut illustrates a two-track subway. Part of it, however, will be wide

THE BOSTON SUBWAY—INTERIOR OF THE TWO-TRACK SUBWAY.

enough for four tracks, side by side. The two-track subway is 24 feet wide, and the four-track one is 48 feet wide. . . The ventilation problem has been much simplified by the determination to use electric traction. It is proposed also to have a fan for every 600 feet section of the subway."

AERIAL PHOTOGRAPHY—"William A. Eddy, of Bayonne, N. J., has succeeded in making several distinct photographic views of Boston from a great height, by means of a camera supported from kites. The kites were of the tailless type used at the Blue Hill Observatory, where an altitude of 7,441 feet was obtained, and were six and seven feet in diameter. Four to eight of these kites were required to support the camera, depending upon the strength of the wind."

GERMAN INDUSTRY—"Perhaps the most notable fact in the industrial world just now is the commanding position which is being won by the German manufacturers. . .Her industrial triumph, which has come as a surprise to the world at large, and with a rude, awakening shock to Great Britain in particular, is no surprise to the German people themselves. In school and college, in workshop and factory, by carefully planned organizations at home and abroad, they have set in motion a system of industrial forces which are now working out the desired results with mechanical regularity and precision. . .Germany owes her industrial success to her system of scientific training in schools and colleges, to the close fellowship which exists between her factories and her schools, and to her elaborate organizations for the control and development of commerce."

PATENT MEDICINES—"Of all the so-called patent medicines, very few are really patented at all, and they are supposed to be, and often are, of unknown and secret composition. Protection by patenting, which involves disclosure of their composition, is the last thing their proprietors would think of. It is such secrecy that is opposed to every fundamental principle of medical ethics."

ROLLER SHIP—"Shipbuilding and naval circles are interested in a new type of vessel which has recently been launched in France. . .It is called the Ernest-Bazin, and, in brief, it consists of a rectangular iron frame or platform (carrying deck houses) about 120 feet long and 40 feet wide, mounted on six hollow lenticular rollers, each some 39 feet in diameter . . .Only one-third of each roller is submerged. A 550 horse power engine actuates the screw propeller, which rotates in an inclined plane between the pairs of rollers."

TRANSCONTINENTAL—"At noon on the twenty-fifth of August, a war message and a post office dispatch were intrusted by the government authorities to a bicycle relay for transmission across the great American continent. Thirteen days later the last of the 220 couriers reached New York, the eastern terminus of the trip and unslung the scarred and weather beaten wallet from his shoulders, the distance of 3,400 miles having been covered at the average speed of about 11 miles an hour."

COINS—"Advices from Washington, D. C., state that experiments with pure nickel and aluminum as substitutes for the present nickel pieces and one and two cent bronze pieces will be made at the mints."

100 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of September, 1846)

FRENCH RAILROADS—"A Paris letter says that when the 2,619 miles of railroad, now constructing, can be added to the 906 miles already completed, France will possess three thousand five hundred and twenty-five miles. . .Every city in the kingdom will be within a day's journey of the centre of power and movement."

INVENTION AND PRACTICE—"It is a matter of wonder to the present generation, that many of our most useful and indispensable inventions in machinery, were not introduced to practical use for ten, twenty, or fifty years after they had been discovered, and their utility demonstrated—among which are steamboats, railroads, and locomotives."

FORESTS AND RIVERS—"That remarkable man, Humbolt, has reduced it almost to a demonstration, that the streams of our country fail in proportion to the destruction of its timber."

BRIDGE—"The railroad bridge at Deerfield, Mass., is said to be a splendid affair. It is fifty feet above the traveled stage road bridge, and nearly eighty feet above the waters of the river. The piers are already erected, and nearly ready for the superstructure."

TWENTY YEARS AGO

the movies learned to talk

THEN Broadway saw a dramatic presentation by Warner Brothers, using a synchronized system for high-quality sound developed by Bell Telephone Laboratories and produced by Western Electric.

Epochal for the motion picture industry, the occasion was only one of many landmarks set up by the Bell System along the stream of communication development.

BELL TELEPHONE LABORATORIES

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

Previews of the Industrial Horizon

By A. P. Peck

STYMIED PATENTS

SEVEREST physical blow ever suffered by the United States Patent Office was dealt at the outbreak of the war when the examining divisions were removed from their specially designed offices in Washington to an old tobacco factory in Richmond, Virginia. Divorced from the public research room and from their invaluable scientific library, the examiners were forced to struggle along as best they could, handicapped by inadequate quarters, lack of reference material, and the necessity for vastly increased correspondence plus arduous trips between Richmond and Washington.

All this could be put up with under war-time conditions. But the situation is still at a stymie. A start was made to re-consolidate the Patent Office. Red tape entwined the procedure. About half the examining divisions were returned to Washington. The rest remain in Richmond. No one knows what is to happen next. The cumulative effect on the morale of the examiners is obvious.

More important, however, is the effect of this official stymie on the issuance of patents themselves. Today industry is grasping for new ideas, new products, essential to peace-time progress. And with the Patent Office in the tangle of war-time hinderances, protection for these new ideas is being held up. When everyone is looking to the Patent Office for inventions that will speed production and operate to keep prices down, the Patent Office is found split in twain, inefficient, and unprepared for its vital part in the post-war era.

Here's how the situation stands at the time of writing: Over 11,000 applications await consideration by the Patent Office. Each week the Office falls more than 500 cases further behind. Unless something is done—and done immediately—to alleviate this situation, it will soon be that only a young inventor can expect to live long enough to see his patent issue and to enjoy the benefits of the full life of the patent grant.

The need is obvious. The course of action is equally so. The Patent Office must be consolidated, returned to its pre-war efficiency. If this is not done, the progress of peace-time technology will be so greatly hindered as to act as a brake on the wheels of industry.

Our patent system is good. This has been proved beyond question. But when it is held up mechanically so that it can function only in an inefficient manner, then the time has arrived for action. There is no reason why the Patent Office cannot be restored to its former quarters, with all the advantages that lie there. Let's get is done and done *now*, so that industry, inventors, and the consuming public alike can benefit from American genius.

STATIONARY POWER

STEAM, hydro-electric, and Diesel are the three forms of stationary power that are of main interest to the industrial user. The first two are old standbys; the third is a relatively new-comer that has to win its spurs in each individual case before it is accepted.

Already there are between five and six million installed horsepower of stationary Diesel engines in use in the United States. They are used by municipal power plants, private utilities, oil pipe lines, cotton and oil mills, the grain industry, in the manufacture of ice, and so on. In every case the Diesel has more than proved its ability to compete with other forms of power on a cost and efficiency basis.

On the horizon can be seen clearly a continually increasing use of Diesel power in stationary plants. Modern design shows trends towards engines which are suited to jobs that could not be done economically by the older and more cumbersome units. Particularly is this the case where installation is to be made in city buildings. The high-speed Diesels now being produced offer advantages of reduced space requirements as well as a decreasing necessity for vibration isolation. These factors, coupled with the simplicity and economy of the Diesel, are bringing this prime mover into greater prominence in many fields of industry. Diesel manufacturers are well aware of the possibilities ahead of them; if developments of the Diesel continue to keep pace with the opportunities for its use, the power-consuming public will come to depend more and more on these engines.

LATEX—NATURAL OR SYNTHETIC?

MILK of the rubber tree, latex can now also be called milk of the synthetic rubber factory. And in considering the future uses of latex, distinction must be made between the natural and the synthetic product.

At the present time—and disregarding the political aspects of rubber—synthetic latex holds the edge on price and availability. Whether this will hold true two years, or even a year, hence is not seen in our crystal ball. However that may be, synthetic latex has the advantages of resistance to oils, greases, and many acids.

Pre-war, latex uses were largely confined to foam products such as cushions, surgical goods, toys, and coatings for tire cords. Now chemists have developed other uses which include, besides former applications, paints, textile and paper coatings, adhesives for a wide range of purposes, mechanical rubber goods formerly made exclusively from hard rubber, and a host of other articles that must be water- and air-tight.

Synthetic-rubber production facilities in the United States, and the superiorities of synthetic latex, point to a battle royal between synthetic and natural rubber milk. It is a battle fraught with many possibilities. Our money rides on synthetic because of its availability within the confines of the nation, its inherent advantages, and its innumerable applications that can (and have) come out of the test-tubes of the chemical laboratory.

CONCRETE FACTS

CEMENT, aggregate, and water make concrete. But concrete is not always as simple as that. Witness, for example, the expanded funds and facilities made available recently by Portland Cement Association for research and development in the field of cement and concrete use. The findings that stem from this work, an acceleration with over 30 years of background, will be made freely available to engineers, architects, contractors, builders, and the general public.

FOR FUTURE REFERENCE

RAYON, with production up some 600 percent since 1930, is looking for new worlds to conquer; watch it hold its place in tire cord construction and whip the bad name it has made for itself in men's clothing, shirts, and underwear. . . Any industry that uses water and does not concern itself with problems of preventing pollution of streams, lakes, and oceans, is heading for real trouble with the public at large and the health authorities in particular. . . Frozen foods are seen as a huge future industry, far greater than the refrigerator at the corner store; bidding for part of this big business are improved packaging for the foods, door-to-door delivery in refrigerated trucks, and expanded locker-plant facilities.

Scientific American
SEPTEMBER • 1946

Oxy-acetylene flame spinning, supplanting deep drawing for many operations, will close tubing ends or reduce diameters at any point. Practicality of such methods requiring intensely hot flames depends to a large extent on low-cost oxygen of highest purity

ENGINEERING

Oxygen For Industry

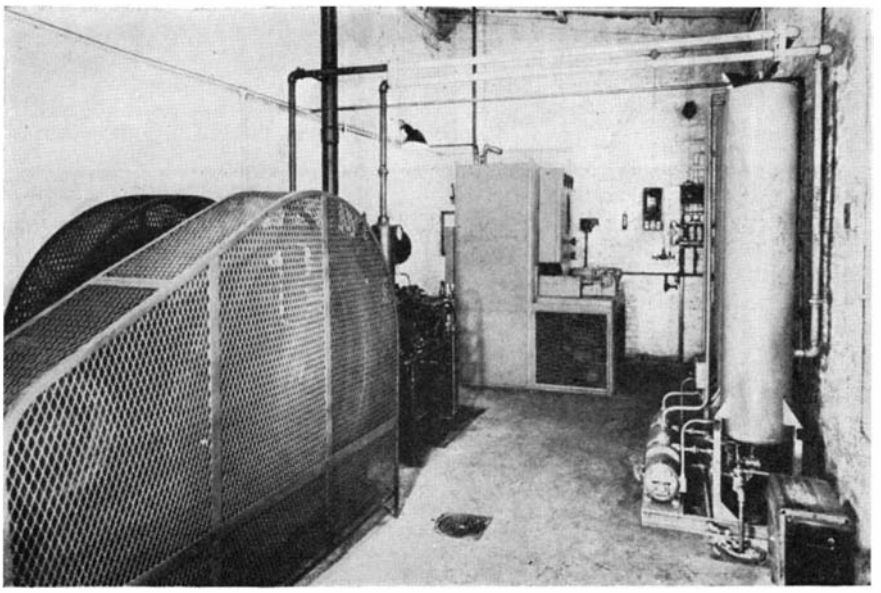
By EDWIN LAIRD CADY

The Uses for Pure Oxygen in Industry have been Growing for Years—Now they are Growing Even Faster. To Meet the Demand for this Hard-Working Gas, New Methods of Transportation, Plant Distribution, and Even Manufacture Within the User's Plant are Steadily Being Developed

EVERY hour some 10,000 cubic feet of oxygen are being produced in the steel mills and other large plants which use it. Just a few months ago, all such gas would have been brought in cylinders from the special factories which produce oxygen or, perhaps, would have been kept at some 300 degrees below zero, Fahrenheit, and transported as liquid oxygen in tank cars.

This 10,000 cubic feet per hour of 99.5 percent pure oxygen is not much as the oxygen business goes. On the basis of a 2000-hour work year, it adds up to only 20,000,000 cubic feet a year, or less than one out of every thousand of the more than 22,000,000,000 cubic feet of oxygen which industry used during every war year.

But the important point is that generation of oxygen right on the job can make one more reduction in the cost of the gas at the flame tip or the nozzle. And every time the cost of oxygen at the point of work



Courtesy Air Products, Inc.

• LOOKING AHEAD •

Costs of oxygen will be cut. . . Large-scale uses will expand, bringing increased production capacity to blast furnaces, as one example. . . Liquid oxygen may become practical for smaller plant use. . . Oxygen produced at point of work will expand possibilities, especially in larger plants. . . Synthetic jewels from oxy-hydrogen furnaces. . . New discoveries of uses for by-products of gas production.

goes down, the use of oxygen goes up. And the industrial use of oxygen is due for a further boom.

LOW COST: NEW USES—Strange to say, the basic method of producing oxygen has not changed much in the past century. Air is chilled by expanding it through a series of heat exchangers, each of which cools it more until it gets cold enough to become liquid air. This liquid air is allowed to rise in temperature at carefully controlled rates. Each of the gases of which air is composed —nitrogen, oxygen, helium, and argon—boils from the liquid at a different temperature and so may be collected while the liquid is held at that temperature. Oxygen comes off at minus 297.2 degrees, Fahrenheit.

The makers of oxygen have gradually improved this process, increased efficiencies, passed savings along to consumers. And the consumers in turn have used more and more oxygen. In 1921, a little more than one billion cubic feet were produced and the selling price averaged about $1.30 per hundred cubic feet. With the average price in 1944 down near $0.55 per hundred, the volume was up above the 22 billion cubic feet.

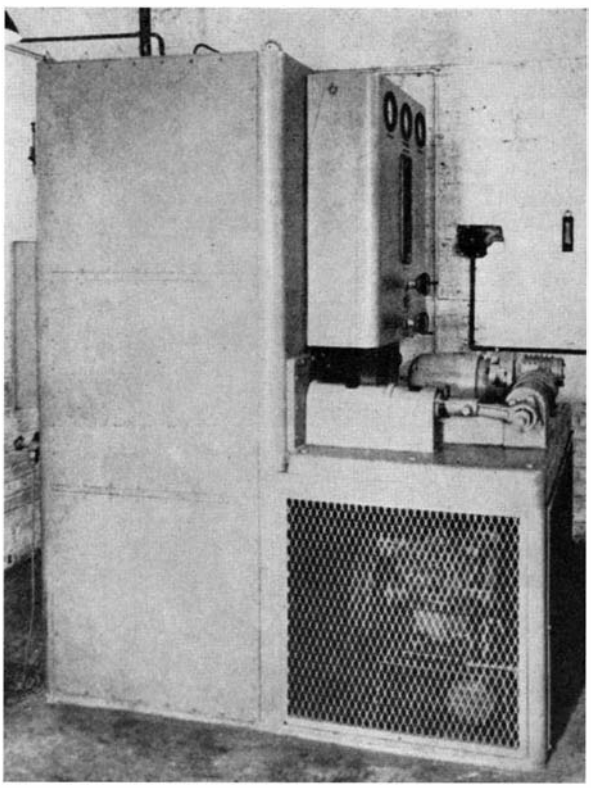
A lot more had happened than the Adam Smith formula of "down with the price and up with the volume." Makers of oxygen and of oxygen-using equipment had put into the field some of the best sales-engineering forces ever to co-operate with industry. These men worked out use after use, are still working them out. The new oxygen uses made the markets, the markets demanded the volume, the volume brought the price down. Thus was an industry built out of thin air.

Most of the new uses sprang from the fact that almost any operation which needs flame temperatures can be done better if pure oxygen is used in the flame. With pure oxygen, not only can steel and metals be burned like fuels to supply the heat for their own melting, but also the flame and the application of heat become more controllable. Heating becomes less of a black-smith shop operation and more of a precision-tool one.

Flame welding and simple flame cutting were followed by flame scarfing, gouging, skiving, stack cutting, priming for paints, and a multitude of others. But many a fully developed operation had to wait for oxygen's point-of-use cost to go down before it became commercially practical. Many operations still wait.

TRANSPORTATION HIGH—Sticking up like a mountain which every such cost reduction must cross is the problem of transporting oxygen from its point of production to its point of use. The situation is so complex that no one seems to have any real figures on it. Best obtainable estimates are that transportation costs are at least 60 percent of all costs to oxygen users. They may be even much higher than that.

The simple cylinder, familiar to almost everyone, is the most common means of transporting oxygen. It weighs about 150 pounds when full and 130 pounds when empty. That means shipping 130 pounds of steel from the producing plant and back in order to get 20 pounds—244 cubic feet at 2200 pounds pressure—of oxygen to the job. This is equivalent to shipping 260 pounds



Oxygen-producing plant (above) consists of air compressor at left, air purifier at right, and air separator in background. Latter unit (right) is comprised of air drying, liquifying, and distillation equipment, plus the oxygen compressing system. As yet, such plants are of greatest value to big industry

Large, multi-tank trailers are connected to plant oxygen manifolds—usually two trailers are used, one as a standby. Such equipment boosts oxygen uses

one way, and the figures show that more than one pound of steel has to be shipped from the generating plant to the user for every cubic foot of oxygen bought in those cylinders.

Such a cost is not too bad for garages and small welding plants which use oxygen for a few highly effective operations and can well afford to pay $1.00 or so per hundred cubic feet and then add the transportation costs. But in a steel mill or a large glass-making plant, the oxygen cost has to get down as low as 60 cents or even clear down to 25 cents per hundred cubic feet before some of the most important oxygen-using operations can be practical, and the delivery costs have to be proportionately low.

One way to reduce these costs has been the trailer truck which has built into its body several cylinders, each of which holds far more than 244 cubic feet of oxygen. These trailers are made in different sizes and capacities to suit the needs of various oxygen users. At least two trailers are kept at every plant that buys its oxygen this way; one trailer at a time is emptied into the plant distribution system so there almost always is a full trailer standing by.

Another advanced method is to ship the oxygen in liquid form, thus getting far more into the same shipping space. On a pound-for-pound basis this method can get down to one pound of steel for each pound of oxygen as compared to the 6.5 pounds to 1 ratio when oxygen in gas form is shipped in the simple cylinders. No one knows how far this liquid oxygen method will be carried. It has proved highly practical and economical when the liquid is shipped in tank cars. Experiments are under way with handling it in cylinders no larger than the common ones which now hold no more than 20 pounds of oxygen in gas form. Liquid oxygen may yet solve problems and save money in the smallest of machine shops.

PLANT DISTRIBUTION—When the oxygen in its containers reaches the user's plant it still is not at the point of use; it has to flow through pipes or hoses to the point of use. And this can present problems.

First of all, the oxygen must not be contaminated. It is 99.5 percent pure when received. The addition of any contaminant such as water vapor sufficient to reduce this to only 99-percent purity can reduce by 25 percent the effectiveness of the oxygen for metals cutting. The distribution system has to be clean.

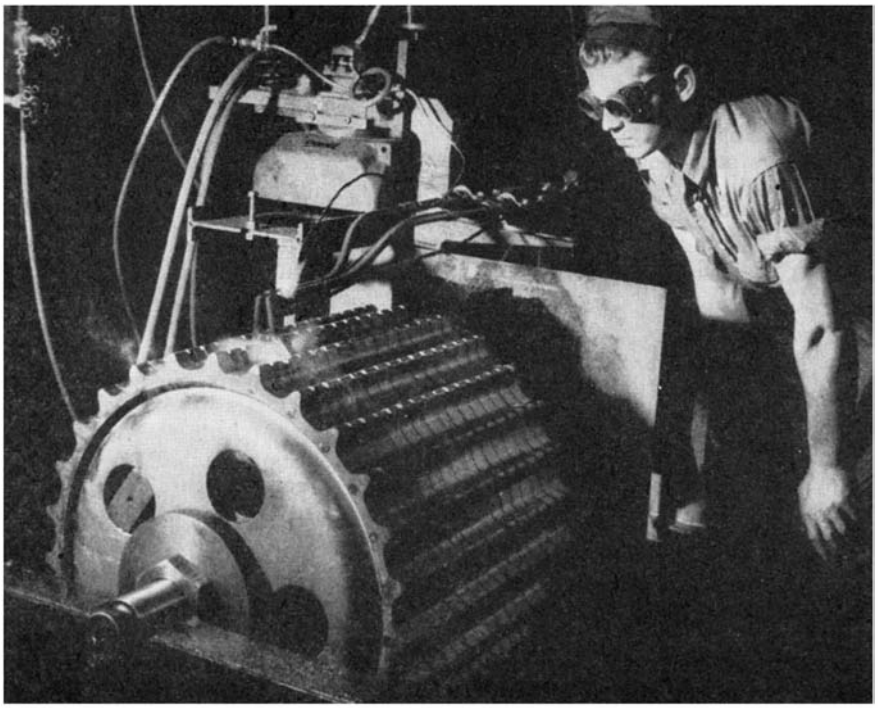
Secondly, the oxygen must be kept from leaking. Oxygen in itself is not dangerous. But if it leaks to where any oil or grease will come into contact with it, and especially if it is released in a room which contains oil fog from metal cutting machines or from the lubricants of high speed shafts, then a fire and even explosion hazard may be created. And, of course, the oxygen in the pipes commonly is at high enough pressure to be dangerous if the pipes are mechanically damaged.

The simple cylinders are easy enough to handle. They may be individually mounted close to their points of work and the gas run through fairly short hoses. For this reason, quite a few of these cylinders are likely to be found even in the plants of the largest users. Despite their extra transportation costs they can save materials-handling costs in getting the gas to places in the plant where only a little is used.

Gas from the trailer trucks, and from gangs of the simple cylinders, often is fed to manifolds and from these to pipe lines throughout the plants. The pipe lines must be ample in size both to maintain the pressure and to permit the flow of gas with a minimum of frictional losses.

Steel pipe commonly is used because of its strength. So far as is possible all joints are welded. Threaded joints must be gas tight, doped with materials which contain no oils or greases. Pipe interiors must be perfectly clean.

The gas pressure in the cylinders or other containers is sufficient to keep up the operating pressures in the distributing pipes, and these in



Flame hardening tractor-drive sprockets—a typical oxygen-using shop process

turn are regulated by automatic regulators. Makers of oxygen are careful about recommending pipe layouts which will supply adequate pressures at all work points, and specifying the number of cylinders or other containers which must be connected to a manifold at any time to assure adequate flow. Usually there are two or more banks of cylinders so one may be working while the other acts as a stand by.

One cost problem with many oxygen-distributing systems is that they are obsoleted long before they are worn out. Oxygen, once used in a plant, has a way of finding more and more uses. A high proportion of distribution systems are now so over-loaded that they need complete re-building for higher capacities.

HOME-MADE OXYGEN — The method of producing the oxygen right in the plant of the user avoids the problem of transportation, but not that of distribution. Generating plants for this purpose require only 100 square feet of floor space but at present are not practical unless the user needs at least 500,000 cubic feet per month. Plants suitable for only 200,000 cubic feet per month are on the drafting board, but even these will not mean much to any but the larger consumers.

Effects of these new plants, and of some of the new methods of low-cost distribution from the plants of the oxygen makers, are more likely to be greater expansion of the uses of oxygen rather than heavier competition for present uses.

Blast furnaces, for example, can have their production capacities increased by as much as 20 or even 30 percent by the use of pure oxygen in their air. This would take more oxygen than anyone seems ready to supply for such a purpose right now, and would require the gas to be supplied at extremely low cost.

Cheap commercial gas can be made from coal by the use of pure oxygen; a new battle of the fuels—oil *versus* gas *versus* solid fuel—may be in the making. Pure oxygen is used to produce high-octane motor fuel from natural gas, in the manufacture of nylon and other plastics, and in the removal of sulfurous gases from petroleum and many other products.

Pressure welding, and its twin process pressure upsetting, both depend upon the use of pure oxygen. Heat and pressure are applied simultaneously to the area to be welded or upset, but that heat is controlled so exactly that the metal becomes plastic but does not melt. Welds so made can be heat treated, after which not even a microscope will find the actual weld.

Synthetic corundum, sapphire, and other products can be made in oxy-hydrogen furnaces. Development of such furnaces was rapid during the war, but even so they can hardly be said to have passed the infancy stage.

Oxygen is only one of the useful gases taken from the air. To date it is the most widely employed one, the others mostly being considered as by-products. But more and cheaper oxygen, with the distribution-costs problem being reduced, means lower costs and more uses for nitrogen too. Hundreds of old processes may be improved, hundreds of new ones born, by giving more oxygen to industry.

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.

AIR CONTROL

Reduces Cost Through Precise Design

With factory equipment arranged more compactly to reduce the problems of materials handling, and with every machine operating at higher speeds and capacities than ever before, the necessity of exhausting dust-laden and otherwise fouled air is continually increasing. In addition, winter needs for heating and summer needs for air conditioning are making the evacuation of any more air than is necessary an expensive luxury.

As a result, the old method of making sure that the evacuation system had enough capacity—and not worrying too much if it had a gross over-capacity — is being discontinued. Duct capacities, fan and blower sizes, and air speeds are being worked out to match evacuation needs exactly, with just enough over-capacity to provide an adequate safety factor.

To preclude such carefully balanced systems becoming leaky, clogged, or inefficient, portable testing instruments have been devised that will reach into out-of-the-way places and give instant checks on air speeds in feet per minute. Literally, such instruments will save production workers and their supervisors many a headache.

PRECISION COOLING

Controls Contraction to Form Holes Accurately

The use of fixtures to establish precise dimensions on materials and parts which must be cooled from liquid or plastic states is an industrial method which seems to have sprung from a number of sources and to be rapidly growing in as many directions.

Most materials contract when cooling. If prevented from contracting on some bores or other interior surfaces, they can be held stable on those dimensions while the forces of contraction are diverted to other directions.

Plastics and some of the softer and more ductile metals are therefore allowed to contract upon accurately made and placed steel pins or other shapes. Holes so made can be held to plus or minus .0002 inches without further finishing.

Ceramic cores also are used for this purpose. These will withstand the temperatures of the molten materials without serious deformation. Some are later knocked out with air hammers. Other cores, of shapes too complicated or used in parts too weak for hammering, are made of materials which can be dissolved out in caustic soda.

BELOW-ZERO TECHNIQUES

Improve Machine Work, Castings, and Lubricants

Low-temperature mechanical engineering begins at about 50 degrees below zero, Fahrenheit, and goes on down to minus 300 degrees and lower. It exists because some assemblies can be made more readily if parts are cooled and shrunk, and because some metals and other materials can be machined, upset, or otherwise fabricated much better at low temperatures.

Primary method of achieving these temperatures is by simple refrigeration. The parts are placed in mechanical coolers, kept there until chilled, held there until needed.

A method now coming into use is chilling by liquid nitrogen. There are whispers that liquid nitrogen actually is being used as a cutting oil on top-secret production lines.

The cold techniques have grown large enough so that some of the largest makers of special castings are producing new alloys which have high strengths at low temperatures, and lubricants makers are giving the field special and concerted study.

Conducted by D. H. KILLEFFER

Take A Grain Of Sand . . .

Chemical Marriage of Sand and Hydrogen has Produced a New Family —the Silicones. In Liquid, Rubber, or Resin Form, These Unique Hybrids Combine the Heat Resistance of Quartz with a Variety of Other Special Capabilities Including Water Repellency, Insulation, and Lubrication

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

• LOOKING AHEAD •

Electric motors with lifetime insulation. . . Paints, plastics, and rubber that will resist high temperatures. . . Pastel automobile tires. . . Fewer power-line troubles with humidity-proof insulators. . . High-temperature greases for maximum motor outputs. . . All are possible now because of "modified sand"—the organic silicon compounds.

SILICONE chemistry has been described as a new continent, lying between the mineral silicates such as glass and clay on the one side, and plastics on the other. The analogy is well taken, for the silicones actually do partake both physically and chemically of these thoroughly dissimilar types of materials. Chemically, a silicone polymer is a network of silicon and oxygen atoms just as in sand or quartz, but attached to the silicon are hydrogen groups derived from petroleum. These groups modify the properties of the sicila network, thus giving the materials certain properties of liquids or of plastics.

Physically, the silicones bear little resemblance to sand except that, because they share the same basic structure, they are extremely resistant to heat.

The Corning Glass Works started to experiment with silicones as long as 10 years ago, hoping to develop glass-like plastics or other materials which would be useful in conjunction with glass. Results were so promising that they joined forces with the Dow Chemical Company, who had the chemical manufacturing technology, in the formation of the Dow Corning Corporation to manufacture the new materials. General Electric Company was also pursuing the investigation of silicones independently, and both groups have brought out commercial products within the past few years.

SILICONE LIQUIDS — Depending upon the method of manufacture, the silicones vary in physical properties from water-thin liquids to glassy resins. The liquids themselves can be made in wide ranges of viscosity and volatility. In this respect they are comparable to liquid petroleum distillates, which range from light, low-boiling naphthas to heavy lubricating oils. Before the war the new liquid silicones were laboratory curiosities, chiefly interesting for their unusual combination of properties. They are water-white, brilliantly clear fluids which remain liquid at temperatures as low as minus 40 to minus 120 degrees, Fahrenheit, and are stable up to 500 degrees, Fahrenheit. Liquid silicones are neutral, chemically inert, non-corrosive to metals, and highly resistant to oxygen and oxidizing agents, mineral acids, and corrosive salt solutions. Their flash points are higher than those of petroleum oils of the same viscosity, and—except for the very low-viscosity grades—they are non-volatile. Soluble in most organic solvents, they are insoluble in water and alcohol.

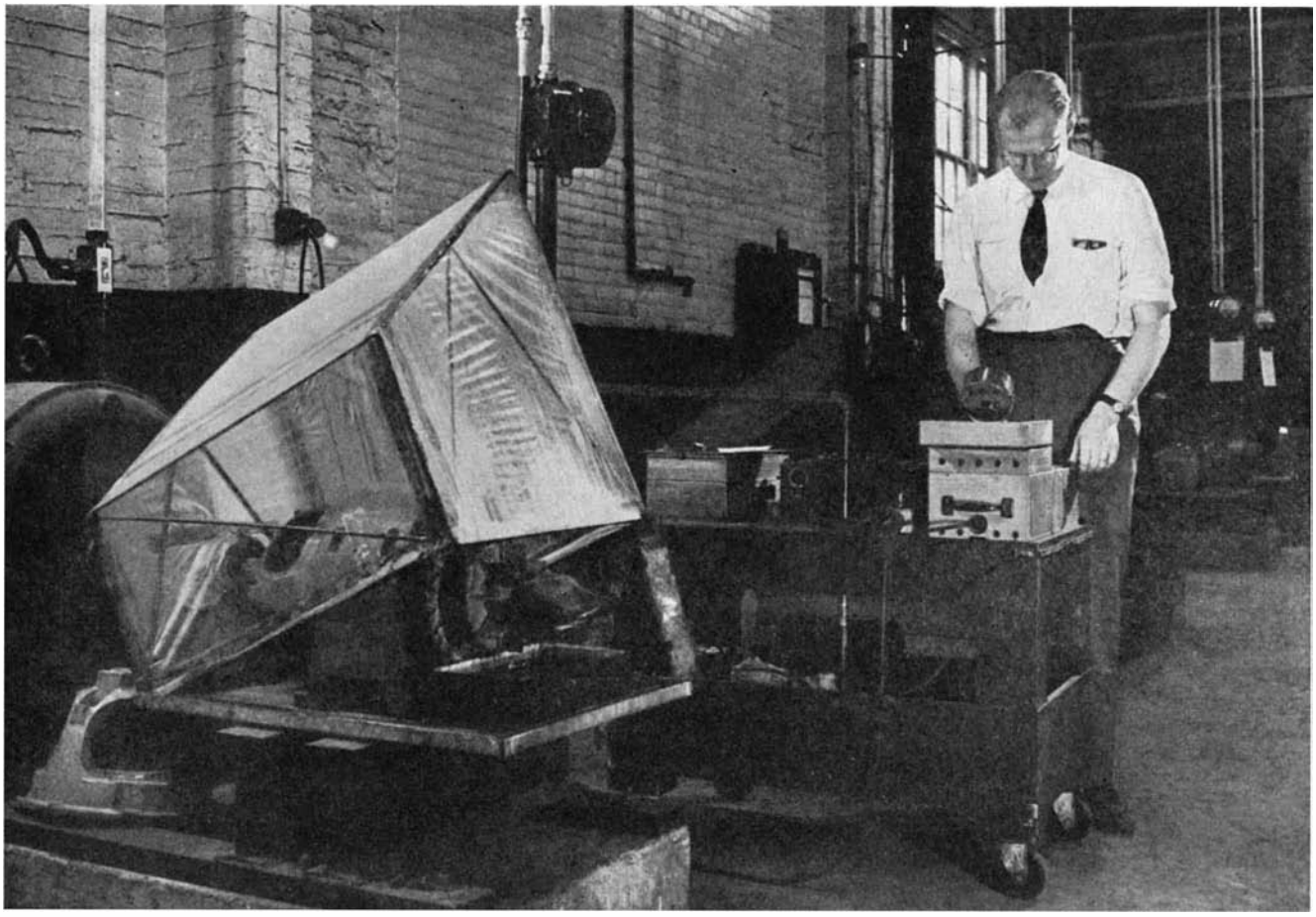
This combination of properties is remarkable enough, but their phenomenal acceptance is due to three additional properties: For one thing, their viscosity does not change as much with temperature as petroleum oils, hence they do not "freeze" at winter temperature and get water-thin under heat. Secondly, glass, ceramic, and metal surfaces are readily wet by the silicones, thus making them water-repellent. The third property, the one responsible for their wide use in the electrical industry, is their extremely low electrical conductivity and resistance to voltage breakdown over a wide range of frequencies.

Courtesy Dow Corning Corporation

Silicon ignition-sealing compound on its way to a difficult job in high-tension leads and disconnect fittings

These remarkable qualities promise a wide use of silicone fluids as transformer oils, damping fluids, gage fluids, hydraulic fluids, and heat transfer media. It is quite possible that buildings may some day be heated more efficiently with silicone-containing radiators operating at 400 degrees, Fahrenheit.

Exceptional resistance to the corrosive action of chemicals has made



Test motor, operating through repeated cycles of high humidity and extreme temperature, proves serviceability of silicone insulation

the silicones useful impregnants of asbestos packings and gaskets in chemical pumps.

The silicones do not dissolve other plastics materials, and for that reason they are used to free plastics articles from molds, particularly in the injection molding of hollow articles.

To make surfaces water repellent, they can be treated with a solution of silicone in carbon tetrachloride or some other suitable solvent. When this is done, moisture does not condense on a treated surface as a continuous film but rather as minute, isolated droplets. Insulators so treated retain their high electrical resistance even under humid conditions.

An alternative method is to expose the surface to the vapors of the so-called chlorosilanes. These are the intermediates in silicone manufacture and react with water to form the final product. The chlorosilane deposited on the surface of the material reacts with moisture in the atmosphere to form a silicone film on the article. The process has been used chiefly on metal, glass, and ceramic bodies, but progress is being made in similarly treating paper, wood, and textiles.

The films obtained withstand washing, dry cleaning, and even considerable abrasion. This process has been placed on a commercial basis by General Electric under the name "Dri-Film."

Still another special use has cropped up for the silicone liquids. In concentrations as low as 0.1 percent they inhibit the foaming of hydrocarbon lubricants. This manifestation of surface activity may again suggest new fields for these versatile materials.

SILICONE RUBBER—The next step in the scale from liquids to solids is silicone rubber. During the research leading to this product, an experimental material, "bouncing putty," was developed which received quite a bit of attention in the popular press. The putty, however, lacked the ability to retain its form and was hardly more than a curiosity. Now, the newer material looks, feels, and, with one exception, behaves like the natural and synthetic organic rubbers. The exception is that Silastic, as the new material is called, retains its rubber-like properties at temperatures far above and far below the serviceable limits of the organic rubbers.

The remarkable resistance of silicone rubber to heat is the result of its quartz-like basic structure. Ordinary rubbers contain what are termed unsaturated linkages. These linkages absorb oxygen very rapidly at high temperatures and cause the rubber to become brittle. Chemically, the behavior is exactly like that of linseed oil, another unsaturated compound, which "dries" upon exposure to air by absorption of oxygen.

Demands for elastic materials which would remain resilient and neither soften nor harden at temperatures above 250 degrees, Fahrenheit, remained largely unsatisfied until silicone rubber was introduced. Silicone rubber shows only slight changes in its properties from minus 70 to over 500 degrees, Fahrenheit. Under service conditions it does not deteriorate at continued exposure to 300 degrees, Fahrenheit. At the other end of the temperature scale it behaves just as admirably, remaining flexible even after 24 hours at minus 70 degrees, Fahrenheit. Some stocks can even be subjected to dry-ice temperatures and still retain their flexibility. One reason for these properties is that ordinary rubbers owe their low-temperature resilience to plasticizers, which are volatile with heat and soluble in organic solvents. Hence, if the rubber is subjected to heat or the action of solvents, its low-

temperature resilience is lost. Silicone rubber does not contain plasticizers, and consequently its properties are relatively permanent.

Since silicones contain no reactive centers—like the unsaturated linkages in the organic rubbers—it follows that silicone rubber is resistant to weathering, ozone, sunlight, and the other ills that beset natural rubber. The same water repellency that is characteristic of silicone coatings is also a property of silicone rubber. Therefore, the good electrical properties of silicone rubber are not affected adversely by humidity or even immersion in water.

Although silicone rubber weathers well and is certainly superior for extremely high or low temperature uses, its properties under ordinary conditions are comparable to those of the organic rubbers. Its resistance to acids, alkalies, and solvents is no better, and its tensile strength, and tear and abrasion resistance are lower. For this reason it is not useful for such applications as automobile tires.

In view of its cost and limitations, silicone rubber is no competitor with natural or synthetic organic rubbers except where resistance to extreme temperatures, ability to withstand oxidation, or good electrical insulation characteristics under severe conditions are required.

Among the uses already established are heat-resistant gaskets, diaphragms, and packings; impregnation of glass or asbestos fabrics for gaskets; coating conveyor belts for high-temperature service; coating glass tapes, wires and cables, and metals; embedding transformers; and fabrication of tubing, hose, rollers, pads, vibration mountings, and the like.

Silicone rubber comes in the form of crepes and pastes, and it can be fabricated by molding, laminating, extruding, and coating.

SILICONE RESINS — Still harder materials are the thermosetting silicone resins which have found their widest use in insulating varnishes.

The hard resin is simply dissolved in a suitable solvent, such as toluene, and used to coat magnet wire, impregnate glass or asbestos fabric, bond mica laminations to glass fabric, and to fill voids and render assemblies water-proof.

Here, the use of silicone varnishes instead of bulkier insulating materials makes it possible to decrease the overall size of electrical motors.

Two properties of silicones which make them especially suitable for insulating electrical equipment are their water repellency and resistance to heat. In a great many environments the chief purpose of insulation is to keep out water. Many organic varnishes are sufficiently water-repellent at ordinary temperatures, but they crack or become carbonized at high temperatures and then admit moisture. Silicones are inherently water-repellent, and because they are stable up to 500 degrees, Fahrenheit, or higher, they do not lose their desirable properties in service.

The use of silicone insulation permits as much as a 50 percent reduction in weight of electrical equipment where the operating temperature can be increased; and where it is desirable to maintain a lower operating temperature, the service life of the insulation can be greatly lengthened. For example, in an accelerated test at 590 degrees, Fahrenheit, one motor operated the equivalent of 2000 years at 320 degrees, Fahrenheit. The use of silicone varnish has therefore been hailed as the most notable advance in insulation since the advent of the electric motor itself.

Silicone resins have also been combined in enamels and heat-resistant paints. Formulated with titanium dioxide or aluminum flake, these resins give paints which are exceptionally resistant to heat and weathering and do not become yellow with age. The properties of these finishes are midway between ordinary organic coatings and ceramic finishes.

SILICONE GREASES — The advantages of higher operating temperatures for electric motors afforded by silicone insulation will only be fully realized when high-temperature lubricants are available. Progress is being made in this direction in research upon silicone oils and greases, and it appears likely that electric motors eventually will not only be silicone-insulated but also silicone-lubricated.

These greases, which are simply liquid silicones thickened with carbon black or metallic soaps, are extremely resistant to oxidation and to chemical attack. Silicone stopcock lubricants for laboratory use have already appeared on the market.

OTHER COMPOUNDS — While the silicones are the most dramatic of the organic—silicon compounds, there are others that deserve mention as well. One of these is ethyl silicate, which is the ethyl ester of silicic acid. It is useful as a source of amorphous silica and is used as such as a bonding agent for casting molds; as a preservative and a weather-proofing agent for stone, brick, concrete, and plaster; in heat-resistant paints; in nitrocellulose and vinyl resins to improve adhesion to glass; and in the preparation of solid fuels.

Also, ethyl silicate will burn, giving off fumes of finely-divided silica "smoke." This fumed silica has the same physical properties as carbon black except, of course, that it is white. It can substitute for the carbon black which is so necessary in rubber to give it tensile strength and wearability, and in the near future it will be possible to make automobile tires of solid white or any pastel shade.

Other esters of silicic acid—especially tetraphenyl silicate and tetracresyl silicate—are being studied as heat-transfer agents for industrial processes. In the absence of moisture they are stable at very high temperatures. Another type of compound being studied for the same use is tetraphenyl silicon, which is chemically more stable.

The organic chemistry of silicon is truly a modern development. The first synthetic plastics was made almost a century ago, but the silicones were not even known in the laboratory until the turn of the century.

Even now it is too early to predict what will eventually be discovered in so virgin a field. Surely they will be used more and more in electrical equipment, lubrication, paints—wherever heat and moisture are natural enemies. They are not cheap, to be sure, but cost is secondary, in many uses, to the improved performance, lower maintenance expense, and other benefits accruing from their use. It is not at all unlikely that in future kitchens, to take a familiar example, food which is taken from a refrigerator powered by a silicone-insulated and lubricated motor suspended on silicone rubber will be cooked on a silicone enameled stove.

ANODIZED MAGNESIUM

Holds Paint, Resists Attack Like Aluminum

THE PROCESS used to apply a colorable or protective layer on aluminum has now been successfully adapted to coating magnesium with a similarly useful surface coating of its own oxide-silicate. The anodic layer formed on the metal can be dyed, acts as an anti-corrosion protective coating, and provides a surface to which paints and enamels will satisfactorily adhere.

Conducted by KEITH HENNEY

Tubing Without Troubles

An Electronic Sleuth Probes From Within Metal Tubing to Ferret Out Hidden Corrosion and Other Defects that Might Cause Serious Accidents and Production Losses. Good Tubing is Not Wasted· Salvagable Tubing is Clearly Recorded by this Speedy, Non-Destructive Testing

By VIN ZELUFF
Associate Editor, *Electronics*

Probolog is compact, easily carried to job. Pen traces permanent record

• LOOKING AHEAD •
Development of electronic inspection units for steel tubing. . . Lower operation costs of complex chemical and steam plants. . . Greater assurance of trouble-free passage for ships powered by steam. . . Increased reliability of many tubular structures such as aircraft engine mounts. . . Longer plant operating periods without shut-downs for inspection.

ONE of the most serious problems in oil refineries, chemical plants, steam-power plants, sugar mills, and countless other industrial installations using tubular heat-exchange equipment is the constant threat of failure of the tubing due to internal corrosion. These failures often result in serious accidents, loss of life, and destruction of equipment, and levy a heavy toll of lost production due to forced plant shutdowns.

Heat-exchange equipment consists of hundreds, or thousands, of tubes arranged in parallel and gathered into bundles within a metal container or shell. The petroleum industry alone has thousands of heat exchangers and condensers. Through the tubes of heat exchangers pass all crude oils en route to refining process equipment. These oils are heated in the exchangers by outgoing gases or liquid on the outside of the tubes. The condensing of gasoline from a vapor to usable liquid is performed in condensers. Here, the gases pass around tubes which are kept cool on the inside by constantly flowing water.

The chemical industry likewise uses heat exchangers and condensers for either heating or cooling corrosive liquids, vapors, and so on. Steam-power plants have condensers containing as many as 20,000 tubes through which cold water flows to condense steam.

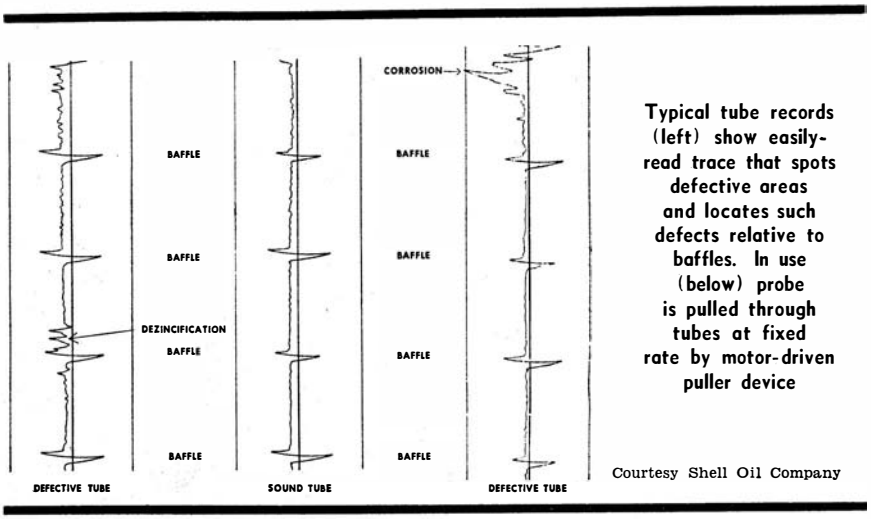
TUBE TESTS—To offset the corrosion problem, engineers have ordinarily provided generous corrosion allowances in the design of heat-exchange equipment, and imposed strict schedules of periodic inspection and test. In the latter, they have used what are admittedly imperfect hit-or-miss methods. An example is the hydrostatic test in which water under pressure is forced into the shell of the exchanger around the tubes, so that tubes which fail completely are detected by water leakage.

Another popular method is that of destructive inspection of random samples, wherein individual tubes from different sections of the exchanger bundle are cut out and split open for visual inspection or examination by chemical, physical, or metallurgical tests.

These conventional methods leave much to be desired. The hydrostatic test shows up only those tubes which are already corroded through, or so nearly through that they cannot withstand a slight extra pressure. Thus it gives no assurance that the tubes which survive the test without leakage will stand up in service until the next scheduled shutdown, nor even that they will not fail in a few days and cause a serious interruption of plant production.

In the destructive-inspection method, the sample tubes cannot be returned to the exchangers even if they are not split open, since it is usually necessary to cut them out of the tube sheets. In addition, there is no certainty of how representative a sample tube may be, and of just what fraction of the bundle. A perfectly good tube may adjoin a row of tubes which are on the verge of failure and, conversely, the detection of a faulty tube might lead to discard of all surrounding tubes even though many of them actually may be in excellent internal condition.

In practice, if either test locates a defective tube, that entire segment of the exchanger may be retubed; or if the number of "leakers" appears high it is safest to discard the entire bundle of several hundred tubes rather than risk an emergency shutdown of complex manufacturing operations. Oil refineries have graveyards that are full of discarded heat-exchanger bundles about which the maintenance engi-



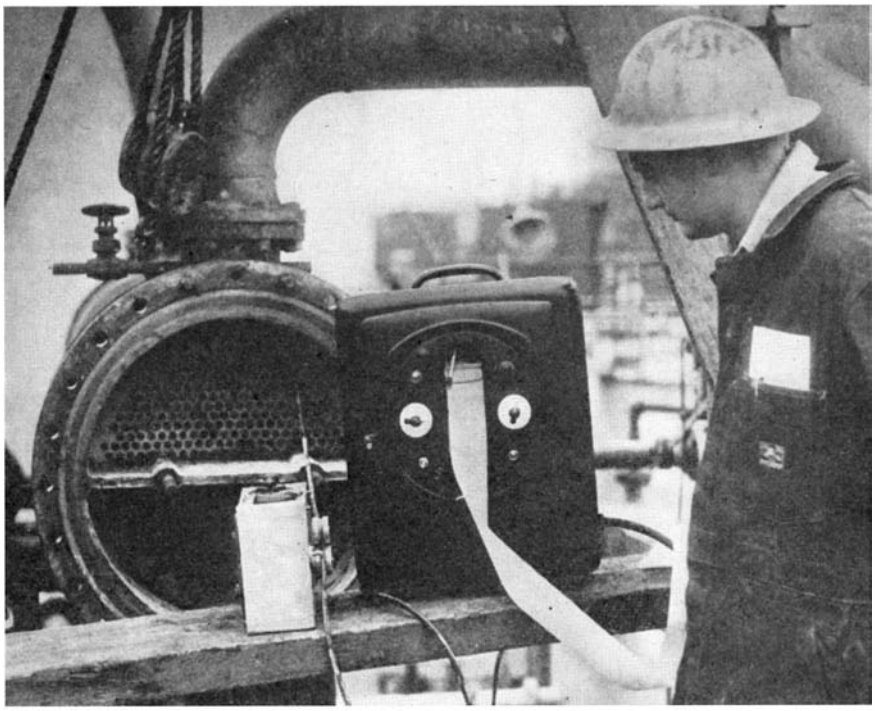
Typical tube records (left) show easily-read trace that spots defective areas and locates such defects relative to baffles. In use (below) probe is pulled through tubes at fixed rate by motor-driven puller device

Courtesy Shell Oil Company

neer often wonders if the right thing was done in consigning what might have been perfectly good and valuable equipment to the scrap-heap.

NON-DESTRUCTIVE TEST — There has been an urgent need for a non-destructive tube-testing method which, by providing a comparative record for each individual tube, would eliminate all the guesswork and place exchanger maintenance on a logical basis. To fill this need, a new electronic instrument has been developed that detects and records quantitatively all types of irregularities in tubes of non-magnetic metals, including such defects as pinholes, cracks, corrosion and erosion pits, variations in wall thickness, and differences in chemical composition. The device is portable, and can be operated by one man at the normal location of the exchanger in the plant. It inspects the tubes from the inside and requires no preparation of the equipment before inspection other than removal of the exchanger head. In use it may be operated either as an indicator or to make a record that can be retained for direct comparison with those of other tubes or with those from other inspections of the same tube at different lengths of service.

The new electronic instrument is called the Probolog, a product of Shell Development Company. In its present commercial form the unit performs routine testing of non-magnetic tubes, and consists of one or more interchangeable probes of different diameters; a mechanical probe puller, usually synchronized with the chart drive of the recorder; and an electronic recorder, equipped with a continuous strip-chart but also incorporating a neon lamp as an indicator. Any defect encountered by the probe upsets the balance of a bridge circuit of which the probe is a part. This is transmitted to the recorder by an electronic amplifier to make a characteristic record of each defect.



The Probolog may be employed in several ways depending on the particular application and the data sought. For inspection of tube bundles during a routine plant shutdown, for example, one oil refinery uses a standard procedure.

TESTS RECORDED—The instrument is first used as a visual indicator, and a rapid preliminary survey is made of all the tubes. The electronic equipment is adjusted to flash the neon lamp whenever a signal exceeding a specified minimum intensity is transmitted by the probe and the operator explores the tubes as rapidly as he can draw the probe through. Those tubes which are shown by flashes of the lamp to contain defective areas are marked for further inspection, and the remainder passed as satisfactory.

A second inspection of the marked tubes is then made, using the strip-chart recorder, and the probe puller is synchronized so as to draw the probe through the tube at a standard rate, perhaps 10 feet per minute. A permanent record is thus obtained of the internal condition of each suspected tube. Here, each defect is not only shown graphically but is located along the tube. The record of a faulty tube consists of a series of deflections from a central line—at which the pen is originally set by testing a tube known to be in good condition—and the magnitude of each deflection is proportional to the extent of the particular defect. Relatively little experience is required for proper interpretation of these records, and an objective basis is thus provided for the retention or rejection of each partially corroded tube.

Metallic baffles and tube sheets appear on the record as defects, causing a wide swing of the pen. Since these deflections are of a large order of magnitude, however, and occur at regular intervals, proper allowance may be made and the record is not obscured.

When records of several tubes are made consecutively on a continuous strip of recorder paper, the wide deflections caused by the terminal tube sheet actually serve to separate the logs of individual tubes. Scale and other non-metallic deposits do no affect the record

The instrument is designed specifically for the inspection of non-magnetic tubes like copper, brass, Monel, Admiralty metal, copper-nickel, aluminum, magnesium, and austenitic stainless steels. It is unsuitable for

the examination of steel tubes, but a modified instrument adapted to magnetic metals is now under development. An important future use of the instrument is seen in the inspection of new tubes for structural faults. Aluminum tubing, for example, could be tested before construction of an airplane and thus preclude building in basic weaknesses.

TUBE SAVER—The Probolog has repeatedly repaid its cost in terms of savings in heat-exchanger tubes saved from the scrap-heap. The case of an isobutane column condenser recently inspected at the Shell Martinez refinery may be cited as a typical example:

The condenser contained 1224 tubes arranged for two-pass contact of hydrocarbon gases in the tubes against cooling water in the shell. Probolog inspection revealed that 40 tubes in the upper or "hot pass" were defective to the point where replacement was advisable, and that virtually all the 612 tubes in the lower section were in very poor condition. Since the first 40 tubes were scattered throughout the upper bank, it seemed that the entire bundle would have to be scrapped.

The Probolog records showed, however, that the remaining 572 tubes in the "hot pass" might confidently be returned to service and that the corrosion in the lower section was restricted to the first 12 inches of the tubes in from the tube sheet. The result was that not only were 572 tubes of the original bundle retained in place, but 612 additional tubes—shortened from 155 to 120 inches by sawing off the corroded ends—were made available for retubing a shorter bundle in another piece of equipment.

The electronic instrument is now in use at Shell refineries in the United States. Training of operators has presented no problem, the average individual usually acquiring facility with the method within the first day. By specifying standard settings of the probe puller and chart drive, tube records are obtained which may be accurately interpreted by any member of the maintenance staff. Files of these records, duly numbered and dated, provide the refineries with a reliable running inventory of their tubular equipment in corrosive service.

A commercial model of the Probolog, embodying all the refinements indicated by practical plant experience over a prolonged period, is now in production. It is expected to find wide application in the many plant installations in which nonmagnetic tubing is subjected to corrosive conditions.

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SHORAN MAPS

Accurate to 10 Feet in 300 Miles, Made Electronically

SLOW and inaccurate methods of surveying land areas by establishing one fixed point after another along a line with rod and chain have been outmoded by Shoran—short-range navigation—another war-time electronic development for which a peace-time use has been found.

In operation, a Shoran-equipped plane sends 20 short-wave radio pulses per second to two ground stations. The stations transmit these signals back to the plane, producing bumps or pips on a thin circular pattern on the cathode-ray screen in front of the operator in the plane. A third pip represents the plane. The operator adjusts the controls until the three pips merge into one, at which instant the exact distances to the ground stations are shown on two dials calibrated in thousandths of a mile. Simultaneously, a camera photographs the dials and another camera photographs the ground vertically below, thus preserving the fix for future use.

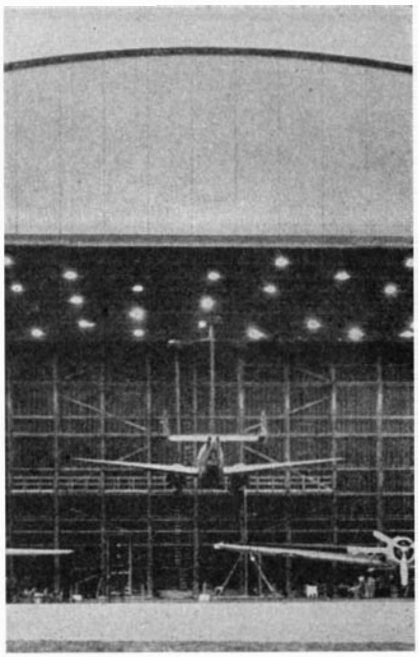
Charts and maps can be drawn from a number of these fixes, and older maps can be recalibrated for accuracy. Since each point is located individually, errors do not increase with the number of measurements made, as they do when ground surveys are made along a line. With Shoran, a point may be located within 10 feet at a range up to 300 miles from the ground stations. A geodetic control network of the world is possible, with control stations about every 500 miles.

Initial Shoran surveys are now under way at Buckley Field, Colorado, under the direction of the United States Coast and Geodetic Survey.

ST. ELMO'S FIRE

Long an Aviation Radio Menace, Foiled by Wicks

PRECIPITATION static, the noise caused in aircraft radio receivers by static discharges of millions of volts when the airplane flies through particles of ice, snow, dust, or highly-charged clouds, has at last been almost eliminated from the list of unavoidable menaces to air travel.



Plane suspended in static-test hangar

Intensive research by a group of scientists at Wold-Chamberlain Airport in Minneapolis showed that this so-called St. Elmo's fire, often clearly visible at night on propeller tips, antenna, antenna masts, wing tips, and other projections, can be suppressed by draining off the electrical charge on the airplane. This is accomplished by means of 12-inch long silver-impregnated cotton wicks exposed to the air stream and by using complete polyethylene insulation on the radio antennas and their connections. About a dozen wicks are needed per plane.

TRAMP METAL

Spotted On High-Speed Conveyor Belt by Electronics

DETECTION of metal particles in plastics, food, textiles, rubber, and other materials that pass along a conveyor belt is now possible by a new electronic machine. In operation, a conveyor belt carries the material to be inspected through sensitive coils arranged in a high-frequency circuit developed by RCA. A metal particle hidden in the material creates an impulse voltage in the coils because it distorts their electromagnetic field. This impulse is sufficiently amplified by an electronic unit to operate a warning bell or lamp, stop the conveyor, mark the object, or reject it from the belt. The speed of the conveyor is about 600 feet per minute. Both minute and large particles of ferrous and non-ferrous metals are detected and no specially trained operator is needed.

Conducted by FRED P. PETERS

Extrusions by Impact

For Certain Products—Particularly Those Requiring Tubular Shapes and Closed Ends—Impact Extrusion in a Fast, Simply Tooled Means of Fabrication. Its Essentials are Only a Punch, Die, and Press—but Its Potentialities Range from Collapsible Tubes to Aircraft Parts

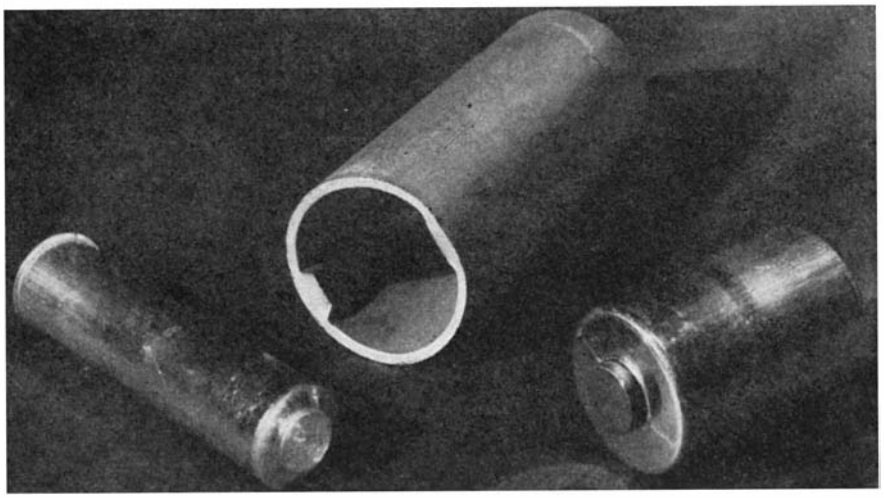
By HERBERT CHASE

AMONG the various methods of producing small metal parts, few have expanded more in recent years than impact extrusion. Once confined largely to the manufacture of collapsible tubes for tooth paste, shaving cream, and like items, impact extrusion is now being increasingly applied to many other types of products, especially those of cylindrical shape with either one end or both ends closed.

Impact extrusions are made by placing metal slugs within a die and striking them with a punch. Thus a part of the metal is extruded through the annular opening between the die and the punch. Such products always have a cupped shape as they come from the die.

Applications include a large variety of cup-shaped parts and tubular elements, many of these being produced as substitutes for, or in competition with, similar parts either drawn from sheet steel or fabricated as die castings, from brazed tubing, and so on. Many extruded parts, however, cannot be duplicated by drawing. This is partly due to the fact that the base of the extrusion is often much thicker —or sometimes thinner—than the walls and frequently incorporates bosses and extensions not feasible to produce by drawing.

In addition to collapsible tubes, which are said to constitute some 95 percent of the total present output of impact extrusions, other products made by this method embrace cases for dry cells; cans for vibrators and condensers, both electrolytic and foil types; transformer and radio-tube shields; cylinders for pumps, door checks, and grease guns; cans for ignition coils; flashlight and cartridge cases; textile sleeves and bobbins; and many other items of cupped or tubular form. At least one aircraft manufacturer has produced flanged and unflanged parts for use as structural elements in aircraft.



Accurate forming of walls and ends increases utility of rapid, impact method

As has been indicated, the electrical and electronic industries are the largest consumers of impact extrusions aside from those using collapsible tubes as containers. It appears likely, however, that other uses will be extended as the utility of impact extrusions becomes more generally known.

MANY POSSIBILITIES—The bottom of an extruded cup usually is thicker than the side walls and is, in reality, a forging. Side walls are commonly of uniform thickness, but can have longitudinal beads, can be fluted either internally or externally, and can have a length many times the diameter of the base.

In one type of impact extrusion, the base includes a flange which can have a diameter two or more times that of the extruded portion. In others, a flange is produced by a secondary heading or upsetting operation.

Many secondary operations are performed on impact extrusions. They are usually trimmed at the outer end of the extruded portion and sometimes a projection on the base requires trimming to length. In certain forms the base is cut off, leaving only the extruded tube. The base can be pierced, drilled, tapped, threaded, or otherwise machined. Beads are often rolled in side walls and the walls can be pierced, notched, slotted, serrated, given a stepped diameter, spun over, or machined in other ways.

SOFT METALS BEST—Only soft and ductile metals are suited for impact extrusions, largely because the pres-

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Increasing competition between impact-extrusions and drawn sheet metal parts. . . Greater appreciation of the utility of the process. . . Expanded use of copper, magnesium, and silver extrusions as techniques are developed. . . Application to many cup-shaped forms now made by die casting.

sures required for harder and less ductile materials become prohibitive. At present the materials used, in order of commercial importance, include lead, aluminum, zinc, and tin. Copper, magnesium, and silver are among other soft metals that can be impact extruded, but as yet the demand for these is slight.

In general, metals that are substantially pure are most readily extruded and—with the exception of lead and zinc metals which are used as nearly pure as can be economically produced—are used for most extruded products. Although pure lead can be extruded readily, the resulting product, especially when it has very thin walls, is too soft to be handled without distortion. For this reason, lead for extrusion is commonly alloyed with about 3 percent of antimony to give the product adequate stiffness. When antimony has been scarce, other stiffening metals—including 0.5 percent silver—have been used in its place.

Although lead has high resistance to some types of corrosion, it is not immune to chemical attack by certain materials for which lead-alloy tubes serve as containers. For this reason, the tubes are commonly lacquered, given some other protective finish, or are tin-clad.

Tin is readily extruded and before the war was used in pure form for the manufacture of collapsible tubes despite its rather high cost. Tin has a brighter color than lead, is quite resistant to tarnishing, and is highly resistant to corrosion. All these are desirable qualities in collapsible tubes. Pure tin, however, though much stiffer than lead is not stiff enough for some extruded tubes and has often been alloyed with 0.5 to 1.0 percent copper or with small amounts of zinc or bismuth to increase stiffness.

Shortages of tin during and since the war have restricted its use in pure or tin-rich alloys to only a few extrusion applications, chiefly for small containers for drugs or medicinals that cannot be packed safely in other containers. Tin is permitted, however, for cladding of lead for making extrusion slugs for some purposes, provided that the total tin does not exceed 3 percent of the slug's weight. About 95 percent of all collapsible tubes are now made either from lead-antimony alloy or from this alloy in tin-clad form. The remaining 5 percent are nearly all extruded from pure aluminum slugs.

Although lead and tin extrusions serve well for collapsible tubes, they lack the strength, hardness, and stiffness required for most impact extrusions classed as "shells"—not to be confused with shells such as are used for ammunition. For this and other reasons, either aluminum or zinc, in pure or alloyed form, serve for making most impact-extruded shells and open end tubes—the latter being shells from which the closed end has been cut.

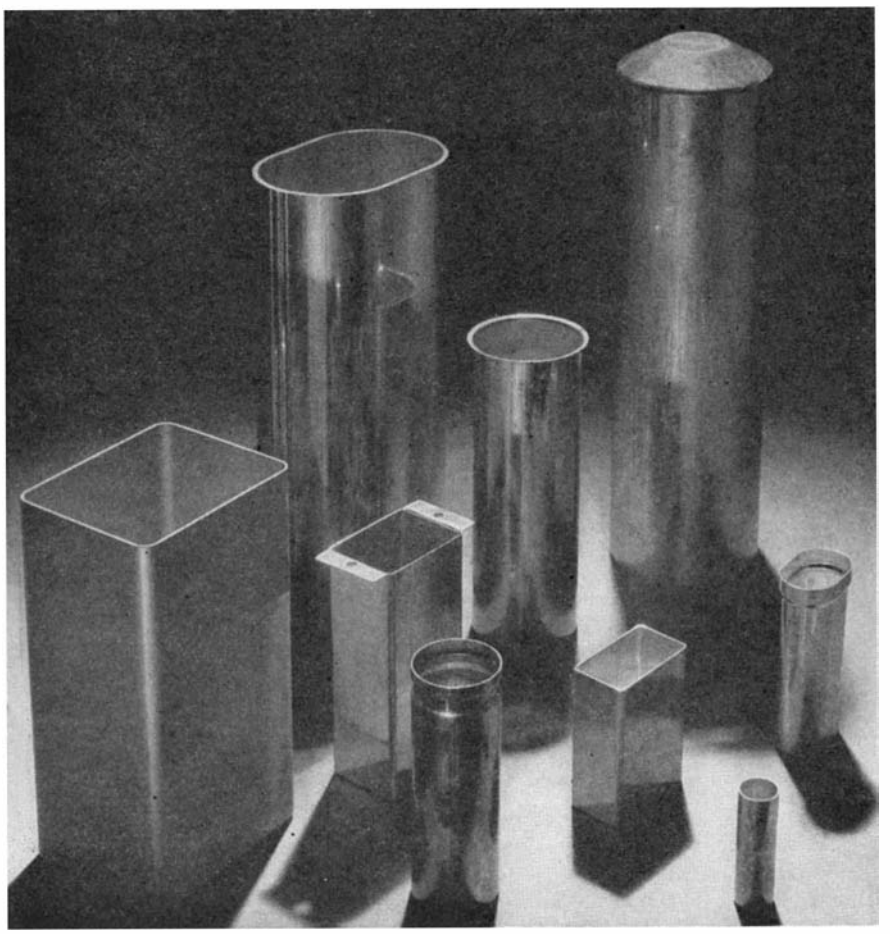
Where low weight or some other special property of aluminum or of its alloys are not essential requirements, either zinc or aluminum may be chosen. Under current market conditions, costs per extruded piece are about on a par. Aluminum and its alloys have some advantage in initial appearance and sometimes in strength over the zinc extrusion, but are not so easily soldered or plated. Zinc is required, of course, for dry-cell cases and, although these are frequently drawn, some shapes for such cells are extruded.

Considerable impact extruding of pure copper has been done. Among the products that have been made are short, open tubes for honeycomb, automobile radiator cores but less expensive types of cores have largely, if not fully, supplanted this type. Other impact extrusions of copper are still of minor importance.

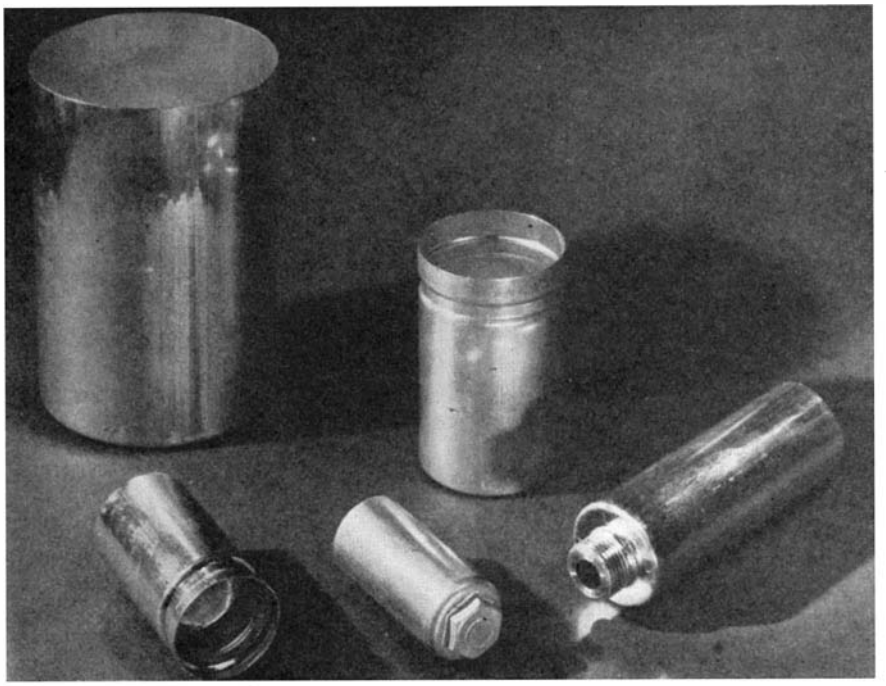
SIMPLE TOOLING—For rapidity and economy in production, crank-type or equivalent positive-mechanical—as opposed to hydraulic—presses are used for impact extruding. As the pressures required are high, the presses have heavy frames and flywheels. For some aluminum extrusions, pressures approaching 200,000 pounds per square inch are said to have been attained. Less pressure is required for softer and more ductile metals. The required pressure is influenced by the shape of the punch and die, and by the thickness of the extruded wall.

All production of impact extrusions requires a die and a punch. In general, the die block and punch holder are more or less standard items. All that is required for making most ordinary extrusions, beyond the standard elements, are a die ring and a punch tip, each being made to fit its respective holder. If special bosses—either interior or exterior—are required on the base of the extrusion, the punch tip, or die, or both must have corresponding recesses.

In the usual procedure, the slug to be extruded is blanked in a press to make a reasonably close fit in the die. In most cases, the slugs are circular, and the parts to be made from them have circular sections. This greatly simplifies manufacture of punch and die parts and makes them quite moderate in cost.



Parts for electronic and radio equipment are well-adapted for impact extrusion



Impact extrusion affords a great variety of closed, formed, or machinable ends

The punch is always smaller than the hole in the die; the resulting space between the die and the punch provides the opening through which most of the metal in the slug is extruded to form the side walls of the product. As the punch is forced into the metal, the latter "squirts"—usually upward—around the punch, thus forming the wall in a small fraction of a second even though it may be several inches in length.

Ordinarily, the slug is made to fit the die fairly closely; the impact of the punch forces the metal to fill all die recesses completely, including any holes for bosses or extensions, before the extruded wall is formed. As the operating cycle proceeds, there is a further flow of metal between the die and the punch to complete the part. As the punch approaches the end of its stroke, it may come fairly close to the bottom of the die recess but usually not closer than 0.030 inch. At that point friction between die and punch end becomes excessive and the punch is stopped. Proper shaping of the die and punch end help to reduce the friction and to lower the maximum pressure required.

RAPID PRODUCTION — Although the production speed on extrusions up to about 1½ inches in diameter varies from about 35 to nearly 70 pieces per minute, the average is close to 60 per minute or one per second. Of this second of time, only about 20 percent is for forming the extrusion itself, even when an extrusion to seven inches long is made. This is considered about the maximum rate of flow economically feasible in impact-extrusion work.

The length of impact extrusions is limited only by the length of the punch that can be used and the available pressures; extrusions longer than 18 inches have been made and length tolerances can be held to within 0.015 inch. Some aluminum extrusions having an outside diameter of five inches have been made, although zinc extrusions are usually smaller than 1½ inches outside diameter.

The advantages of impact extrusions that appeal to many designers include rapidity of production; availability in forms that are made, ready for use, in a single fast operation, except for trimming; low scrap losses; highly smooth surfaces; one-piece seamless fabrication; unusually low tooling cost; accuracy of dimensions; and close reproducibility from piece to piece.

The limitations are restriction to tubular shapes, with or without a bottom; limited range of materials suitable for the process; specialized techniques; and the necessity for using as raw material slugs which have been previously cut from relatively expensive sheet, strip, and bar stock.

Aside from collapsible tubes, impact extrusions seem to be establishing a special area of use for parts whose length is 1½ to 2 times their diameter, and particularly when the bottom must be thicker than the walls. When the design calls for ribs or bosses in the bottom or sides, or for other special features that cannot be drawn from sheet stock, impact extrusion often is indicated as the best production method.

Exceedingly keen competition exists between drawn sheet metal and impact extrusions for such nonferrous metal products as dry-cell cases and radio condenser cans. On the other hand, for the collapsible tubes that constitute most of the present market, impact extrusions cannot be duplicated with comparable economy, if at all, by any other method of manufacture.

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STEEL-ALUMINUM RIVET

Heat-Treatable to Handle High Shear Loads

Developed in the aircraft industry to overcome previous limitations on the strength of riveted joints, heat-treatable, alloy-steel rivets are equipped with aluminum alloy collars. The alloy-steel, load-carrying part of the rivet may be heat treated to high strengths, while the aluminum collar permits deformation for heading without altering the body strength of the rivet.

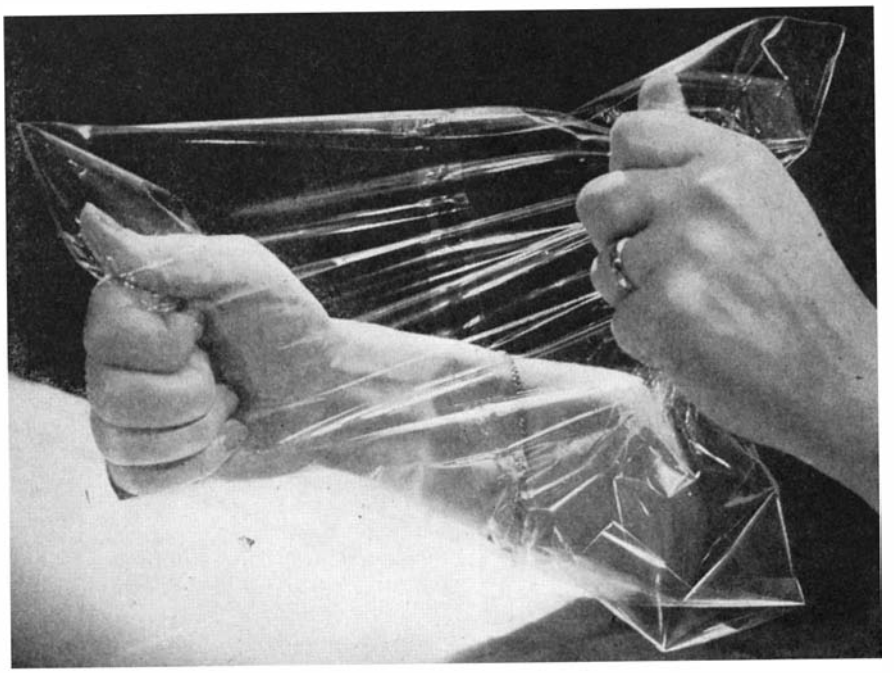
This type of rivet is designed primarily for resistance to shear, shear strengths of 75,000 pounds per square inch being available after heat treating. The rivet was developed by engineers of North American Aviation Inc. and is now being produced by four licensed manufacturers—Pheoll Manufacturing Company, National Screw and Manufacturing Company, American Screw Company, and Fibre and Metal Products Company.

Its success in meeting the need for a fastening of high strength and low weight for critical locations in airframes led to its adoption by most airplane producers for engine mounts, wing spars, stabilizers, firewalls, and so on. It is now going into commercial planes, automobile truck trailers, and other civilian items.

PLATED PISTON RINGS

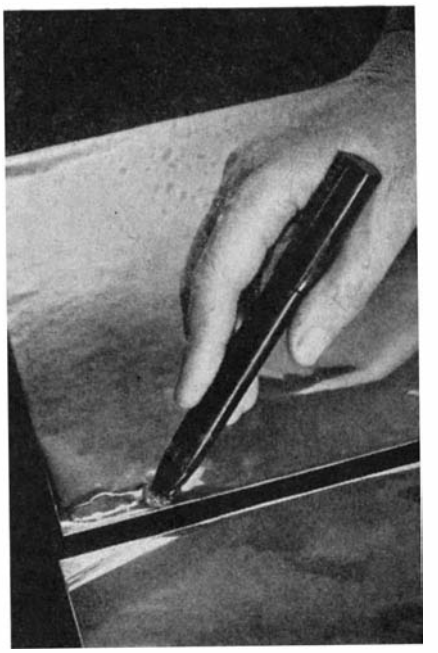
Show Longer Wear, Better Oil Retention

Application of the van der Horst porous-chromium plating process to cast-iron piston rings for aircraft, truck, bus, and automotive engines is said to have increased piston-ring life about five times and reduced cylinder wear 30 to 50 percent. Only the top ring of each piston is plated, and the plating thickness is 0.004 to 0.006 inch on the cylinder-contacting surface. The chromium-plated rings are much harder and more wear resistant than unplated rings and the porosity of the plate provides an oil-retaining surface.



Welding of thin-gage acetate sheet is accomplished by applying solvent with pen applicator (below), then quickly placing other sheet on wet area. When set, joint is clear and strong (left)

Courtesy Celanese Plastics Corporation



PLASTICS

Plastics Stick Together

Joining Two or More Pieces of Plastics Together is Something Beyond a Gluing Job and It Just Misses Being Welding. Consequently, Many of the Methods Used are Not Universally Known. With Proper Techniques for the Plastics Involved, Strong, Clear Joints are the Rule

By CHARLES A. BRESKIN
Editor, *Modern Plastics*

• LOOKING AHEAD •

Better looking, longer lasting plastics products when joining is better understood. . . Designs conceived with a closer attention to assembly problems. . . Lower production costs with faster assembly rates. . . Fewer consumer complaints about plastics articles "coming apart."

EXAMINATION of almost any article made of thermoplastic materials—acrylics, cellulose acetate, cellulose acetate butyrate, polystyrene, and cellulose propionate—discloses that it has either been formed or sawed. And, in a high proportion of parts, the pieces thus fabricated have been cemented together to make the finished piece.

Even more than the forming, bending, sawing, and other cutting operations, the cementing job spells the success or failure of an article. While a slightly uneven edge on a product may marr its appearance, the article can be used as long as the cemented joints are sound.

The cementing of thermoplastics depends on the intermingling of the two surfaces of the joint so that there is cohesion similar to that in the material itself. With care and practice it is possible to obtain with two pieces of acrylic, for example, a cemented joint that closely approximates in transparency a solid block of this plastics.

This intermingling of the surfaces is entirely different from wood gluing which depends on the adhesion of the glue to each of the two surfaces being bonded. To effect cohesion between pieces of thermoplastic material an organic liquid solvent is used which actually attacks the plastics, forming a well-defined, soft, surface layer called a "cushion." Actually the term "welding" is more descriptive of the process than the term "cementing," and the term "solvent" more descriptive than "cement," though the latter is the word most commonly used to describe the material making the weld.

To achieve the best bond, the acrylics must be handled differently from the other thermoplastic materials. And polystyrene, while handled in the same way as the cellulosics, should employ a different solvent.

SOLVENTS—While both the technique and the solvent are important in cementing thermoplastics, the

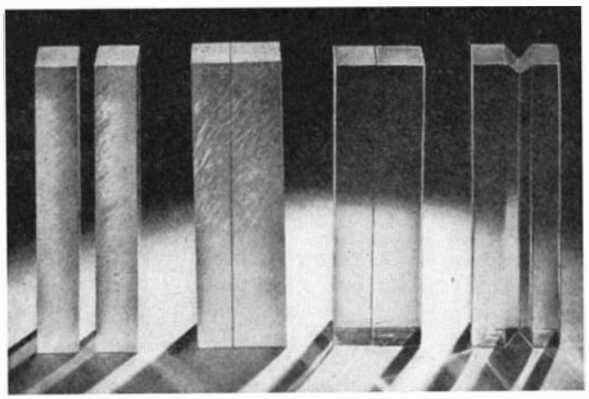
selection of the solvent comes first. Highly recommended for use with acrylics is a mixture of equal parts of monomeric methyl methacrylate —inhibited with 0.006 percent hydroquinone—and methylene dichloride. Immediately before using this solvent, a small capsule of benzoyl peroxide is added as a catalyst in the proportion of one capsule to one pint of solvent mixture. Since the catalyst acts to thicken the solvent unless the mixture is refrigerated, the best procedure is to make up only enough solvent for about a half day's work. The mixture also tends to lose a portion of the methylene dichloride through evaporation.

Certain types of work may require the use of a more active solvent than the 50-50 mixture just described. There are small parts that will not be expected to withstand heavy stresses and there are circumstances when for economic reasons production must be speeded. In such cases, the liquid methylene dichloride may be used without any other components. But there is the danger that the joint may show blushing or whitening at the point of weld.

Further down the list of recommended solvents for the bonding of acrylics is glacial acetic acid which must be handled with great care since it is very corrosive and irritating to skin and eyes. At the bottom of the list of solvents is acetone.

BONDING TECHNIQUES—With the solvent decided upon, the next step is to determine the most effective method of using the mix. Most of the work on larger acrylic pieces is accomplished through the use of the soak method which consists of dipping one of the two pieces to be welded in the solvent and holding it there until a softened cushion is formed on the surface to be welded. When the piece is removed from the solution the surface of the cushion is wet with solvent. As this surface is pressed against the dry surface of the other part being welded, the excess solvent forms a second cushion on this matching edge, shallow but enough to permit the intermingling of the two surfaces.

Four steps in cementing thermoplastics—left to right: mating surfaces are formed, cemented, polished and finally grooved, if practical, to conceal joint



Courtesy Plasteck Manufacturing Company

Sometimes clear acrylic shavings are dissolved in the solvent to give it a consistency which allows it to be applied like glue. This thickened solvent may be applied with a brush or other mechanical means, but it works on the same principle as the mix used for the soak method, the viscous material acting only as a carrier for the solvent.

The time that a piece of acrylic is left to soak in the solvent varies, but a good average is 15 minutes. The critical period is that between the time the piece is taken from the soak tank and the moment it is joined to the second piece. Since it is the liquid solvent on the surface of the cushion and not the cushion itself that effects the bonding, the joint must be made before the liquid has a chance to evaporate. Otherwise a poor bond results and, if the joint does not break open, it still has poor strength qualities.

Another important time element in the bonding of acrylics is the interval between the time the two pieces are placed in contact and the time actual bonding pressure is applied. This is the period when the liquid surface of the cushion is being absorbed by the opposing dry surface. Naturally this is not done instantaneously: a satisfactory interval ranges from 15 to 30 seconds.

The acrylic pieces must never be immersed in the soak bath unless all surfaces that come in contact with the solvent but are not being bonded have been covered with a pressure-sensitive adhesive. This taping confines the action of the solvent to the area of the joint. It is important for the covering to be well applied and that there is enough overlapping of the tape to prevent the cement from seeping under the edges. If this is not done the surface of the acrylic not being bonded will be marred.

JIGS AND EDGES—Besides the solvent used and the time elements there are a number of other factors effecting satisfactory bonding of acrylic materials. For one thing, the two parts must be joined with great accuracy. In butt joints, for example, both edges must be made true and square before the welding operation begins. Where possible, an effort should be made to design the article so the joining edges are flat. If a curvature is unavoidable, both curves should have the same radius if the pieces are to be butt joined. If an overlap joint is called for, the radii of the two curved parts should be different enough so the two areas mate perfectly.

Sometimes the construction of the article is such, whether the edges to be joined are flat or curved, that jigs must be used to hold the parts firmly together until the weld is hardened. The jigs should be so designed that they apply enough pressure to squeeze all air bubbles from the joint, thus assuring a thorough intermingling, and apply the pressure uniformly. They must also be built to compensate for the shrinkage which always takes place during the hardening of the solvent, for only in this way will the pressure on the bonded joints be held uniform. If the two pieces of acrylic are held rigidly in the jig so that they cannot move together while the joint is drying, the bead of excess cushion will tend to draw back into

Welding halves of plastics barrel-bank. Felt pad is partially immersed in acetone; operator transfers small amount of acetone from pad to edges to be joined together

Courtesy Elmer E. Mills Corporation

the joint, leaving dimples along the outside surfaces. In some cases, bubbles may even be visible. The parts being joined should be allowed to stand in the jig for at least four hours, and an additional period of four to five hours should elapse before the joint is subjected to handling.

To make a stronger joint, the temperatures can be raised slightly while the acrylic pieces are held together. This will cause the cushion to enlarge slightly. Upon cooling, the size of the cushion will remain constant and will be harder since some of the solvent will have evaporated from the joint. This operation must, however, be undertaken with caution for if the cushion becomes too large or deep serious weakening of the plastics section results.

CELLULOSICS—When the bonding of such thermoplastics as cellulose acetate, cellulose acetate butyrate, cellulose propionate, and polystyrene is undertaken, all the technique learned regarding the acrylics must be discarded. The soaking process should never be used with cellulosics because of the quicker action of the solvents on these plastics. Even thorough taping will not protect the surfaces, the action of the solvent through the exposed edges quickly ruining the appearance over a wide area.

Acetone is one of the most commonly used solvents for the cellulose esters. If it is used alone, however, the cemented pieces often take on a white, frosted appearance due to the high evaporation rate of the acetone. So rapidly does it evaporate that it may not even have time to soften the surfaces and effect adhesion. These difficulties can be overcome by the addition of one or more solvents of higher boiling point —methyl Cellosolve acetate, for example. This addition, however, increases the drying time of the weld.

Rather than using either acetone or methyl Cellosolve acetate, it is sometimes found advantageous, particularly on jobs where the surfaces are not smooth, to use a more viscous solvent. For cellulose acetate, such a solvent or dope can be made up with 10 parts cellulose acetate, 60 parts acetone, and 30 parts of ethyl lactate—all parts by weight. The formula for cellulose acetate butyrate is 10 parts of butyrate, 60 parts of acetone, and 30 parts of methyl Cellosolve acetate.

When cellulose acetate is being bonded with cellulose acetate butyrate a suitable cement may contain 75 parts cellulose nitrate of medium viscosity, 25 parts of camphor—nitrate film scrap can be used in place of the first two ingredients—400 parts acetone, and 200 parts ethyl lactate. For cellulose propionate a satisfactory body cement can be made with 10 parts of cellulose propionate, 60 parts acetone, and 30 parts methyl Cellosolve acetate.

Polystyrene is yet a different matter, benzol being the most desirable solvent for the welding of this plastics. During the war, however, when benzol was difficult to obtain, xylenol was used instead. Since with both of these solvents a more viscous solution is the best, granules or shavings of polystyrene may be added until the proper mix is obtained. A good rule of thumb is a 50-50 mixture by weight. It should be borne in mind that both benzol and xylenol are very toxic, hence the area where they are used should be well ventilated.

METHODS IMPORTANT—There are a number of methods of applying the solvent to the cellulosics and polystyrene. One way is with a brush, care being taken that the solvent is painted only on the bond surface. An even more widely used procedure is that of dipping.

In the dip method the solvent is placed in a suitably shaped container. A felt pad is placed in this pan so that its top surface is just level with the surface of the solvent. Then a fine wire screen is placed over the top of the pad. The felt pad acts as a wick, allowing light contact of solvent with the part to be welded and the screen acts to prevent contamination.

With the equipment ready, the surface of the parts to be bonded are brought in contact with the screen and are left in this position until the material has softened substantially. Then the pieces are clamped together and held until the bond is set. This may be done by hand if the parts are small since the joint takes but a few seconds to set. Ordinarily after the joint has set there is a protuberance of material at the weld line. This must be removed by mechanical means but not until the pieces have been allowed to set for from 24 to 48 hours to permit the solvent to evaporate.

Properly done, a cemented joint should cause no trouble and be almost invisible to the eye. What failures there have been have occurred due to lack of knowledge of the "know-how" of cementing—an unfamiliarity of both the solvents that should be used and the methods of using them.

PLASTICS RE-DESIGN

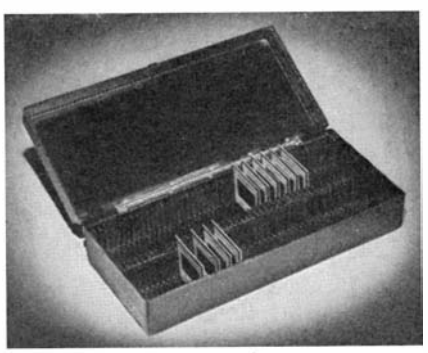
Proves Need for "Engineering" On "Non-Plastics" Parts

IN ADDITION to the new plastics products now appearing on the market, a number of old articles are coming back with new and improved component part. An example is a 35-millimeter Kodachrome slide box molded of Bakelite material.

The original slide box was designed to be assembled by means of a standard hinge having a spring clip in its center. The hinges were first put into molded slots in the side of the bottom half of the box. This, however, made a poor assembly. The fault lay principally in the weight of the cover which was too great for the type of hinge being used. Consequently, when the cover opened up, the snap of the spring plus the weight of the cover frequently pulled the hinge out of the bottom half of the box.

Manhattan Screw Company, in redesigning the slide box, decided that piano-type hinges with no spring would be the best choice for this particular application. This hinge is attached to the two halves of the box with drive screws and thus far has proved successful.

There are many other examples



Hinge, not plastics, needed re-design

of this type of redesign work, particularly in products that combine plastics with other materials. Surprisingly enough, it is often the "other material" that is altered.

DUST PAN

Low-Pressure Laminated, Does Not Warp at Edge

OF INTEREST to manufacturers of household appliances, retailers, and housewives is an experimental dust pan produced from Fiberglas impregnated with Bakelite polyester resins. Turned out by the low-pressure laminating technique, this dust pan thus far shows no tendency to warp or become distorted along the leading edge.

Wax Against Water

Capable of Satisfying the Demanding Packaging Requirements of War, Plus Previously Unposed Problems of Protecting such Things as Frozen Foods, are the Waxes and Waxed Papers. Water Doesn't Penetrate Wax and Modern Waxes are Tough—Hence Give Efficient Protection

By JOHN C. DEAN
Technical Division, Process Products
Socony-Vacuum Oil Company, Inc.

• LOOKING AHEAD •

More ready-to-eat foods in light, easy-to-open, waxed paper packages. . . . Fewer instances of water damage when the microcrystalline waxes are used. . . Extensive shipment of tools and precision parts in moisture-vapor-grease-proof wrappings. . . Further progress in substituting wax for lacquer container-wall coatings.

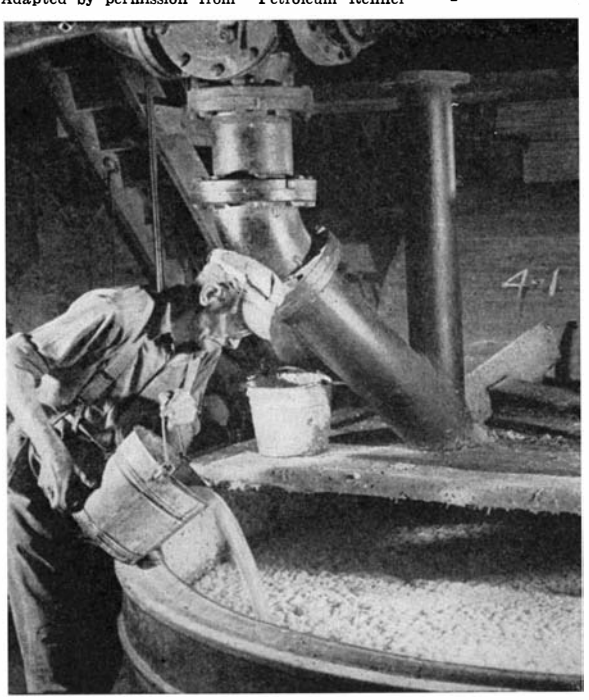
NATURAL waxes of animal and vegetable origin have been employed for centuries in the manufacture and decorating of a variety of articles. Eventually, craftsmen found that these natural waxes could be employed for water-proofing as well as decoration. Natural waxes, however, were not replaced until 60 or 70 years ago when it was found that paraffin, one of the constituents of petroleum, was of a waxy nature.

Paraffin-type waxes, mainly fully-refined waxes, are desirable as coating materials due chiefly to their hard, dry texture. For many applications, however, they are unsuitable because of their brittleness and of limitations in melting point. The former adverse characteristics is most pronounced at low temperatures, or where rough handling is encountered.

Microcrystalline waxes owe their usefulness to their flexibility and their highest melting point. The drawback to their use alone is tackiness at ordinary temperatures.

It is evident, however, that the advantages of one type may be used to conteract the disadvantages of the other, hence the usefulness of a blend. Usually blends are prepared containing up to 50 or 60 percent of microcrystalline wax, but the exact formula depends on the properties desired to meet service conditions. Increased quantities of microcrystalline wax raise melting point and improve flexibility, but above 25 percent also increase tackiness and the tendency to block or stick together.

Adapted by permission from "Petroleum Refiner"



Wax treatment of paper is often done after the paper is manufactured. Here, however, a wax-emulsion sizing is added to pulp in beater to impart water resistance to, and lay surface fuzz of, finished paper

WATER-TIGHT PAPERS—Approximately 80 percent of the production of petroleum waxes is used for the treatment of paper. The value of this treatment is that it provides paper with waxy coatings or impregnations which resist the passage of water or water vapor. Paper consists of countless cellulose fibers felted together and bonded with an adhesive such as resin and alum. As a result, there is a continuous contact of cellulose to cellulose throughout the paper sheet with minute openings between the individual fibers. When water passes through a sheet of paper, it does so largely through these openings rather than along or through the fibers themselves. Therefore, a paper can be made water-tight by filling these openings with a material which is impervious to water.

Water vapor, on the other hand, can be transmitted by cellulose fibers as well as through the openings between them. In order to render a sheet of paper resistant to the passage of water vapor, it is necessary to provide a continuous film of a vapor-impervious material which completely covers the cellulose fibers of the sheet as well as those which protrude above its surface. If the surface fibers or "fuzz" are not coated they can serve as wicks to absorb moisture from a humid atmosphere on one side of the paper and carry it along a chain of cellulose fibers to the other side where

Microcrystalline waxes stay flexible at low temperatures, do not chip or flake in packaging of frozen foods

it can be given off to a less humid atmosphere.

These fundamentals are responsible for the fact that three basic types of wax-treated paper are made today. These papers may be classed as wet-waxed paper, dry-waxed paper, and laminated paper.

HEAVY WAX FILMS—Wet-waxed papers are those which have continuous wax films on their surfaces. They are manufactured by applying a heavy film of wax, and immediately setting this film on the surface. Absorption into the paper is prevented either by passing the waxed sheet through a bath of cold water, or by chilling it with a cold roll. These papers may contain as much wax as base paper stock.

The most important characteristic of a wet-waxed paper is that it possesses a truly continuous coating of wax. This film covers the surface paper fibers completely and prevents them from absorbing moisture from the surrounding atmosphere. Such papers are used where moisture-vapor proofness is required.

A great variety of wet-waxed papers is produced by industry. This is because these papers are extremely moisture-vapor proof and therefore have greater utility in all types of packaging. The commonest wet-waxed paper, and the one produced in greatest volume, is bread-wrapping paper. Similar sheets are those used for candy wraps, and in the interior and on the exterior of cracker and cereal boxes. Practically all of these papers have been produced by the cold-water method of chilling and are therefore very lustrous in appearance.

Fully-refined wax is the most commonly used coating for wet-waxed papers, but in many applications it falls down because of its inherent brittleness. This is particularly pronounced at low temperatures where it becomes fragile, and where the wax film can be broken quite easily. Any break in the wax film exposes paper fibers which are free to absorb water vapor. Microcrystalline waxes are especially useful in overcoming this deficiency of the paraffins, since when they are blended with paraffin wax they impart a portion of their flexibility to the mixture. The increase in ductility is roughly proportional to the quantity of microcrystalline wax used.

There are a number of applications where such an improvement in flexibility of the wax coating is essential. The packaging of frozen foods is probably the one which will be of greatest importance. Foodstuffs so packaged must be handled at temperatures as low as zero degrees, Fahrenheit, and must be continuously protected against loss of moisture. If straight paraffin waxes are used for coating paper or packages for these frozen foods, the wax films on them will be subject to fracture and their protective action will be lost. Blends containing 25 percent of microcrystalline waxes are far superior to straight paraffin waxes for this purpose.

DRY WAXING—When waxed papers are so treated that relatively little wax remains on their surfaces, they are termed "dry-waxed." These sheets are prepared by processes which cause a controlled amount of wax to become impregnated into them, and which eliminate surface wax to a large degree.

The fundamental characteristic of dry-waxed papers is that they do not possess continuous films of wax. Paper fibers which protrude above the surface are not completely coated and so are free to absorb moisture which can be carried through the sheet by the cellulose fibers. Such papers cannot be employed where moisture-vapor proofness is essential. Dry-waxed papers, however, are waterproof for practical purposes, since wax has filled the openings between the fibers through which water would pass.

As with wet-waxed papers, there is also a great variety in the types of dry-waxed papers which are produced today. These papers are employed where there is no requirement for moisture-vapor proofness, and where the only need is for resistance to water. Typical examples are delicatessen papers, drinking cup stock, and water-proof bag papers.

Dry-waxed papers are most commonly made with either fully refined waxes or crude scale waxes. Since the wax in the paper does not exist as a continuous wax film there is little advantage in the use of microcrystalline waxes. Furthermore, the wax is so firmly supported by paper fibers that cracks or breaks in it are not apt to be formed during rough handling or exposure to low temperatures. In most instances, therefore, service conditions are not severe enough to warrant the use of microcrystalline waxes.

GREASE-PROOF PAPERS—The passage of grease through paper is generally through the openings between the paper fibers and is not along the fibers themselves. Obviously the most grease-resistant sheets are those which consist of a continuous film of cellulose such as cellophane or glassine paper, but other papers can approach these grease-resistant sheets if they are impregnated with an oil-resistant substance.

When a sheet is thoroughly impregnated with a slightly oil-soluble material, grease, fat, or oil can pass

Wax between layers of paper laminates acts as adhesive and moisture barrier

through the paper only after it has dissolved enough of the material to develop openings between the fibers. Obviously, therefore, products which are the least soluble in these non-aqueous substances will be most effective for grease-proofing purposes. Microcrystalline waxes are only limitedly soluble in oils, fats, and greases, hence they are useful as grease-proofing agents. The solubilities of petroleum waxes in fats and oils are directly related to their melting points. For example, a wax melting at 133 degrees, Fahrenheit, is only half as soluble as one melting at 125 degrees Fahrenheit. When the melting point is increased to the microcrystalline-wax range the dif-

ference is even more pronounced. A wax melting at 165 degrees, Fahrenheit, has only one twentieth the solubility of one melting at 133 degrees, Fahrenheit. This disproportionate effect of melting point permits a fairly grease-proof paper to be produced with conventional microcrystalline waxes.

PAPERS LAMINATED — Laminated papers consist of two or more layers of paper bonded together with an adhesive. When wax is used as the binder it also serves as a moisture-vapor-proof barrier. These papers are prepared by applying the wax to one of the sheets and combining the second with it by means of press or squeeze rolls under controlled conditions.

Laminated papers are useful because two entirely different sheets may be used simultaneously and advantage taken of the characteristics of each. For example, a moisture-proof and grease-proof boxboard can be produced by laminating glassine paper to chipboard with a microcrystalline wax. The chipboard supplies the structural strength, the wax the moisture-vapor proofness, and the glassine the grease-proofness. Because of their unique construction, laminated papers have many of the advantages of both wet- and dry-waxed papers. A continuous wax barrier is present, as in the case with wet-waxed paper, yet the wax film is protected on each side so that its continuity cannot be destroyed by careless handling or scratching.

The wax employed in laminating plays a dual role. It provides the moisture-proof barrier and also serves as the binder for the layers of paper. Even paraffin waxes would provide a satisfactory barrier, but these waxes do not possess adequate adhesiveness; and as previously stated, they are not sufficiently flexible to maintain a continuous wax film. Microcrystalline waxes are particularly suitable for laminating because they are adhesive substances and because they are plastic and flexible.

Many combinations of paper and laminating agents are possible, but all may be grouped roughly into two basic classifications. The first group is composed almost entirely of transparent or translucent papers such as glassine. These grades are used largely for packaging foodstuffs, particularly where their transparency is needed to permit an inspection of the contents of the packages.

The second group is more diversified and comprises papers made by laminating either glassine or parchment to such sheets as paperboard, or kraft and sulfite papers. These products are employed in many packages such as coffee bags, doughnut and cracker boxes, paper cans, wrappers for paperboard cartons, and certain meat wraps.

PACKAGING METHODS — Some packages, notably paper milk bottles and containers for some foodstuffs, are waxed prior to filling. This is accomplished by immersing a carton, the bottom of which is usually glued, into a wax bath, allowing it to fill, emptying the wax from it, and permitting it to drain.

More commonly, wax is applied to paper packages after they have been filled and sealed. This method may be used for dry materials, and is preferable for several reasons. Since the package is glued before waxing, it is stronger mechanically. Waxing is generally the last operation, and handling of the waxed package is held to a minimum, thus reducing the possibility of marring the wax film. Finally, this type of package does not depend upon a separate sealing operation to insure a continuous wax film.

Two basic methods of applying the wax are in common use. One is by passing the carton under a shower of molten wax, and the other is by dipping the carton in to a wax bath. The shower method is generally more complicated, and has the disadvantage of aerating the wax, which is conducive to oxidation.

The dipping method, therefore, is most widely used, but the modifications of it are numerous. Two general means of dipping are employed. In the first, or "complete-dip" method, the entire package is submerged, removed, and allowed to drain and cool. In the second, or "partial-dip" method, only a portion of the package is coated with each immersion. After the first dipping and cooling the package is inverted and the uncoated portion is dipped. This immersion is so controlled that a slight overlap of the two coats is obtained.

FUTURE PACKAGING—The use of wax-treated paper and paperboard as packaging materials will probably continue during the coming years. Many advantages accrue from their use, including lighter weights and lower costs.

In addition, containers for shipping liquids are constructed of metal, wood, or glass, and frequently the container walls are subject to attack by their contents and require a protective coating. Lacquers have been used for this purpose, but microcrystalline waxes offer a less expensive and often more effective means of accomplishing the same result. Thus, metal packages can be adapted for the shipping of materials normally requiring less durable glass containers. Wooden containers can be water-proofed to prevent loss of moisture and to prevent deterioration. Glass and ceramics may be protected from etching. In some cases, such as in shipping hydrofluoric acid, the entire container may be of wax because microcrystalline waxes, composed of hydrocarbons, are chemically inert. Similarly, various metals may be wax coated to prevent attack by the elements.

Thus it may be seen that many factors are at work which will offer even greater opportunity for the waxes as packaging and protective materials. New products requiring new packaging methods, greater knowledge of the abilities of the waxes, wider public acceptance of light, easily-shipped, paper containers, and several years experience in packaging for the most adverse conditions all combine to indicate an ever-growing range of usefulness for wax.

DETERGENT OILS

May Cause Damage
In Outboard Boat Engines

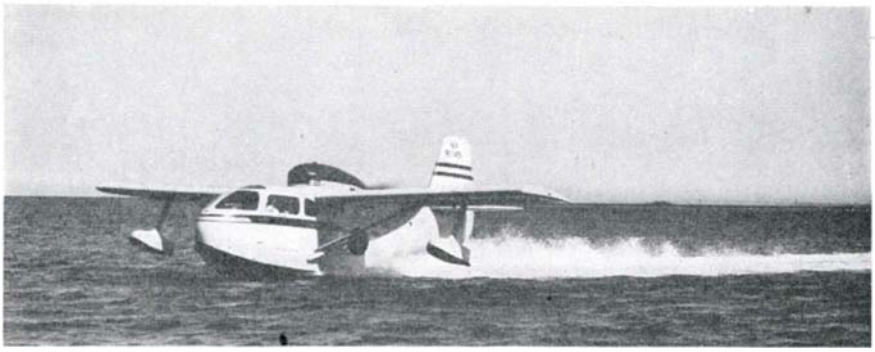
MODERN motor oils containing detergent agents and intended for four-stroke cycle automotive engines are reported by the Outboard Boating Club of America to be causing serious damage to the two-stroke cycle engines commonly used as outboard power. Apparently the difficulty stems from the direct introduction of the fuel-oil mixture into the engine combustion chamber. Here, it is said that the detergent additives form a heavy ash deposit on the piston head and within a short time the deposit engenders pre-ignition.

Once these conditions of excess ash and pre-ignition are established, the restructive effects seem to accumulate rapidly — ash working past the rings damages pistons and cylinder walls, lubrication is impaired, varnish coatings form on the rods and crankshaft, and eventually the engine "freezes" up.

These actions do not occur in automotive engines where the oil is retained in the crankcase and the detergents are allowed to function as intended.

The solution to the problem is, of course, the selection of an outboard-engine oil that is specifically made for that purpose.

Easy handling on water and rapid take-off (right) make Seabee an ideal plane for sportsmen as exemplified by duck hunters (below). Craft holds four men, guns, folding boat, and other equipment—fuel load is adequate for 560-mile trip



AVIATION

Pressed-Out Planes

Sounding a New Note in The Aviation Industry—Where High Costs are Legend—Is the Republic Seabee Amphibian. Capable of Carrying a Family-Sized Load in Automobile Comfort, This Land-or-Water Airplane Offers Much Utility and Good Performance at a Reasonable Cost

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

• LOOKING AHEAD •

In aviation and elsewhere will come wider adaptation of the "Seabee" formula. . . Simplified design plus pre-production market studies. . . Competition from other planes eventually but a substantial lead now. . . A heightened public standard measured in plane-for-money terms. . . Perhaps a greater appreciation of inherent amphibian advantages.

IN THE Seabee amphibian, a bold and successful attempt has been made to build a personal or family aircraft having wide popular appeal and utility. In doing so, Republic Aviation Corporation engineers solved many problems in structural design, metallurgy, and corrosion protection, and have developed mass-production methods on a limited-production scale. This effort, therefore, has immense interest not only for aviation, but for many other industries faced with analogous problems.

Prior to designing the craft, a definite goal was established. What was wanted was a family plane capable of carrying four persons comfortably at reasonable initial and operating cost. Enough speed was needed to realize the real value of flight without seeking to emulate a single-seater fighter. Equally important was a plane that could make use of small landing fields, and primary consideration was given to an amphibian because such an aircraft gives a greater range of utility than either a land plane or a seaplane.

The building of a craft having amphibian characteristics, however, meant that both the difficulties of a land plane and the headaches of a flying boat had to be conquered in spite of the fact that they had been multiplied by combination.

DESIGNED FOR UTILITY — The Seabee, as realized, satisfied all the basic requirements. The hull has good water lines and blends into a well-streamlined upper cabin enclosure. There is no break between the lines of the hull and the lines of the superstructure. The well-rounded bow and the sides of the cabin provide excellent vision through seven large Lucite windows. The engine is mounted above the wing with a pusher propeller so that spray does not touch the propeller blades. Power-plant noises and gas and oil fumes are behind the passengers and reduced to a minimum.

Little spray develops on takeoff and the hull provides pitching stability in the water. Also, to take care of lateral stability, streamlined auxiliary floats are mounted at the tips of the wings.

From the comfort standpoint, the cabin is 110 inches long, 46 inches wide, and 50 inches high—as roomy as most motor cars. Kapok cushions and water-proof washable upholstery are provided. Equipment includes two-way radio; ground adjustable propeller; electric starter; dual-wheel controls with a convenient single instrument panel between the two occupants of the front seats; fully-retractable landing gear and landing flaps, both hydraulically operated; and a fairly complete

instrument board with a ball-bank indicator.

The airplane's price—$3995—is important. It is possible to get nearly anything desired in the air, including flight speeds of 600 miles per hour, but only at a price. The problem is to give the public versatile and dependable flying at a reasonable figure. Economical civil aircraft design is far more difficult in some ways than military design where, provided the specification can be met, expense is a minor consideration.

Many buyers, though they may be satisfied with the initial price of an airplane, are somewhat concerned about the costs of operation. These costs will vary with the hours of use per year. Hence they must be estimated along certain general lines. Ordinarily, for example, to storage or hangar charges must be added 20 percent depreciation per year; for all-risk insurance the premium will be between 5 and 8 percent, with an added charge for public liability. Direct flight costs include 13.5 gallons of gas and a quart of oil per hour for the Seabee—far from negligible.

In addition there is an expense of $1.50 per hour for inspection, maintenance, and overhaul. On a basis of 500 hours of flying per year, the total cost works out to about $9.00 per hour. This sounds formidable, but actually amounts to only 9 cents per mile because the aircraft flies at 100 miles per hour. Thus, per person, the operating costs figure a little over two cents per mile.

METAL OR WOOD? — In planning the Seabee there was one big question to be answered by the designers —should the hull be of wood or metal? The same question is likely to be asked for other products such as canoes and boats; consequently the answer is of rather general interest.

A wooden hull, which really means a hull sheathed in plywood, is a far better product than it used to be because of improvements in adhesives. But plywood hulls still gather barnacles in sea water, and plywood hulls still absorb moisture. Moreover, wooden hulls are likely to splinter in a crash; are liable to disintegration after a few years service, and wood is not as uniform a material as engineers like to have. Finally, wood does not lend itself to rapid-production methods, because wood construction nearly always means the assembly of many small parts.

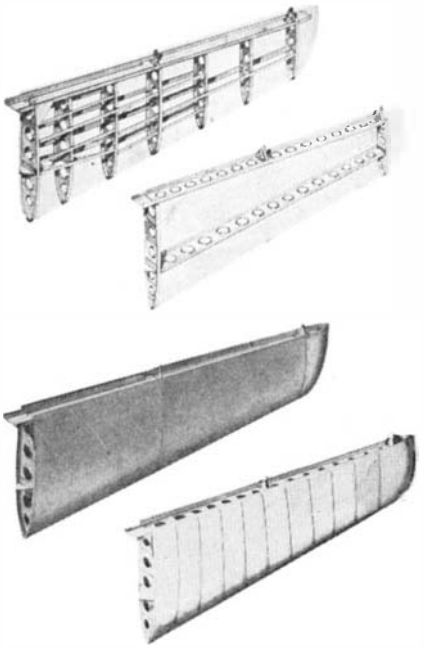
The capacity for aluminum manufacture has vastly increased since the war, its price is going down steadily, and strange as it may seem, a knowledge of aluminum repair is more widespread than a knowledge of plywood repair.

The question of hull corrosion, particularly when used in sea water, appears to have been answered by new alloys which serve for exterior protection. These alloys offer to the elements either a pure aluminum surface or one that has been oxidized, both of which are said to be better and stronger than the Alclad previously used.

If the aluminum alloy is anodized, then covered with zinc chromate and painted, it becomes impervious to seawater. Also, the relatively expensive anodizing treatment may be replaced by a lacquer process which is less costly.

Aside from the actual materials used, other precautions were observed; these included elimination of areas that collect moist dirt and provision of drain holes.

COST REDUCTION — When the aerodynamic, hydrodynamic, corrosion, and general-design problems had been solved, there still remained the great problem of cost reduction in the air frame. In describing planes, manufacturers are apt to stress the great amount of work that has to be done and the many thousands of rivets that have to be put into place. Rivets, however, cost money. Thus the dilemma evolves—costs are high, therefore sales are limited; when sales are limited, costs go still higher.

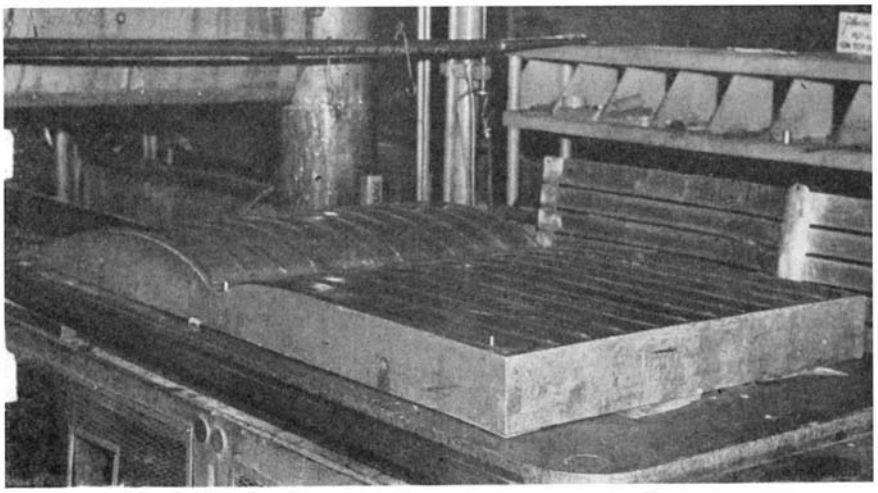


Simplified design is key to Seabee's low cost and production plans. Early, multi-spar tail surface (top) evolved to ribless, two-spar unit. Outer skin was thickened; chord-wise stiffening channels (bottom) are die-pressed in

To meet this problem, as it involved the Seabee, it was decided to build 5000 planes in 1946, with a production of 40 machines a day in August. Next, to reduce costs, the Republic Aviation engineers broke with tradition and adopted new methods of design. From 1800 parts in the conventional air frame the new design was reduced to 450 parts. About 2500 man hours per plane were cut to 200 man hours. Tooling costs were shrunk from an estimated $1,750,000 to $400,000.

Most of these reductions stemmed from a new concept of design in which the aluminum skin was thickened and many interior bulkheads and longerons were eliminated. In a conventional stabilizer structure, for example, a multitude of ribs, spars, and stringers are used. In the simplified structure, thickening and beading the outer skin allows simpler construction, requires fewer parts, and obtains a lighter or at least no heavier unit at much lower cost.

PRODUCED ON PRESSES—The concept of a thickened skin, however, was not sufficient. An equally important step was to follow automobile



Camel back, Kirksite die forms skin contours, pressed-in stiffening sections

practice and stamp out huge skin sheets, larger sheets perhaps than ever before stamped out in the aviation industry.

At first, temporary tools were used to press the wing skins and hull sides of the Seabee. For the wing, the die is a camel-back type made of Kirksite, which together with a slotted steel matt gives sharp bead impressions. After the die pressing on a 5000-ton hydraulic press with a rubber pad, the skin is folded at the leading edge to remove the camel back. Thus in two production operations, the wing skin is complete with contour, strength, and rigidity. Similar methods are used for the hull.

In the permanent production setup, male and female steel dies are used on a double-action mechanical press—the hydraulic cycle being too slow—to turn out over 300 skins per hour of aluminum alloy clad externally with pure aluminum. Similar forming tools are used to manufacture the ailerons, flaps, stabilizers, and so on.

From a sales viewpoint, the Seabee apparently has been almost universally well received. There was a total of $700,000 in sales in nine days during a recent aviation show. Doctors, lawyers, radio artists, business men, and resort and fixed-base operators were among the purchasers.

It seems possible, therefore, that this plane is an overture to a wider realization of the value of limited-mass-production thinking in aviation as well as other industries.

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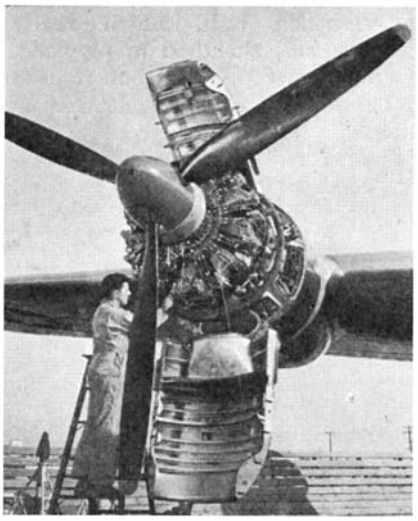
CONSTELLATION COWLING

Opens Like Automobile Hood; Reduces Ground Time

TWO FEATURES must be present in any airplane designed to maintain high-speed schedules. One, of course, is the ability to fly fast; the other is a design that allows ground servicing to be accomplished in a minimum of time. To achieve the latter, a new cowling arrangement on the Lockheed Constellation allows immediate access to all vital areas of the four 2500-horsepower engines. The cowling, which opens in a manner similar to an automobile hood, makes possible a substantial reduction in ground time.

Standard type cowls usually require about 15 minutes for removal, but it is reported that the new four-panel, hinged type may be opened in about two minutes. Quick-opening, flush-type latches secure the



Maximum accessibility for service in minimum time marks new cowling design

panels which are hinged to the main structures of the engine nacelles. When open, there are no support members to interfere with vision or tools.

LONG-RANGE PLANE

Has Cargo Handling Equipment Built-In

THE GLOBEMASTER, aptly named Army version of the new Douglas DC-7, is a four engine transport with a specified maximum range of 7800 miles. A clean lined, low-wing design with tricycle landing gear, a 173 foot wing-span, and a gross-weight of 155,000 pounds, the plane is powered with 3650-horsepower Wasp "Major" engines. Equipped with reversible propellers—either three-blade Hamilton Standards or the four-blade Curtiss models—landing runs as well as tire and brake wear are appreciably reduced and the plane may even be backed into a hangar under its own power. Six fuel tanks, integral with the wing, carry enough fuel at full-range loading to drive a passenger automobile 165,000 miles.

Some of the Globemaster's features, representing the recent advances in aeronautical design, are: de-icing through the application of heat; laminar-flow wings; full-span flaps; and internal wing walkways to permit flight servicing of the powerplants. Cargo handling problems have been given careful attention and a built-in freight elevator and traveling cranes will facilitate handling large or heavy shipments.

UTILITY GLIDER

Is Delivered on "Freight in Tow" Basis

GLIDER manufacturers, encouraged by the war-time success of towed gliders, are hoping to expand the peace-time market for this type of aircraft. Thus, Schweizer Manufacturing is planning nation-wide distribution of its SGU-19 utility glider—a glider of rugged, dependable construction suitable for training, school use, and general purposes.

The SGU-19, while offered in kit form with explicit assembly instructions, is more frequently sold factory assembled. A novel delivery method is being tried in which the glider is flown to the purchaser by towing it behind a small, 65-horsepower tow plane.

It is reported that the SGU-19 has, on occasion, soared to altitudes of more than 5000 feet and has—although only a utility glider—remained aloft for five hours at a time. The 320-pound glider has a gross weight of 550 pounds and a wing span of over 36 feet.

Heavy cargo is easily loaded (above) by plane's self-contained hoist. Full view of Globemaster (below) indicates large capacity of 155,000-pound craft

Paint For Production

Industrial Buildings and Machinery, Painted in Carefully Chosen and Matched Colors, are Something More than Decorative. Tangible Boosts in Production, Safety Records, and Employee Morale are Usual Results; Bonuses are Cleaner Plants, Lower Upkeep Costs, Better Housekeeping

By J. A. MEACHAM
The Sherwin-Williams Company

A STRONG trend toward informed use of color in industrial plants and offices is now underway. Industry is firmly convinced that through properly selected colors, seeing conditions can be improved, and production output increased accordingly. There is an awareness also of the collateral advantages of improved morale, increased safety, and better housekeeping in the plant.

Actually, the idea of using color in factories is by no means new. Magazine articles published nearly a decade ago promoted the very ideas now being so universally accepted. For example, an article published in *National Safety News* in 1937 read in part:

"Today colors of high reflectivity other than white are being used in modern maintenance work because they not only diffuse light but promote a stimulating atmosphere for the employees. Color pleases people, and its effect on workers in a plant is no less than that which influences shoppers in a store to buy merchandise that is attractively colored. There is a growing record of improved morale and employee good will in plants where color has been used.

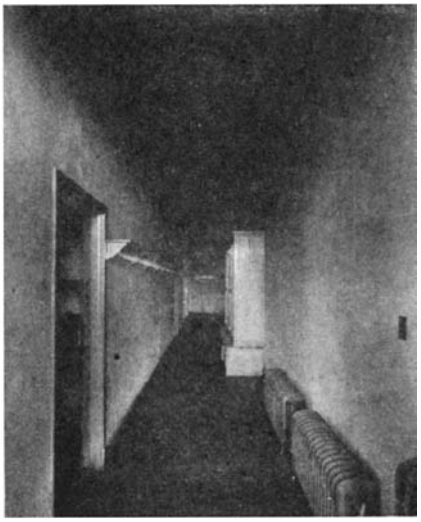
"Machines in light colors are kept cleaner. It has become a growing practice to paint machines and equipment in soft pastel shades that ease the workers' effort to see and reduce eye strain even though the eyes are focused on operations for long periods of time."

Although much progress has been made in the use of industrial color since the foregoing lines were written, they are just as pertinent today and actually represent the foundation on which the color story rests.

INCREASED PRODUCTION — The primary consideration in using color in industry is, of course, increased production. Properly selected colors give better seeing conditions by reducing glare from wall and ceiling surfaces. Lighter colors on the machines themselves give better balance between the brightness of the work and its surroundings. This is essential for sustained critical vision.

Long study of the psychological factors involved has demonstrated that when the brightness of the task is five times that of the surroundings the ability to see is reduced to 77 percent of normal; and conversely where the surroundings are five times brighter than the task vision is reduced to 44 percent. The optimum condition occurs when both the task and the surroundings are of approximately equal brightness, a balance which can be obtained through the wise choice of color. At one southern plant that makes pipe fittings, a time study showed that workers output began to fall off about 10:30 in the morning and 3:30 in the afternoon. After the plant had been refinished in color, production did not begin to slump until 11:00 A.M. and 4:00 P.M.

MORALE — Of almost equal importance is the function of color as a morale builder. The factory worker spends most of his waking hours



Contrast of light values in hallway prior to painting (left) and after a coat of well-chosen paint (right) is a typical result of functional color

• LOOKING AHEAD •

Dark, dingy factories are going out. . . . Employees will expect and demand pleasant, colorful, working atmospheres. . . Plant streamlining forces careful planning; will increase storing and handling efficiency. . . Better lighting must accompany color-conscious painting. . . All factors will improve safety, save money above painting costs.

at his shop. He is entitled to a reasonably pleasant and attractive atmosphere at his place of work. It has been amply demonstrated that employees respond to an occasional change in work or environment. This may take the form of an increase in wage, a new operation to perform, or work in a new department. Repainting walls, ceiling, and machines is one way of supplying this boost in morale.

Exemplifying this factor is a concern with a number of plants in various cities. In one of these cities there were two other companies engaged in the same type of production, all competing for a limited supply of labor. The two competitive concerns were in brand new plants whereas the first company occupied a building designed to meet the requirements of a previous period when employee welfare was not a prime consideration. All these firms paid the same hourly rates, yet the firm with the older building was unable to hold its labor supply. The solution was the creation of an attractive atmosphere in this plant through the use of paint.

NEAT AND SAFE — From the practical angle, experience shows that workers keep a plant cleaner when attractive colors are used on machines, walls, and ceilings. The worker is proud of the improved appearance of his surroundings, and tries to keep them so. Actually, maintenance costs are lowered rather than increased. The factory manager of one manufacturing concern said, after his plant was painted recently: "For the first time in my life I saw a man walk 20 feet to throw a piece of waste cloth in a bin. Individual workers do more of the cleaning in their spare moments. I have watched a lathe operator wipe off his machine with a piece of waste cloth while watching the cut." When machines are painted in a dull, unattractive gray amid bleak surroundings, there is no incentive to individual housekeeping of this type.

Not the least of the advantages of color is its contribution to safety. One plant reported a decrease of 40 percent in personal injuries after a modern color job was done. Simply through the improvement in illumination, color makes a safer plant. Westinghouse engineers say that their philosophy is to make "every hazard visible." When dangerous parts are identified with attention-compelling colors, when aisle ways are outlined with zone marking lines, when dark passageways and areas are brightened up with light reflecting colors, the safety index of the plant rises noticeably.

COLOR USAGE—Before taking up some of the more recent developments in industrial color harmony a few fundamentals should be reviewed upon which industrial color usage is based. The colors of the spectrum of white light are familiar to all. From deep violet they shift imperceptibly, wavelength by wavelength, to deep red. Essentially, however, industrial painting does not deal with the pure colors of the spectrum, but with softened or grayed tints vastly different in appearance and effect. Only for accent and to demand attention is pure color resorted to, and then in small areas only. This fact, of course, is not new. Not only in the paintings of old masters, but also in the architecture of the past, this knowledge of the proper use of soft color tints is evidenced.

Color is a sensation rather than a property of matter, and perception of the same color may be quite different under different conditions. For example, a piece of blue paper against a black background appears to be quite another shade when seen against a green background. Gray circles, all identical, appear vastly different in brightness when seen first against a dark background, and then against a light background.

In like manner color effects the perception of other properties, notably size. A white circle appears larger than a black one of the same diameter. A gray circle appears midway in size between the white and the black. Some colors cause objects to stand out. These are called "advancing colors." Other colors push objects into the background. These are termed "receding colors."

Some colors give the effect of warmth. Yellow, peach, and red are examples. Other colors, such as blue and green are associated with the out-of-doors, and are known as cool colors.

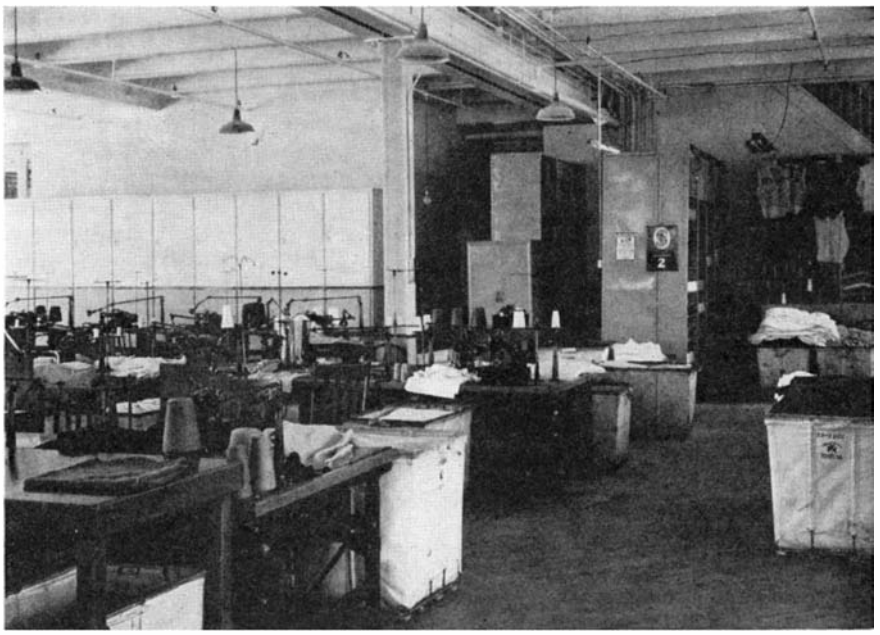
Then there are psychological factors. For example, red is known as the most powerful color of the spectrum. It is associated with strength, action, and has a tremendous influence on human moods. Yellow is gay and cheerful. Green is cool and refreshing, but neither exciting nor subduing. It is probably the most liked of all colors.

COLOR FOR INDUSTRY — The heart of the color idea for industry is the color selected for the machine. The choice is fairly wide and in general is not confined to a single color. The machine's color should have a fairly high light-reflection value to build up the brightness of the immediate surroundings to approximately that of the task itself. Machinery should have a semi-gloss finish which, while practical in every sense, reduces highlights and glare to a minimum.

In some operations the task is performed to best advantage when the tool or piece of work is silhouet-

Unpleasant working conditions—laboratory before painting

Light and cheerful—same laboratory in harmonious colors



Neutral background for colored yarns, good lighting for inspection needs; this knitting mill uses white ceiling, ivory walls, silver-gray dado, red striping

ted against a light background. A silhouette color is also effective as a reflecting background to bring up the brightness of the immediate surroundings to correspond to that of the work. Reflecting areas which will throw a uniform light on vernier surfaces and working lines should also be painted with the silhouette color. In some cases a two-tone effect is desirable, in which case a lighter shade of the machine enamel itself is used.

The accent color is a small area of pure color appropriately harmonious with the machine enamel. It serves a dual purpose — to indicate points of danger, operating levers, and buttons; and as a decorative feature by adding the interest value of a small area of bright color.

ROOM COLORS—In large plants it is not always practicable to select a single color scheme which will meet all conditions throughout the plant. On the other hand an abrupt change in color from one department to another is equally objectionable. The use of related colors for adjoining rooms provides an excellent solution for this problem.

Experience proves that there are three essential steps to doing a first-class color job in an industrial plant. First, equipment must be arranged in an orderly manner and miscellaneous items such as stock piles, lockers, and switchboards must be removed and put into separate buildings wherever possible. Anything that tends to clutter up the plant and give the impression of disorder must be carefully rearranged.

The second step is to provide proper illumination. It is impossible to make a good-looking plant without correct arrangement of the interior; neither can an efficient plant be made without proper lighting. Painting in the right colors is important to good light, but no amount of painting can overcome the handicap imposed by glaring lamps directly in the operator's field of view, or in sufficient light at the working level.

The third step is the selection of an appropriate color scheme. Here, careful consideration of all of the foregoing principles comes into play. On an extensive job, technical advice from specialists in the color field is generally helpful and leads to a better appearing plant in the end.

Planned painting is not new on the industrial scene, but the next several years promise a much wider use of this production-boosting, morale-building, and economical technique.

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ATOMIC POWER PLANT

Now Designed for Experimental Uses

THE FIRST atomic pile specifically planned to produce power, has been designed at the Metallurgical Laboratory of the University of Chicago, and is now in the blue-print stage. Unlike the piles—atomic reactors—used in the production of the atomic bomb, the experimental power plant pile will be operated at a high temperature.

According to Dr. Farrington Daniels, director of the laboratory, "the low temperature at which piles have been operated in the production of the fissionable material used in the bomb is not efficient when heat for power is the aim." No insoluble problems of control or safety are involved in operating the pile at a high, rather than a low temperature, explains Dr. Daniels, but he points out that the power plant should be viewed as experimental—a pilot plant from which knowledge will be derived for subsequent development and exploratory work. On this basis new developments may bring the cost of atomic power down to a point where it can supplement coal and water power, but since the cost of fuel, in this country, is only about one fifth of the total cost of generating electricity, no great reduction in cost could be expected even if atomic power should become cheaper than coal.

Dr. Daniels predicts: "It is for outlying regions where transportation is difficult and for locations where neither coal nor water power is easily available that atomic power plants will probably find their first use."

ARTIFICIAL LIMBS

Offer Challenge to Ingenious Inventors

A PLEA to American inventors and mechanical engineers to develop better artificial limbs was issued recently by Dr. Paul E. Klopsteg, Chairman of the Committee on Prosthetic Devices, through the facilities of the National Inventors Council, Department of Commerce. Stressing the urgent needs of 17,000 war amputees and an estimated annual minimum of 25,000 civilian amputees, Dr. Klopsteg urged inventors and engineers to submit ideas and suggestions for better prosthetic devices for analysis and screening.

Acknowledging the ingenuity of American manufacturers in making artificial limbs, Dr. Klopsteg pointed out a number of pressing problems as still requiring solution. Needed to solve some of these problems are improved ankle, knee, hand, wrist, and elbow joint mechanisms; materials lighter than those now being used in artificial limbs, but with sufficient strength; new fabrication methods; and further fundamental study of the mechanics of human motion. Also improved fitting procedures are needed, as are techniques for describing and teaching these procedures.

The Committee on Prosthetic Devices was set up in April. 1945, under the sponsorship of the National Research Council of the Office of

Scientific and Research Development. It is now supported jointly by the Army and the Veterans Administration. Consisting of three orthopedic surgeons and three engineers, the Committee initiates, supervises, and lends financial support to research institutes and laboratories willing to undertake special research problems for improving prosthetic devices.

Members of the Committee have prepared a report especially for engineers and inventors, summarizing its work over the past year and analyzing problems as yet unsolved. A mimeographed copy of the report will be mailed free of charge upon request to the National Inventors Council.

MICROBE TRAP

Samples Purity of Room Air With Static Electricity

DEVELOPED as an aid to effective war against disease-spreading airborne micro-organisms, a portable electrical air sampler is described as capable of revealing a reasonably accurate "count" of invisible microbes in the air at various times. The new device, about the size of a shoe box and weighing but 12 pounds, is called the Duplex Electrostatic Air-sampler.

The unit has two important uses. One is in computing the amounts of germicidal-lamp energy needed to keep airborne bacteria reduced to a minimum for human safety; the other is in checking the effectiveness of germicidal-lamp installations. Equipped with an electrically driven blower, the General Electric air sampler "inhales" air at the rate of half a cubic foot per minute. Static electricity is used to attract the germ-laden particles out of the air stream.

The attracted air particles are intercepted by Petri dishes coated with a nutrient jelly. The bacteria captured on the Petri dishes are then incubated for about 40 hours at a temperature most favorable to their growth. Quantitative and qualitative bacterial counts are made from the germ colonies which appear, by the end of the incubation period, on the nutrient jelly.

Put to use in a cafeteria, the sampler revealed that the average number of organisms per cubic foot of air during the lunch period was 27. The maximum number varied from 44 to 88 per cubic foot of air. After the cafeteria had been emptied of its people, the bacteria count dropped down to 15.

As regards the effectiveness of germicidal lamps, tests made in a germ infected poultry-house showed that a system of germicidal lamps reduced the number of airborne bacteria more than 75 percent after as little as an hour's treatment of the air. These tests, according to the designers of the sampler, are now being extended to include germicidal-lamp installations in the human field.

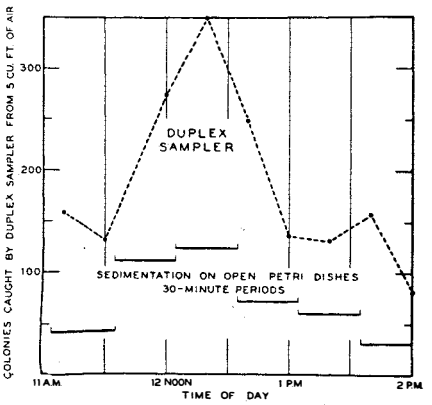
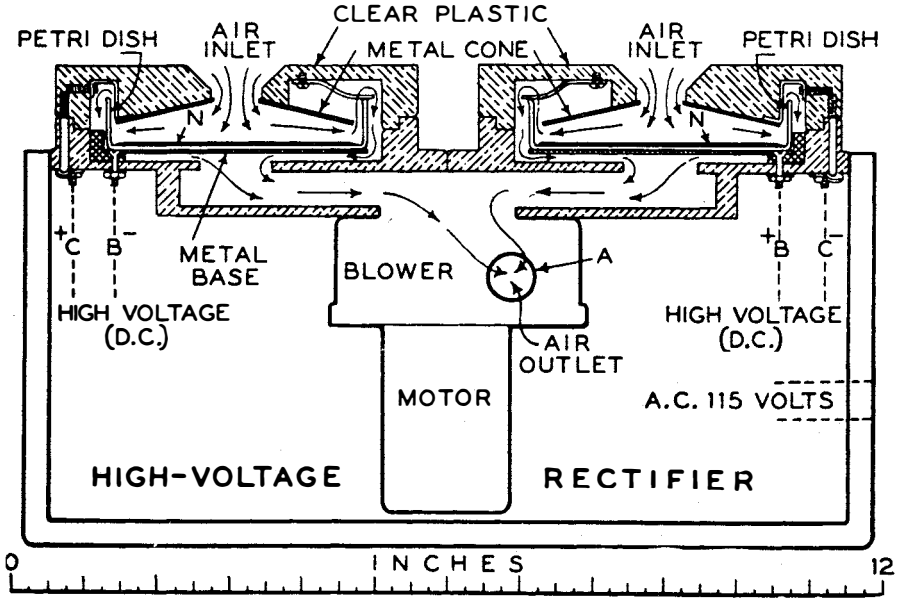


Chart (above) shows concentrations of airborne organisms present in eating area before, during, and after period of high occupancy. Section through an air sampler (below) shows Petri dishes and electrostatic attracting charges



THERMISTORS

Detect Temperature Variations of One-Millionth of a Degree

EYES that see the warmth of a man's body in the dark a quarter of a mile away, that locate ships at night, and the chimneys of factories by their heat radiation were recently demonstrated as potentially valuable to industry. These devices, a product of Bell Telephone Laboratories, are built around tiny elements called thermistors, substances which have such unusual electrical sensitivity to heat that they can detect temperature variations as small as one-millionth of a degree, Centigrade.

Developed originally for use in telephone networks and mass-produced by Western Electric Company, thermistors are reported to hold promise of increasing the precision of temperature measurements tenfold.

Thermistors stem from a group of materials known as semi-conductors which are interesting because their electrical reaction to temperature is the reverse of that in normal conductors. When semi-conductors are cold, their resistance is high; as their temperature increases, their resistance drops rapidly, an unusual behavior.

As an example of the utility of these materials it is pointed out that standard precision thermometers, which use the resistance of a platinum wire as a temperature scale, are accurate only to a hundredth of a degree. With apparatus no more elaborate, however, thermistors can gage variations of five ten-thousandths of a degree.

A proposed large-scale adaptation of thermistors for war purposes was based to some extent on the idea underlying instruments known as "bolometers" — very sensitive heat-detecting devices which astronomers have used for some years to measure the heat radiated by distant stars. With the new heat-sensitivity provided by thermistors, it seemed possible that bolometers could be devised to detect the lesser heat radiated by such non-incandescent objects as men, vehicles, ships, and factory chimneys and provide observable indications of the heat.

Several equipments of this type were successfully tested before the war ended. The basic principle was that heat rays behave in much the same way as light rays; hence they might be collected in a parabolic reflector which could be pointed at

specific objects in the same manner as the reflector of an astronomical telescope. This reflector focussed the "black light" radiation of the object on the tiny thermistor element, which was connected with an amplifier to signal any change in the heat it received.

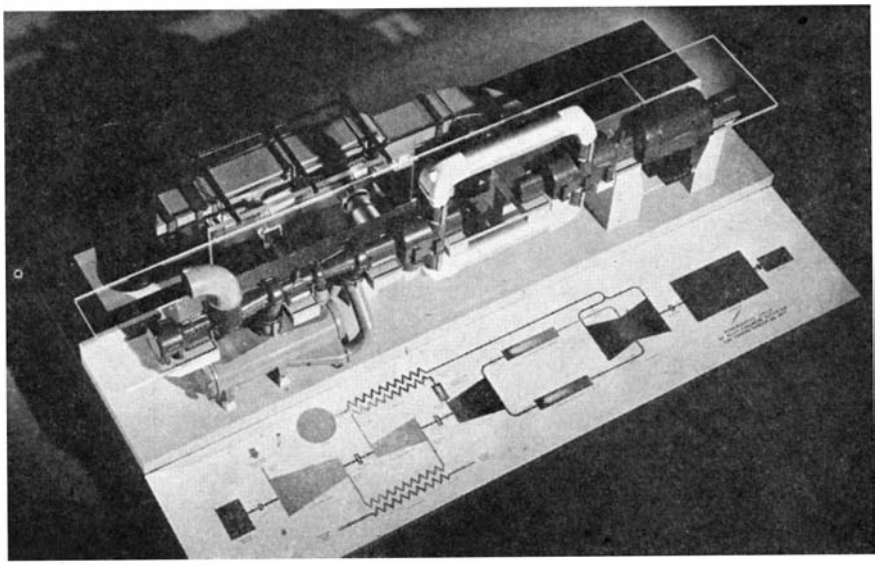
Evidencing the sensitivity of thermistors is the fact that where copper will double its resistance with a temperature rise of 300 degrees, these semi-conductors can halve their resistance with an increase of only 20 degrees. Used as automatic gain controls for long-distance amplifiers, there is at least one thermistor in most amplifiers in the nation's carrier cable network. The scope of this task is indicated by the fact that the power transmitted by a length of overhead cable between two amplifiers may vary in a magnitude as high as ten to one with the seasonal variation in cable temperature. Over a long cross-country cable this variation, if unregulated, could pile up to an almost incomprehensible factor, roughly represented by figure one, followed by 180 zeros. Thermistors restrict this immense potential change to a variation so small that it is virtually undetectable by the human ear.

Thermistor-type bolometer can detect man's body heat at quarter-mile range

A speck of semi-conductor, sealed in a glass bead little larger than a pinhead, does this job and replaces a complicated maze of equipment. In operation, the thermistor material is tapped into the amplifier output so that if the power increases, the thermistor heats up. As it heats, it passes more and more current through itself into an electronic valve which cuts down amplification. On the other hand, when amplifier output decreases below the proper level, the thermistor cools, cutting down the signal to the valve and thereby increasing amplification.

Thermistors are described as having a wide variety of additional uses in and out of telephony. They can be balanced with resistors in voltage regulators to supply a constant output from a varying source or under varying temperature conditions.

Another example is their use as time-delay elements. This is based on the time it takes for them to heat up enough to pass the large and sudden surges of current sometimes fed to them. By varying the design of the particular thermistor and the circuit application, the time delay may be set anywhere from one ten-thousandth of a second to more than ten minutes.



Scale model of gas-turbine power plant—actual unit will have high efficiency

GAS-TURBINE GENERATOR

Proposed as Commercial Unit in 10,000 Kilowatt Size

BELIEVED to be the first commercial-design gas turbine actually proposed for power generation in the utility field, a new 10,000-kilowatt unit is now being studied in model form. Described as a high-temperature, high-efficiency version of this recently developed type of prime mover, the gas-turbine-driven power generating unit is designed for operation at 1300 degrees, Fahrenheit, and will have an efficiency of about 31 percent, according to the Allis-Chalmers steam turbine department.

At the same time the company has proposed another 10,000-kilowatt unit to operate at 1000 degrees, Fahrenheit, with the same guarantees as offered with comparable steam-turbine units—15 to 20 percent efficiency. It is believed that such a unit will have an application in the power-generation field.

Modeled for study on a scale of one half inch to a foot, the high-efficiency unit will occupy an actual area of about 4500 square feet.

An advantage pointed out for the gas turbine in certain power-generation applications is its ability to operate without the great quantities of cooling water needed for steam plants. Standby uses are also said to appear promising.

DDT CONCENTRATE

Has High Potency and Safety As Well as Long Life

KNOWN as Pestroy, a new DDT concentrate is designed to provide farmers, stores, hotels, factories, public carriers, restaurants, hospitals, cities, and other commercial users with an economical, safe, and easy-to-use insecticide with high residual value.

Pestroy, developed by The Sherwin-Williams Company, is a 25 percent DDT concentrate. It is diluted with water to make a powerful repellent and insecticide which can be sprayed or brushed on any type of surface to destroy flies, mosquitoes, moths, gnats, fleas, roaches, bedbugs, silverfish, wasps, crickets, ants, and other common insect pests. A one-gallon can of Pestroy, diluted with four gallons of water to make a 5 percent solution of insecticide, will effectively cover 4800 square feet of surface. On interior surfaces, the residual deposit left by Pestroy will remain effective for from two to three months. A 5 percent solution of Pestroy will protect outside surfaces such as screens and doorways for from two to three weeks under average weather conditions.

Pestroy is odorless and stainless. When properly diluted with water it is fireproof. Continual freezing and thawing has no effect upon its effectiveness. While reasonable care must be taken to protect humans, household pets, and foodstuffs from repeated or prolonged contact with Pestroy, it can be safely handled without special protection and can do no damage to fabrics, wood, paint,

wiring, metals, or other materials. Pestroy can be mixed with kerosene instead of water, in the same proportions, for use on fabrics, carpets, upholstery, and other delicate materials where a water spray might not be suitable.

"COLD" TREATMENTS

Speed Car Production, Improve Metal Characteristics

ASSEMBLY-LINE use of mechanical refrigeration is one of the new industrial techniques which is helping to speed production of new passenger automobiles. Installed on the engine production line, mechanical refrigeration equipment is being used to shrink steel valve inserts by chilling for permanent fitting into cylinder blocks, according to the Refrigeration Equipment Manufacturers Association.

By chilling at a temperature of 120 degrees below zero, the inserts are shrunk two thousandths of an inch and are then automatically ejected for fitting into the cylinder blocks. At room temperatures, the inserts expand to normal size and become a permanent part of the block. Through use of this method it is possible to install the valve inserts at the rate of 360 per hour without interruption of the assembly line, it is reported.

Other industrial uses of refrigeration include "cold" treatments to increase the strength and ductility of auto body metal, and to lengthen the lives of high-speed drills, hack saws, and other cutting tools.

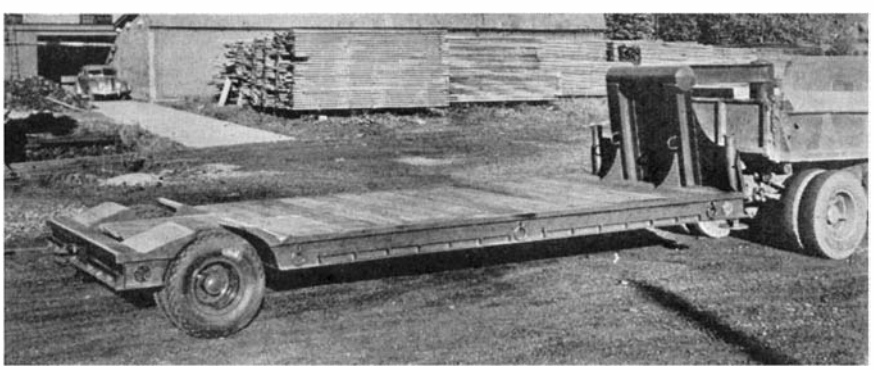
DUMP-TRUCK TRAILER

Meets Contractors' Needs, Eliminates Tractor Unit

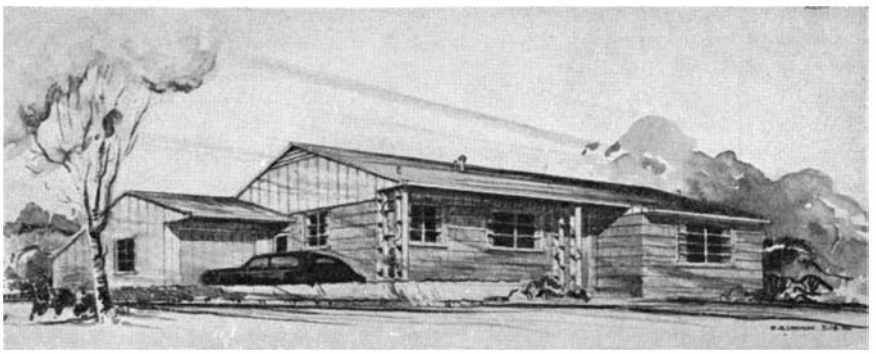
AN IDEA in trailer design that promises to be extremely useful to contractors, particularly those whose automotive equipment consists only of dump trucks, has recently been reported by The Lincoln Electric Company. The heavy-duty trailer has a "fifth wheel" built as an integral part of the design, arranged so that it can be mounted easily in the bed of any standard dump-truck body. The arrangement not only eliminates the need for a tractor to haul the trailer, but also permits maximum maneuverability of the outfit as compared with the conventional, front-wheel type trailers.

The trailer platform has a deck height of 29 inches and is eight feet in width. Ground clearance is 20 inches, and the flooring is of air-dried oak.

The unit, designed and built by Mead Machine and Iron Works, has a capacity of 11 tons, is 30 feet long, and weighs 7745 pounds.



Welded trailer mounts conveniently on fifth wheel resting inside dump truck box



Four miles of wire, over 200 thermocouples will check heating in "typical" house

HOME-HEATING TESTS

Will Be Conducted in Typical, Family-Size House

A ONE-STORY, 5½-room, modern home was built recently by the University of Illinois for the purpose of studying warm-air heating. This will be a co-operative project of the University and the National Warm Air Heating and Air Conditioning Association, which in 1924 in a similar project with the University built the world's first house constructed expressly for the home-heating research.

Study under actual home conditions in this earlier house is credited with providing the fundamental information upon which almost all modern warm-air home heating is based, and also many facts important to any type of home heating. This house has been used for research for 22 years, but it is an 11-room, 2½-story house, much larger than the typical American home of today.

The new house will be typical in size of those being built now. It will benefit from the research findings and techniques developed in the older house, and promises to open the way for even better heating in homes of tomorrow. Like the older house, the new one will be completely furnished and will be occupied, to provide tests under actual home conditions. To obtain heating data, four miles of wires will be built into the house, connecting more than 200 thermocouples with a central switchboard for determining temperatures at many points in the rooms, in and on the heating plant, and inside the walls and other parts of the structure itself.

The first heating plant to be studied will be a conventional forced-air system whose main trunk duct will, instead of diminishing in size with distance from the furnace as in ordinary construction, be the same size throughout its length. If this proves successful, such construction can mean appreciable savings in labor costs for every forced-air heating installation made in the future.

Robert W. Roose, special research assistant at the University, who will be in charge of the new house, advises that the objectives for research include improvement of heating-plant operation and reduction of costs; study of air-transmitting duct layouts, heating-plant layouts, and heat distribution under controlled heat input; study of a house with a full basement compared with one having only crawl space under the floor; study of summer, home air conditioning; and study of new materials and ideas. As an example of the last, it was noted that the chimney of the house will be of a new type, made of molded asbestos instead of brick and mortar. Also another identical house without a basement but with the floor resting directly on the ground may be built later.

The basement of the house now being built will be arranged so that it can be separated from the rest of the house, and the heating plant put

into the utility room for studies of homes having no basements but with space under the floor.

Other features of the experimental house will be floors built with steel joists so that floor panel heating can be tried and walls built with panels instead of plaster, so ducts and equipment can be changed easily.

PLASTICS WINDSHIELDS

Called Less Satisfactory than Safety Glass

EXPERIMENTS indicating that plastics currently are unsuited for automobile windshields were reported at a recent meeting of the Society of Automotive Engineers. Transparent plastics, it was explained, are difficult to clean, attract dust and road scum, resist wiper action during rainstorms, hold ice and snow, and quickly show a tendency to rattle.

As a result of various tests, it was claimed that even after three or four years of normal service in an automobile, safety glass windshields are superior to present transparent plastics after a few weeks' service.

LOCOMOTIVE BOILERS

Now Welded to Stop Leakage, Reduce Maintenance

FOR THE first time in American railroad history welded locomotive boilers are now being built. Nine years of experimental operation of a welded boiler built by American Locomotive Company in 1937 for a Consolidated-type freight locomotive of the Delaware and Hudson Railroad preceded the start of regular production. It is reported that the experimental boiler has been completely free of leaks during this period and all of the welded seams are still in excellent condition.

One important step in the manufacture of the boilers is the use of X-ray apparatus which greatly speeds up detection of flaws in metal. After passing X-ray examination, the boiler is stress-relieved in a furnace large enough to take the boiler as a unit. It is expected that the use of welded locomotive boilers will materially reduce boiler maintenance costs in railroad shops and will also reduce the time that locomotives are out of service for boiler repairs.

In discussing the earlier experiments with this construction The American Locomotive Company pointed out that before the first boiler was installed for road service in 1937, it was set up as a stationary boiler and operated for six weeks. Later it was mounted on a locomotive and examined every three months for the first year. All the welded seams were carefully gone over and the second year the same procedure was followed every six months. Subsequently the boiler was examined once a year.

Several other advantages are claimed for welded boilers; these include the elimination of riveted joints which sometimes permit seepage between boiler plates even when the most careful fabricating techniques are employed. Boiler leaks are eliminated by welded boilers thus removing the possibility of cracked sheets which can be a major maintenance expense. In addition, the smooth contour of the welded boiler permits an easier application of the boiler lagging and jacket and provides an equally smooth surface on the interior. This contributes to more satisfactory wash-outs by maintenance crews.

On many modern locomotives, it was noted, the saving of weight in the welded design over the riveted one is an important item. Depending upon the type and size of the locomotive, this weight saving may be from 3000 to 6000 pounds for the boiler alone, with additional saving in weight of lagging and jacket.

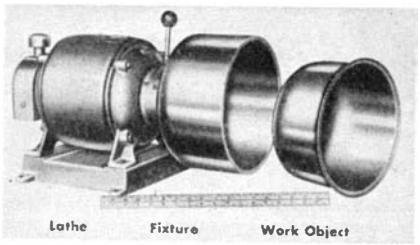
It is expected that a considerable number of welded boilers will be built for American railroads in the next few years.

New Products and Processes

SPEED LATHE

Retains Work by Action of Built-In Vacuum Pump

A NEW model, heavy-duty, vacuum-grip speed lathe, introducing a built-in wet vacuum pump which holds work pieces without chuck or collet, has recently been announced. Without the use of piping or glands, the pump generates its own vacuum that holds the work securely when the lathe is in motion, releases the work instantly when the machine is stopped.



Single lever controls both brake and switch; stopping lathe releases work

Starting and instant stopping of the spindle are accomplished through a mechanical brake and switch that is controlled by a single lever.

The vacuum seal is created by drawing oil from a large reservoir into the pump early in the vacuum cycle. The oil is separated from the exhaust air on the discharge cycle and being recirculated requires only occasional replenishment.

Adaptable to both small or large work pieces, the Crozier Vacuum Grip Lathe holds metal, plastics, rubber, wood, or glass. A few of its uses include lens grinding, utensil polishing, utensil sunraying, disk valve grinding, trimming rubber products, removing flash from plastics products, machining copper disks, and polishing of ash trays and novelties. Motors are two or three phase, 220, 440 or 550 volts, 50 or 60 cycles, with several speed combinations available.

INSULATING WINDOW

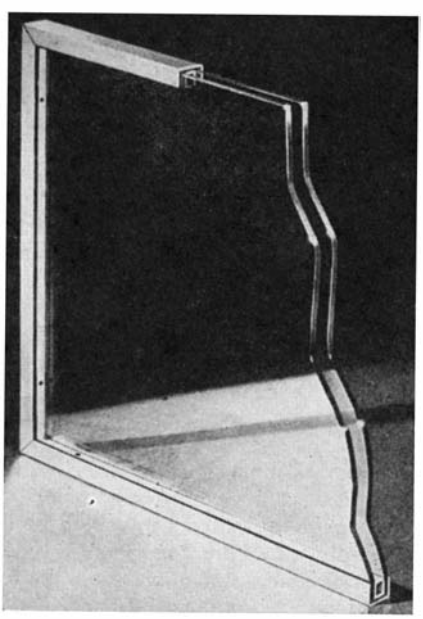
Multi-Glazed with Sealed Inter-Pane Space

A NEW, double-glazed window-insulating unit for industrial, home, business, commercial, and special use, has been named "Twindow" and consists of integral insulating units of two or more plates of glass enclosing a quarter-inch or half-inch hermetically-sealed air space. One of the features of Twindow is use of hollow aluminum tubing to separate and hold the glass plates in position.

The entire unit is framed with a light-gage, stainless-steel channel with the channel legs extending three-eights of an inch inward on the surface of the glass from the base around its periphery to give maximum protection during installation and use. It is reported that the arrangement is an efficient thermal and dust insulation unit, and that it virtually prevents condensation. This, in turn, permits use of larger windows in offices, stores, and homes and at the same time appreciably reduces heating and air-conditioning costs.

The hermetically-sealed, dead air in the space between the plates of glass is held at atmospheric pressure. It is dehydrated initially by means of a drying agent within the aluminum spacer tubing which has access to the air space. The drying agent remains in the unit and provides added insurance against vapor diffusion and helps considerably in meeting more than normal atmospheric changes.

Clear, polished plate glass is used in construction of the standard Twindow unit. In addition, however, the units can be fabricated with special glasses to meet practically all needs. For example, special units can be made of Solex heat-absorbing glass and plate glass. Such units would be particularly adaptable for use in airport towers, large offices, or other locations where the direct rays of the sun pose a problem. The use of water-white plate glass, which permits true color definition with a maximum clarity of vision, would make this type of window convenient for use in test chamber multiple glazing. There are many other combinations of special glasses that can be used in fabricating Twindow units including polished wire, heavy plate, figured ornamental, sand-blasted, blue- and flesh-tinted, and various window glasses.



Lower heat loss makes large windows practical—dehydration stops fogging

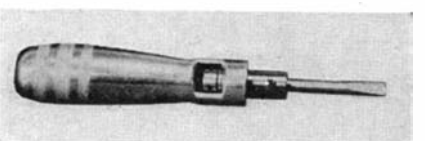
Special production processes make it possible to provide the windows in a wide range of sizes in any combination of straight edges. These units include the standard double-glazing as well as the special triple, quadruple, and multiple glazed panels. It is also possible to produce certain simple cylindrical bends within definite limitations, according to the manufacturer, Pittsburgh Plate Glass Company.

SCREW TORQUES

Properly Set With New Screw Drivers

SMALL, lightweight torque-measuring screw drivers of the friction-disk type are claimed by the manufacturer to be very accurate in torque measurement and control. Known as "Tru-Torque," the screw drivers are manufactured in three standard sizes—small, from 0 to 6 inch torque pounds; medium, from 0 to 12 inch torque pounds; and large, from 0 to 25 inch torque pounds. They are designed for continuous service on production and assembly lines, and for maintenance work.

In operation, the screw driver is preset at the desired torque; when the operator tightens the screw, nut, or bolt and the predetermined torque is reached the screw-driver handle slips and no further tightening of the screw is possible. There are no dials or spring mechanisms.



Handle slips at pre-set torque value

The tools come complete with one regular blade for slotted screws, one Phillips-type blade, and one Allen wrench and pin setter.

A beam stand is used for setting the torque screw driver. Reported to be accurate to a fraction of an inch torque pound, it provides large-scale readings from 0 to 25 inch torque pounds, and fractions thereof. Screw drivers are also available with sealed torque setting, as well as special torque measuring equipment.

TENSION BRAKE

Uses Factory Air Pressure, Adjusts for Accurate Drag

A LINE of brakes designed to apply accurately controllable continuous tension in industrial machinery are available either as self-contained units or for building into new equipment.

Features of the brake, made by Linderman Devices, Inc., which make it suitable for applying continuous retarding force are the absence of self-

energizing action—permitting accurate control of tension desired; ability to apply even heavy loads under ordinary factory airline pressures; radial shoe actuation, eliminating sensitive adjustments and high pressure areas; and use of 90 percent of the drum area for braking.

In operation, the amount of tension desired is secured and maintained by setting the air-pressure regulating valve in the lead from the factory air line. Slight increases or decreases in tension are obtained by changing the gage setting, since the amount of braking effort is directly proportional to the air pressure applied.

This accuracy of control is said to be largely traceable to the elimination of self-energizing action. This also accounts for the smoothness of the brake in operation. Shoes are self-equalizing, full floating, with no localized high-pressure areas on lining or drum.

Also, the Linderman tension brake is described as unusually powerful due to the fact that the four shoes virtually fill the entire drum with lining. Since no high-pressure areas exist, higher average lining pressures can be used, it is claimed. Thus, under continuous load, a 14 by 4-inch brake will absorb from three to ten horsepower, based on a maximum lining temperature of 475 degrees, Fahrenheit.

Application of shoe pressure to the drum is through multi-stage steel diaphragms—one for each shoe. These diaphragms make it possible to use a minimum of expansion, since the shoe travel obtained is the sum of the expansions of each stage of the diaphragm. The brake shoes incorporate a wedge mechanism to adjust for lining wear. In the brake proper there are no operating parts which require lubrication.

Due to the closed design of the brake-actuating mechanism, the only air consumed is that required to expand the diaphragms to apply the initial pressure against the drum.

CONTINUOUS WIRE RECORD

Plays Back Display Message Without Re-Wind

USE of the wire recorder for window or showroom displays, for voice tests, and as a device to attract audiences to booths at sales conventions or public displays has now been developed and several installations of this type of recording have been made, according to Lear, Inc.

The regulation wire recorder ordinarily requires that the wire be rewound before it can be played back. For displays, however, the operation of the sound on wire must be continuous, hence it was necessary to construct a recorder for that special purpose.

For displays, the message is recorded on the required length of wire, and then the wire is mounted on drives in a continuous strip. The length of wire depends on the length of message required, and by a series of drives and posts, any length can be accommodated. This wire keeps going through the playback head continuously, reproducing its message. It can be synchronized with the mechanical movement of the display, if desired, so that a constant automatic "demonstrator" can perform before the public without any personal attendant.

For voice tests and other purposes, a similar construction is used. In this case, the person picks up the microphone, speaks for a minute or two, and by the time he has finished his conversation, the part of the wire on which his first words were recorded has come around to the playback head, and is automatically played back to him. The length of time for recording can be regulated by the length of the wire.

This method does away with the necessity of re-winding and it also saves cost and space since only a playback is required. The recording on the wire is done separately. By the use of two amplifiers, one for the recording and one for playback, no switch is needed.

One of the present designs, which permits about two minutes of recording, requires no more than a space three by five feet for the wire loop. This can be made even smaller, but in most cases the size is immaterial, since the wire can be placed anywhere, and only the speaker is needed near the point of contact with the public or the display.

Although the present models have been constructed for special purposes, and used to a large extent as novelties.

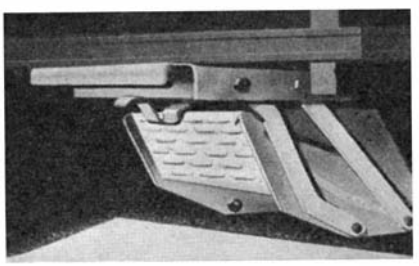
similar designs are being prepared to serve as automatic "information booths" for railroads, bus lines, and other public services. Answers to questions as to train time, athletic events, and so on are recorded on wire, and played back to the public when the button which carries such query is pressed. There is a large field for this type of recording in the commercial and amusement field; probably even more important than the field of home recording.

TRUCK STEPS

Reduce Driver Injuries, Swing Down for Use

SAVINGS in money, time, accidents, driver fatigue, and a reduction in the number of hernia cases among truck drivers, are claims made for a new quick-acting, folding step for motor trucks and trailers.

The manufacturer states that these steps are intended for use on flat racks, stake bodies, vans, trailers, and semi-trailers, and are easily installed with four bolts. In closed position, the steps are compactly folded under the truck bed. When the trip is manually operated, two sturdy 16-inch slip-proof steps swing down and lock in open position ready for use. A slight lift and push on the bottom step swings and folds them back under the truck bed where they are automatically locked in closed position out of the way. One



In closed position, steps lock under truck bed; a trip-release lowers them

style of step is designed for side or "tight spot" mounting.

The steps are all metal and built to support a weight of 1000 pounds, although they weigh only 40 pounds. The tread plates are said to have an unusually secure gripping action.

It is claimed that drivers of trucks equipped with these steps show a pronounced reduction in the number of hernia and other physical injuries common to truck drivers. Large truck operators state that many hernia cases are caused by jumping off trucks. Also, frequent climbing on and jumping off heights ranging from 40 to 50 inches, sometimes dozens of times a day, contributes to driver fatigue.

The steps are manufactured by the Safety Step Company.

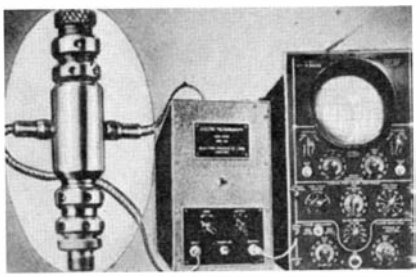
PRESSURE INDICATOR

Traces Operating Conditions of Machinery on Tube Screen

SUBSTANTIALLY linear pressure-time curves on the screen of a cathode-ray tube, connected to a new test instrument, indicate the performance of an engine, pump, or other device subject to pressure variations. Intended uses are studies of internal-combustion engines, pumps, compressors, air and liquid pipe lines, and so on.

Called a Pressuregraph, the unit is said to show instantly the erratic operation of a device which normally cannot be observed by other means, due to inertia of flywheels and other factors. The instrument also shows static or slow pressure variations and covers all mechanical speeds and pressures up to 10,000 pounds per square inch. The makers, Electro Products Laboratories, say that there is no appreciable inertia to overcome in the electronic driving mechanism.

The pick-up unit has been designed



Inertia minimized for quick response

to make it vibration-proof, and is furnished with or without water-cooling. The cabinet is designed for mounting alongside the oscillograph in a similar cabinet, making a compact testing and recording unit.

In operation there is only one control. The pick-up is inserted in cylinder, chamber, airline, or a similar location and a diaphragm, when acted on by pressure impulse, unbalances an electronic circuit. The unbalanced voltage from the pick-up is delivered to the cabinet where it is amplified, passed through a negative modulation suppressor, and then sent to the oscillograph.

The sweep circuit of the oscillograph is adjusted to the speed of the engine or mechanism under test. A band of light appears on the screen, the contour or shape of which is the true pressure-time curve. This band of light is not a line or tracing, but an area similar to that of a television picture, and easily readable.

MACHINE VIBRATION

Isolated from Other Tools with Leveling Mounts

A SIMPLIFIED, low-cost means of stopping the transmission of vibration from machine tools which interferes with precision work being done on adjacent machines is reported to have been found by the use of leveling-type machinery mountings. Called Vibro-Levelers, the units are intended as dual-purpose mountings for machinery —to stop the transmission of vibration and to permit leveling of the machine on which they are used.

In an example of such an application, four mountings, of 1000 pounds capacity each, were placed under the base of a shaper which had been causing transmitted vibration. After the machine had been raised from the floor, the threaded stud of each mounting was inserted through the hold-down bolt hole in the base of the shaper and the machine was then lowered so that it rested on the lower of two adjustment nuts supplied with each Vibro-Leveler. When the machine was brought to exact level, the second nut was turned down to lock and maintain the machine in the leveled position.

Time required for the entire installation was reported to have been less than two hours with no cutting of the floor, no special adapting of the mounting, and with the cost for mountings themselves being relatively low. In operation, the vibration interference was stopped and the "throw" of the shaper did not cause the machine to "creep" although the mountings were not bolted to the floor.

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.

TURBINE TESTER

Uses Resonance Principle To Spot Incipient Trouble

TO DETERMINE malfunctions of steam turbines, an industrial "stethoscope" has been developed. Turbines in normal operation have little characteristic noise, although tips of their blades may whirl more than 700 miles an hour. However, indications that something is wrong inside a turbine, may come with a hum, a wheeze, or some other unusual sound.

The part which causes the noise may range from a worn bearing to a "stretched" blade and can be determined by use of a simple formula, the

Tube length is adjusted to resonant wavelength of turbine "trouble" noise

resonance tube, or stethoscope, and the engineer's experience.

The resonance tube, a hollow plunger fitted into a sleeve, and varying in size from six to 60 inches, locates discordant sounds by tuning to the sound's frequency, much as a radio is tuned to the frequency of a broadcasting station. This is done by extending or retracting the plunger—at any one position only one frequency can be heard. By measuring the length of the tube at the position at which the noise can be heard, the frequency is determined, and by dividing the known velocity of sound by the frequency, the wavelength of the noise is determined.

Wavelengths of "trouble sounds" have been pre-computed and charted, and the particular fault of the machine tested is revealed by comparing the calculated wavelength with the chart. Since minor repairs may be made without tearing down the whole machine, thus precluding major difficulty, the industrial "stethoscope" saves time and money and assures quieter and more efficient performance.

FLEXIBLE COUPLING

Constructed as One Unit, Is Easily Installed

FOR OIL burners and air conditioning units, and also applicable to many other machines requiring maximum flexibility, a new coupling is described as compact and easy to install.

Of one-unit construction, the device, called a CX Double-flex coupling comes out with the shaft when pump or motor is removed. A standard body is permanently inserted into the molded synthetic rubber unit, this being permanently secured to the pump shaft by a set-screw. Molded into the other end are the sockets that engage jaws on the blower hub.

Other features of the coupling, made by Lovejoy Flexible Coupling Company, are quick assembly in dark or close quarters, no metal to metal contact, tight fit, no rattle, deep center hole for a firm grip on the shaft.

X-RAY ANALYZER

Detects Impurities, Based on Ray Absorption Principle

A NEW kind of "seeing" instrument, whose X-ray vision can detect counterfeit coins, spurious diamonds, and certain impurities in many types of solid, liquid, or gaseous materials, has recently been developed. Called the General Electric X-ray Photometer, the device is a rapid, accurate analyzer able to indicate within a second or two the concentration of certain chemical elements in the presence of others.

Plus its potential role as a detective, the instrument is expected to find application determining sulfur content of oil, tetraethyl content of gasoline, ash content of coal, heavy metal content of glass, and concentration of fillers and impregnating agents in wood, cloth, and rubber.

The instrument operates by aiming an X-ray beam through the material being tested and then measuring the amount of ray absorbed by the material. In testing a questionable coin, a genuine coin is first checked for its amount of ray absorption. The doubtful coin is then checked, and if its amount of ray absorption does not match that of the genuine coin, the doubtful coin can be assumed to be counterfeit.

In most other applications, however, the instrument employs aluminum disks of different thicknesses which act as proxy for the known item, against which the unknown item is being checked. In checking a diamond, for example, the stone in question is compared to an aluminum disk, whose thickness corresponds in ray absorption to a genuine diamond. Because genuine diamonds are almost pure carbon, very little radiation would be absorbed, whereas fake diamonds of glass, particularly if they have a lead content, would absorb a much larger amount of radiation, according to General Electric.

Estimating the amount of ash in a piece of coal without actually burning the coal is also possible with the X-ray photometer. First, the component chemicals of coal that result in ash are checked for the amount of X-ray absorption, and the aluminum disk which absorbs a like amount of radiation is selected. Then, the sample of coal is matched against the disk. Since

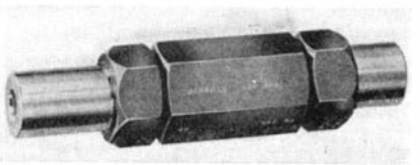
the amount of X-ray absorption of the sample is in ratio to its ash-producing elements, the amount of ash in the coal can be calculated.

The photometer measures ray absorption by directing an X-ray beam at a fluorescent screen. The strength of the ray, after it has passed through material under test, is transposed by the fluorescent screen into visible light, intensity of which then is measured by photoelectric equipment. Final reading is given on a dial.

GAGE WIRES

Used on Both Ends with Collet Handle

FEATURING a light aluminum-alloy, collet-type handle which firmly positions a set of wire-type cylindrical plug gages, a new plug-gage handle enables



Lowers cost of gage usage

the user to reverse the gage member after it has worn under the allowable limit. Thus, full advantage may be taken of the unused gaging surface that was formerly in the handle. This arrangement is said to increase the gaging life and lower the cost per hole gaged. Tapers, drift pins, and split handles are eliminated in the gages, called Dubl Duty.

Made by Schrillo Aero Tool Engineering Company, the gages are furnished in a size range of 1/16 to one inch in 1/16-inch steps.

ACID SUIT

Made of Fabric Coated with Resistant Plastics

ADDITION of acid suits to its industrial-clothing line is announced by The B. F. Goodrich Company. Made of Koroseal, a flexible plastics material, coated over textile sheeting, the suit has been designed for maximum light-

Light, tough suit resists solvents

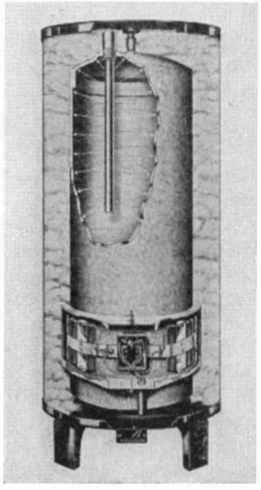
ness and toughness, including resistance to abrasion and practically all solvents and acids.

Jackets and pants are furnished separately or as a unit. The jacket has a fly front with concealed fasteners, strapped armholes and seams, and stand-up collar. Pants are the bib type with adjustable shoulder straps in the back.

TANK CORROSION

Greatly Reduced by Electrolytic Counter-Action

PROTECTION for hot-water tanks now takes advantage of the fact that corrosion in such locations is largely electro-chemical in action. Thus a new system operates by setting up counter-forces to electrolytically neutralize the forces which normally cause the tank to be corroded. In use, a rod of pure magnesium inserted in the tank forms,



Magnesium rod protects steel tank

with the steel, a galvanic battery, and the current produced causes the magnesium to go into solution to protect the steel by a plating action.

Since the hot water and the combination of iron and magnesium cause such a strong current that the magnesium rod would be eaten away in but a few months, it has been found necessary to reduce the current by a resistance placed in series between the iron and the magnesium rod. This feature of the installation, called the Ionodic system, permits a current flow sufficient to give adequate protection, yet meters or retards the rate at which the magnesium is consumed and thereby assures, according to the McGraw Electric Company, the protection for a much greater length of time.

STENCIL BRUSH

Carries Ink Supply for 500 Addresses

A NEW model fountain brush for use in marking stencils is said to be more convenient than former types of brushes in that it releases stencil-marking ink, held in a hollow hand reservoir, at the touch of a button. Thus controlled, the ink flow is sufficient to mark 500 address stencils be-

fore refilling is necessary. A saving in ink is also claimed.

Of light-weight aluminum construction, the 6½-ounce brush is said to eliminate hand fatigue.

Other construction features are washers that are reported to make the brush absolutely leak-proof; brush tips that can be changed easily, using three

Finger-tip button controls ink flow

standard sizes for varying stenciling conditions; and hexagon construction of the tip holder which allows the brush to be laid down without danger of rolling.

The manufacturer, Marsh Stencil Machine Company, reports that a stencil can be marked in three seconds with the reservoir brush.

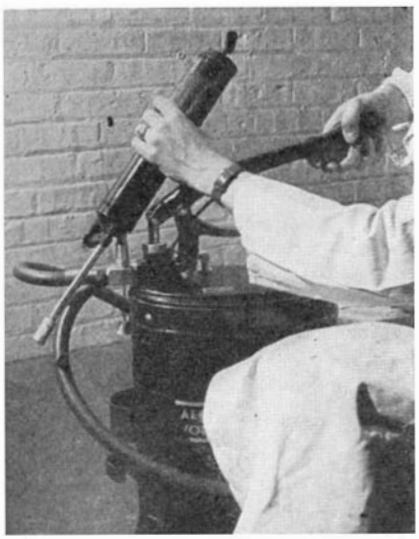
GREASE-GUN LOADING

Simplified and Hastened by New Fittings

USERS of pressure-lubrication systems can now load hand guns by the use of new equipment which eliminates disassembly of the gun, precludes danger of lubricant contamination or waste, eliminates air pockets in the gun, and permits rapid gun loading.

The system is based on a "gun-loader fitting" which is mounted on the head of a hand gun and permits grease to flow into the grease reservoir of the gun in the same manner that it flows out into a bearing through a lubrication fitting in normal lubrication. A loader valve mounted on a bucket pump or loader pump, functioning in the same manner that a coupler does when applied to a fitting, is the companion item to the loader fitting on the hand gun.

Although several hand guns, both push-type and lever-type, as well as



Eliminates air pockets, grease waste

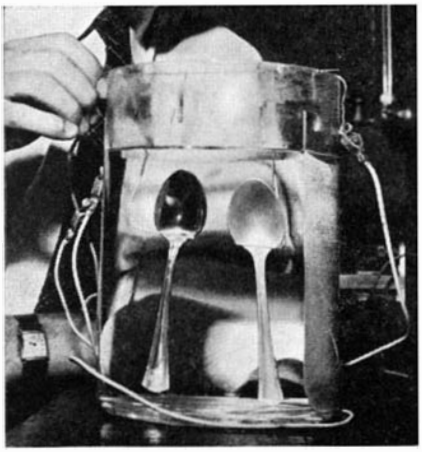
loader pumps of 25, 35, 100, and 400-pound capacity, all equipped with the special fittings and facilities required by the new gun loading system, were announced by the manufacturer, Alemite division of Stewart Warner Corporation, users of guns and bucket pumps already in the field can "convert" their units to the new system.

SILVER POLISHED

In One Minute Without Buffing

ACCIDENTAL use of a silver-plated wire in cleaning phosphor bronze electrolytically is reported to have given birth to a new polishing process that may be of major importance in the silver industry. Credit for the novel electro-polishing method was given to Dennis R. Turner, physicist in the electronics department of the Research Laboratories of the Westinghouse Electric Corporation.

It was explained that ordinarily metal articles to be silver plated are immersed in a bath of silver-cyanide



Before electrolytic process, polished spoon (left) looked like one at right

plating solution and negative current sent through, causing a deposit of pure silver upon the objects. When removed from the bath, they are evenly plated with silver but are white and lusterless. Hence, they must be buffed by hand on a revolving wheel. The buffing not only entails an extra handling of every piece but the loss of a certain portion of the silver through abrasion. Only by a troublesome, costly procedure can the lost silver be collected and reclaimed.

With the new method of polishing, it was found that the best product results from immersing the silver-plated object in a bath of silver cyanide solution normal to the regular plating operation. Instead of sending negative current through the bath as in plating, however, a positive current is applied at about four times the amperage used to plate the metal, but not continuously. The positive energy is applied for a few seconds, discontinued, then sent through again, and this intermittent action repeated for several cycles. When the article has reached its peak of luster, it is taken out of the bath, rinsed and dried as a finished, highly polished product. The entire operation takes slightly over a minute.

So that the current is applied and interrupted at the proper and regular intervals, Mr. Turner connected a small motor with a switch that controls the intermittent flow of energy.

Although the electrolytic polish can be effected equally well by employing a plain cyanide solution, it was pointed out that the more practical way is to utilize the same silver cyanide bath used to plate the objects, rather than having to transfer them to another tank containing only cyanide.

Industrial practice, it is suggested, would be to immerse the metal pieces —many at a time—apply a negative current to silver plate them, then intermittent positive charges to attain the bright finish—all in the same bath. In addition to eliminating the buffing process, such a procedure would have the advantage of retaining in the original solution the small quantity of silver removed by the electrolytic action of the cyanide while polishing.

The new method has been successfully used to polish silvered contactors, items of switchgear, microwave apparatus, radar parts, and other devices needed in experimental work.

CONTROL WHEEL FINISH

Applied By Dipping, Shrinks to Base Metal

BY DIPPING lightweight aluminum castings in Tenite II Gel Lacquers, airplane control wheels are now provided with an attractive, dark red finish that is described as smooth and pleasant to handle, tough, chip-proof, and easily and economically applied.

The lacquers are made by dissolving cellulose acetate butyrate plastics pellets of the desired color and opacity in suitable solvents. Coatings of this mixture adhere mechanically to the castings through shrinkage of the lacquers as they dry. Upon cooling and partial loss of solvent, the Tenite lacquer sets quickly in a hard, continuous-surface coating which is characterized by a natural high gloss and absence of flash or other markings. Polishing and finishing operations on the wheels are thus eliminated. Lettering is applied by stencil to the gel-lacquered surface.

The Editors Recommend

Best Sellers In Science

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

HIGH FREQUENCY INDUCTION HEATING — *By Frank W. Curtis.* Answers many questions concerning induction heating and its utility in industrial processes. Thoroughly practical in scope. **$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. **$3.60**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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CURRENT BULLETIN BRIEFS

Conducted by K. M. CANAVAN

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

DIE-LESS DUPLICATING. Summarizing recent developments in "die-less duplicating" with specially designed tools, this 40-page illustrated catalog describes their applications and advantages. These precision tools, highly flexible in operation, are finding increasingly wide use on production lines where metal wire, rod, and strip are shaped, as well as in experimental shops and laboratories. Request Catalog Number 46-10. *O'Neil-Irwin Manufacturing Company, Minneapolis 15, Minnesota.—Gratis.*

RECOMMENDED PRACTICE OF STREET AND HIGHWAY LIGHTING. Compact factual information on the necessary amount of illumination needed to increase traffic safety and decrease the highway death rate is given in this 32-page report. *Illuminating Engineering Society, 51 Madison Avenue, New York 10, New York.—50 cents.*

INSULATION IN THE HOME. This eight-page circular gives brief but succinct details of methods of home insulation by which, it is reported, as much as 50 percent of heating fuel can be saved and summer comfort increased. The facts presented are the results of several years of university research. All available types of insulation were studied. Request Circular F6.0. *Small Homes Council, University of Illinois, Urbana, Illinois.—Gratis.*

COLER HARMONY FOR INDUSTRIAL PLANTS is a four-page folder showing how properly selected wall, floor, and ceiling colors can promote production, safety, and cleanliness, and build worker morale. It supplements the article on page 123 of this issue. *Request this folder from Scientific American, 24 West 40th Street, New York 18, New York.—Gratis.*

DRILL BUSHINGS. This four-page folder, punched for loose leaf binding, is essentially a listing of standard stock sizes of drill jig bushings. *Products Engineering Company, 9045 Wilshire Boulevard, Beverly Hills, California.—Gratis.*

MICROCHEMICAL SERVICES. This eight-page bulletin answers the question "What does a micro-analytical laboratory do?" It also summarizes the work of one consulting laboratory. *Foster D. Snell, Inc., 305 Washington Street, Brooklyn 1, New York.—Gratis.*

THE WATERTOWN BOOK OF PLASTICS lists and describes, in 44 pages, with illustrations, a large number of the more important industrial plastics. These include different molding compounds,

thermosetting materials, thermoplastics, and so on. It also describes production methods. A "plastics comparator," included in the manual, is a handy reference check chart. *The Watertown Manufacturing Company, Watertown, Connecticut.—Gratis.*

50 BILLION RECORDS CAN'T BE WRONG. Microfilming, whereby valuable records, drawings, and so on, can be filed with a saving of 98 percent in space, is here explained in detail, together with discussions of the equipment required. *Recordak Corporation, 350 Madison Avenue, New York, New York.—Gratis.*

SYNTHETICS BRING NEW ERA IN PERFUMES is a 20-page pamphlet outlining the development of synthetic chemistry and how it has provided the field of perfumery with new raw materials which have usurped nature's products in the entire perfume industry. *E. I. du Pont de Nemours and Company, Inc., Wilmington 98, Delaware.—Gratis.*

SOLVING INDUSTRIAL CRIMES, CASE NO. 32, is a pocket-size pamphlet which shows briefly how measuring and recording instruments can reduce waste in a wide range of industrial production processes. *The Esterline-Angus Company, Inc., Indianapolis 6, Indiana.—Gratis.*

HOW TO SPEED AND SIMPLIFY CLEANING METHODS IN INDUSTRIAL PLANTS gives specific information concerning such procedures as rust removal, water-scale elimination, steam cleaning, paint stripping, metal surface treatment, and general maintenance. *Turco Products, Inc., Export Sales Division, P. O. Box 2649 Terminal Annex, Los Angeles 54, California.—Gratis.*

YOU'VE GOT SOMETHING THERE. This amusing yet instructive 20-page booklet on one company's suggestion system can point the way toward the development of similar systems in other industrial plants and offices. *The B. F. Goodrich Company, Akron, Ohio. —Gratis.*

NORELCO DIAMOND DIES. How diamond dies are made for industrial applications is described in this eight-page illustrated booklet. The various steps are detailed with text, drawings, and photographs. *North American Philips Company, Inc., Publicity Department, 100 East 42nd Street, New York 17, New York.—Gratis.*

MAGNESIUM ANODES FOR CATHODIC PROTECTION is a 13-page illustrated booklet presenting information on this method of corrosion control for industry. *The Dow Chemical Company, Magnesium Division, Midland, Michigan.—Gratis.*

OUR INDUSTRIAL AIR POWER is the title of a motion picture film showing the many industrial uses of compressed air. This 25-minute film is available without charge on a loan basis for showing before students, engineering societies, and other groups. *Quincy Compressor Company, Quincy, Illinois.*

Our Book Corner

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

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The Editor

THE ATOMIC REVOLUTION

By Robert D. Potter

PRESENT at a now historic meeting when successful splitting of the atom was announced in January 1939 was the author of this book, a physicist and research worker as well as a writer of no small ability. In the world-stirring years which have elapsed since that date Mr. Potter has followed closely the whole development of nuclear fission. Into the pages of the present book he has crammed the cream of his acquired knowledge. He not only presents the available facts in simple and non-technical language, but he also analyzes the present and future possibilities arising from the splitting of the atom—military, medical, and industrial. (165 pages, 9 by 12 inches, well illustrated with photographs and drawings.) —$3.60 postpaid.—*A.P.P.*

YOUR FUTURE IN AVIATION

By J. Fred Henry

NOT a sensational, misleading guide to quick riches in aviation, but a solid, reliable study of the vocational opportunities which really exist in aviation, and of the training needed to qualify for such opportunities. The information is detailed and specific, and covers almost every phase of aviation manufacture, operation, air transport, fixed base and airport work, and government service. (328 pages, 5½ by 8 inches, unillustrated.)—$3.10 postpaid. —*A.K.*

THE WEATHER FOR A HOBBY

By Raymond Yates

HERE is an intriguing little book that holds within its pages the essence of one of the world's most challenging and fascinating hobbies. Tone and treatment are both chatty and non-technical as regards meteorological theory and practice. In line with its title, the book has a main purpose of explaining the construction of simple instruments with which the amateur may make his own weather observations. In no case does an instrument herein described require more than a minimum of tools, skills, or parts. Most of the parts are of the type to be found about the house or at the local automobile and bicycle shops. Also, the basic principles underlying the home-made instruments are stressed, rather than hard and fast rules of manufacture. There is ample room for ingenuity and experiment. Simplicity and home-built equipment notwithstanding, the book offers a starting point for a genuinely intellectual hobby calculated to provide more than a little benefit for those who enter upon it. (172 pages, 6 by 8 inches, 14 half-tones, 48 figures and diagrams, 4 tables.)—$2.85 postpaid.—*E.F.L.*

FEATURES OF THE MOON

By J. E. Spurr

TWO YEARS ago the author, after 20 years of hobby study of Mt. Wilson photographs of the Moon and after a lifetime as a geologist (formerly Chief Metal Mining Engineer, Bureau of Mines, later Editor of *Engineering and Mining Journal*) published "The Imbrium Plain Region of the Moon." Now he extends this study to the whole Moon and includes the entire former book within the newer one. He favors the volcanic theory of the craters. Detail by detail in minute particular he goes over the Moon's surface interpreting the sequence of events as a geologist sees them but, of course, very largely (fully half) overlapping the astronomer's point of view. There is enough detailed, specific material in

this big book to keep an amateur astronomer actively occupied at his telescope for years checking and examining. He must use an erecting lens and relearn his lunar map, since Spurr re-erects the astronomer's inverted images—or he can invert the book. (122 plus 331 pages, 7 by 11 inches, 14 Mt. Wilson photographs, 95 drawings.)—$5.10 postpaid.—*A.G.I.*

BUILDERS FOR BATTLE

By David O. Woodbury

RUNNING through the text of this story of how our Pacific Naval Air Bases were constructed, is the definite feeling that the author was at the scene and knows what he is writing about. Such was the case. Thus this story of one of the mightiest construction feats in history bears the stamp of authenticity. It can be read for pure enjoyment; it can also serve as a reference book for students and historians who would dig deeply into the records of mechanical and technological feats which did so much to insure victory in the Pacific. (415 pages, 7 by 10 inches, 25 full page drawings and 48 smaller but equally important sketches, well indexed.) —$7.60 postpaid.—*A.P.P.*

"STEP DOWN, DR. JACOBS"

By Thornwell Jacobs

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both be right. He states that, while fair-minded people still accord Burbank a place in the scientist's Valhalla for his accomplishments in plant breeding, friends gave him a false and huge build-up which his excessive egotism led him to let ride, and this ruined him. This book is no stuffy study but a live, readable, absorbing, human narrative and analysis. Some chapters: Burbank the Egotist; Burbank the Pariah of Scientists; Burbank's Ethics; Burbank's Religion; Summary of Burbank's Products. (206 pages, 7 by 10 inches, illustrated, paper cover, as it is issued as a part of the scientific journal *Chronica Botanica.*)—$3.85 postpaid.—*A.G.I.*

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By Devon Francis

A PILOT in his own right, Mr. Francis is also an experienced writer on aviation with a profound interest in the helicopter. His latest book presents an attractive and accurate account of the historical and modern development of the helicopter; readers will also find in it an interesting and simple explanation of principles and practice. Present and future possibilities are dealt with and the most important machines are described and illustrated. The book abounds with fascinating personal glimpses of the great pioneers—Da Vinci, Cierva, Sikorsky, and many others. Original research by the author brings Edison into the helicopter picture, along with other noteworthy additions to the general development of the subject.—(182 pages, 8¼ by 5½, $3.10 postpaid.)—*A.K.*

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Telescoptics

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

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

LAST MONTH in this department George P. Arnold, a graduate student in nuclear physics, State College, Pa., offered extensive and definitive data on the design, testing, and performance of the Dall-Kirkham spherical secondary telescope. Figure 1, squeezed out of that layout, shows his telescope, a 10″.

So well was the spherical secondary (why not simply the "s.s."?) principle regarded some years ago (1938) when Kirkham referred it to those in charge of the 200″ telescope, that it probably will be used on the tenth-scale (20″) model. Before the 200″ was built a 20″ model was made and tried out, and that very interesting model was not afterward tossed on any junk heap or given to any of us TNs to get it out of the way (maybe we should have asked!) but instead it was mounted on the roof of the Astrophysical Laboratory at "Cal Tech" where it will be used in its own right. Last January, during exchanges of mixed telescoptical lore with Porter such as have gone on by mail every few days since 1926, he wrote the following note in pencil on the bottom of a page: "In our tenth-scale Cass—our guinea pig—the primary was and still is spherical, as Dr. Anderson was in a hurry to get it working, and the secondary was corrected to fit it. Dr. Anderson is now computing the changes required in the primary if the secondary is made spherical and it seems that his procedure follows Kirkham exactly."

Your scribe recalls that at various times when "Kirk's" ideas were shown to Dr. Anderson via Porter they, and evidently Kirkham himself, were very well thought of. Telescoptics lost much when the genius Kirkham died after prolonged pathetic vicissitudes revealed in letters in files still preserved. "Kirk" was one day suddenly made highly aware that he had been ill with pulmonary tuberculosis for years, and it is a fact that his attempts to help other amateurs less well favored with a knowledge of design optics were a contributing factor in his fatigue and ultimate death. He wrote in 1938, when working on an invention: "If I can dope out a way to make diffraction gratings 10″ long in a few minutes, I can go to the sunny southland—which I realize is about the only hope I have of living to see 1940." A proposal to collect a fund from amateurs was then made but Kirk apparently was not in favor of it. He died in 1943, at Pendleton, Oregon.

Returning to the Dall-Kirkham or, as Dall prefers, the Kirkham-Dall: In 1672 William Cassegrain proposed a telescope having a paraboloidal primary and a secondary to suit, which called for a hyperboloidal convex. It is passing strange that he thus was able to set the mode for almost three centuries, when the s.s. telescope with spherical convex secondary and elliptical primary was just as obvious and simpler. Probably, however, he asked for the hyperboloidal convex simply because he had the thought fixed in his mind that a reflecting telescope necessarily called for a primary which was paraboloidal.

This leads to a new question. Since Cassegrain didn't, himself, invent the actual idea of a telescope having a secondary mirror and perforated primary, for Gregory had already published it in 1663 (Bell, "The Telescope"); and since he failed to find the spherical-secondary-elliptical-primary idea only recently found by Dall and Kirkham, is the Dall-Kirkham telescope then a *Cassegrainian* telescope of any kind or at all? Why isn't it simply the Dall-Kirkham telescope? Thus deposed as a child of the Cassegrainian, it becomes instead a brother of the Gregorian and Cassegrainian. If this is logic then this is advanced as the declaration of independence of the Dall-Kirkham telescope. In time it is likely to supplant the Cassegrainian. The poorer form was discovered first.

That it took nearly three centuries to find a thing so simple and so obvious (after the event) is perhaps a reproach to the past personnel of telescoptics. Another such reproach is the obvious and beautifully simple Schmidt principle, only recently hit on. During the two decades of this department's telescoptical life many proposals for new principles have been submitted and many of them have proved to have been anticipated by someone or other. One gets the feeling that every possible avenue has already been explored and exploited, with nothing left to discover. History shows, on the contrary, that in such situations the unborn souls of more discoveries are flitting around invisibly overhead, eagerly waiting to be discovered and named for the discoverer. While most searchers evidently look for complexity, the best finds usually prove to be simple, like the s.s. telescope and the Schmidt.

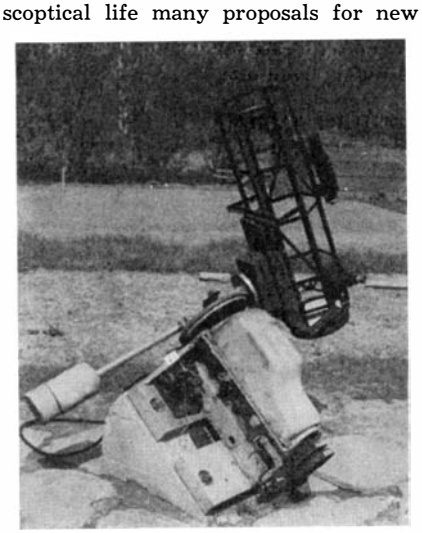


Figure 1: Arnold's s.s. telescope

BUILDERS of compound telescopes should, though they usually do anyway, work to a tight tolerance. Least squares treatment shows that when n surfaces reflect in a series, the tolerance should be $1/8\sqrt{n}$. On the 200″ telescope six surfaces sometimes will be used in series, calling for 1/20 wavelength. On a two-mirror telescope the tolerance is about 1/11 wavelength.

CHAMPION member of the American Association of Variable Star Observers, Cyrus W. Fernald, of Wilton, Maine, with 7216 observations to his credit for the year, also Dr. William L. Holt, Scarboro, Maine, and Winter Park, Florida, who made the Association's millionth observation since its organization, both use telescopes having Springfield mountings.

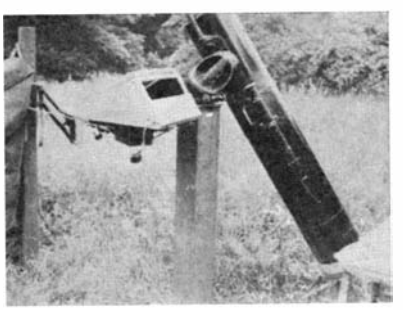


Figure 2: Reversing chart box

In the Springfield mounting, due to the added reflection of the second diagonal, the star field is reversed and, as Porter himself comments, "disoriented" for any kind of chart work. Asked how he was able to reconcile this difficulty Dr. Holt replies: "Fernald and I would not trade our 8″ Springfields for Clark 6″ refractors. He has a geometrical mind and the reversal does not bother him. It does me, and so I have used, since I began variable star observing in 1932, a mirror chart box (Figure 2) which, when the chart is placed face down above a mirror, normalizes it. The box is shaped like a wedge and the upper, left-hand face as seen or, rather, not seen in the photograph, is a strong sheet of window glass. It has a hinged cover to keep the charts from blowing away. The level bottom has a plate glass mirror 12″ square. The side shown at the right is mostly open, to permit viewing the reflected image of the chart. The closed part below the opening serves to shield the eyes from the weak red flashlight installed within.

"The chart box," Dr. Holt states,

"is attached to the end of a swinging, extended bracket and can be put in just the right place on either side of the telescope pier, so that one looks down into it at about 30° (parallel to the glass back) and sees the chart, placed face down on the transparent glass, reversed. Thus the top of the chart becomes the bottom, but right remains right and left stays left. Finally, one has to adjust the chart on the glass back so that the east-west line corresponds with the east-west line in the sky as seen in the telescope.

"All this doubtless sounds complicated but it really very simple, both to make the box and to use it. It enables me to find and estimate magnitude rather carefully of 10 to 15 variable stars an hour. With the Springfield one wastes no time or energy and has no discomfort from nearly lying on the ground for a star near the zenith or mounting a stepladder for a star near the horizon. I observe by the hour, sitting comfortably on the high stool shown at the lower right-hand corner in the illustration. This is an advantage of the Springfield mounting that Fernald and I swear by. We believe we are the only A.A.V.S.O. members using Springfields."

Dr. Holt, a year ago, was runner-up for the A.A.V.S.O. championship. He observes summers in New England, winters in Florida, carrying the mounting and tube with him and attaching it to permanent pedestals having tops beveled to suit the respective latitudes.

Continuing in praise of the Springfield, Dr. Holt writes: "The most important of all advantages and the one which provides the chief explanation of the miracle by which Fernald finds, estimates, and records magnitude for 30 or more stars an hour, is the great ease in reading the setting circles; they can be read without getting off the stool. I have often worked for an hour or more and get 15 stars without getting off. Neither Fernald nor I use our finders or look at the sky at all in finding our stars; we just have the correct local sidereal time for the night and place, instantaneously (nearly!) subtract the star's R.A. from sidereal time or vice versa (I use a sidereal watch hung on the chart box), and set the star's hour angle and declination with help of the convenient slow motions, the whole process taking from 20 to 60 seconds."

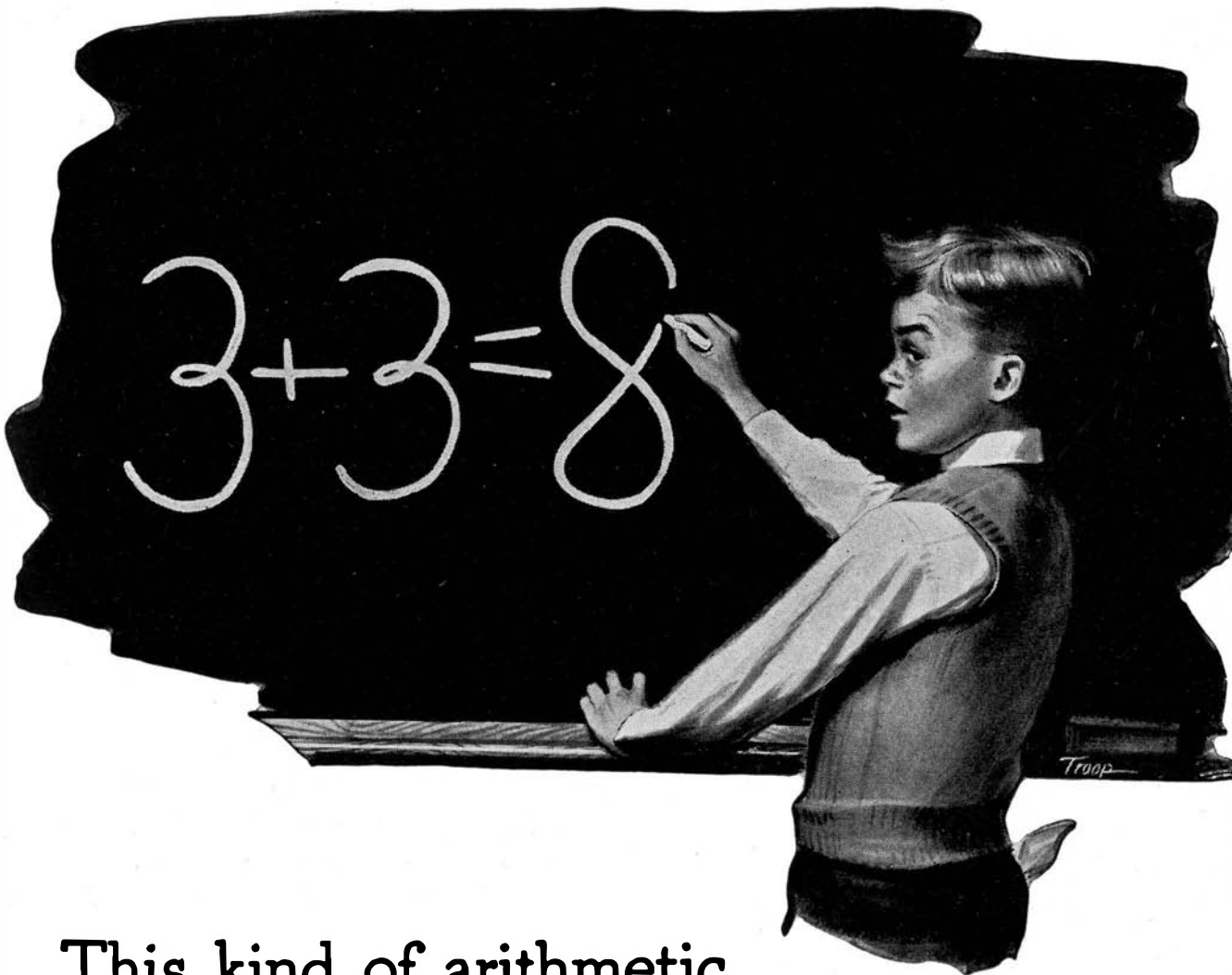
CORNING casts mirror blanks up to 12½" diameter in permanent iron molds and tries to keep them in stock, but above that diameter they have to build up a special, temporary mold from firebrick and the make-ready costs them more than the glass and the pouring. Thus a single 20" blank 3 1/3" thick costs the buyer $225 and a 16" blank of same thickness $140. But if 25 or more orders can be accumulated, so that the same make-ready can suffice for that many blanks, the price can be cut more than a little. Today the quotation is $37.50 net for each of 25 or more 16" blanks.

In 1941, Clyde Tombaugh sponsored a Sixteen-inch Club in which Corning agreed to provide 16" blanks at similar price, provided 20 orders were received before pouring. This department (July and November 1941) lent its help and eventually Tombaugh was able to round up 33 members who ordered 37 blanks (this department, October 1942). These were delivered but the war sent most of them into temporary storage and only a few have yet emerged. Such holdovers tend unhappily to deaden the spontaneity of a group where each member knows others are doing the same job at the same time and knows who they are.

This department now proposes a new and additional or post-war Sixteen-inch Club of its own—though the Tombaugh group will be revived by its sponsor—and will take much interest in its progress and outcome. It obviously cannot undertake any kind of middle-man responsibilities of an actually business nature and therefore, pending accumulation of the 25 orders necessary to put the Club over the hill, orders and cash must be deposited with Corning Glass Works, Corning, N. Y. Two potential orders are now known of as a starter. Please keep this department posted; it cannot keep posted through Corning since, while C. F. Henkel, Jr., Corning's Manager of Optical Sales, is a friend of your scribe's (summers, we both bathe in and drink from the same lake and what more do you want?) this does not make it ethically possible for any outsider to snoop into company orders to see how things progress in order, if necessary, to do a little supplementary selling to reach the quota. The Tombaugh club started dubiously but in the end 17 more orders than were necessary came in. But those same orders partly saturated the market, also. Sights are now set for 50 in order to hit the 25.

Tools: In 1941 some of the Tombaugh group bought 16" tools of plate at $7.80 each from Pittsburgh Plate Glass Co., Ford City, Pa. Many prefer to work 16" disks (about 50 pounds) face up with sub-diameter tools on a modified Draper or other extemporized machine. If a 16" tool is used it possibly should be channeled as described by Ferson in "A.T.M.A." (printings after June, 1944) to avoid risk of sticking and for other advantageous reasons there described.

TEST for mirrors, described by **H. E.** Dall, Luton, Bedfordshire, England: "First, if a mirror is *f*/7 or longer focus a careful center-of-curvature Foucault test will be good to 1/20 wavelength. I favor using masks with ½" holes. Then put two short vertical scratches, about ½ mm apart in black enameled glass, in front of the test lamp and arrange a good ½" Kellner or similar eyepiece in front of the lamp on a measuring stand capable of measuring to and fro movement. Adjust the eyepiece inside focus to give four *equally* spaced bars of light. Mark the position and repeat outside focus. The center of these two positions is the zonal focus and this method is capable of better accuracy than most."



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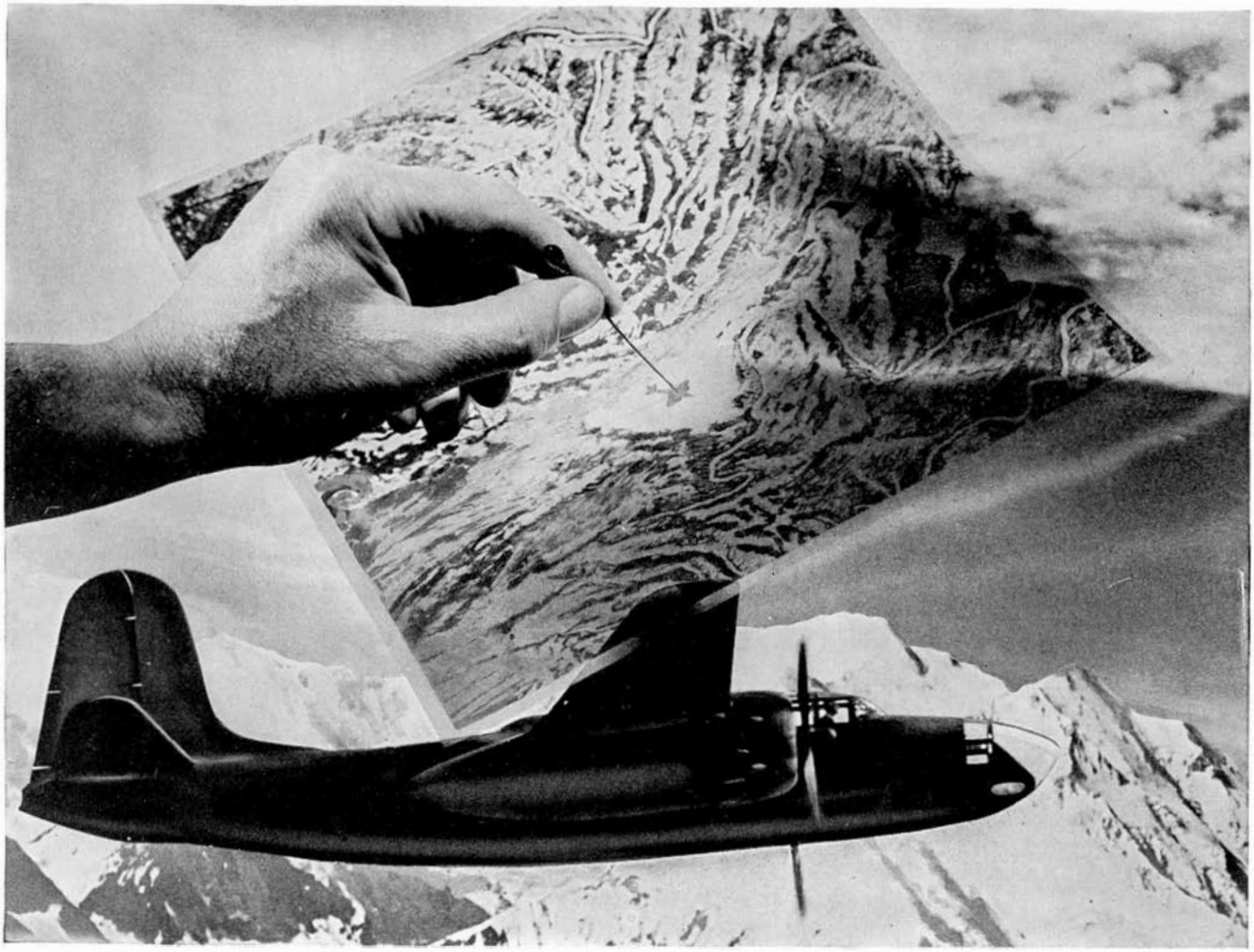

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