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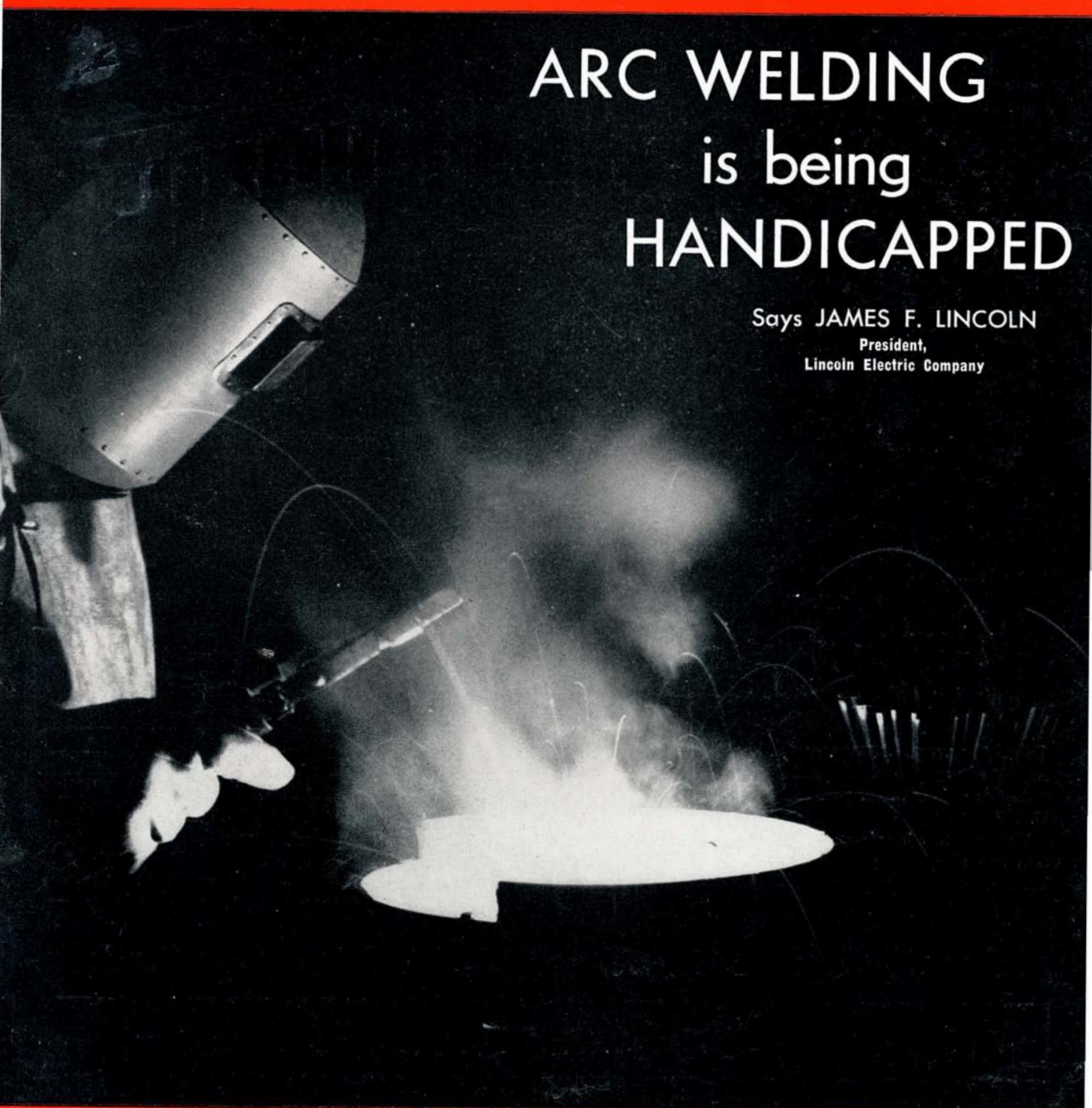
PROGRESS IN INDUSTRY



ARC WELDING is being HANDICAPPED

Says JAMES F. LINCOLN
President,
Lincoln Electric Company

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PUZZLE:

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INDUSTRIAL DRAMA: An aura of mystery surrounds many photographs of arc-welding processes, such as the one on this month's cover. Not so mysterious are some of the reasons why handicaps are being placed on arc welding in many quarters. See the article starting on page 101 of this issue.

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Founded 1845

In This Issue • September 1947

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of September, 1897)

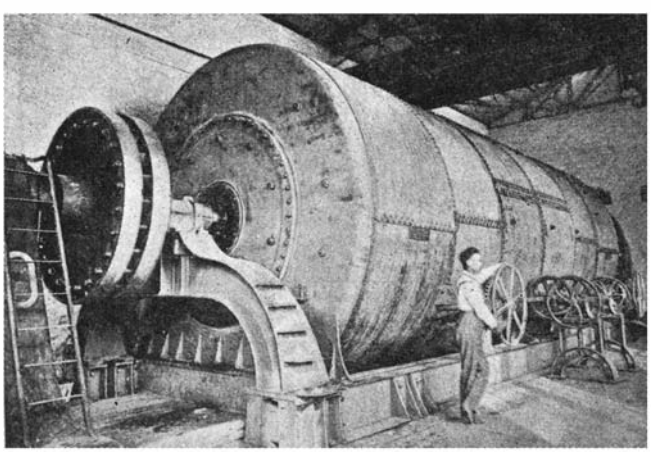
CANAL PROGRESS — "The British consular officers at Panama and Santa Martha describe in their last reports the present condition of the work on the canal across the isthmus and of the railway connecting the Atlantic with the Pacific. The New Canal Company, formed in Paris in 1894, to continue and complete a ten lock canal rising to a maximum altitude of 133 feet 8 inches, in place of the original sea level scheme of M. De Lesseps, has made good progress with the small capital at its disposal, and the reduced canal trough, or cunette, in the Emperador and Culebra sections is now assuming definite proportions."

ELEVATORS — "The comparative novelty of the elevator and the fact that it carries its passengers in midair invest it with ideas of greater risk than are commonly associated with other methods of conveyance, as by train, car or steam ship. As a matter of fact, statistics show that, for the number of passengers handled, the accidents are fewer on first class elevators than upon street car lines or railroads."

RAIL EXPANSION — "The extraordinary activity in railroad construction between the years 1885 and 1892, when the total construction for one year alone reached a total of over 12,000 miles, will explain the enormous demand for steel rails. At the close of that period some of the ablest railroad men in the country gave warning that the country was being over-supplied and stated that most of the country contained more railroads than would meet its needs for the next quarter of a century."

GAS DETECTION — "For detecting deleterious reducing gases such as carbonic oxide, methane, etc., in the air of mines, A. Mermet finds a dilute solution of potassium permanganate, containing a little nitric acid, highly efficient, the effect of these gases being to decolorize the permanganate solution."

TURBINES — "What is probably the largest and most powerful pair of horizontal turbines, for the head of water under which they will operate, that has ever been built, has recently been erected by the Dayton Globe Iron Works Company, for the Boston and Montana Consolidated Copper and Silver Mining Company, of Great Falls, Montana. . . The two turbines . . . and the draught chest are inclosed within a huge cylindrical flume, 14 feet 4 inches in diameter and 32 feet 6 inches long. The body of the flume is built of ½ inch tank steel and the ends are closed by massive cast iron covers, the turbines and draught chest being thus entirely inclosed. The wheels were guaranteed to show an average efficiency of 80 per cent from three-quarters to whole gate and develop 2,800 horse power under 40 feet head."



ELECTRIC TAXIS — "In London a company has placed a dozen electrical cabs in the streets. They resemble coupes, and the accumulators consist of forty cells, capable of propelling them over fifty miles, at a cost of fifty cents. The rear wheels do the driving and the front wheels do the steering. They have heavy rubber tires and upholstered spring cushions, are lighted by electricity, are speedy, and almost noiseless."

POSITION FINDER — "Nothing is worse than fog at sea. . . To lessen the danger which then exists, Professor E. C. Pickering, the director of the Harvard College Observatory, suggests a method of determining the position of a vessel in a fog based upon the velocity of sound. If two fog horns of different pitch be placed at equal distances from the middle of a channel or entrance to a harbor, and be sounded simultaneously at regular intervals of about a minute, it will be evident that a captain of a vessel will be able to locate his position with fair accuracy by noting when the sounds of the horns are heard."

DIVING BELL — "An improved diving bell of great capacity, moving along the sea bottom by means of screws moved by electricity, is on exhibition in Paris. . . It is lighted by electricity, which also furnishes motive power for any tools that may be used."

100 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of September, 1847)

NOW A POPULAR SONG — "There is a woman in the west who is so large round the waist that her husband can't hug her all at once; but when he takes one hug he makes a chalk mark, so as to know where to commence the next time."

WATER PIPE — "The various contracts made in Pennsylvania to furnish iron pipes for the Boston Water Works amount in all, to between seven and eight thousand tons. Messrs. Merrick & Towne, alone, of Philadelphia, are filling up a contract for one thousand of the thirty inch pipe, to form the principal main between the pond and the city."

STEAM BOAT WANTED — "The Oregonians are determined to have a steam tow boat, so that vessels may be brought up the Columbia River with safety. The wind blows down the river five months of the year, and vessels are said to be two months in sailing up 100 miles, whilst the difficulty could be easily overcome by steam, and a large trade opened with the Pacific."

FALLS DISCOVERED — "There has been a new water-fall discovered in the river of St. Louis. This cataract falls into the Western part of Lake Superior, which has not yet been described by the geographer. . . The volume of water is immense, and the height of the fall is fifty feet."

CHROMIUM — "Chromium is a metal of a greyish color, very difficult to fuse. It unites with oxygen and forms a fine green oxide. This is the basis of a fine yellow paint."

At Philadelphia, a testboard man answers as an electronic watchman calls attention to conditions on one of the coaxial systems to Baltimore and Washington

"Send Help to Manhole 83"

Strung out along every Bell System coaxial cable, electronic watchmen constantly mount guard over your voice. Some are in manholes under city streets; some are in little huts on the desert. Most situations they can deal with; if things threaten to get out of hand, they signal the nearest testboard.

Principal care of the electronic watchman is the transmission level. Sun-warmed cables use up more energy than cold ones, so a transcontinental call may take a millionfold more energy to carry it by day than by night. Each watchman — an electronic regulator — checks the transmission level and adjusts the amplification which sends your voice along to the next point. Many hundreds of regulators may be at work on a single long distance call.

Without automatic regulation, the precise control of energy in the Bell System's long distance circuits would be a superhuman task. So Bell Laboratories, which in 1913 developed the first high vacuum electronic amplifier, went on to devise the means to make them self-regulating in telephone systems. This is one reason why your long distance call goes through clearly, summer or winter.

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

FIGHTING FRICTION

UNDER the title "18,000 Ways to Fight Friction," an article in our October issue will tell the complete story of anti-friction bearings and their little-short-of-miraculous performances in modern industry. Some examples: Farm machinery, formerly equipped with plain bearings requiring an hour or more a day for adequate lubrication, now is built around anti-friction bearings which require greasing only once a season, saving not only time but also fuel and oi' as a result of easier starting and running. Users of industrial conveyor belts have found that ball and roller bearings not only stand up better under adverse operating conditions but also have far lower replacement records than plain bearings. There are some 2700 anti-friction bearings in the new XC-99 Consolidated Vultee transport plane which, weighing 265,000 pounds, will be capable of carrying 100,000 pounds of cargo; the bearings are in the six 3000-horsepower engines, the landing gear, ailerons, rudders, flaps, and so on.

Thus is exemplified the increasing importance of anti-friction bearings, from the size of the lead in your pencil to the size of your hat . . . and larger.

KEEPING IT COOL

REPORTED to have a lower thermal conductivity than still air, heretofore theoretically considered the most efficient thermal insulator, a new material is 6 percent silica and 94 percent air. Chemically known as an aerogel, this new insulator is so efficient that it will make possible an increase in refrigerator and freezer capacity of up to 60 percent. Preliminary reports on practical applications of this insulator indicate that a household refrigerator using it can be increased from seven and a half cubic feet capacity to eleven cubic feet, merely through the reduction in wall thickness made possible by the efficiency of the new material, available as a fine powder or in irregular lumps up to one half inch in diameter.

IS THERE A DOCTOR IN THE HOUSE?

WHEN costs soar and sales decline, that's the time to call an industrial doctor. Just as an abdominal pain warns against the use of a physic and calls for consultation with a qualified physician to determine the presence or absence of acute appendicitis, so does an unusual business condition call for the services of an expert. Such experts, generally known as "management consultants," specialize in cost-cutting, standardization, sales advice, and similar procedures which many company management men overlook because they are too close to the woods. . .

Don't get the idea that these management consultants are valuable only to small concerns. Witness the expenditure of $1,500,000 by United States Steel Corporation over a three year period for such services. On the other hand, the investment of a few thousand dollars for a systematic study of a wage incentive plan or a market survey may mean the difference between profit and loss, even in a relatively large operation where tradition, sentiment, or simple pig-headedness on the part of company officials may be unseen stumbling blocks.

WHAT DO EMPLOYEES WANT?

ALL TOO often management tries to guess at the things that employees want, at the things that will make for better industrial relations, for greater output, lower costs, and the like. When these things trouble executives, let them go to the right source for the answers—to the employees themselves. The National Drygoods Association recently undertook such a survey. They asked eight questions of employees and supervisors. Here are a few samples from the final tabulation: Employees placed first the desire for credit for work that they are doing; supervisors guessed that this factor would take seventh place. Second, employees wanted interesting work to do; supervisors guessed that this would be third in importance. Third in employee preference came fair play and salary increases; this is the element that supervisors placed first. Last on the list of worker-preference was job security, which the same supervisors had placed second.

Moral: If you want to know what a man wants, ask *him* . . . not his boss.

STRAWS IN THE WIND

INCREASED use of Diesel engines, which offer the greatest thermal efficiency of any proved type of power, is seen as the result of fuel shortages for all types of engines. . . Wood, oldest structural material used by man, is being subjected to intensive study in an effort to determine causes of decay and precise means of preventing the losses which result; gains will be not only in the preservation of the material itself but also in fewer replacements and in reduced costs of labor in making repairs. . . Radiant heating for homes, still in the pioneer stage but making rapid strides, is now being accomplished experimentally by means of electrically heated ceilings; the current passes through a heating element of conductive rubber sandwiched between two thin layers of plastics. . . Electrical insulation, still much the same today as it was a century ago, is receiving increased attention from chemists; new and improved insulations are needed if high-voltage techniques are to progress.

ARC WELDING is being HANDICAPPED

"Great and Unnecessary Expense is Being Put on the Manufacturer Using Welding. This, of Course, is Paid by the Buyer in Higher Prices. No Possible Return Accrues to the User"

Says *JAMES F. LINCOLN*
President, Lincoln Electric Company

EDITOR'S FOREWORD: Some months ago a thought-provoking letter was received from Mr. Lincoln regarding limitations and restrictive tests placed upon arc-welded joints, but not on similar joints designed for similar purposes and completed by riveting. We decided to publish Mr. Lincoln's views but first made intensive efforts to present the subject in debate form, with a representative of the rivet-manufacturing or using industry as Mr. Lincoln's verbal opponent. Our efforts bore no fruit. But more of this later. First, Mr. Lincoln's letter:

"ARC WELDING has been of decisive importance to America. Arc welding did more than most other manufacturing processes in the producing of the tools of war during World War II. Arc welding has produced a record for reliability in billions of welds, made over many years, that is unmatched by any other manufacturing process, yet arc welding is being attacked in a way which is tremendously handicapping its application, and promises still more to interfere with its future uses.

"This attack is aimed not at the process, as such. It is obvious such tactics would fail. The attack con-

sists in throwing suspicion on the process by writing into specifications expensive and impractical tests which have little to do with the excellence of the weld. Most of them have to do with infinitesimal variations of no possible importance, but of great cost. The attack has already eliminated the economic use of arc welding in many proper applications. If continued, it will soon eliminate many others.

"We see, for instance, the ruling that welds must be X-rayed, which increases the cost by several times, yet the commercially welded joint is always of greater strength than the parent metal and is tremendously stronger than any riveted joint, where X-raying never has been suggested.

"We see riveted joints which are made tight by caulking. This process is accepted without question. The resulting undercut is enormous, yet a welding undercut that is infinitesimal is frequently made the reason for rejection of welds.

"We see welds chipped out, re-welded, and welded vessels rejected because of trifling defects such as infinitesimal porosity either on the surface or beneath, yet parent metal in the same structure with defects much greater, and whose weakening effect would be tremendously more serious, are accepted without question.

"We see welding electrode specifications being written which enormously increase the cost of production with no increase in either the reliability nor in the excellence of electrodes. Rivets have no such test to handicap them.

"While a welding electrode is tested in every conceivable and nonsensical way, no one suggests any test on a rivet, yet the riveted joint is always the weakest spot in any structure. This is never true of a full-sized welded joint.

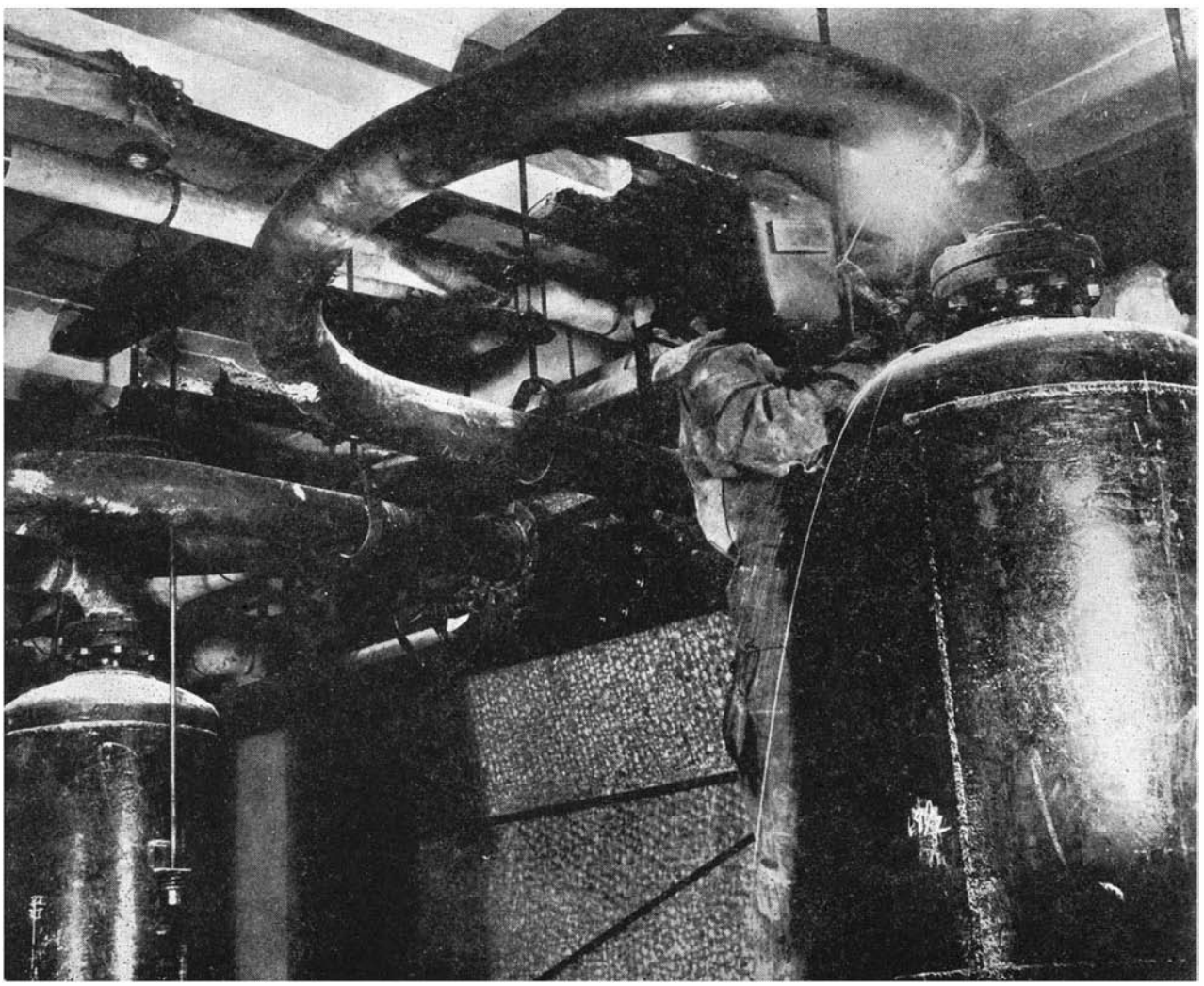
Much time and expense is used in testing electrode deposit to make sure it has great ductility and the weld is rejected if the ductility is low, yet riveted joints have no elongation and are accepted without question.

"The contour of the deposit of a weld is a matter of very close inspection, yet no one examines the contour of any rivet or the hole it only partially fills.

"All insured vessels must have their welds X-rayed and any weld is rejected if any infinitesimal defect is found, yet no one X-rays a riveted joint nor rejects it because of the voids between the rivets and the rivet holes which are known to be always present.

"Because of the higher elastic limit of the weld metal, there is no load that can be put on a welded

Welded steam pipe in this heating plant is giving satisfactory service, was economical to fabricate



structure in which the weld is of equal or greater section than the parent metal which can affect the weld in any possible way until great distortion of the rest of the structure has taken place. Such distortion would make that structure valueless for its intended purpose, yet all this testing and rejecting listed above is made mandatory in many welded structures—never in riveted structures.

"Further instances of the same kind can be cited by the scores. The examples shown are sufficient for the author's purpose.

"Welding over the years has done a more reliable job than the rivets it has replaced. That record is conclusive. The engineering profession, which relies so completely on welding in so many cases, must recognize and resist this studied attempt to eliminate the arc-welding process. The attack has already eliminated the economic use of welding in many structures. The success of such an attack on this tremendously valuable method is neither good advertising for the engineering profession nor good ethics for those involved in the attack. It is time we dealt with reality."

REFUSAL TO DEBATE — Several invitations were issued by the editor to various people who should be in a position to defend the status of rivets in a controversy of rivets-versus-arc-welding. In every case the issue was avoided. Typical was the reply of Mr. Herman H. Lind, President of the American Institute of Bolt, Nut and Rivet Manufacturers. Said Mr. Lind: "It is not in line with the policy of this organization to disparage any other method of fastening, and we do not believe that a debate of this kind could work out otherwise. Therefore we will simply proceed along the line we have been following of selling the virtues of bolted and riveted connections."

The editor did not feel that the proposed debate would necessarily involve a disparagement of other methods of fastening. A letter to this effect went forward to Mr. Lind but remained unanswered.

Now back to some other correspondence with Mr. Lincoln: In attempting to rationalize the reasons why restrictions are placed on arc welding which are not placed on riveting, the editor wrote Mr. Lincoln as follows: "Riveting is the old-timer and arc welding is the child. There is little or no danger that riveting will change the metallurgical structure, whereas arc welding often will do so. Then, too, riveting produces 'exposed' joints fully opened to view; arc welding produces what might be called a 'covered' joint. For this reason arc welding may be open to suspicion."

Replied Mr. Lincoln: "I must admit that I do not get the point you make that welding changes the metallurgical structure of steel whereas riveting does not. If you mean that the rapid heating and cooling makes a fundamental change in the steel, there is no doubt there is a slight change of no particular importance, but I am under the impression that the heat of a rivet would, to some extent, do exactly the same thing. But in neither case would it be controlling to any extent."

ANALOGIES AND TESTS — While the editor was making further unsuccessful efforts to promote the rivet-versus-arc-welding debate, another detailed communication was received from Mr. Lincoln. It follows:

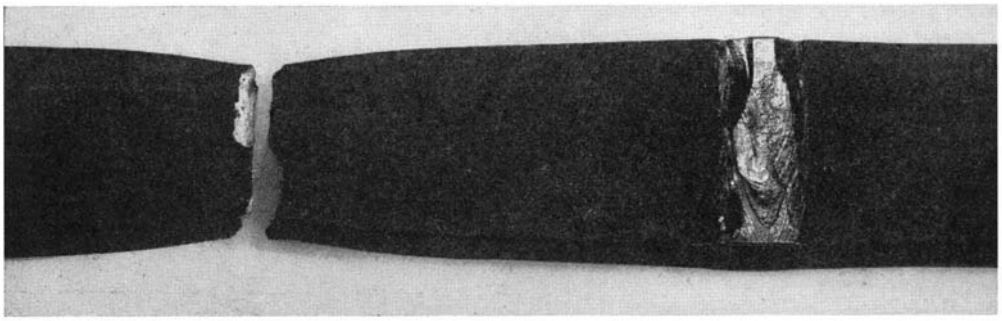
Not a single welded joint in a mile of pipe in a factory steam distribution system showed even a pinhole leak under hydraulic test at 400 pounds gage

"Some time ago I wrote you regarding unnecessary handicaps now forced on the welding process. Since that time, I have become even more disturbed.

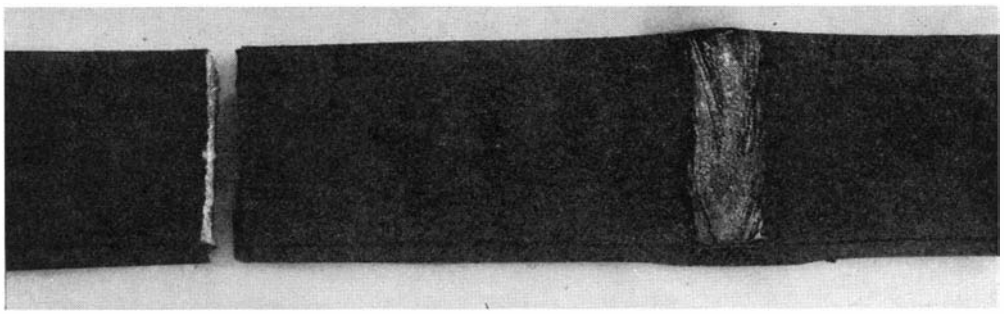
"Anyone following the standards and discussion covering arc-welding electrodes and techniques cannot help but wonder. Here is a process that has been used in billions of cases for every imaginable purpose over a generation, whose record has been almost perfect, yet it is criticized and limited more than any comparable process in all mechanical history. The criticism is not because of failure, as there is none. The criticism is entirely in the region of theory covering conditions which could never occur in commercial application.

"Anyone who views the situation objectively cannot help but wonder whether the people writing such standards and making such researches can possibly be serious.

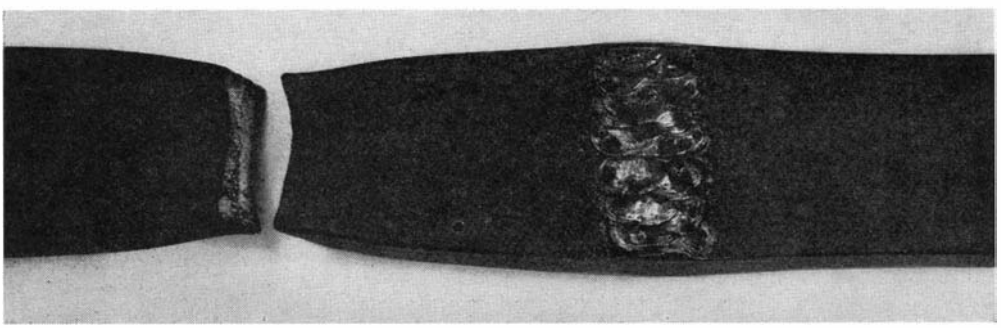
"There is one controlling fact regarding welded structures which, from a practical point of view, makes all of this activity nonsensical. That fact is



Although the weld in the test specimen at left had an abnormal amount of undercut, the specimen failed in plate when subjected to a tensile pull of 59,400 pounds per square inch



The welded joint (right) was extremely porous, yet did not yield under tensile test; specimen failed in plate at 62,500 pounds per square inch



Abundant surface porosity in weld at left did not affect the service-strength of the joint; the specimen failed in plate at 59,100 pounds per square inch

this—in the case of mild steel, which embraces more than 95 percent of all the welding which is done, the welded joint is very much stronger and has a very much higher elastic limit than the plates joined.

"Since that is true, the weld can never be used in actual service at anywhere near its point of failure. As a matter of fact, in actual application if the welded structure should be loaded to a point which would even approach the elastic limit of the welded joint, or the metal immediately adjacent to the weld, the structure itself would be useless.

"Perhaps we can illustrate the matter this way: Suppose there is a chain of 100 links, each link being made out of one-inch round, 99 of these links being made of mild steel and one link made of high-strength alloy steel. Then suppose the chain were tested. Would anyone worry about the chain breaking in the one alloy link? He would not, because every one of the other 99 links would break long before the alloy steel link was even partially loaded.

"Exactly the same thing is true of a welded structure. The weld itself and the metal immediately adjacent to it has an elastic limit 50 percent above that of the parent metal and has ultimate tensile strength at least 20 percent greater. If the strength of the rest of the structure is sufficient, certainly the weld must be. As a matter of fact, structures are designed with a factor of safety so that at its maximum load the structure would not be up to one half of the elastic limit of the parent metal. Obviously, it would not be stressed to more than one third of the elastic limit of the weld metal and the plate immediately adjacent to it. Using our illustration, why should we worry about the alloy steel link when the mild steel chain is not loaded to its yield point?

"Because of this program of criticism, great and unnecessary expense is put upon the manufacturer using welding. This, of course, is paid by the buyer in higher prices. No possible return accrues to the user. There are countless illustrative cases that could be cited; the following are examples. If there is surface porosity, even so much as a little hole on the surface, the weld is rejected. If that same little hole were below the weld surface where it could not be seen, the manufacturer must cut it out carefully and *re-weld the joint,* at great expense, after finding it with expensive X-ray. Again, if there occurs slight undercutting at the edge of the weld, the weld must be re-welded and the slight undercut eliminated.

"Perhaps we could understand such rules if they were not made by engineers who obviously know the facts. However, all such rulings are made by men who insist they are expert in the profession of arc welding. Hence, the conclusions are not based on ignorance.

"While the accompanying photographs of test

samples show facts that are well known to all those who are versed in the art, they are shown again to bring out the obvious facts. Here is the proof of all the above statements regarding the efficiency of welded seams with so-called defects. Here is porosity carried to the greatest extreme that skill can take it, yet the joint is stronger than the plate. Here is great undercut and even laps in the weld; still the plate breaks in tension. Not only would such joints be rejected, but if they had 1 percent of these so-called defects the structure itself would be rejected. The question naturally is asked, 'Why?'

"It is perfectly obvious that there could not possibly be a riveted joint which could join any of these pieces of steel together in any way which in tension would not break, yet there is no testing of the rivets, no X-ray of the voids in their joint, no elimination of the undercut. Yet we know in every riveted joint that all of these defects are present not only occasionally, but in every case. Again we ask the obvious question: 'Why accept such defects in a riveted joint and reject them in arc welding with its greater strength, ductility, and soundness?'

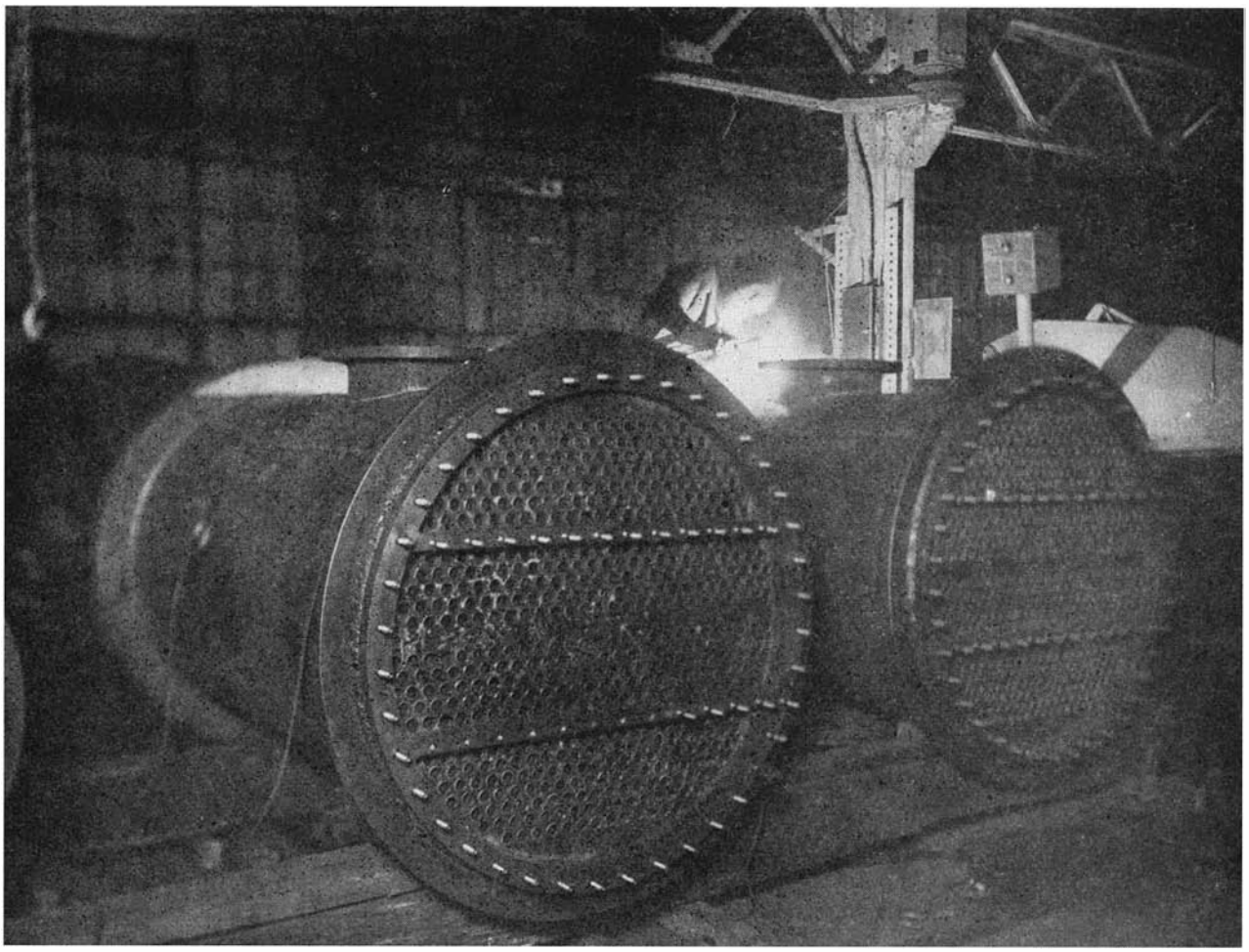
"Engineering has contributed to America's prosperity in an unbelievable way, but I tremble to think what would occur to our prosperity if all engineering were as remiss in its understanding of the problem as is true of many engineers' attitude toward electric welding.

"There is no doubt that if the foolish restrictions, which can add nothing whatsoever to the success of any welded joint, were removed, the cost of welding those structures could be reduced by as much as 90 percent in many cases, yet because of these restrictions, concurred in by many engineers, the industry paid hundreds of millions of dollars in additional costs over the years with no increase in safety and no betterment of the product from any point of view.

"These same restrictions still stand and are being rapidly amplified. There can be no doubt that their presence is not the result of engineering judgment. It is impossible to believe that can be true. There can be only one reason and that is a studied attempt by some people to discredit this tremendously valuable manufacturing process which contributed more to the winning of the war and to the production of a standard of living than almost any other recent mechanical development. Such a program must be stopped."

NO REPLY — Still the editor has been unable to secure authoritative arguments in favor of riveting, answering the forthright statements made by Mr. Lincoln. Admittedly we have not canvassed the *entire* field, have not approached *everyone* concerned with the process of riveting. Perhaps the publication of this correspondence will bring forth some interesting discussion. Comments are invited.

Fabricating a pressure vessel with the "Shield-Arc" welder at Lasker Brothers' Chicago plant

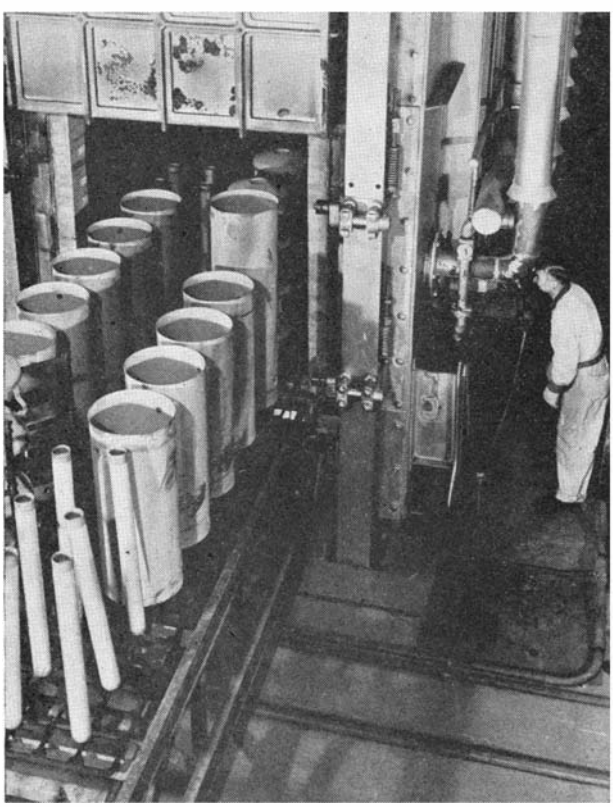


Porcelain Coats on Metal Bases

Research by Porcelain Enamelers and Steel Producers is Aimed at the Development of Even Thinner, Even More Resistant Coatings Which Will Improve Countless Products for Both Home and Industry

By Edward Mackasek
Managing Director, The Porcelain Enamel Institute

Porcelain enameled parts coming out of the firing oven



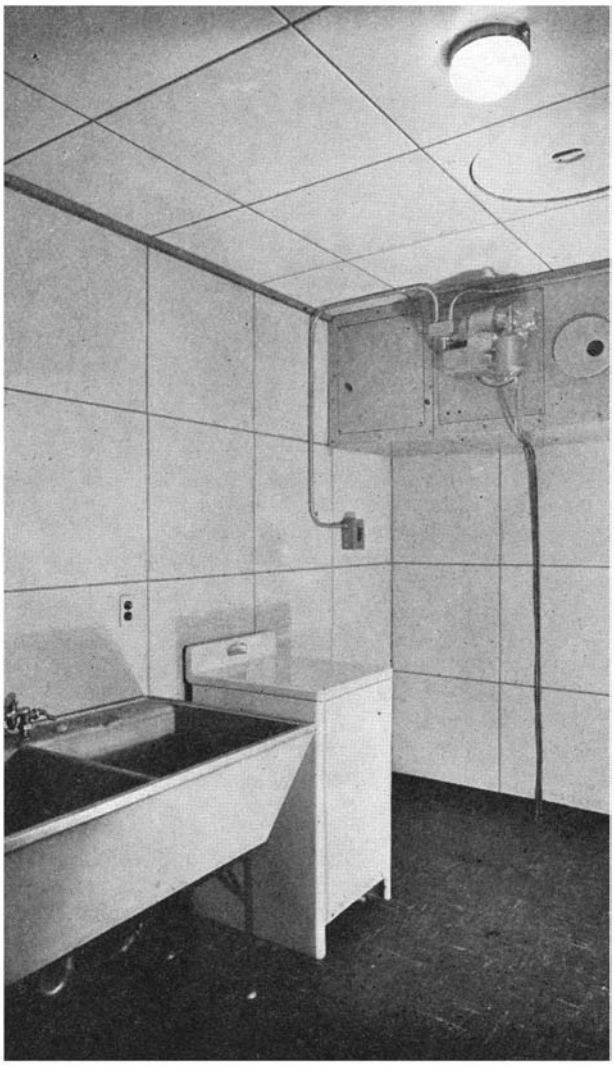
IT MAY seem somewhat paradoxical to say that porcelain enamel has come of age, since it is a material which was well known to the ancient artisans of Egypt, Greece, and Rome. Yet it is true in the sense that this surface finish is contributing more and more to our modern standards of living and has become an important factor in many industrial operations.

Porcelain enamel is an inorganic, glass-like material, fused to an iron or steel base at a temperature of usually between 1500 and 1600 degrees, Fahrenheit. The resulting coat has a smooth, glossy surface and is held firmly to the metal by both mechanical and chemical means.

To the ancient craftsman, the value of porcelain enamel lay in the beauty that he could create with it; today, porcelain enamel is usually thought of in terms of the services that it renders. Modern research, spurred on in the past few years by war-time necessity, has brought out a wider variety of utilitarian properties of porcelain enamel than were recognized before. New porcelain enamels, incorporating these superior qualities, are now available to manufacturers, and it is anticipated that these enamels will continue to broaden their applications for domestic, commercial, and industrial use.

So many and so varied are today's porcelain enamels that it is necessary to regard the phrase as the family name of a large group, rather than as denoting a single substance. In selecting a porcelain enamel, the manufacturer specifies the condition under which his product is to operate, and a porcelain enamel is selected for this service. Thus, enamels may be chosen for resistance to abrasion or gouging, to acids or alkalies, to atmospheric corrosion, or to heat.

IN THE HOME—It is its high resistance to heavy wear and its pleasing appearance, in addition to the fact that it is so easily kept sanitary, that has long made porcelain enamel a favorite for kitchen and bathroom fixtures. A newer application of this surfacing is to the exterior of houses, stores, service stations, and so on. Here, bright, colorful porcelain enamel can retard weathering, virtually eliminating costly maintenance. Roofs, shutters, awnings, entrance hoods, window boxes, and decorative items are also being finished in porcelain enamel. Inside, porcelain enameled clothes chutes will add to the importance of this household utility. Porcelain enameled hot water heaters are finding increasing use in the home.



In the laundry room, as in the rest of this house, all of the walls and ceilings are of porcelain enamel

And a host of other items are on the designers' drawing boards or coming from production lines—such items as porcelain-enameled parts for fruit juice extractors, electric mixers, and other appliances for the housewife's convenience.

IN INDUSTRY — Of even greater importance, however, are the industrial applications of porcelain enamel which have multiplied too, making for better, longer-lasting machines, and overcoming some provoking mechanical service problems.

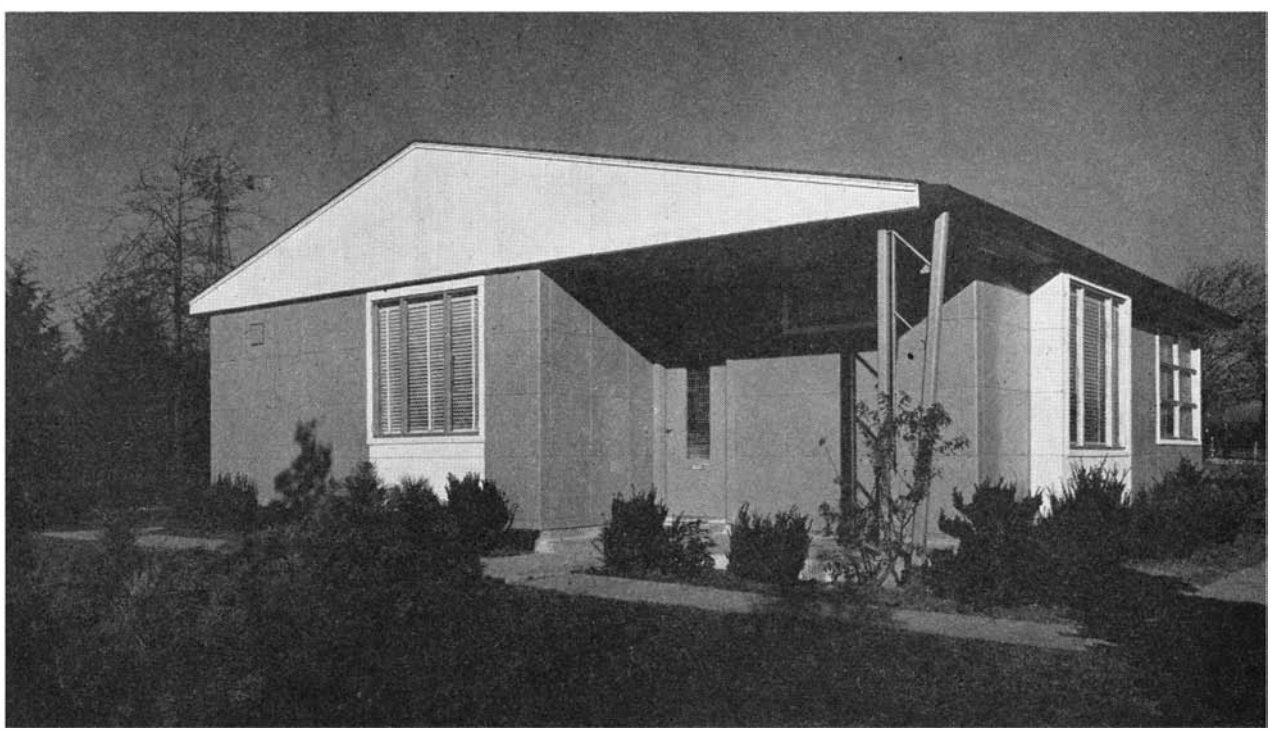
A new type bearing, particularly suited to pumping equipment for corrosives, is entirely coated with acid-resisting porcelain enamel, and can be lubricated with anything that is liquid. A deep-well turbine pump, equipped with such bearings, has been successfully handling corrosive oils for five years. These bearings have also been adapted to boats, to pumps of many other kinds, and to chemical equipment.

Porcelain enamel coats applied to electric motor parts which are subjected continuously to friction have outworn many other materials tested. As a coating for light-metal casting crucibles, porcelain enamel shows possibilities as a refractory. And porcelain enamel offers many interesting dielectric properties.

During the war the Navy sought a coating or material for submarine exhaust stacks which could withstand both blistering heat and the corrosive action of

This prefabricated house makes extensive use of porcelain enamel for both interior and exterior surfaces

Courtesy Lustron Corporation



sea water. Porcelain enamel research produced a special heat and corrosion-resisting coating which handled the job not only on submarines, but later on aircraft and other types of engine exhausts. While primarily a war project, this achievement now shows promise in many applications where both high temperatures and corrosive atmospheres or liquids are a factor. Among these are the piping and equipment of oil and gasoline refineries, synthetic rubber plants, chemical and food processing plants, power plants, hydro-electric equipment, corrosive-carrying pipe lines, and many others.

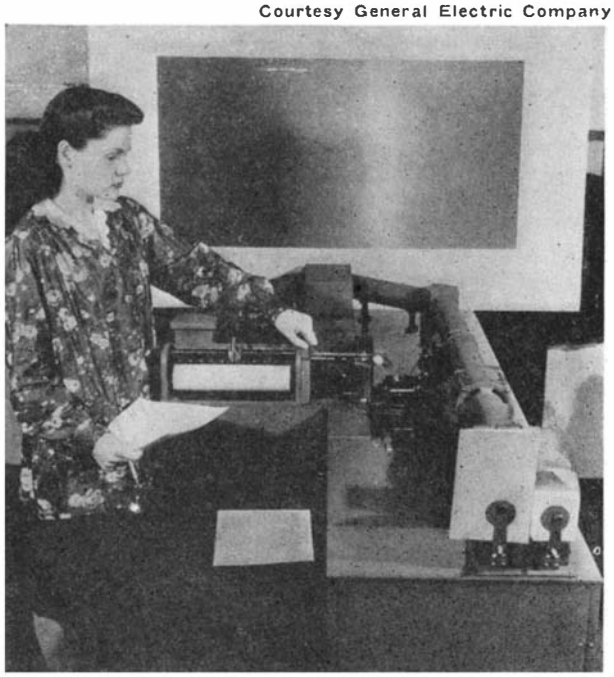
The refractory qualities that can be built into porcelain enamel can be appreciated when it is realized that some new coats running in thickness as low as .002 to .004 inch can withstand exposure to temperatures above 1500 degrees, Fahrenheit. Such enamels are able to function satisfactorily even when subject to sudden drops of temperature amounting to several hundred degrees. These special refractory-type coats are being explored further to find out whether they can be used on jet turbines where the rapid destruction of the housing metal at the high temperatures of operation is a serious problem.

TOWARD THINNER COATINGS—One goal toward which the porcelain enamelers are working is thinner coatings. Reducing the thickness of the coatings is desirable primarily because it lowers cost of application and increases serviceability. The thinner coating makes possible greater flexibility and impact resistance, thus permitting a wider range of product design.

Ten years ago, a porcelain enameling manufacturer regarded a total thickness of .025 to .04 inch as quite satisfactory. Today's improved porcelain

Color variations between batches of enamels can be determined by the use of the spectrophotometer

Courtesy General Electric Company



• LOOKING AHEAD •

Depreciation of buildings retarded by application of porcelain enamel to exterior surfaces. . . Simpler, more efficient handling of many corrosives. . . Possible solution of high-heat problems in jet engines. . . . More effective porcelain enamel coatings at lower cost.

enamels and improved enameling irons make it possible to establish specifications for ordinary work of .015 inch or less. These improvements have been obtained without impairing light-reflectance or appearance. In fact, it is probable that much thinner coatings with even higher reflectance will soon be available.

These thinner coatings of improved quality will have increased service life compared with the thicker enamels. The chief struggle in their development is to produce them more economically.

TOWARD FEWER COATINGS—The usual porcelain enamel application has been three coats—a ground coat or base coat, and two cover coats—each applied and fired individually. To reduce the required number of coats has been the objective of much recent research. The enameler's fondest dream is to do away entirely with the conventional ground coat, which would mean a vast expansion of porcelain enamel into many new fields. For many purposes the new super-opaque enamels, some containing considerable amounts of titanium oxide, have permitted a reduction in the number of coats.

At the end of World War I, the porcelain enameling industry found its operations seriously threatened by the shortage and rapidly increasing price of tin. Tin oxide was considered an indispensable ingredient that provided the opacity of white enamels. As evidence of the progress which has been made since then, tin oxide is now used very little in the industry. It has been replaced by oxides of antimony, zirconium, and, more recently, titanium. At the same time, efforts to increase opacity have been paralleled by research to reduce the quantity of enamel needed to provide the required degree of reflectance. Titanium opacified enamels are relatively new, but they have created a great deal of interest. It is now possible to achieve a high degree of opacity, as measured by reflectance, with a light-weight application; in some cases less than one half as much as for other enamels.

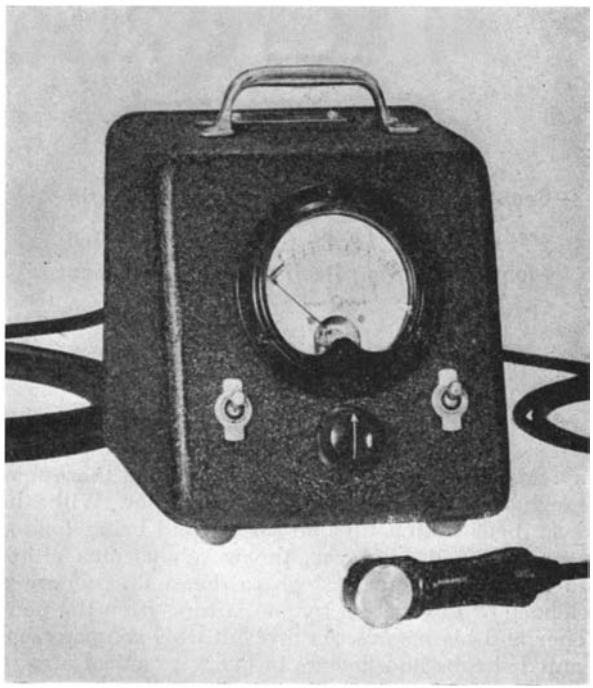
Using a new zirconium-type white cover coat, a number of porcelain enameling plants have been able to speed up their furnace operations, and thus achieve a real economy in operation. Usually the ground coats must be fired at higher temperatures than the cover coats, necessitating separate processing for each. With the new zirconium type, it is possible for both ground coat and cover coat to be fired on the same furnace chain.

The industry is following with keen interest the work being done to formulate porcelain enamels that will mature or fuse at temperatures lower than the

1500 to 1600 degrees, Fahrenheit, required for conventional types. Such low-fired enamels, if feasible, would help products which have been highly stressed by forming operations to hold their shape when subjected to enamel-fusion temperatures.

STEEL INDUSTRY HELPS — A vast amount of research lies back of the high-quality iron and steel that go into many products; nowhere is this more true than in the case of objects which will be coated with porcelain enamel.

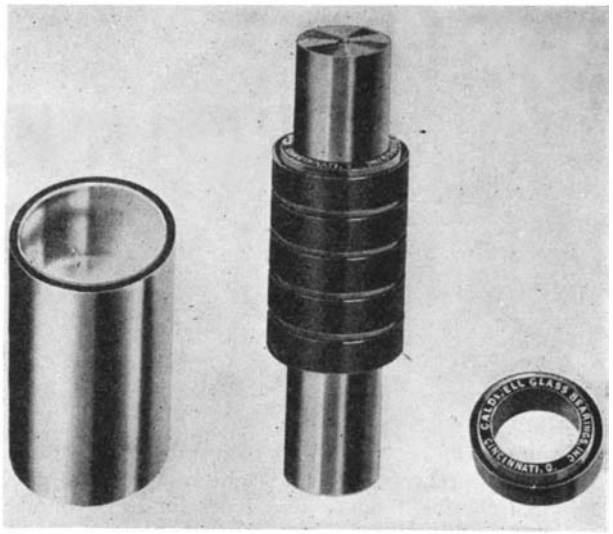
At the turn of the century, most of the metal for porcelain enameling came from England. Today, American steel suppliers produce enameling stocks considered the best in the world. A porcelain enameler cannot use the ordinary grades of sheet metal. The high temperatures reached in this process demand a metal that can "take it." The steel industry has responded with sheets which have enabled the manufacturers to turn out high quality porcelain enamel products at low cost.



Courtesy General Electric Company

With this gage, the manufacturers of porcelain enameled products can check accurately the thickness of coatings

Today the steel companies are working even harder to provide the industry with improved enameling stocks on which porcelain enamel may be applied in one fire without the use of the conventional ground coat. Such new stocks would speed up the production line and lend themselves to thinner applications of super-opaque enamels, permitting thicknesses of .004 to .006 inch instead of present accepted coatings ranging to .05 inch. The accomplishment of such a forward step will multiply by many times the various applications of porcelain enamel. It is expected that the ultimate product from such a development will cost less, even though the improved metals and enamels may cost more, since the improvements will provide such great production savings.



Courtesy Caldwell Glass Bearings, Inc.

Rubber parts in porcelain-enamel bearings, when wet, slide over the enamel bearing surface with little friction

STANDARDS ESTABLISHED — Quality control depends upon the availability of methods for the measurement of specific properties. In the past decade the porcelain enameling industry, through its trade association, the Porcelain Enamel Institute, in co-operation with the National Bureau of Standards, has developed a series of standard tests to evaluate porcelain enamel properties. With these tests manufacturers can now check the quality of the finish on their products. These tests have become the basic tools of the research engineer in evaluating the properties of different enamels, and have proved of invaluable assistance to him in his constant search for better formulas. They have enabled the specifications writer to establish definite procedures for measuring the level of quality that he has written into his standards.

The Porcelain Enamel Institute tests now cover the following properties: acid resistance, reflectance, abrasion, impact, and torsion.

Porcelain enameled product manufacturers no longer need depend upon human eyesight, with its uncontrollable variations, to judge the qualities of their finishes; mechanical controls are used. The thickness of the coating, which bears such an important relation to its service, can be accurately checked to the thousandth part of an inch by a new electromagnetic gage. Reflectance is scientifically measured by an instrument called the reflectometer. Ability of the finish to withstand hard wear and tear in service can be determined by a special machine developed at the National Bureau of Standards which gives an index of surface abrasion. Color matching has been greatly facilitated by a new color analyzer. Thus, guesswork as to quality has been eliminated and standards of known quality can be set up to guarantee any desired performance.

BETTER GROUNDS make BETTER FACTORIES

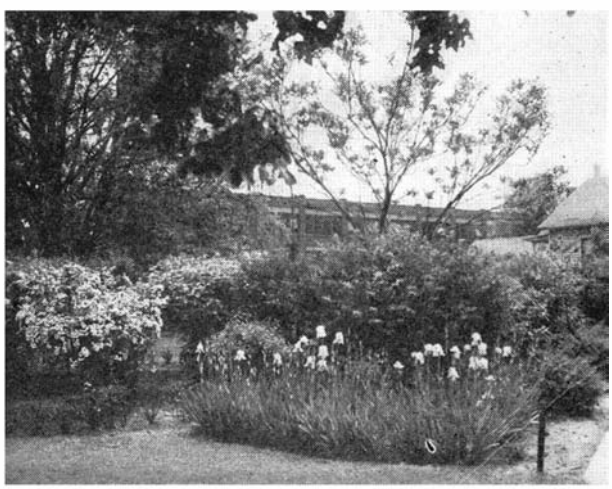
By Edwin Laird Cady

Beautification of Factory Grounds, Considered by Some To Be at Best a Waste of Money, Is Proving Itself a Sound Investment

HIGH ON the activities lists of hundreds of industrial purchasing agents right now are the selection of shrubs, flowers, and trees for the grounds around their factories, and the placing of the 1948 contract for planting and caring for them.

Not very long ago such an activity was considered a show-place stunt, a waste of money, even a form of vulgar ostentation. Factory exteriors were supposed to look "practical." But now industrial managements have learned that well-kept grounds have high values. And, from companies which have 50 factories to factories which have 50 men, the practice of good grounds-keeping is growing.

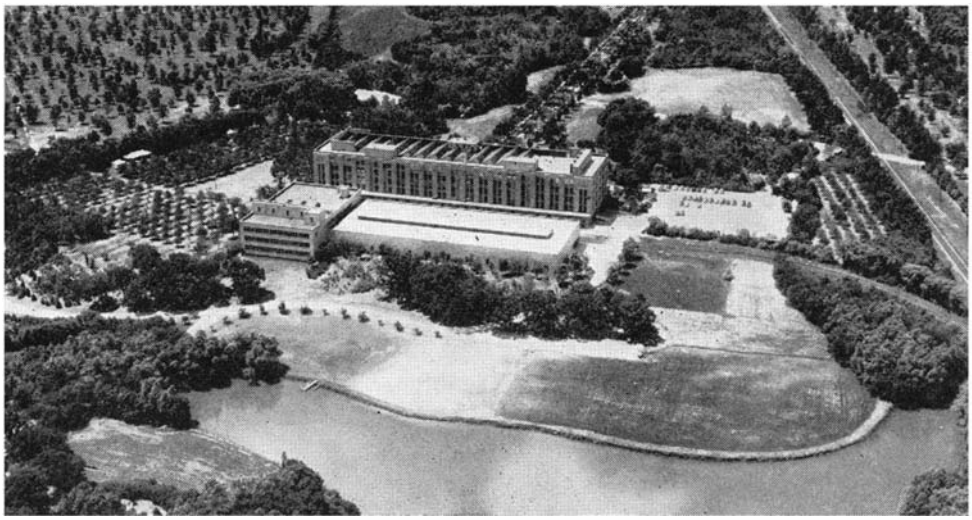
One of the values is the promotion of safety. In a recent survey hundreds of factory managements reported that well-kept grounds are second only to good interior housekeeping as a way of inducing employees to observe safety rules. There is something about a plant which is neat and orderly outside and in, that makes the better employees want to be orderly and safe about their machines.



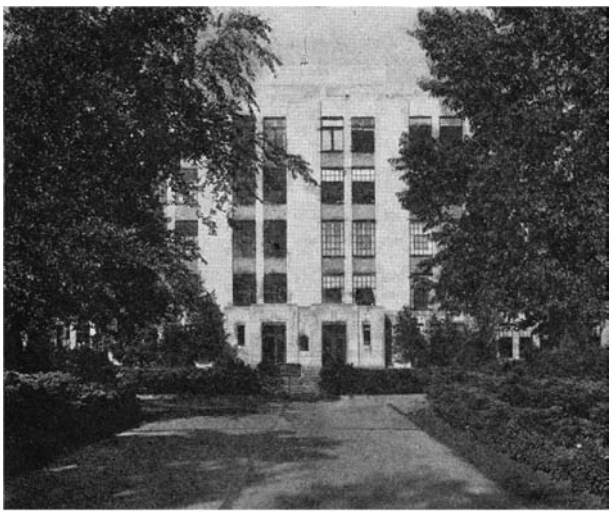
The grounds of the Upson Company are of exceptional beauty

A plant which handles a great many bulky steel items thought that good grounds-keeping was impossible. The land was needed for trucks and for railroad tracks. But the planting of flower beds in odd corners changed this idea. Warehouse and materials-handling employees had been "temporarily" piling excess stock in these corners just to get it out of the way. All too often the stock had remained there long enough to be damaged by the weather. With the flower beds taking up that space, and being tended by a pensioned employee, the warehousemen either had to take the excess stock to the shelter where it belonged or else take a tongue lashing from the pensioner and his friends. As a result, this company has planted shrubs and flowers in every practical area.

AIDS DUST CONTROL — A company which makes ball bearings and other precision devices found a practical value for landscaping in dust control. Originally these grounds had been planted to lawns and



Landscaping at the plant of the Jewel Tea Company, Inc., is not limited to the front of the building (below), but includes a considerable amount of land on all sides of the plant (left)



• LOOKING AHEAD •

More and more stress laid on esthetics in industrial plant design. . . The term "factory town" losing its stigma. . . Results—an upswing in efficiency, safety, and comfort in the plant. . . Better living conditions and higher property values in factory towns.

trees because the president refused to have his factory look any less attractive than his home. But after the trees had developed and lawns had grown for a year or so, the factory maintenance engineer noted that there had been a profitable reduction in the problem of keeping dust out of the plant during the dry summer months. And dust, of course, is one of the worst enemies of precision production.

The sales value of good grounds-keeping can be astonishingly high. A study which was made to find out which local factory had made the best impression on its community found many of the citizens mentioning plants which were thousands of miles away. They remembered these distant factories which they had seen while on vacation tours; furthermore, they had bought goods, invested money, taken other actions for the benefit of those companies.

DISPLAYED WITH PRIDE — A maker of kitchen ware, wondering at the influence which its factory gardens seemed to have on sales, found that much of the value came from local townspeople. The factory had become a showplace, something which the local people displayed with pride to all who visited them.

Community spirit makes a big difference. Cities like Rochester, New York, have so many beautifully landscaped factories that it seems difficult to find an ugly plant there. The city of Louisville, Kentucky, awards an annual garden club prize to industries; calls it the Beautification League Prize. But in many another town the factory grounds look like dumps.

One of these ugly cities is just waking up. The secretary of the Chamber of Commerce is doing the awakening. He visited a fellow secretary in a distant city and took a busman's holiday in going around to see how the other fellow worked.

There was the usual business of persuading new industries to settle in the town. He heard the familiar arguments about taxes, concessions, railroad sidings. But these discussions were carried on while riding past one beautifully landscaped factory after another, and while going inside to see the neat housekeeping which follows so naturally with a well-groomed plant exterior. And he saw that those well-kept grounds created a favorable sales atmosphere just as a well-decorated store will do.

Now he is back in his own town and building up the same community picture. Two local factories have begun their lawns and other landscaping, while others have made their plans for 1948. Efforts are afoot to have the local horticulturists make a master industrial plan for the town, fitting each plant into the background of homes or fields that surround it.

Within a year or so this will be a truly beautiful factory town. It will be the only one in its section of

a large industrial state. And since prospective new industries usually consider several towns within the same general region, the secretary of the Chamber of Commerce will have the sales advantage over all his neighboring communities for a long time to come.

Planning the landscaping in relation to a community poses some interesting problems. The Boston and Maine Railroad, for example, likes to create the feeling that it belongs to its communities. It therefore has learned to use only the shrubs that the local home owner might plant in his own lawn or garden, the kinds that will make him "feel at home."

CHECKS EROSION — In the far west, one of the oil companies has a chain of refineries, by-products plants, and service stations, all in a territory where soil erosion by wind and by water drainage is a serious problem. Shrubs and other beautiful plants of soil-holding varieties are therefore planted on an experimental basis around all the company buildings. New varieties are tried every year, together with the kinds which have proved themselves. Employees are encouraged to learn about these plants and to explain them to any callers who express interest.

High minded as this procedure may seem, the company also is protecting its own pocketbook. Soil erosion does not have a good effect upon the sale of gasoline and of other products in any territory.

This company is one of hundreds which try out new varieties of shrubs and plants, talk about them in their company magazines, take photographic records, then make up combination orders so employees may have the advantage of bulk prices in beautifying and improving their own homes. Behind this procedure is the idea that good housekeeping and safety practices begin in the home, that what the employee practices in the upkeep of his house he will follow in the protection of his place of work.

The actual buying and selecting of the shrubs is a careful procedure. For new factories it may be left to the architect. For older plants the horticulturist may be called in. But many managements prefer to have the selecting and planting done by employees who follow gardening as a hobby.

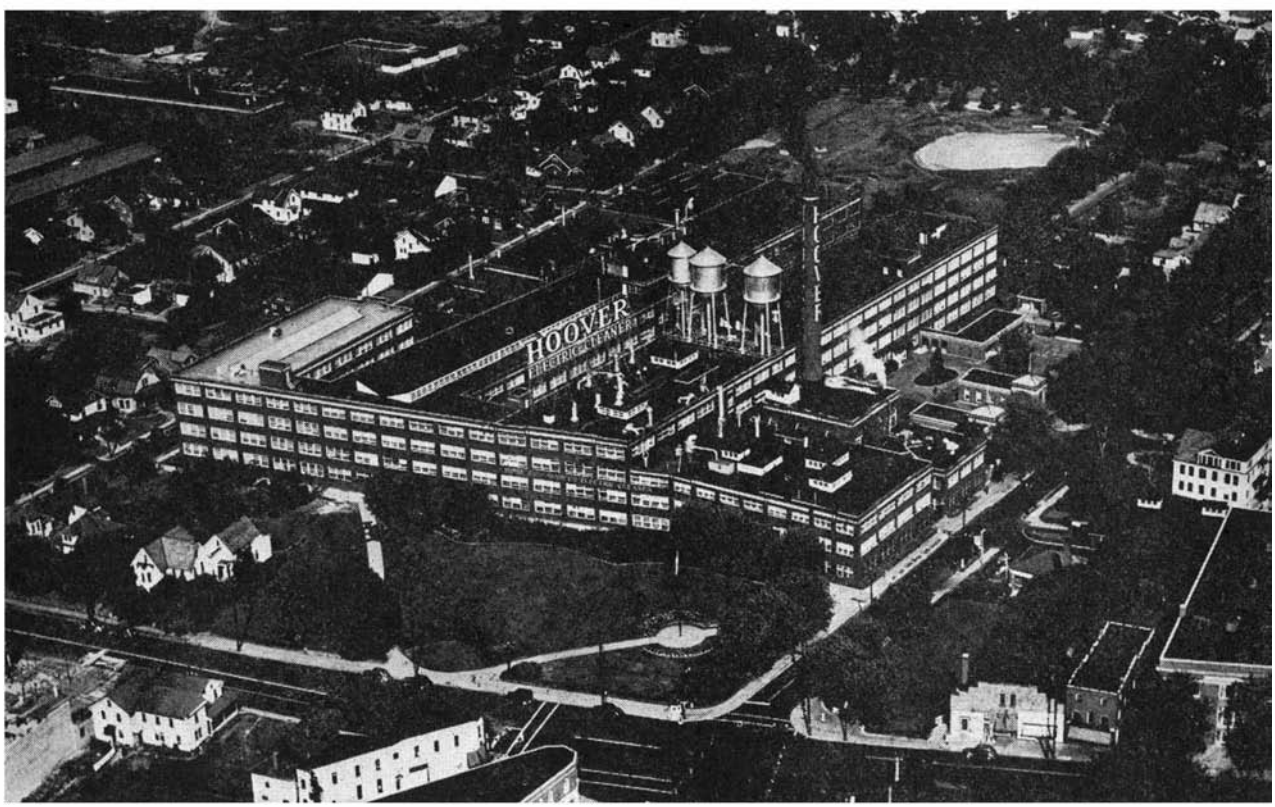
Some grounds practically are "engineered," the nurserymen being required to specify the height, width, and rate of growth of shrubs which they will plant in specified locations. This procedure is followed especially when one of the functions of the vegetation is to keep down the summer dust problem, and the landscaping will include many lawns and low shrubs which will be kept well sprinkled so that dust which strikes them will adhere until rain washes it to the ground.

Purchase contracts often include specific intervals at which the nurseryman or other supplier is to spray the plants. Or where a single contract covers many branch factories and buildings, the contract may call for instructions to be mailed to the local managers at specific intervals.

A few factories plant rose bushes and other blooms. But the great majority stick to evergreens, shade trees, shrubs, lawns, and a scattering of perennials.

This last angle of making sure that the factory landscaping involves the lowest maintenance costs is proof that the plantings serve practical purposes and are not mere hobbies of management. Factory exteriors are being engineered for beauty because such beauty is good management.

Landscaping at the Hoover Company plant



INDUSTRY GETS Nosey

By D. H. Killeffer

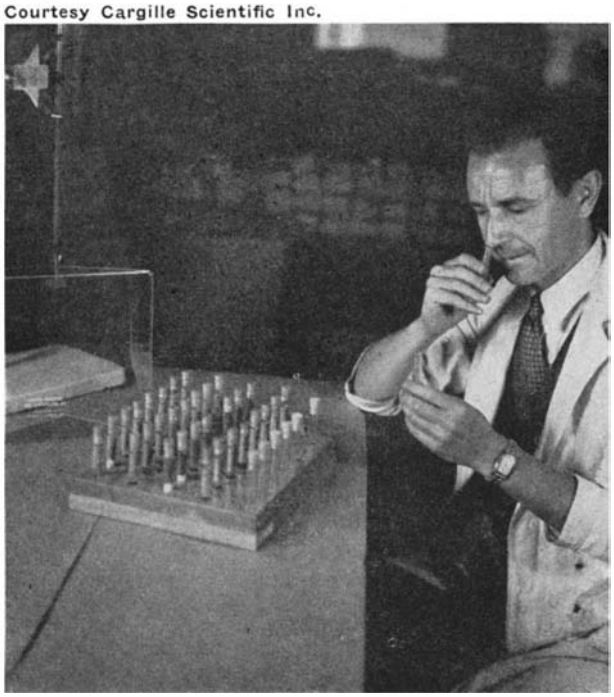
The Science of Odors Is Still in Its Infancy, With Its Greatest Potentialities Yet Unknown. But Already Such Practices as Deodorizing, Masking of Odors, and Faint Perfuming Have Achieved Much in Extending the Utility and Salability of Many Products of Industry

MUCH HAS been made of industry's discovery of what women have always known—that good odors powerfully promote good will. Like many another simple and obvious fact unearthed and adopted by big business, this one is rolling up an impressive record of consequences on industry's several balance sheets. Furthermore, these consequences often appear in greatest weight and profusion in the most unlikely places.

And yet these are only beginnings. So far, the ages-old arts of perfumery have hardly more than suggested the possibilities inherent in the precise control of odors and flavors. As an art, the preparation and compounding of odors is well advanced; industrial applications of the art are proving useful and profitable; but the science of odors and flavors and the relations between causes and effects in this vast domain of the chemical senses remain unsatisfactorily explored and imperfectly mapped. Not only is the comparatively little that has been done in this field of odor control yielding fabulous returns, but the prospect is clear that rich opportunities awaiting exploitation lie in yet unreported researches, and in many which have not yet even been started! Obviously, it is worth looking into.

The Crocker-Henderson system of odor classification consists of comparing the specimen's odor with those of 31 established standards

Courtesy Cargille Scientific Inc.



Psychological effects of odors are potent almost beyond belief. The powerful and universal attraction of the odors of the kitchen—baking bread, frying bacon, broiling beefsteak, and boiling coffee—leaves no room for argument. At the other end of the scale, the tremendous repulsive force of the odors of putrefaction and of the chemical weapon of the skunk is equally irresistible, if opposite in effect. Between these extremes every shade of intermediate feeling is stimulated by odors, faint or strong, possessing individual or general associations, and calling up memories coupled with every degree of pleasure or revulsion. Here lies the power of odors.

OIL DEODORIZED — Industry has lately learned this. Like many another equally obvious improvement, this one has lain in industry's path, to be stumbled over repeatedly. Decades ago, highly malodorous petroleum from certain fields was found to contain certain types of sulfur compounds, and these proved responsible for the "skunk" which drove away possible buyers. When Herman Frasch discovered the effectiveness of metallic oxides in removing this sulfur by chemical action, he not only "sweetened" the oil by destroying its odorous constituents, but he also brought into the market vast new supplies of oil from Canada, Ohio, and subsequently from other fields. Sales resistance, extremely high so long as the then important kerosine, or coal oil, carried a pervading stink, vanished when the new product had none.

This has always been a powerful tool for creating good will for industry—to remove impurities causing the unpleasant odor of a product. It effectively cures many cases of industrial halitosis. An offender even so notable as carbon bisulfide, with its characteristic stench of rotten eggs, becomes pleasantly ethereal when freshly distilled over caustic alkali! Steaming,

Courtesy Givaudan-Delawanna, Inc.

When an aromatic is sniffed from a blotter, it is easier to detect variations in odor as the perfume dries

escapable result of the vulcanization of rubber; at least it was so considered until rubber manufacturers and perfumers got together on it. Then things began to happen. By slight modifications of manufacturing techniques, rubber makers reduced the odor of their product a little, but it remained for the perfumers to mask the rest by suitable additions of their own.

The industrial technique of masking one odor by adding another is at least half a century old; but it is still much misunderstood, and has only lately been re-discovered by industrial psychologists as something new to them. One must carefully distinguish between the mutual blocking-out of two different odors and the mere overpowering of one smell by a stronger one. This latter characterizes many of the household products—based on cresols, naphthalene, and the like—designated as "disinfectants and deodorizers" which not infrequently leave odors as strong as, and barely less objectionable than, those they destroy. Their purpose is primarily germicidal, and the odors they kill are microbial in origin.

It is also necessary to distinguish between the mutual masking of odors and their destruction by chemical reaction. Alkalies will absorb and chemically neutralize hydrogen sulfide; potassium permanganate, a powerful oxidizing agent, readily destroys most

Such stills as this are used in the manufacture of many synthetic aromatic chemicals for industry

Courtesy Givaudan-Delawanna, Inc.

• LOOKING AHEAD •

The study of smells gaining the stature of an exact science. . . Odor taking on importance comparable to that of color in product design. . . Research revealing the now-unknown whys and hows of odors . . . Complete and accurate control of product smells.

plus the use of adsorbent earths or carbon, effectively sweetens fatty oils and puts many common oils, cottonseed for instance, into the salad-oil class when ordinarily their odor and taste, which are closely related, would doom them to the soap kettle or hydrogenation plant. Today, even castor oil is refined to practical tastelessness, although its objectionable oiliness remains.

Unfortunately, many industrial products possess inherent smells of greater or less intensity and unpleasantness, and these cannot be purified away. The vulcanized rubber goods—automobile tires particularly—of a decade ago or so past gave off an effluvium wonderful to smell—if your stomach could stand it. That smell was apparently a natural and in-

organic odors by chemical reaction; and we have already mentioned the removal of "skunk" from oil by chemical combination with metallic oxides. These are strictly chemical destructions of the odorous compounds; they differ essentially from the neutralization of one odor by another without destruction or change of either.

SMELLS BLOCK EACH OTHER — The effect resembles nothing so much as the interference of two out of phase light waves, or the beat produced by two musical tones of slightly different frequencies. It is certainly not unexpected that odors behave similarly.

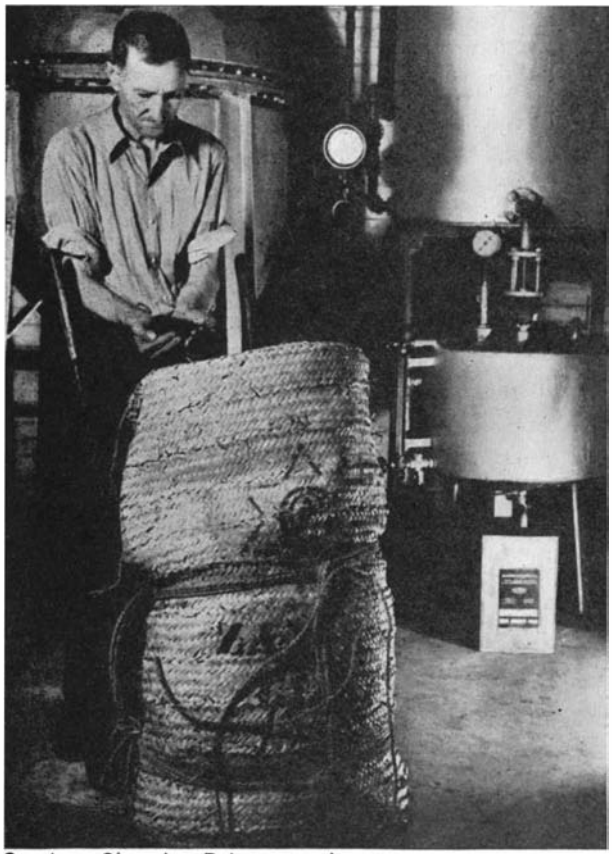
Utilizing this effect, perfumers are sometimes able to render highly smelly products virtually odorless even though they may contain substantial added amounts of an odorizer in addition to that inherent in them. Balsam tolu, for instance, can largely offset the disagreeable odor of vulcanized rubber—neutralize it as complementary colors offset each other.

The masking effect constantly arises to plague the perfumer. In making his various products by mixing a number of ingredients to yield an odor combining those of the several constituents, not infrequently he finds that some of the known additions to the mixture seem to have vanished completely for no evident cause. Actual analysis of the mixture will show that no chemical change has destroyed or altered the original constituents. Obviously, their apparent disappearance is only the masking of one odor by another.

Industry, too, is finding substantial values in compounds possessing odors which are powerfully disagreeable to insects, for example, but which are quite unperceived by the human nose. Ethyl-hexane-diol effectively repels mosquitoes, even the ravenous ones of the South Pacific, by what seems to be an odor disagreeable to them; yet the compound is practically odorless to human noses. Undoubtedly, a whole family of odorous substances of this kind exists, possessing scents which—like ultra-violet and infra-red light, and like supersonic sounds—are outside the range of perception by our human senses. Disagreeable odors *per se* also possess high value, for instance, as warning agents in odorless natural gas to give the alarm in case of leakage.

As has been noted, industry is finding these facts valuable in the extreme. Faint amounts of odorous stuffs added to products of many kinds from laundry soap, lubricating oils, printing ink, and rubber goods to lingerie, woolens, cosmetics, and paints make them more pleasant and acceptable, often (and usually) without imparting to them even the suggestion that they have been perfumed. Although the percentages added in this way are infinitesimal, the total quantities of odorizing materials so used already reach a staggering value beyond $50 million per year.

KNOWLEDGE IS SCANTY — Yet we still know almost nothing about odors and why they are. Three recent books on the subject, "The Science and Art of Perfumery" by Sagarin, "Flavor" by Crocker, and "The Chemical Senses" by Moncrieff, provide together a fascinating survey of this field. But when one has read them all (and anything else he can find on the subject), he is impressed more, perhaps, by the gaps in our knowledge than by what we know.



Courtesy Givaudan-Delawanna, Inc.

From these Zanzibar cloves is prepared vanillin, which has a sweet, chocolate-like odor

Only lately have systems appeared for scientific designation of odors, for instance that of Crocker and Henderson, which give us more exact terms than the customary comparisons (onion-like, flowery, ethereal) to use in describing odors. The Crocker-Henderson system involves the use of a set of 31 carefully selected and graduated standards. By comparing a particular odor with these standards, its several elements can be evaluated and the whole then assigned a number of four digits. From this number the odor can be practically duplicated at any time. The standards are prepared from highly purified chemical compounds so that they too can be readily described and duplicated. The principal value of such odor standard comparisons is in the control of the odors of commercial products in regular production.

Still the number of questions we cannot answer about odors we cannot describe is immensely impressive. What makes a chemical compound smell? How is chemical constitution related to odor? How are odors themselves characterized? What properties of two odors allow them to mask out each other? What characteristic of an odor makes it objectionable to an insect or to an animal but not to man? Are the differences between pleasant and unpleasant odors purely psychological? These and a thousand more vital questions remain puzzling; they supply bases for many broad and penetrating researches, which will some day yield answers of immense value.

Mass-Production WIRING

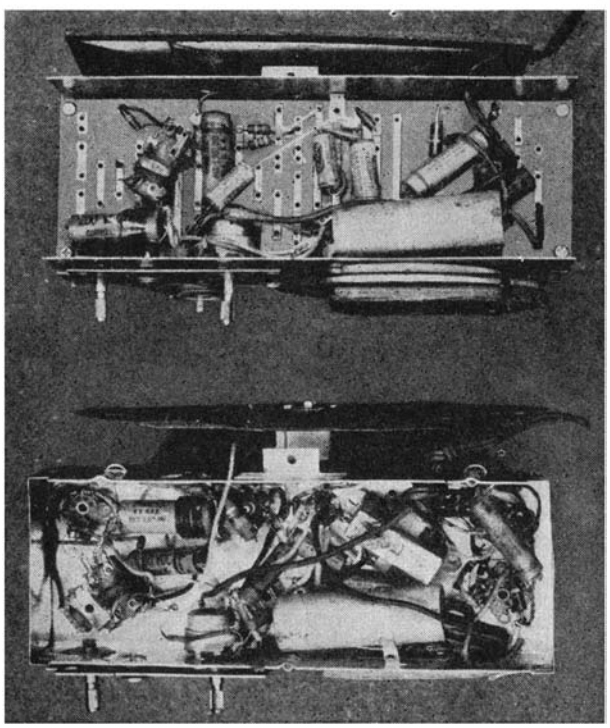
Electronics, Which Has So Greatly Aided in Speeding Production in Many Industries, is Only Now Beginning To Rid Itself of Its Own Wasteful and Antiquated Assembly Methods. Mechanized Wiring Techniques Promise to Bring True Assembly-Line Methods to the Manufacture of Electronic Equipment of All Types

By Vin Zeluff
Associate Editor, ELECTRONICS

GREATEST single factor in the total labor cost in the electronics industry is that required by hand operations—a strange condition in this day of electronically controlled automatic machinery and other labor-saving devices. This is especially true in the tedious manual assembly and connecting of wires between various components that make up a piece of electronic equipment.

Depending on the number of tubes and their circuits, the average radio receiver contains from 100 to 300 soldered connections. Modern television receivers have upwards of 400 connections, and industrial electronic equipment varies from about 30 for a simple one-tube relay unit up to several thousand for more intricate, multi-tube equipment. In most cases, all of these connections are made by hand but a number of ways of forming several circuits or circuit components simultaneously are now coming into use.

The tangle of wires and circuit components in the hand-made receiver (below) is reduced to neatness and order when the Franklin stamped wiring is used in an identical model (above)



PRINTED WIRING — The printed circuit was first developed by the Bureau of Standards as a solution to the space problem in the much-publicized proximity fuse. This technique, in which paths of printed silver or silver oxides are used in the place of conventional wiring, has undergone many refinements since the war, and recent announcements from the Bureau have described several miniature radio receivers and transmitters operating in the VHF band in which printed silver "wiring" has been used.

The first commercial application of the printed circuit is a complete coupling unit, called the Centralab Couplate, used in audio-frequency amplifier stages. The two resistors in the plate and grid circuits, and two condensers—the plate by-pass and the coupling condenser—are printed on one small insulating plate. Purchased by a manufacturer of electronic equipment as a complete unit, only four soldered connections are needed to incorporate it into the rest of the circuit, instead of the usual eight or nine required when each component part is mounted and wired individually.

Such units cuts materially the assembly time of electronic equipment, in addition to lowering the possibility of errors in wiring. And the reduction in the number of soldered joints means more efficient circuits.

STAMPED WIRING — Another method of forming many circuits simultaneously is the stamped wiring technique, in which metal strips are stamped or die-cut into a pattern that conforms to the electrical connections. This technique, originated by A. W. Franklin, president of The Franklin Airloop Corporation of New York, appears applicable to mass-production methods, since one basic unit can be turned out for many manufacturers. Alterations in the basic unit are readily made by means of dies, so that 90 percent of the wiring within the average electronic device can be stamped out. Most component parts may be connected to the wiring in one operation by dip or induction soldering. Substantial savings in labor, material, and in final adjustment are probable.

• LOOKING AHEAD •

More compact, more shock-resistant electronic units. . . Extension of mechanized wiring from radio sets to house wiring, switch boards, and other standardized electrical equipment. . . Servicing problems simplified. . . Costs lowered and circuit uniformity raised.

Stamped wiring starts with a thin sheet of insulation having a series of parallel metal strips running in a horizontal direction on one side and a series of vertical conductors on the other side. Connection between horizontal and vertical strips is accomplished by punching through the insulating sheet between the conductors, and inserting an eyelet or pin.

For connecting a component to a single horizontal or a single vertical conductor, an eyelet or pin may be punched into the selected metal strip at a point where it will miss the metal strip on the reverse side. Where breakup of a single conductor into several conductors is required, the strip may be cut at one or more points along its length.

Electronic circuit drawings consist essentially of horizontal and vertical lines with cross-overs and interconnections. Stamped wiring consists of horizontal and vertical metal strips with the insulation between them constituting inherent cross-overs, and eyelets, rivets, or some other type of fastening providing the connections between strips. Thus the transition from schematic to stamped-wiring drawing may easily be made. Location of eyelets, points at which conductors should be cut, and placement of parts are easily predetermined.

HOW APPLIED — A typical stamped wiring deck developed for a five-tube table-model radio receiver having a conventional circuit is made as follows:

Sheets of Bakelite punching stock, similar to that used in the manufacture of wafer-type tube sockets, are sheared to three by nine-inch size.

A roll of five-mil pure electrolytic-type oxygen-hydrogen-free copper, tinned on both sides, is coated on one side with United States Rubber Company's Kotol thermoplastic cement.

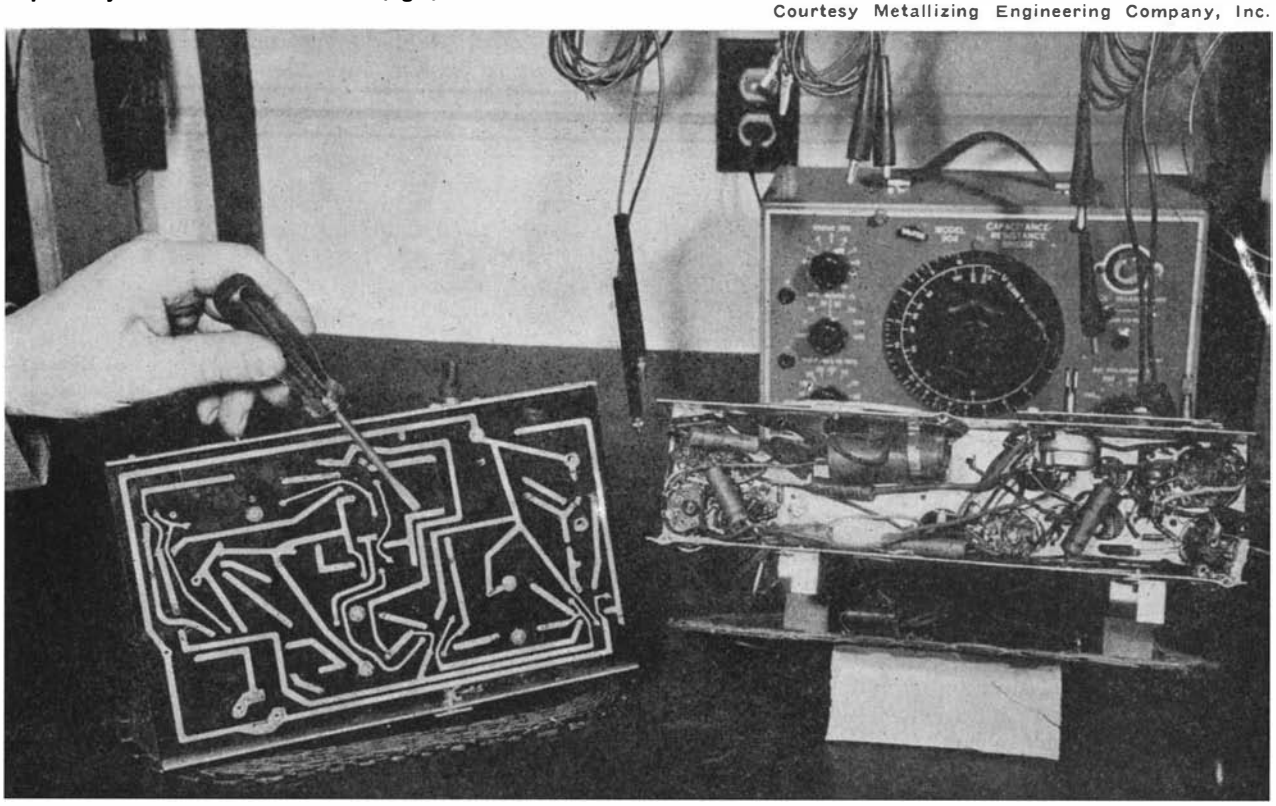
Both the insulating sheet and the copper are fed to a 150-ton automatic toggle press containing a shearing and forming die. The die cuts the copper into metal strips 5/32-inch wide, with equal spacing between strips, and presses their edges and ends 3/1000-inch into the insulation. The die is heated electrically to 230 degrees, Fahrenheit, and softens the insulation sufficiently to lock the conductors securely in place. The heat simultaneously sets the thermoplastic cement so that the material strips are both cemented and mechanically locked to the insulation.

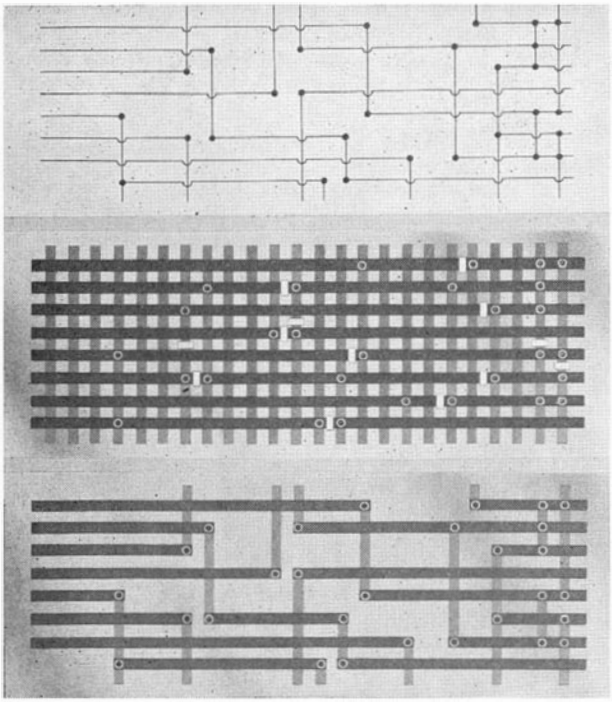
The press turns out 20 sheets per minute with metal strips on one side. (Metal strips may be placed on both sides at once by using upper and lower dies.)

The sheet goes next to a punch press where all

Receiver wired by spraying metal through a stencil into grooves in plastics panel (left) was manufactured in a fraction of the time required by the hand-soldered model (right)

Courtesy Metallizing Engineering Company, Inc.





With the schematic drawing (above) as a guide, plastics panel (center) is marked where rivets will be driven (circles) and strips cut (white rectangles). After the stamping operation, the excess metal is removed, leaving the finished circuit (below)

holes for eyelets and pins are knocked out in a single operation. The holes in this particular case are 0.096 inch in diameter, taking pins similar to those used in the manufacture of tube bases. In still another press, eyelets and pins flow from hoppers through feeder tubes to holes in the sheet and are clinched in place. Heating by conduction or induction may be used to solder conductor and eyelet together.

The leads from condensers, resistors, and coils are dropped into eyelet or pin holes in the stamped wiring. This may be done also by the hopper method. Most component parts are placed beneath the sheet where they are soldered in place by the induction method in one operation. Other components, such as tube and transformer sockets, are inserted on the top of the sheet and the sheet is then installed beneath a metal chassis which has cut-outs through which tubes and transformers may be inserted from above. A self-tapping screw in each corner of the sheet holds it in place beneath the chassis.

The tuning condenser, loudspeaker, and controls are mounted on the metal chassis by conventional methods. Leads from these are pushed down through chassis cut-outs to connectors, or soldered directly in the circuit.

Receivers made by the stamped wiring technique perform quite as well as conventionally-wired sets with respect to sensitivity, selectivity, and fidelity. Final adjustment of circuits in production should be materially simpler than in sets where conventional wiring is used, since wiring stamped out by a die will not vary from set to set.

Exact cost figures for such methods must wait until a sufficient number of units employing stamped wiring are manufactured to permit accurate accounting, but it has been estimated that it will be possible to supply stamped-wiring sheets for five-tube table-model radios, with tube sockets built in and ready to receive component parts, for about twice the present cost of the tube sockets alone.

SPRAYED WIRING—Still another new method of mass-forming wiring is known as Spraywiring, which is a method of forming electrical circuits by spraying metal into grooves in an insulating panel. The technique involves cutting a stencil to coincide with the wiring design of the device to be produced. This stencil is placed on a panel and sandblasted so that grooves are formed in the panel. Metal is sprayed through the stencil into these grooves, and remains when the stencil is removed.

The metals sprayed may be copper, aluminum, or silver, with plastics, ceramics, glass, and wood among the suitable insulating material.

The stencils are made of a special masking tape, adhesive on one side, and hard enough to protect the covered face of the insulating panel from the effects of sandblasting and metallizing. Stencils made from the tape are die-cut in continuous strips.

Vacuum-tube sockets, condensers, and other parts are assembled on a panel prior to sandblasting or metallizing, with their contacts placed so that they will be in the proper grooves. The contacts are metallized into permanent connection with the circuit when the panel is sprayed. As in stamped wiring, conductors may be applied to both sides of the panel, and the conductors on opposing sides can be connected by metal eyelets, insertion of eyelets being done prior to sandblasting or metallizing.

Thickness of the metal deposited by spraying is at least 0.005 inch. If insulation of a conductor is required, suitable insulating material can be applied by spraying, dipping, or brushing. Since the circuits are actually imbedded in durable insulating material, they are inherently strong, and not easily damaged.

The Spraywiring method is adaptable to the manufacture of many types of products which embody wiring. According to Spraywiring Laboratories, Inc., it can be used in producing the circuits of a tiny hearing aid, or the basic wiring of a prefabricated house, in addition to its application to commercial and industrial electronic circuits.

The process is completely automatic and continuous in flow. The plastics base pieces are fed into the apparatus and a complete chassis is turned out every 20 seconds, after spraying, milling, lacquering, and testing. Each stage of the operation is electronically controlled, and if any one process fails or lags, all other stages up to that point are stopped.

All of these mechanized wiring techniques are in their infancy, but they hold promise of great and sweeping changes throughout the electronics industry. They signal the approaching end of the antiquated, time-consuming hand operations which have long held down production rates. They will bring with them true mass production, with no danger of impairing quality. And they will greatly aid the manufacturers of electronic equipment in the struggle common to all industry—the struggle for a better product at a lower cost.

Expanding Fields for Expanded Plastics

Rigid or Non-Rigid, Cellular Plastics Have High Strength-Weight Ratios and Many Possible Applications, Especially if Prices Can be Made More Competitive

By Charles A. Breskin
Editor, MODERN PLASTICS

THE WAR gave this country a number of new plastics materials and techniques. But it left unsolved many of the problems that govern the application of these materials and techniques to the civilian market.

One of these is the group of materials known as expanded plastics, developed largely as the result of the shortage of balsa wood during the early days of World War II.

These expanded plastics are either plastics that have been made porous by one of a number of methods, or combination plastics and paper or cloth materials processed so that they take on a cellular, or honeycomb, structure. They may be rigid or non-rigid. They are used largely as a core material. Originally, their primary use was in the construction of military aircraft, where they were employed for their high strength-weight ratio (as was balsa wood), but they seemed to labor under a number of disadvantages when the time came for conversion to civilian uses.

It remained, then, for plastics materials manufacturers and processors to refine the materials and techniques already developed, and to develop new materials and handling techniques to meet the requirements of all the applications that seemed possible for expanded plastics in the civilian market. The range of these possibilities is wide, covering as it does such diverse items as boat hulls, decks, and bulkheads, toys, luggage, gift packages, ornaments, refrigerators, shipping containers, partitions, prefabricated housing panels, aircraft components, buoys and floats, all types of sandwich structures with core materials, and thermal, electrical, and sound insulation.

HOW THEY ARE MADE—Perhaps the best idea of just what expanded plastics are can be had from a description of six methods of production.

1. The plastics chosen for the work—cellulose acetate, polystyrene, phenolic, and so on—while in a condition of low viscosity is made into a foam by mechanical agitation, with or without the use of foaming agents. When solidified, this foamed mass retains its porous structure.

2. The selected plastics substance is manipulated into a soft dough-like condition, then expanded into a somewhat porous substance by blowing air uniformly throughout the plastic mass.

3. A gas, or a mixture of gases, is dissolved in a soft plastic mass under relatively high pressure. Upon release of pressure the mass is made porous by the expanding gas. Hardening fixes the porous structure.

4. A soluble solid is incorporated in the plastics. After molding, this solid is leached out by solvents.

5. A fibrous or other bulky constituent is mixed with a binding substance to produce a porous product. In some cases, thermoplastic fibers are employed in bulky fibrous mats in which the individual fibers may be bonded together by action of heat or solvents.

The expanded polystyrene "snow ball" provides a novel, attractive package for the perfume bottles

6. A plastics material, or a resin-impregnated paper or fabric, is formed into a structure whose geometry favors low apparent specific gravity. Small tubes, grids, or hexagonal cells may be arranged to produce a very bulky product.

APPLICATIONS ARE BROADENING — One of the best indications that real progress has been made in the diversification, in the handling, and in the economic phase of expanded plastics is the adoption by the Frigidaire Division of General Motors Corporation of polystyrene foam as the inner liner for commercial ice cream cabinets. This new product is an application that might be regarded as an opening wedge in a potentially great market for expanded plastics—including household refrigerators and freezers as well as industrial and commercial units.

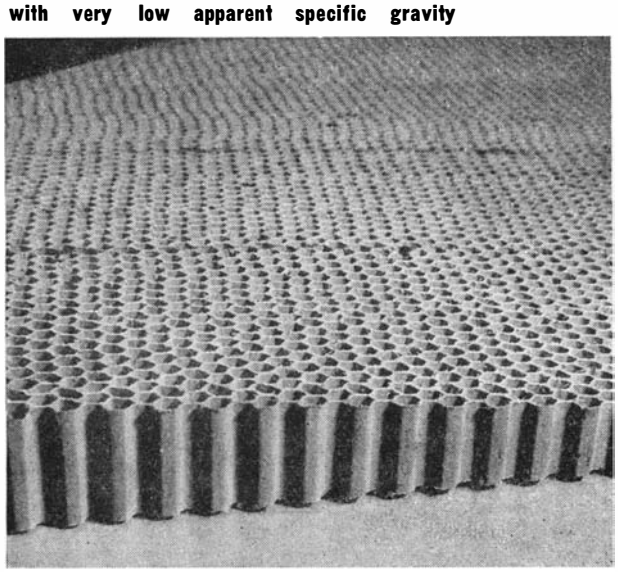
The material's use in airplanes has grown by leaps and bounds. In this instance, improved fabricating techniques have contributed the most to the growing volume. Today, the Glenn L. Martin Company uses phenolic resin impregnated honeycomb structures for bulkheads, partitions, and flooring of its latest planes, the floor of one plane alone using 240 square feet of the material; and such other uses as in the wing sections of these planes, luggage racks, instrument panel bases, and interior doors must alo be included.

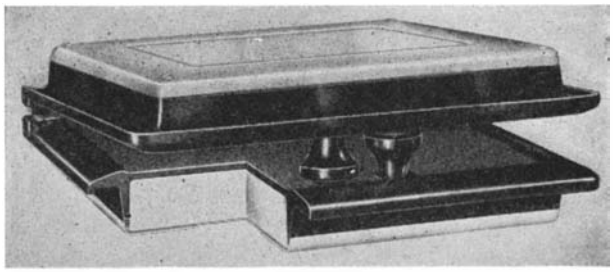
Even bigger than the aviation field is that of building, where the plastics core material has made a beginning as the filling of a sandwich with aluminum sheets outside. And there are boats to be considered. Already a one-piece hull has been formed from honeycomb core with a laminate surfacing; this field would seem to offer many opportunities to the suppliers of expanded plastics.

Luggage is yet another market where this type of plastics material has been tried. There is, too, a wide array of ornaments and gift packages that can be made from the foamed polystyrene.

Each of the above mentioned outlets for expanded plastics can benefit from one or more of the outstanding characteristics of these materials which include low density, good electrical and thermal insulation properties, mechanical strength, and buoyancy. Furthermore, experience indicates that a variety of properties may be achieved in the sandwich type structure. It is possible, for example, to accentuate any desired feature such as structural strength or sound attenuation, or it is feasible to develop a material having a variety of balanced characteristics.

Honeycomb core material is strong and rigid, with very low apparent specific gravity





Courtesy General Motors Corporation

The insulating material (see cut-out section) employed in this ice cream cabinet lid is expanded polystyrene

TYPES OF EXPANDED PLASTICS — Each form of expanded plastics, however, has its special advantage and its outstanding characteristic which best fit it for certain types of applications.

Expanded polystyrene. Extremely light and with unusual thermal properties, expanded polystyrene is moisture-resistant, has low density, and is pleasing in appearance. The first three characteristics explain its selection by General Motors Corporation for ice cream cabinet insulation; the last—attractive appearance—was the reason for its selection as a packaging material and as a base for Christmas tree ornaments. This same quality should attract those interested in window and counter displays, stage and motion picture properties, and toys. The boating field should find use for it because of its moisture resistance and buoyancy.

The physical structure of this material consists of a mass of small sealed cells. It is the continuous wall of these individual cells that prevents water permeation and freezing within the structure and insures the retention of the expanded polystyrene's efficiency as an insulation material.

Currently, this material is available in the form of boards several inches thick, and varying in lengths and widths. A board of this kind can be easily shaped by conventional wood-working equipment, and may be bonded to itself, wood, metal, or other materials by available adhesives and cements.

Cellular cellulose acetate. Possessing excellent thermal insulation properties and temperature stability, this material has the advantage of being easily formed into rather complex shapes. For instance, it may be hot-formed at temperatures in the range of 195 to 200 degrees, Fahrenheit, or it may be formed after soaking in water. Further, when properly prepared and laminated on one side, the material can be bent with its laminated face on the convex part of the curve. All of this suggests possible outlets for the material in refrigerating and insulating applications.

Produced by extrusion in strips with a rectangular cross section, cellular cellulose acetate is an unoriented multicellular form of cellulose acetate. It is available in four ranges of density, varying from four

to eight pounds per cubic foot. The secret of its temperature stability lies in the absence of any plasticizer. The extent of this stability is shown by the fact that mechanical properties at —70 degrees, Fahrenheit, approximate 80 percent of the corresponding properties at room temperature.

Expanded phenolic resin. Differing markedly from both foamed polystyrene and cellular cellulose acetate, expanded phenolic resin is produced to the desired shape by being foamed in forms of plywood, thin sheet metal, or glass, made to the desired dimensions, rather than being worked with tools from a strip or block. The rise of the phenolic resin foam in the forms occurs within a few minutes after the resin has been activated.

Its outstanding properties include thermal insulation and acoustical characteristics. Further, expanded phenolic resin is fireproof, fungus-resistant, and non-melting. Though it will absorb water unless protected by a moisture- and vapor-proof barrier, the resin itself is unaffected. All of which makes it suitable as a core material for sandwich structures of high strength and low weight such as those used in aircraft construction and luggage.

Honeycomb construction. This material, which has been successfully employed as the core in laminated structures, can be made to meet almost any specification laid out for the final product by the proper selection of sheeting and impregnating resin—the two elements that comprise this type construction. If good thermal insulation is required, it is necessary to introduce an insulating material into the cells since the honeycomb by itself has a K factor little better than that of solid lumber. If dielectric properties are desired, a glass cloth impregnated with a polyester resin is suitable. To obtain fire resistance, an asbestos paper impregnated with a phenolic resin has been used.

These honeycomb structures are made of a resin-impregnated sheet material which has been cured and assembled into the honeycomb design—either tubular or hexagonal. While optimum cell size has not yet been determined, a core with 3/8 to 7/16 inch cells, measured across the flats, has proved satisfactory and economical in a general purpose application.

There are two methods of producing this type structure. Honeycomb core can be cured on a corrugating drum in the form of a continuous corrugation. These sheets are then cut to length, indexed, and assembled into block form, after which the block is sliced on a band saw into sheets for panels.

The other method consists of strip-gluing single sheets of material to a pattern and stacking the sheets for curing in a press. The cured blocks are then cut into strips which are expanded mechanically to make honeycomb core sheet. This expanded honeycomb is sprayed or dipped in a resin bath, air dried, and cured in an oven to set the resin and stabilize the expanded structures.

Laminates made with these cores are associated mainly with the transportation field. Houses have been constructed, however, in which honeycomb laminates are used for walls and flooring. Other suggested uses are air-freight shipping containers, cold-storage shipping containers, scaffolding, lightweight furniture, partitions, and trays for handling semi-finished work between processes.

At least a start has been made in applying these versatile materials to the many civilian and industrial fields for which their properties would seem to suit them. Price, however, is a factor that must be refined even further if the various expanded plastics are to be used in such articles as table tops (as a core material) or in the many types of packages for which they are fitted.

Courtesy Lincoln Industries, Inc.

Honeycomb laminates are employed in both walls and ceilings of this house

FUELS OF THE FUTURE:

For Ram-Jet Motors

By F. W. Schumacher
Associate Director, Process Division, Esso Laboratories

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

JET PROPULSION depends upon the fundamental reaction principle: a force is required to counterbalance a change in momentum, momentum being defined as the product of mass and velocity. The rowing of a boat is an example. Velocity is imparted to a mass of water by the oars. Therefore, the momentum of the water is increased. The counterbalancing force is against the oars, and it is this force which moves the boat.

The original statement that jet propulsion depends on the reaction principle is correct, but a more specific definition is required if we are to avoid placing both the supersonic ram-jet and the row boat in the same classification.

A more specific statement is that jet propulsion can or does take place when a change in momentum occurs by virtue of material being ejected from the propelled body. If all the material expelled was originally carried by the propelled body, the device is a rocket. If part was carried (fuel) and part taken in from the atmosphere (oxygen), it is some sort of jet engine—a turbo-jet, ram-jet, or pulse-jet.

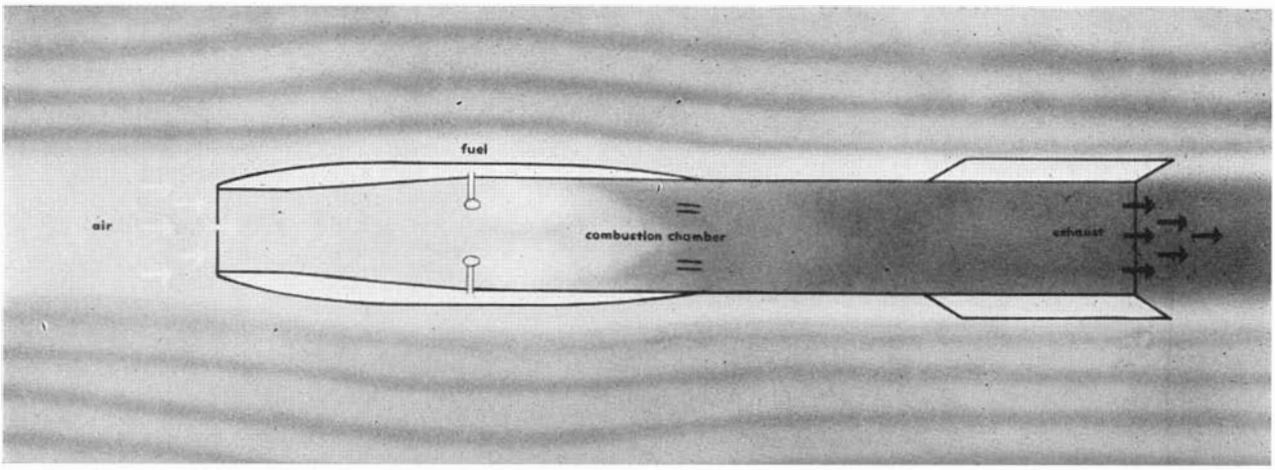
With jet propulsion so defined, the first reasonably authentic record of the application of the jet propulsion principle is the use of gun powder rockets by the Chinese several hundred years B.C. The jet propulsion principle was employed by Hero of Alexandria in about 100 B.C. and many scientific historians consider him its discoverer. He described a device known as the Aeolipile which, rather than a means of locomotion, was intended to be a stationary engine for production of power. Steam exhausting through two tangential jets on cylinder caused the cylinder to rotate. The steam rocket for jet propulsion of a vehicle was proposed many centuries later by Isaac Newton. There were many other early uses of rockets; for example, the famous incendiary Congreve rockets with which the British burned most of the city of Copenhagen in 1807.

It was not, however, until early in the present century that the prototype of our modern jet motors was visualized. In 1908, René Lorin proposed a propulsion system where the exhaust of an internal-combustion engine was used for jet propulsion. The engine did not produce power in any other way. Five years later, in 1913, he described a jet-engine where the air was compressed solely by the velocity, or ram, effect of the entering air. This is the ram-jet.

TUBE AND TAPERED NOSE-PIECE — The ram-jet has been described as consisting basically of a cylindrical duct containing flame stabilizing parts and a tapered nose-piece open at the end. The inside of the ram-jet is therefore a duct of varying

Similarities and differences between reaction motors

TYPE OF MOTOR	PULSE-JET	RAM-JET	ROCKET
OUTLINE SKETCH OF MOTOR	FUEL, VALVES	FUEL, DIRECTION OF AIR FLOW	FUEL OXYGEN
CONTINUITY OF OPERATION	INTERMITTENT	CONTINUOUS	CONTINUOUS
SOURCE OF OXYGEN	AIR	AIR	SELF-CONTAINED



Ram jets, "flying stovepipes," are the simplest of engines but are limited to "super" speeds. Flights at velocities of over 1400 miles per hour have been made

diameter into which air enters, and from which combustion gases leave. Air at supersonic velocities relative to the ram-jet approaches the circular hole in the leading end of the nose-piece of the duct. Supersonic flow of a gas inside a duct of this sort is thermodynamically unstable and tends to decrease sharply, the rate of flow becoming subsonic. This very sharp velocity decrease is known as a shock wave, and is accompanied by a rise in gas pressure and temperature. If the ram-jet burner pressure is at its design value, this shock wave is right at the leading edge of the nose-piece and maximum thrust will be obtained.

The conical section through which the air passes to reach the combustion section is known as a diffuser. In this section the entering air, now subsonic, is slowed down even more because of the enlarged cross section. The air pressure is also further increased as a result of the conversion of velocity energy into pressure energy. At the diffuser exit, the fuel is mixed with the air stream and combustion takes place, having been initiated by either a spark or pyrotechnic tracer. The flame is stabilized by parts inserted in the air duct for this specific purpose. During the combustion, velocity of the gases increases very rapidly through the duct and, just to the rear of the ram-jet, attains a speed up to 2000 miles per hour. When the velocity, and therefore momentum, increases, pressure must decrease; at the end of the combustion zone the pressure is little, if any, above atmospheric.

It now becomes evident how the ram-jet works. The momentum of the exhaust gases is greater than that of the entering air. This difference in momentum must be counter-balanced by a force, which is the pressure exerted on the inside of the diffuser wall. This pressure on the inside wall is greater than that on the outside, so a forward force, or thrust is exerted. Since ram-jets have been proved capable of flight, it is evident that this thrust is large enough to overcome the wind resistance, or drag, of the flying body.

For the past two years, the Standard Oil Development Company has been doing research on the development of ram-jet motors suitable for supersonic flight, at the request of the Navy. The Esso Laboratories are one of a number of industrial laboratories and universities co-operating in the development of a supersonic ram-jet, on a project known as "Bumblebee." This work is being done under contract with the Bureau of Ordnance of the Navy Department; and the Applied Physics Laboratory of Johns Hopkins University is providing the technical coördination and direction for the project.

POTENTIAL ANTI-AIRCRAFT WEAPON — The project was started during the war, when it was hoped that it would be possible to develop ram-jet propulsion so that it could be used in an anti-aircraft weapon against the suicide planes used by the Japanese. It now appears to have other applications, and the work has been continued with emphasis on developing the ram-jet as a means of supersonic propulsion. One of the major aspects of the work in these laboratories is the development of suitable fuels for these ram-jets.

An accompanying chart shows in tabular form the similarities and differences between the pulse-jet, the ram-jet and the rocket. Both the ram-jet and the rocket operate continuously, whereas the pulse-jet, as its name implies, involves intermittent combustion. Both pulse- and ram-jets obtain their oxygen by taking in air while in flight. The rocket, of course, carries its own oxygen supply with it. These characteristics are responsible for three fundamental differences:

1. The speed of pulse-jets is low by comparison with other jets, due to the intermittent character of the combustion. This type of propulsion was employed in the German V-1 missile.

2. The range of the ram-jets for a given weight is longer than that of a rocket, since oxygen is obtained from the air.

3. The altitude ceiling of the rocket is virtually unlimited since the oxygen supply is self-contained.

The ram-jet, shown in the accompanying oversimplified drawing, consists basically of a cylindrical duct having a tapered nose piece which is open at the end. The direction of flight as pictured is from right to left. Therefore, air enters the device in the opposite direction—from left to right. The entering air is compressed by reducing its velocity in the tapering section. Fuel is sprayed into the air stream

and the resulting combustible mixture is ignited with either a spark or pyrotechnic tracer. The combustion is carried out in the right-hand part of the system, and the flame is stabilized by several simple parts of special design. The exhaust gases leave at a very high velocity, attaining a speed much greater than that of sound at the rear of the apparatus. The force —the power—which makes a ram-jet go is the development of a pressure on the inside of the tapering nose which is greater than the corresponding pressure on the outside.

NO MOVING PARTS— The construction of the ram-jet is very simple. The motor proper contains no moving parts, which is quite a contrast to the reciprocating aircraft engine, and even to the turbo-jet. For flight, the necessary wings and controls are added. Since the ram-jet cannot deliver any power unless it is moving, it cannot take off by itself. Launching is accomplished by rockets. Ram-jet units, usually about six inches in diameter and 12 feet long, have been nicknamed "flying stove pipes."

The internal design details of a ram-jet burner are inseparably related to the properties of the fuel employed. To preserve the mechanical simplicity of the burner, a fuel must burn efficiently under the widely different temperature and pressure conditions encountered by a ram-jet in flight as speed and altitude are varied. One of the objectives of the Esso Laboratories is to develop such fuels from petroleum.

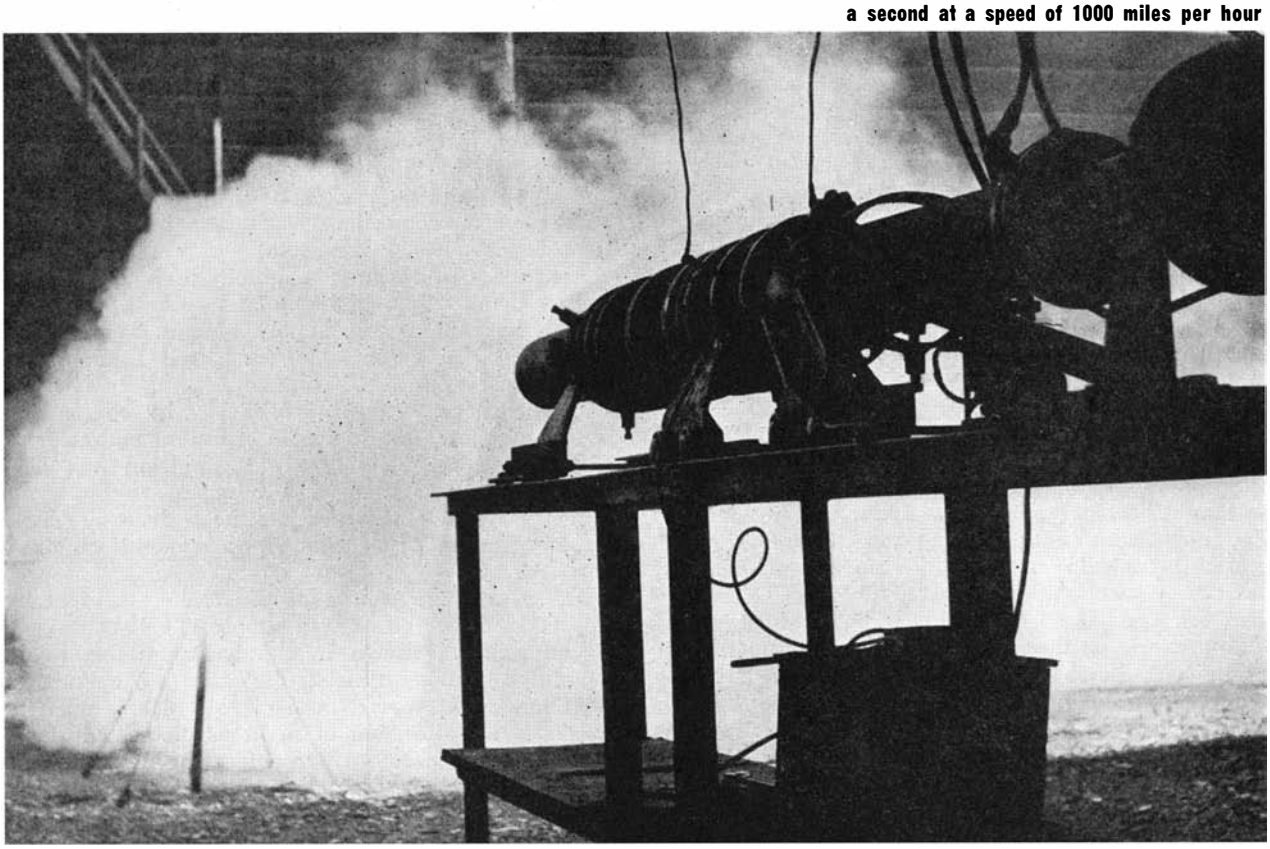
Supersonic flight has been proved possible with the ram-jet burners so far developed. Short pilotless flights at velocities exceeding 1400 miles per hour have already been made. When further developments make flights of moderate distances possible, this will be equivalent to a flying time of about 15 minutes from New York to Pittsburgh. A ram-jet will then be able to out-run the sun, and its pilot will be able to see the sun set in New York, rise over the horizon, and set again in Pittsburgh. The flight will be made in the stratosphere where fuel consumption will be about a tenth of that required at sea level.

Present ram-jet burners are only a fraction of the weight of a reciprocating aviation engine of comparable power. At 1400 miles per hour the ram-jet develops one horsepower for each one-half ounce of weight—more than 30 times the power developed per unit weight in a modern aviation engine. One man can easily lift a 2000 horse-power ram-jet.

Cabin cooling, which is of relatively minor importance in the transport planes now being developed, becomes a significant problem when sustained plane speeds of 1400 miles per hour are reached. Without refrigeration, cabin temperatures of 300 degrees, Fahrenheit, will be approached by a plane traveling at 1400 miles per hour even in the stratosphere. At 2000 miles per hour this temperature will become 650 degrees, Fahrenheit.

What use is visualized for the supersonic ram-jet today? As stated, it is a fundamental method of high speed propulsion. It was intended originally to propel an anti-aircraft weapon. But it is evident that if supersonic transportation of mail, express, and ultimately passengers develops, the ram-jet motor offers great promise. A military project thus promises to influence the peace-time transportation of the world.

Test cell set-up for a ram-jet in which a fixed jet, equipped with measuring instruments, is supplied with 11 pounds of air a second at a speed of 1000 miles per hour



NUCLEAR TRACK PLATES

Used to Record the Paths of Charged Particles

SPECIAL photographic plates made in the laboratories of Eastman Kodak Company are being used by scientists to picture actual atomic fission and to study action of highly charged nuclear particles.

White streak marks the paths of two new atoms created by the fission of a uranium atom at midpoint of streak

The plates, recognized as valuable new tools for research in nuclear physics, are known as "nuclear track" plates from their special use in recording the paths of the particles.

Characteristics of the new plates are markedly different from those of ordinary photographic materials. The plates are super-sensitive to the electrical charges carried by atomic particles. At the same time they are relatively insensitive to light.

The silver grains in the emulsions of the nuclear track plates are unusually close-packed. It is these silver grains, suspended in the gelatine emulsion, that are particularly sensitive to the charged nuclear particles.

When a highly charged particle speeds into the emulsion, a dotted line of affected silver grains is produced. These silver grains, when the plate is developed, make an identifiable track. This is the path of the nuclear particle through the emulsion.

From the length and curvature of the track and the grain-spacing along it, information is obtained of the particle's speed, energy, and other characteristics. Thus the particle can be identified as a proton, alpha particle, or heavily charged nucleus.

Actual fission was recorded when one of the plates, first bathed in uranium nitrate, was exposed to slow neutrons from a radium-beryllium source. A neutron, striking a uranium atom in the emulsion, brought about the fission which was recorded on the plate as the track of two new atoms.

CYLINDER CONTOUR GAGE

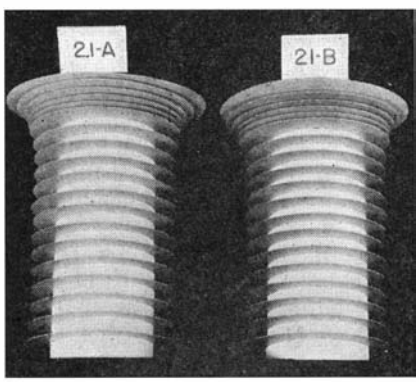
Measures Radial Distances to Give Accurate Picture of Wear

MEASURING the diameter of internal combustion engine cylinders at many points has long been used as a means of determining the amount of taper from the worn upper part to the unworn lower part, and to determine the amount of out-of-roundness of the cylinder. Such diameter measurements, however, do not necessarily give a true picture of the actual shape of the cylinder. Badly misshapen cylinders often appear quite straight and round on the basis of the diameter measurements, because a low spot on a cylinder is quite likely to have a high spot directly opposite it, leaving diameter measurement relatively unchanged.

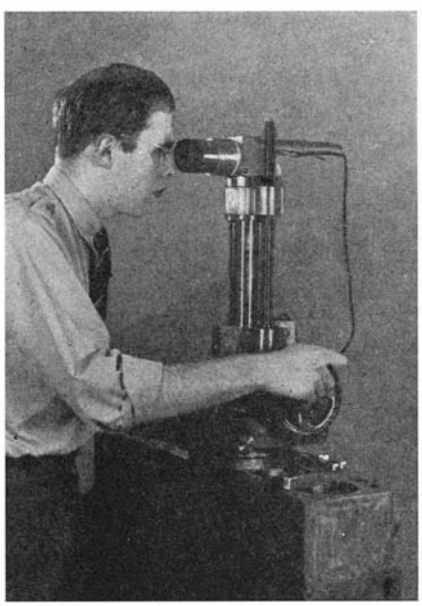
Only measurement of the radial distances from the cylinder axis to the cylinder wall can describe the true shape of the cylinder; a cylinder contour gage has been developed by the Perfect Circle Corporation for that purpose.

In operation, the contour gage is alined with its axis coinciding with the axis of the cylinder. Radial measurements to the cylinder wall are made at as many points and at as many different levels in the cylinders as desirable. Readings are usually taken at intervals of 5 to 20 degrees about the axis and in half inch steps down the cylinder. The top inch of the cylinder is almost always measured in smaller steps because most of the wear takes place in that area.

Scale models are made from the recorded data by plotting the measurements on stiff board, connecting the points, cutting out the contours, and stacking the resulting disks with spacers of the same thickness as the



These exaggerated scale models, made from data obtained by contour gage, reveal the extent of cylinder wear



Contour gage in operation

level intervals of the readings. In order that the contour may be easily visualized, deviations from the nominal cylinder diameter are magnified three hundred times when the constours are plotted.

This gage was originally developed during the war for the study of distortion and wear in aircraft cylinders. It is now being used extensively in the development of piston rings and the improvement of the conditions under which they must operate.

GRAVITY-FEED DISPENSER

Saves Floor Space, Simplifies Packaged Goods Stocking

AN INTERESTING example of how simply gravity can be put to work is seen in a grocery dispensing device for super markets which has many advantages over conventional shelves and stacks. This Food-O-Mat, as it is called, consists of tiers of metal racks gently inclined at carefully worked-out angles. These racks are placed with their backs far enough from the wall of the store to permit stocking them from behind. The packaged groceries are placed in rows on the racks, which slope toward the customer. When a bottle, can, or box is taken by a customer from the front of the rack, the entire row slides down the inclined plane, with the next item taking its place at the front.

The angle of incline must be carefully adjusted to insure that the packages slide down the rack when the first item is removed. And equal care must be taken to see that the goods do not slide so fast that they jump over the stop at the front of the rack and fall. Thus, the angle for racks containing heavy bottles or cans which roll easily is far less than that for those containing light packages wrapped in wax paper, for example.

This dispenser, which was devised by the Grand Union Company, makes it possible to re-stock fast selling items as frequently as necessary without interfering with customers; it insures that goods are always at the customers' finger tips, rather than far back on a shelf; and it requires far less floor space than would shelves of equal area.

A similar gravity-feed dispensing arrangement could be used in tool rooms, stock rooms, and so on, where its space saving ability, its neatness, and ease of operation would be of definite advantage.

HYDRAULIC BULGING

Forms Metal Cylinders Larger Through Body Than Neck

ONE OF the newer press-forming methods receiving increasing application is the bulging of metals in hydraulic presses. An outstanding example of this type of work is in the making of stainless-steel dairy equipment by International Harvester Company.

Segmental dies are employed for facility in loading and unloading the work. When pressure is applied, the dies form a seal around the mouth of the drawn part. After sealing, the hydraulic fluid is allowed to flow inside the piece and fills it out by forcing it against the dies, using pressures up to 3000 pounds per square inch. Bulging produces a cylinder which is narrower at the mouth than through the body.

Bulging is also employed to make aluminum alloy parts. The high-strength alloys are formed more readily if heated to 400 degrees, Fahrenheit, and pressures up 4000 pounds per square inch are used.—*F.P.P.*

As soon as a package is removed from the rack, another slides down to take its place

IMPROVED CASTERS

Give Industrial Trucks New Abilities

WHILE the airplane has had nearly everybody looking at the sky, a comparatively unnoticed but highly important improvement was going on at the floor level of industry. Truck wheels and casters, those small but ubiquitous tools of materials handling, were being vastly improved.

This "revolution in wheels," as punsters have called it, was not deliberately planned. The war caught industry with an immediate need for handling more materials than ever before at higher speeds and over longer distances. Complex materials-handling equipment was not available and could not be built in time. The lowly truck, pushed by hand or towed by tractors, had to take over.

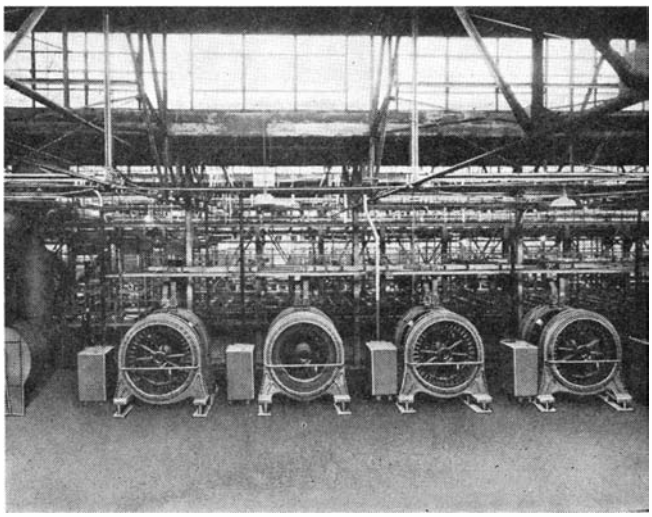
The immediate result was the first real break-down service testing that these wheels and casters had ever had, and they stood up surprisingly well.

Later results were new designs, spring loaded axles, shock absorbing devices, better locking and fastening devices for fastening the wheels to the trucks, better floor locks for holding the wheels still while loading and unloading, and better tire and wheel materials.—*E.L.C.*

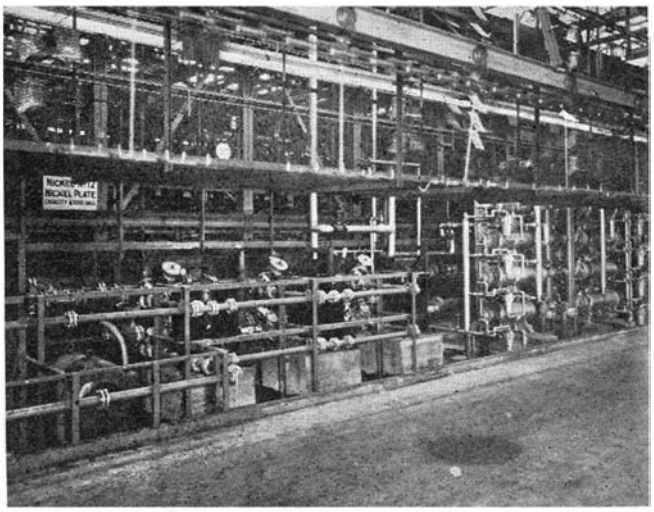
AUTOMATIC PLATING PLANT

Handles Copper, Chrome, Nickel In Continuous Operation

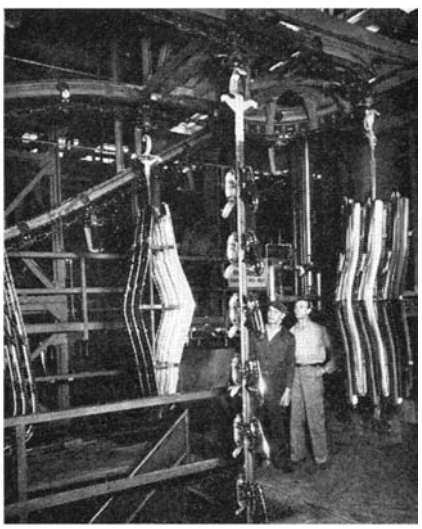
A FULLY automatic plating plant 660 feet long and 50 feet wide—three-quarters of an acre of continuous plating machines—was recently completed by the George L. Nankervis Company, for one of the large manufacturers of automobiles. The plating machines were built by Meaker Manufacturing Company



Four of the 22 motor generator sets which supply current for the plating operations—total capacity, 285,000 amperes



The plating solutions are filtered constantly and are heated with heat exchangers to maintain a predetermined temperature



Parts for automobile bumper assemblies coming out of the chrome plating bath

and consists of three sections—one for copper, one for nickel, and one for chrome.

The first section, for copper plating, is 207 feet long and includes 15 automatic operations requiring 52 minutes to complete the cycle. The main copper plating tank contains 58,000 gallons of copper plating solution, which is circulating constantly at the rate of 1500 gallons per minute, and is filtered at the rate of 1260 gallons per minute. The circulating system passes through 16 heat exchangers to maintain a constant predetermined temperature. By means of the pump equipment, the entire content of the copper plating tank can be transferred to an adjacent storage tank in 25 minutes.

The nickel section, which is 250 feet long, includes 14 different tanks and operations, requiring 64 minutes for a complete cycle. The nickel plating tank contains 67,200 gallons of solution which is the equivalent of 8½ tank cars. The nickel plating solution is filtered constantly and heated with 15 heat exchangers. Part of this nickel solution being circulated is passed through an electrolytic purification tank which is connected to a General Electric 2000 ampere, six volt rectifier.

The chrome plating section is 139 feet long and includes ten automatic operations. The main chrome tank, having a capacity of 15,700 gallons, is divided into two compartments, allowing two lanes of work which may be operated at different cathode current densities. The chrome plating solution is circulated through both heat exchangers and coolers to maintain the predetermined temperature.

There is a master panel at the starting end of each automatic machine. If the machine is stopped for any reason, a light at the master panel indicates the point of trouble and the machine cannot be started again until the light is off, and a warning horn has sounded for at least 30 seconds. In addition to this master panel, there is a stop cord available the entire length of the automatic machines.

The plating capacity of these automatic plating machines it 22,500 square feet each, of copper, of nickel, and of chrome—a total area of 67,500 square feet of plated surface per eight-hour day. The electrical energy for the plating procedures is supplied from 22 Chandeysson motor generator sets ranging in size from 5000 amperes at 6 volts to 15,000 amperes at 12 volts.

Demineralizers with a capacity of 3000 gallons an hour furnish water for the plating tanks and the rinses preceding the plating. The temperatures of the heated solutions and levels on all plating tanks, cleaner tanks, and power wash machines are automatically maintained. All rinse sprays operate intermittently, as the work is being raised from the tank, by means of remote control switches, relays, and timers.

Ventilation of tanks is afforded by 32 blowers with a total capacity of 434,000 cubic feet per minute.

OIL FIELD ANALYSIS

By Following Tracer Through Sample Core With X-Ray

To HELP solve the riddle of how oil flows through the sand and rocks of an oil field, and how it is affected by underground water and gas, an X-ray method of studying a sample taken from a drill hole has been developed. A small three inch by one inch sample, or core, from the drill hole is made to reproduce in miniature the layer of rock or sand from which it was taken. Study of the reactions in the sample gives a picture of flow conditions in a stratum perhaps hundreds of feet thick and miles wide.

The core is subjected to artificial pressures and saturations of oil, gas, and water, and the progress of these elements in the core is gaged by an X-ray unit called "apparatus for determining permeability-saturation." The X-ray beams follow the reaction by means of an opaque tracer mixed with the liquid or gas.

An extensive series of flow experiments, reproducing conditions which might be created by various recovery methods, are run through. The effects of gravity, capillary attraction, and the amounts of oil, gas, and water already in the sand are charted. By correlating such data, it can be determined how natural

pressure, artificial gas injection, or water flooding will move oil toward well shafts through the various strata of the field being studied. Methods of working the field can be planned accordingly to assure the greatest yield, and extent of yield can be forecast.—*K H.*

HOME DUST PRECIPITATOR

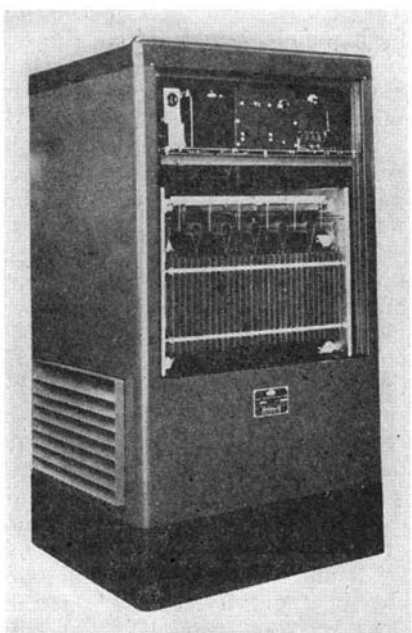
Eliminates Foreign Particles By Electrostatic Charge

REMOVING 90 percent or more of all airborne dirt when used in conjunction with a warm air furnace or an air conditioning unit, an electronic dust precipitator is designed for home use. Far more effective than mechanical filters, it removes from the air not only the visible dirt, dust, and soot, but virtually all of the microscopic and sub-microscopic particles of smoke, pollen, and other contaminating particles down to as small in diameter as 1/250,000 inch.

The precipitator, a product of the Raytheon Manufacturing Company. is attached to the air intake of the furnace or to the intake of an air conditioning unit. No fan is needed as the air is circulated by the furnace or air conditioning system. The precipitator consists of two principal parts: the power pack and the heart of the unit—the ionizer-collector cell. The power pack utilizes the regular house current to energize the ionizer, thus creating a strong electrostatic field.

As the airbone particles pass through the electrostatic field, they become positively charged. Then the air passes down between the vertical collector plates. These plates exert a powerful electrostatic force which attracts the charged dust particles in somewhat the same way as a magnet attracts metal particles.

The collector plates are periodically washed to remove the dirt. This is done by turning a valve which produces a spray of water over the plate. When the unit is thoroughly dry, the ionizer is turned on again. The Raytheon Home Precipitator measures 54 inches high, 28 inches wide, 27 inches deep, and weighs 300 pounds. Power consumption is only 50 watts.

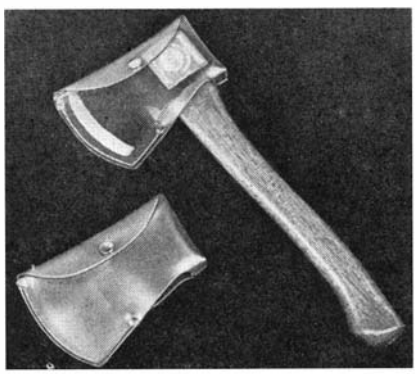


At top in the dust precipitator housing is the power supply, below which is seen the ionizer-collector cell

NEW VINYL USES

Include Fishing Tackle Cases, Axe Sheaths

NEW OUTLETS are constantly opening for vinyl sheeting. Among the latest of these are axe sheaths and fishing equipment cases which are fabricated of Vinylite by the Westcox Plastics Company. An interesting feature of the axe sheaths, made from sheets 0.04 inch thick, for Fayette R. Plumb, Inc., is the means used to achieve three dimensions. A strip of rigid vinyl is welded to the inside of the sheath in a position corresponding to the wide section of the back of the axe. The sheath is fabricated entirely on bar-type welding equipment.—*C.A.B.*



Sheaths are made from vinyl sheeting

HANDLING BY LIFT TRUCK

Results in More Efficient Storage, Speeds Many Operations

AS PART of the company's plans for a completely modernized handling system, the Pemco Corporation has recently put into operation a fleet of lift trucks. The newly adopted operations put emphasis on palletization of uniform "grid" stacking and vertical row removal of merchandise. Towmotor lift trucks in capacities of 4000 to 5000 pounds are used to transport the palletized loads of porcelain enamel frit, clays, chemicals, and other products.

Since initiating this system of handling it is reported that lift truck operations, at no additional expense except for the cost of the trucks, have provided two thirds more usable storage space than was available with the former method of hand stacking, and that the amount of merchandise handled per man has increased approximately 60 percent.

Providing two thirds more storage space

In addition to transport of the palletized loads, lift trucks are utilized for the difficult job of handling refractories kept in storage for repairs of their smelter units.

Many operations have been reduced to one fourth of the time required under former methods, and it is expected that lift truck operations will greatly expedite shipments of materials.

CYANIDE FROM GAS

Now a Possibility in Large Plants

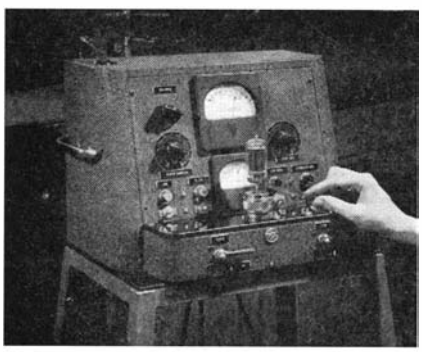
A NEW PROCESS of recovery of hydrocyanic acid from coal gas is expected to put gas companies and by-product coke ovens into the business of producing this important fumigant for sale. Heretofore the ordinary gas purification processes have turned hydrocyanic acid and hydrogen sulfide into the plants' furnaces to be burned to harmlessness. Now both are to be recovered for sale in plants large enough to make the operation economical.—*D.H.K.*

New Products

VACUUM LEAK DETECTOR

Spots Minute Faults By Using Hydrogen as Tracer

DESIGNED for use in laboratories and factories to locate leaks that might eventually destroy the vacuum in such devices as electronic tubes, X-ray tubes, cyclotrons, vacuum stills, and furnaces, a new instrument utilizes a high-sensitivity gage tube which responds only to hydrogen. Hydrogen is used as the "ferret" in this leak detector, developed by the Radio Corporation of America, since it has the smallest molecule of any of the elements and therefore easily penetrates infinitesimal leaks.



Hydrogen finds leaks

In operation, the tube or other vacuum enclosure to be tested for leaks is hooked into the vacuum system of the leak locator, and a continuous vacuum is established between the instrument and the tube being tested. Hydrogen or other gas containing hydrogen is then applied to the outside surfaces of the tube under examination. If there are any leaks in the tube at points such as the glass-to-metal or metal-to-metal seals, the tiny atoms of hydrogen creep in, run down through the leak locator to the hydrogen-sensitive tube, which immediately registers the incoming hydrogen on the instrument's microammeter and thus indicates the presence of the leaks. Leaks once located can be corrected at the source in manufacture.

The new hydrogen-sensitive gage tube at the heart of the leak detector is an ionization type in which the bombardment of electrons sets up an ion current. The tube contains a palladium plate which, when heated, is porous only to hydrogen. Thus, hydrogen entering the instrument through a leak in a tube being tested, as described above, passes through the palladium plate, causing an increase in the ion current of the gage tube. The increased current is amplified and registers on the microammeter.

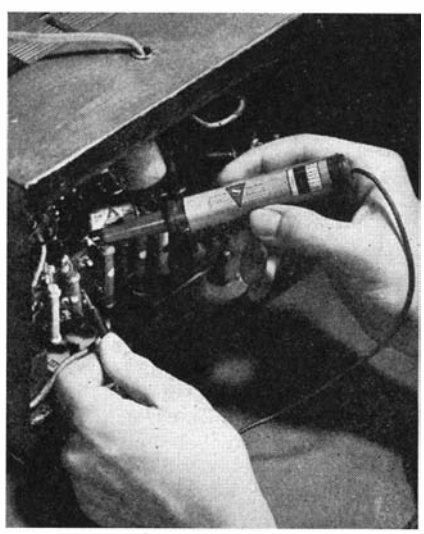
This new leak locator is simple in design, and extremely sensitive. It weighs only 25 pounds, is easily portable, and can be operated by non-technical personnel.

POCKET OHMMETER

For Preliminary Isolation Of Electrical Faults

COMPACT and inexpensive, a pocket-sized ohmmeter has been designed particularly for use by servicemen. Electrical faults in circuits and components can be quickly isolated with the instrument, making possible prompt estimates of service charges, time required for repairs, and so on. It is useful in checking radio and other electronic units, as well as many types of electrical equipment including automobile horns, relays, generators, and starters, electric clocks, and similar equipment.

In radio servicing, the miniature ohmmeter will indicate faults in difficult replacements including i-f transformers, tuning units, and audio sections; approximate values of individual resistors; and open or shorted conditions in other circuit components. It also provides a handy direct-reading means for spot check in automotive electrical equipment, industrial electronic apparatus, home appliances, and experimental or development electrical circuits.



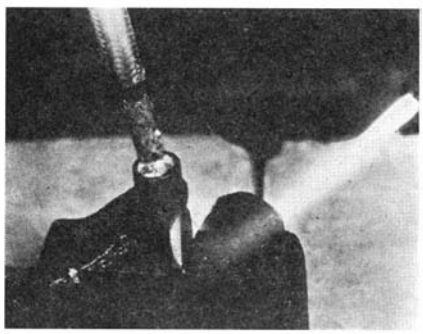
From 0 to 10,000 ohms

The ohmmeter, made by Sylvania Electric Products, Inc., is enclosed in a tubular plastics case ⅞ inch in diameter and 5¾ inches long overall. Direct readings between 0 and 10,000 ohms are given on a 1.5 milliampere full scale sensitivity Weston meter in series with a 1000 ohm molded carbon resistor and a standard penlight dry cell. Test electrodes include a stainless steel prod built into the meter case and one secured to the tip of a 17 inch test cord.

ALUMINUM SOLDER

Needing No Flux, Shows High Strength in Laboratory Tests

INDEPENDENT laboratory tests on the metallic and electrical properties of a new aluminum solder from Switzerland proved that this material, which is used to solder aluminum to aluminum without a flux or flux substitute, resisted shearing after a 250 hour salt spray corrosion test, even though the aluminum base metal itself broke. Actual decreases in strength after the 250 hour salt spray test of the three grades of this Alsoco solder, designated as types M-1001, M-1002, and M-1003, were found to be 3 percent, 8.6 percent, and 4.6 percent, respectively. As for electrical resistance, the tests, conducted by the New York Testing Laboratories, revealed that when an aluminum wire was fastened to a standard copper lug with this solder, resistance of the joint was in the neighborhood of 20 microhms. After the 250 hour salt spray test, the average increase in resistance was only eight microhms.



The aluminum solder firmly joins the aluminum cable to this copper lug

Regarding the corrosion-resistant qualities of the solder, produced in this country by the Alsoco Corporation, metallographic examination of the soldered joints after the 250 hour salt spray test showed that there was no preferential attack on the base metal by the solder. Although the solder showed surface corrosion, it did not appear to be caused by galvanic action.

According to the laboratory report, the soldering operation, using the three grades of Alsoco, was fast and effective. No fluxes or any protective methods were used in the operation, and

the flow points of all three grades were found to be well below that of aluminum and its commercial alloys.

DUST CONTROL UNIT

Uses Capsuled Compound, Makes "Wet" Water Inexpensively

CONCENTRATED and solidified, a cartridge three inches in diameter and eight inches long will, with a special proportioning unit, automatically proportion itself into a water line, providing up to 1000 gallons of "wet" water for dust control in mines, power stations, industrial plants, and similar places. The automatic proportioning unit, which was developed specifically for the application of the compound cartridge, called Compound M, is a casting four and one half inches in diameter and 19 inches high. It is connected directly into the water line, and the water pressure itself furnishes the power for both proportioning and spraying. The unit is fully automatic, and is designed for over 100 pounds pressure. It requires no adjustment or servicing, other than replacing the cartridge as required.

The Compound M cartridge, produced by the Johnson-March Corporation, dissolves automatically in proportion to the water passing it, producing "wet" water so inexpensively and easily, without the necessity for pumps, motors, and mechanical proportioning units, that it can be available at any point for both dust laying and fire control.

PLASTICS FUNNEL

Has Two Sections to Provide Three Different Sizes

A FUNNEL which, in effect, provides not one but three sizes, is now available in the Kodak Combination Funnel. Made in two plastics sections, the larger of which has an intake diameter of five inches and a spout two inches in diameter, and the smaller of which has an intake diameter slightly greater than two inches and a half-inch spout, the two halves fit together by friction and are ideal for work with large volumes of liquid that are to be poured into small-mouthed bottles.

When, however, large volumes of liquid are to be poured into large-mouthed bottles, or small volumes of liquid are to be poured into small-mouthed bottles, the halves may be separated and used independently.

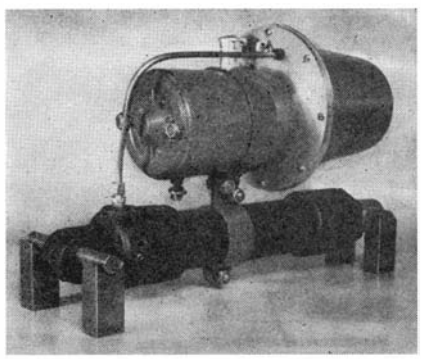
Can be used together or independently

HYDRAULIC PUMPING UNIT

Actuates Rams on Automotive or Industrial Equipment

OPERATING in either vertical or horizontal position, a new low-cost hydraulic pumping unit is supplied with a six-volt driving motor, a reservoir-inclosed 1000 pound-per-square-inch hydraulic pump, a check valve, release valve, and an adjustable relief valve.

The standard unit exerts a ram force of 2500 pounds at the rate of one inch per second with a maximum output of 46 cubic inches of hydraulic fluid. Overall dimensions of the unit, manufactured by John Dusenbery Company, are 14 inches long by seven and one half inches in diameter, without mounting brackets.



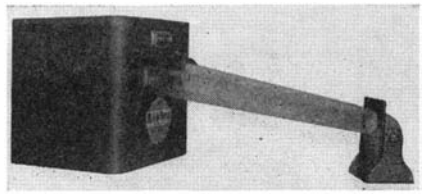
Exerts ram force of 2500 pounds

Primarily intended for actuating rams on automotive and tractor equipment, the standard unit may be modified for other uses. These modifications include larger capacity reservoirs, externally mounted four-way valve for double-acting cylinders, and a 115 volt A.C. motor for industrial applications.

PHOTO-ELECTRIC COUNTER

With Light Source, Photo Tube, Counter in Single Housing

DESIGNED to meet industrial needs for a compact, easily installed photo-electric counter, a new unit contains the light source, photo tube, and counter, all built into a single housing. The counter operates on the interruption of light reflected from a swivel-type, adjustable reflector. The relay will carry a load of up to three amperes continuously for eight million impulses. Minimum time for one cycle is .08 seconds, or 700 cycles per minute.



Compact high-speed counter

The sensitivity adjustment can be easily reached through an aperture in the housing, which permits settings for various light intensities. The maximum number of counts before returning to zero is 99,999. The unit, a product of the Ripley Company, Inc., operates on 115 volts, 60 cycles current, and is applicable wherever a compact, high-speed counter is required.

FUME RESISTANT ENAMEL

Protects Interior Surfaces from Acid, Alkali, Sulfide Vapors

POSSESSING unusually high resistance to acid, alkali, and sulfide fumes, a new white enamel can be applied to interior surfaces of wood, brick, concrete, plaster, or metal. The surfacing is washable, and, if properly applied, it will not chip or flake. This enamel, made by the A. C. Horn Company, is a polymerized thermoplastic elastomer, made from an olefinic base. Called Fumex, it is supplied in brushing consistency. However, it can be sprayed if first thinned with turpentine.

RADIANT HEATING VALVE

Serves to Balance System as Well as to Vent Air

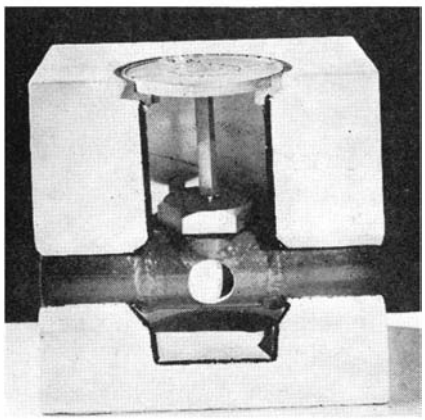
EXPECTED to reduce materially installation cost of radiant heating systems, a combination balancing valve and air vent eliminates the additional piping, fittings, and welding which would otherwise be required for air vents.

Basically, the purpose of balancing valves in radiant heating systems is to regulate water flow to individual coils in accordance with the comfort conditions required in the area serviced by those coils. One valve generally is used for each coil. Air vents are specified by most engineers to insure against air-lock even though radiant heating systems operate at relatively low temperatures.

The "Radiantrol" Valve, as the new unit is called, is somewhat similar to a butterfly-type control valve. It can be used with pipe coils buried as deep as eight inches below the concrete surface because the hollow brass control stem can be cut to appropriate size. The stem extends from the valve to a brass floor plate 3⅝ inches in diameter, marked to indicate open or closed position. This traffic plate fits flush with concrete floor and can be operated by foot. A slightly different model is manufactured for hand operation. These are designed to be located in a valve pit or off the floor in a cupboard or similar location.

The valve disk is built into a wrought iron body made of a short piece of pipe and end-beveled to facilitate welding into a section of the heating coil. Since the most popular sizes of wrought iron pipe used for radiant heating systems are 1 inch and 1¼ inch, according to records of thousands of installations, Homestead Valve Company is manufacturing Radiantrol valves in the 1¼ inch size, which is adaptable to both sizes of pipe.

The fiber container in which the valve is shipped is so designed that it



Adaptable to 1 or to 1¼ inch pipe

may be used as the concrete pouring form, thus eliminating additional cost. Slots can be cut in the container to fit snugly over the pipe so that no concrete will flow around the valve itself.

GLUE SOFTENER

Assures Firm Bond With Gummed Tape

ELIMINATING the annoying and often costly loosening of moistened gummed tape after it has been apparently secured, a glue softening agent can be used with any tape requiring wetting before application. When mixed in a ratio of one part of softener to nine parts of water, the chemical assures a strong lasting bond by softening the glue more effectively than plain water. This material, called Tak by its manufacturer, Kano Laboratories, may be used with tape dispensers, label moisteners, envelope sealing machines, and so on.

SILVER BRAZING ALLOY

Features Strength, Fluidity, and Low Working Temperature

PENETRATING rapidly and completely between closely fitting parts, a new low-silver brazing alloy diffuses into the surfaces to be joined, producing an alloying action which forms a bond of great strength and ductility. The brazing alloy's unusually low working temperature (1145 degrees, Fahrenheit) makes it possible to raise the work rapidly to brazing temperature, resulting in a saving of time and heating energy.

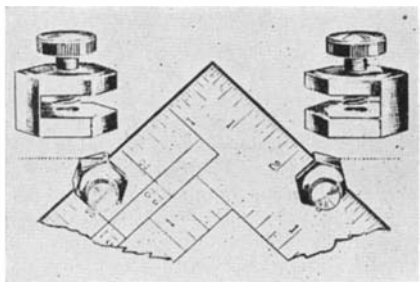
The alloy, called Easy-Flo 45, has unusual fluidity. The instant 1145 degrees is reached, capillary action draws the alloy, a product of Handy and Harman, quickly into the joint clearance, and spreads it completely throughout the joint area. Little or none is left outside. Thus, only a relatively small amount of the brazing alloy is required to make a strong ductile joint.

The fast brazing action, lower silver content, and smaller amount of alloy needed for a joint, in addition to the fact that through the use of the alloy, the number of rejects is said to be greatly reduced, all mean lower cost per joint.

STAIR GAGE FIXTURE

Once Set, Needs No Readjustment

SIMPLE, slotted, hexagonal fixtures designed to clamp on carpenters' steel squares to assist in laying out many



Courtesy A. D. McBurney

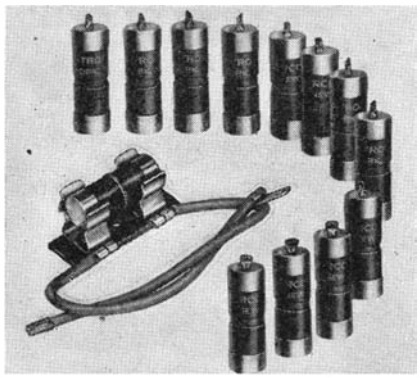
Fits on carpenters' steel square

types of angles are made of high grade nickel-plated steel and furnished with brass thumb screws. The fixtures may be clamped on instantly and secured with the thumb nuts. Set to mark out a given angle for a stair stringer, for example, this angle may be used accurately again and again without time-consuming placement of the steel square.

MERCURY SWITCH

Is Fully Enclosed For Safety In Explosive Atmosphere

HERMETICALLY sealed by fusing metal to ceramic, small mercury switches are especially adapted to explosion-proof areas; the metal enclosure insures hazard-free operation in atmospheres where switch-sparking constitutes a danger. They provide mercury-to-mercury contact without arcing, pitting, or burning, and will operate at 110 and 220 volts A.C. or D.C., in an ambient temperature of 100 degrees, Centigrade. Pressure of the gas inside the switch to quench the arc is 28 pounds per square inch above atmospheric pressure. Under test, it has been found that these small switches, product of Mercontrol, Inc., can stand an overload of 400 percent for a short period of



Ratings of 5, 10, 15, and 20 amperes

time; they are provided with ratings of 5, 10, 15, and 20 amperes.

Only 1½ inches long by ½ inch in diameter, these switches may easily be installed in standard cartridge-fuse holders. Mercontrol switches are also available in a miniature unit; 1 inch long by ½ inch in diameter.

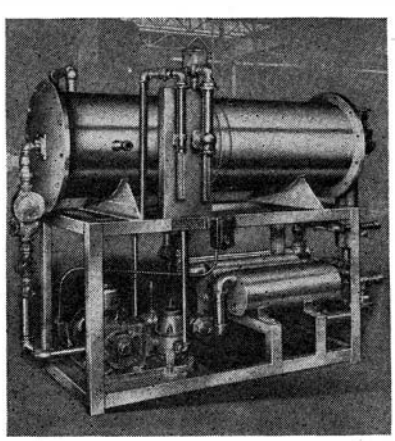
GAS PRODUCER

Creates Prepared Atmospheres By Partial Burning

GENERATING a prepared atmosphere by partially burning natural, artificial, or propane gas, a gas producer uses a micrometer-adjusting valve to control the air-gas ratio needed for the desired atmosphere. This definite gas-air mixture is then passed through a fire check valve and into the special burner, and is burned within the primary and secondary combustion chambers. The water vapor which results from combustion is condensed out of the prepared protective atmosphere by water cooled condensers and collected by means of water traps. The combustion chambers of this gas producer, manufactured by the Bellevue Industrial Furnace Company, are provided with a water jacket.

Specific protective gas atmospheres having higher hydrogen content with air-gas ratio of five to ten (air) to one (natural gas) may be provided by the use of the Bellevue special catalyst in the secondary combustion chamber.

This gas producer may be built in sizes to generate 350, 650, 2000, 3500, 9000, and up to 60,000 cubic feet per



Natural, artificial, or propane gas used

hour. When lower than normal water content is desired in the protective gas atmosphere, the gas producer may be supplied with a refrigerating unit.

These producers find application in such processes as bright or clean annealing and sintering of ferrous and nonferrous mixtures in powder metallurgy.

BETTER SEAT CUSHIONS

Are Filled With Resilient, Light Glass Fibers

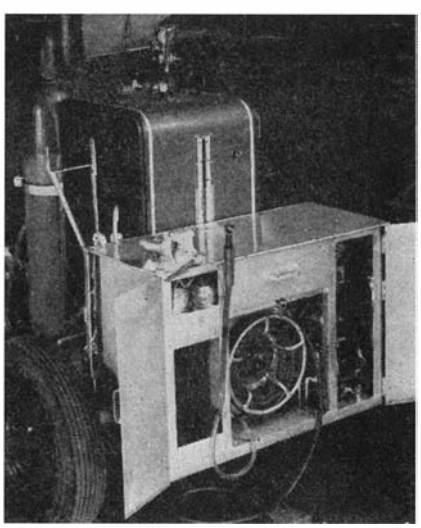
PROVIDING a low-cost, light-weight, non-combustible, resilient filler for railroad, aircraft, motor coach, and automobile seat and seat-back cushions, superfine glass fibers show excellent over-all riding qualities. In a typical aircraft installation, where weight-saving is of major importance, use of these fibers in seat and seat-back cushions has resulted in a weight-saving of two pounds per seat. Identified as Fiberglas Superfine PF, Type A44, and produced by Owens-Corning Fiberglas Corporation, the individual fibers have an average diameter of 0.00011 inch. In order to provide dimensional stability and handleability, the fibers are treated with a resin binder and formed into one inch thick blankets.

Maximum riding qualities are obtained by folding, cutting, and installing the material in accordance with tested procedure. It is recommended that batts be fan-folded vertically and compressed. For handling purposes, the fan-folded pack can be held together by stitching through with coarse twine. The pack is then sliced horizontally into pieces of the thickness required.

VACUUM EXPOSURE HOLDER

Eliminates Fuzziness Due to Poor Contact In Radiomicrographs

BETTER X-ray pictures of microscopically thin sections of metal, paper, and textiles are possible with a new instrument that uses a vacuum to provide close contact between the section and the photographic plate.



Developed for use in microradiography by Harold F. Sherwood of Kodak Research Laboratories, the device is a "vacuum exposure holder" modeled after those used in the graphic arts.

The holder consists of a rigid sheet of metal recessed enough to hold a glass photographic plate and the material to be X-rayed.

When vacuum is applied through a tube leading to the recess, the section and plate are drawn together, and exposure is made with an X-ray tube.

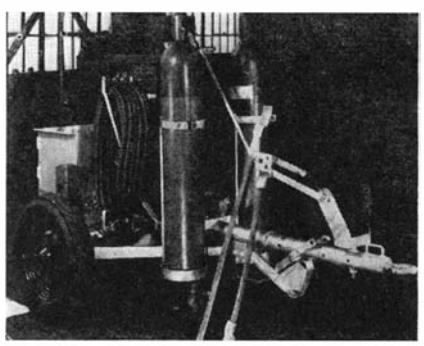
Previously, poor contact between a section and a photographic plate, or repeated exposures because of movement, usually resulted in a lack of sharpness. This was noticeable in X-ray negatives magnified beyond 50 diameters.

With the new instrument, fuzziness due to poor contact is eliminated. Negatives are obtained that are reasonably sharp when magnified as much as 400 diameters.

PORTABLE WELDING UNIT

Facilitates Joining of Aluminum In Hard-to-Reach Locations

ALTHOUGH built specifically for welding electrical conductors during construction and assembly work, a portable inert-gas metal arc welding unit is readily adaptable to many other applications. This three-wheeled unit, constructed by the welding section engineers of the Aluminum Company of America, carries the welding transformer, cylinders of argon gas, and the connections for the water and drain lines for cooling the torch and power cables. Electrical control provides protection for the torch against failure of the water supply, and also starts and stops the flow of both power and argon gas to the torch.



Welder includes gas tanks, transformer, torch cables, and cooling lines. Left: 75 feet of hose in cabinet permit a wide radius of operation

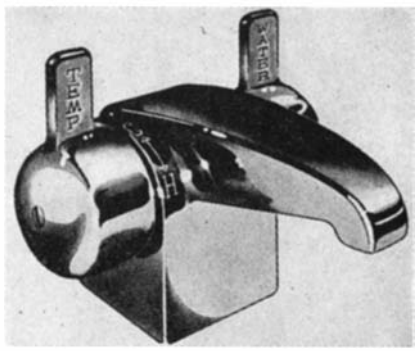
Torch leads, 25 feet long with a 50-foot extension, permit welding in positions usually considered inaccessible. This portable unit satisfactorily joins aluminum tubing, extrusions, and sheet up to one-quarter inch. The resulting joints are smooth and bright.

The unit requires a source of about 20 kilovolt-amperes of 440 or 220 volts at 60 cycles, and a source of clear, cool water at a rate of one-half gallon per minute with a pressure of 50 pounds.

WATER FAUCET

Permits Temperature Control Independent of Volume

INTENDED for either domestic or industrial wash-room installation, a new type water faucet eliminates the annoyance of scalding the hands while one is trying to obtain water of the desired temperature. Instead of the conventional system of having one faucet to control the hot water and another the cold, this faucet has one knob which regulates the temperature of the water and another which controls the volume. After the volume-control knob of this Cole Valve Company faucet has been set to the amount desired, turning the other handle mixes the water to any temperature wanted without altering the volume. Or the temperature knob can be preset before the water is turned on.



Left-hand knob regulates the temperature; the right controls the volume

VELVET-LIKE FINISH

Achieved By Blowing Rayon Fibers Onto Adhesive-Coated Surface

IMPARTING a velvet-like finish on a variety of materials, a new finishing method is suitable for small shop application. The necessary materials for producing the finish are supplied in kit form. This kit contains an undercoat adhesive in two colors—brown and green—the Suede-Tex (as the material is called) in the same colors, an applicator brush, a bottle of thinner, and a spray gun for applying the Suede-Tex. The adhesive undercoat is brushed on the portions of the object to be coated. Then, before it dries, the same color of Suede-Tex is loaded into the reservoir of the spray gun, and the material is driven into the undercoat. The material consists of extremely short fibers of rayon in a variety of colors. The stream of air through the reservoir of the spray gun separates the fibers, causing each to drive straight into the undercoat at high velocity.

With one end embedded, the rest of the fiber stands erect, forming a pile somewhat like velvet.

Suede-Tex, manufactured by DonJer Products Company, finds wide application in coating the bottoms of such articles as ash trays, lamp shades, trays, candlesticks, and so on. It can also be used to cover books, albums, picture frames, toys, lamp shades and the like, and to line drawers, radio cabinets, and metal boxes. It can be applied to any surface—metal, plastics, wood, paper, or cloth.

IMPACT WRENCH

Removes Frozen Nuts By Momentum Of Spinning Weighted Handle

BADLY rusted or jammed lug nuts on truck and tractor wheels now can be easily moved by an unusual type of wrench. The usual twisting of an ordinary wrench is given great power in this new tool by putting to work the momentum of a free-swinging weighted handle. The operator swings the weighted handle around the shaft, and as its lugs strike against the corresponding lugs on the shaft, its momentum is transferred to the shaft and lug nuts in a series of a hammer-like twisting blows that shock frozen nuts loose. Both handle and shaft of the tool, called the Jari Shock Wrench, are of drop forged steel, heat treated and cadmium plated. The handle is 24½ inches long, and weighs 10¼ pounds. The shaft is 25½ inches long and weighs seven pounds. The unit is designed to take all standard ¾ inch drive sockets and the shaft is also fitted with an integral socket.

Takes standard ¾ inch drive sockets

The wrench, manufactured by Jari Products, Inc., can be taken apart or re-assembled in a few seconds and occupies but little space in a tool kit.

CLEAR PLASTICS

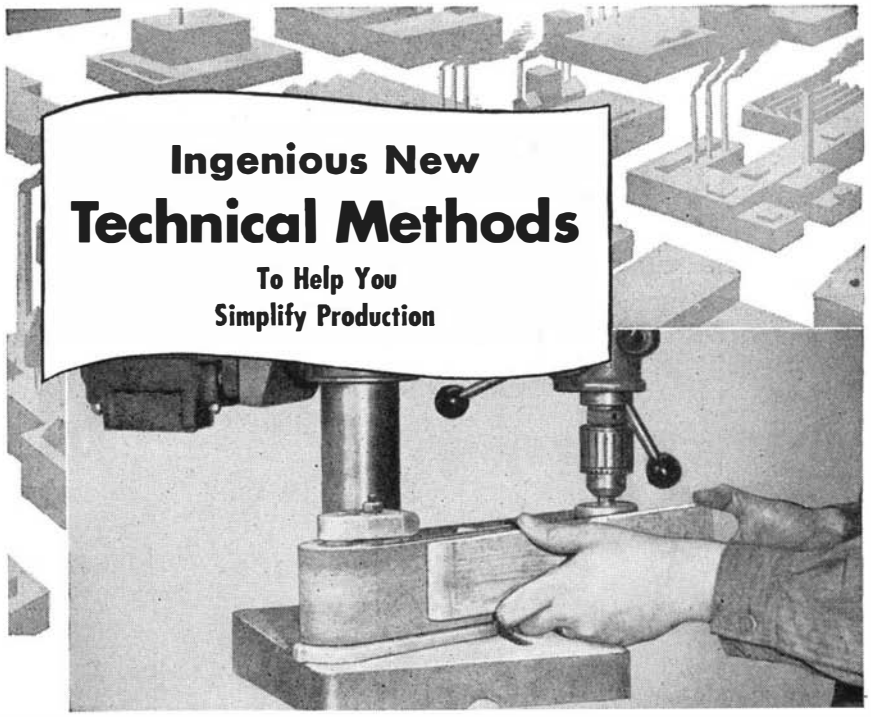
Hard and Flame Resistant, May Serve Best as Copolymer

A COLORLESS liquid in its monomeric (or original) form, diallyl phenyl phosphonate, a new plastics material, polymerizes (a one-way chain reaction) to become a transparent, thermosetting, hard, and strong resin which has been named V-Lite. Flame resistance of pure diallyl phenyl phosphonate polymer, developed by the Victor Chemical Works, is such that it extinguishes itself within 30 seconds of removal of flame. Index of refraction of the pure plastics is approximately 1.57, a figure higher than any but optical glass. Not only does this fact cause improvement in appearance of common plastics when copolymerized with them, but it makes possible the production of clear sheets of plastics with an adjusted index of refraction.

The Victor resin is insolube in ether, acetone, benzene, butyl acetate, naphtha, alcohol, carbon tetrachloride, water, 5 percent hydrochloric acid solution, or 5 percent caustic soda solution. It has proved stable when immersed in 30 percent sulfuric acid at 150 degrees, Fahrenheit, for more than five days.

Speaking of possible uses for the new material, James M. Gillet, director of industrial research of the Victor Chemical Works, said:

"It is too early to predict in what manner our plastics will find widest application. The flame-resistance suggests coating use for flammable decorations or veneers, and as windows in passenger aircraft. The high index of refraction suggests transparent laminates strong enough to support themselves in outdoor illuminated display work and for hail-proof greenhouse lights. The insolubility suggests use in chemical equipment and in storage



Ingenious New Technical Methods

To Help You Simplify Production

NEW BELT SANDER FOR DRILL PRESS

Does Finishing Jobs Faster, Better

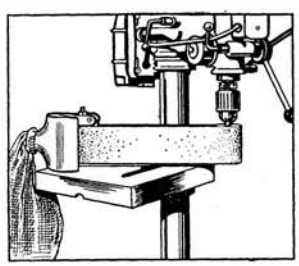
A new, simple, faster method for many surface finishing jobs on wood, metal, plastic and other materials has been announced by the OK Specialty Company of Chicago. The new finishing method takes the form of the OK Belt Sander, a drill press attachment.

The new sanding device weighs less than 5 pounds. It is made up of an aluminum base with backing plate or platen, a driven pulley mounted on ground steel shaft and running on precision ground ball bearings, and cast aluminum driver pulley mounted on ½" ground steel shaft to fit into the drill press chuck.

The base of the sander is bolted to a drill press table. Merely by moving the drill press table, the attachment can be adjusted to handle sanding belts from 26" to 36" in length.

The sander takes belts from ½" to 3" in width. Two sanding belts, one coarse grit and one fine grit, are furnished with each attachment. The device comes assembled ready for use with any drill press. Most efficient performance is achieved at 3500 to 5000 RPM. The sander stands 5" high, and the base measures 10½" long by 3¼" wide.

Another time-saver on the job is chewing gum. Chewing gum may be used even when hands are busy; and under dust conditions helps to keep the throat moist—prevents "false thirst." For these reasons many plant owners make Wrigley's Spearmint Gum available to everyone.



OK Belt Sander Assembled, Ready for Action

You can get complete information from OK Specialty Company, 4655 N. Clark St., Chicago, Ill.

AB-69

battery cases. The hardness suggests copolymers for machined parts and for optical use. We think the greater possibilities for the resin will be found as a complement to other plastics rather than as a pure material."

HYDRAULIC VISE

Of Sturdy Construction For Heavy-Duty Operation

REQUIRING no outside power source whatsoever, a new hydraulic vise is completely self-contained. It has gibs of high-grade steel set at an angle of 45 degrees in V-ways of semi-steel,

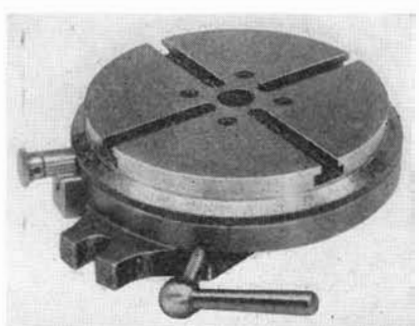
Foot pump leaves hands free

and is suitable for the heaviest vise operations. Called Speedvise, this product of the Studebaker Machine Company is controlled by a foot pump leaving the operator's hands free. It can be mounted in any position. Two models are available, one with a maximum pressure of five tons between the precision-made jaws, the other with a grip of seven and one half tons.

ROTARY WORK TABLE

For Engraving or Machining Small Circular Pieces

FIVE INCHES in diameter, a rotary work table for engraving, profiling, graduating, milling, and drilling on circular name plates, dials, round dies, or any object requiring circular or semi-circular cutting, is adaptable to virtually any engraving machine. It can be used



Graduated in degrees

to advantage also on small-production milling and drilling machines where, it is claimed, layout work can be greatly reduced on many types of jobs.

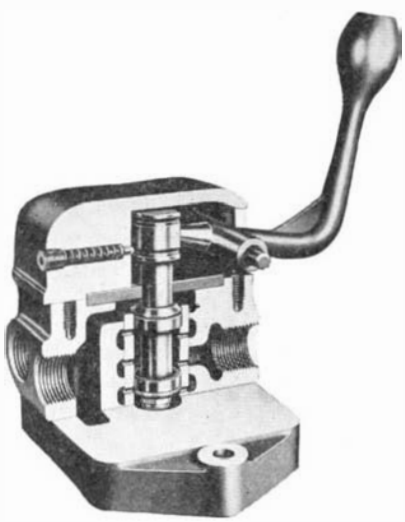
The outer rim of the turn-table, product of the H. P. Preis Engraving Machine Company, is marked in degrees and numbered at every tenth degree. Every degree is notched for quick and accurate division by engaging the index unit. This unit can be disengaged for free turning, using a cam-lock to secure the turn-table. Top and bottom surfaces are ground accurately parallel to assure an even depth of engraving or other class of machining over the entire surface. The working surface is provided with four tee-slots for ¼-inch bolts, and a ⅝-inch-diameter hole for centering the work with a stud. The over-all height is only 1¾ inches, weight is nine pounds.

AIR CONTROL VALVES

Have No Seats or Rod Packing, Are Easily Maintained

COMPLETELY re-designed, and now available in 79 standard models, a line of air control valves features sliding piston-type construction which eliminates valve seats and rod packing, together with the wear and maintenance they entail.

These new air valves may be used in manufacturing and processing operations of all kinds, as well as for original installation in air-operated equipment on the market.



One of 79 standard models

Effortless operation is assured, because these valves, manufactured by the Logansport Machine Company, Inc., do not operate against air pressure; the balanced construction produces equal pressure on both sides of the piston. The pistons are light in weight, permitting high-speed operation and rapid reversals, particularly in the electrically operated models. Longer sealing life is obtained through the self-cleaning construction, which wipes piston walls clean of abrasive particles with every piston movement.

The Editors Recommend

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

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

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

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

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

MUSICAL ACOUSTICS — *By Charles Culver.* Textbook for college students majoring in music, and essentially physics throughout. Covers all important phases of acoustics of music. **$3.10**

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

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

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

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

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

SLIDE RULE 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. **$4.10** including a slide rule; for book alone. **$2.85**

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

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

Best Sellers In Science

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

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

EXPERIMENTAL SPECTROSCOPY — *By Ralph A. Sawyer.* Covers theory and types of spectroscopes and spectographs, 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**

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

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

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

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

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

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THE BOOK OF HOUSES — *By Dean and Breines.* Basic factors in home construction are considered, as are also financing costs, legal details, safety factors, and so on. Fully illustrated, including 150 photographs and 100 floor plans in the $5000 to $10,000 price range. **$2.10**

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

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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.)

SHORT STORY OF RAYON. Containing facts about the history and development of rayon, this booklet also covers: the discovery of the viscose and acetate processes; the part rayon played in World War II; and the role of research in developing and improving rayon yarn and staples and in increasing the usefulness and versatility of rayon. *American Viscose Corporation, Public Relations Department, 350 Fifth Avenue, New York 1, New York. — Gratis.*

RCA PHOTOTUBES, CATHODE-RAY TUBES, AND SPECIAL TUBES. This 16-page booklet includes 113 types of tubes, with descriptions, terminal diagrams, dimensional outlines, spectral-sensitivity curves, and equipment design work. *Radio Corporation of America, Commercial Engineering, Tube Department, Harrison, New Jersey.—10 cents.*

ANNOUNCER OF SCIENTIFIC EQUIPMENT is a periodic house magazine containing illustrations and descriptions of various types of scientific equipment manufactured by this company and which they call "Modern Tools of Science." *Eberbach and Son Company, Ann Arbor, Michigan. — Gratis.*

AEROIL TANKS is a leaflet containing specifications and "X-ray" diagrams of melting and dipping tanks for waxes, oils, paraffin, pitch, hydroline, and similar compounds. Request leaflet No. 581. *Aeroil Products Company, Park Avenue at 57th Street, West New York, New Jersey.—Gratis.*

3/16" PITCH SILENT CHAIN. In 16 pages this booklet describes and illustrates the applications of this chain for fractional horsepower drives. Actual installations are illustrated and information is given on how to select a chain drive. Request Bulletin No. 2010. *Link-Belt Company, 220 South Belmont Avenue, Indianapolis 6, Indiana.—Gratis.*

HARDENABILITY OF ALLOY STEELS is a treatise containing current data on designing, testing, and ordering steels by hardenability-band specifications and is designed to stimulate interest in selecting and buying steels by hardenability. *Society of Automotive Engineers, Inc., 29 West 39th Street, New York 18, New York.— $2.00 ($1.00 to SAE members.)*

HOSE MASKS designed to safeguard workmen where high concentrations of gas or insufficient quantities of oxygen exist are described in this six-page bulletin. These masks provide maximum wide-angle vision and per-

fect gas-tight fit and are available with double inhalation tubes for extra protection. Request Bulletin No. EB-5. *Mine Safety Appliances Company, Braddock, Thomas, and Meade Streets, Pittsburgh 8, Pennsylvania.—Gratis.*

PRODUCTS FOR HEATING, VENTILATING, AND AIR CONDITIONING, a 12-page bulletin, describes and illustrates equipment which includes Texrope V-belt drives, centrifugal pumps, A.C. and D.C. motors; and a line of motor controls, dry-type transformers, and A.C. and D.C. welders. Request Bulletin 25B6183. *Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin.—Gratis.*

CAN LABELING ADHESIVES is a four-page bulletin describing a range of can label adhesives designed to meet the majority of labeling, handling, and storage conditions encountered in the packaging industry. In addition to a list of products effectively labeled with these adhesives, an offer is made for free consulting service on adhesive operations. Request Bulletin No. 16. *Paisley Products, Inc., 1770 Canalport Avenue, Chicago 16, Illinois.—Gratis.*

THE CHEMICAL CONSULTANT AND YOUR BUSINESS is a brochure outlining many of the types of problems which the chemical consultant encounters, and indication is given of the types of business enterprises which find continual or occasional use for the services of chemical consultants. The brochure covers the various branches of services offered, corporation policy in relation to clients, the basis of charges, and the types of agreements offered. *Foster D. Snell, Inc., 29 West 15th Street, New York 11, New York.—Gratis.*

BASIC CHARACTERISTICS OF USEFUL INDUSTRIAL LABORATORY INSTRUMENTS is a two-page wall chart with data presented in convenient form for ready reference. Covering 15 instruments, the data are arranged in columns under seven headings. Request Chart R-1066. *North American Philips Company, Inc., 100 East 42nd Street, New York 17, New York.—Gratis.*

HYDRAULICALLY OPERATED ASSEMBLY PRESSES is a bulletin containing details of an expanded line of presses that includes models from 10 to 50 tons capacity. Designed so that the height of the base can be selected to suit the individual job, the machines also feature high-speed ram return, adjustable working stroke speed and length, and quick adjustable operating pressure through a combination of external pressure gage and dial type regulator. Request Bulletin PA-47. *Colonial Broach Company, Box 37, Harper Station, Detroit 13, Michigan.—Gratis.*

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The Editor

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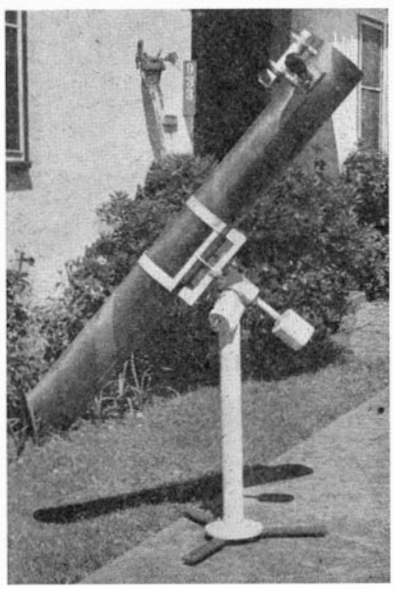
" 'WOWS' MY NEIGHBORS"

Says Amateur Maker of Telescope

THERE is hardly a reader of Scientific American who has not at one time or another yearned for a man-sized astronomical telescope. Some have been deterred by the cost of commercial instruments, others by the thought (erroneous) that telescope making requires some unattainable skill, some black magic beyond reach of ordinary mortals. Excellent telescopes can be built partly from prepared kits of glass and grinding materials, with the aid of readily available instructions. Almost any amateur mechanic can thus build a reflecting telescope for about one tenth the cost of a ready-made instrument of equal size and power. And the thousands of amateurs who have made



An average beginner's first telescope

such telescopes attest that the work involved was actually fun—absorbingly interesting fun.

Typical of good amateur telescope design is the example shown in the illustration above, made by G. M. Reavis, 933 Divisidero, Fresno, California. In a letter to the editor, Mr. Reavis writes: "I have derived a *lot* of pleasure from it, especially when looking at the Moon a view which always 'wows' my neighbors." This telescope is a half-portable instrument, a feature that will appeal to many.

The functioning heart of a telescope such as Mr. Reavis has made is a concave glass mirror disk ground by hand on top of an equal sized glass disk with loose grains of abrasive. After a few hours the upper disk becomes concave the lower convex but, having done its work, it is discarded and the other disk is polished with rouge and water against a layer of pitch. It is then coated with aluminum (formerly with silver) and installed in the lower end of the open-top telescope tube. Near the upper end is a small flat mirror at diagonal angle which reflects the rays from the concave mirror into an eyepiece lens on the side.

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"

TERRESTRIAL telescopes for ordinary landscape gazing do not require the same top optical standards as astronomical telescopes and thus the one shown in the upper part of Figure 1, made by H. Clifford Allen, Princeton, N. J., proved good enough for that purpose. It contains an erecting system made of selected pieces of ordinary plate glass.

Not certain his plan for a three-mirror erecting system was correct, Allen collected a few compact mirrors, feminine gender, arranged them as shown and proved that his idea would work. Then he cut some pieces from 3/16" plate glass, tested them by interference against a standard flat, and

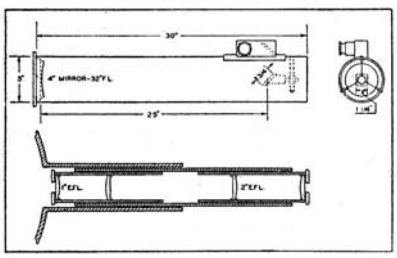


Figure 1: Two erecting systems

selected three which were thus proved to be not more than two fringes (1/50,000") uneven. These he front-surface aluminized and mounted as shown.

Using an eyepiece of 1¼" focal length he obtained a magnification of 26 diameters—the focal length of the main telescope mirror divided by that of the eyepiece—and he reports that definition, light-gathering power, and contrast proved very good in terrestrial observing.

Plate glass diagonals, given some sanction in "A.T.M.," may satisfy the tyro when used with his first mirror, if selected as described there—as some have not been. No matter how nearly flat they may be over their area as a whole, they still are not flat on a minute basis because plate glass is felt-polished and has a minute "lemon-peel" finish. This diffuses some of the light. They get by easily on terrestrial telescopes (except target spotters) but less so for astronomical uses.

A better erecting system is described by Doncaster G. Humm, 1219 West Twelfth St., Los Angeles 15, California. He writes:

"Reflectors make excellent terrestrial telescopes. They are light and easily transported. Their light-gathering power is relatively high. The chief obstacle preventing their more frequent use in this field is difficulty in securing a good erecting system.

"The Ramsden eyepiece, used somewhat differently than is customary, offers a solution for the difficulty. Bell notes in "The Telescope" that the Ramsden performs best when the faces are exactly their focal distance apart, but notes also that this brings every bit of dust into sharp focus, thus interfering with good vision. This objectionable feature is not, however, noticeable when the Ramsden is used as an erector.

"The Ramsden eyepiece consists of two plano-convex lenses arranged with their convex sides facing each other. Usually, the two lenses are spaced two thirds or three fourths their focal distances apart.

"The formula for the combination is: $F = \frac{f_1 f_2}{f_1 + f_2 - d}$

"In this formula, F is the focus of the combination; f_1, the focus of one lens; f_2, the focus of the other; and d the spacing.

"The best chromatic compensation is obtained with $d = \frac{f_1 + f_2}{2}$

"In the Ramsden suggested as an erector, $f_1 = f_2$. Hence, both equal d. So, the formula becomes: $F = f$ (1 or 2).

"Two such Ramsden eyepieces may be arranged in tandem (Figure 1, below) in such a way that the distance between them may be varied. The closer they are placed, the lower the magnification, since the combination is in effect a low-power compound microscope.

"I have such a combination mounted on a 6.5" reflector of 50" focal length. Each Ramsden is mounted in a brass slip-tube 3" long. One Ramsden has a

Figure 2: For quick height change

2" focus; the other, a 1½". Their slip-tubes have a sliding fit in a 6" focusing tube. When the two Ramsdens are at closest position, the power of the telescope is approximately 40; at their farthest distance apart, the magnification is nearly 100.

"Used at these low powers, the light-gathering capability of a 6" telescope is very great. Flowers viewed at a little distance take on a richness of color not apparent to the naked eye. Twilight and evening viewing of animal life becomes possible, since the setup is in effect a very powerful night glass.

"Astronomical viewing suffers little from the light loss caused by the erecting lenses, since seeing at from 50 to 75 power is more frequently possible

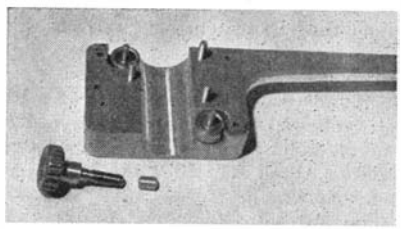


Figure 3: Arm with skate wheels

than at high powers. The reflector has been used to view the cloud bands on Jupiter, the globular cluster in Hercules, the great nebulae, and many other spectacles—all very effectively."

AMATEUR ASTRONOMERS who have had to run numbers of non-astronomical uninitiates quickly through observations well know how hard it is to manage the manipulations and keep the visitors happy. For such uses the special mounting shown in Figure 2, made by John Holeman, 305 Thayer Drive, Richland, Wash., seems especially well adapted. The telescope runs easily up and down its post on two roller-skate wheels which don't stick, and has a clamping screw. It has a simple pointing handle which even your old Aunt Sally can work without a course in mechanics. Holeman designed it for use in teaching large classes of totally unsophisticated observers who, of course, would be of all heights.

The tripod at the bottom is made of ¾" pipe and the post is a piece of 1¾" seamless steel conduit. The telescope is mounted on an arm which Figure 3 describes better than words. The arm was built up of ¼" and ½" dural pinned together with taper pins and screws: Holeman didn't have a casting.

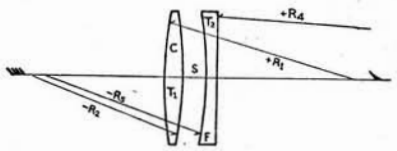
The alt-az mounting at the outer end of the arm is a Royal camera tripod head.

"The RFT telescope," Holeman states, "contains a 3", f/6 Navy coated spy-glass objective. I made the mounting, including the toric cell ring and push-pull adjustments, from scrap. The chart table shown in Figure 2 beside the observer (Mrs. Holeman) is a folding photographic light stand (tripod) with a plywood table and spring clothespin clips to hold charts, as I also use this telescope for looking for telescopic meteors of which we see quite a few

in the clear dry desert air of southeastern Washington. Over the table is a length of BX conduit carrying a flashlight bulb behind a red filter, the batteries being clipped under the table."

TO POOL among amateurs, through publication in this department, as many specifications for good objective lenses as can be found by its readers is an aim of its editor, expressed some time ago. From Colonel Troy W. Lewis, 1812 Schiller Avenue, Little Rock, Arkansas, come the specifications given in Figure 4. He writes:

"This lens was computed and constructed with Parra-Mantois et cie crown and flint glass prior to the outbreak in Europe of World War II. It gave excellent results on either nebulae or clusters, and was quite effective in terrestrial work when viewing objects against deep shade or in poor light.



Type 519604, *Hard Crown*, N_d 1.51899; V. 60.4; C — F, 0.00859. Type 613369, *Dense Flint*, N_d 1.61323; V.36.9; C — F, 0.01661.

(Radii that present convex faces to incident light are considered positive; concave faces against incident light are negative.)

Finished diameter, 2"; E.f.l., 24"; focal ratio, 1:12.00.

R_1	=	+9.0213360"
T_1	=	0.2667840
R_2	=	−7.7213592
Sep.	=	0.3333312
R_3	=	−7.2730488
T_2	=	0.1666224
R_4	=	+269.1965952

Gauss condition satisfied to	−0.0005671"
Sine condition satisfied to	+0.0022351
Chromatic aberration on axis	+0.0001353
Spherical aberration on rim	0.0000000
Chromatic Dif. of Mag. on axis	−0.0032680

Figure 4: Lens specifications

Because of its large light-gathering power and short focal length it should make an exceptionably desirable objective for a spotting telescope or, with some modifications, a night-glass for rich-field observation.

"When French glass became unobtainable the design was recomputed for Bausch and Lomb optical glass with the thought of making the objective available for amateur construction. That computation, although performed with patience, was made during odd moments using log-tables and pencil under trying conditions. The probability of error in the calculations became at once a sobering factor making it seem imprudent to release the specifications without further study. Since the time necessarily involved to re-check the work could not then be taken from missions of greater importance it was thought advisable to withdraw the design from the publisher.

"Recently it was my good fortune to acquire a large computing machine that is capable of the highest class of work. Now that it appears probable English optical glass soon will be on the American market again, and since Chance Brothers Company, Smethwick, England, makes a glass-pair highly suited

to this air-spaced design, I have recomputed my Clark-type objective to be made with Chance Brothers' glass specified in Figure 4. The glass is obtainable through the American Agents, The Ednal Company, Inc., 95 Madison Avenue, New York.

"This objective design was subjected to a careful trigonometrical trace of two rays through both the axial and rim regions. Spherical and chromatic aberrations have been reduced to zero, or practically so. I was unable to satisfy fully both sine and Gauss conditions simultaneously, due in all probability to the form of the objective rather than to the glass selected, but the residuals, as shown in the specifications, are considerably smaller than the amount that can be tolerated in this type of lens when used for the purposes indicated. A slight increase in separation would satisfy entirely the Gauss condition but other more desirable corrections would be slightly upset. The chromatic difference of magnification on the axis, now roughly —0.0033", would be slightly enlarged, while the error against the sine condition, now +0.0023", would be increased. The corrections as they stand are probably of astronomical grade although not so claimed. The highest class of terrestrial objective is claimed.

"I have not actually constructed this particular Clark-type objective with these specified English glasses, although a similar objective has been made with French glass to specifications not so perfect as those given here. Splendid results were achieved, as previously stated, and no reason is seen why this recomputation for English glass should not prove equally good. Judging from past experience, and relying on the accuracy of the computing machine, I am convinced this objective will fully satisfy those amateurs who may choose to make for themselves a fine spotting telescope from those specifications.

"After long and careful study of this design I am forced to conclude that the perfection attained in the original Clark air-spaced objectives was due more to the magic touch of Lundin, the elder, than to the exact science of pure mathematics. My air-spaced objective, when made to specifications, will prove to be highly acceptable. If we have the necessary skills we may hope to satisfy both the sine and Gauss conditions by figuring the fourth surface slightly. Perhaps, with diligence and patience, we, too, may attain the high degree of perfection seen in the masterly work of Lundin."

Doctor D. Everett Taylor, Willimantic, Connecticut, has made the valued suggestion that the telescope be equipped with a roof prism inverter for terrestrial use, also that the surfaces be given a coating of fluoride, which should add much to resolving power.

Any reader who undertakes this objective is invited to keep in touch with Colonel Lewis or with this department, or both—though progress reports to either one are likely to be seen by the other since this department similarly keeps in direct-mail touch with numerous readers everywhere.

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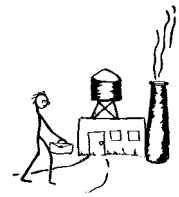

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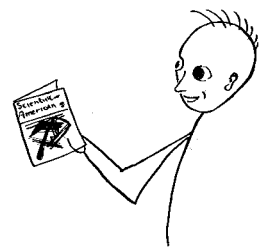

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