Scientific American

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AUGUST
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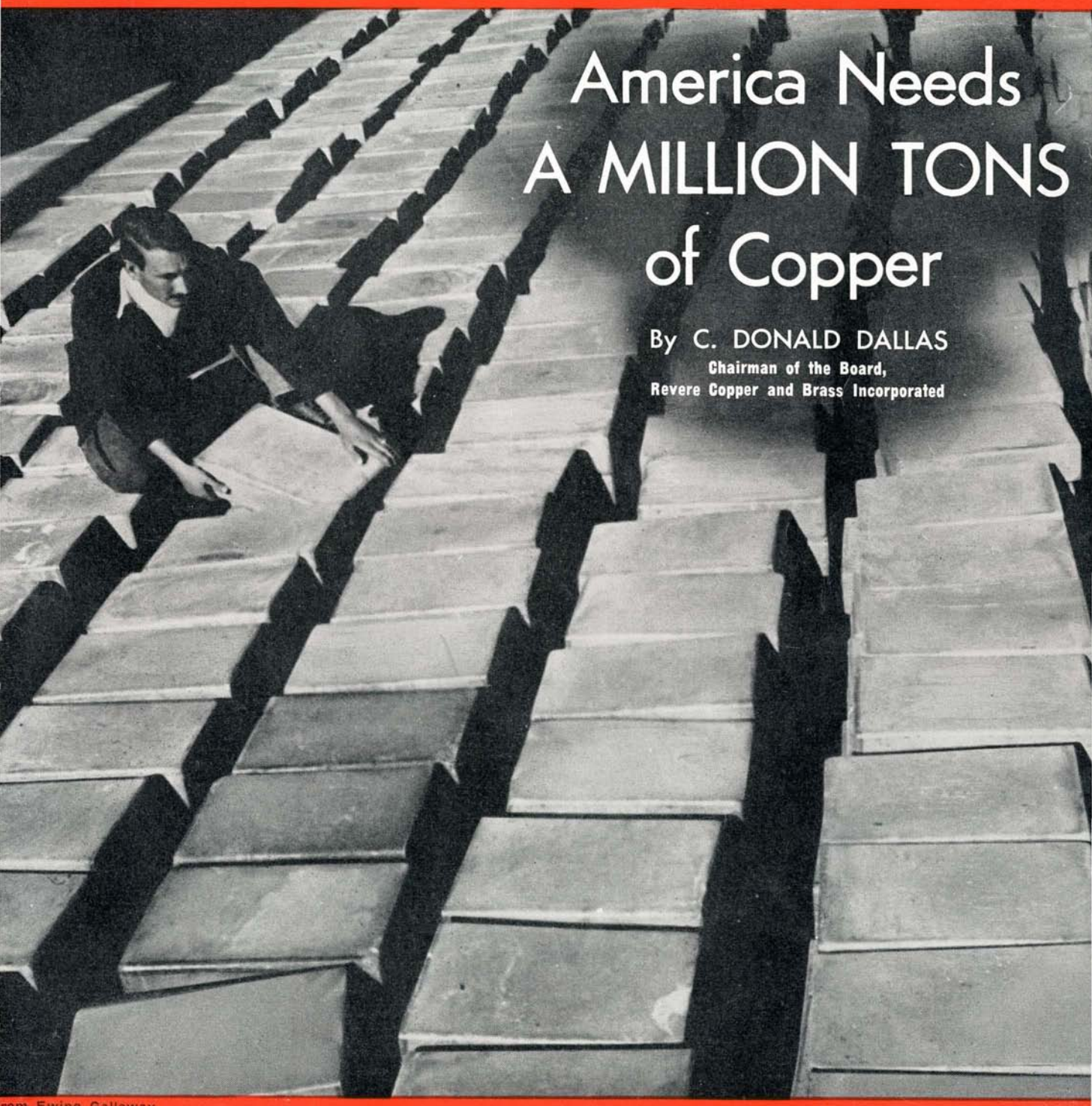
PROGRESS IN INDUSTRY



America Needs A MILLION TONS of Copper

By C. DONALD DALLAS

Chairman of the Board,
Revere Copper and Brass Incorporated

rom Ewing Galloway

Ever wish you were Aladdin?

You remember him . . .

He was the lucky fellow who found a magic lamp. It gave him everything he wished for—from diamond-crusted palaces to a sultan's daughter as his bride.

You've probably wished a lot of times for a miracle like this to happen to you. Maybe not for out-of-this-world treasures, but for something that will take care of the things that are bound to come up.

Like medical expenses, or college for the kids. Or maybe just for the nice, safe feeling it gives you to have some extra money put aside for the future.

Though no magic is involved, there is a way to give you this security. The Payroll Savings Plan. Or, if you're not eligible for the Payroll Plan but have a checking account, the new Bond-a-Month Plan.

Either way, it's almost unbelievable how quickly your money accumulates.

Where else can you get such a *safe*, generous return on your money ($4 for every $3)? It's so simple—so easy, you hardly miss the money that you're saving.

And don't forget—at the same time, you're *making more!*

Next to a magic lamp, there's no better way than this to make sure your future is secure.

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

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INDUSTRIAL DRAMA: Copper "cakes" ready for shipment from the big mining and smelting plant at Chuquicamata, Chile, point up the arguments for an adequate copper stockpile in the United States, as put forth by C. Donald Dallas in the article starting on page 52.

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In This Issue • August 1947

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of August, 1897)

SAFETY IN FLIGHT — "In a critical review of recent progress in aeronautics, Mr. Octave Chanute, the well known engineer and promoter of aviation, pointed out a fatal defect in most if not all the attempts that have been made to fly by mechanical means. 'The machines,' he said, 'have almost always come to grief for lack of that stable equipoise which the bird maintains by instinct under the varying conditions of flight and wing. Without assured equilibrium safety is uncertain; and without a reasonable degree of safety, flight, whether for pleasure or for business, is out of the question.'"

X-RAY DETECTIVE — "The X-rays are winning fresh laurels nearly every day through some new application of their mysterious and irresistible power. The most recent of such applications is the utilization of these inquisitive and all-seeing radiations by the custom-house. In the railway stations of Paris, the X-rays have been employed for a week past for examining packages of all kinds and sizes, from small parcels and valises up to trunks and large bales, in order that their contents may be ascertained without having to open them. The experiments are not confined to baggage, for the travelers themselves are inspected, in order to have the X-rays reveal any objects that may have been concealed under the clothing."

X-ray examination of a valise

EAST RIVER BRIDGE —"Work upon the new East River suspension bridge, which is to connect New York and Brooklyn at a point about a mile and a half to the north of the present bridge, is now well under way. . . The foundations of the bridge will be four in number, two under each tower, and they will rest upon timber and concrete caissons, sunk by the pneumatic process, upon which piers of solid masonry will rise to a height of 23 feet above high water."

BRICKS AND BUILDINGS — "After the great fire of 1872, the cost of bricks laid in the wall was reckoned in Boston at $36 a thousand. Now, better bricks, quite as well laid, with better lime and cement, cost there, in the wall, $15 a thousand. Fireproofing processes have been greatly improved and cheapened, so that an ordinary mercantile building can be erected, with floors, roof and partitions all of iron and concrete, or terra cotta, for 10 to 15 per cent more than it would cost with cheap wooden floors."

KLONDIKE — "The announcement of the return of two steamers from the Alaskan gold fields last month with a small party of miners on board who carried about a million and a half in gold between them, has gone through the world like an electric shock and bids fair to end in a 'gold fever' comparable only to the wild excitement of the California discoveries in 1849."

ROAD SAVING — "The United States Department of Agriculture is carrying out experiments with a view to saving country roads from deterioration. The device consists in laying down in the center of the road two flat steel tracks to the gage of the average farm wagon. . . They will be bedded in gravel laid in trenches, and they will be tied together at the joints and in the middle."

SUPER-INSULATION — "It has recently been found that liquid air is one of the most perfect insulators, and that most insulating materials cooled to the temperature of liquid air are greatly improved in insulating qualities. It is known also that cooling renders it more difficult to cause a spark to occur between oppositely electrified conductors, the striking distance for a given pressure being diminished."—Elihu Thomson.

ROAD RACE — "Under the auspices of the Figaro and the Journal des Sports, the race for automobile vehicles between St. Germain and Dieppe, a distance of 170 kilometers (105 miles), was run on July 24. The weather was splendid and the roads were in perfect condition. . . . As might naturally be expected, the motorcycles arrived first, that of M. Jatin reaching Dieppe in 4 h. 13 m. 33 s. The motorcycle of M. Pellier arrived 4:43:55. The first horseless carriage to arrive was that of MM. De Dion et Bouton, which arrived in 4 h. 18 m. 34 s."

100 Years Ago in . . .

SCIENTIFIC AMERICAN

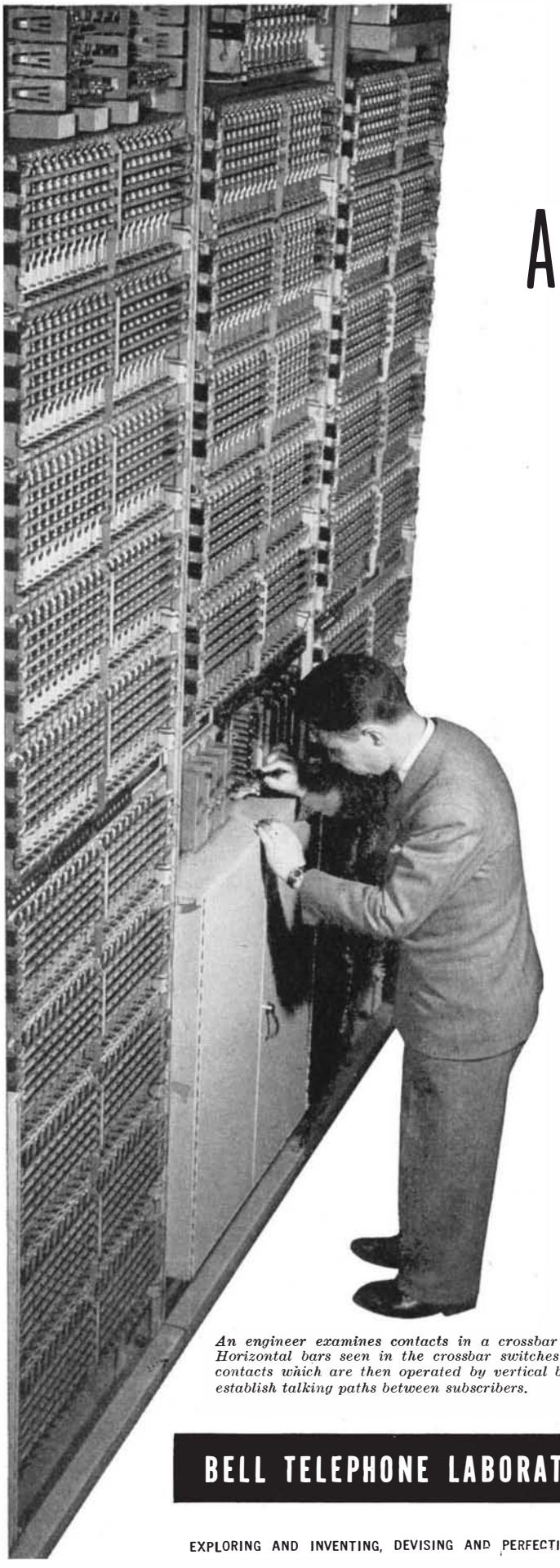
(Condensed from Issues of August, 1847)

FERTILIZER — "Sulphuric acid, invaluable for many purposes, is coming into common use among the English farmers. . . Crops remove the phosphate of lime from the soil—bones dissolved in sulphuric acid produce the phosphate, and the phosphoric acid so produced has been brought to bear upon the land with the most beneficial effects."

BAROMETER — "An improved Barometer was patented last year, which appears to be of some importance. It consists simply of a cup with a disk placed over it, air tight, and the air is exhausted from the interior. The disk, which is of sheet metal, is made waving in concentric circles, and can therefore yield as the pressure of the atmosphere increases; and by a very simple device the yielding of the disk operates a hand upon the dial."

WIRE ROPE — "A rope, nearly three miles along, now lies at Gateshead, England, which was the other day a stone in the bowels of the earth! Smelted, the stone yielded iron. The iron was converted into wire. The wire was brought to the wire-rope manufactory near Gateshead, and there twisted into a line 4,660 yards long. It is the stoutest rope of the kind ever made."

ANCIENT STEEL — "The steel of the ancients in consequence of not being cemented, suffered itself to be hammered, and was not near so brittle as the hardest with which we are acquainted at present."

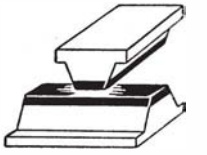


An engineer examines contacts in a crossbar office. Horizontal bars seen in the crossbar switches select contacts which are then operated by vertical bars to establish talking paths between subscribers.

A BILLION ORDERS A DAY

In a large modern telephone office 2,000,000 switch contacts await the orders of your dial to clear a path for your voice. They open and close a billion times a day.

At first, contacts were of platinum—highly resistant to heat and corrosion but costly. Years ago, Bell Laboratories scientists began looking elsewhere, explored the contact properties of other precious metals—gold, silver, palladium and their alloys—and with the Western Electric Company, manufacturing unit of the Bell System, restudied shape, size and method of attachment.



Outcome of this long research is a bar-shaped contact welded to the switch and positioned at right angles to its mate. For most applications, an inexpensive base is capped with precious metal.

Savings from these contacts help keep down the cost of telephone service. This is but one example of how Bell Laboratories serve the public through your Bell Telephone Company.

BELL TELEPHONE LABORATORIES

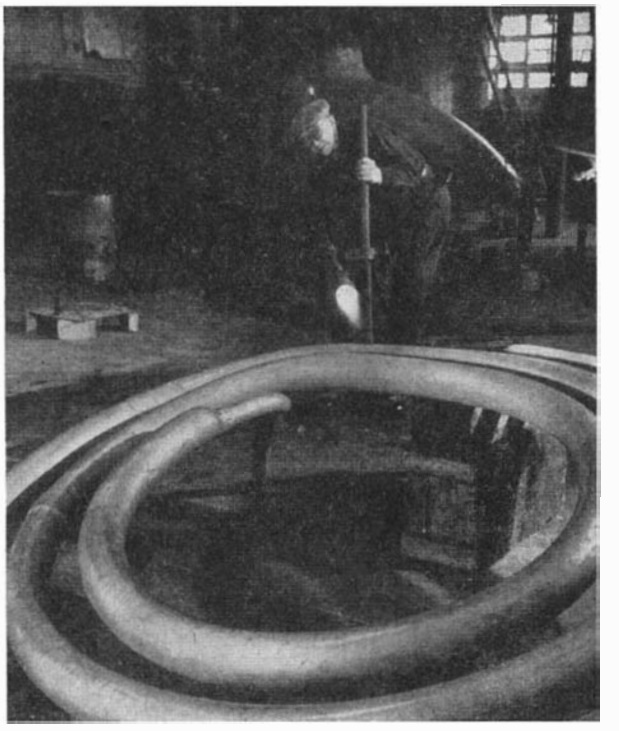
EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

Scientific American
AUGUST • 1947

America Needs A MILLION TONS of Copper

By C. Donald Dallas
Chairman of the Board,
Revere Copper and Brass Incorporated

An Adequate Stockpile of Copper — in Ingots, Bars, or Other Convenient Shapes — is Essential to All Industry in Peace as Well as in War. The Cost of Such a Stockpile Would be Low; It Would Represent an Investment Which Never Would be Wasted. At Least a Part of the Stockpile Might be Acquired by Accepting Copper in Payment for Some of Our Nation's Many Loans



ONE MILLION TONS of copper is a lot of red metal. In cold figures it is hard to visualize but if all this metal were concentrated in one cube, the block would contain 3,640,000 cubic feet and would be almost 155 feet on each side. Or, in the form of the customary ingots, it would load 20,000 gondolas or a freight train approximately 225 miles long.

But one million tons is the amount of copper needed to provide this nation with an adequate stockpile—a reserve of copper that is essential to our national security. Such a reserve is as great a defense against potential aggression as is a well-equipped fleet in time of actual war.

By a national copper reserve, I do not mean a million tons of copper in the stockyards of the copper fabricators or metal as yet not smelted or unmined. The need is for that million tons in ingots, bars, or other convenient shapes, owned by the government and stored at strategic points for use in a national emergency.

Today this nation is without a stockpile. We had a

national copper reserve at the end of the war and the government was still buying copper. However, another national emergency arose this spring and the country experienced a copper famine. The government reserves were allocated to copper and brass mills. Because such reserves were available, factories remained in operation and men kept their jobs until suspension of the copper excise tax by the Congress brought some further relief by permitting foreign copper to flow into this country.

Copper is as essential to national defense as steel or rubber or petroleum. Planes won't fly, battleships and subs won't sail, radar won't work . . . without copper. Brass is required for shell cases, and copper is essential for driving bands on projectiles.

Today's great barrier to a stockpile is that there is barely enough copper available now to supply the critical needs of industry. Today we are importing copper from Chile because our own mines don't produce enough copper by 600,000 tons to meet our national commercial demands.

Obviously, the government is not going to bid against the copper fabricators who are supplying essential copper for automobiles, manufacturing equipment of all sorts, fractional horsepower motors, and all the other things that are needed so badly. Instead, as previously mentioned, the government has drained its own reserves to help out industry.

So, the government must wait until the copper supply in this nation is on a more even balance. The hope of the copper industry is that that long-delayed balance will be a fact in 1948. But with all the world hungry for copper and with our national consumption of copper at an all-time peace-time high, it is also apparent that that million-ton stockpile won't accumulate overnight.

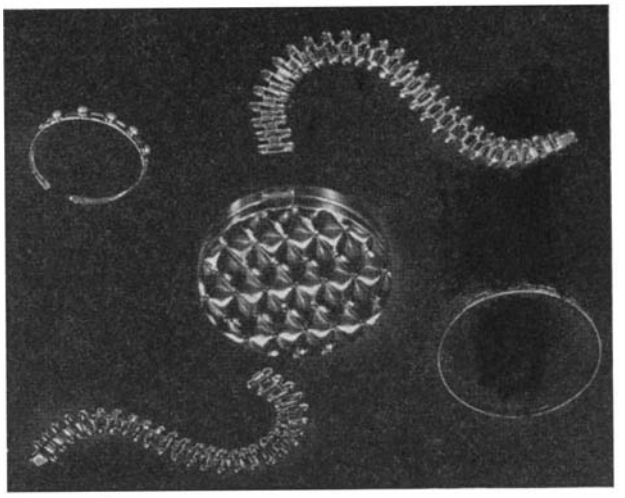
The stockpile law, as now written, provides that the government reserves shall come from domestic mines. However, the three major producers of copper, who account for 80 percent of the national production, use almost their entire production in their own fabricating plants. A certain amount of reserve copper may come from the submarginal operations. In fact, government purchase of copper may encourage additional development of these submarginal deposits. Even so, the United States must look to foreign mines for its essential reserve copper.

COPPER FOR LOANS — It is possible that some of our more astute governmental economists will work out a plan whereby we can be repaid some part of our many loans in copper. That possibility, so far as I know, has not been discussed in Washington. It should be.

There is little to indicate that this nation ever again will have a surplus copper production. In fact it has been estimated by experts that, at our present rate of production, our unmined known reserves will begin to dwindle rapidly at the end of ten years. There may be new discoveries in South America and there may be additional developments in Canada. And we have been told that a surplus may develop in the African mines. Such additions to world supply, of course, should lower the price of copper and provide the government with an incentive to step in and build up the million-ton reserve as rapidly as is possible.

Not only is the national stockpile non-existent at present, but the manufacturing stockpiles of the nation also are still dangerously low. The manufacturers, during the copper shortage, had to drain their reserves to keep their mills running. In some mills,

At left and right are views taken in the George Keller Copper Works, Brooklyn, New York, one of the largest fabricators of brewery and other processing equipment. Here copper is shaped to required forms in huge sheets and tubes, much of the work being of such a specialized nature that it is done by hand



In a national crisis, would copper jewelry be reconverted into more essential items?

ingots shipped from the smelters were being rolled within a few minutes after they were unloaded from freight cars. In normal times such shipments of ingots go into stockpiles and are withdrawn as needed, so that mill operations are not on a hand-to-mouth basis. Today we have an entirely abnormal situation. Orderly manufacture, on an economical and continuous basis, requires an adequate reserve of raw materials as well as a stockpile of finished or semi-finished products. This provides an even flow through the channels that run from mill to factory to consumer and makes it possible for the consumer to obtain what he needs with a minimum of delay.

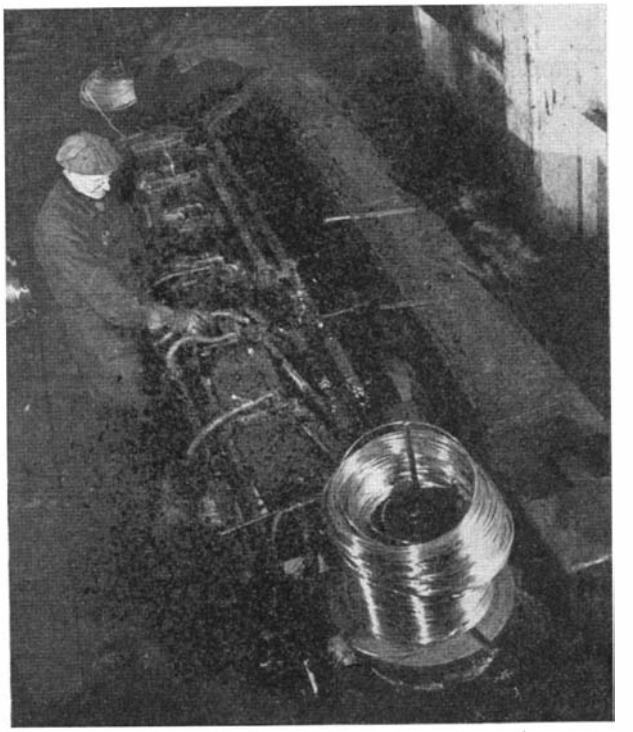
If faced with a rush of war orders, the manufacturers may rapidly exhaust their reserves. Then is the time that the national stockpile would serve its best purpose. Victory has always gone to the force with the largest and best-managed reserves of materials.

During 1942, this nation was in an extremely critical position because of lack of rubber reserves. If we were brought face to face with a national emergency in the next 12 months, our situation would be even more critical insofar as copper is concerned. Instead of combing vacant lots for old tires, we would be calling on American housewives to turn in their lovely old copper bowls and their antique brass candlesticks to be melted down into shell casings and the wire needed for multi-motored fighting planes. We would be stripping buildings of their beautiful and everlasting copper roofs, just as Germany did during both World Wars.

DESTROYER OF COPPER — War destroys copper. Industry at peace uses the same metal over and over. Hundreds of thousands of tons of copper were lost forever in battles on land and sea and in the air. In peace-time, though a machine may be junk, the copper and brass in it may be used again and again. The loss of copper and brass through oxidization is relatively minute and is industrially unimportant.

We have not yet begun to calculate the complete loss of copper from 1941 until 1945. We are only now feeling its effect. But, with a million tons of copper in a national stockpile, with our manufacturers adequately supplied with reserves, and with our mines operating at full capacity, we could feel reasonably secure. Until that time arrives, a dangerously weak spot exists in our plan of national defense.

Nor is copper the only metal that should be put into a national stockpile. Lead and zinc are vital metals and our reserves are low. Along with tin, government stocks of these metals were channeled into industry this year by the War Assets Administration to relieve



Drawing copper wire in a multiple die

shortages. Tin has been in short supply and the disaster at Texas City, affecting tin smelting operations as it did, made the situation still more serious. It is obvious that adequate metal reserves are essential to peace-time economy as well as to war-time emergencies.

People have been known to question the displays of copper and brass ornamental ware and the use of copper and brass in costume jewelry at a time when factories have been threatened with closing because of a shortage of raw materials. Actually, the amount of copper diverted to costume jewelry or ashtrays is negligible. At the same time, the manufacture, distribution, and sale of these articles for which there is a demand supplies work for many people and is essential to our normal economy. Possibly, in a real crisis, these articles—some of them best described as hunks of lovely junk—could be reconverted into more essential items. However, in a crisis industry needs copper in substantial-sized ingots, ready for the mills, and there is little time to collect and reconvert the purely ornamental into the ruggedly useful. Two million tons of copper in the shape of

• LOOKING AHEAD •

Increased dependence on foreign copper sources . . . Encouragement to develop submarginal deposits . . . Lower price of copper as new supplies are revealed . . . "Scrap drives" for copper would not answer in a crisis . . . More interest in—and action on—vital metal matters.

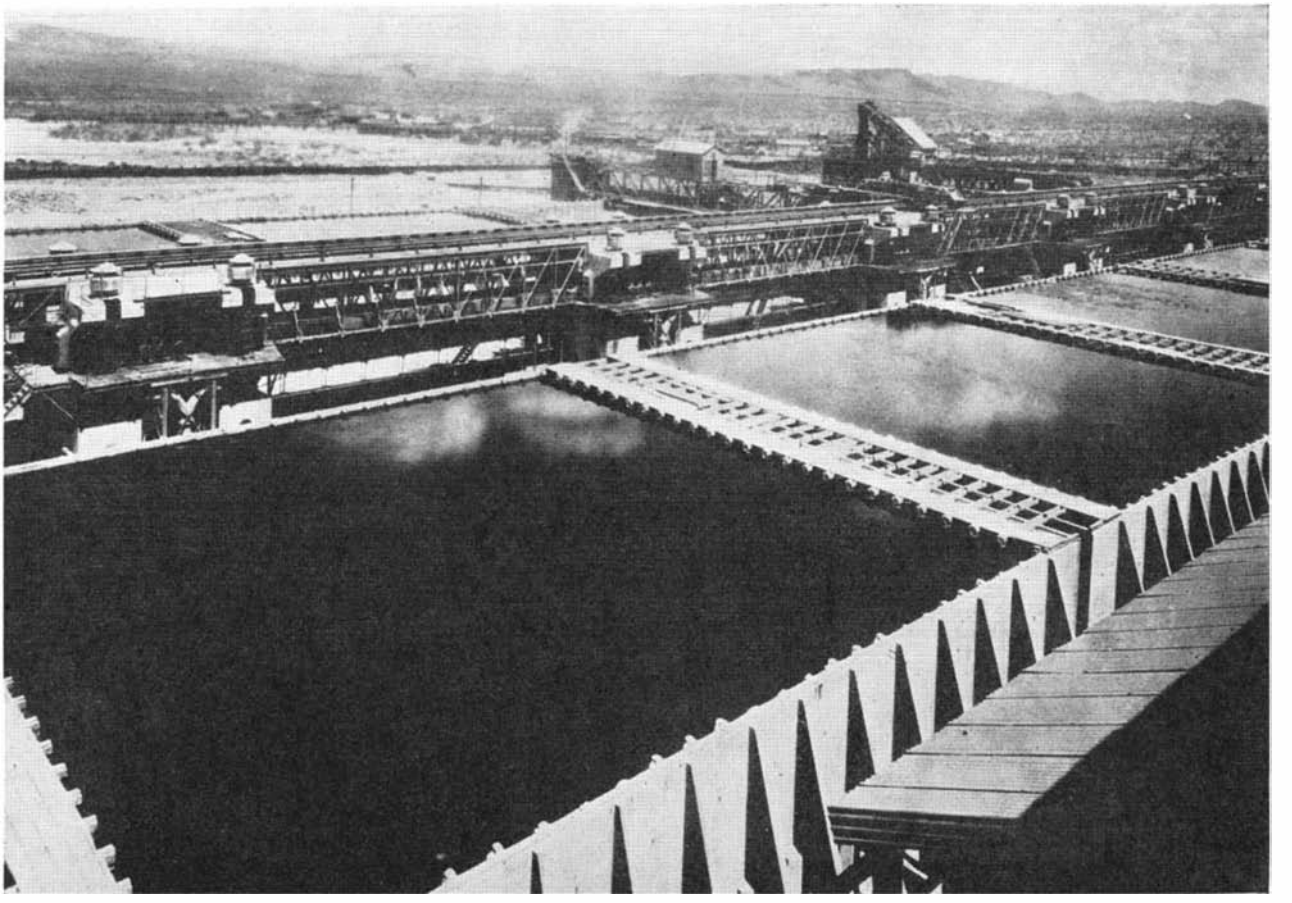
bookends or other metal miscellany and scattered through fifty million American homes would be a poor substitute for those vital million tons placed where they can be put to immediate use.

A STEP FORWARD — This year saw a long step forward in governmental help toward solution of the copper problem. The Congress suspended the $80-a-ton excise tax on raw copper and, for the first time since 1932, American fabricators were free to seek copper wherever they could find it throughout the world to replenish their depleted stocks. Following the suspension of this tax, copper flowed freely wherever it was needed with the result that foreign copper receded from 24 cents a pound plus a tax of 4 cents, or 28 cents a pound, to 21½ cents a pound. With this tax suspension to relieve a critical situation in industry, Congress may next turn its attention to the national stockpile. During hearings on the Patterson bill, which eventually became the act to suspend the excise tax for two years, a number of Congressmen asked pointed questions about the lack of a national copper reserve and there were indications on Capitol Hill of early action in that direction.

The excise tax suspension is effective until April 1, 1949. If by that time American mines can meet American consumption, it will again be imposed. However, there is little hope in the copper fabricating industry that such a condition will exist and it is highly improbable that American mines will be able to contribute to any great degree to the million-ton stockpile that is an admitted national necessity.

Copper, because of the widespread publicity given the battle in Washington to have the excise tax suspended, received more attention this year than it has had in a generation. American citizens today, I believe, are more cognizant of the importance of copper to their everyday lives than ever before. With this awakened national consciousness of the importance of one of our vital metals, it is possible to predict that we can expect action in the near future on stockpiling those million tons against the time when we will need them—and if that time never comes, the investment will not have been wasted, any more than is a battleship that never fires at an enemy, or a life preserver that is never used.

Copper may be recovered from low-grade ore by processing in enormous concrete vats



Courtesy Westinghouse Electric Corporation

The steel cores of these transformers windings are more efficient and compact due to increased knowledge of atomic and crystallographic arrangements

Tomorrow's Metallurgy

While There Are Many Startlingly New and Revolutionary Developments in Metallurgical Sciences Just Over the Horizon, Some of the Most Important Advancements Will Consist Merely of Taking Fuller Advantage of Established Principles

By Fred P. Peters
Editor-in-Chief, MATERIALS & METHODS

IF THE future can be reasonably predicted from the past, as some say, tomorrow's industrial metallurgy may be forecast by projecting recent technical progress into the years that lie ahead.

There is one significant starting point. While there have been hundreds of great technical advances in the development and use of industrial metals in the past two decades, they have stemmed largely from a miserly few fundamental scientific advances, most outstanding of which are:

(1) New knowledge of the transformations in, and the hardenability of, steel.

(2) Successful study and increasing understanding of precipitation-hardening phenomena in non-ferrous alloys.

(3) Definition of the mechanism by which metals fail under mechanical stresses.

(4) The "science" of mass production of precision parts (their reproducibility, interchangeability, and increasingly closer tolerances—all at low unit costs).

(5) Clarification of flow phenomena in metals as related to their atomic structures or lattices.

(6) Discovery of the disproportionately great effects of tiny amounts of impurities, especially gases, in metals.

On such foundations as these is the *present* science of metals based. But even today the scientific knowledge that is available is not being put to its fullest possible use. To take a single example: Despite present fairly accurate and demonstrably useful information on the mechanics and geometry of fatigue failures, how many engineers have studied it, and how many apply these principles to the design of manufactured metal products? It is known that a majority of metal failures occur at surprisingly low stresses, and are due to stress concentrations, especially under repeated or vibrational loading. But is every effort made to determine the stress distribution inside a product before, during, and after processing; to surface-finish it; and then to load it in service in such a way as to reduce the likelihood that it will suffer a fatigue failure? By the full application of existing principles, such failures could be held to a minimum until that day arrives when the present exhaustive research bears fruit, and it becomes possible to design quantitatively (and without "factor of safety" support) with complete assurance that failure will not occur.

GAPS IN KNOWLEDGE — There are still many blank areas in metallurgical knowledge that ought logically to be filled by now. Even now, metallurgists are trying to apply the known laws of atomic physics and diffusion in order to gain understanding of the type of bonding that occurs in powder metallurgy operations, and thereby ultimately to effect significant practical improvements in the processes involved. Other researchers are looking into metal surfaces—studying the relations that exist between the atoms of two highly polished surfaces; investigating the delicate surface phenomena involving lubricating

films on metals; and observing closely the friction and other temperature-dependent reactions that occur when one metal rubs against another. In this way a great deal more may be learned about bearings and machining and automobile clutches and brake drums and what happens to stamping dies—indeed about dozens of related situations where today's knowledge and practice are still entirely empirical.

During the past 20 years no industrial process has matched the growth, in engineering importance and use, of heat-treating as a metallurgical unit operation. The nature of all the commercially important micro-structures of steel is known and a satisfactory understanding has been reached as to why and how steel hardens. But one great opportunity for heat-treating progress is still largely unexplored: Application of the principles of heat transfer—the flow of heat through solids, liquids, and gases, and across fluid films—to the heat treatment of steel. Halting steps forward have already been made in improving quenching practice through consideration of the changing rates of heat flow through the metal, through the vapor or liquid film at the interface with the quenching medium, and then through and out of the quench bath—all at different temperatures. But it is possible to get much more out of steels through the study and use of heat-transfer principles than is being done now by simply trying to improve on existing processes.

How else might the scientific knowledge already available be utilized? A tip could be taken from the developers of the Sendzimir rolling mill, or of the new Tube Reducer process, to find out why and how metals under certain conditions can be given astonishing amounts of reduction in forming without suffering anything like the expected amount of work-hardening. Certainly much more should be done with continuous casting—that is, the continuous production of bars, billets, or sheet direct from the molten metal—than has been done so far. Only the aluminum and the copper-alloy manufacturers employ the processes on anything like a large scale. And the wonderful technical advantages of vacuum metallurgy, potentially useful in a dozen major processes, are only just beginning to be exploited.

EXCITING PROBABILITIES — All of these things can be done merely by extending and applying knowledge already at hand. But what about the fields where new knowledge is needed, or where science is just breaking into new areas marked for future conquest? Here is where one must perforce restrain the imagination, for the probabilities *are* exciting. The metallurgical and materials engineering aspects of atomic fission, the development of *really* high-temperature alloys, the discovery (or rather the *design*) of super-strength metallic materials, the implications of supra-conductivity, and the likelihood of metals like titanium and beryllium emerging as commercially-important base-metals—all are bright spots in the picture of our future science of metals.

Radioactive isotopes, produced in neutron reactor piles like those at Oak Ridge, are already finding many uses as tracer elements in metallurgical research, just as they are in medicine and many other branches of science. They are attacking several of the tough research problems previously mentioned. For example, a study of friction and lubrication has been made by introducing radioactive material into one of two metals sliding against each other, and then measuring the amount and location of the metal transferred from the first member into the second.

Again, a major problem confronting the steel industry is a controlled method for removing sulfur

These all-aluminum home freezers in production by the Reynolds Metals Company typify the broadening applications to which the light metals are being put

from iron when the iron is separated from the slag. Before this can be accomplished, the mechanism by which sulfur is distributed between slag and metal must be understood. Researchers are now in a position to study the reaction, since radioactive iron and sulfur atoms can now be introduced into it.

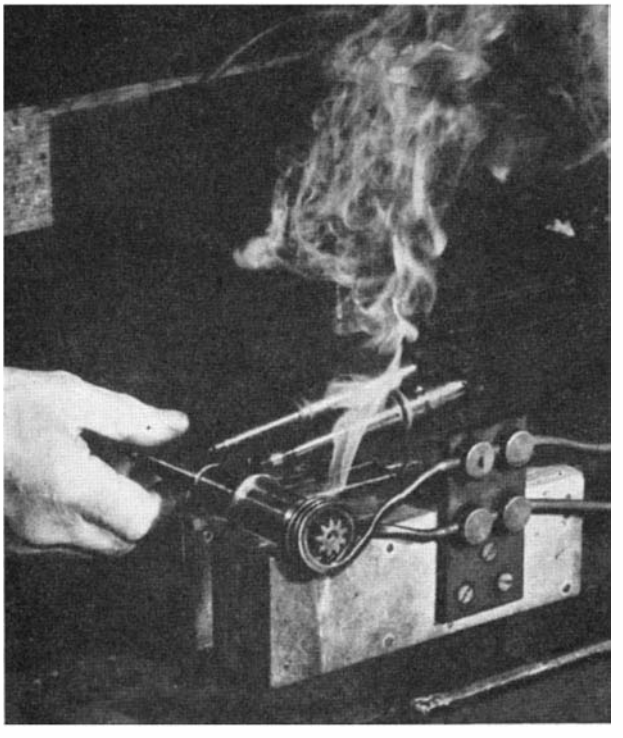
Other metallurgical problems that may be successfully studied with the aid of this brand new technique include the absorption of gases in metals, diffusion of the elements in alloys, the thermionic activity of electronic filaments, and so on. One of the most interesting possibilities is the use of certain extremely active radio-isotopes in place of radium for gamma-ray radiography—isotopes which can furnish radiation of a penetrating power comparable to that of the multi-million-volt betatron X-ray machine.

An off-shoot of nuclear fission that will be of increasing interest to materials engineers and metallurgists is the need for information on the nuclear properties of materials. Determination of the half-lives of radioactive isotopes for calibration purposes and for tracer applications is only part of it. Metals used in reactor piles must have definite neutron absorption properties—usually the lower the better. Beryllium, for example, is in itself a good moderator because of its very low neutron-absorption proclivity. But even tiny amounts of other elements present as impurities in beryllium can absorb so many neutrons as to stop the reaction. Hence "neutron absorption properties" will certainly be among the physical characteristics of metals as published in the future.

The high-temperature alloy developments of recent years have been significant, for the so-called

Heat treatments by induction, such as this hardening of an armature shaft, are expected to be used on a greatly increased scale

Courtesy Eclipse-Pioneer Division, Bendix Aviation Corp.



• LOOKING AHEAD •

Titanium and beryllium gaining commercial importance as base metals. . . Radioactive tracers providing solutions to many problems. . . Neutron absorption properties as important metal characteristics . . . Metals of super strength, lightness, heat-resistance—or nearly any other property—made to order.

"super-alloys" gave us turbosuperchargers and jet engines. But, by and large, they were simple extensions of existing knowledge, often evolved under the terrific pressure of war-time urgency. Also, they are good as far as they go, but admittedly they do not go far enough. Reaction engines can be operated today at 1500 to 1600 degrees, Fahrenheit, but *really* high efficiency must wait upon materials that can continuously withstand temperatures hundreds of degrees higher. Chromium-base alloys, tungsten- or molybdenum-base materials, and metal-ceramic combination are all under study or consideration. There are "bugs" that plague all of these, and the final answer to this problem is not yet visible. But there will be an answer ultimately and its development will be an interesting chapter in the future "Science of Metals."

REARRANGE ATOMS — Many well-informed scientists today believe that only a minor fraction of the mechanical properties are now being obtained from metallic materials—that metals of the future will be vastly superior. Lest this seem too fantastic, remember that up to now (and probably this will be true for many years still to come) metals have been used in the atomic forms and structures in which the Good Lord provided them. Who can say that it may not be possible to put atoms together in new ways, to achieve combinations of nuclear or atomic particles hitherto unknown, and which may result in extraordinarily dense or phenomenally strong and cohesive engineering materials?

The new science of metals, too, will include a lot more plain practical common sense mixed in with fundamental science. Simulated service testing will replace arbitrary standardized test methods for many purposes where the standard tests are misleading or meaningless. Specifications will be considered suspect unless frequently revised; performance will carry a larger burden of importance than chemical composition when materials are selected and specified. Such techniques as those of quality control by statistical methods—a science in itself—will be more widely applied to eliminate wasteful and unnecessary inspection, and to improve production efficiency and product quality.

Indeed the science of metals of the future will be not only for the research metallurgists in their ivory towers, but will be a living thing understood and used by all who work with metals.

It will not be greatly different from the old. There will just be more of it—and a whale of a lot more people professionally and vocationally interested in or dependent on it.

Previews of the Industrial Horizon

By A. P. Peck

PROGRESS IS SOMETIMES SLOW

CHEVROLET recently unveiled its first post-war automobile assembly plant. Proudly were shown conveyors which bring chassis to the workmen at bench height so that a minimum of stooping and lifting is required. Paint spraying is done in shielded booths where the fumes are blown by fresh air away from the operators and into a water wash. Headlights are adjusted by photoelectric means.

Viewed from our editorial vantage point (those who disagree with us will call it an ivory tower), it often seems that industry is unnecessarily slow in adopting methods which would result first in worker convenience but would be somewhat tardy in showing up on the profit side of the ledger. Chevrolet simply happens to be a convenient case in point. Why should bench-height convenience for workers only now be coming to the production line? Advantages of water-wash curtains for paint spray booths have been known for years. Photocell methods of headlamp adjustment are at least equally old.

Please let answers not refer to Columbus and the egg; also, please assume relative familiarity with the problem of equipment cost. Industry in general, and the automotive industry in particular, has been quick to seize new materials and new methods if they promise immediate profits. But where worker convenience and comfort are concerned there is often a thunderous silence of apathy. Sure enough, the vice-president in charge of worrying about workers may provide clean wash-rooms, may see to it that the plant has the best soft-ball team in the community, may pass out an occasional gold watch for long and faithful service. But does he worry very much about the cricks in the back which comes from unnecessary bending and lifting, about the respirators which must be worn because forced-draft air circulation is not provided, about inaccurate assemblies that are passed because of archaic checking methods but that do not have too much of a day-to-day affect on profits?

Perhaps in these few lines lie some of the reasons for worker unrest, for strikes, for slow-downs. Where such more or less intangibles have been put under humanistic scrutiny which weighs the relative values of ways and means for employers and employees alike, the horizon is bright. . .

HOW ABOUT GETTING BACK?

PRESENTED without comment:

Dr. J. M. Zucrow, professor of jet propulsion and gas turbines at Purdue University, says that available rocket construction materials and fuels could be developed into a "multi-step" rocket to carry human passengers into space. Such rocket flights could be accomplished, says Dr. Zucrow, without awaiting the advent of atomic power to drive the ships.

E. H. Heinemann, chief engineer of one of the Douglas Aircraft plants, says that since rockets operate most efficiently above the earth's atmosphere, the problem of using them for human transportation is complicated by the necessity of re-entering the atmosphere at a speed of several thousand miles an hour and landing safely. Everyday rocket travel, according to Mr. Heinemann, therefore appears to be in the rather distant future.

PREFABRICATED BUILDING MATERIALS

THIS is NOT a paragraph about prefabricated houses. Rather, it is about a movement to standardize—prefabricate, if you will—the materials which go into home construction. A national association of building materials dealers aims to have cinder blocks, bricks, lumber, building supplies of all kinds, cut or shaped to standards at mills and factories, thus eliminating much of the tremendous waste of time and materials which now occurs at the building site.

Prefabricated houses, except in emergency and other isolated cases, will probably never fill the nation's practical needs plus esthetic desires for housing; conventional methods of building homes is a national disgrace to our vaunted industrial efficiency. Standardized materials, if really standardized, hold some promise of relief from an intolerable situation.

STRAWS IN THE WIND

INDUSTRIAL MOVIES for training employees, selling goods, promoting public relations, and so on, are doing a fine job, but there are too many producers in the field; casualties among them are high. . . A practical farm tractor selling for less than $1000, with a full set of accessories—plow, planter, cultivator, and so on—is in production, will be welcomed by large and small farmers alike. . . As predicted here before, many plastics gadget manufacturers are hitting slumps through ill-advised applications of otherwise useful materials. . . An authority on the subject states that synthetic gasoline and oil made from natural gas or coal can keep the United States supplied with liquid fuel at a reasonable cost for at least 1000 years. . . 2,4-D, the selective weed killer that has had so much publicity, appears to be capable of improvement; when mixed with onion juice, for example, its action is speeded tremendously. . . Plastics floor coverings are invading the linoleum field, offering relative price competition plus high flexibility, immunity to water and cleaning compounds, and "self-polishing" surfaces; Vinylite and Koroseal are two of the synthetic resins being used. . . Steel leaf and spiral springs for automobiles face serious competition from Torsilastic (rubber in torsion) springs being promoted by Goodrich.

MICROFILM MAGIC

By Paul D. Green

In Addition to Its Better-Known Functions of Compressing Bulky Records Into Minute Spaces, Microfilming Is More Than Paying Its Way by Simplifying, or Completely Eliminating, Many Cumbersome Tasks

The eight small packages of microfilm contain records equivalent to those on all the papers in the two tall stacks

DURING the war, microfilm served to confound a number of Jap Admirals who prematurely took bows for putting American fighting ships out of action. Within a few weeks the same Nip commanders were thinking of committing *hara-kiri* when the supposedly permanently disabled vessels were back in action, as deadly as ever. Some indestructible ships were resurrected three and four times, until the enemy officers thought they were seeing double. These miraculous revivals were due to one of our most unusual weapons: microfilmed plans of every floating unit, stored in the Naval Archives building in Washington, D. C., and later, at Pearl Harbor. When a vessel was severely damaged, the facts were radioed to headquarters, and by the time the stricken ship limped into port, the new parts had already been pre-fabricated from plans flown to repair stations. In one case, the destroyer was unable to proceed to base, so the plans, printed from tiny frames of fire-resisting cellulose acetate, were flown to her in a PBY so emergency repairs could be made at sea.

Thus microfilm grew up during the war.

No wonder companies developing commercial uses of microfilm—Recordak, a subsidiary of Eastman Kodak Company, and Remington Rand—see a limitless horizon and are reaching out as fast as their production will allow. And instead of considering microfilm merely as a space-saver and fire hazard reducer, they are promoting it as a great time and energy saver.

Take its recent application by bus companies, for example. There are over 200 bus lines operating within the boundaries of the United States. Quite often one line does business with as many as 80 others, by carrying passengers part of the way along a route. People going from California to Massachusetts, say, buy through tickets from an agent at their starting point. He hands them a long strip of coupons for different stop-over and transfer points. Drivers pick up the coupons which apply to their part of the trip. By the time the passengers reach their destinations, their numerous stubs may be in the offices of a dozen different lines. Normally, each bus company has clerks write up a lengthy transcript—a separate one for each other company whose passengers it carried part of the way—listing ticket numbers, where issued, where picked up, rate, and so on. Then bills are sent to the individual companies, charging them for the total passenger-mileage, and these bills are accompanied by the original stubs, leaving the charging company nothing but a copy of the transcript.

BILLING SIMPLIFIED — Now a group of far-seeing bus companies, with an eye to saving considerable time and manpower, as well as minimizing the chances for error, microfilm the stubs on 100-foot rolls of 16-mm film. They take adding machine tapes of the stubs, by companies, make up statements which merely show total charges for the month. Then they also photograph both tape and bill. All of the originals go forward to the paying bus company; the microfilms remain behind, giving them

• LOOKING AHEAD •

Filing and records-storing given new efficiency. . . Billing simplified and made more accurate. . . Flexible methods adopted by scores of industries to conserve time, labor, and space.

miniature, error-proof records of outstanding charges.

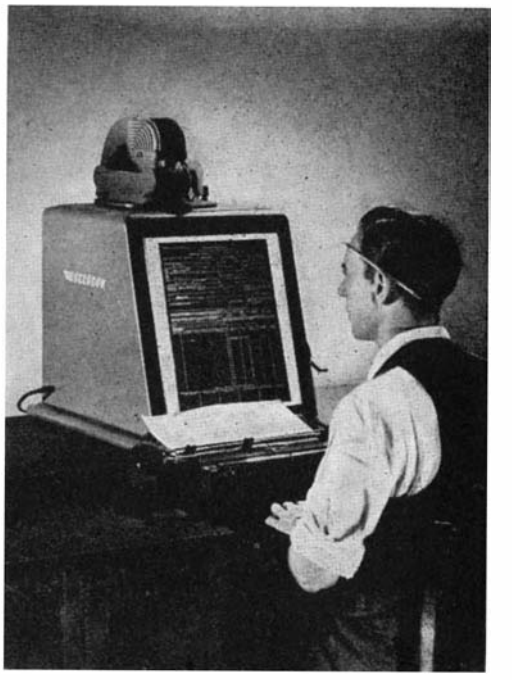
This procedure is a variation of the cycle-billing methods employed by most large department stores in New York and other large cities. Before enlisting microfilm to expedite their billing, a store with, say, 350,000 accounts, staggered the load roughly so that statements went out each business day to names beginning with a different letter of the alphabet. These statements listed the items charged, as shown on sales tickets retained at the store until paid, a finger-crippling job which demanded tremendous manpower, and yielded a high percentage of error. In addition, there was an inevitable flood of complaints on the part of husbands asked to pay for girdles, nylon hose, dresses, fishing poles, and other items they were sure they never ordered. Now the stores microfilm each individual sales slip, attach the originals to a simple statement on which is merely listed an adding machine recapitulation of the various charges. The painful evidence to the paying papa is included with the statement, and he can readily affirm that the questionable items were signed for by the Missus, his daughter, or son, and act accordingly. And the store has copies of each sales slip just in case the statement is mislaid or torn up in a burst of anger. Result—hours of labor saved, with a corresponding saving in money, and fewer aspirins for the paying customers.

Several retail and wholesale milk companies have adopted similar plans. Drivers are given route sheets on which are listed the names of customers served. Down each sheet are printed the items left at doorsteps or on store counters—milk, eggs, cream, cheese, and so forth. Across the sheets are 31 columns representing the days of the month. Each day the drivers mark in the number of items left. At the end of the month, they are tallied up, the charges computed, unpaid balances added. The route sheets, completely tabulated, are then microfilmed and the originals are given to the drivers for collection, or are mailed to the customers.

Airlines and railroads have problems similar to those of the bus companies in carrying passengers who started journeys on other lines. Several companies in each group are planning to install microfilm billing systems.

IN FREIGHT HANDLING — Railroads are among the nation's greatest microfilm users, particularly in their freight department—a development which reached great activity with military shipments during the war. On any freight movement of length, cars may have to shift from one line's tracks to another's at transfer points, sometimes as often as four or five times a trip; on a coast-to-coast run, this process could involve a dozen switches. When the shipment starts, a set of papers is filled out by the shipper at the railroad office, listing all details concerning the load: shipper's name, consignee, number of units, contents of units, total weight, rates.

Lower left: At a busy freight terminal, a clerk inserts waybills into a machine which microfilms them at rate of 90 a minute
Lower right: Another clerk, with a microfilm frame enlarged on a reader, picks out information for a bill or record of shipment



and so on. The original is called the "waybill" and goes with the goods.

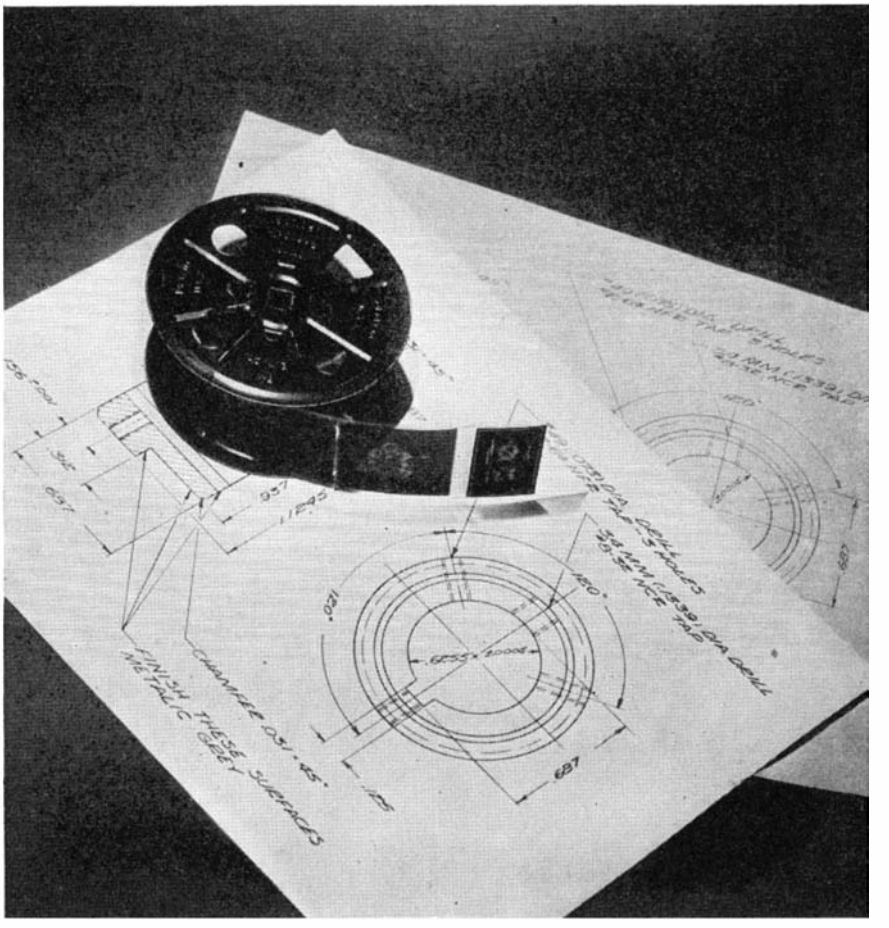
When the long line of cars pulls into a transfer point, they wait at a siding while a clerk copies every single waybill covering merchandise on the train. This is the only way the receiving road can obtain records on which to base charges to the original line for the use of its facilities. For years this practice resulted in time loss of two or three hours per transfer point, making a total of as many as 24 on a trans-continental trip. These long tie-ups often resulted in cars lying in foreign yards beyond midnight, with rental charges of $1.15 per day per car accruing. In addition, there is always the likelihood of financial loss to either shipper or receiver through spoilage of merchandise or delay, which results in loss of business to a speedier competitor.

Now, over a score of railroads throughout the country have solved this problem with microfilm. They have units in each way-station which photograph—60 to 90 a minute instead of 40 an hour copied by hand—each waybill, without error. Trainmen can pick up waybills by the time they are ready to pull out of the station. With time thus saved at each junction, the cumulative saving to all lines is the equivalent of many thousands of hours a year, which can be translated into making more cars available, an important factor these days when the freight car shortage is admittedly most acute.

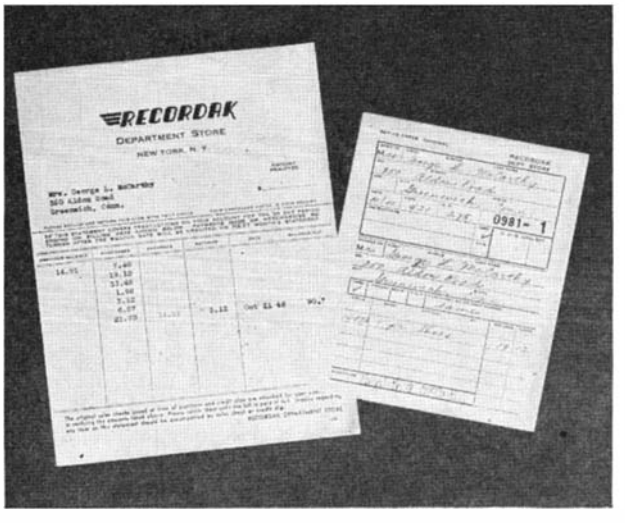
Several wholesale laundries, where thousands of bundles are washed for different independent laundries, have adopted microfilm for billing. Since all bundles come to them with only one ticket—the copy of that issued by the store to the customer—that ticket must be returned with the bundle. Billing is made once a month by a transcript. Now these laundries can microfilm each ticket in duplicate, one going out with their bill, one being retained for their records. Industrial insurance companies are considering microfilm also for their agents who collect hundreds of small premiums, from a nickel to a dollar. And some chain restaurants and hotels, who must keep guest checks and payroll earnings sheets for anywhere from two to seven years to comply with a multitude of government agency regulations, are considering reducing their warehouses and huge storerooms, now piled high with checks, to filing-cabinet dimensions.

BULKY RECORDS REDUCED — Since the war ended, thousands of contractors who performed work for the government were left with uncountable tons of records of their war-time activities. One large contractor's records alone fill 77 freight cars; another

A complete office set-up for microfilming—film recorder, file equivalent to 160 four-drawer cabinets, and reader



How engineering drawings look on microfilm. Such filmed plans helped to keep the Navy's ships in service during the war



Department stores use microfilm for recording charge-account items. A statement, with original sales slips attached, is sent to the customer; the store retains the film

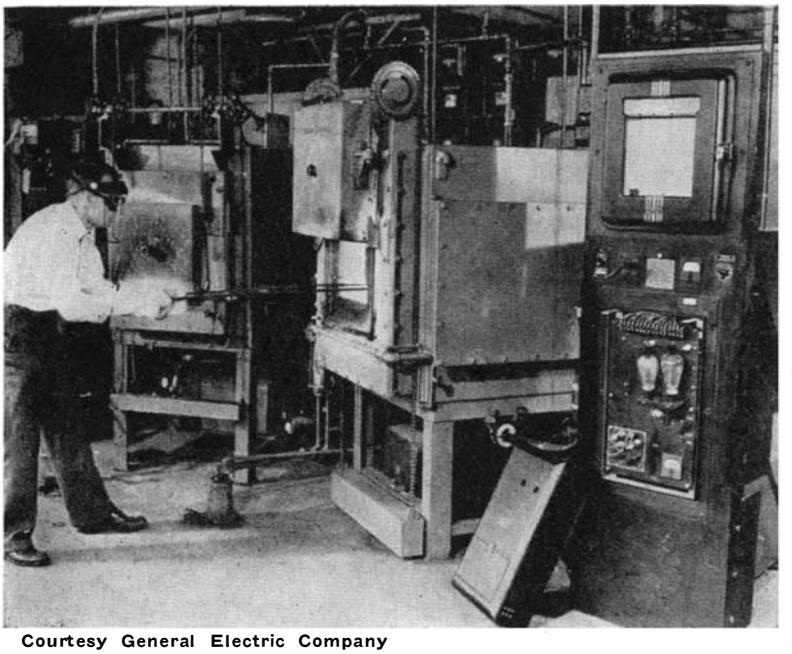
occupies a valuable empty lot; still another fills the entire basement of a huge office building. These records must be retained either until final audit—and the Government Accounting Office is usually two years behind—or until renegotiation is completed. Some of these contractors have solved their problems, and made room for post-war business, by reducing their files through microfilming to 2 percent of their original size—many four-drawer cabinets are condensed into one.

The government, of course, is microfilm's greatest individual user. The Social Security division alone has miniature records of 52 million ctizens. The Treasury has reduced its millions of War Bond stubs to a tidy group of steel cabinets containing 7500 individual records on a single compact 100-foot roll of film. City and state governments are also finding microfilm useful. The New York Police Department recently recorded the faces of a million members of its Rogues Gallery on microfilm, and the Michigan State Motor Vehicle Department figures it saves thousands of dollars in rental on space saved by its midget records of car registrations.

Many states photograph income tax returns to save space. At least one state has an arrangement with the district Federal Collector of Internal Revenue to hold income tax returns 48 hours, so they can make microfilm copies and check them against the returns sent in for state taxes. It had always been difficult to keep up with the pace in transcribing these returns by hand. Now it is done photographically in a matter of hours.

Hospitals, too, are prolific users of microfilm, chiefly to reduce their case histories to handy, permanent status. Only recently, the Remington Rand Company was called on by the Johns Hopkins Hospital to reduce nearly 8000 90-foot rolls, four inches wide, of cardiograms. These long rolls are studied by doctors to help diagnose certain types of cases. Now, reduced to 1/23 their length on microfilm, they are a mere four feet long and roll up into a tiny spool.

All of which sounds like a lot of heavy loads being carried on such tiny frames, but the photographic frames are strong enough to bear the burden.



Courtesy General Electric Company

Vacuum tubes on the control panel at right assure constant temperatures in these metal-melting furnaces, in spite of varying operating conditions

Monitors for Molten Metals

Installed for a Wide Variety of Applications Throughout the Entire Metals Industry, Electronic Controlling and Measuring Devices Have Gone Far Toward Removing the Variable Human Factor From Many Production Processes

By John Markus
Associate Editor, ELECTRONICS

WHEN THE stream of molten steel from the ladle in a mill is too hot to look at, yet just the right temperature for pouring, electronic tubes can be responsible for making that melt just right. Man's senses of sight and feeling are saturated by the extremes of brightness and heat given off by white-hot metals; yet precise control is just as important here as for such subsequent steps as electronic heating for forging. Plain electrical controls have served in mills to supplement human senses after a fashion for years, but they have so many drawbacks that electronics is fast taking over for this hotest job of them all.

Vacuum tubes have a host of other jobs, too, in steel mills, foundries, and die-casting plants. At the blast furnace they can indicate stock line inside the furnace, monitor stock line levels, measure system bed thickness, and control skip hoists. At the open-hearth furnace, they can measure flame radiation, tell how much smoke is going up the chimney, and do a host of critical recording jobs. At the Bessemer converter they can indicate the precise instant for the end of the flow and check other flame characteristics that control the quality of the melt. Analysis of the end products, split-second timing of operations, and automatic control of equipment for processing finished blooms, castings, or sheets are just a few of the many jobs that can be done better and more economically by electronics. Representative case histories of a few successful applications will illustrate how vacuum tubes are taking over in the metals industry to keep production costs down despite climbing man-hour costs.

OPEN-HEARTH EFFICIENCY — In an open-hearth steel furnace, transfer of heat from the flame to the charge depends largely upon radiation. This is especially true after the charge has melted, when it lies flat on the hearth, the flames sweeping above it. It is for this reason that measurements of flame radiation are made to assure maximum operating efficiency of open-hearth steel furnaces.

A portable battery-operated radiation-measuring instrument using electronic circuits has recently been developed to provide quick checks of firing conditions at the many furnaces in a large mill. Technically, this instrument consists of a highly stable bridge-type battery-operated vacuum-tube volt-

• LOOKING AHEAD •

Greater knowledge of furnace behavior gained from new instruments measuring temperature and heat radiation . . . Improved furnace design and operating techniques resulting from this information . . . Higher quality steels consistently produced with melt temperatures accurately controlled . . . More uniform die castings.

meter connected to a radiation pyrometer that can be aimed at any desired portion of the 4000 degree flame.

To take a reading, the instrument is placed at a furnace door so that lugs on the heat screen engage the socket hole. This centers the radiation pyrometer in the aperture and assures an unobstructed view of the flame. Because of the rapid response of radiation pyrometers, a reading is obtained in a few seconds. The pyrometer can be aimed by means of the frame and sighted over quite an angle in the furnace.

The readings are left in arbitrary scale values since it is not intended to find furnace temperature, but to obtain comparative data on the radiating power of the flames. The results are affected by radiation from the furnace walls and the bath, as well as by the flame, and this must be borne in mind when evaluating the readings. They are of comparative significance only in revealing efficiency of combustion.

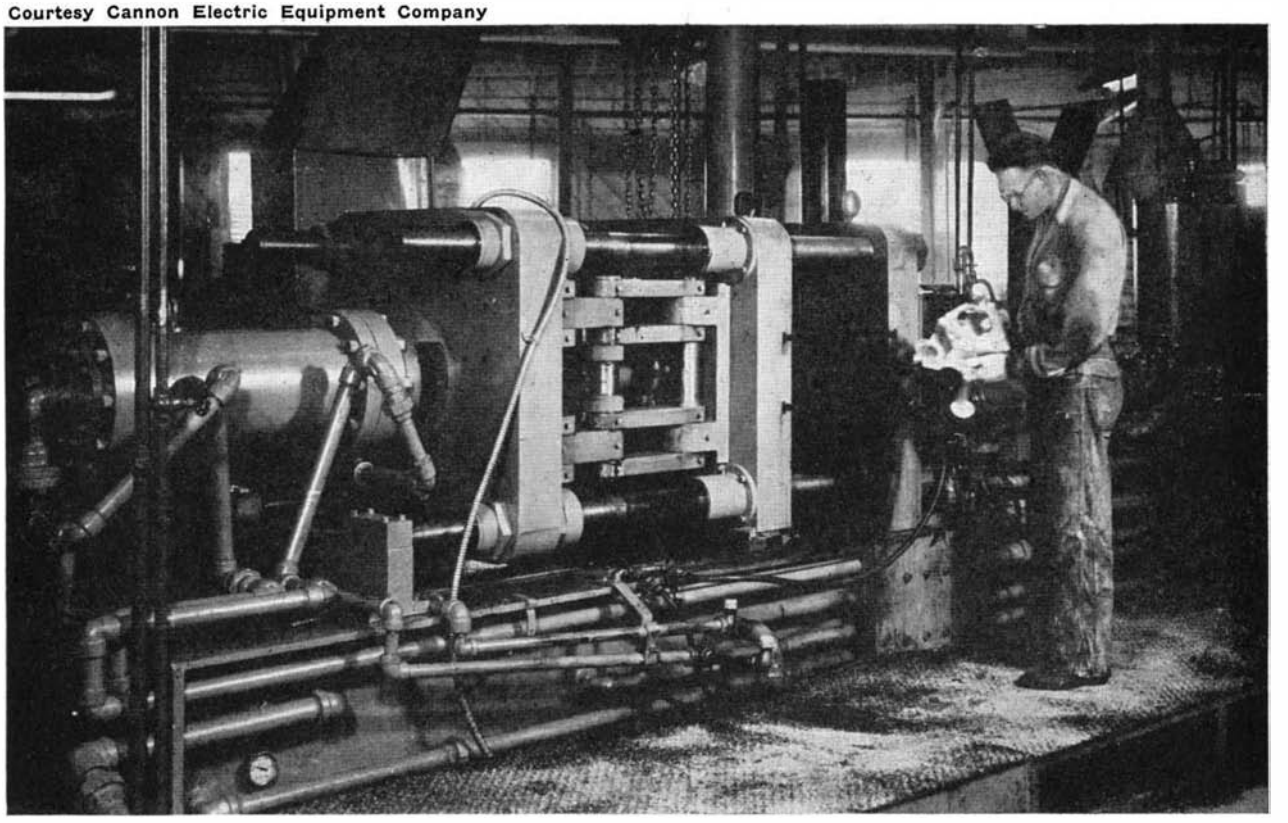
It thus becomes possible with this type of instrument, to obtain quickly a relative measure of furnace efficiency, free from the errors of human judgment. By successively making changes in furnace control settings and taking readings of flame radiation, it is possible to find the best control settings and thus achieve higher average furnace efficiencies. One man can check five or six furnaces with the instrument in less than an hour. Built in the electrical department of John A. Roebling's Sons Company, this instrument is intended for use by combustion technicians to diagnose furnace troubles, and as a measuring tool to help them set up standard furnace adjustments.

MOLTEN STEEL THERMOMETER — An electronic instrument which determines and records the temperature of molten steel in the open hearth is widely used on ten steel furnaces in the Ford River Rouge plant. This device enables the operators to determine the steel temperature prior to tapping, thus giving them an opportunity to make any required adjustments, so as to pour at the proper temperature.

This straight-forward method of open hearth control is contrasted to determining the steel temperature by means of an optical pyrometer during the pouring operation, when it is too late to correct the bath. Each heat is tagged with quality control data, including the molten steel temperature, so that it is possible to study the effects of open-hearth operation on the steel all the way from the ingot to the finished product.

The new immersion thermocouple used here can actually be inserted in the molten steel without melting. It consists essentially of an inner and outer condulet, a heavy graphite extension rod for protection

Courtesy Cannon Electric Equipment Company



Use of an electronic timer on this die casting machine to regulate cooling periods greatly reduces the number of rejects

at the slag layer, a half-inch diameter fused silica protecting tube, and a 30-inch thermocouple with double-bore sillimanite insulation. A secondary tube, of extra heavy pipe two inches in diameter, surrounds that part of the handle that is exposed to intense furnace temperatures. The annular space between the extension handle and secondary tube is insulated with rock wool to prevent possible warping as well as overheating of the extension leads which go to the electronic recorder.

BESSEMER FLAME WATCHER — Investigation of the luminous energy content of the flame of a Bessemer converter has shown that the quality of the steel produced bears a direct relation to the history of the flame. At the plant of the Jones and Laughlin steel Corporation a phototube is used in controlling the operation of the converter.

The phototube is located about 60 feet from the converter and is so arranged that light from other sources does not affect its operation. Suitable filters are used to emphasize those characteristics of the flame which are most important to the characteristics of the steel being produced. The maximum phototube response obtained corresponds to the temperature of the molten metal, and gives an indication of the nitrogen content of the steel. Near the end of the blow, the intensity of the flame dies down, and the point where this occurs is referred to as the end point because it indicates when the blow should be turned down.

IN DIE CASTING — While the die-casting process has been in use more than a quarter of a century, only in recent years has electronic-type instrumentation been used to control the temperatures of the furnaces and melting pots incorporated in die-casting machines. Now hydraulically operated machines with push-button control automatically make castings five or six times a minute, in weights up to 25 pounds.

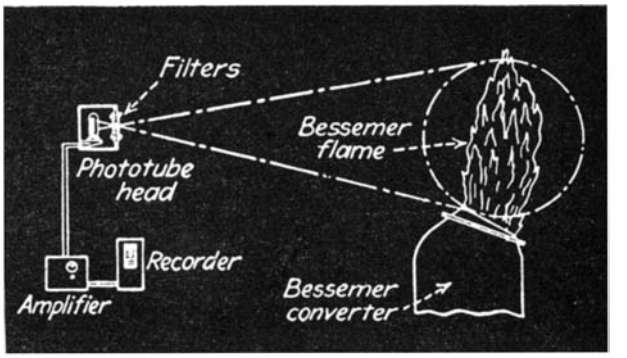
The problem of controlling temperatures of die-casting furnaces is not so much that of extreme accuracy, as of high dependability. Some die-casting alloys permit a temperature range of as much as 25 degrees, Fahrenheit.

The standard electronic controller for many die-casting plants combines the principles of the bimetallic thermostatic strip with those of an electronic capacitance-responsive control. Changes in temperature cause the strip to bend, moving the capacitor plates farther apart and thereby causing the electronic circuit to initiate the required correction in furnace temperature.

Breakdown at the furnace end of a non-controlled die casting machine may cause loss of production due to down-time, or damage to equipment, far in excess of the cost of a pyrometric controller.

Another aid to efficiency in die casting of aluminum and zinc is in use at Cannon Electric Equipment Company. Here an electronic timer determines the correct interval between the shot or molding action and the ejection of the casting from the mold.

Before the installation of an electronic timing unit, the time lapse for cooling or setting up of the metal in the mold was controlled arbitrarily by each operator. The normal human variation of an operator's timing of the die-casting process often resulted in a warped or otherwise imperfect casting. If the operator were on piece-work, he would frequently develop a tendency to open his machine as quickly as possible after each shot. On the other hand, if the operator were fatigued, or his sense of timing slow, he might allow excessive time to elapse before he opened the mold and ejected the casting.



Set-up of photoelectric monitor for flame of Bessemer converter

Tests proved that this interval was a critical constant for a given type of mold. Any significant decrease in the arbitrary interval value (reduction of 0.1 second or more) resulted in a plastic deformation. Greater tendency for cold-flow warping during machining was also evident.

With the electronic timing unit installed on a die-casting machine, the operator closes the die-cast mold and pours molten metal from a ladle into the machine. He then steps on the foot pedal, to ram the molten metal into the mold at high pressure and at the same time close the initiating relay on the electronic timer, starting the timing cycle of from 0 to 18 seconds, as required by the shop foreman. When the time runs out, the tubes actuate a relay which in turn operates a heavy solenoid that actuates an hydraulic valve. This valve opens the die-casting machine. When the machine begins to open, the operator takes his foot off the pedal, pulling the ram back. This also disconnects the coil of the initiating relay, allowing the timer to reset for the next casting.

Since the die-casting machines turn out a variety of products, each machine requires its own timing control unit, and 25 timing units are installed in the plant. These are assembled in one central rack and fed from a common power supply. The removal of one unit does not interfere with the operation of the others. When a new mold is set up in one of the machines, the foreman determines the mold curing time and sets the corresponding timing unit. The operator of the die-casting machine closes the die manually, pours the charge of metal, and kicks the foot switch. From that point, the electronic gear takes over.

So the trend goes—to more-than-human electronic measuring and control equipment in the toughest mill locations imaginable, where fumes and heat combine with the hard knocks of heavy industry to provide a real operating challenge for delicate tubes. Yet the tubes are taking it, to prove that properly installed and maintained electronic controls can mean the difference between red ink and black on year-end statements wherever molten metal flows.

Casting Is Changing

New Operating Techniques Applied to the Ancient Practice of Casting Are Resulting in Products Which Come From Molds With Qualities Obtainable Otherwise Only by Wroughting

By Edwin Laird Cady

AN EXPERIMENTER mounted a mold in such position that either vacuum or gas pressure could be applied to nearly all surfaces of it. The only area excepted was the down-gate—the opening through which molten metal would be poured to make a casting.

Metal for the casting was melted in a completely closed induction furnace, with an inert gas over the melt. There could be no oxidation, no pick up of hydrogen by this metal.

The mouth of the furnace was brought to the opening of the mold. Vacuum was applied to exhaust the air from the mold in order to prevent oxidizing the casting as it was poured. Then the pressure was reversed. Inert gas was forced in through the pores of the mold. Only minute traces of oxygen could get at the hot metal as it was cast. The furnace mouth was blocking the down-gate of the mold so that no air could enter there.

Sprue and runner passages through which the hot metal must pass had been made to exactly calculated sizes. The gates through which the metal from the runners would flow into the casting cavities had been proportioned with micrometric accuracy. This casting was to be made under conditions of exact control.

"Casting, which is the oldest of the metal working arts, is coming on to become one of the newest"

Courtesy The Austin Company, Engineers and Builders

Metal from the furnace was admitted to the mold. The metal was under pressure—about 20 pounds per square inch.

That metal flowed rapidly to the gates at the cavities. But there it stopped for a second or so. The sizes and shapes of those gates, and the pressures of the gas within those cavities, had been calculated so that the metal would be blocked right at the gates.

After a pause too short to allow the metal to cool, the vacuum was turned on again. This process exhausted the inert gas from the cavities, and allowed the molten metal to enter. But the entrance of the metal could be no faster than evacuation of the gas permitted. There was a steady flow of molten metal with 20 pounds of pressure behind it, and a steady cushion of inert gas which permitted the metal to advance only at a slow pace. The vacuum was carefully controlled to keep this balance just as it was wanted.

This experiment was not being performed just to see what would happen. It was one of the final proof tests of a casting method which soon will be in full production. In fact, it was one more stride toward the realization of the ages-old dream of making castings which have all the qualities of wrought-metal products.

CASTING TROUBLES — The casting process has troubles. Molten metal entering the casting cavities in the molds ordinarily comes into contact with air. Oxides then form, mostly on the surfaces of the castings, but also they are likely to be distributed through the metal. Other damaging materials, such as hydrogen gas, may enter the melt. Sand and other impurities may be picked up from the mold walls.

The metal does not always solidify uniformly. Rather, some elements or chemical combinations of elements will solidify at higher temperatures than others and therefore will become solid while the others still are liquid. These high-temperature solidifying elements tend to deposit wherever the cooling conditions are best and therefore to segregate rather than to distribute themselves uniformly throughout the casting.

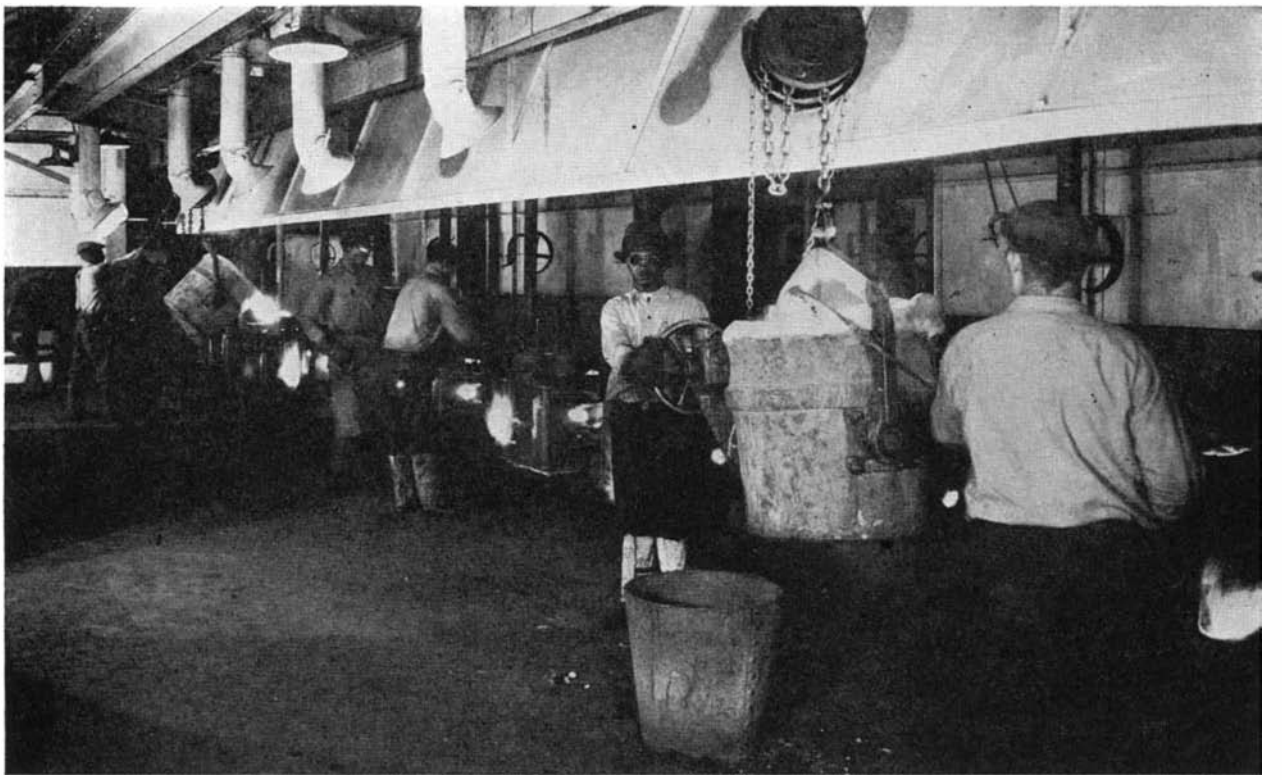
As the metal cools, it shrinks. But the shrinkage occurs more rapidly at the areas which cool first, and this sets up strains as the various areas pull against each other.

Wroughting corrects many of these casting troubles. The badly oxidized skins can be cut away before the wroughting operations begin. Rolling, which ordinarily is the first of the wroughting procedures, can weld shut many of the microscopic porosities which result from shrinkage. Rolling also tends to break up the interior oxides and to distribute them as such tiny islands that they have no weakening effects. The same process can distribute the segregated areas throughout the metal and bring much higher uniformity.

With many alloys, the greater the number of wroughting operations, the greater the improvement. Cold rolling as well as hot rolling, drawing through dies, cold forging or hot forging, all have beneficial effects. And altogether, casting followed by wroughting is the ideal solution of many a metal-working problem.

The trouble is that wroughting has economic problems. One of these is the fact that only rarely can wroughting be done at commercial costs unless applied to large quantities of metal. If hundreds or even thousands of tons are not wanted in a low alloy, and

The modern foundry is operated by strict metallurgical control



• LOOKING AHEAD •

Items of hard-to-wrought alloys, or with complex shapes, produced with wrought-metal strengths, without wrought-metal costs . . . Weaknesses in light-metal castings due to gas-formed porosities greatly reduced . . . Range of metals in wrought condition available to fabricators vastly extended . . . Heat-treating while casting.

if dozens of tons are not wanted in a high alloy, all to be rolled to a few sizes and shapes, then the wroughting processes are likely to be avoided. This tends to limit the ranges of alloys which the fabricator can have in the wrought condition.

Wrought metals also have fabricating problems. If the shape of the finished product be highly complex, the costs to machine or to stamp or to weld can be high.

Worst of all, many alloys do not lend themselves to wroughting. Some of these, like the Stellites and other cobalt alloys, and the tungsten alloys, are too hard. Others, when worked tend to harden, to become brittle, or to tear.

Let casting solve its problems, and the field for wroughting becomes much simpler. Alloys can be blended in any desired quantities, complex shapes can be cast at low cost and with very few machining or other fabricating operations needed to complete them, wroughting problems can be eliminated.

The drive to solve casting problems, then, is intense. And it is leading to some unexpected developments.

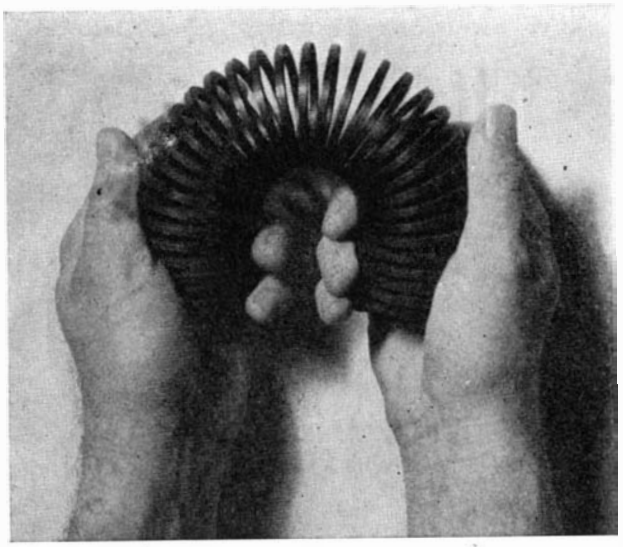
MOLDS ARE CHILLED — In one shop, molds are completely finished and set up for pouring, then are packed in dry ice over night. This chills them to 50 degrees below zero, Fahrenheit. Aluminums and other light metals are cast into these molds.

The light metals have a trouble which wroughting cannot cure. They pick up hydrogen while being cast by ordinary methods. The hydrogen causes porosities which wroughting does not heal.

Ordinary casting cannot prevent this because the metals are too high in thermal conductivities. Rather than cooling at some areas first and then progressively depositing solidified metals on those areas, thus progressively squeezing the gas from the solidified portions into the still molten areas and so getting rid of it, the molten portions tend to transmit their heat until the entire mass cools enough to freeze. Thus the gas is imprisoned until very nearly simultaneous solidification locks it in permanently. But by chilling the molds, the cooling effect upon the outer portions of the castings may be made great enough so that these portions will solidify in spite of the heat conducted to them. The gas then is squeezed out.

Castings made in this way can be 100 percent stronger than wrought products of the same alloys.

Heat treatment also is being done within casting molds. The grain structure, and therefore the strengths and other physical properties of an alloy, can depend upon the length of time during which the alloy is held at a critical or other pre-selected temperature.



Courtesy Cooper-Bessemer Corporation

Cast metals can be highly flexible, as evidenced by this spring, cut from a cylindrical casting of Meehanite metal, an improved form of cast iron

By usual practice a metal product is cast, after which it is either wrought or machined or otherwise fabricated. Then it is heat-treated for strength, after which it must have further corrective operations to restore its accuracy and improve its surface. But by heating the casting mold to the heat-treating temperature, and letting the casting solidify at that temperature, it often is possible to obtain better grain structures and greater strengths than can be had by any subsequent heat treatments.

SPECIAL CASTING ALLOYS — The development of special alloys intended to be cast is another modern technique. Very slight modifications, such as the addition of a few parts of nickel, can make alloys behave better in almost any mold. Stainless steels can be made far more corrosion-resistant if their carbon contents are kept very low. Rather than having the traditional "cast brittleness," cast metals can be highly flexible if cast of special Meehanite alloys.

All of these techniques have made major changes in casting practices. Instead of being a place of dirt and fumes where the foundryman worked by his experience and craft alone, the modern foundry is operated by strict metallurgical control.

It is not common to set up with vacuum and with inert gases under pressure to control every movement of the molten metal. But temperature control and control of pressures upon the metal are constantly increasing in use.

The very shrink forces which have been the enemies of casting are being put to work. Non-crushing cores are placed where high accuracies of cast holes are wanted. The molten metal shrinks around them, compacts itself, holds to accuracies as close as those obtained by ordinary grinding.

No one at this time knows where all of these new techniques will lead. Only one point is certain. Casting, which is the oldest of the metal working arts, is coming on to become one of the newest.

NIGHT COOLING for DAY COMFORT

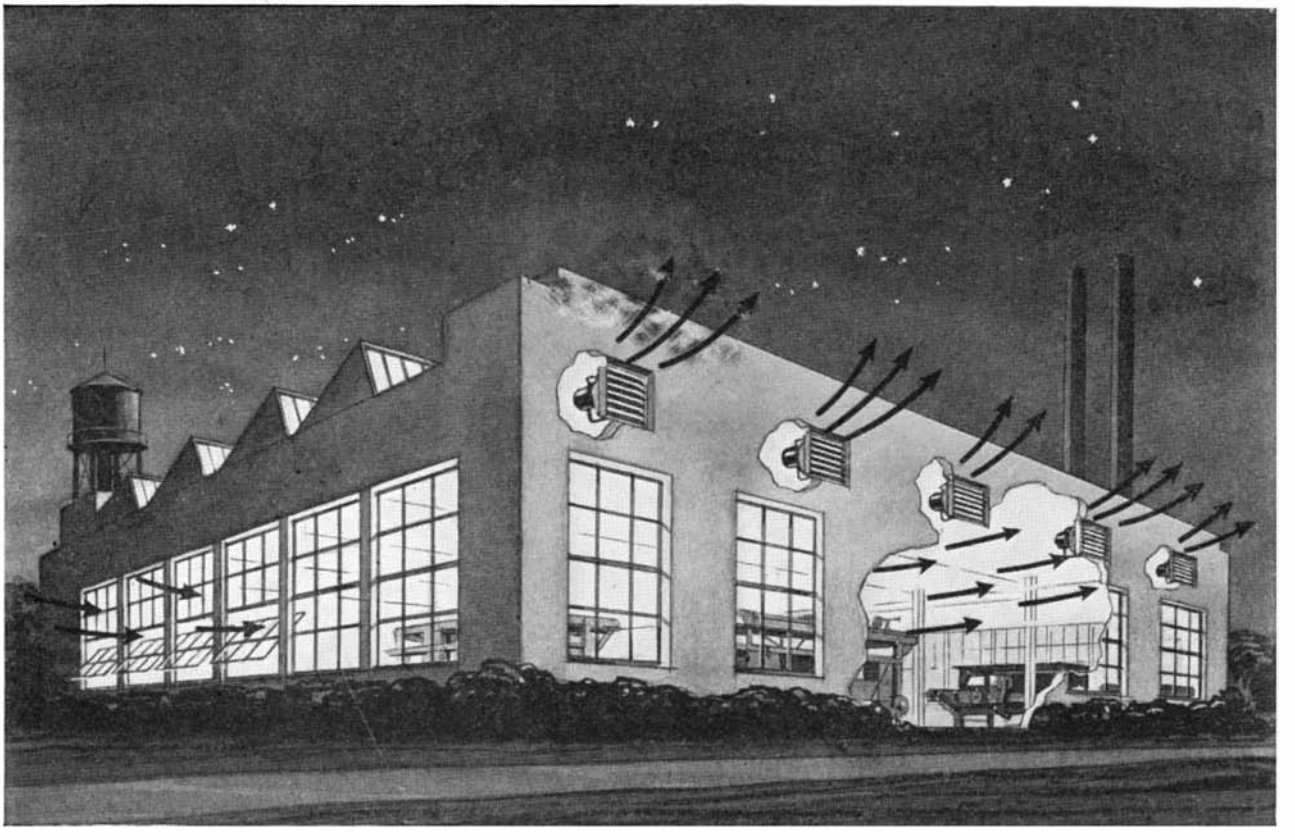
By L. F. Peterson
Mechanical Engineer, Ilg Electric Ventilating Company

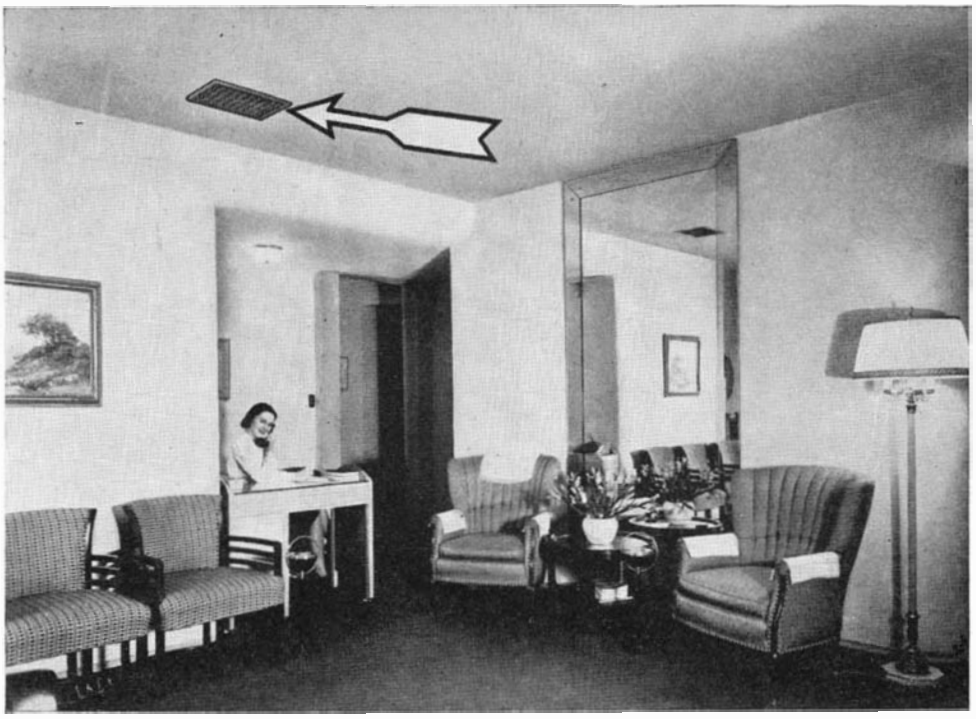
Power Fans and Ventilators, Replacing With Cool Night Air the Heat Accumulated in a Building During the Day, Can Provide Comfortable Indoor Air Temperatures Which Would Be Obtainable Otherwise Only Through the Installation of Vastly More Expensive Equipment

A WAX PAPER manufacturer was encountering heavy losses due to spoilage in his warehouse during the hot summer months. The wax softened, sheets stuck together, causing damage in inventory, rejections from customers, and loss of good will. An estimate on mechanical refrigeration for the storage space ran well over $40,000, with correspondingly high operating and maintenance costs. A survey was made with night-cooling in mind as a possible solution. It was found that: (1) the paper was stacked with ample space for air to circulate between the rolls; (2) the building design permitted inflow of air near the floor level through doors on either side of the warehouse; (3) a skylight extending the length of the warehouse made possible the inexpensive installation of fans.

Hot daytime air, expelled by fans, is replaced by cool, fresh night air entering through windows

All illustrations courtesy Ilg Electric Ventilating Company





The warm air drawn off through the inconspicuous grill (arrow) in the ceiling of this doctor's reception room, is exhausted by roof fans

With such evidence in its favor, a night-cooling system was installed. And in this installation, costing approximately $3000, that company found the solution to its problem.

This is just a single example of how effective air cooling can be provided at low cost with a night-cooling system.

The extremely high air temperatures often attained in buildings during the summer are due largely to the fact that the heat of day is absorbed by the structure itself, and by all that it contains. Then, after the day shift has ended and the plant is closed up, the day-time heat is retained inside the building. As a result, on the following morning the workers come into a hot, humid, heavy atmosphere that is little better than the peak of the previous day.

BASIC PRINCIPLE — Outdoors, however, when the sun goes down, even during extreme heat waves, the temperature drops 16 to 30 degrees. And the basic principle of a night-cooling system lies in taking full advantage of this sharp drop in outdoor temperature.

Propeller fans or power roof ventilators are installed in walls, windows, skylights, or on the roof. Actuated by either electric time clocks or maintenance crews, the fans are turned on as soon as the outdoor temperature has lowered and are stopped in early morning hours. The heat which accumulated in the building during the day, along with the humidity, odors, dust, steam, and other unwanted air contaminants, are driven out of the building as the cool night air is drawn in from outside. Inside temperature may thus be lowered as much as 20 degrees; the atmosphere is then fresh and inviting when the day shift comes to work.

In the case of the wax paper warehouse, fans actuated by time clocks were turned on near midnight to pull cool night air into the building and circulate it around the stored rolls of paper. A complete change of air was produced every four minutes. The fans were automatically stopped in the early morning, at which time the night watchman closed all windows and doors. And care was taken during the day to see that the warehouse was closed as much as possible to retain the low-temperature air. Thus, the spoilage of wax paper due to heat was completely eliminated.

IN ATTICS FIRST — Starting back in 1918, when our company first adapted the exhaust fan to remove heat from attics, this method of cooling buildings has gained increasing acceptance, and today night-cooling systems are being installed in apartments, hotels, stores, industrial plants, and office buildings.

A typical commercial installations is the one made in a group of medical buildings where five buildings contain 170 rooms to be ventilated. Into waiting rooms, doctors' offices, operating rooms, X-ray rooms, laboratories, darkrooms, and rest rooms, it is necessary to introduce fresh air, at the same time exhausting stale air, heat, and odors without "short-circuiting" the air, or transferring odors from one room to another. Power roof ventilators installed on each of the five buildings are started each night by maintenance crews, and are turned off near dawn. Again at noon, the fans are turned on to draw out accumulated heat, and, on excessively hot days, the fans run all day.

The result of this installation is a seeming impossibility—complete satisfaction of the 40 doctors who occupy the buildings, with comfortable air temperatures maintained throughout the entire year.

In almost any building—industrial, commercial, or residential—where accumulated heat is a problem, the judicious placement and operation of power fans or ventilators will provide air conditions which would cost many times more to achieve with any other cooling technique.

FUELS OF THE FUTURE:

For Gas Turbines and Jet Propulsion

By Philetus H. Holt
Assistant Director, Research Division, Esso Laboratories

Editor's Note: **The accompanying article is the second 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.**

THE PRINCIPLE of the combustion gas turbine which has made possible the development of turbo-jet and turbo-prop-jet engines for aircraft, and which appears also to have a definite place in the future of marine and railroad locomotive propulsion, is by no means new. History is full of attempts to develop a satisfactory gas turbine. Early experimenters, handicapped both by lack of knowledge which would permit design of efficient compressors and turbines, and by lack of the proper materials of construction, were unsuccessful. However, the war-time need for greater and greater speed in aircraft prompted intensive research in these fields, and the increased knowledge of aerodynamics, coupled with the discovery of structural materials suitable for extremely high temperatures, made possible the development of the gas turbine, in the form of the turbo-jet engine, for aircraft. This new type of engine has opened new horizons for aircraft performance, and is one of the outstanding developments since the original flight of heavier-than-air machines.

Basically, the design of the combustion gas turbine is simple. There is only one major moving part, a rotating shaft on which is mounted an air compressor and a turbine rotor. The compressor supplies air to the combustion chambers where fuel is burned continuously to increase the energy content of the compressed air by heating it. The resulting hot gases are then expanded through a turbine, causing the turbine rotor and shaft to revolve. In the case of the turbo-jet engine, only sufficient energy is recovered by the turbine to drive the compressor; the hot gases leaving the turbine are exhausted through nozzles to form the jet.

In the prop-jet engine, or in a gas turbine constructed for marine propulsion, the greater part of the energy available in the hot gases from the combustion chamber is recovered by the turbine, and the power thus available, over and above that required to drive the compressor, may be utilized to drive an air screw, in the case of high-speed aircraft, or a generator, for example, in a marine installation. The prop-jet aviation engine, of course, may still be considered a jet-propulsion unit.

The amounts of fuel and air consumed by the gas-turbine engine in developing its power are astounding when first considered. A turbo-jet engine developing 4000 pounds thrust, equivalent to 4000 horsepower at 375 miles per hour, will require more than four million cubic feet of air in an hour. At this rate, all the air in a typical six-room house would be exhausted in about nine seconds. Approximately 20 barrels of fuel are burned each hour—enough fuel, if it were gasoline, to drive an automobile 12,000 miles at a speed of 60 miles per hour, or, if heating oil, enough to heat a typical six-room house for two thirds of a heating season.

Heat is released in the combustion chambers of the turbo-jet engine at the rate of about 20,000,000 Btu per hour per cubic foot of combustion zone, which may be compared with a rate of one million to two million Btu per hour per cubic foot in the case of industrial furnaces. And this great development of power is accomplished with a freedom from vibration unknown in reciprocating engines.

BRIGHT FUTURE — The future of gas-turbine power plants for aviation is very bright. The turbo-jet engine right now far surpasses the conventional reciprocating engine where extremely high speed is necessary, and where fuel economy is of secondary importance, as in fighters, interceptors, and fast at-

tack bombers at present altitudes. When pressurized cabins for very high altitude are developed, it has future possibilities for fast, long range commercial transport. There are two reasons. First, at altitudes of 40,000 feet or higher the turbo-jet unit is much more economical of fuel than at low altitudes. Second, long flights of 3000 miles, which presently take 12 to 14 hours, may be made in six to seven hours, thereby doubling the utilization of equipment and flight personnel, and also providing a more attractive passenger schedule.

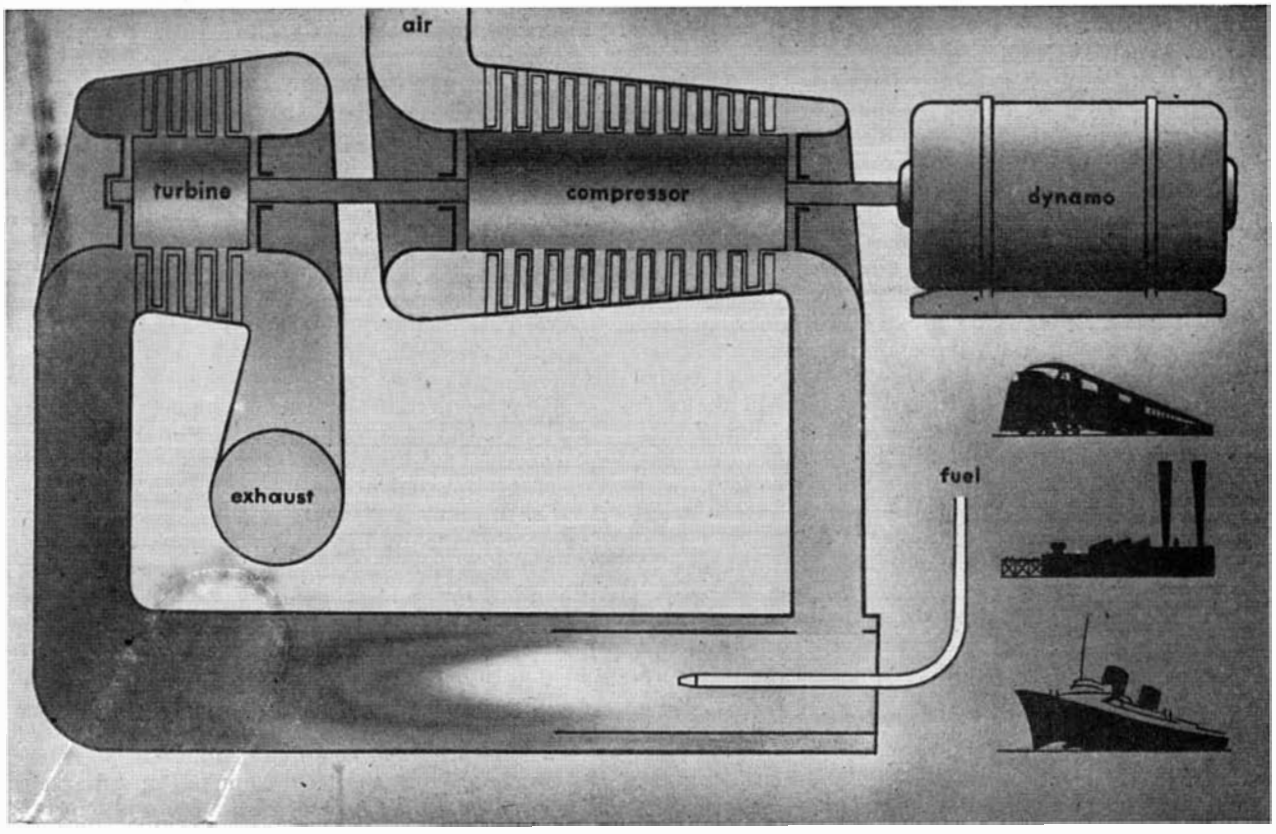
The turbo-propeller-jet power plant has the possibility of competing directly with the conventional reciprocating engine at present-day speeds, since it is to be expected that improvements in design will result in fuel economy and operating life equivalent to those of the reciprocating engine. The rapidity of application of turbine power plants to commercial flying is a subject of varying opinion. Some estimate that they will be introduced in three years, others in five years, and still others in 10 years or longer. However, the rapidity of their introduction will most probably be in direct proportion to the amount and caliber of the effort expended in research and development.

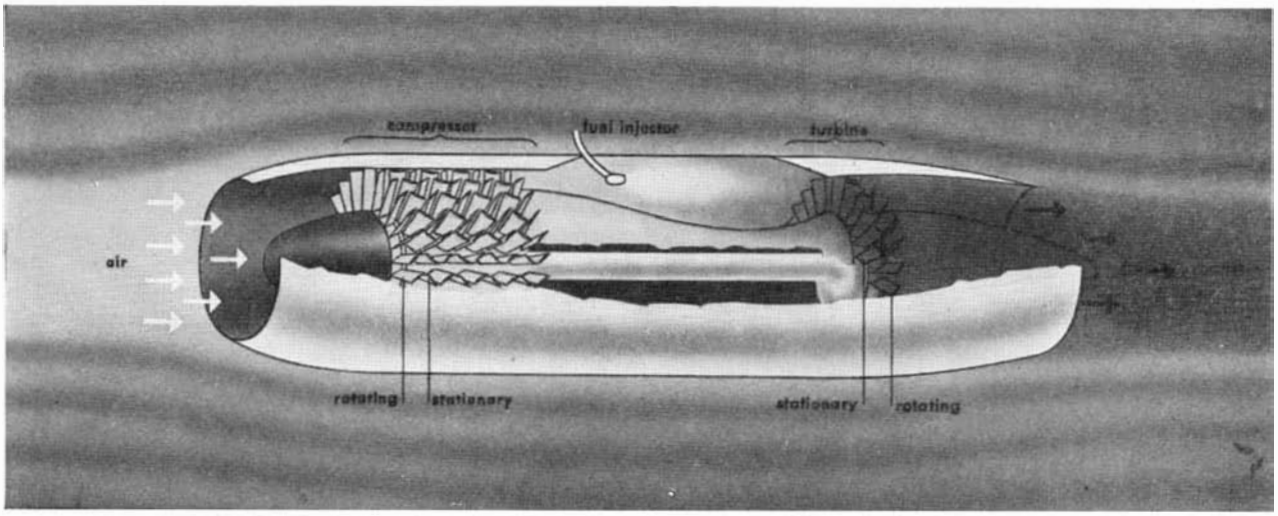
Among the advantages claimed for large gas-turbine installations for marine propulsion are savings in weight and space requirements. The gas turbine will, for example, eliminate boilers. It should be cheaper to construct than modern steam or Diesel equipment and would eliminate many items of auxiliary equipment, such as condensers. If experience obtained in the case of gas turbines in the aircraft field is duplicated, the large-scale gas turbine should also have the advantage of being able to furnish power almost immediately when required. The unit should come to operating temperatures very quickly, and any extensive time-lag, such as is needed for the development of high-pressure steam, would not be necessary.

NOT JUST ANY FUEL — Many misleading statements have been made about the fuel quality requirements of the aircraft gas-turbine engines. One could gather from early publicity releases that these units could burn almost anything that could be pumped and was combustible. Such statements do not reflect the actual situation. It is true that aircraft gas turbines do not require high-octane gasoline, although many of them have been operated successfully on this type of fuel. It has been found, however, that gas-turbine engines perform best on certain specific types of fuels, and these fuels must, in addition to satisfying the characteristics of the gas-turbine combustion chamber, meet a number of specifications which are inherent in any fuel utilized in high-altitude aircraft. For example, the fuel must have a very low freezing point in order to withstand low temperatures at high altitudes.

From the standpoint of engine performance, a satisfactory fuel for gas-turbine engines must burn cleanly, and must not cause deposition of carbon or coke in the combustion chamber. Such coke formation, in addition to being an indication of incomplete combustion with consequent loss in efficiency, may also promote warping and distortion of the metal

Simplified section of a gas turbine. Heated air from combustion chamber is exhausted through turbine, which drives the compressor and also provides power for stationary plants, locomotives, or ships





Power is supplied by the turbo-jet engine through reaction. The turbine operates the compressor and may also power a propeller as in a prop-jet. In drawing, direction of motion is from right to left

liners of the combustion chamber by preventing even dissipation of heat. Furthermore, large particles of coke may become dislodged and severely damage the turbine blades.

The satisfactory fuel must provide a stable flame over wide ranges of air-to-fuel ratio. Flame blow-out must not occur when throttling causes a momentary abnormally lean mixture. Similarly, blow-out must not take place in the event of rich mixture caused by quick throttling while the compressor is rotating at relatively low speed. Blow-outs might well prove disastrous, particularly in combat aircraft, if re-ignition were not immediately obtained, and such cases might be encountered at high altitude.

Finally, the gas-turbine fuel itself and its products of combustion must be of such nature that neither will corrode the metals of which the engine is constructed.

Fuels for aircraft gas-turbine engines at the present time range in volatility from that of 100-octane aviation fuel, which is frequently employed because of its availability, to that of kerosine. Present indications are that fuels of higher boiling ranges are not entirely satisfactory in the combustion chambers of the gas-turbine engines because, among other reasons, of their low temperature properties.

The chemical composition of the fuels may also be an important factor. Aromatic hydrocarbons appear to burn less cleanly than those of the paraffinic type. On the other hand, in the case of jet-powered aircraft, the aromatic hydrocarbons should have a fundamental advantage because of their higher heat content per gallon, and fuel storage space may become a limiting factor on high-speed planes. There are indications that improvements in combustion chamber and accessory equipment design may permit the use of highly aromatic fuels. If the use of fuels containing large percentages of aromatic hydrocarbons should ultimately prove to be desirable, it will permit utilizing many products produced by catalytic or thermal cracking, in addition to the more paraffinic products that predominate in virgin crude oil.

EXTENSIVE FUEL TESTING — In order to determine the most desirable fuel from a performance standpoint, fuels of all types are being evaluated in full-scale combustion chambers of gas turbine engines. The Standard Oil Development Company was the first petroleum company to establish a laboratory for this purpose, and tests are run in all types of currently available units. Facilities are on hand for simulating conditions of flight at altitudes up to 40,000 feet. By this means, the requirements of newly developed engines can be determined as soon as the engines become available.

Knowledge of the fundamental variables controlling high-output combustion is essential for further development of gas-turbine fuels. Studies of the fundamentals of combustion are under way in a special laboratory in co-operation with the Office of Naval Research. Here the many factors affecting rates of flame propagation, flame stability, and heat release per unit volume are investigated on a laboratory scale. The most advanced spectrographic techniques are employed, and it has been necessary to construct numerous unconventional pieces of test apparatus. For example, means had to be developed for confining the flame from fuel being burned at a faster rate than in a domestic heating furnace within a space six inches long and one inch in diameter. Knowledge gained by these fundamental studies will find application, not only to problems relating to gas turbines, but also to pulse jets, ram jets, improved furnaces of all kinds, and even to combustion in the reciprocating engines.

The ultimate selections of the types of fuel to be generally employed in gas turbines will depend upon combustion performance, safety in storage and handling of fuels, and economy of operation. The selection of the boiling range characteristics of the fuels will be affected by considerations of maximum probable future demand for other liquid fuels, such as motor gasoline, 100-octane fuel components, kerosine, and Diesel fuels so that the characteristics will not unduly restrict amounts that can be made. Assurance of proper performance will come only from extensive research over long periods of time.

EXPANSION TESTING

Essential To Understanding of Production Problems

HIGH-SPEED operation in any industry usually means the occurence or the use of elevated temperatures. Temperatures in turn mean expanded dimensions of materials. And expansion can mean breakage of retaining members, losses of production accuracy, and similar troubles.

Courtesy Whip-Mix Corporation

Bureau of Standards type Dilatometer

Materials are studied as never before to find out just how much they will expand and under what conditions. The data, which must be of scientific accuracy, are obtained from such intricate instruments as the Bureau of Standards type Dilatometer.—*E.L.C.*

LINE VOLTAGE STABILIZER

Reduces Variations In Quality Of Photographic Prints

VARYING voltage conditions and the consequent bad effect on the quality of negatives and prints have been eliminated in a lithographic plant by the installation of a voltage stabilizer which delivers a constant output of 230 volts when connected to an ordinary power line whose voltage varies between 190 and 260 volts. The influence of other electrical loads on the voltage output is eliminated.

Installation of the stabilizer grew out of a study by the Charles M. Falk Lithographic Company of the factors controlling the production of good negatives and prints. It was discovered that negatives did not produce the same true colors for a given exposure, or, for black and white negatives, the same densities for a given exposure. Further studies showed that voltage variation caused by changes of electrical loads on the building circuit produced color variations as a result of unequal voltages at the light source.

The General Electric voltage stabilizer, a 5000-volt-ampere transformer network device, was installed for control of the lighting circuit used in the photographic process, resulting in a reduction in negative spoilage and lower time losses.

FUEL VAPORIZER

Distributes Super-Fine Spray Through Pin-Hole Slots

WHIPPING heavy oil into a miniature cyclone of tiny droplets averaging less than four ten-thousandths of an inch in diameter, a fuel atomizer has been perfected to speed work on a new gas turbine engine, according to scientists at the Westinghouse Research Laboratories. Designed by Keith V. Smith, the atomizer will be used on a 2000-horsepower oil-burning gas turbine now under development.

A new-type nozzle that sprays oil into the engine, the atomizer enables a minimum of 96 percent of the fuel to be converted into heat over a wide range of speeds—at times reaching heat-producing efficiency twice that of conventional nozzles.

"This is possible," explains Dr. Stewart Way, who supervises combustion research at the Laboratories, "because the tiny wind-driven droplets vaporize and burn more readily than the spray from a conventional nozzle, which produces fuel particles some ten times larger.

"About 29 billion drops a second are sprayed by the new nozzle, providing a total burning area of one hundred square feet and immensely speeding up the process of vaporization. As a result, greater fuel economy now becomes possible, reducing the cost of gas turbine operation."

Key to the new nozzle's atomizing power is a blast of air that enters through six pin-hole slots cut at an angle in the nozzle. As these separate streams of air enter the atomizer, their whirling motion stirs up a miniature cyclone. This air blast in turn collides with the incoming fuel supply, ripping the thick oil into droplets so fine they approach the size of fog particles.

"The conventional method of supplying fuel is to pump oil through a nozzle at various pressures and let the flame do the rest," Dr. Way points out. "But such a method has two serious disadvantages. First when the turbine is running under light loads, the fuel is distributed unevenly throughout the combustion chamber, a large part going to the walls where some of it cakes in the form of unburned carbon particles. Second disadvantage of conventional nozzles is that the particles are

Courtesy Westinghouse Electric Corporation

New nozzle (right) emits much finer spray than conventional model (left)

too large for best combustion when fuel pressures are relatively low.

"The fuel nozzle designed by Keith Smith goes a long way toward clearing both these hurdles by providing super-fine atomization over a wide range of operations, and by distributing the fuel equally to all parts of the combustion chamber.

"A unique feature," Dr. Way continues, "is that a very fine spray can be attained at oil pressures as low as 10 pounds per square inch, and even lower if a lighter grade of oil is used. With the conventional nozzle, pressures of at least 50 pounds per square inch are required."

CHILLED LATEX

Converted Into Synthetic Rubber Film

CONVERSION of a neoprene latex to a purified synthetic rubber known as GR-M is now possible on a continuous production basis. It has been found that a latex of GR-M can be converted into a thin rubber-like film by freezing a thin layer of latex on the surface of a chilled revolving metal cylinder and then scraping off a film of rubber mixed with ice crystals. This method avoids the use of chemicals and can be operated continuously in a machine. The method by which GR-M is manufactured gives a milk-like dispersion of tiny rubber particles that looks like latex obtained from the rubber tree. Before such goods as tires, hose, and other articles can be made, it is necessary to separate the synthetic rubber from the water and chemicals used in the manufacture of the latex. Such a latex can be coagulated by the addition of chemicals or acids and the solid rubber thus obtained. But it was desirable to produce the synthetic rubber without the necessity of adding chemicals that must be removed later or by the use of excessive labor.

In the new process, developed by E. I. du Pont de Nemours and Company, the latex is fed to a cold revolving drum, the film of ice and rubber is removed and thawed, and the water is then removed by squeezing the film and passage through drying ovens similar to those used for drying textiles. The dried film is very thin and resembles a sheet of elastic transparent paper. This film when dried is fed into machines which squeeze it together into the form of a rope about an inch in diameter. The roped GR-M is then continuously cut into sections and packaged by automatic machinery ready to be shipped to the fabricators of rubber goods.

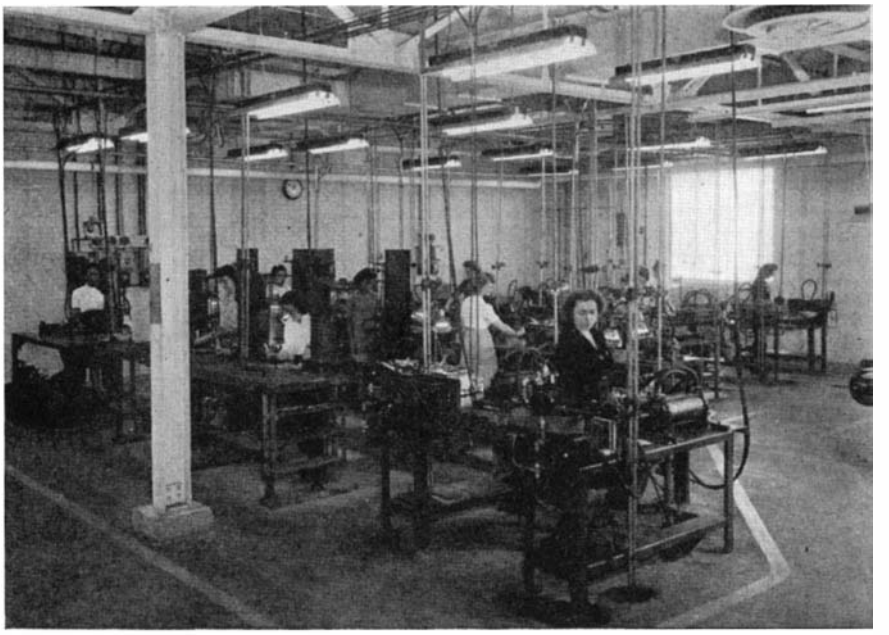
MACHINE-SHOP FORESTS

Return With Installation Of Special Conduits

WHEN BELT drives with their overhead shafting first were reduced in number, many a plant manager sighed happily over the fact that the ceiling space was clear above his machines and his shop no longer looked like a forest.

Gradually, the forest appearance is creeping back. Compressed air lines, hydraulic lines, electrical connections, circulating steam and hot water, special lubricants, tubes for gravity or pneumatic handling of materials, all are being led down from plant ceilings. And with them are coming all of the problems of light without shadows which had existed with the belting.

This condition will increase. No matter what the engineer may desire above his machines, ceiling space is too handy and too valuable to waste.—*E.L.C.*

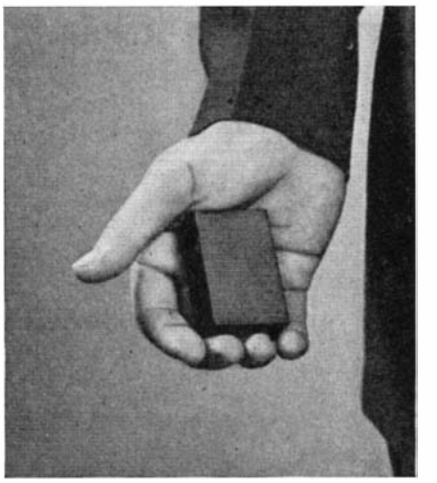


Convenient overhead space is again taken up—now by a multitude of pipes and cables

MIDGET CAMERA

Disguised As Match-Box, Was Tool of OSS

SMALL enough for concealment in a person's hand and yet capable of snapping pictures that can be enlarged many diameters with excellent clarity, a tiny camera was developed during the war for use by the OSS and underground forces. Also the OSS was supplied with "vestpocket darkroom" kits containing several rolls of 16-mm film, photographic developing and fixing chemicals in pill form, a small chamois for wiping the developed film dry, mixing spoon, film clips, and a pencil-size solution agitating stick. By means of this miniature darkroom equipment, the film could be developed in a small glass holding a jigger of solution.



16-mm film is used

The camera, which was planned by J. L. Boon, Joseph Stoiber, and Henry Hood, all of the Eastman Kodak Camera Works, took film in coils or spools in lengths of about two feet. It produced about 30 exposures, had an *f*/5 lens with one stop to close the aperture to *f*/11, and operated at a shutter speed of about 1/50th of a second.

With a one-inch focal length, the lens had an angle of view of approximately 45 degrees, which permitted picture-shooting "from the

hip." The subject was in focus from about eight feet to infinity.

Film coated with standard Eastman emulsions (Super XX or Plus X) was used in the camera, which was constructed of a molded Bakelite inner case sheathed in a metal outer case. The entire camera had a dull black finish.

Functioning with but a slight click, the "M.B." had no view finder and was operated simply by aiming at the subject, then pushing a small plunger. A wire lever enabled the operator to take time exposures as well.

For copying photographs or printed matter the camera was set in a small stand equipped with a close-up lens. In this manner it served as a photo-recording apparatus for reproducing documents and similar material.

INSECTS TRACED

By Tagging With Radio-Active Material

MOVEMENT of insects can be followed by attaching a small amount of radium sulfate to them and detecting the radioactivity with a Geiger-Muller tube. With this tube and its associated power supply, sufficient output is obtained to operate a loudspeaker directly, and to locate through four inches of soil an insect or worm carrying five micrograms of tracer. Periodic ticks from the loudspeaker increase in rate as the insect is approached.—*K.H.*

BETTER LEATHER FINISHES

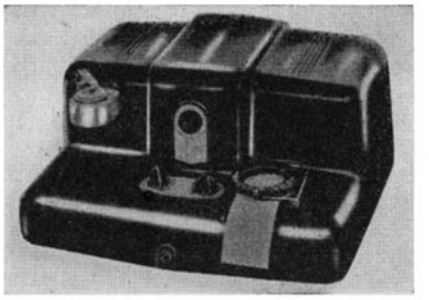
Produced Through Use Of Infra-Red Lamps

MODERN scientific developments are being successfully applied to one of man's oldest industries, shoemaking. Today, progressive tanners are using infra-red lamps to fix the finishes on leathers. They find this superior to the old heat methods, for it permits a second application in a matter of seconds and, in this way, radically reduces the time necessary for finishing.

WATCH TIMER

Compares Ticks With Output Of Crystal Oscillator

NEWEST in watch rate recorders is a device which picks up the sounds of a watch with a microphone, feeds them to an amplifier, and thence



Watch rate shown by lines on paper

to a trigger tube that operates the solenoid of a printing bar. A crystal-controlled oscillator serving as the master time clock also acts on the printing bar, so that the slope of the lines printed on a strip of paper indicates whether the watch is running fast or slow. A series of lines parallel to the sides of the paper means that the watch is keeping perfect time. The instrument, made by the Gibbs Division of George W. Borg Corporation, is supplied in a plastics case for counter use.—*K.H.*

OFF-SHORE OIL WELL

May be First of Many Far From Land

AN OIL well 10 miles out in the Gulf of Mexico—the first operation of this nature so far from land—is only a forerunner of others even greater distances off shore, states R. G. Watts, of the Magnolia Petroleum Company, which drilled the well. This well is about 37 miles south of Morgan City, Louisiana, 10 miles off shore from the mouth of the Atchafalaya River. The same firm has in process of construction another platform 29 miles off shore. Four others are in the planning stage within 10 miles of shore and one more nearly 20 miles out. Prospects are that the next few years will see many more wells drilled in the Gulf waters and probably much further out.

The well was drilled to a total depth of 12,874 feet with no production. At present it is drilling directionally at 10,601 feet from a whipstock set at 10,542 feet.

Water at the location site was 16 feet deep at mean low tide. There are no other wells between this one and the shore in this general area but there are a few in Atchafalaya Bay, in protected and somewhat shallower water.

The quartering of men and transporting them to and from the job site in a reasonable length of time gave promise of being a major problem. This was solved in two ways: First by establishing a quarterboat near Eugene Island just inside the Bay in semi-quiet waters; and secondly by use of a heavy fast boat as crew boat to transport men between the job and the quarterboat.

The distance of the well from land and its location in the open Gulf necessitated providing more platform space or area for storage of drilling mud, fuel oil, fresh water, and standby units than would otherwise be required. The platform was set at an elevation of 20 feet above mean high water to give protection against waves of maximum expected height. The bracing on the piling was designed for the force of such waves which, due to the open type of structure, would be about 800 pounds per square foot of exposed surface.

JET ALLOYS TESTED

By Rapid Spinning At High Temperatures

SCIENTISTS are exploding whirling, red-hot disks of metal in an effort to determine the maximum strength of parts for aircraft jet engines. This "metal torture" will lay the groundwork for development of new alloys especially suited to this work.

Disks of specially-developed alloys, one foot in diameter and one inch thick, will be heated to temperatures above 1400 degrees, Fahrenheit, and spun at a speed of 1200 miles per hour—35,000 revolutions a minute—until they literally fly apart under the combined attack of centrifugal force and heat. A specially constructed dugout, ringed with heavy sandbags and sunk 10 feet below floor level, will bear the brunt of the assault.

"These destruction tests," explains R. E. Peterson, manager of the

Looking down into the pit where new alloys are whirled to destruction

Mechanics Department at the Westinghouse Research Laboratories, where the tests are being conducted, "are aimed at revealing the ultimate strength of alloys now used in gas-turbine rotors for jet engine application. In actual service, these rotors—on which the turbine blades ride—are subjected to terrific stress and temperatures. We plan to simulate and even exceed those conditions until the metal breaks up."

When the actual test is underway the 32-pound disk is covered by a thin steel hood from which air has been evacuated to reduce friction. The hood has been constructed purposely of very light steel, one eighth of an inch thick, so that flying fragments of the metal will easily penetrate its thin skin. Use of a heavier steel would cause serious damage to the fragments and prevent close scrutiny of the type of fracture or break involved—very vital information to the scientist.

As the heated disk spins, research engineers will make continuous measurement of its temperature. Methods for doing this posed a difficult problem. Since the disk is whirling at the rate of 35,000 revolutions per minute, any heat-measuring device attached to the outer rim would have a centrifugal pull of approximately 190,000 times its own weight. Even if the device weighed a fraction of an ounce, it would have to be fastened strongly enough to resist a pull of many thousand pounds. The problem was solved by a special welding process.

Periodic measurements also will be made of the expanding diameter of the whirling metal disk. Under high stress and temperature, all metals tend to flow or "creep;" and with the very narrow clearances in the gas turbine, a knowledge of this rate of flow is vital to the design engineer to prevent future rubbing of surfaces.

DDT MOTHPROOFING

Assures Two-Year Protection From Attack By Insects

MOTHPROOFING clothing by spraying DDT in solution on the material in the centrifugal extractor at the dry cleaner's plant as a last step in the dry cleaning process affords heretofore-impossible protection. The treatment leaves tiny traces of the insecticide so distributed throughout the fabric that insects will not attack it for as long as two years or more after treatment, even though the garment be washed in the interim. The amount of insecticide left in the fabric is so small that it in no other way affects the cloth, nor does it impart color or odor to the work. Application is simple and apparently foolproof; the insecticide is dissolved in the solvent by passing it over a porous bag containing the powder. The solution is sprayed on the material in the extractor just before the work goes to the final dryers.—*D.H.K.*

FABRIC COATING

Contains No Sulfur, Protects Silverware From Tarnish

PLASTICS-coated materials, this time a cotton-base fabric coated with pyrolylin, are making their appearance in many new applications. One is a

Tarnish-retarding chest

silver chest sold with Gorham silverware that is coated with Terek, manufactured by Athol Manufacturing Company. The advantages of this material is that it discourages tarnishing, being compounded without sulfur.—*C.A.B.*

PACKAGE BATTERY CHARGER

Is Fully Automatic, Can Not Overcharge

IMPROVED heavy-duty battery charging equipment for industrial truck service, meeting all the standards of the Electric Industrial Truck Association, is now packaged in one unit consisting of a single-circuit battery-charging motor-generator set, with its control cabinet mounted on a welded structural steel framework directly above. It is completely wired and assembled before shipment from the factory.

The equipment meets the requirements of an 18-cell, 550-ampere hour, lead-acid type storage battery. It charges the battery at the exact tapered charge rate that is indicated by the battery manufacturer as being necessary for longest life of the battery equipment.

The generator is a conventional 47-volt D.C. machine. For exact adjustment of voltage, a slide-wire type resistor is used in the field circuit in place of the usual rheostat. This prevents tampering with the voltage after it has been set.

The equipment, produced by the General Electric Company, is completely automatic. Connection of the battery to the terminals automatically starts the motor-generator set, and when it has attained synchronous speed, the line contactor to the battery circuit is closed automatically. As soon as the battery has reached a voltage representing 75 to 80 percent of full charge, a timing device is actuated which cuts off the battery from the charging circuit on completion of the charge. This shuts down the motor-generator set and prevents overcharging the battery.

PEST KILLER TESTED

Seen As Superior To DDT, Nicotine

HAVING shown in preliminary tests that it may be the answer to the problem of controlling pests which are not eliminated by DDT, a new phosphate, tetraethyl pyrophosphate (or TEP, as it will probably be called) marks as its victims rats, codling moths, aphids, and mites which menace such crops as apples, potatoes, peaches, and cabbages.

No poisonous residue

The importance of TEP as an insecticide lies in the fact that many of the insects which DDT kills are those which hold other insects in check. With the predators eliminated, aphids, mites, and kindred

pests flourish. Estimates rate TEP as ten times as effective as nicotine.

One advantage it possesses is that it leaves no poisonous residue, for it decomposes within a few days after application. Thus food products, on which it will be most widely used, need not be washed before marketing.

The full utility of TEP in agricultural fields will not be established for at least a year or more. Conceivably, it can be used as a spray, or dust component, or as an aerosol ingredient.—*H.C.E.J.*

CONTROL-CABLE STEEL

Has Expansion Coefficient to Match That Of Aluminum

HAVING a coefficient of thermal expansion close to that of aluminum alloy, an alloy steel has recently been developed for use in aircraft control cables. It has successfully solved the problem of maintaining correct control cable tension when used in assemblies with aluminum alloy over a range of temperatures from − 60 to + 75 degrees, Fahrenheit, and without sacrificing necessary strength properties.

The alloy is a nickel-manganese-chromium steel containing 11 to 14 percent nickel, 3.5 to 6 percent manganese and 3 to 6 percent chromium, with 0.3 to 0.7 percent carbon. Tensile strengths of 250,000 to 280,000 pounds per square inch, comparable to those of "18 and 8" stainless steel, are obtainable by cold-rolling. The material is non-magnetic even after severe cold-working, and its high thermal expansion coefficients closely match those of the aluminum alloys used as cable casing.

The alloy will probably also find uses in thermostatic bi-metal parts. Applications have been developed for aircraft engine cylinder liners, valve seats, and crank case bolts. The steel can be nitrided, and seems to have good resistance to impact at low temperatures.

A special field of use is expected to be found in applications that require a non-magnetic material with strength greater than that of the nonferrous metals.—*F.P.P.*

NOVEL WOOD STILL

Gives Better Yield With Less Fuel

STRENGTHENING of the wood distillation industry in competition with synthetic manufacturer of acetic acid and methanol is forecast by R. S. Aries, research associate at the Polytechnic Institute of Brooklyn, as a result of a new wood distillation process.

The new process developed at the Institute, in contrast to the old-fashioned plants in which wood is loaded by hand into cast-iron trains or "buggies" and placed in heated kilns, uses a steel chamber or retort into the top of which the wood is charged and continuously emerges at the bottom as charcoal. The flue combustion gases are circulated several times in the retort, thus drying the wood and saving on the amount of heat necessary for carbonization.

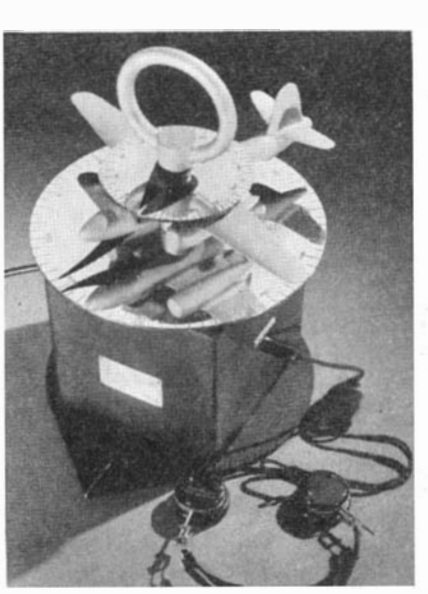
Other advantages of the process are a lower investment and a higher recovery of superior quality products. By the new process one ton of dry wood yields 1000 pounds of charcoal, 125 pounds of acetic acid and 80 pounds of methanol. In comparison, the oven processes now in use yield only 600 pounds of charcoal, 80 pounds of acetic acid and 45 pounds of methanol per ton of processed wood.

These improved yields, coupled with mechanized handling of wood, should permit plants to survive the keen competition from synthetic products and establish distillation as a permanent wood-chemical industry in America.—*H.C.E.J.*

RADIO COMPASS TRAINER

Demonstrates Direction Finding By Sight and Sound

DEVISED for the instruction of aircraft pilots and radio operators in the use of a radio compass, a trainer demonstrates both visually and aurally how positions of a radio station and an airplane with relation to the north magnetic pole and the radio loop antenna combine to indicate a bearing from airplane to station. All of the elements are movable to set up different problems. The trainee listens with headphones as he rotates the loop and plane.—*K.H.*

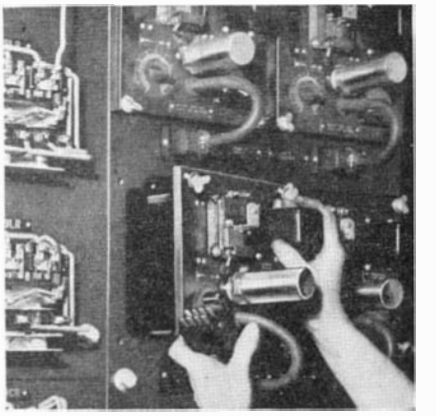


Problems varied by adjusting elements

PLUG-IN CONTROL

Can Be Quickly Replaced If It Develops Trouble

HAVING captive wing-nut mounting and a multiple-contact plug for all external connections, an electronic control unit allows practically uninterrupted machine operation in a factory. When trouble occurs in the control unit, it is yanked out in its entirety, and a spare one plugged in with only a few minutes lost time.—*K.H.*



Entire unit is detached

HIGH-STRENGTH ALLOY

Of Aluminum and Zinc Was French War-Time Achievement

FROM FRANCE are now coming reports of war-time developments in the light-metals field, which reveal that the French went somewhat farther than the United States in the strength level of their new aluminum-zinc alloys.

To obtain the greatest possible strengths, and thus to achieve the maximum weight saving, the French put 8 percent zinc and 2.5 percent magnesium in the alloy (as compared with American alloys containing up to 6 percent zinc). The French alloys (called Zicral) are reported to have 85,000 to 99,600 pounds per square inch tensile strengths, have a specific gravity of 2.8, and to be available as both sheet and forgings, the former clad with a more corrosion-resistant alloy.—*F.P.P.*

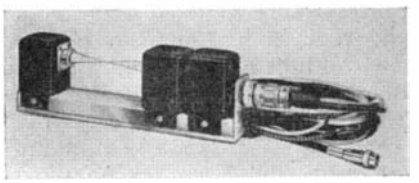
New Products

PHOTOELECTRIC ACTUATOR

Of High Resolution, Counts Tiny Parts With Great Accuracy

FOR COUNTING pills, buttons, watch screws, bottle caps, hardware, and other such items, which because of their small size, light weight, or irregular shape, are difficult to count accurately at high speeds, a high resolution photoelectric actuator has a beam approximately 1/16 inch wide and will respond to changes in light level as small as 20 percent. Since complete interruption of the light beam is not required for normal operation, objects as small as 0.010 of an inch have been counted with high accuracy. This feature also permits the counting of objects which do not have a distinct separation.

This Model 600 Photoelectric Actuator, product of the Potter Instrument Company, provides the negative pulses required for operation of that company's electronic counters, and is designed to detect objects at rates up to 30,000 per minute. The unit also contains a capacitor discharge output circuit for the high-speed operation of control solenoids such as required for deflector gates and packaging equipment.

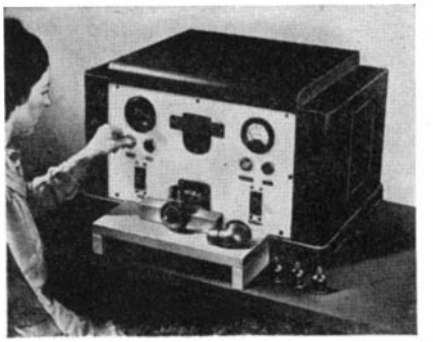


Can count up to 30,000 units per minute

SMALL INDUCTION HEATER

Applicable to Short-Run or Production-Line Operation

AN EFFICIENT source of radio-frequency energy for hardening, annealing, soft-soldering, brazing, or melting operations is found in a low-cost, bench-type induction heating generator engineered for continuous, full-load operation on the production line or for short-run work. This unit, delivered ready to use, operates on 120 volt, 60 cycle power, and has a full-load output of 43 Btu's per minute at a normal operating frequency of 450 kilocycles. The generator is designed so that water-cooling of working coils is unnecessary, as are any adjustments on the generator when changing from one coil to another. Single or multi-turn coils can readily be made by simply shaping copper wire or tubing to the work piece.



Full-load out-put—43 Btu's per minute

The equipment is fully protected by a plate overload circuit breaker and an instantaneous line circuit breaker, either of which will automatically shut off the generator if improper line voltage or load conditions should arise.

This versatile generator, called Ther-Monic Model 43 by its maker, The Induction Heating Corporation, bridges the gap between slow, costly hand treating methods, and large industrial heaters.

DDT WHITEWASH

Has Long Lethal Life When Made With Skimmed Milk

PERMITTING the use of DDT in whitewash coating, a new formula has resulted in the longest-lasting residual effect of DDT against insects yet reported to the Milk and Food Section, United States Public Health Service, according to a disclosure by A. W. Fuchs, Sanitary Engineer Director, of that agency's Washington office.

Using a mixture containing a quart of Pestroy 25 percent DDT emulsion concentrate, a gallon of skimmed milk, and four and a half pounds of high-grade spraying lime, research chemists of the Sherwin-Williams Company produced a whitewash coating which still had a high killing effect on flies 309 days after the coating had been applied. (DDT, when applied to surfaces as part of a coating, is usually considered to be lethal for a maximum of two to three months.)

Until the development of the new formula, it had been impossible to use DDT with whitewash because the efficacy of the DDT was destroyed when combined with lime and water. Skimmed milk as the binder not only makes it possible to lengthen the lethal life of the DDT, but also results in an enamel-like coating that is more durable than water-mixed whitewash.

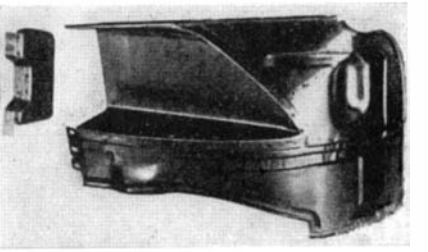
It is believed that whitewash containing DDT will be widely used in controlling parasites in and around stables, hog shelters, poultry houses, outhouses, and dairy barns and other farm buildings, as well as being applied to basement walls in homes, where it can be highly effective against flies, ants, roaches, and so on.

MULTI-SPOT WELDING

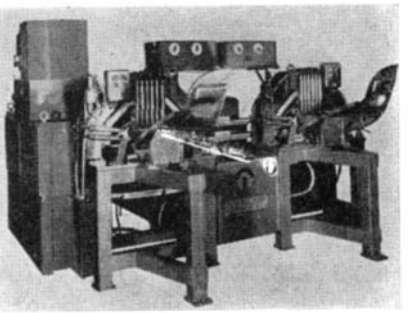
Production Rate Doubled With Battery Operation

AN EXAMPLE of the application of battery-operated spot welding machines to mass production is seen in the welding of dust-shield assemblies in the plant of an automobile manufacturer. The parts to be assemblied required 11 spot welds. A double station machine was designed and produced by Progressive Welder Company to handle both right and left hand dust-shield assemblies. The batteries (16 cells, 8 volts) are contained in a housing in the rear center of the machine. To the left are a group of package-type chargers, above which is the charger control. A total of only 30 kilo-volt amperes—balanced on three phases—is required to keep the batteries charged.

In operation, only two "shots" from the batteries are required to complete all 11 welds. The first "shot" produces six welds simultaneously, while the second produces the other five welds. Production is 300 assemblies per hour, with two men to load and unload. With the previous setup, two men could pro-



Dust-shield assembly to be welded



Eleven welds in two "shots"

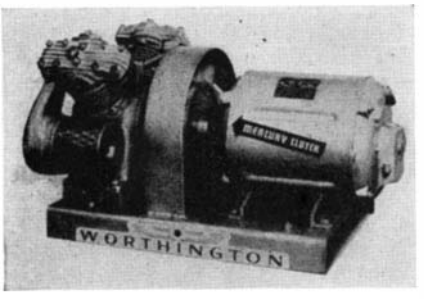
duce only about 125 dust-shield assemblies per hour. The ease of loading the machine reduces the amount of operator effort required, despite the increased productivity. Material is 20-gage cold rolled steel. Parts are dropped into the fixture and the "start" button is pressed. All electrodes come down on the work, with the electrodes acting as clamps. On completing the cycle, electrodes retract to permit removal of the assembly.

Advantages of the battery-operated machines include a decreased line load, and ability to perform a greater number of welds simultaneously.

COMPRESSOR CLUTCH

Permits Automatic Starting Through Delayed-Action Engagement

INCORPORATING a "time delay" factor which retards its engagement for a second or more—long enough to permit the motor to come up to full speed



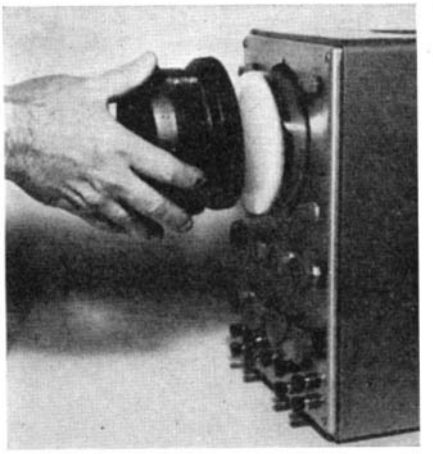
No pressure release valves needed

before any load is applied—a new mercury-activated clutch makes possible the automatic starting of air compressors. The motor is then able to bring to bear its greatest torque, plus the inertia of its rotor to start the load. Motor current is greatly reduced, the starting windings are protected, and the need for pressure release valves is eliminated. Centrifugal force acting on a small amount of mercury in the clutch, manufactured by Mercury Clutch Corporation, produces hydraulic pressure which is dependent upon the "head" of mercury rather than the amount. This pressure is utilized without the use of levers or other mechanical means, to cause the engagement of the friction elements of the clutch.

VERSATILE OSCILLOSCOPE

With Three Interchangeable Ray Tubes To Extend Application

THE FIRST to permit quick interchange of three different types of cathode-ray tubes through the front panel by means of a plug-in connection, a versatile, portable cathode-ray oscilloscope is a general purpose instrument which has been built especially rugged for use in industrial applications. It is constructed of heavy-duty components which will withstand shock and vibra-



Tube plugs in through front of panel

tion. The unit will handle input voltages up to 850 volts peak to peak, and its exceptionally low frequency response permits the observation of wave forms of 0.5 to 300,000 cycles.

Furnished with this oscilloscope, designated Type WO-60C by its manufacturer, the Radio Corporation of America, is a cathode-ray tube of medium persistence for general applications. For the lowest frequencies, however, a long-persistence, flickerless screen is often found desirable. A third tube, having a short-persistence, highly actinic screen, is best for photographic recording without the effect of blurring. The latter two tubes are available as accessories.

The WO-60C permits changeover from one type of cathode-ray tube to another in as little as ten seconds. This is accomplished by merely detaching a built-in light shield, removing the tube, and plugging in another one having the desired characteristics.

PASTE-FORMING RESIN

Easily Processed Without Expensive Equipment

A TRUE polyvinyl chloride paste-forming resin, the first of its type to be made in the United States is a free-flowing white powder with a specific gravity of 1.40. It is easily dispersed in a plasticizer with the use of simple processing equipment. Employing proper heat treatment, articles can be fabricated from the new resin, designated Geon resin 100-X-26, that have the same excellent qualities for equivalent resin-plasticizer ratios to those fabricated from the standard Geon resins.

The principle advantages of Geon 100-X-26 resin, produced by the B. F. Goodrich Company, are ease of processing and the use of conventional equipment. Both of these advantages eliminate, in coating operations, the necessity for heavy and expensive equipment, and the shrinkage of fabrics commonly encountered in water or solvent system coatings.

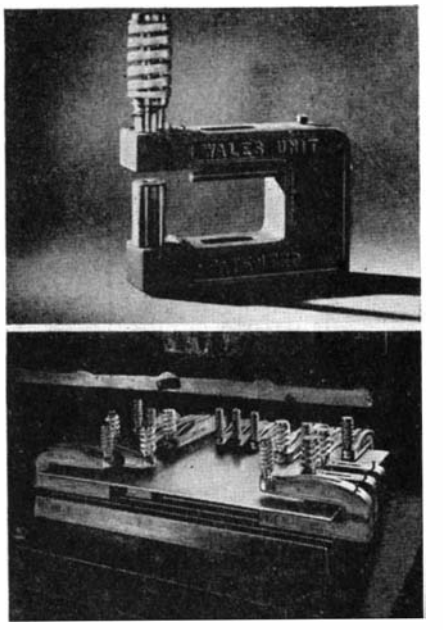
Using the resin-plasticizer formulating method, the fabricator gains the added advantages of 100 percent total solids, no shrinkage of mass due to loss of volatiles, excellent low pressure molding, and thicker coatings with one dip or pass. The inexpensive diluent system gives the advantages of rapid release with no retention of solvents, high total solids, and products fabricated with any degree of hardness.

The ease of formulating and processing with Geon 100-X-26 suggests a variety of applications for the new material. It may be molded, cast, coated, or dipped to produce the same type products commonly made by calendering—or latex coatings. These products include coated paper and fabrics, thin films for curtains or raincoats, and thicker sheeting for upholstery, handbags, and shoes.

HOLE-PUNCHING UNITS

Assure Alinement of Punch And Die, Is Easily Set Up

FOR PIERCING mild steel of thicknesses up to one quarter inch, new hole-punching units have pedestal dies that permit the punching of angles and channels as well as flat sheets. Each unit consists of a holder that carries the punch, die, and stripping mechanism. This design eliminates the necessity of attaching punch to press ram, and assures permanent alinement of



Unit (above) contains die, punch, and stripping mechanism. Once placed in press, setup (below) needs no further adjustments before punching operation

punch and die. Any good mechanic may assemble these punching units into a hole-punching die for operating in stamping presses or press brakes.

Setups are made on T-slotted plates or templates for stamping presses and press brakes. The setup is simply placed in the press and it is ready to start punching with the first stroke of the press without further adjustment of units or punches and dies. The press ram requires only one adjustment regardless of how many hole-punching patterns are placed in operation because of the uniform shut height of

these punches, called the Wales Type "CJ" Hole-Punching Units. These advantages reduce press "down time" between setups to an absolute minimum.

These units are made by the Wales-Strippit Corporation in three holder widths with maximum punch diameter of 7/8 inches.

PAINT DEODORANT

Replaces Traditional Odor With One More Pleasant

PAINTS used in homes, factories, and offices can now be deodorized and given an odor of pine, cedar, or other pleasant fragrances that are barely perceptible. Added by the manufacturer to oil or water paints, enamels, and lacquers, a series of new chemical products, called Paint-O-Dors, primarily neutralize and mask paint odors as the paint is applied and dries. The aromatic mixtures are easy to use, inexpensive, and have no effect on the color, viscosity, drying time, or other qualities of paints. Giving off a slightly fragrant odor when the paint is applied, the aromatic mixtures, produced by Givaudan-Delawanna, Inc., volatilize completely and leave no odor once the paint is dry.

WOOD PREFABRICATOR

Grooves, Glues Pieces for Curved Assemblies Automatically

HAVING adjustable tracks, a new Linderman automatic wood fabricator makes possible the prefabrication of angular or "curved" assemblies. Using the tilting bed of the machine, two pieces of lumber are fed into it from either end. Cutters on the machine automatically trim the edges of the lumber to the correct angle, and cut double-taper dovetails in the edges which are to mate. These dovetails are so designed that when the tongue first slips into the groove as the boards approach each other, the fit is quite loose. As movement proceeds, the fit gradually becomes tighter and tighter, until when completely inserted, a tight wedge fit is obtained.

Prior to the time when the boards join however, glue is automatically spread on the edges, excess glue being automatically removed. As the boards begin to join, the loose fit of the dovetails insures that the glue will be carried into the joint until final position is reached.

An accompanying sketch shows the manner in which the joints are produced on the tilting bed type of machine. The dovetail taper is considerably exaggerated in this view in order to show the principle involved. The strength of the joint produced on the machine, available from the Muskegon Machine Company, is rated by United States Army specifications as being equal or superior to solid wood, the manufacturer reports.

AIR FLOW METER

Accurately Measures Wide Range of Velocities

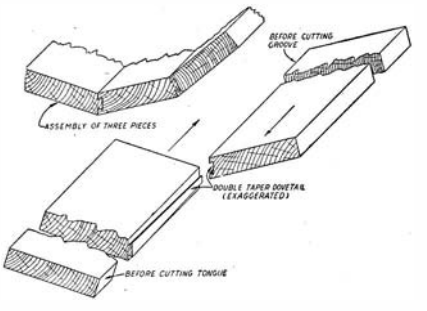
MEASURING accurately air velocities as low as five feet per minute, an ultra-sensitive air velocity meter is applicable to the measurement of velocities in ducts, of wind velocities, and of flow in air and gas lines, as well as surveys of heating and air conditioning systems. The principle of operation is based on a combination of the hot-wire and thermopile principles. This arrangement increases the accuracy of the instrument by minimizing the errors due to air temperature variations.

The pick-up element is a noble-metal thermopile which is placed in the air stream. Alternate junctions are arranged to have much greater cooling than the adjacent junctions which are heated by passing alternating current through the wire. The temperature rise of the warmer junctions is measured by the D.C. thermo-electric voltage generated.

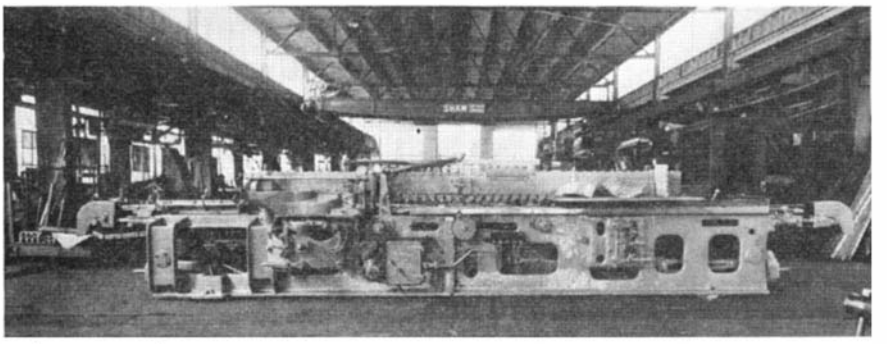
This instrument, produced by the Hastings Instrument Company, operates from 110 volts A.C. power that may be obtained either from the house wiring or from a portable power pack that is battery operated. The instrument may be adapted for remote indication of velocity or flow of air or other gases. The output is suitable for operating standard strip or circular chart electrical recording instruments.

The standard range of the instrument is from 0 to 2000 feet per minute. Fifty feet per minute is approximately 20 percent of full scale.

May be adapted for remote indication



The sketch shows principle of tapering tongue and groove as cut by prefabricator



A Linderman machine for prefabrication of curved or angular assemblies

PHOTOCOPY UNIT

Features High-Speed, Fully Automatic Operation

CAPABLE of turning out twelve 8 by 10, six 9 by 12, or four full-size 18 by 24 inch finished prints per minute, a new self-contained high-speed photocopy unit is fully automatic. A single operator stationed in front of the copy board regulates feeding, cutting of paper, and exposure by a push-button control.

Exposed prints move automatically through the developing, short-stop, fixing, and washing baths, and then on to the two-drum, single-belt dryer. All the processing units are included in one 15 foot long housing, and they can be easily removed individually for simple, rapid servicing. The machine, called Foto-Flo, will blow up copy to double size, or reduce it to half its size; with the aid of a projector, it will make enlargements from microfilm. Power for the unit, a product of the Haloid Company, is 220 volts, 60 cycles, 50 amperes, with a four-wire line required.

METAL ROD CUTTER

For Precision Parting of Round Stock On Production Basis

ACCURATELY cutting, or "parting off," round materials on a production basis

without distortion, a new device is reported to offer high speed cutting of rods and bars, greatly exceeding the limits of high-speed turret lathes and screw machines. Called the Di-Acro Rod Parter, it is available in two models, one taking cold rolled steel bars from 1/32 to 3/8 inch in diameter, the other, bars from 1/16 to 5/8 inch. The numerous holes provided in the cutting head permit selection of the hole of the precise size to part the rod without loss of concentricity.

The cutting heads are of heavy tool steel, properly hardened and precision ground. They are reversible, offering double service, and can be removed easily for resharpening. Roller bearings employed in the multiple lever arrangement assure ease of operation. With this device, developed by the O'Neil-Irwin Manufacturing Company, rods of very small diameter, as well as

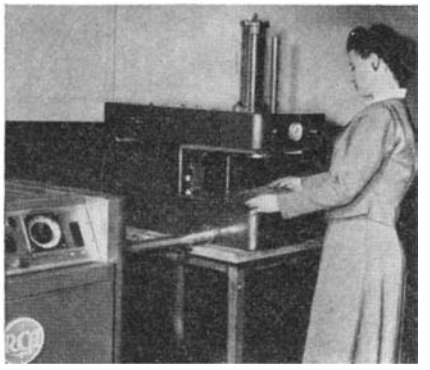
Rods cut accurately

those of larger sizes, are rapidly cut to very close tolerances as to squareness and length, the latter being controlled by a three-way adjustable gage which allows the rods to be positioned quickly and parted with great precision. Although designed principally for use with metals, the parter can be employed also in cutting rods of fiber, wood, rubber, and many types of plastics.

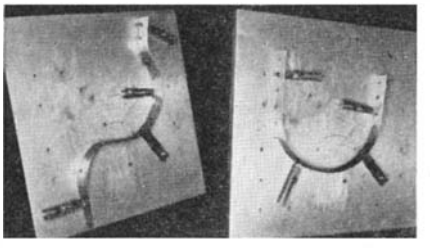
HIGH-FREQUENCY SEALER

Makes Seams of Any Shape Without Machined Dies

DESIGNED for "one shot" bonding of thermoplastic fabrics, a new type of high-frequency sealing press can be adjusted to produce any shape of seal in a thermoplastic material, merely by bending or changing a brass strip (called the die) to fit the desired configuration. This new technique eliminates the need for purchasing the variety of expensive machined dies and die shoes ordinarily required. Seals from 7 to 15 square inches in area can be made in one operation and require only 1 to 4 seconds to complete,



Thermoplastics sealer in operation



"Dies" made of brass strip

depending upon the thickness of the materials to be sealed. It is possible to make seams of any length or configuration that can be accommodated on the platen, which is 14 inches square.

Called the RCA Universal Electronic Sealer, it is especially useful for fabrication of plastics balls, pouches, pocket books, belts, and similar items which will fit on the platen. The device produced by the Radio Corporation of America, may be powered by any high frequency generator similar to the RCA Electronic Power Generator, Type 2 BH. In practice, a generator of this type can supply power to several sealer units.

Dies for patterns of unusual shape can be prepared quite simply. First a wooden pattern of the desired contour is made, and then the die strip is shaped to fit. Strips of copper, brass, or steel may be used as die material. Removal of one die and insertion of a new one requires only the adjustment of a few clamps.

PARTS-CLEANING TANK

Has No Moving Elements, Operates By Compressed Air, Gravity

FASTER and more thorough removal of oil, grease, chips, and other foreign matter that collect on parts during machining, drilling, boring, grinding, and similar production operations is claimed for an automatic, multi-flow, cold tank cleaner which utilizes a new principle of liquid flow action. Actuated by air volume, pressure differential, and gravity, it cleans parts with a combined liquid scrubbing and solvent action. Tiny metered orifices release compressed air which induces a flow of liquid in an inner tank. The cleaning compound is forced under pressure through and around the parts, cutting films from the surfaces and depositing particles in a static sludge compartment. This tank, known as the Turco Turbulator Tank, is efficient in cleaning small parts that are difficult to clean either manually or with ordinary agitated or still tank. Parts are placed in a wire basket whose wide mesh permits free flow of liquid to penetrate even the most inaccessible ports and channels.

There are four models of the tank, made by Turco Products, Inc., capable of cleaning anything from a typewriter to the largest Diesel motor block. Working space ranges from 1 foot 6 inches by 1 foot 6 inches by 1 foot 4 inches to 6 feet 6 inches by 3 feet by 2 feet 10 inches, with working capacity ranging from 52 gallons to 765 gallons.

PRODUCTION-LINE BRAZING

Joins Three Parts of Varying Sizes In A Single Operation

AN INTERESTING metal-joining operation is that by which three parts of a lawn-mower rotor are united in one operation. The parts—spider, drive shaft, and bearing-retainer—arrive at the brazing station cleaned and ready for assembly. The assembler first places four spiders in a ceramic fixture and brushes the center hole of each with flux. A 5/8 inch inside-diameter ring of Easy-Flo brazing alloy made from 3/64 inch diameter wire is slipped on the drive shaft. Next, the end of the shaft and the brazing alloy ring are liberally brushed with flux. A bearing retainer is placed over the shaft end, and the two parts are inserted in place on the spider. The fixture with four such assemblies is then ready for the heating operation.

An induction heating unit with two brazing stations is equipped with jigs for alining and maintaining close tolerances between parts, especially between the drive shaft and bearing retainer. The fixture holding the four assemblies is placed over the heating coils, and all heating is done from the bottom. Heat can be concentrated on the heavier parts—the drive shaft and the spider—thus preventing warping in the lighter gage bearing retainer. With coils so arranged, the brazing alloy is drawn through the joint, bonding the

Three-part assembly at brazing station

parts together accurately and permanently.

With two brazing stations, one heating while the other is loaded, a production of 3840 units has been maintained per eight-hour day in the plant of the Reading Hardware Company.

PHOTOGRAPHIC TRAY

Standing Vertical, Has Separate Sections for Developer, Fixer

ELIMINATING the need for the operator to put his hands in the chemicals, a vertical, splashproof, photographic tray is divided into two compartments, one for developing, and one for fixing. The print to be developed is put in a clamp and lowered into the developer, where it is fully visible through a yellow, transparent front which filters out light harmful to either chemical or print. When development is complete, the operator lifts out the print by holding the clamp, and lowers it into the fixing compartment, which has room for six prints. Special grids guide the papers into the solutions, and prevent them from floating, curling, or sticking to the sides. Known as the Pronto-Tray, it also eliminates the use of chemicals storage bottles, as the cover slides on, and protects the chemicals from light and air. Thus the tray is always ready for instant use.

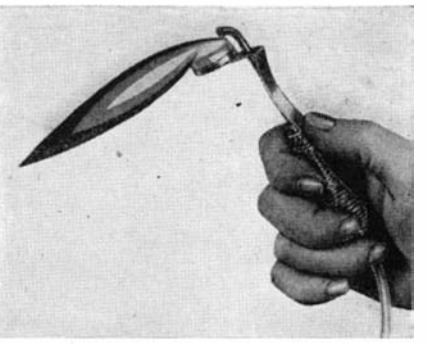
No need for chemical storage bottles

This tray, made by Pronto, Inc., handles prints up to 9 by 15 inches and its overall dimensions are 15½ inches long, by 10 inches high by 5 inches deep. A three compartment model, for developer, stop bath, and fixer, is also available.

SMALL BLOW TORCH

Burns Dry Chemical Fuel In Tablet Form

REPRESENTING a complete departure in design and principle from blow torches now on the market, a new torch uses a dry chemical fuel in tablet form, which eliminates the possibility of spilling, evaporation, or explosion. The torch weighs only a few ounces, is completely



No spilling or evaporation of fuel

portable, and is ready for use at a moment's notice, there being no preheating period. It is equipped with a brass cup to receive the fuel tablets, a brass tube which supports the cup, and an adjustable clip member. The air-cooled handle is formed of nickel plated steel, and the mouth tube is of clear, sanitary, flexible plastics. When in use, only gentle blowing is necessary.

The fuel tablets, known as Super Fuel, are convenient, clean, and inexpensive. Each tablet burns about ten minutes, giving intense heat, leaving the work clean and without residue. They may be extinguished and relighted. Measurements with a thermocouple indicate temperatures in excess of 2000 degrees, Fahrenheit.

The torch, called the Super Jet Blow Torch by its maker, the Birk Manufacturing Company, is suitable for soft or silver soldering, light brazing, annealing, or hardening of small work, finding application with electricians, mechanics, model makers, chemists, dentists, jewelers, and so on.

CO_2 TIRE INFLATOR

Also Serviceable As Fire Extinguisher

WITH two primary functions—inflating tires and extinguishing fires—a strong steel bottle filled with compressed carbon dioxide, and equipped

Tire inflated in four to ten seconds

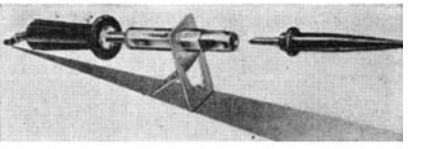
with a control valve to release the gas as desired, is furnished with a short hose so that it can be connected to any standard tire valve. The unit, a product of Beacon Devices, contains a sufficient amount of carbon dioxide to inflate three average tires from flat to safe driving pressure, the inflation taking from four to ten seconds. The gas cannot harm the tire in any way, since it is rated as an effective rubber preservative.

The unit, called Tireflater, extinguishes fires in liquids or vapors, and since the gas is a non-conductor, it is a safe medium for attacking fires in electrical systems.

CORDLESS SOLDERING TOOL

Adapted From Standard Soldering Iron

DESIGNED for intricate work, a pencil-type cordless soldering instrument is well suited to such delicate mechanical operations as the assembly of small



For fine soldering operations

switches, electric meter work, model making, or dental technicians' work.

Called the Kordless Kwikheat, it is placed into operation by replacing the soldering tip of any size Kwikheat electric soldering iron with the heater-receptacle unit, plugging-in. The forged tellurium copper alloy tip holds approximately 680 degrees, Fahrenheit, for nearly one minute, and reheats in approximately 20 seconds by re-inserting into the heater-receptacle, similar to the manner in which a desk pen-set is used. The heater-receptacle and the normal soldering tip are quickly interchangeable in the iron.

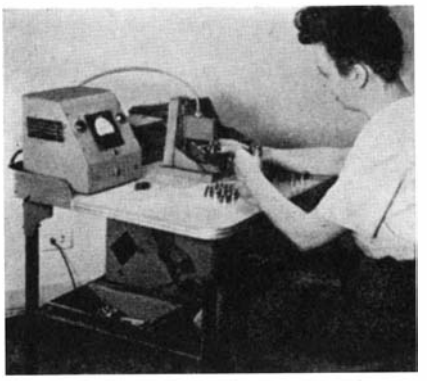
For exceedingly fine work, and without the annoyance of a cord to foul sensitive equipment, the Kordless Kwikheat, manufactured by the Sound Equipment Corporation of California, will speed the soldering work of technicians engaged in the production of intricate parts.

AUTOMATIC SEGREGATOR

Sorts Parts Too Large or Small From Those Acceptable

PERMITTING low-cost, fully-automatic inspection of small parts, an electronic segregator sorts the parts into three classifications: oversize, acceptable, and undersize. Accurate to 0.000010 inch the selector will sort parts with tolerances from + or −0.0001 to + or −0.005 at speeds up to 12,000 parts per hour.

The selector consists basically of three units: the gage head, the master



Speed limited only by rate of feed

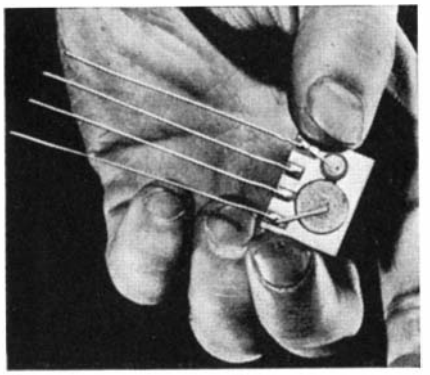
control, and the segregator. The head, where the actual measurement is done, is so designed and constructed as to have no frictional moving parts, no coils, no switches, and no magnets to need adjustment. Because of the unusual electrical circuit, the speed of operation is limited only by the rate at which parts can be fed into the selector. Fully automatic and semi-automatic feed mechanisms are available.

Designated Model DS-20, it comes as a "packaged unit" ready for operation. Besides the gage head, master control, and segregator, the gage head stand, the table, chair, and three tote pans are furnished. The selector is quickly and easily adjustable. By using gage blocks it can be set in a few minutes. Besides having red and green indicating lights, the master control unit has on it a graduated indicating dial gage providing visible readings of the size of each part as it is being sorted. This gage, manufactured by the DoAll Company, is electronically operated and hermetically sealed against dust and moisture.

AUDIO COUPLER

With Resistors and Capacitors Joined By Printed Silver

Two CAPACITORS and two resistors closely bonded to a steatite ceramic plate, and mutually connected by means of silver paths printed on the base plate, comprise a new interstage coupling unit which is no larger than a conventional mica condenser. Because Couplate unit, made by Centralab, mutually connects and supplies all four componets, only four soldered connections, instead of the usual eight or nine, are required to complete the coupling of two audio stages. This reduction in soldering results in increased employee productivity, a decrease in the number of errors in wiring, a considerable saving of space, and a more dependable finished product.

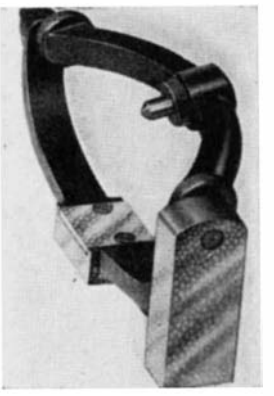


Complete audio coupling unit

GRINDING WHEEL DRESSER

Permits High Accuracy With Minimum Of Skill

EASILY set with gage blocks, inside micrometer, height gage, or planer gage, a precision radius dresser enables even less-skilled operators to achieve maximum accuracy. The radius precision is limited only by the accuracy of the setting devices, tolerances as small as 0.0001 being easily maintained. This dresser, manufactured by the Universal Vise and Tool Company, produces convex, concave, or compound radii up to one inch on wheels up to seven inches in diameter, and can be held either vertically or horizontally on magnetic chucks.



Tolerances of 0.0001 are easily held

PLASTICS FLOOR TILE

Is Long Wearing, Resists Heat, Acids, and Oil

POSSESSING excellent sound absorption qualities, a new laminated decorative plastics floor tile is made from a vinyl compound. The material will be available in a wide range of colors in standard tile sizes of eight and one-half and nine inches square and in sheets 35 inches square. Known as Plastile, it is composed of a 3/32 inch layer of vinyl compound bonded to a 3/32 inch resilient base of synthetic impregnated cork. The natural adhesives in the synthetic resins bond the two plys together. This lamination process gives Plastile a better cushioned action for quietness, with greater resistance to wear under all conditions of foot traffic.

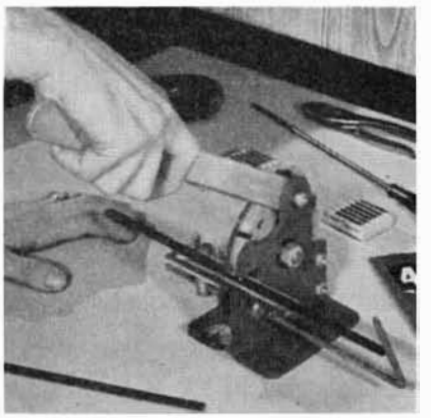
Plastile, product of the United States Stoneware Company, is not affected by

acids, alkalies, oils, grease, abrasion, nor by cleaning fluids, and it is impervious to cigarette burns. It needs no waxing for it maintains a constant shiny surface, and it is a safer flooring, being non-slippery even when wet. Moisture will not cause it to rot, nor will it crack or harden with age. The material will adhere to any surface with ordinary linoleum cement. Plastile's easy bonding, stain-proofness, durability, washability, color range, and flexibility make it applicable wherever there is a need for a heavy-duty floor tile.

COMBINATION BENCH TOOL

Will Shear, Rivet, Form, or Punch

COMBINING four tools in one, a new bench tool will form, rivet, punch, or shear. Sturdily built, all working parts are of heat-treated steel, and all the cutting edges can be sharpened. Three punches (sizes 1/8, 3/16, and



For small-scale metal working

1/4 inch) and two rivet sets, one for solid rivets and one for eyelets, are supplied with the tool. This versatile device, called the 4 In 1—Number 10 Bench Tool by its manufacturer, Ray Lewis Associates, Inc., is especially well adapted to the home workshop or to nearly any small metals working operation. It handles rods to ¼ inch and bar stock to ⅛ by ½ inch.

PNEUMATIC TIRE TOOL

Permits Tire Repair Without Removing Wheel

REMOVING the tire from a motor vehicle wheel without necessitating the removal of either the wheel or hub cap, a new tire tool greatly facilitates tire repair. This tool, designed primarily for fleet maintenance shops, garages, and service stations, operates from the regular compressed air line (100 to 180 pounds pressure). It is shaped like a C-clamp, fitting around the tire, and has two pneumatically operated pushers which rest against the heels of the tire. When air pressure is applied, the two pushers gently but firmly force the heels

toward each other, off the rim into the drop-center, after which the tire can be easily removed.

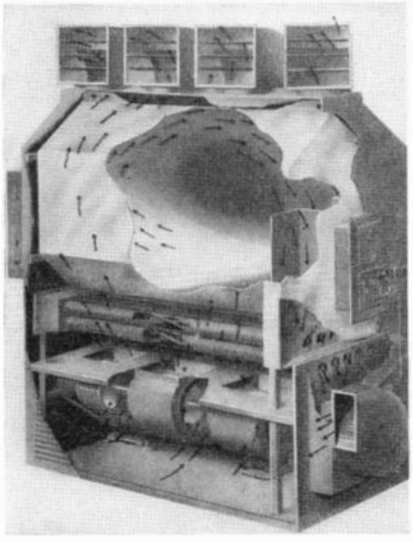
Thoroughly tested and guaranteed by its manufacturer, the H. E. Furman Manufacturing Company, this tire tool is made of sturdy aluminum alloy and weighs only 14 pounds. Called the Vermillion Pneumatic Tire Tool, it is recommended for all passenger car tire removal, including safety wheels, and for light truck tires up to and including 7.50 size, drop-center.

DIRECT-FIRED HEATER

With Unlined Combustion Chamber Reaches High Efficiency

DEVELOPED for commercial and industrial application, a direct-fired heater is equipped with a stainless-steel combustion chamber which resists the oxidation that causes low efficiency and early failure. Refractory lining, which has always been considered necessary with carbon-steel chamber construction, is eliminated, and the resulting compactness and lighter weight makes possible a much wider range of applications. For instance, suspended heaters may be located in the building roof trusses, either vertically or horizontally, depending on the head room, and they can be used by building contractors to provide temporary heat during construction and later moved to permanent positions in the finished structure. Installation of the burner, manufactured by Dravo Corporation, is very simple, requiring only fuel line, power line, and vent stack. They can be arranged to utilize either gas or oil as fuel, and can be readily converted from one to the other.

In this type of heating, warm air is discharged horizontally above the workers' heads at a flow rate of about 2000 feet per minute. This enables wide floor areas to be covered without the use of ducts. The flow rate of the returning air, coming from all directions, is so low that there is no appreciable draft even a few feet from the heater. This method of recirculating the air at working levels provides maximum worker comfort and minimizes heat losses through the roof.

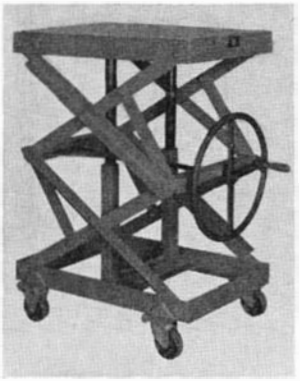


For use with either gas or oil

ELEVATING TABLE

Easily Maneuvered, Can Bear One Ton Load

MADE of steel throughout and designed to safely lift and carry a load of 2000 pounds, a portable industrial elevating table is sturdily and simply built. With a maximum height from the ground of 43 inches, and a minimum height of 26 inches, the top is moved 3/8 inch with each revolution of the hand wheel. The table is equipped with two stationary casters, and two ball-bearing swivel casters, making it easily maneuverable. Manufactured by Montgomery and Company, Inc., the table is ideal for a great many types of heavy parts and materials handling.



Sturdily and simply constructed

SOUND REPRODUCER

Cuts Grooves In Plastics Tape For Long Recordings

CAPABLE of up to 11 hours of uninterrupted recording, a new sound recorder and reproducer was developed specifically for making continuous and permanent records of meetings, interviews, conferences, table discussions, and so on. Because of its sensitive microphone and amplifying system, the instrument can pick up sound within a radius of up to 100 feet.

Sound is recorded by a stylus cutting a continuous groove on an endless loop of cellulose tape .003 inch thick and 16-mm in width. The machine's low operating cost (an estimated five cents per hour of recording) is attributed to the fact that up to 100 parallel grooves may be cut in a single tape. Play-back, accomplished by the recording stylus, can be instantaneous, and over 800 play-backs from the same tape are possible. This recorder, called Filmgraph, is made by the Miles Reproducer Company, Inc., to operate on 100 volt, 60 cycle power, although models for other voltages are available.

The Editors Recommend

Best Sellers In Science

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

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**

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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.)

KLEENKUT, a four-page folder, outlines the typical applications of KleenKut, a laboratory controlled water-mix cutting oil, and describes the proper method for mixing with water. *D. A. Stuart Oil Company, Ltd., 2729-39 South Troy Street, Chicago 23, Illinois.—Gratis.*

CLEANING PROBLEMS SOLVED is a series of booklets describing the applications of Wheelabrator airless abrasive blast-cleaning equipment in gray iron, steel, and nonferrous foundries, and in heat-treat and forge shops. Each booklet deals with a specific type of industry, giving the applications of the equipment in that industry. *American Wheelabrator and Equipment Corporation, 555 South Byrkit Street, Mishawaka, Indiana.—Gratis.*

INFRA-RED AND ULTRA-VIOLET PHOTOGRAPHY is a revised data book which includes the latest available information on these phases of photography. *Eastman Kodak Company, Rochester 4, New York, or your Kodak dealer. —25 cents.*

ASBESTOS—THE SILK OF THE MINERAL KINGDOM, by Dr. Oliver Bowles, chief of the Nonmetal Economics Division of the United States Bureau of Mines. Published as a source of information and background, this 40-page booklet presents the history of asbestos up to and including modern methods of manufacture and the various types of products in which it is used. *The Ruberoid Company, 500 Fifth Avenue, New York 18, New York.—Gratis.*

CASCO GLUING CHART is a new edition of a chart which describes the required properties of glues for various jobs and lists the glues recommended for each. Glues listed are: Casco Powdered Casein Glue, Cascamite Powdered-Resin Glue, Cascophen Resorcinol-Resin Glue, and Casco Flexible Cement. *Casein Company of America, Division of the Borden Company, 350 Madison Avenue, New York 17, New York.—Gratis.*

MODERN GAS CARBURIZING PROCESSES AND EQUIPMENT. This 16-page bulletin is a comprehensive compilation on modern gas carburizing — how it is accomplished and its related processes of suspended carburization, carbon restoration, and dry cyaniding. *Surface Combustion Corporation, Technical News Bureau, Toledo 1, Ohio. — Gratis.*

CAREER OPPORTUNITIES IN AVIATION, A Handbook of Vocational Information. Prepared by the National Council of Technical Schools, this 31-page pamphlet defines almost all occupations in

every branch of the aviation industry, and presents accurately duties, qualifications, and opportunities. This booklet is optimistic, but reasonably so. It will be of aid to all interested in aviation as a career. *National Council of Technical Schools, 839 17th Street, N.W., Washington 6, D. C.—Individual copies, 15 cents.*

LIFE THROUGH THE AGES, by Will E. Burnett, is a visual approach (mainly pictures) to the general story of living things in the earth's long past, with a remarkable table of time periods. It is non-technical, popular, and evidently intended to inspire the youth, but adults would find it equally fascinating. *Stanford University Press, Stanford University, California.—$1.00.*

MACHINE TOOLS FOR EVERY MACHINE SHOP AND WORK SHOP is an eight-page bulletin illustrating and describing time-saving bench machines for industrial and home shop use, including: inclinable punch presses that stamp, crimp, mark, punch, rivet, and form; milling machines that are easily converted from a vertical to a horizontal miller; and bench machine accessories such as rotary tables, collets, and swivel vises. *Benchmaster Manufacturing Company, 2952 West Pico Boulevard, Los Angeles 6, California.—Gratis.*

THE STRUGGLE FOR ATOMIC CONTROL. Written by William T. R. Fox, Associate Professor of Political Science at Yale University, this 32-page pamphlet explains the necessity for international control of atomic energy and traces the efforts of the United States and the United Nations towards an effective control system. A useful and very readable guide. *National Committee on Atomic Information, 1749 L Street, N.W., Washington 6, D. C. — 20 cents.*

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By Daniel Starch

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Telescoptics

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

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

IN THE APRIL number, Dave Broadhead, Wellsville, N. Y., a leading member of the war-time Amateur Roof Prism Gang, described his "moist" technique of mirror figuring and in June told how he made a pair of matched 36" mirrors. In July his modified Draper machine was described, and this month he gives compact working instructions for operating such machines with subdiameter tools. Except for fragments in Ritchey's classic book now out of print and rare, and a valuable paragraph by Ferson in "A.T.M.A.," page 84, (printings since 1944, June) nothing has been available to give the owner of a Draper machine his start in life. What follows will therefore be valuable. By Broadhead:

NEARLY all machines used in precision optics are basically related to the Draper, with the following characteristic adjustments:

1) Rotating table, very slow—½ to 3 r.p.m. according to size of work, speed being governed by optimum balance of accomplishment against heat.

2) Reciprocating arm driving tools over work (stroke, *S*, Figure 1) at rate several times that of turntable—perhaps 5 to 1. Means to vary the length of stroke.

3) Means to vary the offset, *O*, or average path distance of the reciprocating arm from the center of the work.

4) Means to de-center, *D*, the driving pin so that more of the stroke takes place on one side of the center of the work than the other—usually only a fraction of an inch.

5) Variable ratio (cone pulley, for example) drive, so that speed of machine can be adjusted to size of work.

It is convenient to designate sizes of grinding and polishing tools, also stroke lengths and offsets, in abstract terms of decimal fractions of the size of the disk being worked. Thus, discussion becomes applicable to any size of work.

The discussion which follows will be confined to the tool on top method.

A good grinding tool should be channeled. It should be driven by a pin which bears deep down, close to the working surface, to reduce tilting thrust. Most important of all, it should be possible to *choose* a tool of such size that stroke can be balanced against overhang at will and thus gain fairly evenly distributed abrasion over the entire work, as will later be explained. Roughing tools of 0.66 (2/3) work diameter, and finishing or "truing" tools of 0.83 (5/6) work diameter, are strongly recommended. Their use is common practice. My tools are made by cementing blocks of glass on a steel backing but, instead of making the two tools described, I make only one, of 0.83 diameter, and make the outer ring of thinner blocks so as, by normal grinding down, to contact the work about when it would be desired to shift from the 0.66 to the 0.83 size. If this shift happens too soon it is easy to grind off the outer ring on a grinding disk or even on a wet grindstone.

The roughing tool is used with a stroke which passes near the center of the work and extends so that the edge of the 0.66-diameter working part of the tool just passes over the edge of the work. This tool is used with the coarsest abrasive until *full* depth of sagitta is reached. Sagitta should be measured with a spherometer having micrometer dial indicator—an inexpensive one is good enough for average needs—or one having a micrometer movement.

When full depth is reached the outer

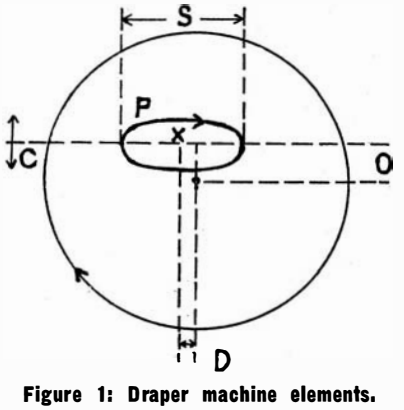

Figure 1: Draper machine elements. *S*: Stroke length. *O*: Offset. *D*: Decentering of drive pin. *C*: Small changes to help clean up zones. *P*: Path of drive pin. *X*: Center of ellipse described by pin on arm

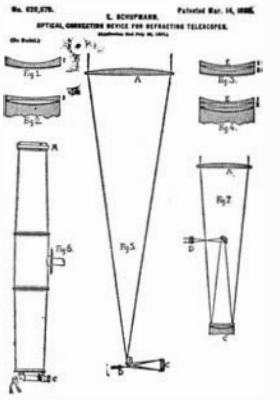

Figure 2: From the patent

ring of glass blocks should start working, now an 0.83 tool. If it does, the stroke (*S*, Figure 1) is readjusted to about 0.35 diameter and the offset, *O*, to about 0.2. If, however, the outer ring of blocks does not yet hit it will be necessary to take a longer stroke—say 0.5 stroke and 0.3 offset—to hold the sagitta fixed till all the blocks are grinding.

We are still using coarse abrasive. Now assume we have run a wet or two with 0.35 stroke, 0.2 offset, and with the 0.83 circle of blocks all working. We read the spherometer and note whether we are deep or shallow. If too deep we

Figure 3: Schupmann experiment

run with 0.5 stroke and 0.3 offset to shallow the curve. If too shallow a very short 0.2 stroke with 0.1 offset will deepen it a bit. Still on same grade of abrasive.

When finally we have the right depth we change to next grade of abrasive. We must now discover the *exact* combination of strokes that will hold the desired depth of sagitta. This is very important. It is about the only "secret" I know. It is important because it is the combination of strokes which, after shaping has been accomplished, will yield and *hold* a sphere (Dévé's "condition of uniform wear." Dévé, "Optical Workshop Principles") without resort to guessing and other monkey work; while work whose radius is constantly being changed is having the center or else the edge ground faster than the other and therefore has differing zonal radii. True, an approach to uniform wear, an oscillation around a sphere, may be had by working half time erect, other half inverted. But an 0.83 tool is enough smaller than the mirror so that the stroke can be made concaving, convexing, or neutral, at will. Since machines and workers differ, it is difficult to state an exact set of ratios that will yield a sphere. Start, perhaps, with an 0.3 stroke and 0.2 offset and after each wet measure the sagitta.

Don't change to the third grade of abrasive until, by small changes in the adjustments, you have found the neutral position accurately. When you have it, grind and polish by it.

When polishing flats this "condition of uniform wear" works at its nicest refinement, a flat being a sphere having infinite, fixed radius. On a flat every slight change in stroke and offset is

made evident—usually painfully so.

Final polishing for a sphere should be done at much slower speed, about 8' per minute polisher travel, than in grinding: heat. Close, tight contact should be held at all times.

Parabolize with small star tools, using great caution since a machine cuts fast. Overcorrect a little, then run the 0.83 lap a few moments (after careful pressing) on the neutral stroke to reduce the correction and smooth the figure. O Hell, it's late and I've got to go to bed.

End of Broadhead's notes.

Of course, after you get your hand in you will begin formulating your own rules which will probably differ, just as you differ. These then will be the correct rules—for you. The idea, often encountered, that there must somewhere be a single correct method in everything optical is hogwash.

THE SCHUPMANN telescope seeks a parent. Joseph Dwight, Hyannis, Mass., writes:

In 1899 Ludwig Schupmann, a German, was granted U. S. Patent 620,978 for the telescope that bears his name. It has the closed tube and long focus of the refractor, and the convenient view and short tube of the reflector. Imagine a conventional Newtonian, with a concave lens of crown glass resting on the mirror, and a convex lens of the same crown glass at the top of the tube, and you have the Schupmann, as in 7 of the patent illustration, Figure 2. The concave lens corrects the color error of the convex lens, and the mirror keeps the rays convergent in spite of the concave lens. The concave lens and the mirror may be combined in a concavo-convex lens, whose convex lower surface forms the mirror, as in 1. The separate mirror and corrector are shown in 2.

It seems that no one has taken the trouble to design a completely satisfactory Schupmann and that, perhaps for this reason, no completely satisfactory Schupmann has yet been made. It is therefore worth while to give the dimensions of a Schupmann which gives a good degree of magnification, though the field is small.

The lenses are of rolled optical plate made by the Pittsburgh Plate Glass Co. N=1.52, V=58.8. The objective and corrector have the lower face plane, and the radii of their curved faces are 58.4" and 26" respectively, and that of the mirror is 56.8". The distance from objective to corrector is 58.75", and that from corrector to mirror is 0.55". These distances are measured between the edges. The diagonal is very close to the objective, and therefore not as in 7. The advantage of a separate mirror is that the mirror, if it has too shallow a curve, can be placed farther back of the corrector. If the corrector and mirror are combined in one lens, the curves must be exactly right. All previous makers seem to have submitted to this handicap.

I used 8" disks, which exactly fitted a strong paper tube. This facilitated accurate alinement, which is essential. The objective was stopped down to

6", and the focal length was probably about 150". A 1" monocentric eyepiece gave an actual field of about 12'. As the tube was not mounted, an unsilvered diagonal was used, and only the moon was observed. The color correction seemed satisfactory, and the definition very good.

I believe that this telescope is superior to the Newtonian for magnification, owing to the great focal length and the closed tube. And the protected position of the silvered or aluminized mirror should be noted. The field probably has considerable curvature, but with a small field this is not very objectionable. It is, however, perhaps the chief fault that a designer should try to eliminate. I should add that my lenses were repolished by Mr. G. E. Gordon, a skilled amateur, of 6 Franconia Avenue, Natick, Mass.

Perhaps the easiest way to make a Schupmann would be to grind a plane mirror on the plane face of the objective, and an equi-concave corrector on the convex face. If the silvered plane mirror is placed at the bottom of the tube, the lower face of the corrector will act as the concave mirror. This combination can be tested on the moon and, even if not satisfactory, it will probably help one to estimate the best curvature for a concave mirror to replace the plane. It may then be necessary or desirable to give the corrector non-reflective coatings. Should the focal length of the objective be found inconveniently short in relation to that of the corrector, which I think unlikely, it can be lengthened till the proportion is the same as in the actual Schupmann described above. And the mirror can be made to correspond.

When the lenses of a Schupmann are correctly spaced, the image of Venus, both inside and outside focus, will be pure gold. The objective should be permanently fixed, and the corrector and mirror should be adjustable as a unit. If this unit is tilted, one edge of the moon's image will be reddish, and the opposite edge bluish. The moon's brightest crater, Aristarchus, should be colorless.

My telescope shows that the Schupmann should not be condemned because the first attempts were failures, and that high-priced optical glass is not absolutely necessary. But ordinary plate glass or Crystallex are not recommended. And it will be safest to begin with an $f/25$ telescope.

Figure 3 shows the tube in a very crude mounting, used when I first experimented with this telescope, and is from Scientific American, 1943 April. The present tube has the lenses repolished and relocated, and they now give a much better image. The tube is, however, unmounted, as I prefer to give my limited skill and energy to the making of an 11½" Schupmann having an equi-concave corrector, which I have begun. I hope that someone with more skill will make and mount a good Schupmann, and that some designer will show us how to get as good achromatism and as flat a field as possible. But I think the design given needs no apologies, provided alinement and adjustment are good.

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