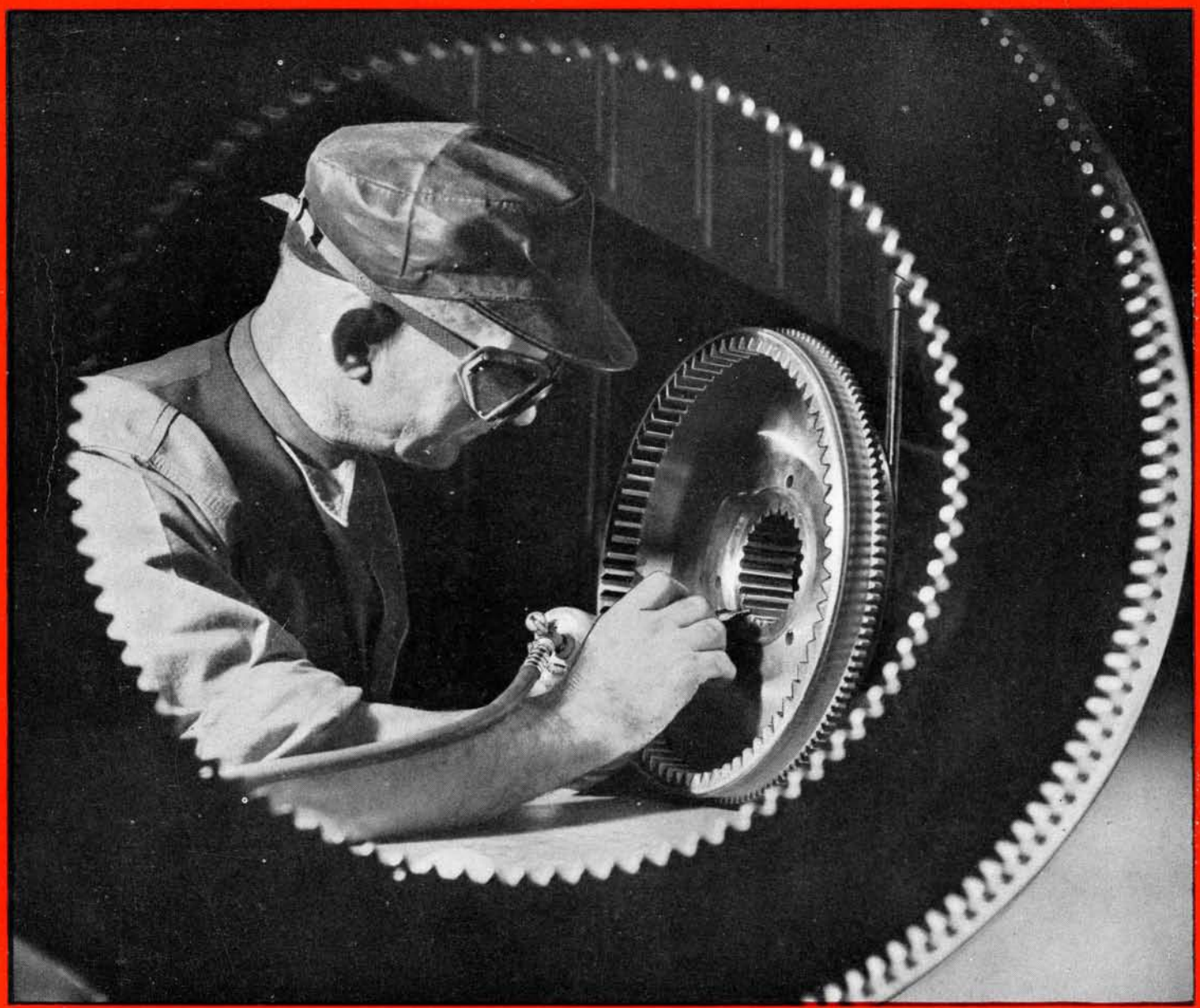
Scientific American

DECEMBER
1943

35 Cents
a Copy
50c in Canada

REPORTING THE PROGRESS OF SCIENCE AND INDUSTRY



Skilled Hands of the Aircraft Industry . . . See Page 241

He'll be judge and jury, too

WE'LL ALL BE ON TRIAL when Arch comes home. We will be facing the man who lived through the hell of battle for us.

What shall we say to him? What will he think of us?

That depends on what we do now—how well we carry through the work that Arch left for us to take care of.

Arch hasn't any elaborate post-war plans. Most of his energy goes into the fight at hand. But there are times when he dreams about coming home—and he figures there ought to be a peacetime job—a job with opportunity—waiting for him in a decent community.

In the meantime, he relies on us.

We'll answer to him if we fail to do our utmost to provide the tools and materials he needs to win, with a fighting chance to come home in one piece.

And we'll answer to him if his country and his community are not the sort of places he expects them to be.

★ ★ ★ ★ ★ ★ ★ ★ ★

Published by

ETHYL CORPORATION

Chrysler Building, New York City

ETHYL
BRAND OF ANTIKNOCK COMPOUND
ETHYL CORPORATION
TRADE MARK REG. U.S. PAT. OFF.

Our war job is making Ethyl fluid for improving the antiknock quality of fighting gasolines.

Scientific American

Founded 1845

CONTENTS • DECEMBER 1943

COVER: Framed in the lights and shadows of a Wright Cyclone-14 warplane engine gear, is our front cover profile of a modern Rembrandt geared to 20th Century wartime production. This skilled worker in a plant of the Wright Aeronautical Corporation is guiding a high-speed rotary burr over the edges of another reduction gear which soon will harness 1700 flying horsepower. With the skill of an artist, this worker is delicately removing sharp edges without changing the gear's profile even minutely.

SCIENTIFIC AMERICAN, December, 1943. Vol. 169, No. 6. Owned and published by Munn & Co., Inc., Orson D. Munn, President; I. Sheldon Tilney, Vice-President; John P. Davis, Secretary-Treasurer; A. P. Peck, Assistant Secretary; all at 24 West 40th Street, New York 18, N. Y. Entered at the New York, New York, Post Office as second class matter June 28, 1879, under the act of March 3, 1879. Additional entry at Orange, Connecticut. Published monthly by Munn & Co., Inc., 24 West 40th Street, New York 18, N. Y.

Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage. Illustrated articles must not be reproduced without written permission; quotations therefrom for stockselling enterprises are never authorized. Files in all large libraries; articles are indexed in all leading indices. Subscription rate $4.00 per year. Canada and foreign $5.00.

A message for you...from 1953

(Today, John Jones is just an average American, wrestling with all the doubts and worries and problems that beset every one of us right now. But let's skip ahead 10 years. Let's look at John Jones* then*—and listen to him . . .)

"SOMETIMES I feel so good it almost scares me.

"This house—I wouldn't swap a shingle off its roof for any other house on earth. This little valley, with the pond down in the hollow at the back, is the spot I like best in all the world.

"And they're mine. I own 'em. Nobody can take 'em away fromme.

"I've got a little money coming in, regularly. Not much—but enough. And I tell you, when you can go to bed every night with nothing on your mind except the fun you're going to have tomorrow—that's as near Heaven as a man gets on this earth!

"It wasn't always so.

"Back in '43—that was our second year of war, when we were really getting into it—I needed cash. Taxes were tough, and then Ellen got sick. Like almost everybody else, I was buying War Bonds through the Payroll Plan—and I figured on cashing some of them in. But sick as she was, it was Ellen who talked me out of it.

" 'Don't do it, John!' she said. '*Please* don't! For the first time in our lives, we're really saving money. It's *wonderful* to know that every single payday we have *more* money put aside! John, if we can only keep up this saving, think what it can mean! Maybe someday you won't have to work. Maybe we can own a home. And oh, how good it would feel to know that we need never worry about money when we're old!'

"Well, even after she got better, I stayed away from the weekly poker game—quit dropping a little cash at the hot spots now and then—gave up some of the things a man feels he has a right to. We made clothes do—cut out fancy foods. We didn't have as much fun for a while but we paid our taxes and the doctor and—we didn't touch the War Bonds.

"We didn't touch the War Bonds then, or any other time. And I know this: The world wouldn't be such a swell place today if we had!"

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

SCIENTIFIC AMERICAN

Previews of the Industrial Horizon

By A. P. Peck

BRIGHTENING THE HORIZON

FLUORESCENT lighting, just coming of age at the start of the war, has amply proved itself as an efficient method of illumination in factories and offices throughout the nation. But the surface of possibilities had barely been scratched when practical needs of the moment demanded rapid production for established uses, halting developments along avenues still to be explored. The basis of fluorescent lighting is found in tiny crystals (called phosphors) which, acted upon by invisible ultra-violet rays, give rise to visible light of controllable color and intensity.

A glimpse of the future of phosphors in varied lighting uses is given by a chemico-physicist of RCA Laboratories in the following statement: "Phosphor crystals will display news and entertainment on the screens of our television sets which may be tuned by the light from phosphors in 'Magic Eye' tuning indicators. Kindred phosphors in the screens of microscopes will aid in fathoming the mysteries of bacteria and molecules in order to insure a healthier and happier life for all.

"Other possible uses for phosphors include intense light sources for sound recording and theater projection; indirect illumination wherein the very walls, ceilings, and murals luminesce to illuminate as well as decorate the room; luminescent plastics in thousands of forms to make night-time safer and more colorful; and phosphors emitting specific radiations for treatments of living tissues and organisms."

THE LOST IS FOUND

WHEN main emphasis in technology is being placed on new processes, new developments, it is a bit startling to find an old method of accomplishing a given end being applied with outstanding success to modern precision work in industry. But that is just what has happened in the case of the lost-wax casting process described in detail on page 259.

Much work in metals requires operations to close tolerances. Such tolerances, of an order formerly attained only through precise machine operations, are now being met, in the case of small parts, by the use of modernized lost-wax casting methods. That these new versions will find increasingly wide application in small part production, giving rise to outstanding economies in materals, time, and machine tools, is a future possibility that is well-nigh assured.

BACK TO PEACE

AS HAS been predicted in these pages in past issues, the material benefits of scientific and technological developments made possible by the progress accomplished under the forced draft of military production will eventually reach the general public. This, however, will not take place, by any means, in a matter of days, weeks, or, in most cases, even months. The first post-war industrial production problem will be to turn out goods to meet the needs of a war-restricted nation just as rapidly as possible. To accomplish this will mean resuming production of consumer goods about where it left off when industry went all out for war, and then gradually incorporating those new designs, materials, methods, and so on that have accumulated in the vast reservoir of industrial "know-how."

Confirmation of these predictions is to be found in the attitudes toward the resumption of consumer goods manufacture after the war which are held by two typical companies.

Thus a spokesman for Westinghouse has stated that they plan to resume production of electrical appliances for the home within a few weeks after the war, but that no revolutionary changes in design are anticipated during at least the first year of peace.

In the automobile field, General Motors assures us that they will be able to start production on cars for civilian use within 60 days after the war. These cars, however, will be essentially the same as those which were being manufactured when hostilities forced the industry to convert to full-time military production. Along with this assurance came a carefully worded prediction that, starting with a blank sheet of paper, it would take two years to design and place into production a complete new automobile.

DIVERSIFICATION

A STRAW in the wind of post-war industrial planning is to be found in a recent announcement by a large manufacturer of a wide diversification of interests which will go into effect after the clouds of war have passed from the face of the sun of freedom. Thus, instead of concentrating largely in the radio field, the Crosley Corporation will expand its activities in the lines of home refrigerators and gas and electric ranges and will produce room coolers, frozen food cabinets, and television equipment.

By this diversification it is expected that outstanding economies in distribution will be effected along with increased manufacturing efficiency. This is no case, however, of the shoemaker straying from his last. Rather it is an example worthy of emulation of a shoemaker who applies his skill to include boots as well. It will be noted that the Crosley plans include products in allied fields, where knowledge gained in one phase can be applied beneficially in another.

MEDICAL MARVEL: CHEMICAL CHALLENGE

SAD, at times, are the results of premature and non-critical publicity given to developments of science before the developments have reached a point where the promises stated or implied in the publicity can be met. A case in point is penicillin. Here, undoubtedly, is a medical marvel, but one that still must surmount the long, steep hill of extensive clinical research before its true nature and possibilities can be charted. Furthermore, and equally important, penicillin presents to the chemical industry a production challenge of a magnitude never before faced under the trying circumstances of life-or-death demand. When the chemical industry has solved this tremendous riddle, detailed in the article on page 247, it will have added the brightest jewel of all to a crown already studded with brilliant gems of past performances.

TECHNOLOGY VERSUS POLITICS

WHEN the very important and absorbingly interesting subject of post-war competition between synthetic and natural rubbers is being considered, it must always be kept in mind that here is at least one field where the technologist may not reign supreme. No matter how good for how many purposes, or how inexpensive to produce, may be the synthetic rubber of the future, the politician is very likely to have the last word. Natural rubber, long a juicy plum for international politics, will, when trade is once more established with the Far East and when Latin American rubber plantations are more fully developed, be brought forcefully into the over-all picture. Exactly what is just over the rubber horizon cannot, of course, be foreseen as yet. But that the synthetic rubber industry will have an all-out battle on its hands, with campaigns extending into the inner recesses of political intrigue, is as sure as death and taxes.

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of November, 1893)

WATER-POWER — "The Cataract Construction Company has recently awarded to the Westinghouse Electric and Manufacturing Company the contract for building the immense generators, et cetera, for the . . . plant at the Falls. . . . The apparatus will be built in units of 5,000 horse power. . . . The weight of the shaft, turbine and armature is to be carried by the upward pressure of the water columns producing the heads for the turbines. The electro-motive force generated will be 2,000 to 2,400 volts, and will be increased by step-up transformers for long distance transmission and lowered by reducing transformers for distribution. The motors will be the two-phase Tesla motors, which have been found to be well adapted for power purposes."

LIFE-SAVING — "Our life-saving service is admirable in many respects. Its use of light surf boats in place of the heavy life boats used in England is characteristic. The English type could not be launched from our sand beaches. The same thing operates against the use of steam life boats. But where a coast is so notoriously unsafe as that bordering on the bay of New York, it would seem possible for the life-saving department to maintain a steamer ready for instant call to the relief of a distressed vessel, anywhere from Montauk Point to Barnegat. It would also seem possible for more powerful line-throwing apparatus to be provided."

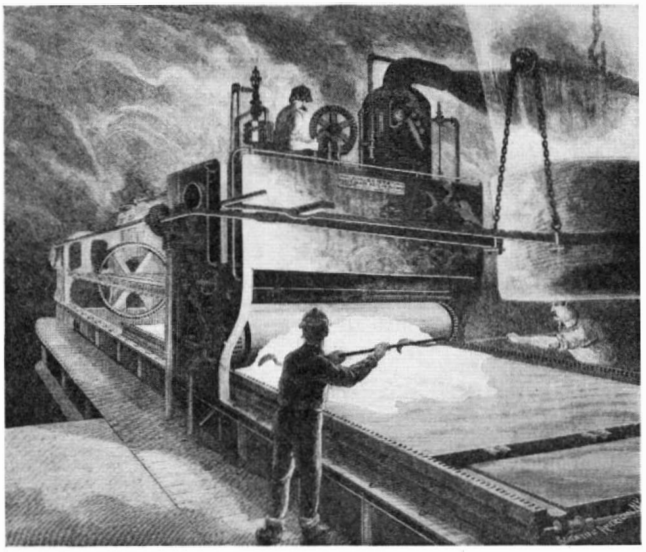
CARBORUNDUM — "From the experiences of the Carborundum Company, crystallized carbide of silicon can be produced at the rate of 150 pounds on the average in a day of 24 hours. The cost of the production is found to be not more than half as much as that of mining and preparing corundum. . . . The chief use to which Carborundum can be put is abrasion purposes. The extent to which emery wheels are employed in factories, mills, and shops has grown most astonishingly, and it is intended that Carborundum should in a large measure supplant the use of emery wheels, on account of its higher efficiency."

EXPLOSIVE — "Plastomenite is the name given to a new kind of smokeless powder invented by Herr W. Guttler. The solution is poured into forms, where it becomes a fairly hard substance, capable of being pressed, rolled, etc. . . . Plastomenite is used for blasting powder, powder for cannons and rifles, signal rockets, etc. . . . The initial velocity from a six and one-half millimeter caliber is 715 meters with a gas pressure of considerably below 3,000 atmospheres."

CAMERA — "A complete little photographic camera, an American invention, eclipses for compactness and novelty anything of the kind that has come under our notice. It resembles in outward appearance a nickel-plated watch, and is readily operated with one hand. The lens is rather minute and of fixed focus, but still makes a sharp, small picture which can be subsequently enlarged four or five diameters."

LIGHTING — "In endeavoring to improve the lighting of his shops at Bolton, Mr. B. A. Dobson naturally turned to electricity. . . . When traveling on the Continent, Mr. Dobson visited some cotton mills, and here he found what seemed a very perfect system of illumination. Arc lamps were used, but they were placed in an inverted position to that which is usual, the negative carbon being above and the positive carbon below. This, of course, threw the greater part of the light rays upward, as most of the illuminating power proceeds from the crater of the positive carbon. The ceiling is kept well whitewashed, so that the light thrown up is again reflected downward. The sides of the room are also whitewashed, in order that a reflection may come from them. The result is that, without any definite source of illumination being observable, the whole room is flooded with a well-diffused light."

GLASS — "We illustrate an improved glass-rolling machine, one presenting striking features of novelty and ingenuity. . . . Its base, built up of plate girders, provides two parallel roller tracks on which the iron and steel bed for



supporting the glass while being rolled traverses back and forth. . . . Duplicate beds on which the glass is rolled are provided, flat tables of metal, one of which only is in the traversing position at a time, the second bed being supported in the rear of the machine in an inverted position, some distance above the traversing tracks. . . . The roller begins to turn, and the end pinions operating on the racks draw the bed and glass toward the rear of the machine under the roller, thus rolling out the molten mass into a plate. When the rear of the machine is reached, the roller is stopped; the upper bed is lowered on top of the hot glass, and the two beds are clamped together. They are then raised, the glass being held between them, and rotated. . . . As soon as the horizontal position is reached, the beds are lowered again on the bearers; the upper one, on which the glass was rolled, is lifted, the roller is started in reverse motion and the plate is drawn back again beneath it, so that the glass is rolled upon the other side."

LIQUID AIR — "Professor Dewar has successfully conveyed a considerable quantity of liquid air from London to Cambridge. The liquid air was carried in one of the double glass, vacuum jacketed flasks, the space between the inner and outer flask containing nothing but extremely attenuated mercurial vapor, together with a little liquid mercury. On pouring liquid air into the inner flask its outer surface is rapidly covered with a mercurial film of extreme thinness, forming a reflecting surface highly impervious to radiant heat."

TELEGRAPHY — "The use of primary batteries in telegraphing has mostly passed away and the dynamo, with its greater steadiness of current and economy, is now employed. . . . In the Western Union Company's Boston office the current is taken in a commutator on one side of the machine, and sent out from a commutator on the opposite side, the transformation being effected by two different windings on the armature."

METEOROLOGY — "One of the most interesting experiments with balloons that has ever been undertaken was that of Messrs. Hermite and Besancon, at Paris-Vaugirard. They succeeded in sending a balloon to the unprecedented elevation of 16,000 meters, or about 10 miles. There were no people in the balloon, but it carried a variety of self-registering instruments designed to record the temperature, the atmospheric pressure, et cetera."

PLEASE LIMIT YOUR CALL TO FIVE MINUTES

When a Long Distance circuit is crowded the operator will say: "Please limit your call to five minutes."

Observing this time limit on essential calls, and avoiding all unnecessary calls, will help the whole war effort.

BELL TELEPHONE SYSTEM

"Quotes . . ."

"CONSERVATION must be carried on until every Axis nation is subdued and the world can be assured of a lasting peace. And after peace there will be the problems of reconstruction for the war-torn countries, which will require conservation for their solution. And after peace and reconstruction there will remain the age-old problems of enough to feed, to clothe, and to shelter all mankind. Conservation is eternal." Howard Coonley, Chairman of the Conservation Division, War Production Board.

" " "

"THE PROFITS we are most interested in are those the public gets from using the commodities that industry produces. After all, the only real profit is the general benefit. . . We never have believed that we could be prosperous alone. Real prosperity is prosperity for all." *Henry Ford.*

" " "

"THE MACHINE tool industry is not greatly concerned about its situation during the remaining period of the war. . . . The great dilemma of the machine tool industry arises when war production ceases." The National Machine Tool Builders Association.

" " "

"HISTORY WILL record as one of the greatest contributions of industry to the war effort the patriotic pooling, for the benefit of the entire country, of secret technical processes and formulae, hitherto guarded as the life-blood of the rubber, chemical, and petroleum companies." *Colonel Bradley Dewey, Acting Rubber Director.*

" " "

"THE SAME forces which are working toward the conservation of our timber, mining, petroleum, and other resources are affecting the field of research. No longer is it possible for any company having the financial resources to expand its research force to any degree it may desire. It becomes necessary to consider ways and means of more efficiently utilizing what we have." Dr. F. J. Curtis, Development Director, Monsanto Chemical Company.

" " "

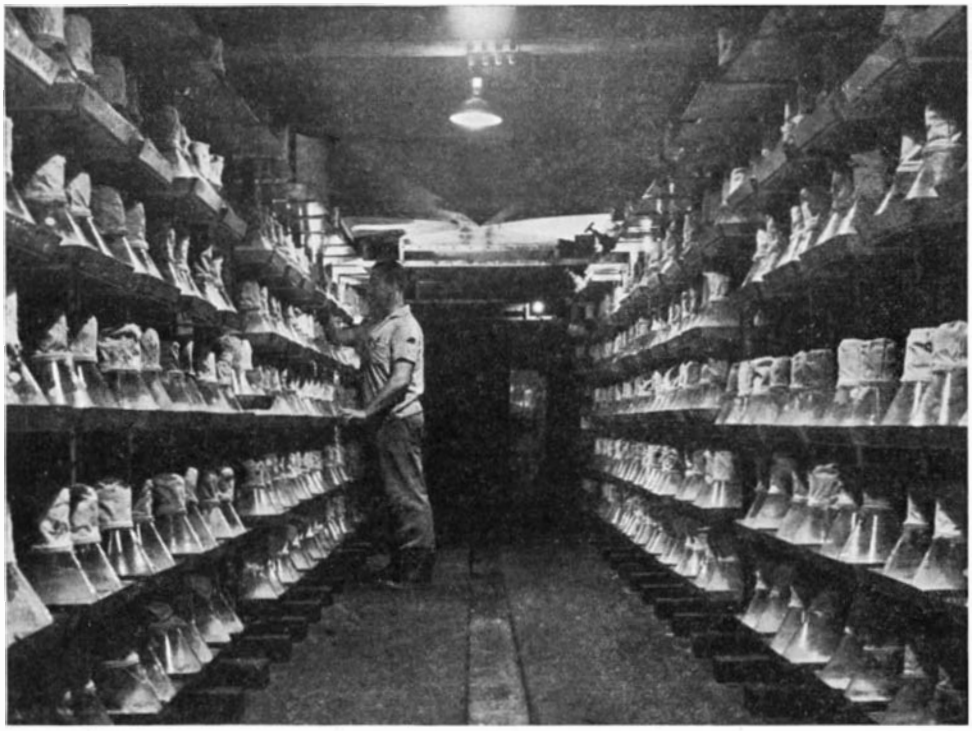
"UNDOUBTEDLY there is oil beneath fields already known, such as that recently obtained in Louisiana from a well 2½ miles deep. Such deep well drilling may be the equivalent of discovering new fields, but the costs of drilling go up as the well goes down." *Professor Jerome J. Morgan, Columbia University School of Engineering.*

" " "

"UNLESS new oil fields are found, the United States may be forced to import oil from abroad and also use more coal of low grade for power generation." E. G. Bailey, Vice President of the Babcock and Wilcox Company.

CHEMISTRY IN INDUSTRY

Conducted by D. H. KILLEFFER



Illustrations not otherwise credited, courtesy Chas. Pfizer and Company

In the flask fermentation room of a penicillin pilot plant

Penicillin Poses Production Problems

Present Cost of this New Miracle Drug is Some $18,000 a Pound. How to Reduce this Cost and to Produce the Pure Drug in Large Quantities Constitute Problem Number One for America's Chemical Industry. Synthesis is Not Yet Possible Because Penicillin's Composition is Still Unknown

PENICILLIN, the magical drug derived from mold, appears as possibly the greatest single medical discovery of this age. It may be. The case is not yet proved. Meanwhile, penicillin quite definitely is the chemical industry's Number One riddle. Enthusiasts eager to herald the miracle of its cures ignore the very practical problems which it creates. Hundreds of scientists search diligently for answers to a multitude of crowding problems that must be solved before the miracle can become commonplace. Mere mention of unsolved problems possibly suggests a deplorable lack of faith, yet no major development, not even this one, springs full grown from the brain of the discoverer.

The basic facts are these: Penicillin is derived from the growth of a common blue mold and it possesses extraordinary potency in combatting certain infections in the human system that other agents—even the invaluable sulfa drugs—do not attain. Cures effected by penicillin are distinctly medical miracles.

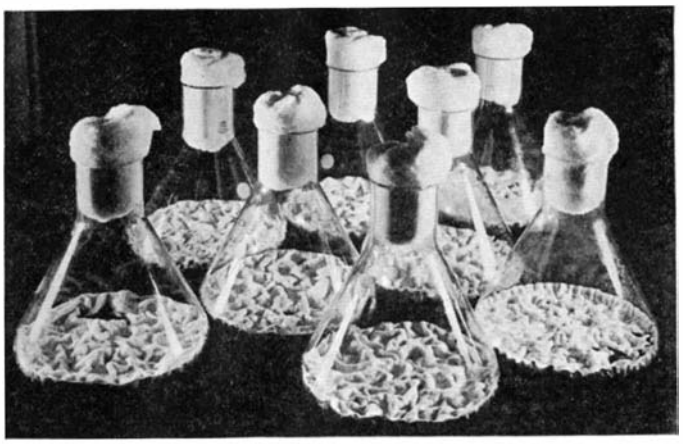
Upon these facts, a sensational new mythology of medicine has been erected. The excitement has reached a pitch where headlines reporting deaths add that penicillin was not used. Thus it is made to appear that some evil genius prevents seriously ill persons from having penicillin, to be thereby miraculously cured, snatched back from the very jaws of death.

Such implications are the deplorable result of premature publicity, of imagination running ahead of fact. For quite obviously no one would for an instant deliberately withhold a cure from anyone. Again, while penicillin is of unquestioned, almost miraculous, value at times, it is not a cure for every human ailment. Indeed, the whole subject is yet so new that no one can state with assurance what types of infection will and what will not yield to penicillin treatment. Nor is it entirely certain yet that penicillin is, as it seems to be, entirely free from dangerous reactions which might injure instead of help the invalid.

In the frantic haste of war, normal procedure has been telescoped to save time. Painstaking clinical tests of hundreds, even thousands, of cases usually required of new drugs before they are permitted to go out generally have been reduced to a small fraction of that number. The urgent need by military medicine for an agent to supplement sulfanilamide and its invaluable family in treating battle casualties provided a demand that could neither be denied nor delayed. Thus treatments in army hospitals are replacing medical schools and clinics as the proving ground for penicillin.

Meanwhile, the production of the potent principle of the drug has become

a national problem. Make no mistake, it is a grave problem. *Penicillium notatum* yielding the drug is one of the family of the common blue mold that grows on bread in the kitchen and that gives distinctive flavor to blue cheese. However, the desperate need for production of this drug fails to excite the mold. It pursues its moldy way without the slightest interest in its new task, and infinitesimal quantities of the drug are all that it will yield. Furthermore, the mold refuses to grow under conditions that vary even slightly from its own rather closely circumscribed needs.



The deeply wrinkled mold *Penicillium notatum*

THE MOLD still must be grown in small batches in bottles. Milk bottles are preferred by some growers because they can be washed and sterilized by existing machines. Into each bottle is put the sterile, nutrient broth on which the mold will feed, and a tiny bit of the pure mold is added just before the neck of the bottle is closed with a loose pledglet of cotton. Then it begins to grow and for ten days it is kept in a room warmed to just the right temperature. At the end of that period the surface of the liquid is covered by a deeply wrinkled greenish-gray layer of the mold itself. Occasional droplets of yellow liquid dot its surface. The yellow droplets contain penicillin. So does the broth in the bottle. Painstaking labor is necessary to separate the drug and purify it.

This is all quite complicated and, in terms of the chemical industry's idea of production, highly inefficient. Efforts to devise a continuous process for growing the mold to avoid the complications of small batches in bottles have so far proved unfruitful. They may yet be successful.

No one would question that the drug is worth any amount of money, since it can perform miraculously. Consequently, despite the fact that penicillin is estimated to cost some $18,000 per pound by present methods of production, plants to produce it are being built at a feverish rate. Even at that extravagant cost each dose of the drug costs only about $2, so great is its potency and so tiny the quantity required for a dose. Obviously, production costs must be reduced, and indeed they will be when the nation's output can be measured by hundredweights or tons instead of by ounces as it is today. But, for the time being, methods of manufacture now available must be used until improvements can be devised and put into operation.

Chemical industry, and it is chemical industry that must produce, prefers to find out the exact chemical constitution of the desired material and then make it without depending on or waiting for a mold to grow. But that won't work yet with penicillin. No one knows its chemical constitution. Indeed, no one has yet succeeded in purifying it to the point of being sure whether it is one or several chemical compounds. So great has been the demand for it by military medicine, that not enough has been spared for these essential chemical studies. But that is coming.

In the characteristic American tradition of co-operation, the problems of penicillin are under attack by the most expert team that can be assembled. As this is being written 17 American chemical and pharmaceutical companies are focussing their production facilities and their research efforts on it as a major undertaking. New plants are being built and existing plants enlarged to insure the early availability of the drug. By the time these lines reach the printed stage these projects will be well under way and others may have been initiated.

Some 200 firms are reported to have offered their services. Careful selection has narrowed the number to those best qualified for the undertaking. Significantly, the chosen firms represent all types of experience that can be expected to be useful. Leading pharmaceutical companies come first, since this is a type of manufacture and product that falls easily within their experience. The handling of the mold is itself a special technique closely analogous to

100,000,000 units of penicillin in weighing cubicle

Measuring penicillin potency by Oxford ring test

Courtesy Lederle Laboratories, Inc.

The characteristic mold pad which forms on culture medium seeded with spores of *Penicillium notatum*. Droplets of a liquid containing penicillin collect on the surface and accumulate in the subjacent broth. When a maximum amount of penicillin has accumulated, the broth is removed and the penicillin is chemically extracted by a laborious process

industrial fermentations. Thus producers of industrial and beverage alcohol add another type of expertness. Finally, companies with wide experience in synthetic chemistry through the production of synthetic drugs and dyes give the team still another point of view which may lead eventually to the synthesis of the potent compound.

A production team with so varied an outlook gives promise that the problems of providing ample quantities of the vital drug will be solved as quickly as possible. Close liaison between these production units, each with its own experienced research staff, and the several groups of scientists studying the problem, assures that no time will be lost and no field of investigation neglected in the race to this vital humanitarian goal. The whole effort is coördinated by a federal director appointed by the War Production Board to avoid duplication of work and to make every discovered fact immediately available to all.

Thus the miracle of penicillin is well on the way to becoming commonplace. It is not commonplace yet.

⊕ ⊕ ⊕

REDWOODS

Yield Chemical Raw Materials

REDWOODS, the mighty giants of the forests of the Pacific Northwest, are joining the chemurgic parade. Long used for lumber, these trees and the wastes from lumbering operations may become the source of many new products as a result of research done by the western redwood companies and the Institute of Paper Chemistry at Appleton, Wisconsin.

Redwood bark fiber is already being blended with other fibers for textile purposes and is also being used as an insulation material. To further utilize the tree wastes, an investigation has been carried out on the chemical composition of redwood bark and has shown it to be composed of cellulose and lignin which is probably the same as in other wood. In addition, there are at least two other products which appear to be high molecular weight—phenolic acids and a form of pectin. Small amounts of two materials named catechal-type tannin and phlobophene are also present. These materials may be recovered and are expected to find many uses in the chemical and chemical specialties industries.

One concrete result of the redwood research is the manufacture of a new, non-critical phenolic type thermoplastic for the production of items formerly manufactured from hard rubber and other thermosetting plastic compounds.

RUBBER PROGRESS

Civilian Tires Will Continue To be Critically Scarce

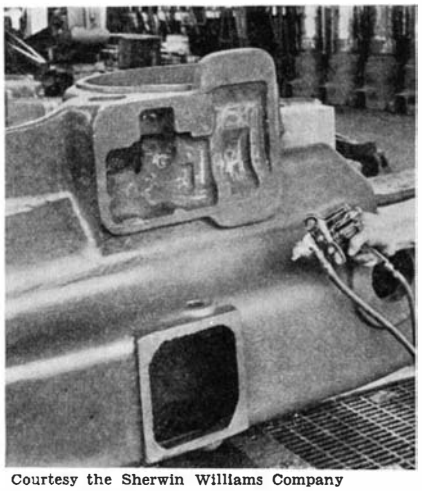
GRUMBLING about shortages of tires and other rubber products for civilian use will continue but its end is dimly visible as our synthetic rubber program develops. Reviewing progress, Col. Bradley Dewey, Rubber Director, stated recently to the American Chemical Society that actual production of synthetic rubber in the United States would exceed 30,000 tons a month in September and that all plants required by the program of 850,000 tons per year will be completed in 1943.

Synthetic rubber has grown to be a three quarter of a billion dollar industry in a little over two years, Col. Dewey said, and "that would have been a miracle had it been achieved in peacetime in 15 years." By the end of 1944, he predicted, some 47 million tires would have been made available for essential civilian use—a little more than one and a half new tires per car over the period from Pearl Harbor through 1944—and about a similar number of recaps. All of which indicates that civilian tires will continue critically scarce for some time to come.

MACHINE-TOOL FINISH

Reduces Application Time, Improves Appearance

A NEW "pebble" finish for machine-tool surfaces not only uses far less finishing materials but can be applied in 1/3 to 1/2 of the time required by usual methods, according to the Sherwin Williams Company. Called a "pebble" finish because of its physical appearance, this new method of protecting machine-tool surfaces solves the problem of "dressing up" a machine surface without fillers, sanding, and numerous coats of sealing paint. WPB officials,



Courtesy the Sherwin Williams Company

New "pebble" finish being applied to a Cincinnatti-Bickford radial drill in three operations instead of the seven that were formerly required

in an effort to boost tool output, have prohibited the use of fillers, sealers, and similar finishing materials and restricted the number of coats of paint that could be applied. With the new method, however, it is now possible to finish a machine tool in three operations instead of seven formerly required. The "pebble" finish effectively hides the scratches, grinding scars, and other surface defects on castings. Application of "pebble" finishing is expected to help accelerate post-war planning for improved industrial finishes.

HOME AIR-CONDITIONING

A Post-War Possibility With New Gas-Operated Unit

POST-WAR homes may be air conditioned by a new type of gas-fired refrigeration unit operated in conjunction with a gas heating plant. One of the important requirements of refrigerating systems for this purpose is that they must employ no flammable or toxic agent to cause trouble in case of fire or accident. The new Servel system employs the absorption principle, using water vapor under low pressure as the refrigerant and lithium bromide solution as the absorbent. This avoids both fire and toxicity hazards.

The refrigeration unit is built as an integral part of a system including the heating plant and the humidity control equipment. The whole operates automatically to hold both temperature and humidity at controlled levels.

Refrigeration is effected by evaporation of water at low temperature and pressure, the vapor produced being absorbed by a strong solution of lithium bromide. After absorption, the water is boiled out of the solution, condensed to liquid by cooling with water from the main, and the cycle repeated. Evaporation of the water takes place in coils in contact with air which is thus cooled and dehumidified before being carried by ducts to the conditioned space.

The unit is not yet available but is already completely planned for large and small dwellings to be produced when peace comes.

Industrial Temperature Control

Many Processes Can be Carried Out More Accurately, Faster, More Efficiently, When Immediate Temperatures are Kept Within a Predetermined Range. This Type of Temperature Control, Often Correlated With General Plant Air-Conditioning, is Being Adopted By a Number of Varied Industries

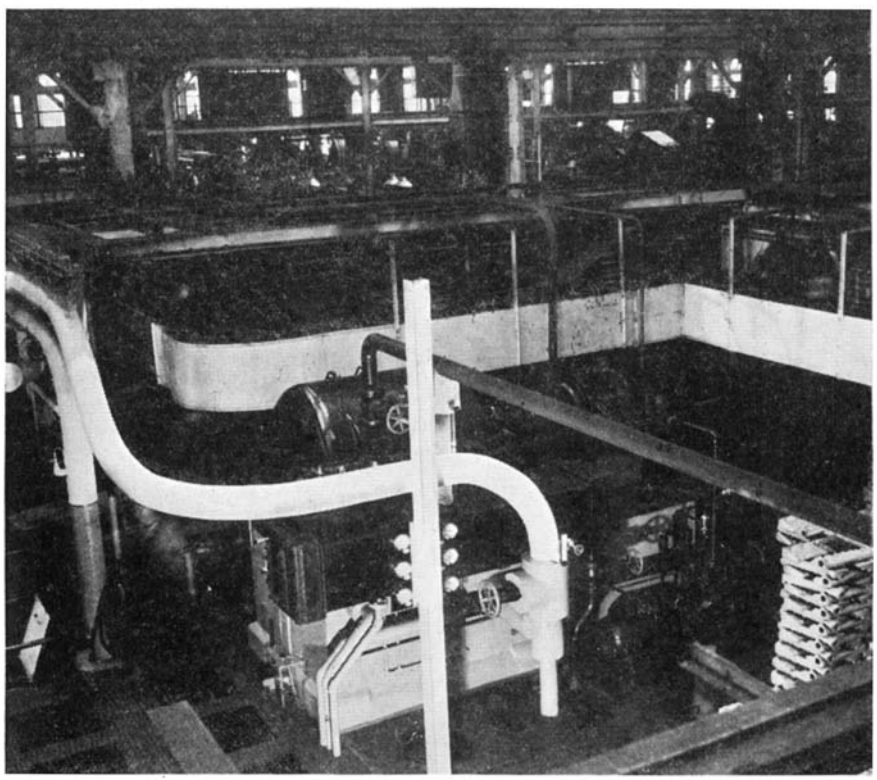
BACK IN 1910, when the Pratt and Whitney Company, makers of fine tools and machines, arranged to keep their master gage room at exactly 70 degrees, Fahrenheit, they little suspected that they were starting something that would make possible the modern airplane, television, synthetic rubber, high-octane gasoline, and dozens of things that are taken for granted today. There even was doubt that such close control was intended as more than a stunt, undertaken perhaps for its publicity value or to convince the European makers of fine tools that Americans intended to produce enough good tools to hold the import prices down. But temperature control for quality control proved to have thorough Yankee practicality and companies desiring to overcome the difficulties of extra fine production turned their eyes toward it.

As one example, take lenses. German methods of making fine lenses were known here; we even had some of their machines. These machines embodied enough control mechanisms to make them almost infinitely adjustable; their flexibility and versatility was limited only by the sizes of materials which they could handle. It took a good man years to learn to get the most out of one of these flexible production units.

The Minneapolis Honeywell Regulator Company studied these machines. Engineers found that the most complex adjustments were intended to serve just one purpose: To grind to true contours in spite of changes in the dimensions of the glass caused by changes of working temperatures. This problem, of course, could be licked, for Minneapolis Honeywell knew how to control temperatures.

With the more complex adjustments eliminated, the less complex ones were divided into functions. These functions in turn were divided into operations, and simple machines were designed for each operation.

In a short while Minneapolis Honeywell was turning out lenses in quantities which Hitler had believed impossible, and at costs which will prevent good lenses from ever again being classed as jewelry. And far from needing years for man training, most of the production operations could be taught in just two weeks. But this American victory of 1942 dated back to what Pratt & Whitney had done in 1910: Control of the operating temperature of the process itself instead of trusting the workman to adjust his machine for process temperature changes.



A 150-ton motor-driven refrigerator unit for industrial air conditioning

In entirely different industries, other lessons were being learned. A large printing plant was one of them. Seeking to do some extra fine lithographic work, this plant brought its entire press room and several tons of paper to constant temperature and held them within a few degrees for several days. At the end of the third day the huge masses of stacked paper and the presses were at the same temperature, and the job began to work as expected.

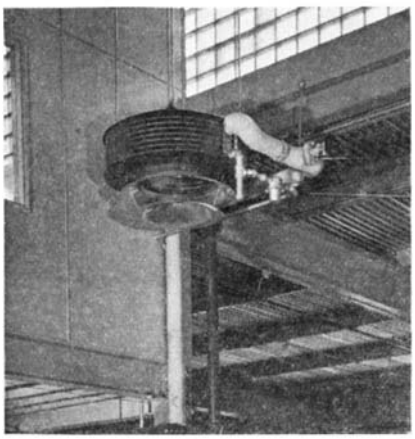
But over in one corner, something totally unexpected went on. Here was a huge monster of a 45 year old Hoe cylinder press, used only on rare runs of extra large sheets. Everyone took it for granted that this rheumatic old timer would go haywire and have to be readjusted every ten minutes or so. But when brought to constant temperature and held there for a day, the old press seemed to be rejuvenated—it started rolling off the work almost without interruption for hours at a time and generally behaving in ways that the oldest old timer in the shop could not remember having it equal in its youth.

It was but a step from these experiences to the practices followed in cutting big turbine gears. The hobbing machines for these are in individual constant-temperature rooms. One gear may take as long as 17 days to cut, yet the work is so perfect that gears several feet in diameter will mate more nicely and work more smoothly than the parts of the finest pocket watches. Each constant-temperature room has its individual air-conditioning unit, with stand-by equipment always ready so that the failure of temperature-control devices cannot ruin a gear worth thousands of dollars.

Many of the largest shops have centralized temperature-control systems, with huge refrigeration and steam generating plants supplying the necessary cold or heat through mains and branch piping. These systems have the advantages of low operating costs and easiest maintenance, all the complex

equipment which needs extensive engineering knowledge and high mechanical skill being in comparatively small areas while the larger acreages of plant space are served by the equipment which plumbers and electricians can maintain. But there is a strong trend toward the decentralized plant which is zoned into areas, each of which is served by an individual temperature control set up. Thus the Douglas Aircraft plant in California has 26 units, each using the same set of its own pipes for distributing cold water for cooling and hot water for heat. Such is the famous California climate that cooling may be necessary for the day shift and heating for the night.

The new Dodge Chicago plant of the Chrysler Corporation has 81 air-conditioning units mounted on the roof to

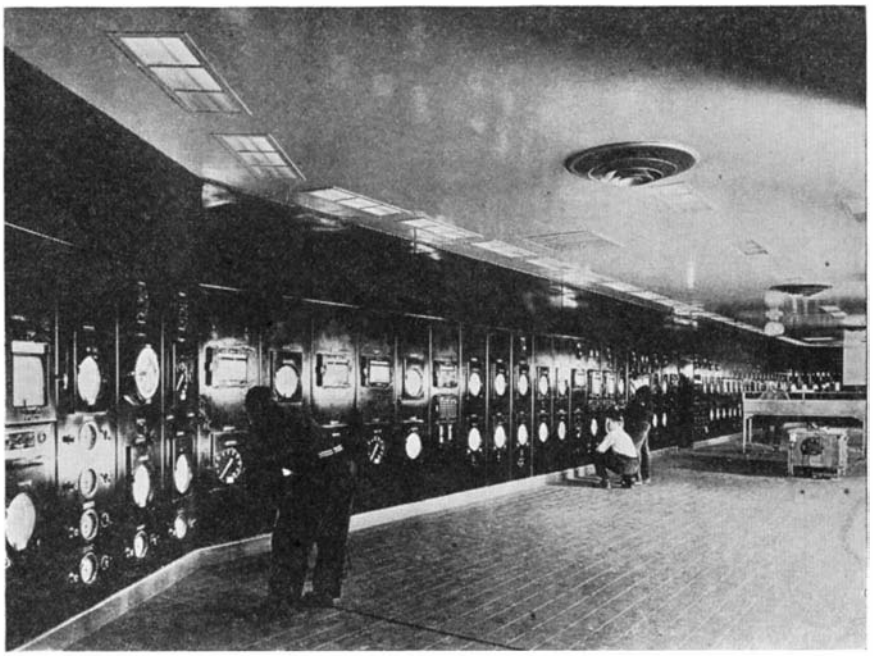


Unit heater which controls winter temperature within 40-foot radius

serve 20 acres of floor space in only one section of the plant. Here steel, magnesium, and aluminum parts must be assembled, and since these metals do not expand and contract at the same rates under changes of heat and cold, failure to machine them all at the same temperatures or to have them all at one temperature when assembling would make a mockery of the accurate production demanded of modern war goods.

The Pratt and Whitney engine plant (United Aircraft Corporation) has 39 separate systems for controlling temperature. Here an activated-carbon device, which acts like a huge gas mask, is used to purify the air which is heated or cooled and to reduce the intake or "make-up" of outside air to the amount needed to supply enough oxygen for breathing. Use of this device has reduced by 80 percent the amount of outside air taken into the plant. And since all outside air has to be either heated or cooled as well as cleaned before it can be used, the savings are plenty. Actually, by permitting the recirculation of some 381,000 cubic feet per minute of air, which otherwise would have to be vented to the outside and replaced, this device reduces by 800 tons of refrigerating capacity the size of equipment needed for plant cooling, and by 33,000,000 Btu per hour the necessary capacity of the plant heating equipment. Some 500,000 gallons of fuel oil per heating season are thus saved.

While close control of plant temperatures has been helping modern machine shops to perform production miracles, a similar development has been going on in the "process industries." The earliest DeLaVergne ice machines—outfits which are museum pieces now—went into breweries and into artificial ice plants. Manufacturers of flammable and explosive products followed along. It was a milestone in temperature control when the Ohio Match Company cooled its factories and worked all summer instead of letting the fire hazard cause it to shut down in hot weather. Rayon manufacture is so sensitive that it was made possible only by plant temperature control. And it was natural for milk and other food-handling plants to follow this trend.



This huge bank of instruments controls industrial process temperatures, integrates them with room and general plant temperatures, and records the conditions

But in Newark, New Jersey, was a bakery which seemed able to turn out the grocery-store varieties of bread with less trouble than its competitors. Its methods were closely guarded; no visiting salesmen found out much about them and no trade-paper men wrote them up. Finally the secret leaked out. Rather than controlling only the temperatures inside the ovens and in the shortening and other heat-sensitive materials storage places, this company kept whole process rooms at constant temperatures. The bakers still had a thousand and one variables to worry about—flour and yeast never seem to behave twice alike, even at different hours of the same day—but the number of those process variables was reduced drastically when the temperatures of all materials, all machines which did not employ heat, all air entering ovens, and the surfaces of all heat-using equipment, were always the same. Not only did this make the baking more uniform, but the wrapping machines also behaved better.

EXAMPLES like this one made all sorts of process engineers think. They thought so thoroughly that when the problems of synthetic rubber came along, plant temperature control was the natural foundation upon which the solutions of many of them were built. In fact, so necessary was this that the industry could not have come into being without it. The necessary refrigeration equipment did not exist—the processes are mostly heat exuding ones and plant cooling was more needed than plant heating. Large department stores, residences, industrial office buildings, and others gave up their comfort control equipment, sold it to the government at original cost less some 5 percent per year for depreciation, and consented to get along without the increased personnel efficiency and the pleased customer profits it had been yielding, just so that this necessary war industry could get under way.

It was fairly easy to get men to give up comfort conditioning in 1943, for "comfort" is a sissy word in war time. But comfort control is highly important in many types of factories, and for a reason which points up the necessity of plant temperature control for modern production.

Operators who handle many kinds of polished steel parts and nearly all kinds of accurately finished non-ferrous metal parts must not be allowed to perspire. If they do perspire, their fingers will excrete microscopic particles of material which are called "seeds of corrosion." The degree to which this happens varies with operators and with such factors as their diets and their health—it is generally worse with women than with men and is worst during periods of menstruation. These seeds may develop into corrosion areas within a few days, or, if the parts are kept cool enough or otherwise well enough protected, the areas may take months to develop. This was bad enough in peace time when goods so damaged were returned to their makers. But in war time it is not enough to be able to return a jammed cartridge or a faulty bomb sight for credit. The

operators thus have to be kept warm enough to work well but cool enough so that the perspiration will not occur and the seeds of corrosion will not be planted; in short, comfort conditioning for those operators must be nearly perfect.

Machine operators, when first coming on duty, will be contributing about 7 Btu per minute to the general plant heat. The conveyor belt or other pace-setting device before them will be moving at its slowest. Then, as the workers warm up, the pace setter is stepped up also, until at the end of an hour or so it is at the gait which is to be maintained for the shift. Regulated automatically by its thermostats, the temperature control equipment supplies more and more cooling or less and less heat. Machine bearings warm up, electric motors give off most heat as the loads upon them increase and build up their temperatures, furnaces and other heat-employing devices get warmer too, and the operators begin giving off up to 17 Btu per minute each, making the control of their perspiration just that much more difficult. Still the temperature control equipment keeps on regulating itself, so completely and easily that nobody notices that it is there.

One plant which makes fine steel and non-ferrous parts but also has process rooms, tried the experiment of turning off its plant temperature control equipment. The experiment lasted half a day. In that time fine steel grinding machines went out of adjustment and spoiled unusual amounts of work; the oil being fed to the bearings of delicate machines changed in viscosity and the automatic variable speed controls on those machines functioned through wider ranges than ever before; the springs on instruments changed their elongations enough so that operators who trusted them made slight errors; personnel complained of odors from furnaces which they never had noticed before; and everything from metal parts assembly lines to package filling machines and crews slowed down.

Plant temperature control is now costing millions of dollars where ten years ago for exactly the same types of manufacturing processes it would not have cost thousands. But it is returning every cent of this, and with profits. Such refinements of the internal control of processes as the use of potentiometers with whole banks of instrument panels in conjunction with thousands of robot valves to control the temperatures of miles of pipes and tanks in the making of high-octane gasoline; or the holding of cutting oils to constant temperatures so that highly accurate machine tools will not vary in temperatures at their work planes; or the feeding of controlled temperature liquids to the forming dies of presses and the tips of spot welders—all might suggest that the temperatures at the working areas of those devices would be so well controlled that the ambient air temperatures would make little difference. But the exact reverse is the case. The finer the work plane control, the more likely is general plant temperature control to pay dividends.

The factory of the future will be a single unit, a single tool, completely coördinated to the service of its operators. And one of the integrating and unitizing elements in it will be the ultra refinement of general plant temperature control.

⊕ ⊕ ⊕

INK AND WAR

Many New Inks and Uses Have Been Found by Research

MORE THAN any other fight in history, this is a war of printer's ink.

Inks which will print on metal and not wash off in water nor soak off in oil, are still military secrets, but more than one soldier, taking a military machine apart in the field and lamenting the loss of his repair manual, will find hints, diagrams, and even full instructions right on the surfaces which he uncovers as he removes the bolts.

Reticule printer replaces spiders

Other inks will stay on metals until washed off, but are especially made to wash off completely and easily. They are used to identify parts which might get mixed with others very much like themselves within factories, to warn of variations in materials or in sizes which must be compensated for along the assembly line, and to put template markings on surfaces which are to be cut. They are cleaned off afterwards, sometimes to provide clean surfaces for plating, rust proofing, or other finishing, sometimes to avoid giving information to the enemy if the parts are captured.

Luminous inks for night fighting were used only for watch dials in the last war; they serve now on all sorts of instrument faces and other devices.

Fluorescent inks, which will show up only in light waves invisible to the naked eye, are useful to military devices but like the luminous ones will serve post-victory industry in all sorts of places in which ordinary light either is damaging to the product or is difficult to apply.

Perhaps the strangest development is the printing of fine "reticule" lines on the lenses used in gun sights for war and in surveyors' instruments in peace. Formerly spider webs were the only materials fine enough to be used for these reticules, but when not enough spiders could be found to fight this war a way of printing these lines was worked out. The printed lines are more uniform than the spider webs, and much easier to handle on the production line. And this development of the printer's craft will reduce the costs of thousands of types of industrial and other instruments during the oncoming peace.

MAGNIFYING GLASSES

Are Finding Wide Use in Many Industries

MODIFICATIONS of the ordinary magnifying glass of powers that might be found on the desk of a stamp collector, have crept almost unnoticed into our war plants but are proving to be among the useful tools of industry.

Some objects or points are easier to see with a lower power lens—say two or four magnifications—than with a higher, while higher magnifications are better with others. The same operator may need to view the same work through two or more different magnifications, or may need a selection for different items which must be viewed. In many cases the operator has lenses of varying powers within convenient reach.

Better seeing, reduced eye fatigue

Uses of these glasses are as varied as the operations of all industry.

Electrical products makers find them handy for girls who weld fine wires together. The glasses eliminate eye strain, make positioning the wires faster and more accurate.

Assembly lines employ magnifying glasses for making sure that small screws or other parts have not been dropped into assemblies which are about to be given running tests, for checking for pin holes and other defects, and the like.

Textile mills, plastics makers, and even wood workers use them to check thread counts, surface finishes, and the spilling or overflowing of cements which might interfere with finishing operations.

Magnifying glasses of these types were rarities in pre-war factories, but will be commonplace in post-war ones.

A Lighter Age Is Coming

Magnesium is Moving Ahead Rapidly and Now Challenges Aluminum in Many Industrial Applications. Spurred by the Demands of War and Particularly by the Needs of Aviation, American Technologists Have Developed Magnesium Alloys and Fabricating Methods of First-Line Importance

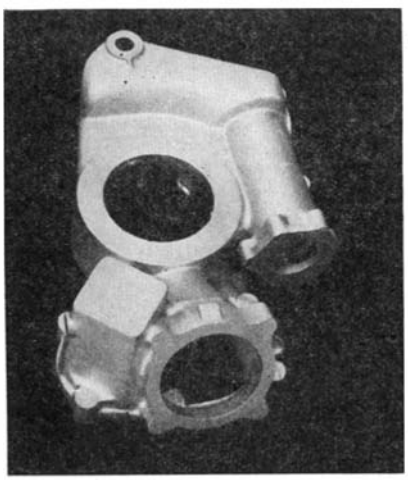
IN THE construction of airplanes and aircraft engines, there is constant striving to save weight without sacrificing safety. For a number of years, aluminum alloys, because of a combination of lightness and strength, have been considered pre-eminent in the building of planes. Now the availability of the still lighter magnesium has brought a formidable challenge to aluminum.

Why this challenge? Because, while magnesium approaches within measurable distance of the strength of aluminum (45,000 pounds at reasonable elongation in some forms) and has a modulus of elasticity of 6,500,000 pounds per square inch, it is only two thirds as heavy as the next lightest metal used in aircraft, as the following table shows:

Material	*Specific Gravity*	*Weight lbs/cu. ft.*
Water	1	62.5
Magnesium Alloys	1.8	112.0
Aluminum Alloys	2.8	175.0
Steel	7.9	493.0
Bronze	8.8	550.0
Lead	11.3	706.0

Thus the combination of high strength and light weight makes magnesium supremely interesting to the aircraft designer, as well as to designers in other fields of industry.

The enormous growth in magnesium production began quite early in the present war. In January, 1941, before we entered the war, domestic production was approximately four times as great as in January 1940. This enormous growth in production, mainly due to the increasing use of magnesium in aircraft, has been brought about in a large measure by the Dow Chemical Company and the American Magnesium Corporation.



A magnesium sand casting of a type suitable for inlet piping, junctions, and other parts of airplane engines

One of the technologists of Dow Chemical, John C. Mathes, points out that a new plant recently built in Texas represents a remarkable technological development, because the process involves the extraction of its magnesium from sea water. In this process magnesium chloride is first extracted chemically and is then electrolyzed to produce magnesium by a relatively simple and inexpensive process. There is in the ocean a concentration of one part of magnesium per thousand of water. On this basis, each cubic mile of sea water contains over nine billion pounds of magnesium. This supply is inexhaustible and if iron and copper become rare, mankind may find all his needs for metal satisfied by magnesium.

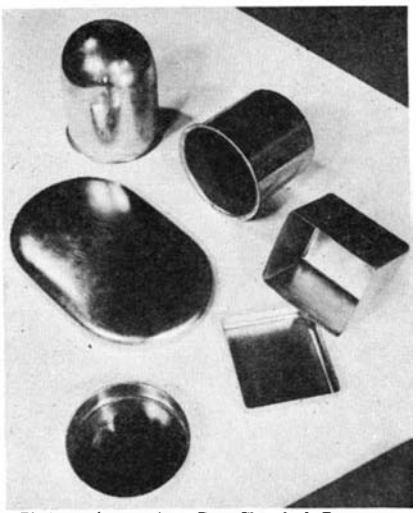
To give the devil his due, the Germans have been pioneers in the metallurgy of aluminum as well as in the metallurgy of magnesium alloys. In using Elektron, as they call alloys of these products, they have led the way. A typical Elektron alloy runs about 6 percent aluminum, 3 percent zinc, 0.2 percent of manganese, and the rest magnesium, with content varying according to the fabrication process—sand casting, die casting, extrusion, forgings, or sheet.

Two German aircraft, the Messerschmidt ME 110, a light fighter bomber, and the Junkers Ju 88, a medium sized bomber—both twin engine machines—fell in England in the autumn of 1940 and were carefully studied from a metallurgical point of view by the Dow Chemical Company. The gross weight of the Messerschmidt was 9900 pounds, and, of this, 300 pounds were magnesium parts. The weight of the Junkers was 24,000 and, of this, 550 pounds in the plane and 300 pounds in the engine were magnesium. The American studies of this magnesium showed high structural strength, high corrosion resistance, and a large variety of forms—castings, die castings, forgings, extrusions, sheet. Compositions used were similar to those in American practice but, contrary to practice in the United States of using most castings in the heat-treated condition, the Germans used a high percentage of the castings in the as-cast condition. Corrosion resistance was somewhat inferior to that of similar materials produced in America. Ultimate strengths and elongations were not far different from ours.

In fact, the meticulous examination showed that from the point of view of metallurgy and fabrication we are not a whit behind the Germans, but it did show that the Nazi designers had more fully realized the potentialities of the metal and were more boldly employing them. Confirmation of this view can be had from a partial list of the locations in which Elektron has been used in either the Messerschmidt or the Junkers or both: Forgings in engine, bearers, supercharger impeller, dive brake, cowl flap; sheet and plate in gunner's seat, wing fairing, other fairings, switch box, compass brackets, and so on; extrusions in a gas-welded fuselage nose structure and the like; castings in the undercarriage supports, in the Jumo engine, in the fuel-tank supports, in the starter assembly housings. And the list is far from being complete.

In one important respect, however, there was complete omission in design. In no instance did these fallen combat planes employ magnesium in primary structural parts such as wing spars or fuselage frame.

It is not solely the war-necessitated increase in aircraft production which has led to greater use of magnesium, since the quantity of magnesium alloy per plane also has increased. Aircraft constructors have always sought out light-weight materials and for many years looked with some degree of envy to Germany where Elektron, a magnesium alloy akin to Dowmetal, was used so extensively. But our technicians were suspicious of the reliability of the magnesium alloys and wary of its fabrication difficulties. If the aviation industry has now adopted magnesium alloys so boldly, it is because of four advances: Improved fabrication tech-



Photographs courtesy Dow Chemical Company

Magnesium alloys can be fabricated in a variety of deep and shallow drawn forms, such as these examples

nique; better chemical surface treatments; higher purity of the alloys; higher strength of structural alloys.

All the above improvements relate specifically to wrought alloys, but magnesium alloy castings have also greatly improved. The whole magnesium alloy art has advanced because of research by the producers of the metal and by a number of government agencies.

First of all, there has been improvement in forming operations. The forming of magnesium is different from that of other metals because it must be done at high temperatures to eliminate "spring-back." During forming, at 750 degrees, Fahrenheit, the material loses its strength, but on cooling it recovers strength without subsequent heat treatment because the strengh is inherent in the material. The warpage, or distortion, attendant on heat treatment is thus eliminated.

SHALLOW forming of magnesium alloys has been paricularly successful because of the Guerin process using heated steel dies with rubber as the forming medium. (Here also is a process which deserves attention in many industries besides aviation.)

Deep drawing of magnesium sheet at high temperatures has now been developed to a point where, with good dies and hydraulic presses, it can be made to serve in making airplane wheel caps, fairings, oil tanks, and so on—instead of an expensive spinning process. Such parts are well illustrated in one of our photographs.

In aluminum the use of the riveted joint is giving way slowly, but only slowly, to spot welding. In magnesium the technique of gas welding has been developed so that strength is adequate, warpage and distortion are eliminated.

Higher strength has come with an increase in tensile strength to 45,000 pounds per square inch for hard rolled sheet, and to 55,000 pounds for extruded metal. Considering the light specific gravity these figures are extraordinary.

And finally, impurities in alloys have been eliminated to such an extent that corrosion need no longer be feared.

So far we have looked a little backward. The more interesting question is: What is the present status of magnesium in the construction of American aircraft? Here Mr. Mathes, in a recent paper before the Society of Automotive Engineers, gives a very satisfactory picture.

Supplies of ingot, fabrication facilities, and equally important information as to fabricating facilities are fully adequate even for our immense effort. There is now a full choice of suitable alloys; surface treatment and protection are well understood and corrosion resistance is excellent. For some time "stress corrosion" was feared—that is, corrosion of parts under continuous stress. But riveted wings constructed of magnesium alloy sheet have proved satisfactory, and there are other indications that stress corrosion need not be feared.

Methods of joining are excellent. Aluminum rivets may be used for joining magnesium, or spot welding may be employed with due protection against effects of weathering. Arc-welded joints are also in wide use.

Service experience has been favorable. Millions of pounds per month of magnesium castings are going into frames, engines, doors, panels, and floorings in the airplane, and no adverse reports seem to be coming in.

Gun-fire is important in combat aircraft, and considerable research has been carried out with regard to its effect on magnesium structures. Regarding explosive shells, Mr. Mathes makes these interesting remarks:

"Explosive shells are more destructive to magnesium structures than to aluminum structures. Our observation has also been that solid shots into a large liquid container, such as a gasoline tank, produce an effect similar to an explosive shell and cause more damage to the magnesium surrounding it than to aluminum. Perhaps paradoxically, the British have had a very satisfactory use of magnesium as gas tanks in their Spitfire airplane. These tanks are constructed as a welded framework of extrusions with the sheet welded in, patch fashion, as small panels. Their observation is that these tanks are not only considerably lighter (12 gallons more capacity and 9 pounds less in weight) than the aluminum tank previously used, but are also more resistant to gunfire because the magnesium does not 'tulip' and prevent the external bullet-proofing rubber from sealing effectively. Such tanks are reported to be readily repaired."

Finally, there is the question of primary structures. Several airplanes have been designed, built, and satisfactorily tested both statically and in vibration. A few have reached the flying stage and stood up well. The British are using magnesium sheet as covering for control surfaces and over portions of the wing on some planes with complete satisfaction. In an advanced trainer in which an outer wing has passed tests, 11 percent of present construction weight was saved. With an aileron 26 percent was saved, compared with aluminum.

Of course, it should be said in fairness that aluminum alloy also is not standing still, that its strength properties are constantly advancing and that the proponents of aluminum are by no means conceding superiority in structural weight to magnesium.

Aviation has drawn support from almost every one of the applied sciences. In return it has taught much to other industries, and one lesson which has been taken to heart by such industries is that of lightness. All transport equipment, for example, has profited by the example of the airplane, with great improvement in performance brought about by the use of lighter metals. Ships, trains, bicycles, have all profited in this manner. High-speed engines in marine and automotive work are employing light alloys in reciprocating and revolving parts to great advantage. Magnesium has appeared in chemical containers and has been used for bobbins and spools and for engraving plates which often must be sent as first-class mail.

Under stress of war our magnesium resources have been greatly multiplied, and our methods of handling it greatly improved.

More magnesium in aircraft will shortly mean more magnesium in many industries.

A lighter age is coming for the United States.

And when we say that a lighter age is coming, aviation is definitely included.

Our brief survey indicates that we have actually surpassed the Germans in the metallurgy of magnesium and that, while we have lagged behind them in its application, we shall now forge ahead of them since we are making use of magnesium in primary structural parts which they do not appear to have undertaken. Magnesium will be used in greater proportion in the metal aircraft to come.

We may also venture the prediction that, besides the more extensive use of magnesium alloys in other industries, the special fabrication processes which have been developed may have an influence on the working of other materials.

⊕ ⊕ ⊕

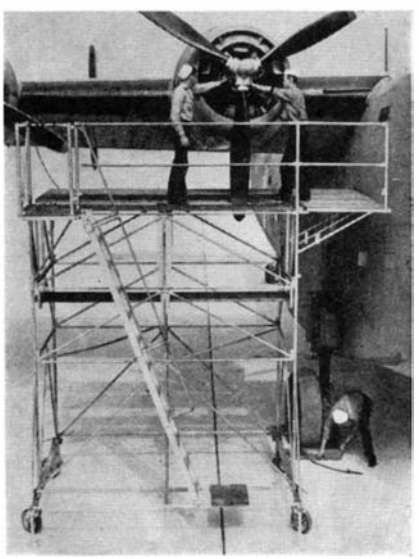
SERVICE STAND

Aids Repair Work,

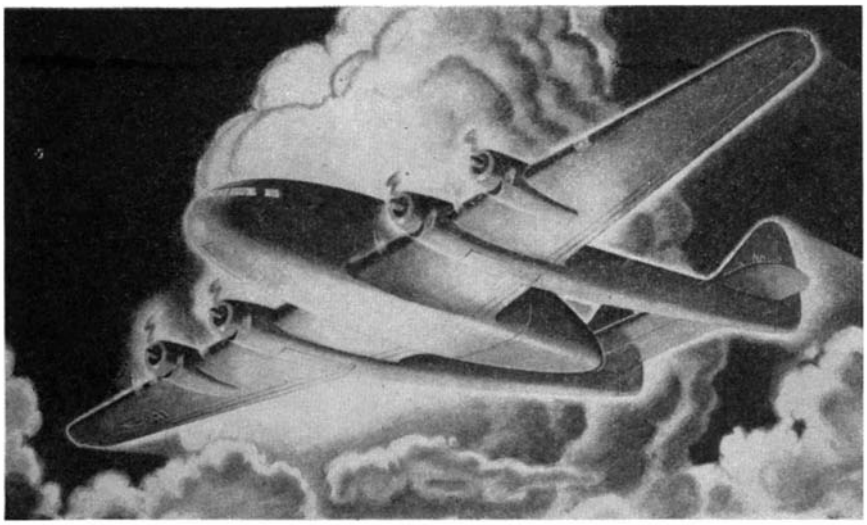
Folds into Small Space

AN AVIATION repair stand, adjustable to shape and heights of wings, fuselage, or tail assembly, developed by Wolfe and Mann Manufacturing Company, can be erected quickly without the use of a single tool and can accommodate as many as half a dozen mechanics. It is provided with ball bearing casters and can be easily rolled about and then locked firmly in position. Because it can be folded into small space to slip under the wings or for moving into the hangar, the stand can be shipped in a package of small dimensions.

Viewing the picture, one might think



Collapsible aircraft service stand



Artist's conception of the Martin cargo plane described below

that this is not a very difficult piece of engineering, but the stand is nevertheless a very useful accessory and one which our Army Air Forces are putting into service in several war theaters.

SAFETY IN FLIGHT

Increased by Minor Precautions

THE CIVIL AERONAUTICS BOARD analyzes flight accidents, gives the reasons for such accidents, and suggests precautions for greater safety. Over the years it is found that such analyses and records will do a tremendous amount to increase the safety of American flying. From time to time the C.A.B. draws on its wealth of gruesome (and sometimes ludicrous experience) to write a Safety Bulletin.

Here is a humorous but worthwhile paragraph: "In acrobatics or gusty air the pilot who flies a plane containing an accumulation of loose articles such as cushions, earphones, maps, a loose portable radio, a chute, or even ordinary dust and debris like nuts, bolts, pieces of safety wire on the floor or in the corners may find himself in the position of the fellow who tries a handstand with his pockets full of change—but probably with more dire results than the loss of a few coins."

Violent movements of the plane may follow from gusts, and sometimes the pilot absolutely must execute a violent maneuver such as a sharp bank. The C.A.B. accordingly gives this fine rule: "When an aircraft is released from a repair depot or from a factory, go over it with a vacuum cleaner to get rid of small loose objects, and check the interior of the cockpit or cabin for loose objects before every flight."

NOVEL CARGO PLANE

Designed for Rapid Loading and Unloading

WITH THE increasing importance of air cargo will undoubtedly come airplanes designed specifically for such duty and differing considerably from the almost conventional passenger transports. Thus, William D. van Zelm of the Glenn L. Martin Company has patented an arrangement which is illustrated in the accompanying sketches.

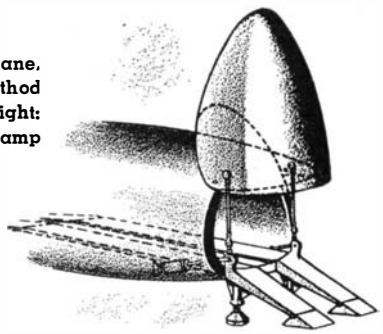
One of the sketches shows a four-engined airplane, in which the customary long fuselage is replaced by a relatively short fuselage and two long booms supporting the tail surfaces. The pilot's cockpit is up front, but the rear part of the fuselage can be swung upward as shown in the second sketch so as to give the freest possible opening for large cargo. This arrangement also permits a truck to drive close up to the loading door.

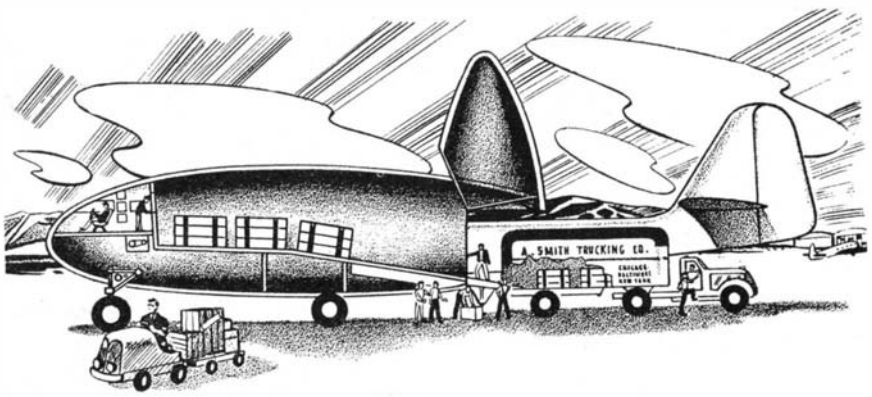
A tricycle landing gear is incorporated in the design, while another feature lies in a hydraulic mechanism which is used both to raise the cargo door and to extend a collapsible ramp which can be adjusted to run either to the ground or to the back platform of a truck. The ramp itself is equipped with adjustable jacks close to the point where it hinges to the plane, so that the cargo does not exert any strain on the structure itself during loading operations.

The tricycle landing gear permits the plane to remain level during loading or unloading; thus it should be possible to load automobiles or other wheeled freight directly aboard the plane.

The four-engined plane shown in the design is to have a gross weight of 86,000 pounds and a useful load of 36,870 pounds of which 13½ tons would be cargo.

Below: Sectional view of the new cargo plane, showing the pilot's cockpit up front and the method of loading through the rear of the fuselage. Right: The open cargo door and the collapsible ramp equipped with adjustable jacks





SUPER GAS

Increases Engine Power Some 50 Percent

BAD NEWS for the enemy is contained in a recent announcement by Dr. Gustav Egloff, President of the American Institute of Chemists, of the commercial perfection of a motor fuel called triptane, which has raised engine power half again over 100-octane gasoline.

Triptane is said to be the most powerful hydrocarbon known for use in the internal-combustion engine. Its antiknock properties are also remarkable. Thus, in addition to furnishing more power, the new gas will allow the use of greater compression ratios on the airplane engine which, in turn, means more specific output and greater efficiency. Triptane has been known for several years, but it is only now that it can be made in quantity. It used to cost $3000 a gallon; now, in a relatively small pilot plant, its cost has been reduced to $1 a gallon.

The advantage of such a gas to combat airplanes can scarcely be overemphasized. The Germans are said to be employing some method of "doping" their engines to produce a burst of power and speed in an emergency, but the method ruins the engine. Triptane holds great advantages in this regard.

Color Matching in Industry

Photocells and Tubes, Taking Up Where the Human Eye Fails, Make Possible Accurate Matching and Measuring of Colors, Leading to Applications in Many Fields. In Colorimetry Standard Colors are Eliminated and a New Scientific Tool is Provided that Promises Much for the Future

By JOHN MARKUS
Assistant Editor, *Electronics*

COLOR is a mental concept induced when radiant energy of certain frequencies falls upon the retina of the human eye. Many words have been coined in attempts to describe and define the concepts caused by different frequencies, but the futility of securing precise and unmistakable terminology is evident when one considers that under favorable conditions the normal average human eye can distinguish at least 5000 different colors.

Color standards, especially pieces of colored glass, might seem to be the answer, but even if it were possible to assemble a complete standard set of colors there would be no assurance that the different colors would remain constant for any period of time.

To complicate the problem still further, color appearance is not always what it seems. Three variables affect the color concept telegraphed to our brain by the retina—our own visual characteristics, the kind of illumination on the color sample, and the optical characteristics of the sample—and each can cover a wide range of variation. Optical characteristics include such things as the amount of each color that is absorbed, the amount reflected, and the amount transmitted, as well as the nature of the reflection. A mirror-like (glossy) surface gives what is known as specular reflection, while a powdery, irregular (dull) surface gives diffuse reflection.

With plastics and other recently developed materials which now are making color an increasingly more important factor in industry, the problem of getting exact colors for particular products has logically been turned over to electronic engineers. To be sure, the optical spectrophotometer has been used for many years in laboratories to measure and match colors, but it still remains strictly a laboratory instrument, too slow for the needs of industrial engineers.

An optical spectrophotometer requires that a large number of individual observations be made to secure the necessary data for plotting a permanent color record known as a spectrophotometric curve. These curves represent color specifications or analyses that are the same for all observers and all conditions of observation, because they involve comparing the radiant energy reflected or transmitted by the sample at each selected wavelength of light with an absolute standard of reflection or transmission.

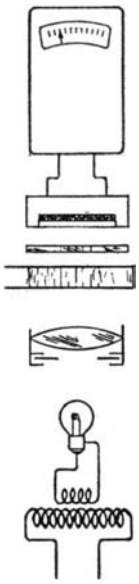
Recording photoelectric spectrophotometer made by General Electric in the laboratory of Interchemical Corporation, where it is used to establish color for inks, paints, enamels, and so on

Because of the complication of the optical spectrophotometer, electronic engineers took over the job of providing these color data in a matter of minutes rather than hours, independently of human errors and in a manner suitable for production-line use. How well these engineers have done their job of meeting the widely varying requirements of electronic color comparators, colorimeters and spectrophotometers in hundreds of different industries is indicated by the fact that available units now cover the entire gamut of photoelectric colorimetric instruments from the simplest $55 comparator to a mammoth and almost human $6400 version, all meeting precision requirements of particular jobs for which they were designed.

An electronic color comparator determines whether a color sample reflects or transmits the same amount of a given light as does a standard sample. In general, this comparison is accomplished by making the comparison four times—first with white light, then with three primary colors in succession. Sometimes white light alone will detect a non-match, but no single light will give assurance of a good match. Only if the standard and sample reflect or transmit equal amounts of white, red, green, and blue light to the phototube or light-sensitive cell is there reasonable assurance that the two objects will appear to have the same color under all ordinary illuminations.

Photoelectric color comparators find widespread use in many industries. In the textile industry, they are used to measure Fadometer and Launderometer results, to detect mis-match of dyes, to detect color errors that might be caused by weave texture, sheen, or surface texture; they also are employed to compare samples of paints, powders, pastes, coffee, food, and other colored materials or liquids. Knowing in what portion of the visible spectrum a color sample differs from the standard, it is often possible to estimate what color pigments or materials should be added to the sample to make it match the standard color.

A typical comparator arrangement consists of a single light source providing two identical beams of light, one directed through or reflected from the



Diagram, very much simplified, of a typical photoelectric colorimeter

standard color onto a phototube or light-sensitive cell, and the other directed through or reflected from the color sample onto another phototube or cell. The two phototubes or cells are connected into a resistance bridge circuit containing an indicating galvanometer that shows whether or not the two light-sensitive devices are receiving equal radiant energy.

A PHOTOELECTRIC colorimeter in its simplest form consists of a light source, a beam-forming lens, a sample holder, a filter holder, and a self-generating photocell positioned to receive either the light transmitted or the light reflected by the sample. The photocell is connected directly to the indicating meter, usually a galvanometer or microammeter. Here the meter deflection is proportional to the amount of light reflected or transmitted into the photocell. Many variations of this basic arrangement are in use, some with additional refinements to provide greater accuracy.

As with comparators, colorimeters employ filters to permit measurements at a number of different portions of the visible spectrum. For a set of three primary colors, three filters are usually standard accessories. Their colors are such that no two of them will combine to make the third, yet the three will combine to make white light. There are a variety of color combinations which meet these requirements, but those most commonly used are red, blue, and green.

With three filters, it is possible to specify the color appearance of a color sample in terms of equivalent stimuli of the three selected primary colors. These relative stimuli values are called tristimulus values.

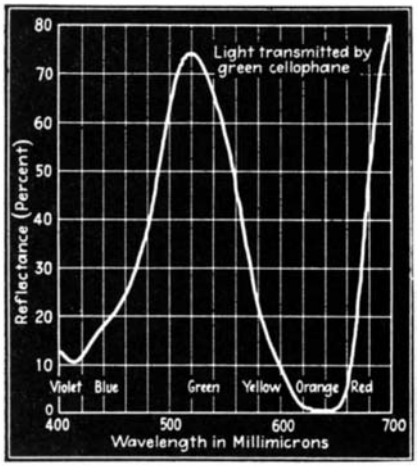
A set of three red, green, and blue primaries has been designated by the International Commission on Illumination as ICI primaries, and readings obtained with these filters are known respectively as X, Y, and Z tristimulus values. An additional feature of these ICI primaries is that fact that the Y tristimulus value gives the luminous reflectance of the sample directly in values from 0 to 100 percent.

In at least one instance, it is possible to obtain a set of 14 different filters for a photoelectric colorimeter, permitting isolation of the visible spectrum into wavebands each approximately 30 millimicrons wide, and giving in effect an abridged spectrophotometer. From the set of 14 values obtained with these filters one at a time, it is possible to plot a spectral transmission or reflection curve approximating the continuous curve provided by a recording photoelectric spectrophotometer, or select a filter most suitable for repeated tests of a material in process control.

If a mercury-vapor lamp is used as the light source, transmission measurements in the invisible ultra-violet region can be made with some types of photoelectric colorimeters. This feature is particularly useful in measuring the vitamin-A content of liquids.

In general, a colorimeter is designed for transmission measurements. Instruments for measuring various types of reflection from colored samples are sometimes called photoelectric reflection meters.

Some work has been done with infra-red spectroscopy, in which the amount of invisible infra-red light reflected or transmitted at various infra-red frequencies is measured with a sensitive thermopile (which converts radiant heat energy directly into electrical energy by thermoelectric means). This measuring technique is useful regardless of whether or not the material appears to have color, because certain seemingly transparent materials definitely absorb characteristic portions of the infra-red spectrum. The method has been already used for controlling the manufacture of synthetic rubber and its raw materials, for dealing with colorless petroleum derivatives, and



Example of a spectral response curve obtained from green cellophane with the recording spectrophotometer shown on opposite page

for studying the molecular structure of organic substances.

One interesting wartime application of photoelectric colorimeters is a compact Westinghouse instrument that monitors the color of the blood in a flyer's ear, and indicates when additional oxygen is needed during high-altitude flying. A tiny light and midget phototube supported on opposite sides of the ear lobe by a spring clip provide an output current that is proportional to the color of the blood and hence to the oxygen content. The output of the phototube is amplified and fed to an indicating instrument and sometimes also to an alarm.

Vast new fields for electronic measurement and control with photoelectric colorimeters are opening up in photoelectric chemical analysis, biochemical analysis for clinical purposes, metallurgical analysis, vitamin industry control, color control in beer and other liquors, process control of foodstuffs, determination of various qualities in blood, and so on. The chief reasons for the great success of these electronic instruments are speed of observation in comparison with older visual methods; lack of fatigue of phototubes or photocells; the full sensitivity in the

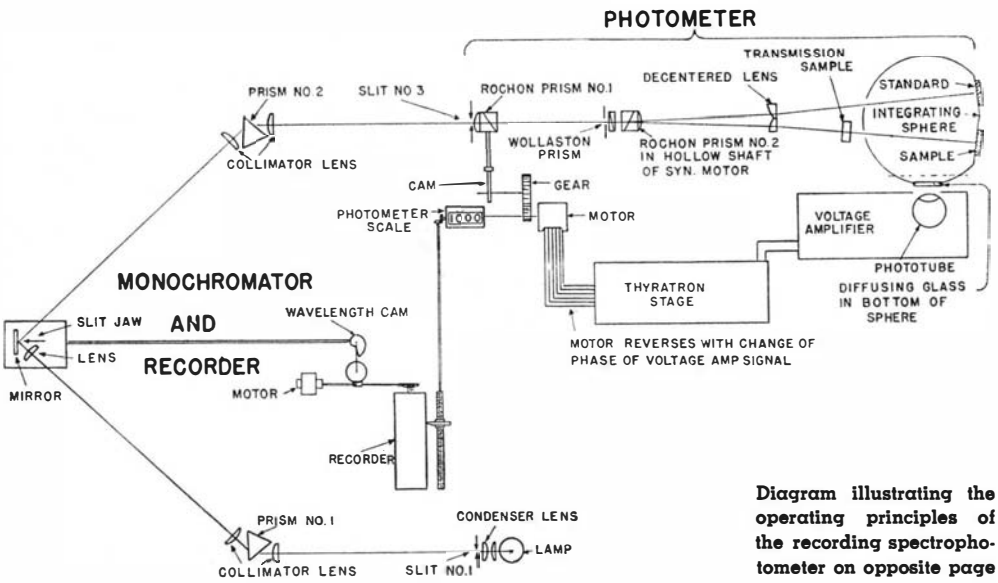


Diagram illustrating the operating principles of the recording spectrophotometer on opposite page

The Photovolt Corporation's photoelectric colorimeter, an example of a unit in the $100 price range

end regions of the visible spectrum and even beyond; the feature of automatic operation in some instances; the fact that electronic instruments do not require trained observers; and the fact that measurements are made without need for darkening the room.

The recording photoelectric spectrophotometer developed by General Electric Company engineers from the original design by Professor A. C. Hardy, of Massachusetts Institute of Technology, will measure either reflectance or transmittance, as desired. It quickly and accurately analyzes and records any color that is visible to the human eye.

THE INSTRUMENT consists essentially of a monochromator, a photoelectric photometer, and a recorder. In the monochromator, white light from a lamp is spread into spectrum colors by a first prism, and reflected by a rotatable mirror into a second prism that spreads the colors still further. The light at the output slit of the monochromator is a pure 10-millimicron wide band of colorded light, the wavelength of which is determined by the position of the reflecting mirror.

The resulting monochromatic light passes through two Rochon prisms and a Wollaston prism that collectively generate two beam components, mutually perpendicularly polarized, which fall respectively on standard and sample inside a photometer sphere. The light intensity varies from minimum to maximum on the sample and on the standard, which are out of phase with each other, due to mechanical rotation of one Rochon prism by an electric motor.

A phototube views a frosted glass in the wall of the integrating sphere, the brightness of which is proportional to reflectance for both sample and standard. When the light reflected from the sample is not equal to that reflected from the sample for a particular spectrum band, an A.C. component is present in the phototube. This is utilized through a thyratron stage to rotate the other Rochon prism enough to remove the A.C. component from the phototube. The angular position of this first Rochon prism is thus a measure of the reflectance of the sample in terms of the standard. This angular position can be read directly on a scale, and also used to actuate the recorder which provides the spectral response curve of the color under study.

The discoloring of an organic finish during service governs to a large extent its quality and usefulness. With the spectrophotometer, the effect of such factors as heat, light, ultra-violet radiation, humidity, and grease upon paints and other finishes can be quantitatively determined by accelerated life tests or by tests at regular intervals under actual use. Tests such as these are being used more and more by military and governmental purchasing agencies as well as by industrial firms as reliable guides in the purchase of finishing materials.

In colorimetry, applications are much the same as for the other instruments, with the spectrophotometer providing a more nearly accurate result, giving the transmission for each wavelength in the visible spectrum so that any one wavelength may be considered to the exclusion of the others. This is important because the human eye integrates over the entire visible spectrum, and interfering colors often make accurate visual comparison difficult or impossible. The instrument also eliminates the use of standard colors for each determination, and provides an absolute permanent record that changes colorimetry from an art to an exact science, gives analytical chemistry what is virtually a new tool, and promises much for the future in all industrial processes related in any way to light and color.

WATER PURITY TESTER

Uses Electronic Tubes to Measure Conductivity

A COMPACT electronic device employing a cathode-ray tuning indicator tube and a rectifier tube has simplified the process of testing distilled water to the mere act of inserting a conductivity cell in the water, adjusting a knob for maximum shadow of the electric "eye," then reading the purity on a scale. The instrument actually measures the electrical conductivity of the water under test, but for convenience the scale is calibrated 0 to 15 parts per million in terms of sodium chloride so that the user obtains a direct reading.

Using the electronic water tester

The circuit is essentially that of an alternating-current Wheatstone bridge, with the conductivity cell and the liquid in which it is immersed constituting the unknown resistance.

MOTOR CONTROL

Multiplies Usefulness of Ordinary Drill Press

THE FIELD of usefulness of the ordinary small drill press may be greatly increased by the addition of a 1/3 horsepower thyratron control. Operating speeds can be adjusted from 25 revolutions per minute to 1750 revolutions per minute simply by rotating a knob, and the direction of rotation can be changed by pressing a button. Independent speed adjustments are provided for both forward and reverse rotation, permitting preselected speeds for both tapping and backing out. The range of speeds makes it possible to use the drill press for a wide variety of hard-to-drill materials from molded compounds to the hardest steel pieces without changing pulleys.

COAL MINE EYES

Electronics Takes the Place of Child Labor

PHOTO-ELECTRIC cells have been in use for some time in coal mines for the obvious purposes for which many industries have employed them—that is, for opening doors and for protective devices. A new job for the photo-tube has now been found—that of the old symbol of child labor, the "breaker boy."

Coal, after coming up from the ground, is sorted; that is, slate, "bony" coal, and other undesirable refuse, are removed. Instead of picking it out by hand, more progressive colleries have devised mechanical means for performing this cleaning job. Nowadays the coal plus refuse is dumped into a trough of water which is agitated by compressed air. Since coal has a lower specific gravity than slate and other undesirable material, the coal floats and is taken away. The heavier materials, however, fall to the bottom and in time pile up so that they must be removed. Here is where modern engineering enters the picture.

The refuse makes contact with a sensitive free-moving float made of aluminum and weighted so that it conforms to the specific gravity of the material to be drawn off. This float rises as the refuse material varies in depth. Attached to this float is a vane which intercepts a beam of light until the refuse becomes high enough so that the beam is no longer eclipsed. Then it shines into a photoelectric cell, the output of which sets into motion a mechanism controlling a rotary gate.

By this means continuous and automatic discharge of the unwanted materials is effected. A second photo-tube speeds up the motors if the refuse piles up faster than the preliminary gate can handle it.

Found: The 'Lost-Wax' Process

Once Employed Chiefly for Accurate Manufacture of Small Metal Jewelry and Dental Parts, the "Lost-Wax" Casting Process Has Been Modernized and Adapted to War Production. It Now Looms as an Important Precision Method for the Post-War Production of Small Metal Parts

IF THERE is one ancient adage that this war has repeatedly disproved, it is: "You can't teach an old dog new tricks." The ultra-modern uses that old stand-bys like cast iron and wood have been given would astonish even some foundrymen and carpenters; even more remarkable is the wartime rejuvenation of one venerable metal-working art, the "lost-wax" casting process, and its sudden emergence as an industrial metal-forming method of new significance for post-war manufacturing.

The unfolding story of the present and future applications of the lost-wax process must be superimposed on a background of the recent trials and tribulations of its parent, the jewelry manufacturing industry. Few industries were in so desperate a plight 20 months ago as was this one. Classed as non-essential, it was properly denied an important part of its raw materials, while its manpower began an exodus to industries and operations that were contributing directly to the war effort.

Independently and in groups the jewelry manufacturers appraised their worsening situation and sought means by which they might participate in war production. One of the groups was the Jewelry Crafts Association in New York, whose president, William B. Ogush, fixed upon the lost-wax centrifugal casting process hitherto used only for the accurate manuacture of rings, mountings, dental forms, and so on, as a likely method of making precision parts for ordnance and aircraft which would simultaneously save tons of raw materials and thousands of man-hours in production time. His association formed a sub-contractors' pool and together with some independent manufacturers demonstrated very quickly to Ordnance engineers that the lost-wax centrifugal process could indeed go to war, that its new name "precision casting" was highly appropriate, and that the use of the method and equipment as already installed in several shops would provide a welcome alternative to tedious machining for making many sorely-needed parts.

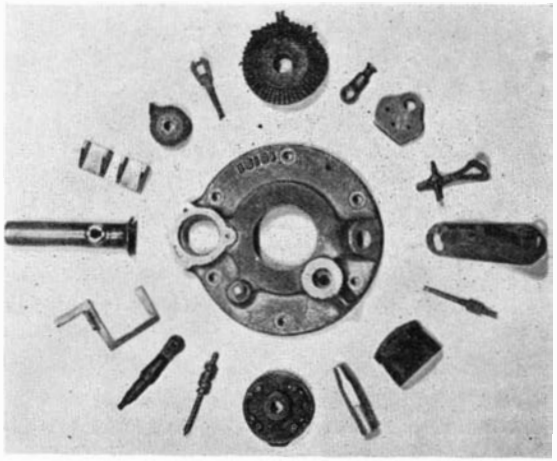
Thus, through industrial application of this old-new process, many jewelry manufacturers have been able to stay in business and to bring the day of Victory just so much closer. But of nearly equal importance is the certainty of most of them that the use of the lost-wax process for making precision *industrial* parts is here to stay. As one of them stated: "Production men with an eye to the future are studying this process now for its possibilities in the mass production of small parts for the automobile accessory industry, outboard motor, refrigerators, and allied fields."

The first thing revealed by these studies is that several variations of the lost-wax process are now in use. In its simplest form the operations are carried out something like this: First a stock sample of the part to be manufactured, a bevel gear, for example, is obtained and employed as a master pattern to produce a master mold or "wax mold" whose cavity is a replica of the solid part. This master mold is in two parts (to permit removal of the stock sample and later of the wax pattern) and may be made of low-melting bismuth alloy, rubber, plastics, and so on. The soft metal or plastic molds are preferred because they can be made directly from the part by pouring the mold material around the latter in a suitable container.

Photographs by Walter S. Much

Making the wax pattern in the lost-wax process

Pouring molten alloy in a precision casting machine



Precision parts made by the process described

Into the cavity of the master mold is then poured a special wax to form a wax facsimile of the part to be cast. This wax form is removed and transferred to an otherwise empty flask, and around the wax is poured the "investment"—liquid plaster of Paris, for example—which is then allowed to "set" or harden. When dehydrated, the investment is heated to melt the wax, which is then poured off to leave a plaster mold capable of accurately reproducing the contours of the sample part when the metal of the final casting is poured into its cavity. The plaster mold is broken up during removal of the finished part.

IT IS at once evident that the virtue of and reason for the wax is that it can be so simply removed (merely by melting) from the mold cavity of the investment, however complicated and undercut the latter may be, without breaking or marring the final mold in the slightest. In the general art of casting no other "pattern" customarily used to form a mold is so simple in nature and so easily removed as wax, and indeed it is this feature—the melting away of the wax pattern—that gives the lost-wax process its name.

The modern variants of this process all include centrifugal casting of the metal finally poured and introduce sundry improvements in the wax or investment material employed. The fanciest centrifugal casting machines in use whirl the electrically-heated melting-crucible and flask as one unit in a horizontal plane, instead of spinning the mold about an axis running through it, as in centrifugal casting of pipe. The machine is set in motion when the metal to be cast is molten in the crucible, which is located directly behind the flask on an arm of the machine. As the machine spins, centrifugal pressure forces the liquid metal into the mold cavity, where it solidifies.

The compositions of wax and investment are closely guarded trade secrets. Waxes may run from beeswax to synthetic compositions, with much interest now being shown in certain injection-molding thermoplastics and even in very low melting point alloys as improvements over traditional waxes. Special centrifugal wax-casting machines are often used to achieve the ultimate in accuracy of reproduction.

Instead of plaster for the investment, ceramics of various types may be used. One company has developed a refractory investment whose high-temperature properties permit its use for casting high-melting metals like stainless steel and other ferrous alloys.

The size of the casting machines used varies, the most popular having an over-all diameter of about 40 inches. A labor force of two workers is all that is required for one machine, and a single machine may produce, through multiple molding, many castings in each operating cycle. A typical machine cycle, from loading the investment through removal of the flask, requires about three minutes. The daily output of one station on a casting machine often reaches 200 to 300 parts.

Part sizes are still small, dimensions of about 3½ inches on a side being the usual maximum feasible at present. On the other hand, the precision available in the process is very high; tolerances of 0.001 to 0.002 inch can easily be met, and in the tiniest parts it is not uncommon to hold tolerances to 0.0005 inch in all directions. In almost all cases the only finish-machining required is removal of the gates.

In the manufacture of ordnance and machine parts, the castings are most commonly made in non-ferrous alloys and stainless steels with only a relatively small (but growing) volume in engineering alloy- or carbon-steels. Best results are obtained with strong bronzes like manganese bronze, aluminum bronze, or beryllium-copper, and with aluminum alloys, zinc alloys, and stainless steels.

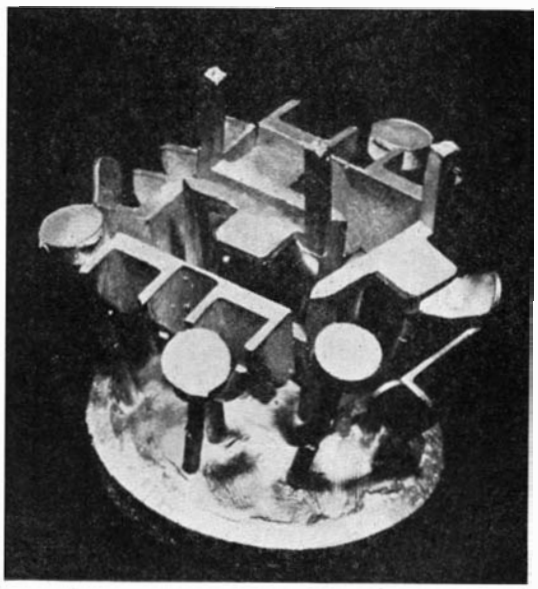
Once acquainted with the nature of the process, its technique, and its engineering feasibilities, the alert engineer translates these into terms of broad production and design advantages and limitations. He notes the latter first: Precision casting by this process has definite size maxima, as mentioned earlier. It cannot generally be applied as yet to the more common ferrous metals. For production runs amounting to tens of thousands of a single part, other fabricating methods involving permanent dies or molds would probably be more economical. Determination of master-pattern and wax-mold shrinkages, the selection of wax and investment material, and the correction of distortion in thin parts are individual problems that must be empirically solved for each case.

But the advantages, on the other hand, seem worth the effort: The dimensional accuracy possible is unsurpassed by any other casting method, and the most complex shapes and surface contours can be reproduced with high precision. Usually no machining is required to produce the finished part and this has led one observer to describe the process as combining the foundry and the machine shop in one art.

IN ADDITION to all the machine time, man-hours, tooling, and waste material saved by the process wherever it replaces the machining of bar stock, or of forging, or of sand casting as a production method, it has important subsidiary features. The raw material can be secondary ingot metal, ideal from the national conservation point of view and also subject to quicker delivery than bar stock or forgings.

Some of the present applications of the process will serve to illustrate its capabilities and provide a background against which to estimate its post-war horizons. Theoretically almost any shape or contour produced by machining can be duplicated by lost-wax precision casting. Tapped and threaded surfaces, gear teeth, undercuts, tapers, holes of all shapes—any of these alone or in combination with others—can be cast in one unit (the process cannot compete economically, however, with stamping or screw machine fabrication on a mass-production scale).

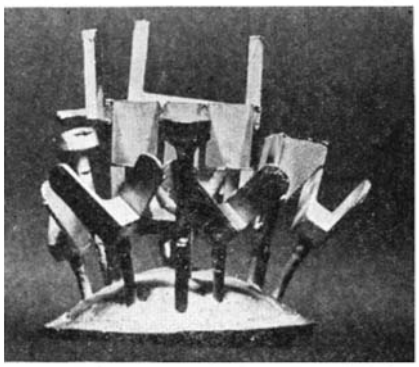
A typical case history is that of a 1½-inch diameter bevel gear formerly machined out of bronze bar stock and ordered in 4000-piece lots. By the former method 80 man-hours tooling and eight minutes production time were required; lost-wax centrifugal casting in Tobin bronze necessitated only 30 man-hours tooling and six minutes production time. But here are items of even greater significance: In producing the machined part 60 percent of the original stock went into the scrap barrel as chips and turnings, as against only 2 percent scrap by precision casting. Furthermore, the delivery time for the bar stock was 21 days from the



Several parts simultaneously cast, immediately after removal from the casting machine

time of ordering, while the ingot metal for casting was received three days after the order was placed.

At the opposite end of the production-volume scale is the case of a 3½-inch diameter aluminum-alloy compressor head of which only 250 units were required. Machining required 250 man-hours tooling and 120 minutes production time and resulted in 55 per-



Another view of a group of simultaneously made castings, showing complexity of the unit parts

cent turnings waste. Precision casting tied-up only 40 man-hours for tooling, 30 minutes for production, and produced only 3 percent scrap—in addition to reducing the inspector's rejections for excessive porosity from 25 percent of total production to only 4 percent.

Many other cases could be cited. In addition to the busy field of ordnance parts, some of the most successful new applications of peace-time significance include beryllium-copper bearing mounts, bronze pinion gears, stainless steel surgical instrument handles, aluminum alloy engine-starter parts, stainless steel supercharger turbine blades, and so on. Millions of non-ferrous parts and hundreds of thousands of ferrous pieces have already been produced by industrial firms using the lost-wax centrifugal casting process.

The future is full of promise for this precision casting method. In the highly competitive period that will follow the war, manufacturers will overlook nothing that can cut costs or that will permit the accomplishment of results not otherwise easily obtainable. Precision casting will appeal to some because it decreases waste and speeds production. It seems destined for increasing use for the fabrication of small parts to be made of metals whose melting points are too high for die casting, of shapes too complicated for powder metallurgy, and of dimensional tolerances too narrow for sand casting.

And it may hold the solution to many new and important designs that could not be commercially produced by the usual fabricating methods because of their intricacy or complexity. What *that* means to both Victory and post-war planners can plainly be seen.

⊕ ⊕ ⊕

HEAT-RESISTANT ALLOYS

Are Low in Critical Metals, High in Strength

ONE of the hardest conservation nuts for our engineers to crack has been the special group of alloys employed for turbines, furnace parts, oil-refinery equipment, and so on, because of their superior resistance to weakening and to oxidation at high temperatures. High in critical chromium and nickel (usually 5 to 20 percent chromium and 35 to 8 nickel), these materials have so far seemed unreplaceable by other metals without sharp loss of high-temperature resistance.

At a recent meeting of the American Society for Metals, however, it was announced that for service in the most important temperature range (up to 1400 degrees, Fahrenheit) a new "emergency" heat-resistant alloy was entirely satisfactory and could replace the widely used 18 percent chromium, 8 percent nickel, and 25 percent chromium, 12 percent nickel alloys with considerable saving in critical-material content. The saving is achieved by replacing a large part of the nickel and chromium with silicon and manganese.

The new alloy, developed by O. E. Harder and J. T. Gow of Battelle Memorial Institute, contains 10 to 13 percent chromium, 4 to 10 nickel, 2 to 12 manganese, about 2 silicon, and between 0.30 and 0.35 carbon.

With the nickel and manganese contents properly balanced, the new alloys have sufficient high-temperature toughness for the customary rough handling while hot in the foundry and yet are low enough in hardness to be machinable. The strengths of the alloys at 1400 degrees, Fahrenheit, are substantially higher than those of the commonly-used heat-resistant alloys at 1800 degrees, Fahrenheit.

Here is an "emergency" alloy development that is obviously destined to outlast the emergency.

BRAKE PISTONS

New Materials Being Tested For the Future

A REVEALING glimpse of what lies ahead in the field of automotive brake materials is afforded by some recent remarks of J. F. Bachman of Chrysler Corporation.

Brake cylinder pistons have very often been made of aluminum alloy, but wartime stringencies have forced engineers to use other materials, and some of them are definitely "here to stay." Tin-plated cast-iron pistons, for example, have turned out to be at least as satisfactory and certainly less expensive than aluminum.

Tin-plated steel and plastic with hardened steel inserts have also been successfully used and may survive the war period. Steel pistons, however, create a difficult handling and inspection problem because of the possibility that tiny burrs or nicks may scratch the cylinder bore and cause leakage. The plastic-and-steel pistons are still "under observation."

GUN BARRELS

Made from Seamless Tubing For 75mm Artillery

FOR DECADES, artillery gun barrels have been made by forging on large presses, a time-consuming operation followed by considerable machining, especially to make the bore. Then, a few years ago, Army production engineers developed the centrifugally-cast gun barrel, which is cast virtually to finished size and shape in a revolving mold. Centrifugally cast barrels can be produced much faster than forged, involve a minimum of waste metal to be machined away, and are cheaper to make.

Since the beginning of this war a brand new method (generally referred to until very recently simply as "Method X") has come into use for high-speed production of artillery gun

Columbia Newsphoto

A gun barrel in the making

tubes. This method, which is the fastest yet, consists of piercing an axial cavity in a long hot billet by means of piercing rolls, sizing by broaching, and then surface-finishing.

The method is in use at the Steel and Tube Division of Timken Roller Bearing Company, who are thus applying their knowledge of and equipment for making seamless steel tubes for various peace-time purposes to this important ordnance item. Piercing the hole in the hot billet takes 15 seconds and broaching is a relatively fast operation. The former practice of drilling a tough, heat-treated, solid forging alone required six hours.

The use of existing seamless tube mills for making gun barrels has eliminated the need for building dozens of new forging hammers and presses and hundreds of gun-boring lathes. In addition, the pierced steel tube is not only closer to finished dimensions than a hammer-forging, but the metal that would be cut out of the bore and returned to the mill as shavings is retained in the tube, actually part of the gun's wall.

Music in Industry

Management is Learning that There Was More than Mere Romance in the Old-Time Work Songs and Music. Psychologists and Engineers Show that Music Powerfully Controls Workers' Emotions and Even Their Physiology. The Factory Music Distribution System Increases Production

By HAROLD BURRIS-MEYER

Stevens Institute of Technology

AMID dislocations brought about by industrialization, one of our serious losses lies in the fact that music—the old sea chanteys and work songs—has gone out of work. When you separate work and song, you make work out of work.

The kind of data from which it can be determined what music actually does to workmen have proved to be sadly lacking. Instead of facts we have hearsay, hunch, and theory, all readily available in almost any quantity. Managements which use music and employees who listen to it seem to agree that music is a fine thing. Organizations which install electronic distribution systems and furnish programs have files full of letters from satisfied customers. There is a growing popular belief in this country that music in a factory can do just about everything except rearrange the stockroom or interpret the latest set of government regulations.

Evidence to show how good industrial music is, based on casual or superficial observations, is freely adduced. Everybody who gets his hands on a plant music distribution system at once becomes an expert and can tell you everything about programming, speaker placement, intensity levels, what the boss thinks about it, what the employee thinks about it, how little either of them knows about it, and what a good thing it would be if somebody had consulted him first. Employers sometimes ascribe to their employees their own reactions and opinions. One company gave up playing music because it interfered with the factory inter-communication system. An official of another would not install a system because, said he, "if I get it in and I don't like it, the employees will never let me take it out."

All this adds up to precisely nothing we can use. Even a report published by the Medical Research Council of the British Industrial Health Research Board is of limited use because, though the studies it treats are thorough, they apply only to a group of girls working in a chocolate factory.

Our interest is in emotional control. We are interested in exerting it directly by emotional stimulus, and by inducing physiological change as the basis for emotion. In industry the ends to be achieved by emotional control obviously are: To suit the man to his task; to give the work the status of a calling; to make it for the man, not what he lives by, not that which produces the pay envelope, but a major element in living. If that can be done, even if only in part, the work improves and the employee likes it. If you have control of the stimulus, if you can define it in terms of intensity, spectrum and cyclic quality and then measure the rate and quality of production, lateness, early departure, absences, accidents, and any discoverable indices of employee morale, without the worker's knowledge that he is a subject, you have a valuable technique for the study of emotional control and can, incidentally, find out what music in industry is good for, and how good it is.

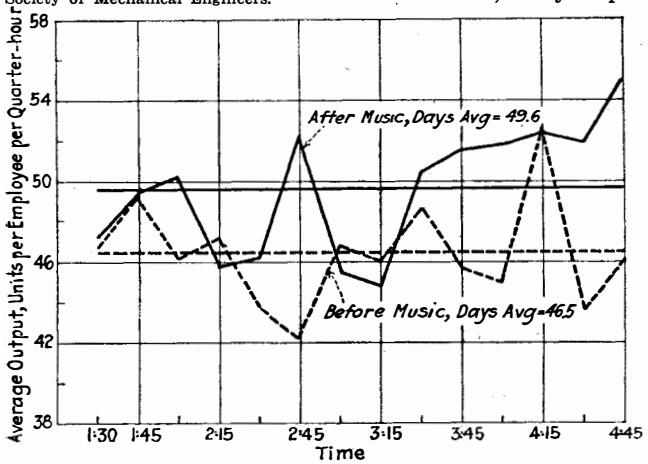
As a starting point, there is a considerable mass of physiological and psychological data. By auditory stimuli, we can control metabolism. We can increase or decrease muscular energy. We can increase respiration. We can increase or decrease pulse rate. (Try that on yourself sometime. Take your pulse while you sing: Change the tempo of the song and you will observe a change in your pulse rate). We can control the threshold of sensory perception, and this is very important in precision work. We can reduce, delay, or increase fatigue. By the control of these phenomena it is possible to establish a physiological basis for the generation of emotion.

Unfortunately, the phenomena I have mentioned have been studied only under laboratory conditions. The subject often knew that he was a subject, and that somewhat conditioned his response. Moreover, he was not engaged in his principal activity while being tested, nor did he share his reactions with a group. The extremely important phenomenon of mass reaction has been neglected. Obviously, then, even our basic theory when applied to music in industry needs validation in the factory.

Accordingly we proceeded to study existing musical programs in factories, and then to assemble programs for specific purposes. It has been our good fortune to have the co-operation of numerous industries and of two organizations dealing in factory music distribution systems and music libraries—Muzak, Inc. and Radio Corporation of America. Lacking the kind of factory records susceptible of statistical analysis for our purpose, we had to get them ourselves. The data we have are indicative. They are not sufficient to form the basis of unassailable conclusions, but we believe they show which way the wind blows.

We set about to measure the most obvious thing—does music in the factory influence the production rate? All the charts here presented were drawn from data taken under controlled conditions. No figures are used where

From a paper presented before The American Society of Mechanical Engineers.



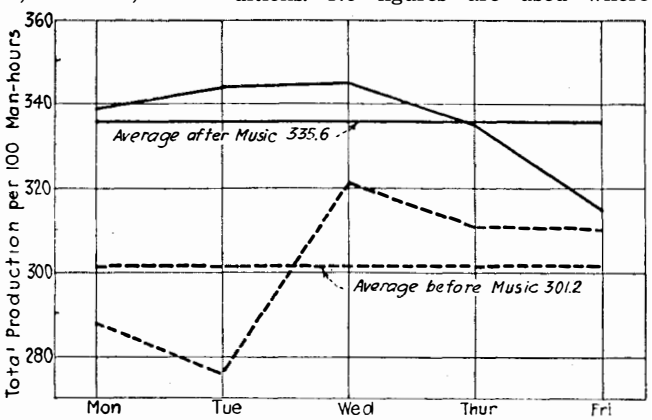
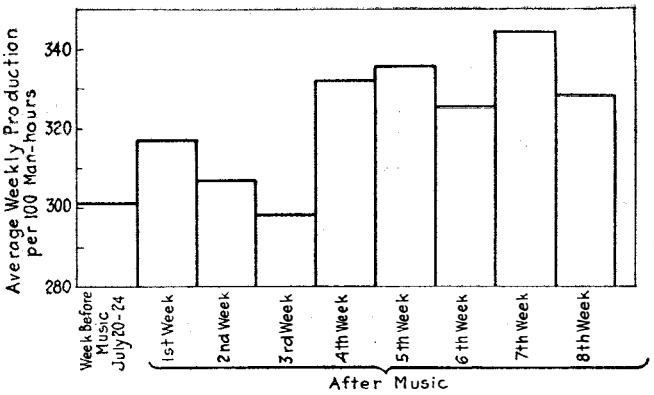


Figure 1, left: Effect of music on a day's production
Figure 2, above: Effect of music on a week's production



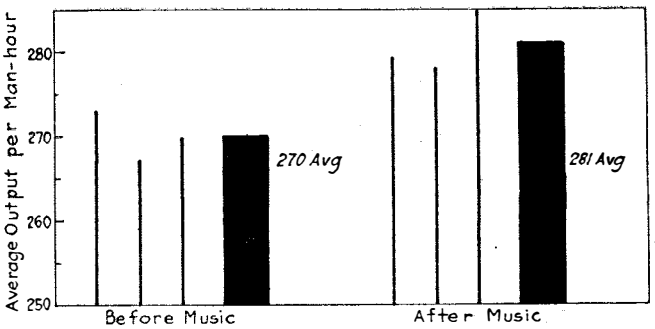


Figure 3, left: Effect of music over several weeks
Figure 4, above: Another result over several weeks

there were significant changes in weather (temperature, humidity, light), or ventilation, or noise, from day to day; or where there was other than normal labor turnover, or any labor-management quarrel; or where there was any plant change in terms of machine arrangement or color, or any variation in the process or the product.

Figure 1 shows the unit output per employee, plotted against time. The dotted curve shows a day without music, the solid curve a day during which music was used. The conditions prevailing on the two sample days were identical in temperature, humidity, ambient noise level, ventilation. The group consisted of 16 experienced employees. Both curves are erratic, but the horizontal line which defines the total area under the curves is considerably higher where music was used than where it was not. The difference amounts to 6.25 percent, based on the average before music. In more than 75 percent of the measurements of this sort in all the factories studied, we have found the area under the curve, or total production, to be greater when music is used than when it was not used.

Figure 2 shows the total production per 100 man hours during two typical weeks, one before and one after a music installation was made, and represents the average for a group of approximately 100 employees of all degrees of experience. The difference amounts to 11.4 percent.

Figure 3 shows what happens to production when musical installation is made. Each block represents the average production per 100 man hours in one week. In only one week was the average production lower after music was used than during the control week before musical installation.

Figure 4 shows a similar result in another factory. In the case of the latter, the operation studied was one requiring a very high degree of manual dexterity and a sense of timing. Employees were on piece work as in the case of Figure 3. The average difference is 4.07 percent. Each line represents a week, and the blocks show the average during the periods of study.

These charts would seem to indicate then that music makes work go faster and, since all the foregoing graphs were made where piecework prevailed, the employees profited by the changes introduced by the music.

A CONCOMITANT of the production rate is the problem of Monday absences and early departures with which some industries have to contend. Figure 5 shows what happened in a plant where the employees were on piecework and where they got tired and went home early, before the musical installation was made, did not do so much of that when there was music to listen to. The graph shows two sample weeks and an average before the musical installation; and four weeks and an average in which music was used.

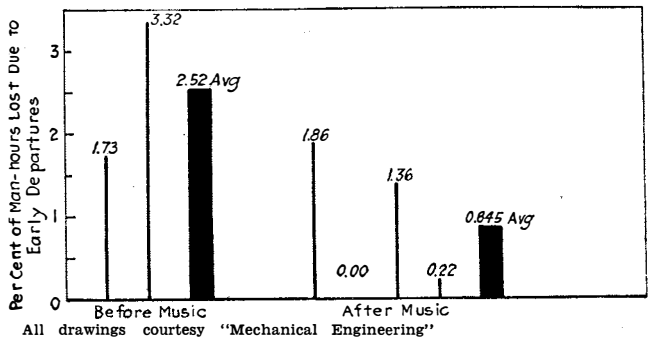
Figure 6 shows what music does to Monday morning absences. The lines show the percentage of absences per week for four average weeks before, and four after music installations were made; and the blocks show the four week averages.

In the case of all graphs, of course, averages have been computed from a base of a similar total number of employees. No data are included which are not based on identical plant, metereological, noise, and light conditions.

Having answered definitely, though for not too many factories, the question of what music does to the production rate, we set about examining the *kind* of music and *when* it was played. Programming is, as may be deduced from the laboratory data on auditory stimuli, of great importance. It is now practised in conformity with theatrical principles plus observation and experience. These serve well as a starting point, but are not susceptible of being weighed, measured, or analyzed by statistical means, and there is a considerable divergence of opinion among those who arrange programs on the question of the number and length of playing periods; the relative values of associative and non-associative music; the value of popular jitterbug versus classical music; the relative value of vocals and instrumental music.

It is generally accepted practice, however, to limit playing time to not more than 2½ hours per day, in periods of 12 to 20 minutes. Marches for opening, and marches and popular foxtrots for change of shift or closing time, are most generally preferred. Music during the last 20 minutes of work period is generally not employed since it might be taken as a signal to get ready to go home. Special radio programs, especially those planned for music in industry, are occasionally used. "Deep in the Heart of Texas" is out. It stops all work in the United States and in England because, naturally enough, the employees feel obliged to drop all work to join in the hand-clapping in the chorus. The "Strip Polka" is shunned for obvious reasons. Hymns are said to be in considerable demand on Sunday in some factories, though it has been observed elsewhere that hymns can *stop* work about as fast as a fire gong.

Luncheon periods are considered the most flexible in programming and often carry recorded messages to the folks back home from the men in service, bond sales talks, news reports, hot numbers for the jitterbugs, salon music alleged to aid digestion, request numbers, and so on. Some factories ban vocals during work periods, others like them.



All drawings courtesy "Mechanical Engineering"

Figure 5: Here music reduced mid-afternoon homegoings

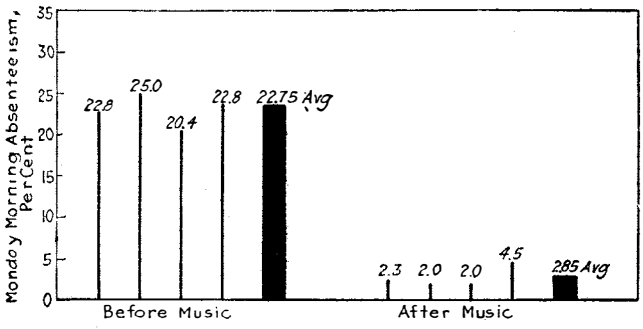


Figure 6: What music did to Monday morning absences

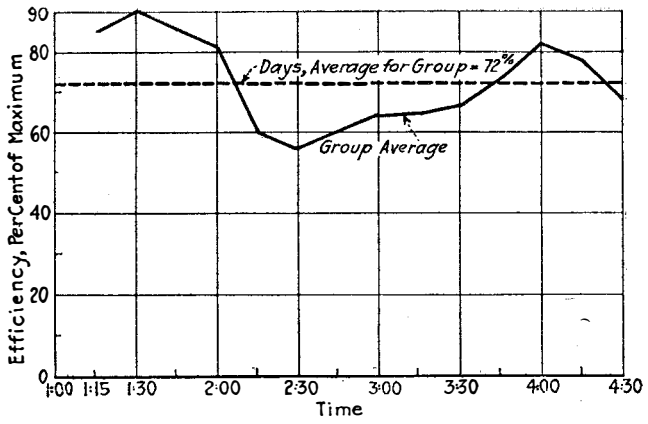


Figure 7: An afternoon production curve before music

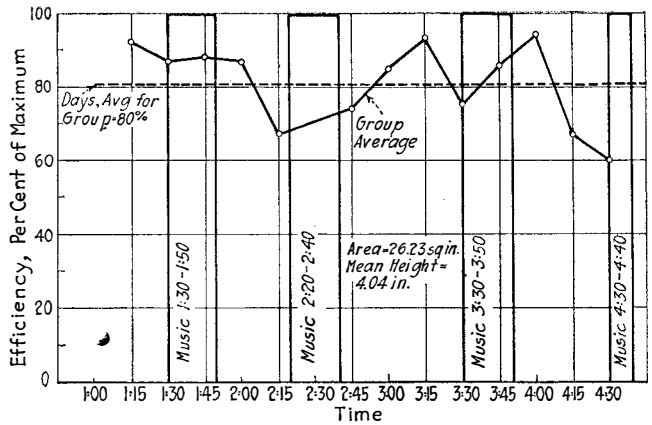


Figure 8: Effect of music, same period, same company

Employee demand for music rises at night, and music is a source of comfort during blackouts. One factory played "Take Me Out to the Ball Game" as the World Series started, and announced the score every third inning.

It is obviously impossible to make the value of many of these program elements the subject of statistical analysis. But the mere diversity of the opinion and material seems to indicate that one kind of program ought to be better than another, especially in the case of a specific set of conditions or type of operation.

So far as I can discover no one has gone down to bed rock on the subject. The empirical development of a system of programming would be all right if records of results were kept. The development of a program from psychological and physiological data at hand is another approach to the problem of programming.

WE HAVE been able to undertake only one experiment in this field designed to demonstrate that a musical program planned for a specific purpose can accomplish that purpose. The factory has had music for six months. Programming was provided by the organization which installed the distribution system and was, so far as we were able to evaluate it, a better than average program. It consisted of numbers especially arranged and recorded for industrial use, was arranged on the basis of experience and observation, and reproduced with high-fidelity equipment.

We were unable to obtain any production figures of our own for the period before music. However, we went back to some records which the company had kept approximately one year before this experiment took place, and, although we cannot vouch absolutely for the conditions obtaining at that time, we believe that Figure 7 provides a fairly representative picture of what their production curve looked like at that time. The average here is 72 percent. As the subsequent graphs will show, there was an increase of 8 percent with the installation of music, and 14.8 percent with a planned test music program.

The production curve, Figure 8, showed a reasonably uniform pattern involving a sharp dip at approximately 2:15 in the afternoon. The test program was planned with the sole purpose of knocking the bottom off the 2:15 dip. Figure 8 is based on a typical day with the standard program and Figure 9 a typical day with the test program. On the second chart the 2:15 dip has been reduced approximately 20 percent, also the total day's production (area under the dotted line) has been increased in the case of the test program 6.8 percent. This would seem to bear out a theory to which I have long subscribed, which is that, while music is better than no music, programming will not be satisfactory until it is undertaken on the basis of a careful analysis of the results it gets. More statistical analysis of factory performance should teach us much.

I believe that programming must ultimately be undertaken for the factory, if not for the specific operation. Fatigue curves vary in shape and amplitude, and it is difficult to find one remedy for dips occurring at different times in different operations. We have, at least, established the fact that the remedy exists and the technique for employing it is in hand.

Whether we like it or not, music in industry appears to be here to stay and bids fair to be of increasing importance as time goes on. It has been indorsed by responsible officers of both the A.F. of L. and the C.I.O. Factory sound installations are now mandatory in England. This is primarily to avoid loss of time in the case of air raids by not calling the employees out until the last moment, but so far as I can discover, more factories appear to use the systems for music than do not. Numerous radio stations here and in England carry musical programs planned for broadcast to factories. Once the sound system is in, music comes in with it. The number of factories employing music in this country grows so rapidly that statistics of this week are no good next. Installations progress and programming improves. Music works but we still have a long distance to go before we can make the work sing.

Little of the music used in the factory is germane to the endeavor it accompanies. The work song took not only its rhythm but its mood and lyric from the work operation. The transcription carries something composed for the concert hall, the stage, or the night club. At best, it is only adapted to industrial use by reorchestration and arrangement. When the composer starts to think of his work as being first and oftenest performed in a factory, before people who are working while they listen; when he proceeds as some composers are already doing, by treating proved auditory emotional stimuli according to musical pattern; when he sets himself the task of making the work sing, then we may well have a musical idiom which is something new on earth.

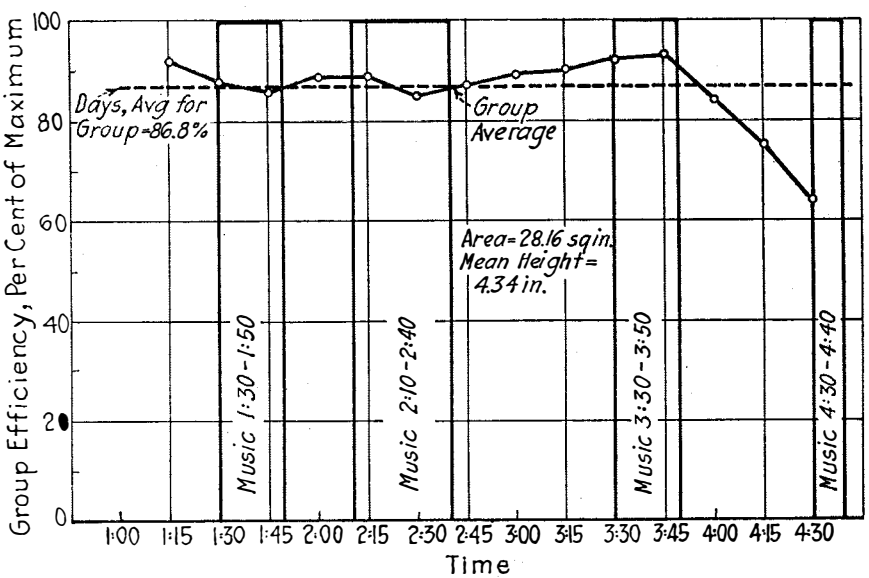


Figure 9: Still better effect. The program was carefully planned

Felt Goes To Work

Either Alone or in Combination With Other Fabrics and Natural or Synthetic Substances, Wool Felt is Being Used in Many Industries. Some of Its New Alternate Applications Will Find Permanence in Post-War Days

By WORTH COLWELL

MONTHS BEFORE our entry into World War II it became apparent that shortages of certain vital materials would be inevitable, and industry began to look around for products that would take the place of such necessities as rubber, cork, leather, rope fiber, tin, shellac, and certain plastics requiring critical chemicals in their processing or manufacture. As defense plans in December 1941 suddenly evolved into a gigantic offensive program, the demand from a multiplicity of diversified sources swelled to astronomical proportions. One of the answers to this demand was found in wool felt, a commonplace, unspectacular, natural-fiber fabric—in fact, the oldest fabric known to man. Through intensive research and experimental effort, this old-new material is now finding uses in many ways that were unexplored before pressure was brought to bear.

Felt has thus become an important alternate and complement for many vital substances, especially rubber. And because of the successful applications that have been found for the material alone and in combination with other substances, wool felt now is regarded as a factor to be considered in the post-war economy ahead; in many cases it has proved superior to the material which it supplanted.

Just how many civilian and military uses there are for this product is not known precisely. Certainly no other material manufactured from natural fibers finds so many ways to make itself useful in mechanical and industrial fields. Throughout the ages it has been valuable for clothing and shelter, but modern minds carry its employment much further. Because of its structure, it is useful for cushioning, filtering, wicking, vibration-isolation, lubrication, sound-deadening, heat insulation, grinding and polishing, packaging, and other applications in other and more specialized fields.

Felt is now rendering service in thousands of recently discovered ways, ranging from tiny filters in hypodermic needles to washers in block busters and padding for Flying Fortresses and amphibious "Ducks." It becomes cushioning for gun-turret mounts, insulation against vibration in fighting planes and tanks, and gaskets for gas-masks. In desert fighting felt keeps fine sand out of airplane engines.

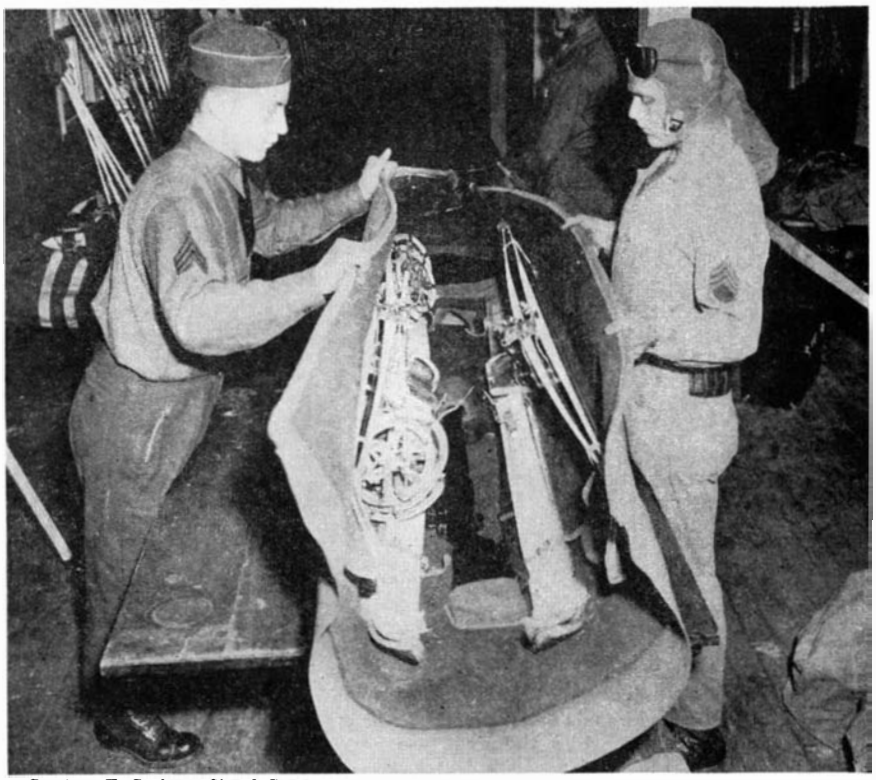
Definite but differing reasons have led to the selection of felt for canteen covers, pack saddles, and ammunition cases. It has kept millions of pairs of feet warm through the centuries, and still is doing the same job. Aviators' helmets are lined with felt and the Navy North Atlantic Patrol, Coast Guard, and other service branches use combination felt masks and helmets in inclement weather. Recently, United States Army research in arctic Alaska, as well as civilian experiment, revealed once more the meritorious properties of wool felt for keeping troops warm.

Many industrial uses for felt have resulted from recent experiments, as, for example, in the elimination of vibration in factory buildings and other structures. This does not mean merely prevention of damage to machines, walls, and floors; eliminating vibration and, hence, noise, improves workmanship, morale, and health of employees.

Because of its porous structure, felt can be made into consistencies which are effective for heat and sound insulation, and it reduces resonance by absorption when applied as a surfacing material, as in the lining of airplane fuselages and cabins. A blend with kapok fiber for such linings provides excellent thermacoustic properties.

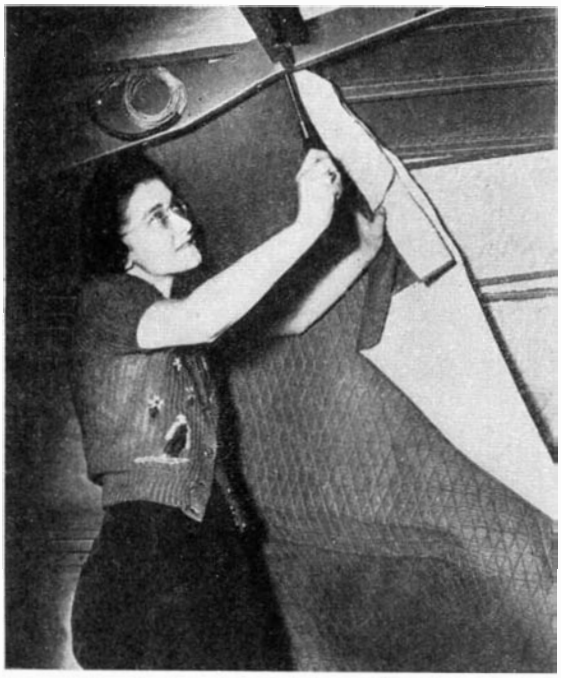
Quite a different type of mechanical use for felt depends upon its capillarity. All sorts of motors—in electric fans, electric razors, and so on—are lubricated with felt wicks. Ink for automatic printing equipment is fed in this way, and numbering machines, postage meters, and telegraphic printing instruments use felt for the same reason.

Sealing of ball bearings against moisture and abrasives and preventing leakage in oil pistons, grease guns, universal drive-shaft housings, and various other



Courtesy U. S. Army Signal Corps

Para-ski troopers rolling ski-equipment bundle, lined with wool felt padding for protecting contents when the bundle is dropped from an equipment-carrying plane



Curtiss-Wright plane being lined with kapok felt for sound-proofing and thermal insulation

units is accomplished by the use of felt. Millions of bearings are literally sealed for life by felt washers backed with a layer of synthetic material. The felt forms an oil reservoir and distributor, due to its natural wicking properties, while the impervious backing acts as a dam to exclude grit and moisture.

THEN, too, the fibers and interstices in certain grades of felt are so fine that they are useful in filtering liquids such as alcohol, gasoline, electroplating solutions, latex, and so on, in both gravity and pressure equipment. Non-reactive tendencies make it desirable for filtering fruit syrups. It has important surgical applications, too, as in blood transfusion apparatus, and finds wide use in respirators and industrial dust masks. It enjoys a high rating for removal of lead particles and other solid impurities in the air.

Another important virtue of felt is that it can be readily combined with certain natural and synthetic substances such as cotton, rayon, kapok, plastics, silk, jute, hair, and so on. Coating felt with a film of synthetic rubber proofs it against absorption of oil, water, and acids. Such rubber-coated felt pads often weigh only about one third as much as similar pads of molded rubber, an important factor in airplane construction. Impregnation and lamination of felt with plastics gives the desirable toughening qualities of felt to the combination.

There are two general classes of felt parts which are acceptable under government specifications as alternates for rubber parts. One is a felt part, identical in form and dimensions to the original, which has been impregnated with rubber or a rubber-like plastic material. The other is that in which the part has been coated, usually by a simple dipping operation. A third development along the same line leads to molded rubber parts having a felt core.

As familiarly known, wool felt is a springy, resilient substance, but it can be processed to almost any consistency from the softness of thistledown to a surprising degree of hardness. Unlike true textiles, in which spun and twisted fibers are guided into a predetermined pattern by weaving or knitting, the fibers in felt are "teased" into an almost self-selected arrangement, without distortion of their natural twists and bends.

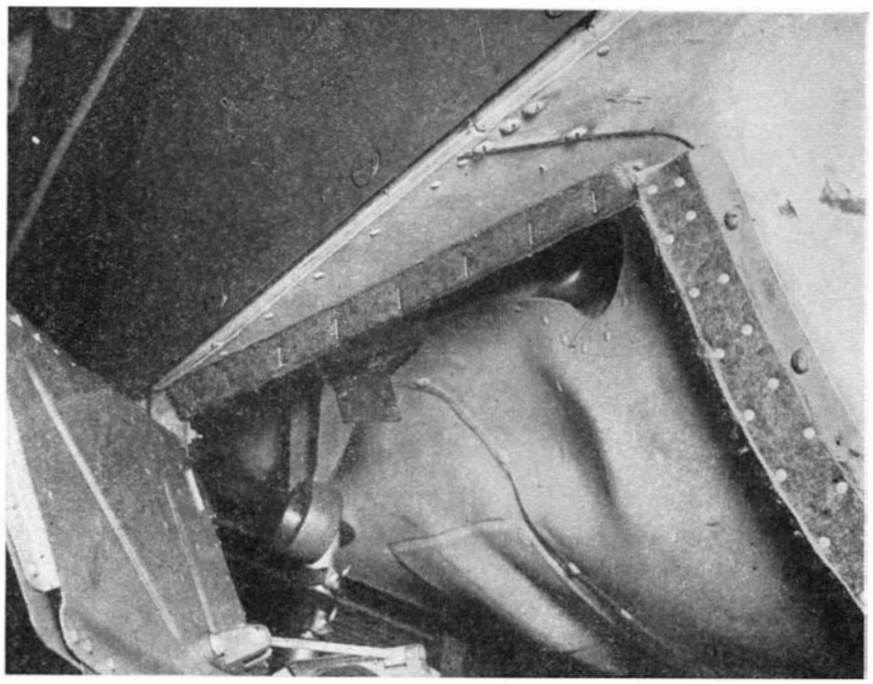
In the highest grades of felt, clip wools and "noils"—the soft combings of the sheep's coat—such as those usually spun into yarn, are used. (Felt hats are often made of rabbit, beaver, and other furs, sometimes with a percentage of sheep's wool, depending upon the grade; but for industrial uses these furs are not employed to any extent, as they lack certain of the desirable qualities offered by wool.)

In the manufacture of felt, the interlocking of fibers is obtained, under controlled conditions of pressure, temperature, and moisture, by carding, hardening, and fulling so that they tangle into a three-dimensional fabric. The longer the pounding of the fulling process is continued, the more closely the fibers are compacted and the denser and stronger the product becomes. By repeating the fulling operation, felt may be rendered hard as a wooden board, a consistency used in wheels for polishing plate glass and searchlight lenses and in numerous metal-buffing operations. With less fulling, intermediate gradations may be obtained, having resilience, which is useful for cushioning; controlled porosity, the property needed in wicks and filters; and warmth, a function of porosity due to the inclusion of dead air.

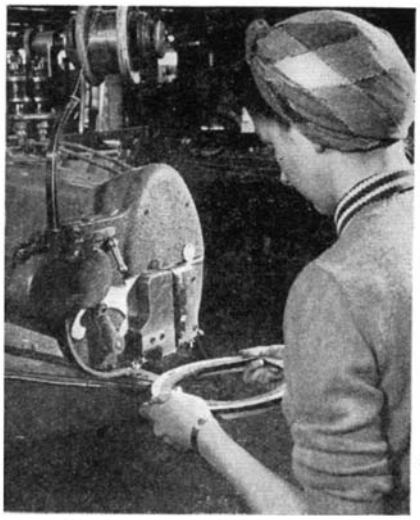
A primary advantage of felt is that when cut in any direction, the edges will not ravel or fray. Consequently thousands of items, ranging from military insignia to corn plasters, are simply cut from the goods at a single stroke of a cutting die, and when so chopped out are ready for use. Mechanical felts, such as washers, oddly shaped gaskets, grommets, grooved channel, and round wicks from one-sixteenth of an inch to an inch in diameter, are in this way cut from roll felt to customers' blueprint specifications. The accuracy of these operations is remarkable con-

A Few of the Many Uses of Felt for Today and Tomorrow

Bomb sight cover padding
Bulkhead insulation
Fuel tank cradle padding
Lubricating engines and motors
Sensitive instrument mounts
Thermacoustic cabin lining
Signal Corps carrier bags
Transmitter tube cases
Arch supports
Boots and shoes
Caps
Uniform linings
Gas mask air filters
Clutch housing and other dust covers
Steering knuckle and other oil seals
Motor car body-to-frame and other pads
Artificial feet and hands
Plaster cast padding
Tourniquet pads
Machine gun scabbard lining
Thompson gun breech oiler
Engine cylinder hones
Eyeshields
Vibration isolators



Two methods of fastening strips of wool felt to metal. Right: Felt sealing strip fastened by old method of riveting. Left: New Morrison metal stitcher method



Metal stitcher efficiently and speedily stitching felt sealing ring to metal

sidering the nature of the material, as permissible tolerances are commonly expressed in thousandths of an inch.

An important fact in connection with the use of felt as an alternate for other engineering materials, is its comparative and often complete immunity from many influences which are detrimental to substances formerly employed. Sunlight, ozone, strong acids, and petroleum derivatives are destructive to most rubbers, for example, but do not injure felt because the wool of which it is composed is impervious to their influences.

Thus the multiple uses of felt derive from the inherent properties of sheep's wool and from the variety of consistencies to which it can be processed. Wool felt, therefore, is sometimes called *natural* felt, to distinguish it from felt-like products which are built up and bonded together by artificial means. Wool felt, by contrast, is composed exclusively of interwoven fibers, and when impregnated with another substance, the impregnation is for purposes other than binding.

Undoubtedly felt is going to play a part of growing importance in the new world of mechanical products in the post-war era. The chief reason is because it is chemically stable. Many products of chemical processing are subject to internal change, as time-tests and research reveals: some "age," as does rubber, whereas felt is different. It is a mechanical rather than a chemical combination, produced from natural fibers whose important element, keratin, was stabilized by Nature before the parental fleece was shorn. This substance is unaffected by manufacture and time has only slight effect upon it. Many relics from Egyptian tombs and other ancient caches bear witness that it lasts for ages.

⊕ ⊕ ⊕

Photography, An Industrial Tool

Sensitized Film is Being Applied to New and Important Uses, not Only in the Laboratory but for Constant Checking of Production. The Spectrograph, the X-Ray, Photomicrography, the Profilograph, and the Motion Picture All Find Applications

By ALLAN PERRY
E. I. du Pont de Nemours and Company, Inc.

In significant and spectacular ways, photography is coming into its own in industry. Headlines have been accorded to such developments as million-volt X-ray radiographs, electron microscope pictures providing useful magnifications of 100,000 diameters or more, and the reproduction of "lofting" layouts printed on steel templates. Yet there are other new procedures, less publicized, which represent important uses of sensitized film as a tool of industrial research and production.

The spectograph, for example, is being utilized increasingly in the laboratories of the nation for making quick and accurate analyses of many substances. By means of this instrument the light given off by burning a specimen of the unknown material is passed through lenses and prisms and made to form a "picture" of the various wavelengths emitted by the burning material. Thus a fine-line spectrogram is produced, characteristic of each chemical element. From this record the unknown material is analyzed in a matter of minutes compared with hours, if not days, required for ordinary chemical procedures. The minutest trace of an element, such as a metallic impurity too small to be analyzed by chemical means, is instantly revealed. And the information is definite and positive.

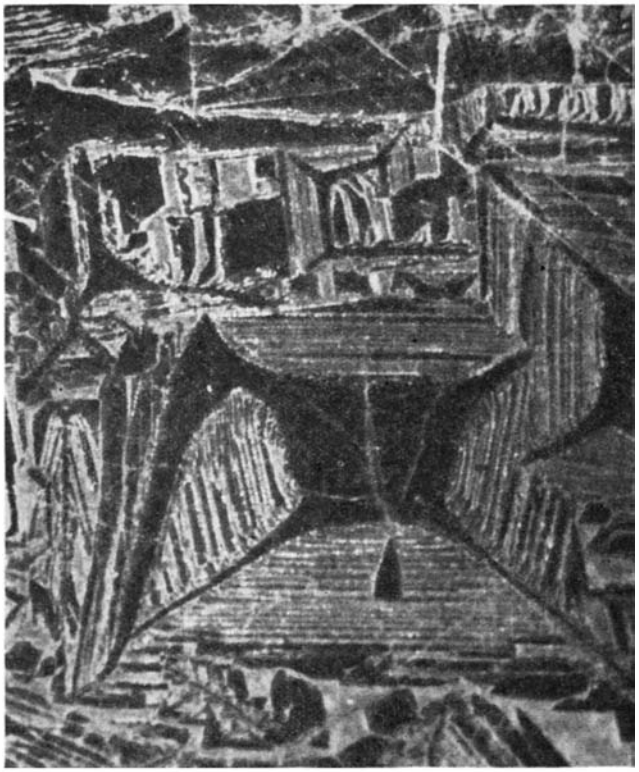
Although proper interpretation of spectrograms calls for a high degree of specialized academic training, many of the mechanical operations incident to making spectrographic pictures can be performed by a skilled technician who has little or no knowledge of the fundamental principles of spectroscopy. But all spectroscopic work calls for the utmost in orderliness and cleanliness, since contamination of the sample by even a slight trace of "dirt" might give rise to highly misleading results.

Operation of the spectrograph is simple. The specimen to be analyzed is placed in the cupped end of the lower of two vertical carbon electrodes. As the specimen is burned in the electric arc, its characteristic light passes through a prism and the prismatic "colors" are registered on photographic film, not, however, as colors, but as narrow lines or bands corresponding to wavelengths of the radiations emitted. Interpretation of the clusters of fine black vertical lines—each group representing one or more spectral colors, and, therefore, the presence of a particular element—is facilitated by comparison with a standard spectrum scale. The relative positions of the dozens—possibly hundreds—of black lines tells the qualitative story. At the same time density or "blackness" of the lines yields quantitative information, which, for rapid work, is accurate to plus or minus 10 percent. With more care, however, the margin of error can be held down to around 2 percent.

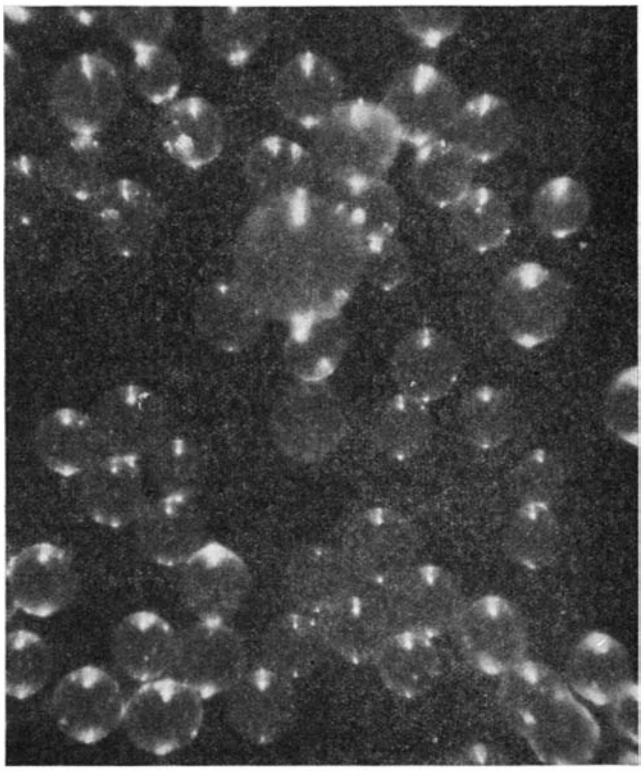
Shortly after a spectrograph was installed at the Du Pont Experimental Station, the instrument proved its worth with a typical performance. At that time new equipment was being installed in a nearby pigments plant. Workmen were lining certain reaction vessels with lead of a supposedly high degree of purity, which, however, was acting badly. It would not "weld" properly and, although the manufacturer of the lead insisted his product was of the required purity, its behavior indicated otherwise. A specimen was taken to the spectroscopic laboratory. Within 20 minutes it was found that the lead contained both tin and antimony in detrimental amounts, and it was the presence of these two unwanted metals which caused the trouble encountered by the "lead burners." Ordinary chemical analysis might have held up lining this essential equipment for days, and even then it is doubtful whether the chemist could have told the entire story, unless very large samples were used, since only small amounts of the contaminating metals were present.

Excellent for such detective jobs, only a short time later the spectrograph tracked down the source of traces of manganese contaminating a chemical product. Inadvertently, so it proved, a piece of welding rod of the wrong composition had been used in making the welded seam of a piece of plant equipment. This error—due probably to improper labeling of the welding rod—resulted in manganese contamination.

In the applications of X-rays to industry, the most familiar branch of the science is called radiography. Different materials absorb X-rays in varying degrees. As these rays penetrate, a



Microphotograph of etched metal surface, showing the pattern characteristic of a certain experimental alloy



Neither soap bubbles nor caviar but greatly enlarged particles of Lucite methyl methacrylate molding powder

"shadowgraph" is registered on film, showing the shadows of structural details or cracks and hollow spaces in welds and metal castings.

It is but a logical step to team up X-rays with magnification. Yet this step was taken with difficulty since there exist no lenses, comparable with the lenses of a microscope, for the enlargement of X-ray images. Micro-radiography must rely, therefore, on microscopic enlargement and photography of the image recorded in the developed silver emulsion of the original X-ray film. Relatively little attention has been paid to micro-radiography as a method for industrial testing and research, yet it has great inherent possibilities.

Enlargements up to 300 diameters without loss of detail are now being produced in research laboratories and in testing many important war materials, especially alloys. This new technique depends on an extremely fine-grain emulsion, together with the employment of radiations of two or more wavelengths. That is, the radiographer, using an ordinary diffraction X-ray apparatus, chooses certain wavelengths which will give suitable differentiation between the metals in any given alloy specimen. For example, certain bronzes have been successfully micro-radiographed using the characteristic radiations of molybdenum and copper.

The advantages of this technique are several. A three-dimensional view of a specimen is obtained, compared with a two-dimensional view obtained by ordinary photomicrography. An instance of the value of such an image is well illustrated by the revelation of an impurity in very large grains of silicon steel for heavy duty electrical use which was missed entirely on photomicrographs of the metal surface.

Another typical micro-radiograph shows copper in layers in an age-hardened aluminum alloy for aircraft when the copper, to give satisfactory performance of the alloy, should have been in solid solution. Still another application revealed cracks in cartridge brass resulting from improper seasoning or annealing operations—a long recognized and dreaded type of failure.

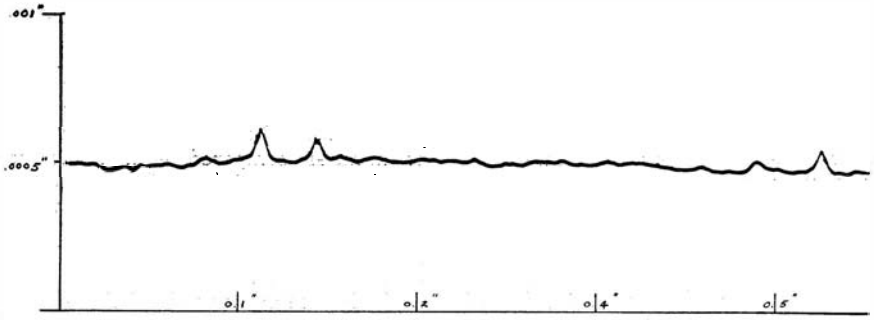
Prof. G. L. Clark, of the University of Illinois, who developed the technique involving the use of an ordinary X-ray diffraction tube instead of the very soft radiation used in earlier work, has demonstrated the value of micro-radiography not only in a wide variety of alloys but in many other materials. Metals such as tungsten, which are most difficult to use in photomicrography, lend themselves to this method. Ceramic materials, minerals, powders, fillers in rubber and plastics, bone structure—especially in the cases of lead poisoning—soil and clay sections, fillers in paper, and foreign particles in insulators all have been successfully subjected to this technique.

Sensitized film plays a part in a useful instrument known as the profilograph, a device capable of measuring the smoothness of surfaces. This machine is so sensitive that it can be made to record even sub-microscopic "roughness" of surface contours. A "profilogram" of a smooth plastic sheeting, for example, has the appearance of an outline of a mountain range.

Roughly, the profilograph comprises a vertical pinpoint with mirror attachment, under which the surface to be examined is moved slowly, in a lateral direction. A ray of light from a fixed source strikes the mirror attached to the pinpoint and is reflected to a distant scale, forming what is known as an "optical lever." As the surface under investigation is moved slowly under the pinpoint, which is free to rise and fall with surface irregularities, these variations are recorded by the light ray falling on film.

Visual education, with movies as textbooks, is being employed to great advantage in training our Army faster than ever before in history. Industry also is educating hordes of new workers to their production tasks with training films.

From the first day in camp for the raw recruit to the time he starts his schooling as a tank repairman, a bar-



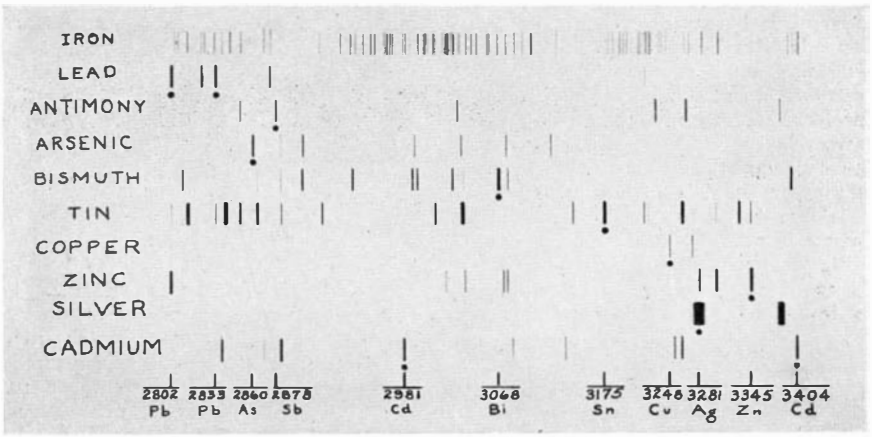
Profilograph record of smooth plastic sheeting at extreme magnification

rage balloon crew member, or just as a smart infantryman, he goes often to the movies to learn his job.

Prints by the hundred of each training film, as factual and accurate as Hollywood's are make-believe and glamorous, are sent to camps all over the nation, and to posts abroad from Iceland to Australia, where they are shown and reshown, studied and restudied. As much as 40 percent of training time has been saved when men see as well as hear their lessons.

Seeing is believing—and understanding. The Army knows that a recruit can be told over and over again the wisdom of digging a fox hole quickly and deep, that German bobby-traps call for extreme caution, but in combat excitement the soldier is prone to forget, especially the first time, which, unfortunately, may also be the last time. Therefore, experts are filmed showing not only what to do, but what happens through failure.

Looking ahead to the post-war world, it may be said that the wartime use of motion pictures in plants and among the services to teach will have far-reaching effects. Peacetime educators long since recognized that the written word is subject to the personal interpretation of the individual, and oral instruction likewise becomes adulterated, but the motion picture impresses the original form and meaning.



Everyday elements in the electric arc as seen by the spectograph

Numerous other examples of film as an industrial tool might be cited. More familiar procedures would include the X-raying of castings to detect flaws, also microcopying for the preservation, economical storage, and easy transportation of blueprints and documents. New is the method of making a photographic "plate" by sensitizing one surface of structural sheet metal with emulsion. Already in use in aircraft factories, this production time-saving process is put into play when a mechanical drawing, made on metal coated with a fluorescent lacquer, is exposed to X-rays placed in contact with the sensitized sheet. The result is a photograph of the drawing, having the same size as the original. Tedious re-drawing by hand as well as the possibility of human error is thus eliminated.

Truly photography has come of age; the day is at hand when sensitized film joins company with man's major inventions for producing things faster, cheaper, and better.

AIR-BLOWN CORES

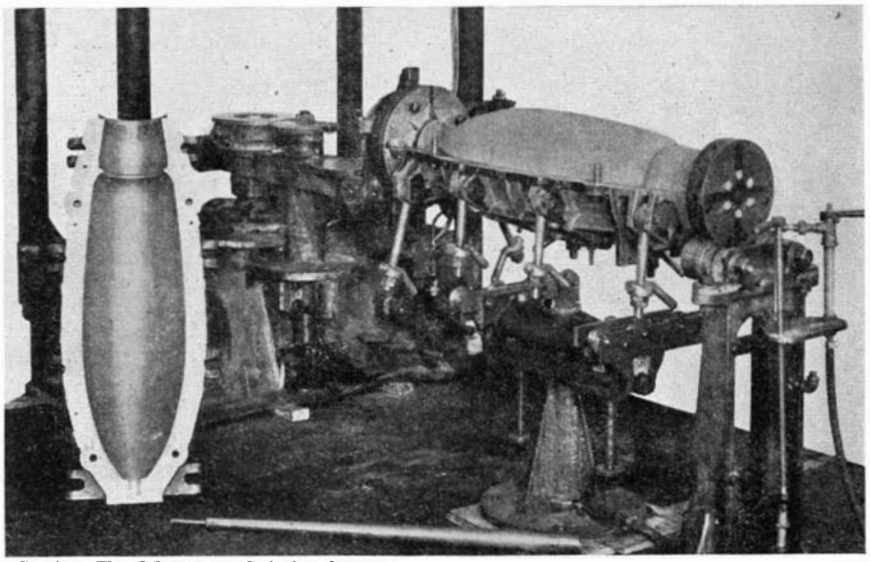
Used in Foundries for Making Castings

HAND or mechanical ramming and tamping of sand to form foundry cores is being rapidly replaced by modern core-blowing machines which turn out cores of more accurate dimensions much faster and with far greater resistance to injury or damage during handling.

Cores to give desired inside dimensions and shapes in many products are absolutely necessary. Due to different shapes, contours, and the necessity for a solid outer surface, it would not be possible to drill or ream out inner cavities. Cores, therefore, of solid character must be a part of the casting pattern. These cores, due to the small opening of the completed casting, could not be removed after the casting is cooled if they were made of one solid piece. Thus sand is blown by compressed air into a core mold, and, because of dry binders, core oil, and moisture, this sand packs together in a smooth, comparatively hard-surfaced core. After the metal has been poured between this core and the outer mold and the casting cooled, the sand can be removed by pulverizing and used again after conditioning in another core.

To produce satisfactory cores for this type of casting, compressed air must be supplied in adequate volumes, at constant pressure, and free from excessive moisture. The most commonly used blowing pressure for core molding is from 100 to 120 pounds at the machine. Small cores, on the other hand, are successfully blown at pressures as low as 90 pounds.

One of the dramatic applications of compressed air in war production foundries is found in the manufacture of aerial bombs. Cores for these bombs are made in quantities and in many different sizes by core blowing machines and air compressors.



Courtesy The Osborn Manufacturing Company

Air formed sand core of a bomb ready to be removed and placed in casting form

CAPSULE-TABLET

Has Advantages in Administering Vitamins

VITAMIN preparations and concentrates can be administered with greater ease and efficiency in a new capsule-tablet used by Lederle Laboratories for its products of the kind.

The new dosage unit consists of an emulsion of the vitamins in gelatine, each unit being subsequently coated with a seamless, leakproof outer layer of plain gelatine. Important advantages lie in the fact that the oily vitamin mixture exists in tiny droplets firmly embedded in the gelatine mass and hence cannot escape, as it would through any

flaw in the gelatine coating of the usual capsule. Furthermore, the dose is released gradually as the gelatine dissolves and in infinitesimal droplets, the preferred form for assimilation. No large drop of oil is suddenly released, as with gelatine capsules hitherto used, to cause eructation and unpleasant aftertaste. The final protective coating of gelatine surrounding the particle of emulsion—thinner than that required to hold oil—is extremely slippery when moist and slides easily down the throat.

AIR-RAIL TERMINAL

Planned to Handle All Transportation Facilities in Mid-West

PLANS for a $25,000,000 mid-continent air freight and passenger terminal at Oklahoma City to provide coördinated post-war facilities for handling highway, rail, and air traffic at the geographical center of America's transcontinental airways were announced recently. The program, which is to be financed entirely by private and local funds, calls for a terminal layout covering six square miles, within nine miles of the city's business center, and a seaplane base on a 2500 acre lake.

Preliminary plans already completed by the Austin Company, designers and builders of the country's largest aircraft plants and airports here and abroad, call for the construction of two 11,000 foot runways, 500 feet wide, to serve glider tow-trains and planes carrying up to 400 passengers or 160,000 pounds of freight. Four other runways for commercial planes, a civilian flying field, a helicopter base, a passenger terminal with 100-room hotel, and hangers would complete the aviation facilities.

Railroads and truck lines will enter the terminal on a level below the apron devoted to loading cargo planes, for direct transfer of mail and freight between land and airborne transports by gravity conveyors and elevators. Private motorists and motor buses, as well as interurban transit lines, will have direct access to the passenger terminal through traffic arteries paralleling the rail and truck facilities.

DIESEL NOISE

Can be Abated by Correct Design

NOISE in Diesel engine exhausts is caused by longitudinal oscillation at acoustic velocities of gases which snap like a teamster's whip unless checked, while noise in Diesel blowers can be silenced by eliminating easy modes of vibration, according to Ralph L. Leadbetter, of Burgess Battery Company.

Mr. Leadbetter, addressing the Diesel Engine and Fuels and Lubricants Meeting of the Society of Automotive Engineers, warned that application of a braking effort to gas oscillation in the exhaust line may interfere with proper scavenging and recommended a "snubber" having a volume of approximately 40 times the volume of gas discharged into the exhaust pipe with each pulse from the engine.

Silencing the air intake was said to call for preventing noises due to vibration of housings and for quieting the air inlet opening, the scavenging pump, or the blower. Mr. Leadbetter suggested that the blower housing could be laminated as an expedient, but should be constructed either in sections or with ribs cast integral with the surfaces, to prevent ringing.

COLOR MATCHING

Camouflage Work Aided By Electronic Device

A VITAL role in helping our fighting forces to deceive enemy observers is being played by General Electric's recording spectrophotometer, which is described on page 256 of this issue. The instrument is being used to match camouflage colors so that they cannot be detected by the enemy's infra-red cameras.

Camouflaging, an art which depends on the use of color, suffered a major setback when the infra-red camera was developed. Infra-red light, which is not visible to the human eye, can be photographed on special film. Thus, two objects which to the eye have the same color may photograph differently with the special film, due to different amounts of infra-red received from them. This means that the camouflage artist cannot judge from the appearance of a color how it will look to the infra-red camera.

But the spectrophotometer, an electronic machine, has now come to the aid of the camouflager. It gives him a measure of color—both visible and invisible—which puts him on an equal footing with the infra-red camera. For by determining the amount of light on infra-red wavelengths that is reflected by any paint or other material he wants to use, he can tell what effect that material or color will have on the plate of the infra-red camera.

COMPRESSORS FOR EXPLOSIVES

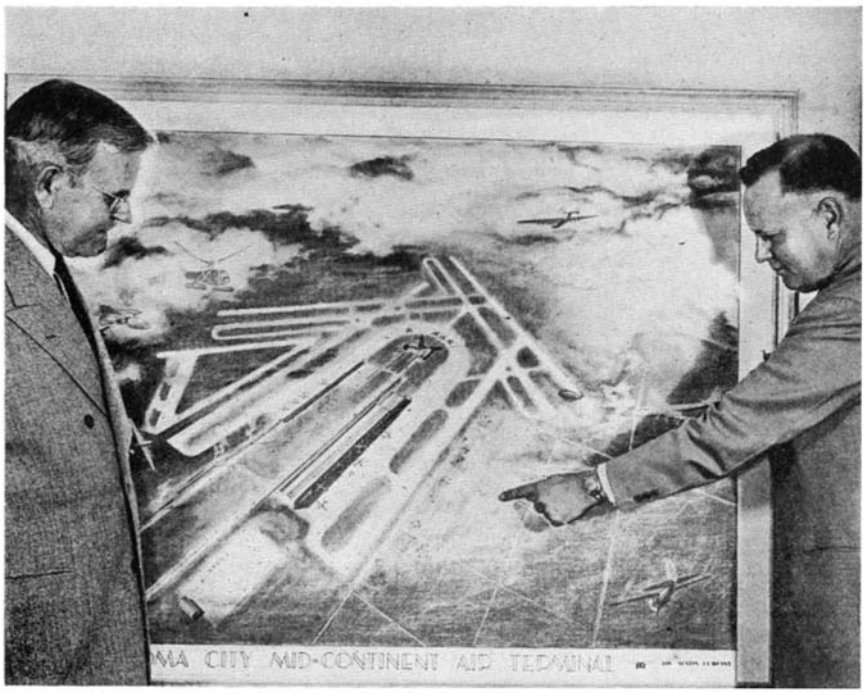
Production of Nitric Acid Requires High Pressures

AIR COMPRESSORS are vital in the manufacture of explosives, being used in many of the involved steps in the production of nitric acid, obtained from synthetic ammonia.

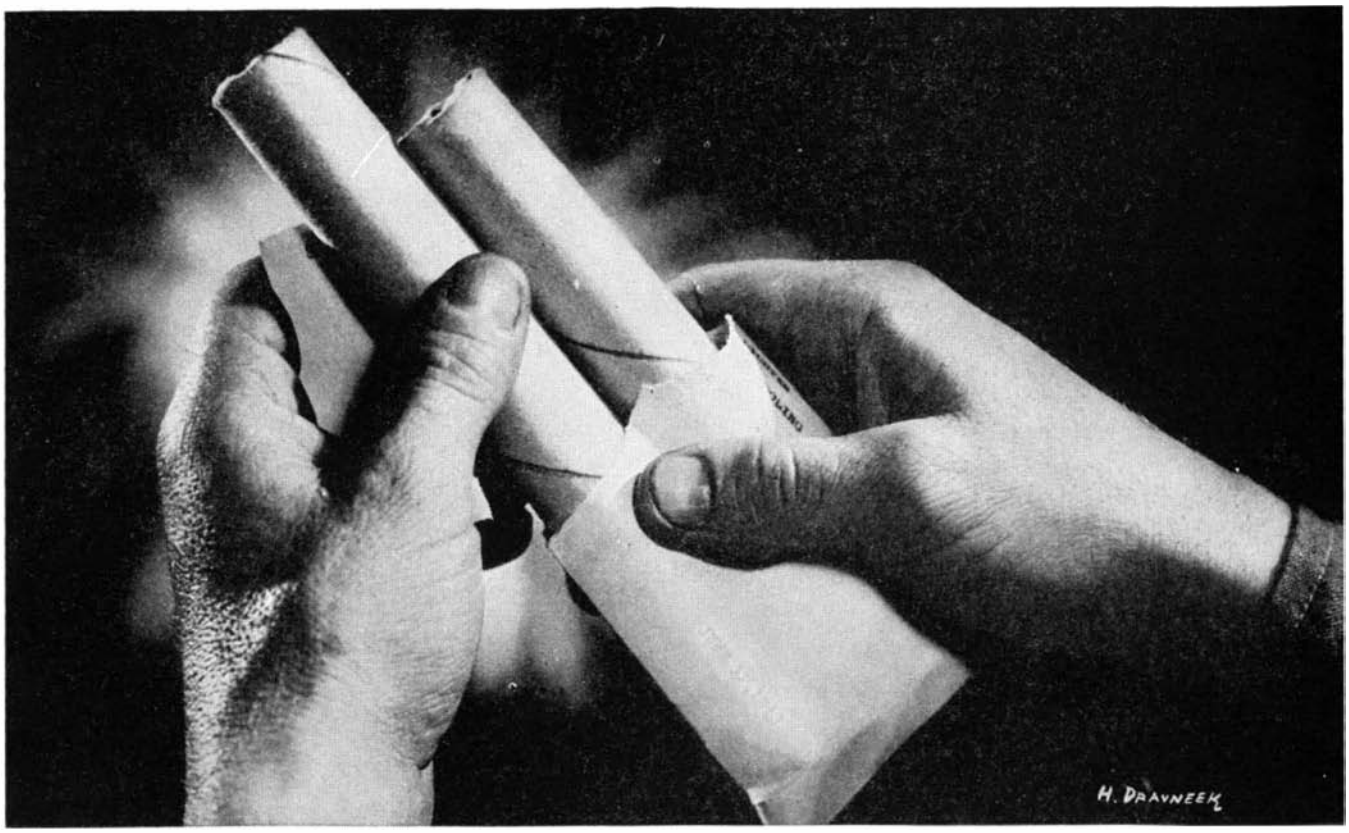
In the process of nitrogen fixation, it is necessary first to obtain a supply of various gases in their free state. This is normally accomplished by burning natural gas in a reducing atmosphere or from a coke-gas plant. The raw gas that is obtained from these plants normally consists of nitrogen, hydrogen, carbon-dioxide, carbon-monoxide, and certain other small impurities. It is necessary to remove all components except the nitrogen and hydrogen from this mixture so that these two gases can be combined synthetically into anhydrous ammonia for fixation of the nitrogen.

The carbon-dioxide is normally removed under a pressure of approximately 200 pounds per square inch by means of scrubbing the gas through a water tower, with the carbon-dioxide being absorbed in the water in a dissolved state. The carbon-monoxide is removed from the gas in a second scrubbing tower under a pressure of approximately 2000 pounds per square inch by the use of an ammoniacal cuprous copper formate solution. After these gases have been removed the remaining product, consisting of nitrogen and hydrogen, is then compressed to a pressure of approximately 5200 pounds at which pressure it is exposed to a catalyst and, through the addition of heat, a chemical combination takes place resulting in synthetic gaseous ammonia which is then condensed by refrigeration to an anhydrous ammonia state.

Only a portion of the gas passing through the catalyst is actually con-



Details of the coordinated air-rail-highway terminal described above



Mister—you're getting paid in DYNAMITE!

LET'S NOT KID OURSELVES about this. Our pay envelope today *is* dynamite.

If we handle it *wrong*, it can blow up in our face . . . lengthen the war . . . and maybe wreck *our* chances of having happiness and security *after* the war.

The wrong way to handle it...and why

The wrong way is for us to be good-time Charlies. To wink at prices that look too steep . . . telling ourselves we can afford to splurge.

We *can't* afford to—whether we're business men, farmers, or workers. And here's why:

Splurging will boost prices. First on one thing, then all along the line.

Then, wages will have to go up to meet higher prices. And higher wages will push prices up some more . . . faster and faster, like a runaway snowball.

The reason this can happen is that there is more money in pay envelopes today than there are things to buy with it. This year, we Americans will have *45 billion* dollars more income than there are goods and services to buy at present prices. *45 billion dollars extra money!*

That's the dynamite!

The right way to handle it...and why

Our Government is doing a lot of things to keep the cost of living from snow-balling.

Rationing helps. Price ceilings help. Wage-and-rent stabilization helps. Higher taxes help. They're *controls* on those dangerous excess dollars.

But the real control is in our hands. Yours. Mine.

It won't be fun. It will mean sacrifice and penny-pinching. But it's the only way we can win this war . . . pay for it . . . and keep America a going nation afterwards.

And, after all, the sacrifice of tightening our belts and doing without is a small sacrifice compared with giving your life or your blood in battle!

Here's what You must do

Buy only what you absolutely need. And this means absolutely. If you're tempted, think what a front-line soldier finds he can get along without.

Don't ask higher prices—for your own labor, your own services, or goods you sell. Resist pressure to force YOUR prices up.

Buy rationed goods only by exchanging stamps. Shun the Black Market as you would the plague.

Don't pay a cent above ceiling prices.

Take a grin-and-bear-it attitude on taxes. They must get heavier. But remember, these taxes help pay for Victory.

Pay off your debts. Don't make new ones. Getting yourself in the clear helps keep your Country in the clear.

Start a savings account. Buy and keep up adequate life insurance. This puts your dollars where they'll do you *good*.

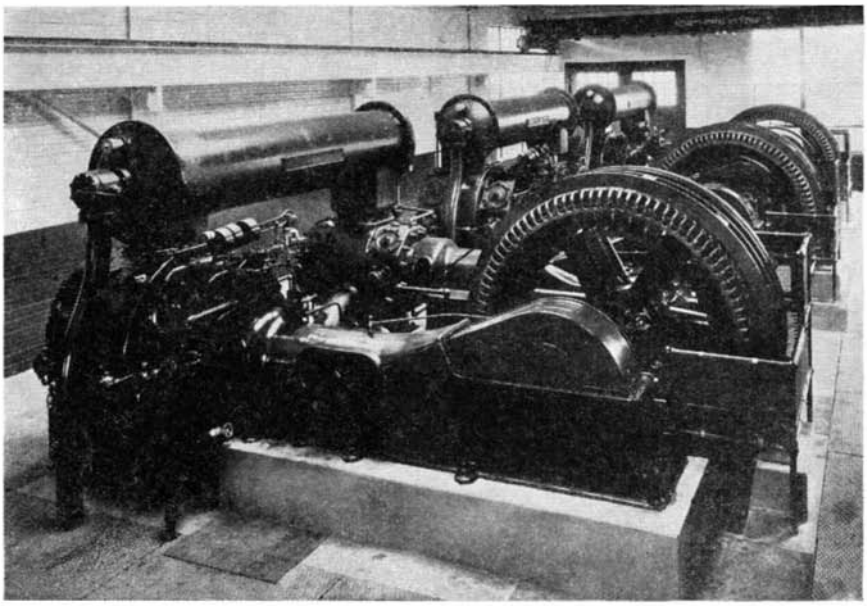
Buy more War Bonds. Not just a "percent" that lets you feel patriotic, but enough so it *really* pinches your pocketbook.

If we do these things, we and our Government won't have to fight a postwar battle against collapsing prices and paralyzed business. It's *our* pay envelope. It's up to *us*.

KEEP PRICES DOWN!

Use it up • Wear it out
Make it do • Or do without

This advertisement, prepared by the War Advertising Council, is contributed by this Magazine in co-operation with the Magazine Publishers of America.



A large electric-driven air compressor of the type used in powder factories

verted to synthetic ammonia. It is necessary, therefore, to install special high-pressure circulating compressors to take the uncombined gases from the system after passing through the catalyst and for recompressing to a pressure equivalent to that of the raw gas being pumped to the catalyst chamber.

A normal present-day synthetic ammonia installation is designed for the production of 300 tons of synthetic ammonia per day and involves approximately 22,000 horsepower of high-pressure compressors and circulators. In addition, approximately 5000 horsepower of compressor capacity is required to furnish the necessary refrigeration for regenerating the solution used in the removal of the carbon-monoxide as well as for other steps in the process.

An additional amount of low-pressure air at approximately 50 pounds pressure is used in the regeneration and stabilization of the solution for the removal of the carbon-monoxide.

Synthetic ammonia is then applied to the manufacture of nitric acid by burning the ammonia gas with air, the by-product being dissolved in water for the manufacture of nitric acid. Nitric acid is normally made at a pressure of approximately 50 pounds per square inch. This acid can then be used for manufacturing TNT, ammonia picrate, or many of the other explosives—*Data from The Compressed Air Institute.*

WORKERS' EYES

Are Receiving Increasing Attention In Industry

INCREASING attention to the visual qualifications of employes is reported in many manufacturing industries, according to the Better Vision Institute. Not only do many plants require workers to tune up their eyes when necessary, but steps are taken to coördinate eyes and jobs.

One New England plant engaged in war production requires tests to determine how the eyes will function on the job. Besides being examined for visual acuity, eyes of some workers are studied to see if they see design lines accurately, and if they see dimensional lines of machines and parts in correct proportions. Such visual qualifications may have an important bearing not only upon accuracy of workmanship, but also safety. Other workers are tested for their visual ability to identify metals and alloys from appearance. Skilled metal workers frequently are able to determine properties of a metal from visual inspection.

ANIMAL BLOOD

May be Made Available For Human Transfusions

EFFORTS to render blood of animals suitable for human transfusions are being made by Professors Frank W. Putnam and Hans Neurath, of Duke University, according to a paper read before the American Chemical Society recently. In the paper it was pointed out that protein molecules have a coiled structure which can be loosened or tightened by suitable manipulation with certain organic substances such as urea to modify their chemical nature and hence their disease-curing effects.

It has been discovered by Drs. Neurath and Putnam, in experiments on animals, that various proteins, including blood serums, lose their shock-causing properties after such treatment.

Investigation has shown that synthetic soaps are most effective in modifying the chemical nature of these proteins. Experiments are under way to learn whether they may serve as a means of treating blood proteins to avoid the serum-sickness that is always a risk in immunizing sensitive persons against certain diseases.

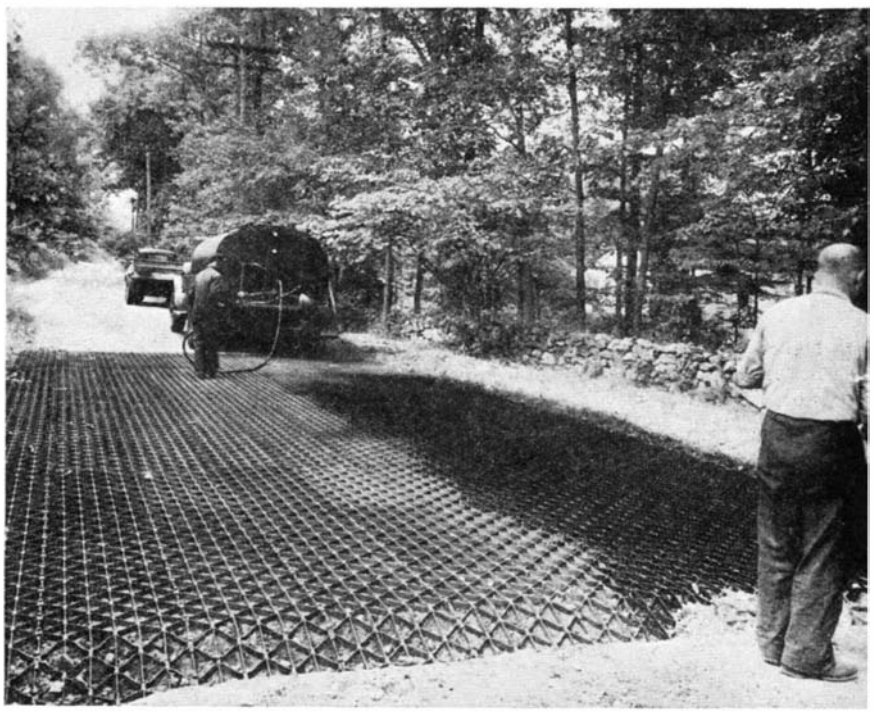
These experiments, conducted in laboratories at Duke, are part of the more general problem of investigating factors which cause proteins to produce anti-bodies when injected into human beings for therapeutic purposes.

STEEL HIGHWAY

Experimental Strip Uses Interlocked Grid

THE POSSIBILITY that American motorists may be zipping over steel highways soon after the war loom as a result of an experimental installation of a steel roadway strip on a Connecticut highway. The installation, while only 48 feet long and 22 feet wide, is expected to provide the answer to the practicability of entire roads based on a steel grid.

The experimental project is a joint venture by the town of Darien and the Irving Subway Grating Company, creator of the steel-type roadway. This "armoring" of highways is an off-shoot



Applying oil to the steel-grating highway test strip

of the technique employed at battle-fronts in laying down landing mats for the air forces.

The Irving Company has experimented with and developed for 30 years various types of steel floor surfacing applied to factories, power plants, and bridges. More recently, at a Long Island City testing grounds, Irving engineers have experimented with steel surfacing of truck roadways in and about roadway plants. In these experiments such roadways have proved durable and quickly and easily laid.

Sponsors of the highway project feel that it is highly significant—that if it proves successful, it may well set the pattern for a network of steel secondary roads throughout North and South America. The technique calls for interlocking steel grating panels, each 2 feet by 12½ feet; filling the mesh with ordinary construction sand; and then applying a coating of road oil.

COPPER SAVER

Used in Electroplating Baths To Increase Hardness

LESS THAN one ounce of a new chemical per gallon of copper electroplating solution reduces by one third the copper required for electrotype printing plates, and cuts in half the scrap resulting from manufacture of these plates. The chemical so increases the hardness of the copper deposit that a much thinner layer will give equal service. It allows a pound of copper to cover one third more square inches of surface; it also assures a smooth finish, and speeds the plating of the electrotypes.

The agent, recently announced by Du Pont, eliminates inferior plating on the edges and corners of the printing plates. That permits a reduction in the width of "safety bearers," and accounts for reducing to half the copper scrap usually resulting from electrotype production.

KOVAR SUPPLY

Problem Solved by Miniature Furnace

A THERMOMETER manufacturer now producing temperature gages for military aircraft was threatened with a stoppage of production of these essential accessories due to the need for "Kovar" wire. Kovar, a nickel-cobalt-iron alloy, was developed by Westinghouse Electric and Manufacturing Company as a sealer for electronic tubes. In these gages, however, it is used in the form of a three-foot length of fine wire, tightly coiled inside a tube immersed in the aircraft engine oil. As the motor warms up the wire offers more resistance to an electric current passed through it, which is indicated by a dial on the instrument board.

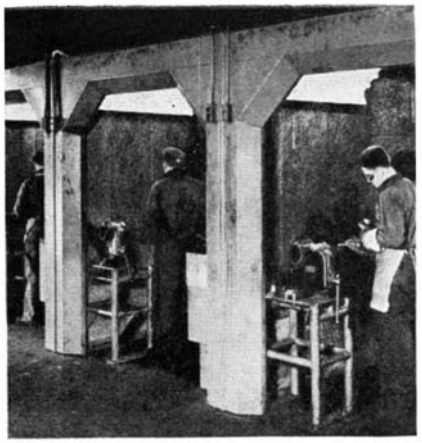
In ordinary production quantities, and for the more common uses, the electrical resistance of the metal is not important, but to the temperaure gage manufacturer, it is vital. As war demands depleted his original supply of Kovar wire, he found that the resistance of additional samples varied widely, and continued production was threatened because the thermometer design was based on the resistance of the old wire and there was no time to re-design the entire device.

The problem was solved by the Westinghouse Laboratories' use of a miniature electric furnace to produce 13-pound ingots of Kovar made to the exact chemical composition of the original product by painstakingly accurate control of the melting process. Actually, a half dozen of these small ingots of proper resistance will keep the thermometer plant supplied with wire enough to last several years, since each ingot contains enough Kovar to make 56 miles of wire, which is enough to make temperature gages for 20,000 four-motored bombers. Yet continued inability to obtain this small quantity of vital metal in the exact quality required, might have caused a serious hold-up in quantity production of these and other military craft upon which final Allied victory depends.—*Nickel Steel Topics.*

SAFETY BOOTHS

Contribute Also to Worker Comfort

SPECIALLY designed booths, perfected over a period of years for the safety and comfort of workers handling difficult and dangerous propeller finishing operations, have now been installed in



Individual safety booths

New Jersey plants of the Propeller Division of Curtiss-Wright Corporation. The individual safety booths, arranged in series with one operator to each unit, are air conditioned to carry off harmful dust particles, lessen workers' fatigue by cutting down noisy grinding operations, and practically eliminate hazards created by flying pieces of metal.

The units, installed exclusively for grinding and polishing operations on hollow steel blades, are built of Thermax, which is a non-priority, non-combustible material. Each booth is clean, comfortable, and lighted by two 80-watt fluorescent lamps designed to reduce eye strain. A fan unit is installed at the rear of each booth to carry off dust and small metal particles while larger pieces of steel are thrown into a salvage hopper below. Passing workers are protected from flying particles by a baffle extending six inches from the interior of each booth.

Propeller Division officials claim the new safety booths have decreased the loss of man-hours through accidents and resulted in a speed-up in the production of blades.

ARC-WELDING SPEEDED

Use of High-Voltage Spark Maintains the Arc

A HIGH-VOLTAGE "trail blazer" that cuts an electric path through air has been developed to speed welding of the thin aluminum and alloy steels used in warplane construction. Called an "arc stabilizer," the new device is an assembly of coils, condensers, and transformers built into an electric welding machine.

"The stabilizer," explains C. L. Denault, engineer at the Sharon plant of Westinghouse, "produces electricity which has a high voltage, or electrical pressure, and changes its direction of flow many thousands of times a second. This type of electricity has the ability to leap through the air from the tip of the welding rod to the metal being welded. It literally knocks electrons off the atoms of gas in the air. When the air is in this condition, it conducts electricity more easily. Then the regular welding current jumps from the rod to the metal along the path created by the trail blazer."

Until the stabilizer was developed, electric welding of plane parts required great skill. Low currents had to be used to prevent burning of the thin metals and this made it difficult for the welding operator to start the electric arc and keep it glowing while he made the weld.

When a welder is working on ordinary carbon steel, he has little trouble maintaining an arc because the current flows strongly, the metal is hot and the welding rod may be as thick as a pencil. But aircraft welding must be done with low currents, the piece being welded must be kept comparatively cold so no holes will be burned in it, and the rods used are often as thin as a pipe-cleaner. The arc itself is about the same size as the head of a safety match.

Under these conditions, the arc tends to go out each time the regular welding current alternated or changed its direction of flow, but this tendency can now be counteracted by the trail-blazing electricity which is turned on by a switch in the holder that grips the welding rod. When the operator is ready to

Laboratory model of arc stabilizer

weld, he flicks on the switch and holds the tip of the rod near his work. The high voltage electricity leaps across the gap and the welding current follows. The "trail-blazing" current keeps flowing until the weld is finished to prevent the welding arc from being extinguished.

COLORS FOR SAFETY

Yellow Often Better Than Red

RED IS traditional in safety practice as a symbol of danger. Yet while it is a rich and exciting hue, it falls short of other colors where high visibility is concerned.

According to the Color Research Laboratory of the Eagle Printing Ink Company, the most conspicuous and visible of hues is yellow. Next in order is a brilliant yellow-green. Following this, orange ranks third, with red fourth on the list.

In industry, for example in a steel mill or a printing plant, a good safety practice would suggest the use of yellow to mark moving parts, trucks, pillars, and the like. Yellow-green and orange might be used for other and perhaps lesser hazards—with red reserved for fire-protective equipment. Many factories have developed specific codes of their own, using the magic of color to serve as silent but effective tokens of identity and danger.

Yellow and yellow-green are the regions of highest visibility in the spectrum. In the dim light encountered in so many industrial environments, they are the two colors that hold their brightness best, with red fading out and resembling black—a phenomenon long recognized by science.

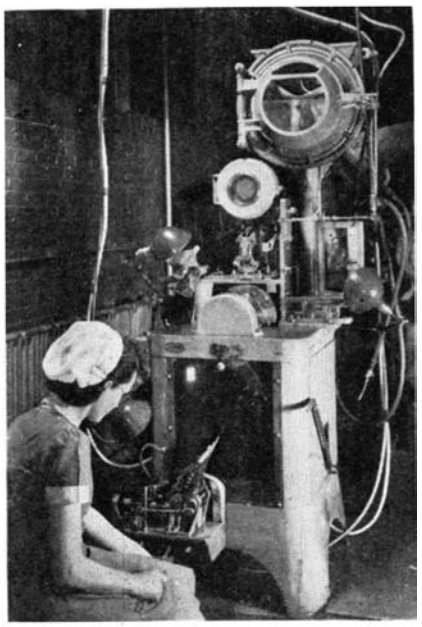
DETONATOR ASSEMBLY

Speeded by New Automatic Machine

A MACHINE that does the work of approximately 75 workers, has been developed by engineers of Aluminum Seal Company for use in government arsenals. Called a foil disk assembly machine, the unit is employed on loading lines for seating foil disks in detonator cups.

Previous to the development of this machine, disk seating was accomplished by laborious hand methods. The tiny foil disks, which measure less than a quarter of an inch in diameter, were gaged by a micrometer to insure the seating of only one disk to a cup, then placed by means of hand tweezers in the cups.

In the new machine the detonator cups are placed in the hopper at the top, from where they pass automatically into a feed chute and from there to a transfer punch which transfers the cups, five at a time, into a seating block on an intermittent turret wheel. The turret carries the cups to a die which blanks out the foil disks and pushes them to the bottom of the cups. The foil used for these disks is coated on one side with a thermoplastic adhesive and is fed automatically through the die. A vacuum shoe under the seating block insures retention of the disks and permits



Detonator assemblies machine

the punch to return to its original position without the disk.

Further revolution of the turret takes the detonators to a hot punch station which heat-seals the disks to the bottom of the cups.

After seating, the detonator cups pass to the next station where they are released and drop by gravity to an automatic inspection unit. At this point the cups are pulled out of the inspection turret by vacuum to drop into a bin at the bottom of the machine. In the event that the disks are not properly seated, they are not ejected by the vacuum plunger but are carried around in the turret to drop into a reject box.

Besides materially speeding up seating operations, the new machine eliminates one of the chief hazards which formerly accompanied the loading. Heat sealing by machine insures perfect adherence of the disk to the cup and does not permit the powder to seep underneath the disk. Results obtained to date indicate a marked decrease in the number of cups rejected for this reason.

ROTENONE INDUSTRY

Expected to Expand in the Western Hemisphere

ELEVEN of the other American republics are co-operating with the United States in a program to expand Western Hemisphere production of rotenone-yielding plants to meet increased wartime demand for this insecticide, now in wide demand for production of food crops.

Before Pearl Harbor, cultivation of rotenone-bearing plants was increasing rapidly in the Far East, and the United States obtained nearly half its supply from that source, although one of the two principal rotenone plants is native to this hemisphere.

Wartime development is giving the plantation industry the strongest impetus yet experienced in the Americas. Out of this development, some agriculturists believe, may come a lasting industry to supply the big Western Hemisphere market for insecticides.

Peru now is the principal exporter of rotenone roots to the United States. Another large exporter is Brazil. Wild roots are being gathered in Ecuador, Colombia, and Venezuela. Development programs have been started in Ecuador, Mexico, Guatemala, Costa Rica, Honduras, El Salvador, and Haiti.

Development plans call for the planting of about 1,000,000 additional cuttings of derris, one of the two chief rotenone-yielding crops.

The full effect of the rotenone development program in Latin America will not be felt until 1945. It takes two years or so for the crops to become ready for harvest. By 1945, however, bumper exports are expected.

In line with the policy of fostering complementary agriculture in the Americas, United States agencies are rendering assistance to the development of rotenone-yielding crops in Latin America. Derris cuttings by the thousands are being distributed from the United States agricultural station in Puerto Rico by the Office of Economic Warfare to plantations and to new experiment stations set up with the United States' assistance in Ecuador, Peru, Nicaragua, and El Salvador.

The newly-established Inter-American Institute of Agricultural Sciences in Costa Rica also is taking a hand in the development of insecticides. The Institute has acquired a rubber plantation in Panama which has a large supply of derris cuttings for distribution to potential planters.

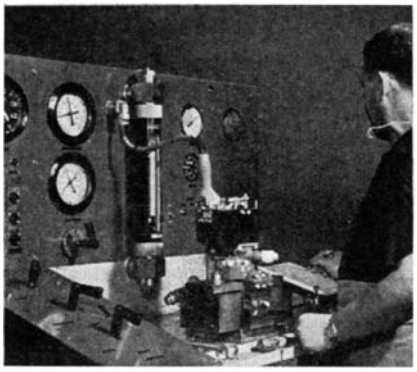
Heretofore, rotenone-bearing materials from Latin America have been obtained mainly from wild and semi-wild growths. The chief Brazilian centers of production have been from semi-wild growths along the Xingu and Tapajoz Rivers and in the upper Amazon region. Now, in the Amazon as elsewhere in the hemisphere, new plantation industries are getting under way.

GOVERNOR TESTER

Is Accurate To Within Two Tenths of One Percent

AN ELECTRONICALLY-CONTROLLED precision testing apparatus that checks the accuracy of delicately balanced hydromatic airplane propeller governors, which are being manufactured for the Army Air Forces, has been developed by the Nash-Kelvinator Corporation.

When the company received a contract to produce these Hamilton Standard governors for propellers, it was found that none of the commercial test-



Timing aircraft propeller governors

ing devices available were sufficiently accurate to provide the test demanded by the specifications. The governor, which automatically adjusts the pitch of the propeller blades so as to make the most efficient use of the engine's power at a given speed, must be accurate to within five revolutions per minute, or two tenths of one percent at maximum speed. This was about four times as fine a "tolerance" as the efficiency of the best tachometer, or speed indicator, which could be obtained.

While the operation of the new testing instrument is difficult to describe, its principle is not complicated. The propeller governor to be tested is mounted on the stand and hooked up to an electronically controlled D.C. electric motor operated from an A.C. power line. The governor is then attached to a pressure oil system which serves as a "dummy propeller." Since the governor itself functions hydraulically it regulates the pressure in the testing device, and thereby actually regulates the speed of the motor by which the governor itself is being operated. But because of the wizardry of the test stand, this same motor, which both drives and is controlled by the governor, also drives an alternating-current electric generator. By measuring the output of this generator in cycles, the person testing the propeller control governor can tell far more precisely how accurate the governor is than he could by using the finest tachometer such as is contained on the control panel of an airplane.

What the amazing device does is to convert time, oil pressure, and revolutions per minute into one set of comparable figures which can be read off on dials as readily as telling the time of day by looking at a clock.

OPTICAL PARTS

Made More Accurately With Air Conditioning

ACCURATE gun fire of America's fighting ships and American artillery are due in a large measure to the utilization of modern air-conditioning equipment in the plant of Bausch & Lomb, where there was recently completed the third installation of air-conditioning equipment in the binocular assembly room of the optical manufacturer. Air-conditioned rooms are required for the preparation of optical parts of binoculars because dirt cuts the light gathering properties of the prisms and lenses. In cementing the lens elements, the room air must be scrupulously clean in order that the Canada balsam shall not be contaminated. Also, the temperature must be held within close limits both for applying the balsam and for drying.

Carrier air conditioning is also being called upon at Bausch & Lomb to aid in high precision work in the manufacture of range finders and height finders, essential components of modern warfare. In space where these products are manufactured, assembled, and tested, Carrier equipment reduces heat that is generated by motors and people, eliminating danger of expansion or contraction of delicate metal parts by maintaining constant temperature. Likewise, it controls humidity to prevent corrosion caused by perspiration on the fingers of workmen.

In the assembly of lenses in microscopes, air conditioning is used to dehumidify the air between the assembled lenses so that they will not fog up under the varying temperature conditions of field use. Absolute dust control is required because a speck of dust on a range finder, for example, might look like a distant airplane to the observer.

Polishing lenses is another delicate operation which calls upon air conditioning to help insure perfection. For the polishing process, lenses are mounted on wax and any change in the wax, either softening or hardening, might cause inaccuracies. Consequently, it is important that the wax mountings remain the same during polishing, and air conditioning insures against the possibility of changes.

SIMPLE X-RAY

Compact Unit Used for Examining Parcels

A NEW anti-sabotage weapon in the form of an effective, simple, easily operated X-ray apparatus is known as Searchray. This newly developed electronic device makes possible the safe, instantaneous, non-destructive, fluoroscopic, and radiographic internal examination of incoming and outgoing packages and small luggage at war plants, air and railway express offices, post offices, custom houses, police stations, and so on. Suspicious looking packages and luggage can be search-rayed without exposing anyone to the danger of opening unknown parcels. It is also useful in discovering contraband and in detecting and discouraging theft.

X-rays examine packages

To operate the unit, manufactured by North American Philips Company, Inc., it is only necessary to plug into a standard 110 volt A.C. power source, open compartment door, insert object, close door, push button, and view the internal structure instantly through an eye-level eyepiece. No skill is required to operate.

The same unit also has wide application in industry for internal examination of assemblies and finished products of rubber, ceramics, plastics, light metal alloys, and similar substances.

COLD WELDING

Makes Cracked Cylinders, Heads, Parts, Strong as New

WARTIME technique of cold welding, which repairs heat and cold cracks in gasoline, Diesel, steam, and other engines as easily as a dentist fills a tooth, is keeping in operation many an engine which otherwise would have been junked.

The technique, originally known as "mechanical lacing," is described in the *SAE Journal* in a report of the Society of Automotive Engineers Transportation and Maintenance Activity approved by Office of Defense Transportation.

The crack, wherever located, and whether caused by heat or cold, is drilled and tapped. Special threaded rods are inserted so as to interlock. The crack then is filled with a special sealing compound, which is also circulated through the cooling system. Finally, the repair is peened and smoothed to a point where it is practically indistinguishable.

The report states that so far as records are available there is no case of a repair failing as a result of time or mileage, and that, apparently, the repair lasts as long as the engine.

PAINT TESTING

Speeded By Use of Thin Iron Foil

THROUGH the use of a new testing technique which employs extremely thin iron foil, an indication of the value of metal-protective finishes under severe conditions frequently encountered in practice can now be had in a matter of days in comparison with months for ordinary exposure tests.

This new technique was described in a paper by Drs. G. D. Patterson and C. K. Sloan of the Du Pont Company, presented before the American Chemical Society. It involves the use of thin, uniform films of paint applied to small sheets of iron foil about one two-thousandths of an inch thick—approxi-

mately 1/8th the thickness of the paper on which this is printed. The film of finish to be tested is about one thousandth of an inch in thickness.

These tiny test panels are then exposed to a carefully controlled, humid atmosphere in the laboratory, which results in rapid rusting of the metal foil underneath the thin paint film in much the same way that painted structural steel would ultimately rust under actual conditions of service. The time that elapses before visible rust spots develop on the iron foil gives an indication of the degree of protection afforded by the paint being tested.

With such extremely thin foils, the slightest rusting eats a hole through the metal, which can easily be detected by looking at the test panel from the back. With ordinary films laid down on steel panels of the type normally used for testing, no evidence of failure would probably appear until rather severe corrosion of the metal had resulted in partial or complete breakdown of the paint film. With a good finish, this might require a year or more.

While the recently-devised technique will not dispense with long-time fence and field tests necessary to determine the protection a finish will afford under actual service conditions, it will greatly facilitate testing by making it possible to reject inherently poor finishes before expensive and time-consuming field tests have been made.

VITAMIN MANUFACTURE

The Human System's Processes Influence Manufactured Foods

THE MYSTERIOUS process by which certain vitamins are manufactured in the intestinal tract holds the key to great advances in the field of nutrition, Dr. Conrad Arnold Elvehjem, professor of chemistry in the University of Wisconsin, declared recently in an address before the Chicago Section of the American Chemical Society.

"We are spending a great deal of time measuring the changes in the vitamin content of food during storage, processing, and dehydration," Dr. Elvehjem pointed out, "but what about the changes that take place after the food enters the intestinal tract?

"All the food we eat comes in contact with trillions of bacteria, particularly in the intestinal tract, before the nutrients contained in that food reach our bloodstreams. The intestinal bacteria have caused us much trouble in the laboratory and will continue to trouble the clinicians for some time, because their effects are different for each species of animal and every type of food combination.

"Some vitamin factors are known to be produced by the intestinal bacteria under normal conditions, but certain individuals may suffer from abnormalities which are sufficient to prevent adequate production, and must have these factors preformed in the diet. In still other cases, abnormal intestinal flora may destroy some of the better-known vitamins at a rate sufficiently rapid to produce nutritional deficiency in spite of the fact that the diet is adequate according to present standards.

"Thus if we were to attempt to formulate a mathematical equation for the relation of nutrition to health similar to the equations formulated by Willard Gibbs in physical chemistry, we would need to introduce a constant to cover the effect of the intestinal flora. We would have to consider the kind of carbohydrate, the level of fat and protein, the ratio of many of the vitamins, the length of the large and the small intestine, the amount of bile secreted, the rate of digestion, the alkalinity and acidity of the intestinal tract, and the natural capacity to inhibit the growth of certain bacteria.

"It is remarkable that progress in the field of nutrition has been as rapid as it has under such variable conditions. In one of the first papers on vitamins, published in 1911, some of these difficulties were suggested."

The older B vitamins — B_1, B_2, and niacin — were recognized first because they are not produced in the intestinal tract of any animal in sufficient quantites to meet the needs of the animal, it was explained, thus making the testing of requirements by withholding certain factors from the diet comparatively simple.

The chief method of altering the intestinal flora is by feeding a bacteriostatic agent, for example one of the sulfa drugs, which inhibits the further growth of intestinal bacteria through

interfering with the supply of the B vitamins needed for bacterial growth. Inhibition of the growth of the bacteria prevents, in turn, the synthesis of other members of the B complex by the bacteria and permits the biochemist to measure the vitamin requirements of the animal by adding synthetic vitamins to the diet, according to Dr. Elvehjem.

NON-SLIP DECKS

Provided by Garnets Embedded in Plastic

BLUEJACKETS of the United States Navy, manning the thundering guns of battleships and cruisers as they hurl their exploding shells into the Nazi-held shores or the Japanese-occupied islands of the Pacific, take their stand on carpets of semi-precious stones. Naval planes, zooming from the flight decks of carriers with their deadly load of bombs and torpedoes, take off from runways of the same sort.

Garnets are being used by the Navy today to cover decks and gun emplacements of our ships, the gems, pulverized into coarse grains, forming part of a new deck covering manufactured for the Navy by The Goodyear Tire and Rubber Company.

The new covering, known as "Dektred," is made by mixing the ground garnets with a special fire-resistant plastic or synthetic-resin binder that has the ability to stick to the smooth steel surface of a battleship deck or similar structure. Dektred can be applied with a trowel or, more quickly, by spraying it from an ordinary spray gun.

The chief purpose of Dektred is simple, but as extremely important as it is simple. It is to prevent slipping, a problem that is of the utmost seriousness in naval operations. Slippery decks can cause accidents, even death. They can lose battles. The problem is particularly acute in rough weather or on small ships whose low decks are normally washed by the waves at high speeds.

Dektred is light-weight and can be shipped as a viscous fluid in sealed metal containers, ready for application. It can be applied to steel, wood, concrete, and many other types of surfaces. It dries quickly, being sufficiently dry for light traffic after 2½ to 3 hours and completely dry after 8 hours. It is resistant to both heat and cold. Cold does not affect it at all. It becomes slightly soft at temperatures above 160 degrees, Fahrenheit, but returns to its normal conditions when cooled. In addition, it resists the corrosive action of oil, grease, salt, sulfur, soap, and other detergents.

VISIBLE STRAIN

Aids in Studying Reponse of Liquids

THE DIVERSE responses of a flowing fluid to variously shaped obstacles such as a boat hull or a heating pipe form a fascinating study, but not a very exact one unless the directions of flow can

be made visible. A new method of doing this, developed at the Massachusetts Institute of Technology, promises a real advance in this branch of hydrodynamics. The method is analogous to that wherein engineers use polarized light, produced with optical equipment similar to that in "Polaroid" non-glare sun glasses, to render visible the strains in plastic models of solid structures, such as gears. When stressed, the plastic model deforms slightly, and, in so doing, bends and twists the polarized light passing through it so that bands and splotches of color show up at the points of strain. In the analysis of fluid flow a suspension of bentonite (a clay found abundantly in the West) in the fluid serves to modify the polarized light shining through the transparent walls of the experimental channel, just as the plastic modifies light in analysis of strains in solids.

The bentonite particles consist of platelets so small that there is no tendency to settle out of the suspension and so light that they move exactly where the fluid takes them, showing substantially no inertia of their own. These physical factors, as well as its optical properties, make bentonite superior to other substances used to follow fluid flow, such as ink streams, smoke trails in gases, or fine bubbles; for these latter materials cannot follow the paths of fine eddy motion encountered when streamline flow is broken up. The bentonite for the first time permits quantitative measurement of velocity change and other factors within the field.

Solid plastic models examined with polarized light show infinitely varied colored patterns when subjected to pressure or tension. A line of a given color connects points where the strain is equal; from this the analyst can determine where the strains are concentrated and the model can be re-designed to put strength where it is needed and eliminate it where it is not needed. Similarly, in analysis of fluids the bentonite so modifies the light passing through the stream that colored bands or "fringes" show up, connecting points where a particular rate of change in the speed of the fluid prevails. Use of improved photographic techniques, including high-speed photography, has enabled observation of highly turbulent as well as more nearly streamline flow by this method.

The method can be used either qualitatively to observe how a moving or stationary object of particular shape affects the flow, or quantitatively to calculate necessary engineering data. Analysis of fluid flow is important not only in such obvious applications as design of boat hulls and bridge piers but also in many chemical engineering problems such as the distribution of fluids in a reaction vessel. It is even possible by polarization analysis of fluid flow to calculate the rate at which heat will be transferred from a solid to a liquid.

Within limits, the information obtained with liquid flow is applicable to gases, so that the method becomes useful in aviation and many other fields. Although there has been time for only a few applications of polarization analysis of fluid flow, one of these is providing graphic demonstrations for training aviators in flight theory. Another application has served to change the design of fireboxes in the locomotives of a western railroad.—*Industrial Bulletin* of Arthur D. Little, Inc.

WARPLANE PRODUCTION

Boosted by Automotive Technique of Zero Welding

In its quest for better products at lower cost, the automotive industry carries on extensive experiments to find new materials and new methods. Though such research often turned out, in the past, to be of no immediate use in the manufacture of cars and trucks, it is today being brought down from the "shelves" of the industry's laboratories to aid in the drive for more and better weapons for the United Nations.

Take the case of zero welding which is now being applied to the production of American warplanes, with a saving of thousands of precious hours.

The application of cold to the hot points of arc-welding devices stems from several automotive factories where it was tried in the manufacture of assembled sheet steel stampings. With the advent of war, automotive engineers, seeking short-cuts in aircraft production, revived the idea and began more thorough exploration. Such striking results were attained that all aircraft manufacturers became interested.

It was found, for example, that, in putting the 1600 spot welds on a single bomb-bay door, operations had to be halted more than 45 times to clean the welding points; but, with temperature of the electrodes reduced to zero, Fahrenheit, 800 successive welds were possible.

The total saving is estimated to be two and a half hours on just one bomb-bay door. And, as an operator and two helpers are required for welding this large unit, more than seven man-hours are thus saved. With four bomb doors

installed on each plane, the savings on this one part alone are considerable.

But, important though it is, time-saving is not the sole benefit of this welding technique. For, since there is less heat at the electrode tips, the aluminum alloy sheets are subjected to less heat expansion. There are, therefore, fewer buckled sheets. Moreover, as high temperatures in the electrodes tend to drive contaminating copper into the welds, the use of refrigerated tips produces stronger welds.

Zero welding came about when normal spot welding caused the grain structure of the aluminum alloy to change at the boundaries of the welds because of heat set up around the welding points. Such changes remained hidden until later stresses revealed them as cracks or breaks.

After a series of experiments with ways to defeat the destructive effect of heat, automotive engineers built a refrigeration device which was capable of pulling the temperature down to 85 degrees below zero.

Then experiments in welding began on sheets of various thicknesses, and at tip temperatures ranging from 25 degrees to minus 85.

As the engineers went to the lower temperatures they were balked by the formation of ice at the welding tips. To counteract this effect, they allowed acetone in the refrigerating system to squirt on the electrodes.

Every step of the experimentation was carefully documented so all companies engaged in aircraft work could profit from the experience. All the experimental welds were rigorously tested, and a library of photomicrographs was compiled on the subject. In addition, time-savings methods were devised for the mechanical cleaning of the parts to be welded as well as a simple method of cleaning and restoring the contour of electrodes without removing them from the machine.—*Automotive War Production.*

HIGH-SPEED X-RAY

Used in Production

Examination of Castings

A NEW mass production X-ray machine capable of inspecting as many as 17,000 airplane castings in a 24-hour day has been developed for a mid-western war plant, according to Westinghouse engineers.

"This revolutionary machine, which brings the advantages of assembly line speed to X-ray work, makes it possible to X-ray metal castings for defects at a rate of one every five seconds," explains C. V. Aggers, Manager of the X-ray Division of the Westinghouse Electric and Manufacturing Company, which developed the new unit.

Key to this new unit's speed is a moving conveyor 40 feet long and three feet wide that transports the castings through the X-ray inspection and provides the fastest method yet devised to spot flaws in large quantities of metal parts, says Mr. Aggers, adding:

"This unit produces an exposed film of six castings every 30 seconds—or the

equivalent of one casting every five seconds—to provide an almost continuous flow of exposed film ready for developing. When developed, each film shows an inside view of the six castings. The faulty castings with 'blow' holes, cracks, and other defects then can be weeded out, so that no man-hours or machine-hours will be wasted on imperfect castings."

Designed to inspect both engine and fuselage castings up to five inches in thickness, the mechanism includes two steel towers, each 12 feet high and situated near the middle of the conveyor, inside which the actual X-ray inspection is conducted. Each tower houses an X-ray tube—one tube operating at 140,000 volts, the other at 220,000 volts—so that castings of different types and thicknesses can be examined at the same time.

"The castings move along the conveyor on trays that halt automatically under the X-ray tubes," Mr. Aggers says. "A lead-lined protective device shields workmen from X-radiations while the exposure is made, and the castings then continue along the conveyor. For quickly identifying any defective castings, corresponding numbers are given the film and the castings."

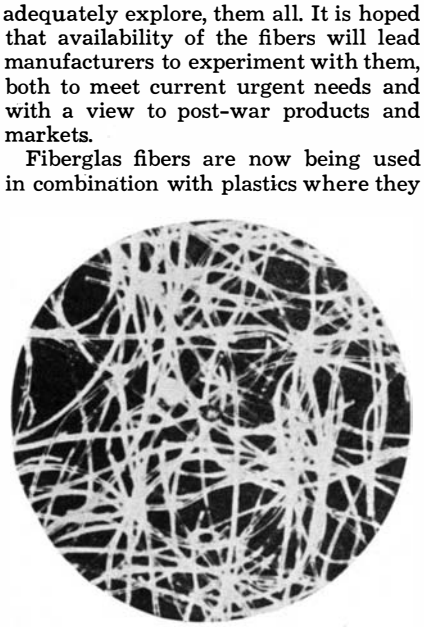
GLASS FIBERS

Now Available in Seven Basic Types

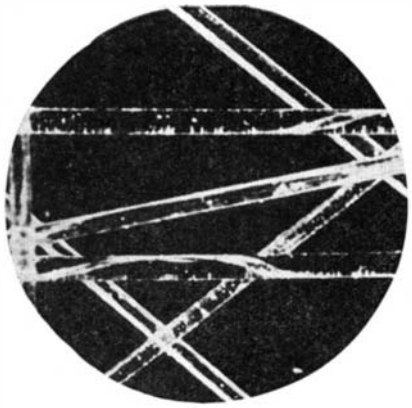
IN THE belief that they may find new and important military uses, and that they may assist manufacturers in the development of new post-war materials, Owens-Corning Fiberglas Corporation has made available seven basic types of glass fibers. These fibers are offered as raw materials for use with other fibers and with plastics and cements, and for use in various types of industrial and chemical process equipment.

Such possible applications of glass fibers have been by no means completely explored, and it is realized that the number is so great that Owens-Corning cannot hope to develop, or even adequately explore, them all. It is hoped that availability of the fibers will lead manufacturers to experiment with them, both to meet current urgent needs and with a view to post-war products and markets.

Fiberglas fibers are now being used in combination with plastics where they



One of seven—curly glass fibers



Another glass-fiber form—straight

serve as reinforcement for light-weight, high-strength structural parts for aircraft. The Fiberglas-plastic parts can be molded at low pressures, reducing fabrication costs and man-hours. Experience indicates, the company says, the adaptability of the fibers to similar use as reinforcement for certain cements and plaster-like materials where their high tensile strength may give improved physical properties to the resulting product.

Another potential field of use is the admixture of the glass fibers with other fibers, as in felts and papers. It is believed that the high tensile strength and non-stretching and non-shrinking characteristics of glass fibers will contribute new and valuable properties to other fiber and textile materials if means can be found to combine the raw fibers economically. Fabrics combining glass with cotton, rayon, and asbestos are now manufactured by combining the yarns of the desired types.

Filtering of air or gases, liquids and sludges by the straining method is cited as another possible use of glass fibers. The substantially cylindrical, smooth-surfaced fibers provide comparatively low resistance to the flow of liquids, yet the interstices between fibers may be modified to provide almost any degree of porosity.

Still other potential processing uses are contact applications in which water is sprayed on the fibers to humidify or dehumidify air that is forced through them, and eliminator applications where the fibers are employed to gather free particles of water or other liquids entrained in the air stream.

The seven basic glass fibers now available are distinguished by differences in fiber diameter, tensile strength and the glass compositions employed. Four glass compositions are used to provide different properties required for different applications.

PLASTICS IN BUILDING

Not Suitable for Load-Bearing Applications

THE USE of plastics as load-bearing materials to take the place of steel and wood, bricks or concrete, is a subject on which there has been some misconception in the minds of the public. For such purposes the choice of plastics is limited. Thermoplastics soften at quite

low temperatures, and the risk of collapse in case of fire makes it impossible to contemplate their use in load-bearing structures. That leaves only the thermo-setting plastics for consideration.

Thermo-setting plastics have the disadvantage that they are lacking in ductility of which a modicum is needed in structural materials to smooth out stress concentrations and to give timely warning of overloading.

The effect of lack of ductility is strikingly shown by some experiments on plastics as reinforcement for concrete made at the Building Research Station. It was found that on loading a concrete beam reinforced with plastic rods the stress was likely to be concentrated in one rod until it broke, throwing the whole load on to another rod, which broke in its turn. The result was that the tensile properties of the reinforcement were not fully utilized and the beam tended to break suddenly without warning. It was concluded that a flat slab reinforced in this way would be dangerous if it were accidentally overloaded, so the experiments were discontinued. In time new developments may change the position, but for the present plastics generally cannot be considered to be eminently suitable for structural use in building—*Highway Research Abstracts.*

PACKING RINGS

Made of New Materials For Food Containers

RUBBER technicians have developed jar-sealing rings of non-critical materials that are enabling commercial food packers to conserve large quantities of foodstuffs that might otherwise be wasted, the research division of The B. F. Goodrich Company recently announced.

"In answer to an appeal by the nation's canners for sealing rings to replace rubber ones now denied by government restrictions for all but most essential uses, we have succeeded in producing two different types of rings which have proved satisfactory and which are already in mass production," Dr. Howard E. Fritz, director of research for the company, says.

One type of ring used for low heat packs is made of Koroseal, a thermoplastic material made basically of coke, limestone, and salt which was originated by Goodrich chemists. The other is a vulcanizable linseed oil compound combined with various secret ingredients. Both are being used by leading food processors and have already provided satisfactory seals for hundreds of thousands of cases of food products.

The sealing rings were developed, he explains, when the canning industry, seeking a replacement for tin cans when limitations on their manufacture became drastic, developed a special glass jar with a glass lid and then found that an air-tight seal could not be obtained by glass-to-glass contact.

Use of the new sealing rings has been confined to packing products which do not rate rubber rings, but

whose processors are able to obtain a fairly high priority rating for use of materials substituting for rubber. They are not available for household canning purposes.

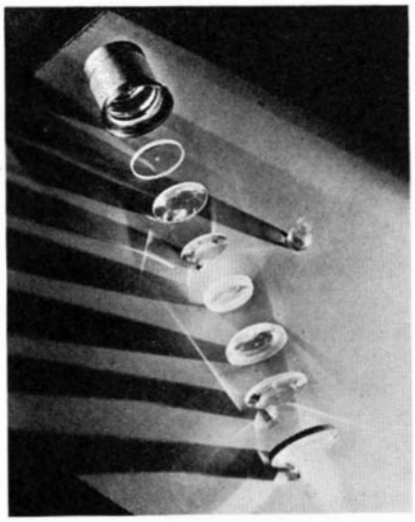
LENS CEMENT

Replaces the Widely Used Canada Balsam

A NEW photographic lens cement developed by the Eastman Kodak Company has proved so much more effective than cement made from natural Canada balsam that the Army Air Forces have changed their lens specifications accordingly.

This development resulted from the fact that an alarming number of lenses in the combat areas were breaking up, discoloring, and being rendered useless because of the extremes in temperature encountered in desert fighting and stratosphere flying.

Aerial cameras, designed to penetrate camouflage and haze, and to record information as to enemy movements, depend upon highly perfected lenses. The



Components of an aerial lens, with bottle of new lens cement at right

completed lenses in turn consist of several component lenses which perform only as well as the transparent cement which holds them together. The cement must do its job under desert temperatures of over a hundred degrees and at high altitude temperatures of 50 to 60 degrees below zero. It must likewise be able to withstand a quick temperature change of more than a 150 degrees.

When investigation showed that the cementing method previously used was responsible for lens destruction and discoloration, the Eastman Kodak Company undertook research which lasted over two years and which resulted in submission of the new product to the Army Air Forces.

JEWEL COUNTING

Speeded by Use of Simple Device

COUNTING tiny glass jewels used in the manufacture of aircraft instruments would be a tedious job but for

Counting 1000 jewels at a time

an ingenious yet simple counter used at one of the General Electric's plants. The operator dumps the pin-head jewels into a tray, gives it a rock back and forth which allows but a single jewel to fall into each small hole, then pulls the slide in the front and 1000 jewels fall into a tray below. Thus in a few seconds she counts 1000 of these small jewels which otherwise would take several minutes. A gallon jug will hold 550,000 of these jewels.

POROUS CHROME

Plating Used on Engine Piston Rings

RECENT removal of certain censorship restrictions has permitted the release, by the American Hammered Piston Ring Division of Koppers Company, of an outstanding example of the "tremendous trifles" of industry which are playing such an important part in American war successes.

By plating airplane piston rings with .005 of an inch of chromium (about the thickness of a sheet of book paper) on the cylinder contacting surface, our fighting aircraft have been able to fly five times as many hours between engine overhauls.

Tightly locked on special arbors, the piston rings are lowered, by an overhead traveling crane, into one of a long series of tanks. Said to be the largest chromium plating department in the world, the operation is based upon the Van der Horst process. (See page 112, September 1943 Scientific American.—*Editor.*) While experimenal work pre-dates the war, the present department, with its block-long line of plating tanks and generators, was planned immediately following Pearl Harbor, and has been in actual operation for over a year.

The "chrome" on airplane rings is not the bright, hard, plating used on automobile bumpers. Instead, it is known as "Porus-Krome"—gentle on cylinder walls, permitting ample lubrication, and yet resisting wear to an extent that, if applied to industrial engines in post-war days, has long-life potentialities beyond any piston ring set-up ever before known in the trade.

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.)

TESTIMONY TO THE FUTURE is a 20-page cross-sectional report of post-war industrial research based upon information obtained from member-companies of the National Association of Manufacturers. It outlines the importance of such research and its implications for the average person and for industry at large. *The National Association of Manufacturers, 14 West 49th Street, New York, New York.—Gratis.*

MEASURING AND CONTROL INSTRUMENTS is a 16-page illustrated bulletin which describes a complete line of temperature controllers and explains the "electronic principle" used for effecting control without contact between the measuring and control functions. Remote controllers, combustion safeguard equipment, and other instruments are also covered. *Wheelco Instruments Company, Harrison and Peoria Streets, Chicago, Illinois.—Gratis.*

THE OBSERVER'S HANDBOOK FOR 1944 contains data on the planets and other astronomical phenomena month by month; lists of double and multiple stars; variables; four star maps; an ephemeris of the Sun; and other data to the extent of about 80 pages. Most amateur astronomers obtain this booklet each year. *Royal Astronomical Society of Canada, 198 College Street, Toronto, Ontario, Canada.—25 cents.*

CASCOPHEN LT-67 is an eight-page bulletin dealing with the characteristics of liquid phenol-formaldehyde resin glue which is claimed to be the most durable type now in use and to be applicable in the construction of aircraft, barges, boat keels, and other wood products. *Casein Company of America, 350 Madison Avenue, New York 17, New York.—Gratis.*

SAFE-T-GRIP FUSE PULLERS is a single sheet describing a new type of insulated pliers for use in handling fuses, as well as other fuse devices. *Ideal Commutator Dresser Company, 1288 Park Avenue, Sycamore, Illinois.—Gratis.*

INSULATED MATERIALS CATALOG is a 60-page illustrated handbook covering an entire line of insulating materials including varnished cloths, tapes, tubings, mica, and cements and compounds. *General Electric Company, Bridgeport, Connecticut.—Gratis.*

RADIOGRAPHY OF MATERIALS is a 100-page plastic bound book which provides a concise yet elementary text describing the basic physical and chemical principles of radiography as applied to the non-destructive examination of materials. Also covered are the fundamental requirements for efficient application of the method. A short bibliography is included. *Eastman Kodak Company, Rochester 4, New York.—Request this bulletin on your business letter head.—Gratis.*

LIGHT FROM FLOORS is a 24-page illustrated bulletin describing a new type of light-reflecting concrete floor which becomes a giant reflector instead of the usual giant absorber of light. Examples show the advantages in overall lighting efficiency of white-cement floors and how such floors promote easier seeing by reducing lighting contrasts. *Universal Atlas Cement Company, Chrysler Building, New York, New York.—Gratis.*

NEW TOOLS FOR LEARNING is a 28-page bulletin which offers a coordinated program of pamphlets, radio transcripts, films, and recordings on vital problems. The section on "Postwar Problems" is of particular interest. *New Tools For Learning, Seven West 16th Street, New York, New York.—Gratis.*

TRAIL BLAZERS TO RADIONICS AND REFERENCE GUIDE TO ULTRA HIGH FREQUENCIES is a two-part booklet of 30 and 56 pages respectively. The first part presents short biographical sketches of those scientists and technicians who have been particularly active in the development of radio. The second part is essentially a bibliography of articles on the subject of ultra high frequencies which have appeared in United States and foreign publications. *E. Kelsey, Zenith Radio Corporation, 480 North Michigan Avenue, Chicago 11, Illinois. —Gratis as long as supply lasts.*

JANSSON HANDBOOK OF PRECISION MEASUREMENT is a 60-page illustrated booklet which gives, in the first chapter, a history of measurement and then continues on through precision measurements with various instruments and with gage blocks. *Jansson Gage Company, 19208 Glendale Avenue, Detroit, Michigan.—Gratis.*

COATED ABRASIVES is a 68-page general catalog on the subject of various forms of abrasive belts, disks, sleeves, cones, sheets, and so on. Included is a considerable amount of information on the overall subject of coated abrasives and their applications. *Armour Sandpaper Works, Chicago, Illinois.—Gratis.*

HERE'S A GRINDING WHEEL . . . is an illustrated folder describing a line of open-structure grinding wheels which, used on certain types of jobs, can speed up production by making it possible to obtain uniform results on each grind. *Norton Company, 100 New Bond Street, Worcester, Massachusetts.—Gratis.*

CONSERVE FOR VICTORY WITH NEAR INFRA-RED is a 12-page illustrated issue of a house publication dealing specifically with the use of near infra-red for industrial heating and similar operations. The illustrations show typical applications, while drawings give specific uses. *The Fostoria Pressed Steel Corporation, Fostoria, Ohio.—Gratis.*

New Products

SCRATCH ELIMINATOR

DEVELOPED for eliminating scratches which occur during the fine-grinding operation in the processing of lenses and prisms, Col-Emeroid is a product which, when used in the fine grinding process, acts as a deflocculent, keeping the emery finely suspended and preventing the emery from coagulating into larger sized particles. Thus it eliminates the tendency for scratching. It also enables the emery to be broken down more finely, thus leaving a smoother finish on the glass. This in turn decreases the time necessary for polishing out the surface. It also acts to eliminate caking of the emery when left standing for any length of time.

Col-Emeroid, according to the makers, Optical Engineering Laboratories, can be used directly with the emery, instead of water, or it may be diluted with water, using one part to four or five parts of water, but the exact proportion is not critical.

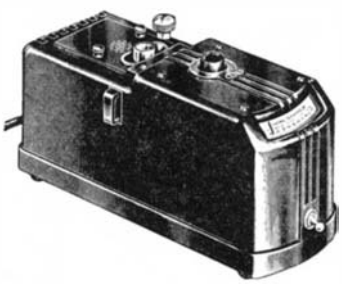
RESISTOR COIL COATING

A NEW type low-loss resistor coating that will be marketed under the trade name of Lectraseel is a vitreous coating that is highly resistant to thermal shock. Accelerated weathering tests indicate that a coil coated with Lectraseel is immune to corrosion and should give satisfactory low-loss service over a long period even under adverse conditions.

FILTER PHOTOMETER

A NEW "Photelometer" of small size for industrial use, with sensitivity and accuracy sufficient for most laboratory determinations, has been developed by the Central Scientific Company. The instrument is a compact filter photometer for chemical analyses in the routine or control laboratory. Molybdenum, titanium, vanadium, or manganese in steel, lead, copper, iron or vitamins in foods are a few typical determinations to which this unit lends itself.

The "Photelometer" is easily standardized by determining the transmittancies of a number of solutions which are prepared in accordance with a specific chemical procedure. The transmittancies, when plotted on a semi-logarithmic scale against the known concentrations on a linear scale, yield the analytical curve or standard with which unknown solutions may be compared.



For routine or control laboratory

COMBUSTION FURNACE

INCIDENT to the stepped-up production of high-octane aviation gasoline essential to the war program, the Universal Oil Products Company has developed a multiple-unit electrically heated combustion furnace offering several novel features. The equipment is manufactured and offered commercially by the Precision Scientific Company.

Although originally designed specifically for the determination of carbon in cracking catalysts used for producing high-octane aviation gasoline, the equipment is modifiable to handle a wide variety of organic combustions within the temperature limit of 1000 degrees, Fahrenheit.

One of many possible assemblies

The equipment comprises an oxygen purification system for combustion gases; an oxygen pressure regulating column; and an electrically heated furnace 24 inches long, with four combustion tubes 1 inch in diameter by 30 inches long. Heating intensity for each half of each tube is independently controlled, and temperature of any tube can be readily observed by means of an indicating pyrometer. Conventional absorption trains, with calcium chloride for absorption of moisture and Ascarite for removal of carbon dioxide, are also used.

The assembly illustrated is merely representative of other multiple assemblies, which can be built up to suit the job involved.

METALLURGICAL CHECKING

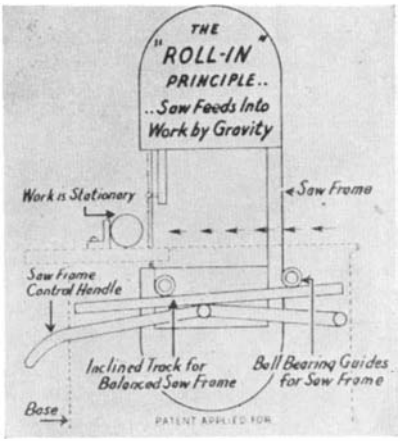
AN ENTIRELY new electronic means of checking and sorting metals for depth of case-hardening and other metallurgical factors, has already undergone extensive trials and has won the keen interest of metallurgists, ordnance experts, and industrialists. It is based on the use of the Du Mont Cyclograph,

a cathode-ray instrument which provides a visual means of checking and comparing known and unknown metallurgical items.

The Cyclograph, by the use of several frequencies, either one after the other or simultaneously, checks or compares known and unknown metal pieces according to such factors as case depth, depth of decarburization, amount of cold-working, brittleness (stress gradients), hardness gradients, structure, and so on.

NOVEL BANDSAW

A "GRAVITY-FEED" metal cutting bandsaw, recently announced, is so designed that the saw blade feeds into the work through movement of a balanced blade wheel frame on an inclined track. Blade pressure is automatically regulated by texture and degree of hardness of metal being cut and requires no



Saw moves; work is stationary

attention from operator. This largely eliminates blade breakage due to incorrect pressure.

This new saw, made by the Universal Vise and Tool Company, is adaptable for cut off, trim, and contour work. It has a maximum cut of 7 inches vertically, and the blade travels 7 inches into the work.

WETTING MATERIAL

DEVELOPED to improve the action of water on the gummed surface of tape employed in sealing operations, a new wetting material called Aquaflux is added to the water in proportions governed by the water hardness.

TWIN THREAD SCREW

A NEW patented screw for wood, plastic, and combination assemblies, known as the Twin-Fast Screw, has two parallel threads which start at opposite sides of the shank and terminate in a single, centered point. The twin-thread construction affords a far greater thread pitch than does the conventional screw, so that the driving speed is doubled. Yet the driving torque is only nominal, since the twin-thread construction provides the standard number of threads per inch.

An added advantage for plastic assemblies is that Twin-Fast Screws,

Double thread, cylindrical contour

made by The Blake and Johnson Company, are self-tapping. They cut their own clean, full threads. The Twin-Fast Screw is cylindrical in contour (not tapered), giving the screw greater strength. Also, the thread area is increased, providing more extensive contact, tighter seating, and greater holding power than with tapered screws.

The relieved shank diameter of Twin-Fast Screws acts to eliminate stresses which may be set up by the shank and cause fractures or ruptures.

SPRING TESTER

A NEW tool for testing compression springs in sizes to 2½ inches diameter and 7 inches in length not only makes it possible to measure rapidly the recoil pressure of springs when compressed to any predetermined length, but makes it possible to accurately match sets of springs, as for use as valve springs in gasoline engines.

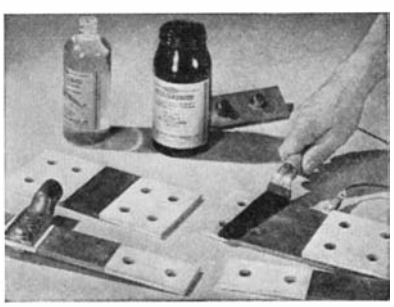
The Sturtevant Spring Tester is operated with any accurate standard torque wrench, the torque wrench not only serving as the operating lever, but also providing the measuring element. The compression of spring is against a rigid platform to prevent accumulated errors in reading.

Developed originally as a means of accurately matching valve springs of airplane and automotive engines, the first of these tools in the field are finding a much wider range of application. They are being used not only for testing springs of all sorts within their capacity, but also for proof-testing strength of press fits and for light arbor press production operations where they permit the rapid application of accurately gaged pressures.

RAPID METAL COATING

DEVELOPED to expedite application of the heavier silver coatings now specified on many government projects, for bus bars, lugs, and other parts of electrical equipment, a new rapid metal-coating process is also useful for plating, replating, or touching up rust and corrosion-resistant coatings of other metals, on production lines or in the field. The system is available for use of silver, cadmium, tin, copper, zinc, nickel, and gold.

Quick and positive in operation, the

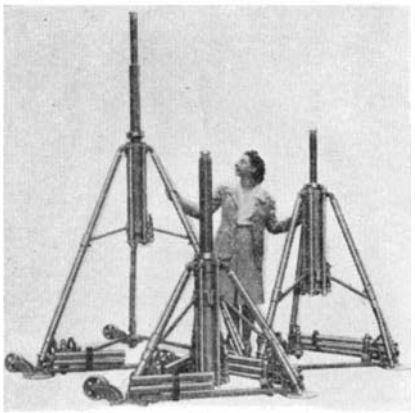


Simple equipment for rapid plating

equipment requires only three basic items: (1) rapid electrolyte; (2) rapid metal cleaner; (3) rapid applicator. Plating current for small jobs can be obtained from dry batteries, storage battery, or any convenient source supplying direct current at three to six volts. A special rectifier is recommended for large quantities of work. Standard applicators are available in three sizes; special applicators can be made to order to facilitate work in very close quarters, or for unusual requirements on production lines.

MANY-HEIGHT JACK

How ONE jack can be adjusted to a variety of heights to eliminate the need for a variety of jacks is shown in the accompanying illustration of a fast action Malabar variable height wing or nose jack. With only a wrench, the leg sections (attached to base) can be interchanged to add 18 or 36 inches to the minimum closed height. The basic minimum is offered in 36, 48, and 60 inch models, with hydraulic lifts of



Jack of many heights

from 24 to 34 and 44 inches. The 16-inch screw increases the versatility so that total extended vertical heights are 76, 98, and 120 inches respectively with minimum legs. These jacks are built with capacities of 5, 7½, 12, 17, and 25 tons.

SEALING TAPES

LITERALLY thousands of miles of specially designed sealing tapes have already been furnished to the aircraft industry by the Paint Division of the Pittsburgh Plate Glass Company. Fabseal, Chromseal, and Stratoseal are made in rolls 50 feet long and in widths varying from one-half inch to 24 inches. The application of sealing tapes is a great deal faster than the application of caulking compounds with a putty gun or by hand. Thus many man hours are saved in the over-all construction of aircraft.

Fabseal is particularly designed for use as a gasket in the construction of flying boat hulls, and of gas and oil tanks where internal or external pressures are encountered under constant vibration or sudden impact. It is an impregnated fabric with an interleaf separating the fabric layers. Before the fabric is impregnated with compound, it is treated to make it water-, gasoline-, and oil-resistant to prevent wicking action. The tape may be applied to any metal or wood section of a fuel tank, pontoon, and so on, and after application the interleaf is removed, exposing the upper surface of the tape, which is then ready to receive another riveted or bolted section. Fabseal is .010 inches thick when compressed between surfaces under rivet or bolt pressure.

Chromseal is a solid ribbon of compound with no fabric as part of its composition, and therefore is more flexible than Fabseal. It is especially suited as a gasket material between riveted or bolted surfaces of integral fuel tanks, droppable reserve tanks, as well as a seal for plastic enclosures and glass cockpit framing. Chromseal can be molded by hand to conform to almost any angle, curve, or contour. It is also highly resistant to gasoline, oil, and water.

Stratoseal, as its name suggests, is designed for the sealing of the cabins of stratosphere-flying planes. In the construction of these cabins and fuselages every seam, joint, and door must be sealed against leaks, and the sealing material used must remain flexible in temperatures ranging from 70 degrees below zero to 150 degrees above zero. Stratoseal, also a solid ribbon of compound, meets these extreme conditions and remains flexible. It can be applied between overlapping metal joints or over the inside surface of the joints by the use of Stratoseal adhesive.

DUST CONTROL

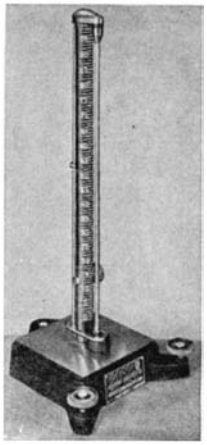
A NEW compound developed for laying airport dust is described as a stable homogeneous liquid of relatively low viscosity which may be diluted or extended with water in all proportions. The concentrate and its emulsions are said to be effective in wetting and penetrating all types of soil including moist earth.

According to the Research Director of the Curran Corporation, the new compound may be actually applied to a soft muddy surface immediately following a rain. Because of a new type

of emulsifier used, the new oil will wet only the top two inches of the soil since it becomes water insoluble on farther penetration. Because of this property, the composition is not dissolved and leached away into the soil by a following heavy rain. The compound is also stated to be safe and easy to handle; is non-corrosive to metal and spray equipment, and contains an effective weed killer. The cost to use is said to be less than that of distillates or sludge oils.

RESILIENCY MEASUREMENT

NOT ONLY rubber technologists and research scientists but manufacturers and consumers of rubber products or other extensible materials often want to know just how much resiliency or "springiness" is possessed by the material in question. Resiliency may be roughly defined as the property which accounts for the "bounce" or rebound of a rubber ball, for example. It is of more than passing interest because it may be an index to other important properties. To measure resiliency is the function of an instrument known as the Resiliometer, manufactured by the Precision Scientific Company.



Dropping a weighted plunger and noting the rebound gives a measurement of the resiliency of rubber and other extensible compounds

Resiliency of rubber and extensible plastic compounds is indicated by the rebound of a weighted plunger dropped on the test specimen from a predetermined height. Resiliency tests are conducted in the development of rubber and extensible plastic compounds, for measuring rate and state of cure; matching competitive compounds; factory control tests on cured samples of mixed batches; quality tests of the finished product without destroying the product; comparing heat build-up of various compounds; measuring plasticity of uncured compounds and masticated rubber.

INSULATED-REFLECTIVE OVENS

CONFIGURATIONS of a wide variety, for application to specific drying problems, may be had with a new flexible type of infra-red oven. The parts of the oven are made up in stock blanks which can be grouped or re-grouped on the job to obtain the drying areas necessary for any specific work.

These ovens, made by Infra-Red Engineers and Designers, use standard incandescent infra-red lamps and also incorporate reflective panels which carom the heat rays to concentrate them upon certain parts.

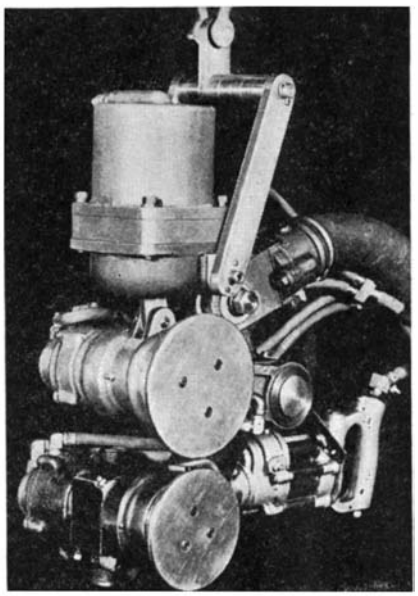
SEAM-WELDING GUN

A NEW development in seam-welding in the form of an air-operated portable gun with which parts that are too big to "take to the machine"—and also large assemblies which are mounted in stationary fixtures—can be seam-welded, announced by Progressive Welder Company, is already in use welding 22-foot seams on disposable light-weight fuel tanks.

The machine has been designed for welding steel up to two thicknesses of 20-gage metal, including stainless steels. The gun is universally suspended and can be swiveled about so that the operator can weld in almost any direction —horizontally or vertically.

Features of this new seam-welding gun include a head operated by an air motor using 42 cubic feet of air per minute under load. When the seam-welding gun is in operation, the air passing into the handle runs the motor. Pushing the control button—which is located on the guide handle at the right of the gun—operates a solenoid switch, letting the air into the cylinder on the gun. This air cylinder has a diameter of 4½ inches, which is large enough to provide a maximum pressure of 1400 pounds per square inch with 90 pounds of line pressure, permitting the seam-welding of stainless steel.

The air flowing into the cylinder forces the upper and lower wheels together. The upper wheel is the idling wheel; the lower is the driven. When the air pressure reaches a pre-set value, the pressure switch starts the welding timer and the gun begins to seam-weld. The air motor runs continuously when the air is "on." Removing the pressure from the button control causes the solenoid valve to release the air in the cylinder. At the same time, the pressure switch cuts off both the timer and the welding current.



Air-operated head of welding gun

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with the names of available books, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for. Books listed in these columns may be ordered from our Book Department. Add 25 cents per book for mailing outside U. S.

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

FORWARD WITH SCIENCE

By Rogers D. Rusk

PHILOSOPHICAL discussions of developments centering around physics: Newly discovered particles; electron microscope; keeping up with X-rays; man-made radioactivity; atom smashing; atomic energy; cosmic rays; man outgrows mechanism; is Einstein outmoded?; astrophysics; does nature make sense?; science and war; remaking the world; human freedom and destiny. This book, by the professor of physics at Mount Holyoke College, sufficiently explains the above things but mainly it discusses their significance in our modern and future world. Thus it is more thought-provoking than mere fact-stating. (307 pages, 5½ by 8½ inches, 28 illustrations.)—$3.60 postpaid.—*A.G.I.*

TECHNICAL HANDBOOK

For Solving Problems in Shop or Factory

By Edward H. Lang

MATHEMATICS and science as applied to the industrial job—covering arithmetic, solving triangles, logarithms, simple machines, properties of materials, chemical computation, and so on—are presented in simple and concise form for easy study and rapid reference. (100 pages, 5½ by 8 inches, a large number of drawings, paper covers, and pages punched for standard three-ring binders.)—$1.10 postpaid.—*A.P.P.*

HOW THE ARMY FIGHTS

By Capt. Lowell M. Limpus

BE A SWIVEL-CHAIR strategist, or a better one. Typical chapters: Old Strategy—New Tactics; Control of the Modern Army; How Modern Armies Attack; Enshrouding the Machine in Secrecy; The New Logistics (to say plain "supply" for logistics today brands you as a back number—and don't say "orders" for directives, else the Armchair Experts' Union will pitch you out); How Modern Armies Attack; The Changing Tempo of Modern War. Main emphasis in this book is on the new in warfare. Author is a West Point man and this is an easy version, in chatty style, of what's taught to modern military officers, enabling the reader to estimate correctly what's behind the unconscious distortions of the daily newspaper and the-people-who-don't-understand. (388 pages, 5½ by 8⅜ inches, 31 illustrations.)—$3.10 postpaid.—*J.P.C.*

FUNDAMENTALS OF SHOPWORK

By William H. Johnson and Louis V. Newkirk

COMPREHENSIVE indeed is the simplified text of this book covering such phases of shopwork as hand and machine tools, measuring and gaging, woodworking and metalworking, wiring and wire splicing, ropes and knots. Although designed as an introductory course for Army technicians, this book will be welcomed by every "home mechanic." (200 pages, 8½ by 11½ inches, lavishly illustrated.)—$2.10 postpaid.—*A.P.P.*

THE MICROSCOPE AND ITS USE

By Munoz and Charipper

TECHNICAL book in non-technical language. Chapters on: Evolution of the microscope; modern microscope; illumination; microtomes; use and care of microscope; stereoscopic microscope; metallurgical microscope; polarizing microscope; accessories; common errors in use; glossary; bibliography. This book would not satisfy (1) experts (2) kids (3) dabblers. It should satisfy adult beginners, at least for a year or so, when they will begin crying for more detail, for it omits theory and presents practice alone. (334 pages, 5½ by 8½ inches, 122 illustrations.)—$2.60 postpaid.—*A.G.I.*

RADIO — II.

By R. E. Williams and Charles A. Scarlott

PICKING up where Volume I (recently reviewed in these columns) left off, the present text deals with vacuum tubes and their applications, microphones and loud speakers, transmitting equipment, antennas, cathode-ray oscilloscopes, and so on, all presented in a simplified and understandable form, designed to complement the pre-induction training course in fundamentals of

The Editors Recommend

Best Sellers in Science

PLASTICS — *By J. H. Bubois.* Revised and enlarged edition of an important work on the whole general subject of plastics, plus much new material on synthetic rubber, manufacturing processes, and plastic molding. **$3.85**

EXPERIMENTAL ELECTRONICS — *By Ralph H. Muller, R. L. Garman, and M. E. Droz.* A solid book of eminently practical information on the characteristics and non-communication applications of electron tubes. The text describes experiments and presents results. For students, radio engineers, communications experts, and the serious general reader. **$4.75**

ATOMS, STARS, AND NEBULAE — *By Goldberg and Aller.* One of the "Harvard Books on Astronomy." An elementary treatise on astrophysics, neither light nor too formidable for readers familiar with elementary astronomy. **$2.60**

GET TOUGH! — *By Capt. W. E. Fairbairn.* How-to-win-in-hand-to-hand-fighting directions, by a man who really knows rough-and-tumble methods that are *not* "clean" fighting but *are* designed to win. **$1.10**

COLLEGE PHYSICS — *By Henry A. Perkins, Sc.D.* Revised second edition (unabridged) of a textbook which places emphasis on the difficult portions, on the old physics instead of modern corpuscular physics, and on principles rather than concrete phenomena. **$6.10**

LEARNING TO NAVIGATE — *By Weemes and Eberle.* For those totally inexperienced or only casually familiar with the fundamentals of navigation, this text will provide a practical handbook leading to an understanding of navigation at sea or in the air. A number of illustrations and tabulations. **$2.10**

FUNDAMENTALS OF RADIO — *By Jordan, Osterbrock, Pumphery, and Smeby.* With this one volume alone, and with some diligence of application, it is possible to obtain a thorough grounding in radio principles. In thoroughness of treatment, with due respect for the needs of the reader. this book is outstanding. **$5.10**

FUNDAMENTALS OF ELECTRICITY — *By a Staff of Electrical Experts.* Although designed to supply men about to enter military service with a foundation for further training, this text will serve a similar purpose for anyone desirous of acquiring such knowledge. **$2.10**

ELEMENTS OF ORDNANCE — A textbook prepared for cadets of the United States Military Academy. Covers manufacture, the chemistry of explosives, types of weapons, mathematics of ballistics, etc. **$6.60**

AIRCRAFT INSTRUMENTS — *By George Ellis Irvin.* All types of instruments for aircraft use described for students, pilots, inspectors. Fundamentals, instructions. **$5.10**

MARINE DIESEL HANDBOOK — *By Louis R. Ford, M.A.* A compendium of data on design, construction, and operation of the marine Diesel engine with chapters covering applications, principles, types, fuel injection systems, lubrication, supercharging, and so on. **$7.25**

MACHINERY'S HANDBOOK—*Eleventh Edition.* "Bible of the mechanical industry," enlarged to 1815 pages of latest standards, data, and information required daily in the shop and drafting room. **$6.10**

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. **$6.80**

STEEL SQUARE POCKET BOOK — *by Dwight L. Stoddard.* Practical methods for using the carpenter's steel square for layout work of all kinds. Time-tried methods used by two generations of carpenters and found both rapid and accurate. **$1.00**

REFINING PRECIOUS METAL WASTES — *By C. M. Hoke.* A practical book, based on experience, dealing with processing, identification, and repurification of such metals as gold, platinum, silver, alloys, iridium, and rhodium. **$5.10**

WORKING WITH THE MICROSCOPE — *By Julian D. Corrington.* For the serious beginner. Explicit, practical. **$3.60**

TOOL MAKING — *By C. B. Cole.* Instructions for making and using all kinds, from personal tools to arbor presses, lathes, planers, etc., in different metals. **$3.60**

THE ELECTRON MICROSCOPE — *By Burton and Kohl.* A well-written account of this newest tool of science, with all technicalities explained for complete understanding by average persons. **$3.95**

ENCYCLOPEDIA OF KNOTS AND FANCY ROPE WORK — *By Cranmont and Hensel.* More knots are described in this remarkable book than in any book on seamanship ever published or dreamed of. 3257 knots are illustrated in half-tone reproduction and are described in the text. **$5.10**

A MATHEMATICS REFRESHER — *By A. Hooper.* Prepared mainly to refresh aviation trainees whose high school mathematics is rusty. Scope — arithmetic through calculus. **$2.60**

PLASTICS, PROBLEMS AND PROCESSES — *By Mansperger and Pepper.* The whole story of plastics, including a resume of manufacturing processes and a number of thorough-going chapters devoted to plastic uses. **$3.10**

AUTOMATIC ARMS — *By Melvin M. Johnson and Charles T. Haven.* Comprehensively covers machine guns, machine rifles, sub-machine guns, pocket pistols, shotguns, sporting, military rifles in automatic classification. ***$5.10***

MIRACLES OF MILITARY MEDICINE — *By Albert Q. Maisel.* The drugs, devices, and techniques used in the services. ***$2.85***

HANDBOOK OF CHEMISTRY AND PHYSICS — A classic reference book recently revised and brought up-to-date to keep pace with recent research. Includes material on all branches of chemistry, physics and allied sciences. Used in laboratories and by engineers throughout the country. Flexible binding. 2503 pages. **$4.10 Foreign $4.50, postpaid**

ATOMIC ARTILLERY — *By John Kellock Robertson.* Electrons, protons, positrons, photons, neutrons, and cosmic rays, all described for the layman in plain language. Also transmutation of the elements and the manufacture of artificial radio activity. **$2.35**

● **The above prices are postpaid in the United States, Add, on foreign orders, 25¢ for postage on each book, except as noted.** ●

For Sale by: December, 1943

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

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

.....

.....

Name .....

Address .....

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

---

radio as prepared by the War Department. (170 pages, 6½ by 9½ inches, a number of drawings, photographs, and tabulations.) — $1.35 postpaid. — *A.P.P.*

BASIC PHYSICS FOR PILOTS AND FLIGHT CREWS

By E. J. Knapp

DESIGNED to give a thorough yet rapid grasp of the fundamental physics necessary for preliminary aviation training, the text of this book follows an outline set up by the Civil Aeronautics Administration. Interestingly written and sufficiently simplified for use as a self-study course. (118 pages, 5 by 8 inches, thoroughly illustrated.) —$1.75 postpaid.—*J.P.C.*

GLOSSARY OF SHIPBUILDING AND OUTFITTING TERMS

By W. J. Eddington

FROM A to Z, an extensive dictionary of living maritime definitions written by an actual, not an armchair, seaman from the modern merchant marine and with emphasis on the practical and not the romantic. Appendix gives list of deck department, engine room, and machine tools. (435 pages, 5 by 7¼ inches, illustrated.)—$3.60 postpaid.—*A.G.I.*

ELECTRONIC CONTROL OF RESISTANCE WELDING

By George M. Chute

ELECTRON tubes and their circuits for the control of resistance welders are presented here in practical and relatively simple form. The text is designed to aid those men who work with and maintain these controls in industry. (389 pages, 6½ by 9½ inches, a number of drawings and a few photographs.)—$4.10 postpaid—*A.P.P.*

FUNDAMENTALS OF ENGINEERING DRAWING

By Warren J. Luzadder

AIMED at the mental level of technical students and professional draftsmen, the text of this book covers the general subject of its title from the selection of drawing materials and equipment through engineering geometry, technical lettering, the theory of projection, symbols, design problems, and technique to an appendix which gives a number of tables of valuable engineering data. (568 pages, 6½ by 9½ inches.)—$4.10 postpaid.—*J.P.C.*

MAN'S UNKNOWN ANCESTORS

By Raymond W. Murray

NONE of the numerous books on ancient man that this reviewer has read in the past 22 years gave so generous and inclusive a round-up of the notable discoveries, and of some of the less well-known finds, as this—not even for one hemisphere; while this very well-rounded work covers both Old World and New World discoveries equally well and for the whole time

scope, early to late. It details each discovery, discusses it, cites salient opinions, arguments, and disputes about it, giving the most recent consensus, thus bringing the whole subject up to date. It is not a light work, nor on the other hand is it a pedantic or professional book, but lies between these levels. About this new book it is possible to enthuse a great deal. (384 pages, 6 by 9 inches, 37 illustrations.)—$3.60 postpaid.—*A.G.I.*

SLIDE RULE SIMPLIFIED

By C. O. Harris

How to use a slide rule in all of the many applications to which this tool of the engineer can be put. The author has gone to great length to simplify slide-rule applications, instead of shrouding it in the mystery that so often surrounds it, using a large number of illustrations to make the whole matter perfectly clear. (250 pages, including practice problems and answers; 6 by 8½ inches; heavily illustrated.)—$3.60 postpaid including genuine Dietzgen slide rule; $2.60 postpaid for book alone.—*A.P.P.*

PRIMER OF CELESTIAL NAVIGATION

By John Favill

Elementary textbook for seamen-to-be or aviators-to-be; being the second edition of a successful treatise. Without frills, it is a solid book of good hard work, with many practical problems, and a lucid exposition of that work. (263 pages, 5 by 7 inches, 43 illustrations.)—$2.10 postpaid.—*A.G.I.*

AIRCRAFT MATHEMATICS

By S. A. Walling and J. C. Hill

Not a textbook of mathematics but rather a selected presentation of those phases of the science which are essential to air cadets and others interested in the technical aspects of areonautics. Although British in origin, the "translation" of specialized terms into American phraseology should not be a deterrent to the use of this compact volume. (189 pages, 5½ by 7½ inches, a number of drawings.)—$1.85 postpaid.—*A.P.P.*

DRYING AND DEHYDRATION OF FOODS

By Harry W. Von Loesecke

Technological treatise for the industry rather than for home users. Compilation of the latest practical information dealing with this subject. Author is senior chemist, Bureau of Agriculture, Chemistry and Engineering, United States Department of Agriculture. (302 pages, 6 by 9 inches, 64 illustrations.)—$4.35 postpaid.—*J.P.C.*

SELL YOUR PHOTOGRAPHS

By Eugene Wyble

This manual for free-lance photographers was written for those with an interest greater than that of a casual snapshooter. All rose-colored statements that breed wishful thinking have been left out. Chapters are devoted to equipment needed, how to prepare and use ideas, how to create a story-telling picture, how to finish prints, and where and what the markets will be. This is a book to guide those seriously interested. (167 pages, 5½ by 8 inches, unillustrated.)—$2.10 postpaid.—*K.M.C.*

SHIPBOARD MEDICAL PRACTICE

By W. L. Wheeler Jr., M.D.

Handbook of ship sanitation and emergency medical aid at sea. As it is written expressly for common seamen and not for doctors, it is free from medical jargon. It covers such subjects as survival on uninhabited islands, care of disaster victims, radio messages requesting medical advice, and ship sanitation. Everything needed is put together in this one thin little pocket-size book. (114 pages, 5 by 7½ inches, 16 illustrations.)—$1.10 postpaid.—*J.P.C.*

SCIENCE, RELIGION, AND THE FUTURE

By Charles R. Raven, D.C.

Eight lectures on: The new philosophy of seeing life whole; childhood of science; conflict of science with religion; ravages of war; new reformation; the intellectual, moral, and religious tasks. Antagonism of science and religion and what to do about it is the central subject. (125 pages, 5 by 7½ inches, unillustrated.)—$2.10 postpaid.—*A.G.I.*

ENCYCLOPEDIA OF SUBSTITUTES AND SYNTHETICS

By Morris D. Schoengold

Encyclopedic in scope, indeed, is this reference book which covers largely those products which have been developed recently to replace critical materials. The text discusses substitutes in all branches of industry and pharmaceutics, including comprehensive explanations of plastics and other synthetics. Particularly aimed at industrial and laboratory chemists but of outstanding usefulness to anyone whose work deals with industrial materials. (382 pages, 6 by 9½ inches, unillustrated.)—$10.10 postpaid.—*A.P.P.*

UNDER A LUCKY STAR

By Roy Chapman Andrews

Lifetime of scientific adventure retold by the famous leader of the Mongolian expeditions (dinosaur's eggs) of the American Museum of Natural History. Few know the rest of this man's life, which has been saturated with travel and adventure as most of us only wish we could live. (300 pages, 5½ by 8¼ inches, unillustrated.)—$3.10 postpaid.—*A.G.I.*

PRE-SERVICE COURSE IN MACHINE SCIENCE

By Samuel H. Lebowitz

Divided into 14 chapters, the text conforms in content to the corresponding sections in the Course on Fundamentals of Machines as established for pre-induction training. Physical and chemical principles are dealt with

simply yet forcefully and are specifically related to practical applications in machine science. Altogether, this text is one which will provide a firm and solid foundation for further study. (440 pages, 6 by 9 inches, 200 illustrations, well indexed.)—$2.60 postpaid.—*A.P.P.*

SCHOOL OF THE CITIZEN SAILOR

By Bolander, Fletcher, Gabriel, and Second Army Board

ABOUT the complex organization of the Navy, presented by the associate librarian at the U. S. Naval Academy; but chiefly on the economic, political, and historical background of World War II. The 190-page section on American History and the Constitution, by Professor Gabriel, is an outstandingly objective presentation of those parts of our nation's development best chosen to give the adult reader (for this is no schoolbook) a clear, full, deep comprehension of what and how much he is fighting for. Suitable for men of the more serious, thoughtful type who are about to enter the Navy or are already in it. (615 pages, 5½ by 8½ inches, one map.)—$3.10 postpaid.—*A.G.I.*

SIMPLIFIED PHYSICS

By Small and Clarke

PHYSICS isn't simple and can't be made so, but this is a good effort in that direction. It will be a help to those who struggle alone with the more formal treatment of the conventional textbook. It covers the older physics—not, however, trying to scale the heights of atomic physics. There are short, modern chapters on the dial telephone, airplane, radio altimeter, radio compass, television, electron microscope, sound ranging, and color photography. (427 pages, 5 by 7¼ inches, 163 illustrations.) —$3.10 postpaid.—*J.P.C.*

NORTON'S STAR ATLAS AND TELESCOPE HANDBOOK

By Norton and Inglis

NEW edition (ninth) of a standard star atlas whose eighth edition was reviewed here November, 1942. Chief changes: Main charts redrawn for epoch of 1950; some stars added, others omitted; N.G.C. numbers now on most nebulae; 6th or 7th mag. variables encircled; new I.A.U. galactic poles adopted. This atlas is still the main standby for amateurs past the cradle roll. (90 pages, 8½ by 11 inches, 20 maps.)—$5.00 postpaid.—*A.G.I.*

SCIENCE FROM SHIPBOARD

By A Group of Scientific Writers

SERVICE men going overseas crave answers to 1000 questions about things en route. This pocket sized book by well-known scientists, with chapters on: Waves, wind, and weather; sun, moon, and planets; time, calendar, and sundial; stars; navigation; ocean geology; sea life; oceanic birds; ships; and seasickness, gives these answers. (268 pages, 4½ by 7 inches, 138 illustrations, cloth bound.)—$1.60 postpaid.—*A.G.I.*

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"

HOW MANY finished mechanics are there in this nation of Yankees, besides those who make their living at it? Maybe the makers of lathes and machine tools know. Who trains them? Many train themselves, or are apparently born trained.

Figure 1 shows one of this legion, Henry Paul, 119 North Broad St., Norwich, N. Y., with a home-made tripod and mainly machined mounting carrying a purchased telescope and camera. Figure 2 shows interesting details of the mounting. Paul is a chemical engineer, with a doctorate in nutrition from Cornell, and is director of a vitamin laboratory for a pharmical house. Shop work represents his relaxation, or escape. His cellar shop is well equipped, though not over-equipped, with machine tools. There are thousands more of the same type of amateur mechanic in Yankeedom—more or less born tool-minded.

The telescope is an old 3½" refractor by the forever famous Alvan Clarke. Paul states: "I have never seen a better objective. It is perfect. It gives perfect diffraction pattern and spurious disks." Paul has also made objective lenses.

The stubby camera is a Zeiss and has a 2½" aperture Sonnar lens of 7" f.l. It covers a 14° field and cost $450, which is a lot of simoleons for an amateur astronomer.

The tripod weighs 35 pounds and is solid brass. It just fits a car crosswise, and, at home, a 4" pipe in a ton of concrete on bed rock.

Commenting on the mounting Paul writes: "It has a ball-bearing polar axis and main worm with friction slip-ring to hour circle. The second worm is jeweled. Reduction is 235:1, plus 22:1, to a regular 2-watt, 3.6 rpm Telechron house clock motor as sold by the thousands. This gives one revolution in 1436.11 minutes, which is plenty close to the sidereal day. If others wish to use this small motor, they should use a ball-bearing polar axis, install a 15,000-ohm, 1-watt radio resistor in its housing to keep the motor warm, and mount it not closer than 1" from any large iron or steel object, as this upsets the synchronization.

"The trailer hitch, ball-and-socket mounting for the camera is handy. I have found Eastman Spectrographic Plates No. 103aE, extremely fast, particularly for dim objects of broad expanse, and very red-sensitive," Paul

Figure 1: Paul and two fortunes

continues. "Used with a gelatin No. 12 (minus blue) filter, moonlight fog and sky fog can almost be eliminated with only a 50 percent increase in exposure. For direct exposure on the Moon at focus I use 35mm Eastman miniature microfilm (good for 20X enlargement) and develop twice normal in D-76. This gives correct contrast. Exposure varies from 1/10 to 1/50 second at f/8, depending on phase of Moon. Eastman microfilm has a resolving power of 135 lines per mm, against about 50 for most films, and the high contrast is perfect for lunar work. In a pinch, regular high-speed press plates could be substituted for the spectographic plates."

Paul sends no data on Figure 2. The photographs practically explain themselves and the detail is well worth close study.

Paul submitted some beautiful stellar photographs enlarged to 6" diameter from the 1" diameter originals, but no attempt is made to reproduce them here, for the same reason that has excluded many others kindly sent to this department: The half-tone process degrades them all to the same low level—the good ones, the indifferent ones, and the bad ones alike. The chances are, however, that a capable wangler could wangle photoprints from Paul, if he could exchange some similar work of his own for them.

This worker was a member of Scientific American's famous Amateur Roof Prism Gang. Too busy with his regular vocation to go into actual production, he nevertheless proved up his ability to make a high-grade roof prism, and then made a limited number in order to be sure he could do it every time. These tested up very well by others. To ex roof-prism makers the easier mirror work is going to seem like duck soup after the war. They'll be a kind of royalty of the hobby fraternity.

ECCLESIASTICUS is one of the apocrypha and in the first verse of the thirteenth chapter it says: "He that toucheth pitch shall be defiled." (See "A.T.M.," page 359). Quite obviously, the author or authors of Ecclesiasticus must have been trying to make a telescope.

Here is a contribution by Dr. D. Everett Taylor, 191 Prospect St., Willimantic, Conn., who has touched pitch and been duly defiled, as have we all in our time.

"Channeling a pitch lap is one of the headaches of telescoptics. Cutting shallow channels in a revolving lap, using the point of a pen-knife, is simple. Reasonably simple also is molding the channels in a large lap with the aid of a rubber mat. On the other hand, rolling or melting in the channels on a pitch lap already formed to curve distorts the pitch surface. Cutting pitch with a knife or razor blade is tedious.

"The drill press furnishes a quick and highly satisfactory means of producing almost any desired type and size of channel. Point an old or broken twist drill with two pairs of surfaces at about 45° from the drill's axis, or point a large spike or rod with a similar, square, regular pyramid (spikes come

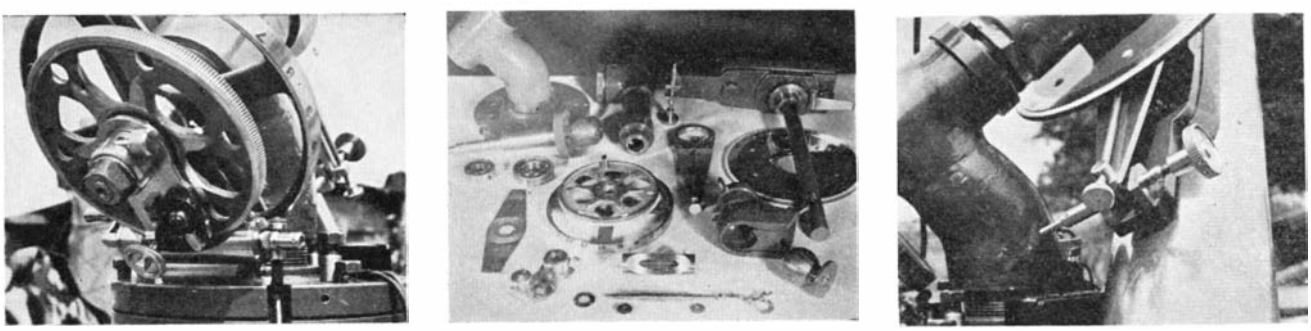


Figure 2: Details of mounting. For rough, temporary end-nut in first photograph substitute streamlined version in second

already pointed that general shape but the angles are too steep). Run the tool thus made at 600 to 900 rpm.

"Draw the lap, freehand, across the rotating tool thus made, until the desired width and depth are attained. An alternative, not quite so good, is a succession of slightly overlapping holes made with the same tool.

"The quarter-inch tool will thus produce a wide variety of channels, both in depth and width. For wider ones, increase its diameter."

LUNARIANS will find much of permanent value in a 76-page booklet reprint of articles by Walter H. Haas, entitled "Does Anything Ever Happen on the Moon," originally published serially in *The Journal of the Royal Astronomical Society of Canada.* It contains a list of lunar observers, data on observational procedure, drawings, discussion of each, on lunar colors, on lunar changes (the essential subject of the writings), and on the lunar atmosphere, also an extensive bibliography. David P. Barcroft, First National Bank Building, Madera, Calif., a member of the widespread observing group whose work is discussed, has a number of copies but only a limited number, which he therefore will be forced to allot for sale only to those who can show genuine interest. Barcroft also is a member of the Telescope Makers of Central California, of which Harry R. Lytle, of Madera, is now secretary.

TEMPLATES for gaging the depth of concavity of a telescope mirror are described in "Amateur Telescope Making" by Porter on page 3, and by others on pages 310 and 344. While it is thought that a majority use the Ellison method of reflection from a wetted mirror, as described on page 78 of that book, some prefer the template, which is easier and simpler once it is made.

Figure 3 shows how Warner Williams, connected with the Culver Military Academy at Culver, Indiana, made his template. Abrasive paper was glued to the face of a motor-driven wooden disk, and the metal template strip was attached to the radius bar, pivoted at the left, far out of the picture. This bar then was worked back and forth as the motor ran.

There came, one day, to your scribe's office a large express package containing, when opened, the striking bas-relief, or plaque, made by Williams and shown in Figure. 4. This measures ¾" x 12½" x 16" and is made of cast plaster painted a delicate shade of green. William's letterhead indicates that he is a Chicago sculptor and designer. He made the bas-relief from the picture of Foucault on page 511 of "A.T.M.A."

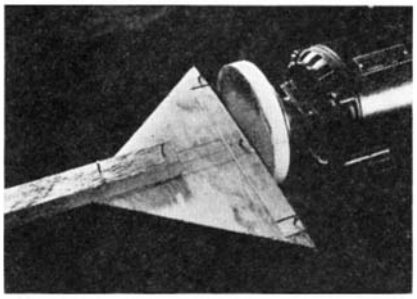


Figure 3: Williams' template job

Figure 4: Foucault by Williams

This copy, cast from a negative which he has, now hangs on your scribe's office wall beside the famous framed original focogram of Mary Everest's mirror (reproduced in "Amateur Telescope Making—Advanced," page 24). Williams has also donated duplicate copies of the plaque to Russell W. Porter and to Stellafane. He states in his letter what probably few amateur telescope makers know, that Cassegrain was a sculptor.

BROKEN tool needn't mean a broken heart. Cyril G. Wates, Edmonton, Alberta, writes: "We are told in 'A.T.M.' what to do in case of a broken mirror, but not in the case of a broken tool. The latter is much more common because it is standard practice to immerse the tool in warm water to soften the pitch, and because tools are generally plate glass which has a high coefficient of expansion, and are therefore more likely to crack than Pyrex blanks.

"My friend, H. W. Parnall, of Foothills, Alberta, recently had the misfortune to fall down the cellar stairs while carrying a 10" plate-glass tool. (Parenthetically, Mr. Parnall has a pet dog which weighs more than he does. When Fido gets hungry, his master goes out and shoots a moose. After satisfying doggie's appetite, Parnall sends me what's left of the moose. In return, I give him bad advice on the subject of telescope making.)

"To return to our muttons, Parnall wrote and told me about his accident, adding that he had mended the broken tool and finished the mirror on it. In reply to a slightly sceptical question, he said laconically: 'I wound stovepipe wire around it.'

"Now it happened that I too had cracked a plate glass tool, via the hot-water route. Taking a leaf from Parnall's book, I made a band of steel out of an old clock spring, with a screw for tightening. Having carefully cleaned the broken surfaces of the glass, I coated them with china cement, brought them into contact, put the steel band in place, tightened it, and have been using the tool ever since."

INDEX TO VOLUME 169, JULY—DECEMBER, 1943

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

The Rubber Plant

with roots two miles deep!

THE MAKING OF synthetic rubber involves among other things the exact control of gas mixtures of great complexity. Formerly the analysis of some gases required several days of painstaking laboratory work, and in some cases a complete analysis was impossible.

Westinghouse scientists—working in close collaboration with engineers of leading oil and chemical companies—have perfected an electronic "chemist" which is an important addition to the present methods of analysis.

With the improved technique and apparatus now available, the time required for accurately making some of these analyses has been reduced *to an hour or less!*

An amazing electronic device . . . known as the* mass spectrometer *. . . not only improves the accuracy of the synthetic rubber process, but frees hundreds of skilled chemists from tedious but important production testing in these vital plants.

The mass spectrometer analyzes gases by sorting the molecules—according to their mass—in (roughly) the same way that a cream separator sorts out the cream from whole milk.

Let's say we want to analyze a simple gas mixture containing *one part* of oxygen and 10,000 parts of nitrogen. Here's how the mass spectrometer accomplishes this incredible feat:

First, the gas sample is bombarded with electrons. This *ionizes* the nitrogen and oxygen molecules, giving them electrical charges of their own.

These ions are then drawn by electrical force into a curved vacuum tube. Here, ions of different molecular weights whizz around *different curved paths*—depending upon their reaction to a powerful electromagnet surrounding the tube.

The heavier oxygen ions follow a straighter path than the lighter nitrogen ions and are directed through a tiny exit slit onto a plate where they give up their electrical charge. The amount of this charge, amplified and recorded by sensitive electrical instruments, is an extremely accurate measure of the *quantity of oxygen* in the gas mixture.

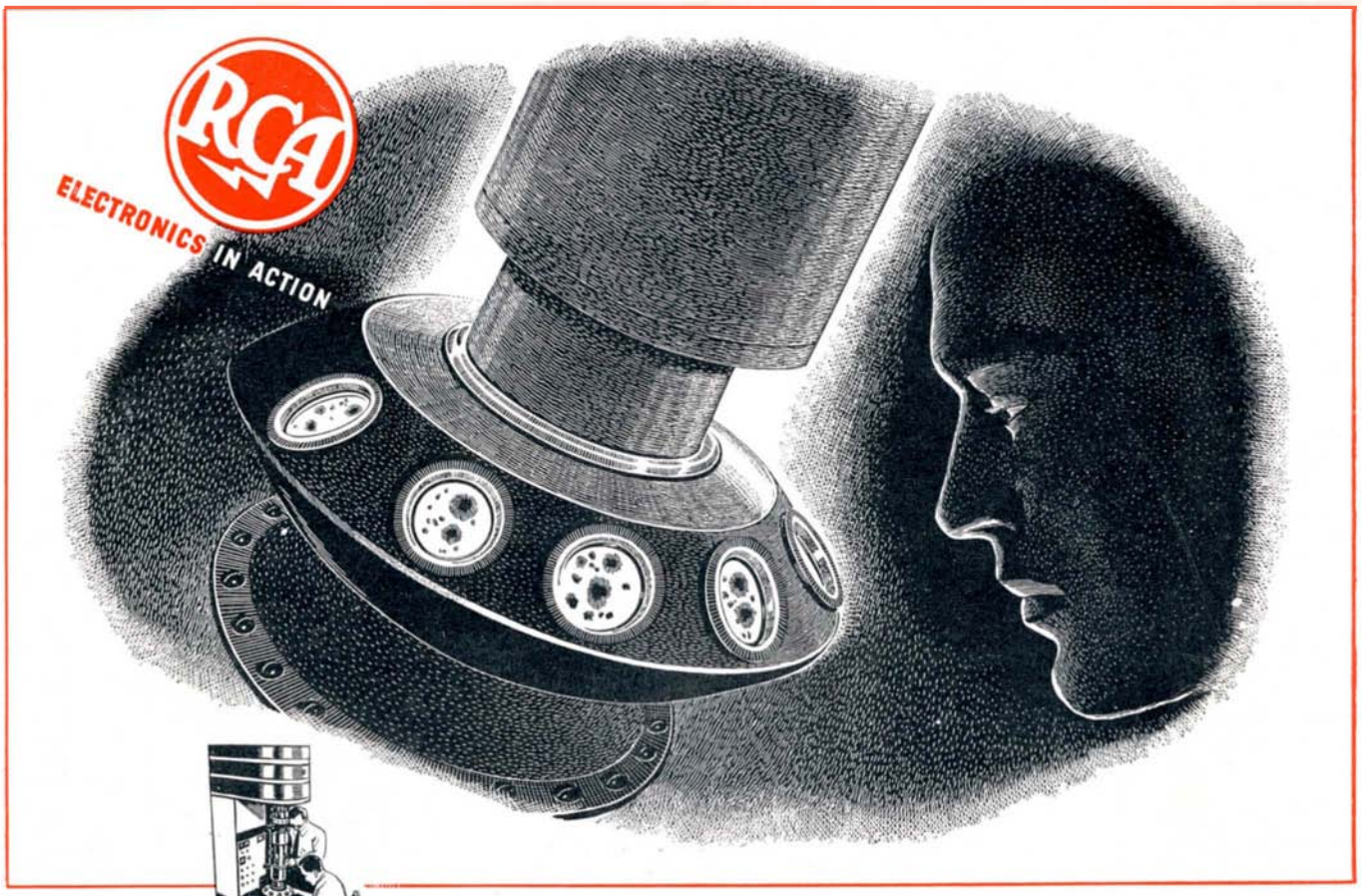
The starting voltage is then changed to allow the nitrogen ions to pass through the same exit slit—thus measuring the *quantity of nitrogen.* This same principle applies to the analysis of complex hydrocarbon mixtures.

The development of the mass spectrometer . . . for the quick, accurate analysis of butadiene . . . is a typical example of the way Westinghouse "know how" in electronics is tackling the wartime problems of industry in an effort to speed victory.

Westinghouse Electric & Manufacturing Company, Pittsburgh, Pennsylvania.

Westinghouse

PLANTS IN 25 CITIES OFFICES EVERYWHERE



Exploring a New Universe

THROUGH those small round windows—observation ports of an RCA Electron Microscope—this bacteriologist is studying influenza virus—magnified 25,000 times!

For years medical research men have had to fight the devastation of influenza "blindfolded" — for the simple reason that flu germs are invisible even under the most powerful light microscope. *But why invisible?* Why couldn't this virus be seen? The answer is—even the shortest waves of visible light are *far too long* to permit seeing anything so small. Nothing so infinitesimal ever was seen—or could be seen—prior to invention of the Electron Microscope.

But man *needs* to see these smaller things—among which are long-hidden causes of many diseases destructive to human beings, animals and plants. Man *needs* to be able to peer down, down, down into molecular structures—in order to learn what makes rubber behave like rubber, leather like leather, wool like wool, lubricating oil like lubricating oil, or metal like metal. For under the whiplash of war it is imperative to learn now, not tomorrow, *why* one kind of rubber, leather, fiber, oil or metal is more elastic, tougher, stronger, more useful than another.

Every branch of science and industry can benefit through proper use of this extraordinary microscope—which utilizes electrons instead of light for illumination. The RCA Electron Microscope is only one of many RCA applications of *electronics*—the art of harnessing electrons to the service of man. *Every* electronic device of *every* kind depends basically on electron tubes. And RCA is the fountain-head of modern electron tube development.

In addition to our armed forces, the list of industrial firms and scientific institutions now using RCA Electron Microscopes reads like a Blue Book of American Industry and Science. Inquiries regarding this instrument will be welcomed from research men connected with similar organizations, and will be promptly answered. Address Department 131-765, RCA Victor Division, Radio Corporation of America, Camden, N. J.

TUNE IN "WHAT'S NEW?"

RCA's great new show, Saturday nights, 7 to 8, E. W. T., Blue Network.

A new booklet—"RCA Electronics In Industry"—may suggest electronic applications important to your business. Free on request. Please use business letterhead when writing. Address—Dept. 68-2N, RCA Victor Division, Radio Corporation of America, Camden, New Jersey.

BUY WAR BONDS

ASK ABOUT... RCA INDUSTRIAL MUSICAL SERVICES

RADIO CORPORATION OF AMERICA